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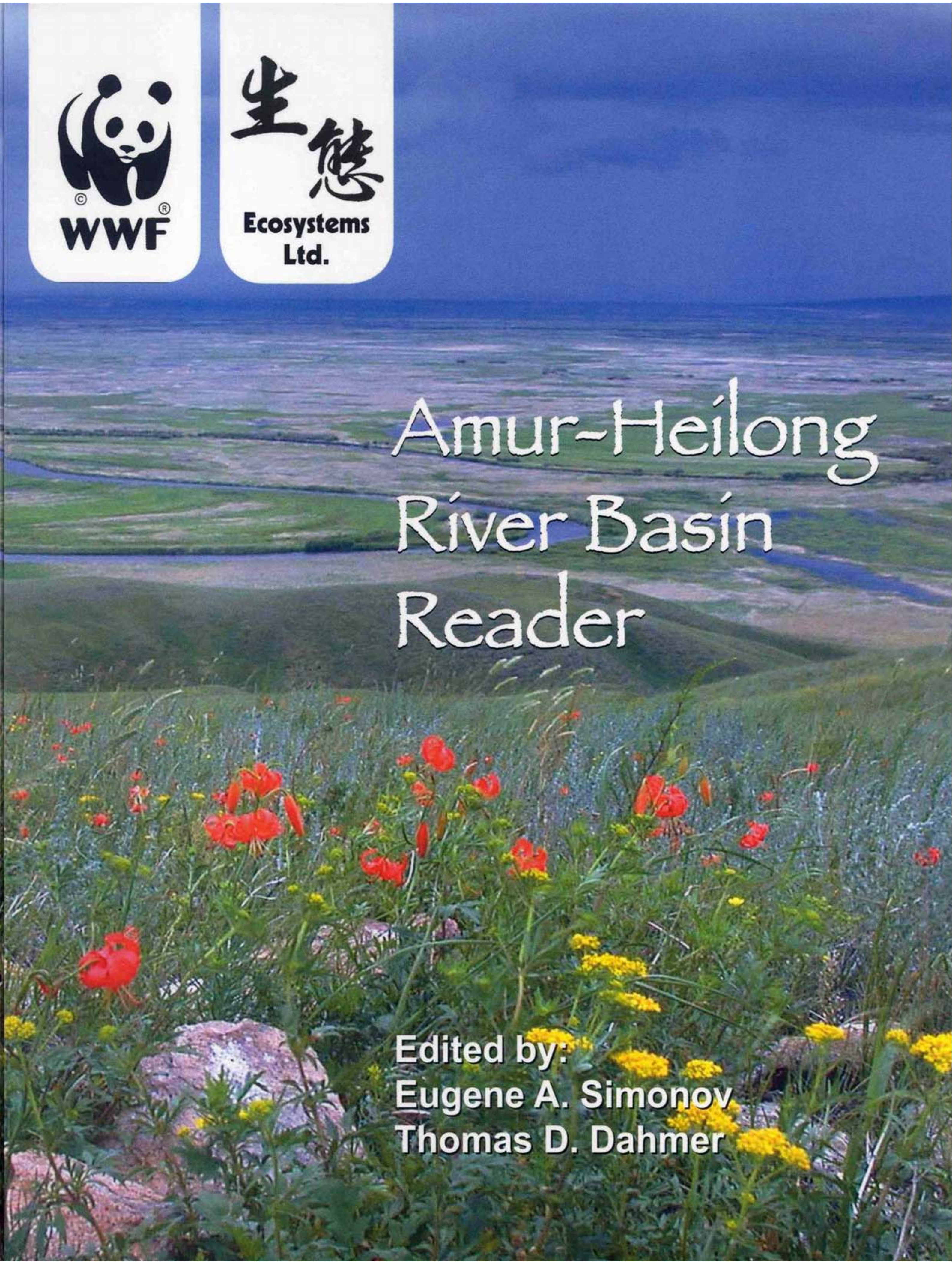

Amur-Heilong River Basin Reader

Edited by:
Eugene A. Simonov
Thomas D. Dahmer

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Wetlands at confluence of Gorin and Amur-Heilong Rivers © WWF-Russia / Y. Darman

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February 2008

Recommended citation: **Simonov, E. A. and T. D. Dahmer, editors. 2008. Amur-Heilong River Basin Reader. Ecosystems Ltd., Hong Kong.**

Library of Congress Cataloging in Publication data.

Amur-Heilong River Basin Reader /
edited by Eugene A. Simonov and Thomas D. Dahmer

includes bibliographical references.

ISBN 978-988-17227-1-3

1. Amur River
2. Heilongjiang / Heilong River
3. River basin management
4. Biodiversity conservation
5. Natural resource conservation

Printed on recycled, acid-free paper

Design by Kathy Harestad, Selah, Washington, USA, www.kathyart.com

Manufactured in Hong Kong by Power Digital Printing Co. Ltd.

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Preface

By Yury Darman

It is strange that the Amur-Heilong River is still unknown to the modern world, being one of the ten largest rivers on Earth. Even its name conveys mystique and legend from historic times. European world maps use the name Amur, whereas China uses the name Heilongjiang, or "Black Dragon River", for the same river. Russians believe the name "Black Dragon" has negative connotation related to its often unpredictable tendency to flood, but for Chinese the Black Dragon is an important and positive symbol, a "good critter"! In Russia, the name "Amur" is used only downstream from the confluence of the Shilka and Argun Rivers, after these main tributaries have covered about ¼ of the overall river length. From this confluence the Amur flows under its controversial name and unimpeded by dams several thousand kilometers to the Tatar Strait. Each of these two main tributary rivers has its own mystery. The northern source of the Amur, the Shilka River, starts from Sokhondo Ridge on the Great Continental Divide. From this one ridge, the rivers flow either northward to the Arctic Ocean through Lake Baikal, or eastward to the Sea of Japan. While the southern source, the Argun River, collects its flows from endless steppe of Chingis Han's (Genghis Khan) motherland.

In fact, the Amur is the only river in Siberia which runs not from south to north, but from west to east. Thus it forms the natural border between the severe boreal taiga and broadleaf temperate forests. Moreover, the river basin delimits the northern border of forest-steppe and steppe ecosystems that support the unique migrations of Mongolian gazelle. The floodplains of the Amur and its tributaries create the belt of wetlands, without which the millions of migratory ducks and geese could not reach their breeding grounds on the tundra at the Arctic shores. And where else in the world can you one find the Kaluga sturgeon – the king of freshwater fish, reaching 1000 kg? Even today millions of salmons still rush upstream to spawning areas in mountainous tributaries through the un-dammed main river channel!

But if you study a satellite image of the transboundary ecosystem, you will see that the Russian side of the basin remains green with dense forests and expanses of grassland. In contrast, the China side is mostly fields and settlements. The human population in northeast China has redoubled during last three decades. Finally, the color of the steppe zone in the upper basin is scorched to yellow, indicating desertification caused by climate change and overuse by people and their livestock. This contrast represents both the threat and the challenge. How can we use some of the world's successful examples to shift rapid development toward sustainability? How can we combine the experience of China, Mongolia and Russia to save nature and benefit people? The time has come. We must create a platform for international cooperation, to implement the Amur Green Belt as the system of protected areas linked by buffer zones and corridors, and to keep the Amur-Heilong as one of the world's last free-flowing rivers! Mongolia, Russia and China can only solve the many problems facing the Amur-Heilong basin by working together and adopting an integrated river basin management approach.

Fifteen years ago, the first international conference devoted to conservation of Amur-Heilong wetlands was jointly organized by the International Crane Foundation of Baraboo, Wisconsin and Russia's Socio-Ecological Union on a big vessel, rafting downstream on the Amur-Heilong River. The conference was called "Amur 1992". This was the first time for conservationists from all over the world to listen and learn about the problems of this forgotten region. This was also the first time we declared that the Amur-Heilong should be free of planned dams on the main stream. A decade of intensive international contacts and cooperative research started at that meeting. This resulted in many outcomes, including satellite-tracking of the majestic Red-crowned Crane, White-naped Crane, and Oriental Stork. By 2000, WWF and IUCN had revitalized international interest in the Amur-Heilong River, and this marked the starting point for a growing ecological program now supported by offices of WWF in Vladivostok (WWF Russia), Harbin (WWF China) and Dadal (WWF Mongolia). In 2005, the PIA (Project Implementation Agreement) on the Amur-Heilong Ecoregional Program was signed between these offices and all major donors from the WWF family. The coordinated work plan with three years of a committed budget became the tool for implementation of cooperative efforts. In May 2007, Russia and China governments finally formed a special working group on biodiversity and protected areas to coordinate planned joint activities and address conservation problems in the Amur-Heilong River basin.

Of course, the first stage of any ecoregional program is evaluation of the current situation and review of existing documents. The Amur-Heilong River Basin Reader represents this compilation of information from many and diverse sources available mainly in Russian and Chinese. In 2004-2005, WWF in Russia, China and Mongolia hired experts to collect basic information on biodiversity and environmental problems under coordination of Eugene Simonov. This work took considerable time to complete, due to tremendous fragmentation and incompatibility of available data. To ensure greater cohesion WWF also designed basic basin-wide GIS database with focus on protected areas. The first outcomes of this project were used to illustrate this compilation.

The Amur-Heilong River Basin Reader is a first step, or reconnaissance effort for an ecoregional program. But we hope that the Reader will also serve as a source of basic information about this extraordinary and biodiversity-rich ecoregional complex that is faced with the impending threat of economic development. We also hope that the Reader will provide information and stimulus to challenge the path of such development and shift it toward sustainable management through integration of river basin issues. In any case, the Amur-Heilong River has become a global example of a sharp contrast between two civilizations, two approaches to land use, and two attitudes to all of the life on Earth. It is possible to conclude that the border between Europe and Asia is no longer the Ural mountains, but now it is the stream of the Amur-Heilong River. For this reason, the Amur-Heilong basin is among the globally important testing grounds for resolving conflicts and contradictions, and paving the way to a more ecologically sustainable future with biodiversity conservation as a top priority.

Yury Darman, Director

World Wide Fund for Nature — Russia, Amur Branch
Vladivostok, Russia

Acknowledgements

From the compiler, Eugene Simonov

When the Amur/Heilong Initiative (AHI) was launched by WWF in 2002, the Russian Far East office (WWF-RFE) was tasked with developing a basin-wide knowledge base covering all requirements for the planning of integrated river basin management (IRBM). A substantial body of information has been collected on the Amur-Heilong River basin related to water management, wetland protection, infrastructure development projects, fisheries, forestry, protected areas, species diversity, and projects of domestic and international agencies. Due to uneven levels of knowledge on similar subjects in different parts of the basin and the virtual absence of basin-wide analyses or comparable materials this knowledge base after five years is still a patchwork of different pieces of information. It is very useful when specific information is needed, but does not tell an objective story on major features and trends in the basin as a whole.

In an attempt to fill this gap we took the risk of compiling this volume, the Amur-Heilong River Basin Reader, to provide the first basin-wide description of the status of natural resource use and conservation problems in the Amur-Heilong basin. A multitude of studies, published and unpublished reports, governmental programs and various other sources were used to supplement the material compiled from the three country studies. The source documents somewhat better reflect English and Russian language sources, since processing volumes of Chinese and Mongolian material was often impeded by language barriers and time and resource constraints. The resulting text is somewhat uneven because information on some subjects was plentiful and reliable, while other important subjects were only superficially covered in the literature. However we believe that the current version reflects the availability of information on different integrated river basin management (IRBM) subjects in the basin and can be used as a guide by anyone who wants to get familiar with basin-wide environmental issues as they stand at year-end 2006. We must add a disclaimer that this document is by no means a WWF standard "Ecoregional Assessment", but rather is a preparatory stage for such an assessment that will require a much larger group of experts and greater resources.

Many sources were used to compile this text, therefore it is difficult to attribute the authorship to a certain small group of individuals. As a complier I want to express my sincere gratitude to all managers, donors, experts, officials, NGO-activists, photographers and GIS-wizards who supported this work and provided essential pieces for its compilation, provided advice and review. Making a full name list will contribute another chapter to this already rather thick volume, therefore I need to apologize to those whose names are only mentioned in references.

WWF Living Waters Programme supported country overviews subsequently commissioned by WWF China and Mongolia in 2004-2005, which, along with RFE Ecoregional Conservation Action Plan (RFE ECAP 2003), formed the initial framework for this compilation. The original RFE ECAP was prepared by Yury Darman, Vladimir Karakin (WWF RFE), Andrew Martynenko (Far Eastern National University) and Laura Williams. Additional country reports were prepared in 2004 by Li Xiaomin (North East Forestry University, Harbin, China) and Tseveenmyadag Natsagdorj (Institute of Biology, Mongolian Academy of Sciences, Ulan-Baatar). Mongolian data were expanded and updated by WWF's Mongolia team under leadership of Chimed Ochir in 2006.

Much was drawn from the eight volume Russia-China Scheme for Water Resources Management in Transboundary Amur and Argun Rivers (Ladygin et al. 1996) which was reviewed by experts on WWF request (Gotvanski 2004; Podolsky et al. 2006) to formulate WWF's position on a Comprehensive Scheme for Amur Water Use (Ladygin et al. 2006, cancelled prior to completion). At the same time, the China Academy of Engineering published the ten volume "Strategic Questions on Water, Land Allocation and Environment in relation to Revitalization of North East China Old Industrial Bases" (CAE 2007), the Summary from which was provided by the CAE Secretariat in 2006 and helped to asses the situation and economic plans on China's side of the Amur-Heilong River.

Substantial information and case-studies were provided by the editor Tom Dahmer (Ecosystems Ltd., Hong Kong, China), who relied heavily on reports of various projects he participated in on the China side of the basin. Asian Development Bank, Global Environment Facility, United Nations Development Program and United Nations Environmental Program were the primary funding agencies for these projects. Additional contributors included Alexander S. Sheingauz (Institute of Regional Economy RAS, Khabarovsk, Russia), S. S. Ganzey, V. Karakin, Alexey Lankin (Pacific Institute of Geography, Vladivostok, Russia), Liubov Kondratieva (Insitute of Water and Environment Problems, Khabarovsk), and Tatiana Strizhova (IPREK, Chita).

Anatoly Mandych (Institute of Geography, Moscow) and Aleksey Kokorin (WWF Russia) contributed to general analysis of climate change influence on ecosystems and land-use.

Critically important material on nature reserve management and species and ecosystem process research was contributed by Russian zapovedniks (strict scientific nature reserves), more particularly by: the Research team of Khingansky Nature Reserve (led by Sergey Ignatenko, Mikhail Parilov and Vyacheslav Kastrikin); Dauria International Protected Area (DIPA) (Vadim Kiriliuk, Olga Kiriliuk, Oleg Goroshko (all Russia), Odmaa Badamjav (Mongolia), Liu Songtao (China); Lake Khanka International Nature Reserve (Irina Maslova (Russia), and Wang Fengkun (China).

Some essential information was collected in cooperation with Green Longjiang Youth Environment association of Heilongjiang Province, and Liu Xuechan (then a graduate student at North-East Forestry University, Harbin).

Updated databases on protected areas and other useful pieces were provided by Vladimir Andronov (RFE Division of Federal Agency for Control in the Sphere of Natural Resources) and Yury Bersenev (WWF RFE), Natalya Kochneva (Chita Province Administration), Vassily Gorobeiko (Evreiskaya Autonomous Province Division of Federal Agency for Control in the Sphere of Natural Resources), and Han Manglei (Hulunbeier Flora and Fauna Protection Station of Forest Agency).

Kind invitation to attend international negotiations greatly informed the work of the compiler and I wish to thank for this opportunity Amirkhan Amirkhanov, Tatiana Petrova, Olga Krever (Russian Ministry of Natural Resources), Tatiana Minaeva (Amur-Heilong GEF Project "Ecologia" Russian Federal Project Center), Andrey Makarov (Amur Basin Water Resources Agency), Victor Bardiuk (Khabarovskiy Province Administration), Boris Tsoy (Primorkiy Province Division of Federal Agency for Control in the Sphere of Natural Resources), and Dr.Namhai (Mongolian Ministry of Nature and Environment).

Compilation work was greatly supported by WWF staff Nikolai Efimov and Petr Sharov (WWF RFE, who also did initial editing of parts of Chapter 1 and 3), Dong Ke, Lou Jia (WWF CPO), and Batnasan (WWF Mongolia).

Most WWF RFE maps, including the standard AHRB map, were prepared by Evgeny Egidarev and Andrey Purekhovsky (WWF RFE). Some crucial maps were provided by Frederic Lasserre (Ontario, Canada).

Photos for this book were donated by WWF RFE, Vadim Kiriliuk, Guo Yu Min. Graphs, figures, and tables were kindly remodeled and created anew by Meeling Yau (Ecosystems Limited, Hong Kong, China). Translation of Sheingauz's book on RFE Forestry was provided by Misha Jones (PERC, USA).

I am very thankful to our reviewers and advisors, whose comments helped to improve the final manuscript:

Professor Frédéric Lasserre (Département de géographie Université Laval, Québec, Canada) and Professor Xiaoming Bai (Jilin Province Environmental Sciences Institute, China).

Text became readable and finally got clarity and consistency exclusively because of tremendous editorial effort of Tom Dahmer who for three consecutive years devoted his free time and energy and much of his company's time to improve each consecutive version of this book. Moreover, Tom took upon himself the burden of getting this book published in Hong Kong, which undoubtedly the main reason it finally reached our readers.

At the last stage of our long work Darron Collins (Amur –Heilong Program manager, WWF USA) provided concentrated energetic help to improve style, language and structure of each chapter, as well as conducting a thorough review by fresh eyes when Tom and myself could no longer do it ourselves. Darron also greatly improved the ecological networks essay in Chapter 6.

Personally I am especially thankful to Yury Darman (WWF RFE director) for his unceasing patience, firm support and editorial advice in multi-year production of this manuscript. Yury not only laid the foundation to this effort by compiling the original ECAP, but was acting producer for the overall work for 3 consecutive years.

I also thank my Academic Advisor Professor Ma Jianzhang (North East Forestry University, Academician of CAE), who inspired me to continue this compilation as the foundation of my doctoral research.

Draft compilation and most of the commentary (with all flaws and inaccuracies yet to be revealed) was done by myself, Eugene A. Simonov/Ximeng (Amur Heilong Programme Consultant to WWF). I and Tom Dahmer (Editor, Ecosystems Ltd.) should be held responsible for all inaccuracies and we hope to receive comments and corrections from readers in hopes of making subsequent editions more accurate and useful to a wider readership.

I dedicate my share of effort put in this compilation to the bright memory of remarkable man and thoughtful scholar of Amur River biodiversity, Vladimir M. Sapayev (1935-2006), who did not live to see publication of the Reader, which he always anticipated and encouraged. Vladimir Markyanovich Sapayev spent at least 40 years of his life studying the wildlife and ecosystems of the Amur River basin, and for his last four years was inspiring and leading a research team at the Institute of Water and Ecological Problems in Khabarovsk conducting a pilot design for the Green Belt of Amur – an ecological network to safeguard wetland biodiversity of the Amur-Heilong floodplain.

Please forward your comments and additions to: Evgene Simonov, WWF RFE, esimonov@wwfrfe.ru and/or to: Tom Dahmer, Ecosystems Ltd., ecosys@pacific.net.hk

No maps in this book imply that WWF, authors or publishers express any particular opinion regarding delineation of national borders under demarcation.

Acknowledgements

From the Editor, Tom Dahmer

Although I first entered China in 1986, I did not see much of the Amur-Heilong River basin until 1999. Since that time my challenge has been to help governments protect natural resources mainly in the forests and wetlands of northeast China's Song-Nen and Sanjiang plains. In contrast to my late arrival, many contributors to this Amur-Heilong River Basin Reader are natives of the Amur-Heilong River basin. Our guiding light in this project, Yury Darman, Director of the WWF Russian Far East office in Vladivostok, is a native of the city of Blagoveschensk where he swam and fished in the Amur-Heilong as a youth. My introduction to the Amur-Heilong was given by Ma Keping, originally from a village near Heilongjiang's capital city of Harbin and now the distinguished director of the Chinese Academy of Sciences Institute of Botany in Beijing. Over the course of their lifetimes and professional careers, these and our many other contributors witnessed the accelerating degradation of their river basin, whose natural features would be legendary throughout the world if the basin were only easier to get to and inhabit. But it was this remoteness and inhibiting character that protected the Amur-Heilong and its biodiversity during the many centuries when other more accessible rivers were dammed, over fished, contaminated, and dried. Times have changed and the tides of population and economic growth have brought more people to the basin with their growing demands on the natural resource base. During the course of this century-old invasion by people intent on exploiting and taming the basin, there have been a few voices advocating its protection and sustainable management. I have enjoyed the great pleasure of working with some of these professionals and I wish to dedicate my work on the Reader to their inspiration. Their names are listed in somewhat chronological order after I discovered the Amur-Heilong in 1999: Ma Keping, Ma Yiqing, Ma Zhong, Li Xiaomin, Ni Hongwei, Zhao Kuiyi, Lang Huiqing, Liu Xingtu, George Archibald, Jim Harris, Xue Dayuan, Hao Anlin, Tao Jin, Daniel Xu Yanchun, Eugene Simonov, Yury Darman, Svetlana Titova, and all the rugged individuals that staff the protected areas of the basin with little compensation other than being surrounded by great natural beauty. I salute you all and hope your continued efforts will restore and protect the magnificent resource you all treasure.

I would not have worked in the Amur-Heilong basin without employment offered by international organizations. I am grateful to those employers and their personnel who made this experience possible, enjoyable, educational, and, I hope, useful for nature conservation. The Asian Development Bank (ADB), Global Environment Facility (GEF), and government of the Peoples Republic of China (PRC) were my employers for the Songhua River Flood, Wetland and Biodiversity Management project in 1999-2000. Ian Fox was our Project Officer and he deserves great credit for helping to make the most of a challenging project. Thank you, Ian, for your patient guidance. The United Nations Development Program, GEF and PRC next employed me to work on the Sustainable Use of Wetlands in China project in 2002. Gerald Gunther was Head of United Nations Office of Personnel Services and I greatly appreciate his support and encouragement. Dr. Kirsten Leitner served as Resident Representative of the United Nations in China in 2002 and she provided valuable encouragement and advice. In 2003-4 I was again employed by ADB-GEF-PRC as a specialist on the Sanjiang Plains Wetland Protection project where I enjoyed the leadership and assistance of Kay Choe, Task Manager for ADB. Thank you, Kay, for a job very well done. Finally, Takehiro Nakamura of United Nations Environmental Program in Nairobi was the leader of the Integrated Management of the Amur/Heilong River Basin project in 2005-6. His efforts to involve the three basin countries in a single project are commendable and I am grateful for the chance to be involved.

Many China government agencies and their personnel assisted greatly in all of these projects. My thanks go to Bao Daming of State Forestry Administration and Sun Xuefeng of Environmental Protection Administration in Beijing. In Heilongjiang Province I am grateful to Zhao Yongsheng and Ms. Su Fengxian of the Environmental Protection Department, and to Cui Guangfan and Cheng Shaoxia of the Forestry Department.

Introduction

By Tom Dahmer

Land area and water volume alone are not enough to make a river basin famous. Several globally recognized names rank among the world's largest river basins and even some smaller basins enjoy global notoriety. The Amazon, Congo, Mississippi, and Nile are widely known as the world's largest river basins, but the Yangzi (or Yangtze or Changjiang), Indus, Ganges, and Mekong also make headlines around the world nearly every year. The former four are all larger than the Amur-Heilong; the latter four all smaller. The Ganges and Mekong basins each cover less than half the area of the Amur-Heilong. So why is the Amur-Heilong, eleventh largest river basin in the world and the longest free-flowing river in the Eastern Hemisphere, so little known and appreciated outside its own catchment?

Rivers that affect the most people are in many cases the best known. This is true for many of the world's largest rivers, particularly those in South and East Asia, where human population densities are generally high. The Indus, Ganges, Yangzi, and Yellow Rivers for example provide water to hundreds of millions of people for domestic use, industry, transport and farming. The Indus and Ganges basins combined support around 750 million people; the Yangzi and Yellow River basins together support nearly 600 million. In contrast, the Congo and Mekong River basins are much smaller, each with around 60 million people, and the Amazon, the world's largest watershed, has a population of just 25 million. If human population is an indicator of river basin importance, the Amur-Heilong with its 75 million people should attract as much attention as the Congo, Mekong or Amazon. Yet it doesn't.

Over 93% of the population in the Amur-Heilong basin resides on 43% of its land area in northeast China where population density is high and settlement is recent. The remaining 7% of the populace is spread over relatively sparsely populated Mongolia and Russia, which together account for 57% of the basin area. In these countries, the environments are more harsh, economic development less vigorous, and population densities much lower. The Mongolian and Russian portions of the Amur-Heilong basin have much in common with the bordering basins to the west (the Yenisey River basin, seventh largest in the world) and the north (the Lena River basin, ninth largest). These two rivers drain northern Siberia to the Arctic Ocean and together support fewer than 10 million people on a land area 52 percent larger than North America's Mississippi River basin where over 70 million people reside.

The Yenisey, Lena, and Amur-Heilong are among the world's largest river basins yet all are relatively unknown outside northeast Asia. The Lena River lies entirely within the territory of the Russian Federation whose government manages the basin. The Yenisey is shared by Russia and Mongolia, but most of the basin lies in Russia and only some of the headwaters flow from Mongolia. Environmental, social, political and economic conditions in the upper Yenisey are similar in Mongolia and Russia, and this provides a foundation for shared understanding of land and water management. Russia and Mongolia have built on this foundation throughout a long history of cooperation on land and water management, and this enhances transboundary management of the Yenisey River.

Although the Amur-Heilong shares some characteristics with these Siberian rivers, the similarities end at the China border: The Amur-Heilong basin in Russia and Mongolia contrasts sharply with that in China. Part One describes the natural setting of the entire Amur-Heilong basin while Part Two presents the contrasts by describing and comparing socio-economic conditions and natural resource management in the three main basin countries (a few square kilometers of the Amur-Heilong Basin are in the Democratic Peoples Republic of Korea).

While the Yenisey and Lena Rivers might continue to receive national or even regional recognition yet seldom find a place on the global stage, this is unlikely to be the case with the Amur-Heilong. The increasing global influence of China will, in coming decades, increase global awareness of all things Chinese. But there are additional reasons for the rise in global public awareness of the Amur-Heilong and these are many and important.

First, the Amur-Heilong River is one of the longest national border rivers and one of the longest undammed rivers in the world. Along the 4,444 km length of the main channel of the Amur-Heilong there are no dams and only two bridges, at Khabarovsk and Komsomolsk cities in Russia's Khabarovsk Province. While dams have spurred economic development in many regions of the world by increasing availability of or reducing costs for electricity and water, global opinion about the costs and benefits of dams is shifting. This results in part from recognition that many large dams have failed to meet expectations for water, electricity, or growth of local economies. The November 2000 Report of the World Commission on Dams concluded that feasibility studies and other assessments of large dam projects must consider the costs and benefits to the natural and human environments. The conclusions of this report underscore the global importance of the Amur-Heilong as a large undammed river. Beginning with a clean slate, the Amur-Heilong could well become a model for sound management of water resources throughout the world.

Second, the basin is home to some of the world's most outstanding ecosystems and most charismatic wild plants and animals, including wild ginseng, Siberian tiger, Far Eastern leopard, Mongolian gazelle, snow sheep, Siberian Spruce Grouse, Red-crowned Crane, kaluga and Amur sturgeon, and Hucho taimen. The world's most diverse temperate forests, extensive grasslands, and wide, fertile belts of floodplain wetlands characterize the basin. The basin includes four of the world's top-priority 200 ecoregions as delimited by the World Wide Fund for Nature. These and other natural features are summarized in Part One.

Third, and probably the most compelling reason for the recent increase in awareness of the Amur-Heilong, is the suite of environmental threats brought by the rapidly growing economies and human populations described in Part Two. Although the history of human settlement in the basin is short, damage done by excessive resource exploitation in the 20th and 21st centuries has severely depleted not only natural resources, but also the capacity of some renewable resources (such as fisheries, wetlands and forests) to recover.

The native peoples of Siberia represent a diverse range of ethnic groups. In the 17th century their total numbers are thought to have been less than 250,000 (Longworth 2005). Their economies were based mainly on fishing, hunting and reindeer herding. Europeans arrived in the last decades of the seventeenth century and by 1710 numbered 66,000. When the early European explorers were just beginning to roam eastern Russia, the major rivers in China had already experienced nearly two millennia of engineered water management. In the early nineteenth century, the Yangzi and Yellow Rivers had already been "harnessed" and "controlled" for human use, while the Amur-Heilong was scarcely known outside the native communities living along its banks.

Settlement of northeast China occurred at a pace similar to that in Russia prior to the second half of the twentieth century. A treaty between Russia and China in 1689 settled one of the first border conflicts. At that time cross-border trade relied on barter of silk and tea from China for furs and hides from Russia. Agriculture began in northeast China over the ensuing 50 years to provide food grains to military forces guarding the border. But there was little increase in the farmed acreage until the Eastern China Railroad was constructed in the late nineteenth century under a Sino-Russian treaty and the region became involved in global trade. Nevertheless much later and after the Peoples Republic of China was founded in 1949, farmland accounted for less than four percent of the total area of the Sanjiang or "Three Rivers" plain in eastern Heilongjiang Province. Even by the mid-1960s the three northeastern most counties of Heilongjiang Province remained unfarmed. The pace of exploitation changed after 1966 at the beginning of China's Cultural Revolution when hundreds of thousands of young urbanites were sent to northeast China to begin "harnessing" the great northern wilderness. Their conversion of uplands and wetlands to farmland, and felling of forests was followed in the late 1970s and later by efforts on larger scales supported by international financing and imported heavy equipment. These efforts continue today although national and provincial laws and regulations have been drafted to regulate the extent and pace of exploitation. The remaining wildlands of northeast China are small, isolated, and fragmented representatives of the 900,000 km^2 of wilderness that was present only a few centuries earlier. Whereas the human population in Russia's Amur basin is small and declining, China's Heilong River basin population is 15 times larger and growing.

Mongolia's portion of the Amur-Heilong has also changed most rapidly during recent decades and this has been prompted in part by a shift from a planned to a market economy. But eastern Mongolia's topography and climate are poorly suited to farming and better suited to the nomadic herding that has been practiced there for millennia. Eastern Mongolia was never richly endowed with forests as were southeast Russia and northeast China. And, at 224,000, the human population in Mongolia's Amur-Heilong basin is only a small fraction of that in Russia (4%) or China (0.2%), and is growing slowly. For these reasons the changes in the Mongolian portion of the basin have been less dramatic than in China. There has been relatively little conversion of wildland to farmland in Mongolia but formerly rich grasslands have been degraded by overgrazing over large areas. Forests are isolated, and limited in extent, and have been degraded by over harvest and anthropogenic fire. Rather than develop rural environments, people in eastern Mongolia are moving to urban centers where employment and education opportunities are better and standards of living higher. In rural areas, the one economic sector that is expanding rapidly is mining of the rich mineral resources.

As the above short summaries show, the three basin countries differ in their recent histories, socio-economics, demographics, and development strategies. This leads to a mix of conditions that complicates the management of the tri-national river basin as a single entity. Long-term goals for the management of Amur-Heilong resources differ between the three basin countries and this accounts to a large extent for the many conservation issues on which so little progress has been made. Many natural resources are severely threatened as discussed in Part Three. Some of these crises are well documented, such as the many wildlife species recognized as globally threatened on the Red List of the IUCN World Conservation Union.

Less well known but equally urgent crises include the quality and quantity of water in the wetland ecosystems and the ecological integrity of regional forests. These resources are, of course, linked because surface and groundwater quality and quantity are determined in part by the type and quality of vegetation cover on land. Both forests and water are threatened ultimately by the time lag between economic development and conservation in East Asia and throughout the world.

Waters of the Amur-Heilong River have been polluted for decades by industry and agriculture in all three basin countries, but most severely in China. The most recently publicized chemical spills on China tributaries of the Amur-Heilong reflect two different proximal causes of river contamination by toxic materials: one an accidental explosion at a chemical plant and the other intentional dumping of waste. In both cases, the rush for financial gain in a developing market economy outpaced the application of constraints to protect the river and its ecology. The results are water and fish too toxic for use by wildlife, livestock or people.

Similarly, in commercial forestry, protection has lagged behind the pursuit of profit. Northeast China's forests were logged or burned by anthropogenic fires from the 1950s through the 1990s and in the process a catastrophe was born. When unusually heavy rains fell in autumn 1998, the rivers flooded, property was destroyed and 154 people were drowned. Recognizing the role of degraded forests, China responded by banning logging in most natural forests. This reduced the supply of domestic timber and caused a spike in demand for timber imports. Russia stepped in to meet this new demand by felling her forests virtually without regulation. Unless this situation is addressed by effective controls on logging in the Russian Far East, China's mistakes will be repeated in Russia, where some of the world's most unfragmented, high value forests remain outside the tropics. Conservation in Russia must catch up with exploitation and do so quickly.

One thread ties many of these basin-wide issues together in this book, and that is the concept of transboundary responsibility. The above examples of water and forests demonstrate clearly the need for basin countries to accept their shared responsibility for conservation and sustainable use of these resources. However, an even more pressing example is provided by fisheries, sturgeon fisheries in particular.

Sturgeon have been over fished for decades and the remaining stock of mature sturgeon cannot produce enough roe to meet the demand from world caviar markets. The Amur-Heilong River is home to two endemic species of sturgeon, both of which yield caviar of high value. But populations of both species are declining due to overfishing to the extent that both are globally endangered per the IUCN Red List. Legal fishing (in China) and illegal fishing (in Russia and China) continues despite knowledge in both countries that both species are sliding rapidly toward extinction. Sturgeon in the Amur-Heilong now mainly occupy the main river channel, which, for most of its length, marks the China-Russia border. The two countries share the river and its resources, and this precludes either country resolving the sturgeon crisis on its own: If the Amur-Heilong sturgeon fishery is to be restored, both countries must not only contribute, but enthusiastically and cooperatively wage a protective crusade for sturgeon and all other life in the river. But the problem is not only overfishing. It includes water pollution, forestry, and potentially even hydropower generation, each of which will affect aquatic resources depending on the balance achieved between economic gain and environmental protection.

In recent years there have been many attempts at transboundary management of the Amur-Heilong's natural resources. Unfortunately, most of these have failed to yield results, leaving only a few cases of effective cooperation for sustainable resource use. Most of these are transboundary nature reserves that are only small and isolated islands of protection on large landscapes of unregulated exploitation. In Part Four we discuss in four essays and two case studies new approaches needed to acknowledge and address the transboundary threats to natural resources in the river basin, and to overcome past failures.

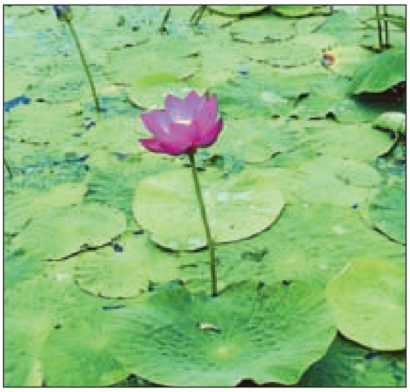
Our goal in this Amur-Heilong River Basin Reader is to present a compelling case for launching prompt and effective action backed by appropriate technology and adequate funding to restore the natural wealth of this globally important but largely unknown natural treasure. We hope that administrators, managers, researchers, politicians, planners, conservationists, and business interests will find this Reader useful in defining their role in this process. Most importantly, we hope the Reader will accelerate the spread of global awareness of this magnificent region and contribute to the restoration and long-term protection of its many unique features.

Part One

Natural Setting of the Amur-Heilong River Basin

Chinese Soft-shelled Turtle © WWF-Russia / V. Solkin

Oriental white stork © WWF-Russia / Klimenko



Lotus © WWF-Russia / V. Solkin

Far Eastern Leopard © WWF-Russia / V. Solkin

Tiger © WWF-Russia / V. Solkin

Mongolian gazelle © WWF-Russia / V. Kirilluk

Chapter 1

General Description

The Amur-Heilong is the largest river in northeast Asia. It flows through Mongolia, China, and Russia from its origin at two sources (**Table 1.1, Map 1.1**). The northern source is the Shilka River in Russia and its tributary the Onon River that drains the Henti (Khenty) Mountains in Mongolia. The southern source is the Argun River, which drains the western slope of the Great Hinggan (Da Xing'anling) mountains in China. The Amur-Heilong River is one of the world's largest free-flowing rivers and, at approximately 4,444 kilometers in length, is the ninth longest river in the world. At approximately two million square kilometers, it also has the eleventh largest watershed (**Table 1.2**). The Amur-Heilong flows in a northeasterly direction to its estuary in the Tatar Strait of the Sea of Okhotsk. The largest tributaries of the Amur-Heilong River are: Zeya (Russia), Bureya (Russia), Amgun (Russia), Songhua (China), and Ussuri/Wusuli (China, Russia). The river forms the border between China and Russia for over 3,000 km, making it one of the world's longest border rivers. The Upper Amur-Heilong Basin includes the Mongolian headwaters and Argun/Erguna River basin, the main stream of which flows for more than 900 kilometers and forms the China-Russia border. The main stream of the Amur-Heilong River proper is often referred to as a river of three reaches, Upper, Middle, and Lower. The Upper Amur is shared by Russia and China for 937 km from the confluence of Shilka and Argun Rivers downstream to the mouth of the left-bank tributary the Zeya River at the Russian city of Blagoveshensk. The Middle Amur-Heilong is also shared by Russia and China along the 950 km reach of the main stream from the mouth of the Zeya River downstream to the confluence of the right-bank tributary the Ussuri-Wusuli River near the Russian city of Khabarovsk. The Lower Amur lies completely within Russia and stretches 947 km from the mouth of the Ussuri River to the Amur Estuary.

Map 1.1 Location of the Amur-Heilong River basin

Western and southwestern reaches of the basin in China and Mongolia have numerous endorheic rivers, rivers that drain into closed inland wetlands or lakes, rather than into the main river system. Other partly endorheic basins drain into the Amur-Heilong only in wet years and some have stopped flowing entirely due to human water consumption. For these reasons, authors estimate the total watershed area differently. The most common estimates of basin area are 1.86 million km2 in official Russian sources (Surface water resources of the USSR. Hydrology. 1966), and 1.93 million in many international sources (IUCN/WRI World Watersheds eAtlas 2005). Throughout this book we consider Kherlen, Khalkh, and Uldz Rivers and some other closed basins to be important intrinsic components of the Amur-Heilong basin ecosystem. When considering these headwaters, the estimated basin area is 2,129,700 km2 (**Table 1.1**), which corresponds with the estimate of Sokolov (1952) and is the estimate we use throughout this text. The Amur-Heilong River basin also includes around 100 km2 of mountainous lands within the territory of The Democratic Peoples Republic of Korea (North Korea). Because this represents a very small portion of the total basin, we do not discuss it further in this text. The total area of the basin is compared to other better known basins of the world in **Table 1.2**.

Table 1.1 Amur-Heilong River basin area by country and reach of the basin

Country	Reach of Basin	Total Area (km^2)	Area in Amur-Heilong Basin	Percent in Amur-Heilong Basin
Russia		16,995,800	1,008,000	6
China		9,326,410	905,700	10
Mongolia		1,565,000	189,000-224,000	12-14

Table 1.2 Amur-Heilong River basin area compared to other river basin areas

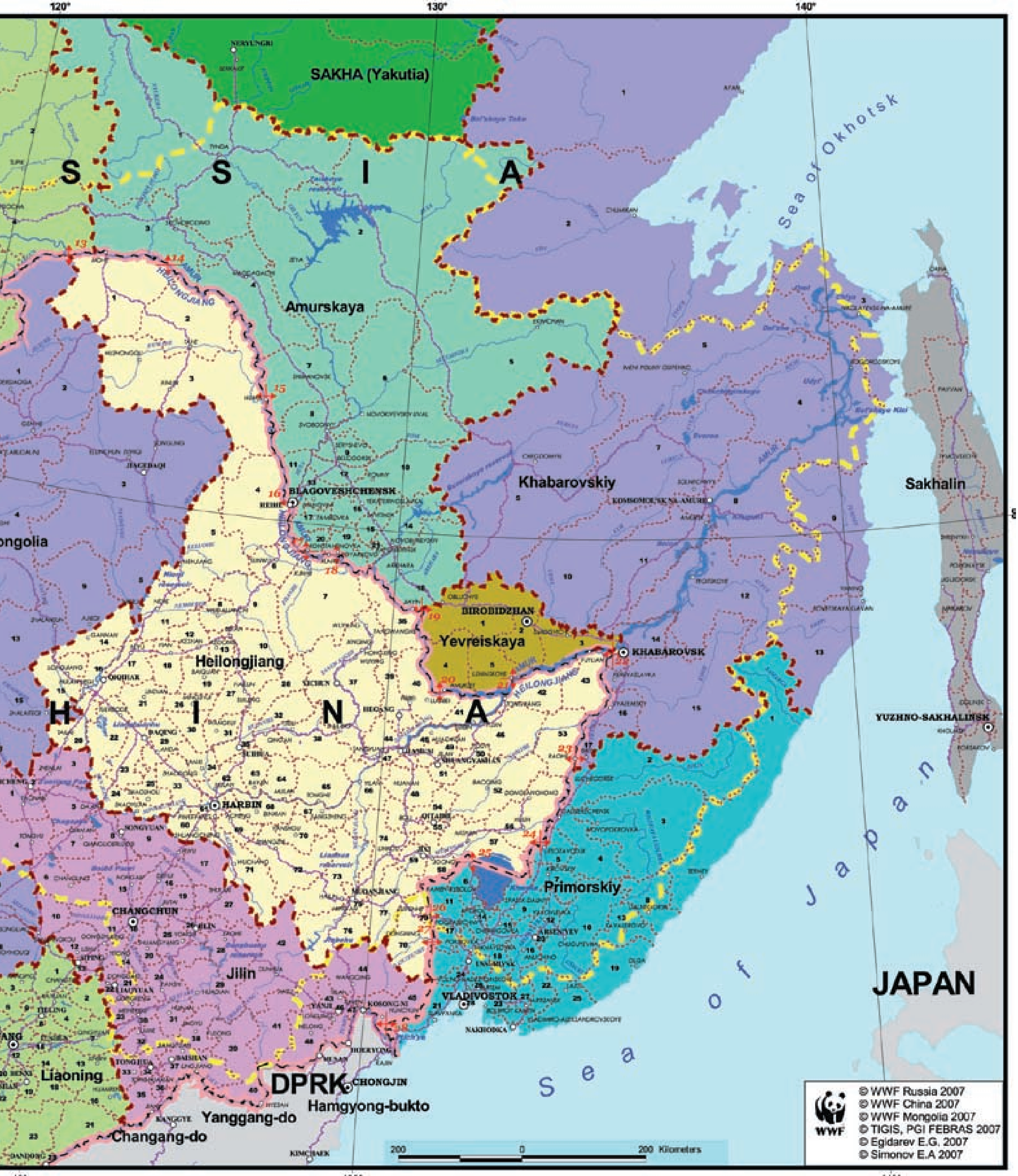
Basin	Countries included in basin	Area (km2)
Amazon	Peru, Bolivia, Venezuela, Colombia, Ecuador, Brazil	6,144,727
Congo	Cameroon, Central African Rep., Democratic Rep. of Congo, Equatorial Guinea, Gabon, Rep. of Congo	3,680,000
Nile	Uganda, Sudan, Egypt, Ethiopia, Zaire, Kenya, Tanzanian, Rwanda, Burundi	3,254,853
Mississippi	USA, Canada	3,202,185
Paraňa	Brazil, Argentina, Paraguay, Bolivia, Uruguay	2,954,500
Ob	Russia, Kazakstan, China, Mongolia	2,950,800
Yenisey	Russia, Mongolia	2,557,800
Lake Chad	Chad, Niger, Central African Republic, Nigeria, Algeria, Sudan, Cameroon, Chad, Libya	2,388,700
Lena	Russia	2,306,743
Niger	Nigeria, Mali, Niger, Guinea, Algeria, Cameroon, Burkina Faso, Benin, Ivory Coast, Chad, Sierra Leone	2,133,200
Amur-Heilong	Russian Federation, People's Republic of China, Mongolia	**2,129,700**
Yangtze	China	1,900,000
Indus/Brahmaputra	India, Pakistan, Afganistan, China, Nepal	1,165,500
Murray-Darling	Australia	1,061,469
Tigris-Euphrates	Turkey, Syria, Iraq	970,000
Yukon	Canada, USA	916,667
Ganges	India, Nepal, Bangladesh	907,000
Yellow	China	800,000
Mekong	China, Myanmar, Cambodia	795,000

The largest portion of the Amur-Heilong River basin, about 1 million km^2, lies within the Russian Federation. The river basin includes six Russian provinces: Primorsky Province, Khabarovsky Province, Amur Province, Chitinskaya Province, Aginsky-Buryatsky Autonomous Region, and Evreiskaya Autonomous Province. The latter two are the only Russian provinces that lie completely within the Amur-Heilong River basin. Vladivostok, the capital of Primorsky Province is the only provincial capital located outside the basin (**Map 1.2**).

The Amur-Heilong basin area in China covers about 0.9 million km^2 in parts of three provinces: Heilongjiang, Jilin, and Inner Mongolia. The total area of the basin within Heilongjiang Province is 447,400 km^2, or over 98% of the 454,800 km^2 province land area, and including all cities except Suifenhe. The basin in Jilin Province includes 5 cities and 30 counties, and covers an area of 134,700 km^2, or nearly 72% of the 187,400 km^2 province land area. In Inner Mongolia all cities of Hulunbuir (253,000 km^2) and Xing'an Meng (59,806 km^2) prefectures lie within the basin, which covers an area of 323,600 km^2 and drains over 27% of Inner Mongolia's 1,183,000 km^2 total land area.

Map 1.2
Political boundaries in the Amur-Heilong River basin

(see Attachment X for list of counties and prefectures indicated by figures)


120°
130°
140°
SAKHA (Yakutia)
S
S
I
A
Sea of Okhotsk
Amurskaya
Khabarovskiy
Sakhalin
BLAGOVESHCHENSK
ongolia
BIROBIDZHAN
Yevreiskaya
KHABAROVSK
Heilongjiang
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N
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YUZHNO-SAKHALINSK
HARBIN
Primorskiy
CHANGCHUN
Jilin
VLADIVOSTOK
NAKHODKA
JAPAN
Sea of Japan
Liaoning
DPRK
CHONGJIN
Hamgyong-bukto
Yanggang-do
Changang-do
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WWF

The eastern part of Mongolia lies in the Amur-Heilong River basin. Here Mongolia borders the Russian Federation to the north and the People's Republic of China to the east and south-east. However, only the Onon River with a watershed of 30,000 km^2 drains into the Amur-Heilong system annually, while the more southerly Kherlen and Khalkh Rivers only drain into the Amur-Heilong Basin in wet years via Dalai Lake. Mongolian Provinces in the Amur-Basin include Hentiy and Dornod *aimag*s (provinces) and 3 *soum*s (counties) of Tuv province (Mongonmorit, Bayandelger and Bayanjargalan) and 4 counties of Sukhbaatar *aimag* (Monkhkhaan, Tumentsogt, Sukhbaatar and Erdenetsagaan).

The terrain of the Amur-Heilong basin is largely mountainous (**Map 1.3**). Mountain ranges, ridges, foothills, and plateaus cover two-thirds of the region. Most mountains are low, ranging from 300 to 1,000 meters in elevation. Only isolated mountain ranges and peaks, covering just over seven percent of the territory, reach elevations of more than 2,000 meters. The major mountain range situated along the Okhotsk Sea coast, the Dzhugdzhur Mountain Ridge, was formed in the Mesozoic Era. These ranges reduce the influence of monsoons on inland areas during the summer and autumn. Similarly, the mountain ranges that extend from east to west

Map 1.3
Topography of the Amur-Heilong River basin

SAKHA (Yakutia)
S T A N O V O Y
DZHUG-DZHUR
Sea of Okhotsk
S S I A
TUKURINGRA
UPPER ZEYA PLAIN
DZHAGDY
AMUR
HEILONGJIANG
Amurskaya
AMUR-ZEYA PLAIN
TURANA
BUREINSKIY
Khabarovskiy
Sakhalin
BLAGOVESHCHENSK
ZEYA-BUREYA PLAIN
ongolia
BIROBIDZHAN
Yevreiskaya
KHABAROVSK
Heilongjiang
H I N A
SANJIANG PLAIN
YUZHNO-SAKHALINSK
HARBIN
Sea of Japan
Primorskiy
CHANGCHUN
SIKHOTE-ALIN
Jilin
VLADIVOSTOK
NAKHODKA
JAPAN
Liaoning
DPRK
CHONGJIN
Hamgyong-bukto
Yanggang-do
Changang-do
CHANGBAI SHAN
200 0 200 Kilometers
120°
130°
140°
50°
40°

along the northern border of the basin form a barrier that reduces the influence of arctic air masses in winter.

Three wide (300 to 500 km) and parallel bands of mountain ranges cross the Amur-Heilong basin in a more or less north-south direction. The Great Hinggan (Da Xing'anling) Range spans the upper reaches of the Amur-Heilong River. The Small Hinggan (Xiao Xing'anling) and Bureya Ranges cross the center of the basin. Furthest downstream, the Sikhote-Alin Range separates the Amur from the Pacific Ocean near the Tatar Strait and the Sea of Japan. An even wider mountain system, the Stanovoy and Tukuringra-Dzhagdy ranges, extends in a nearly east-west direction along the northern border of the basin.

The Changbai Mountains, an isolated outcrop located in the China part of the basin, mark the extreme southeast of the basin.

The Mongolian part of the Amur-Heilong River basin is surrounded by Henti Mountain Range to the west, small hills along the west side of the Kherlen River to the south, and the Dariganga basalt plateau and the Greater Hinggan mountains to the east. The highest point in the Mongolian basin is Asralt Peak of the Henti Mountain Range at 2,452 m and the lowest point is the Khokh Lake depression at 560 m in the Uldz River basin. The basin land surface is located in tectonic depressions dominated by plains and flat land between the Henti Mountains and the Greater Hinggan (Khyangan) Mountains.

The area of plains is also large. Extensive hilly steppe plateau occupies the south-west part of the basin in Mongolia, Russia, and Inner Mongolia. The main plains and lowlands are located between the Zeya and Bureya Rivers, near Khanka Lake, in the valley of the Lower Amur, at the confluence of the Amur-Heilong with Songhua and Ussuri Rivers (Sanjiang Plain), and in the middle reaches of the Songhua at the confluence of the Nen and Second Songhua Rivers, which drain the Song-Nen Plain. Geological research in the Middle Amur-Heilong and the Song-Nen plain suggests that several huge shallow lakes covered these areas millions of years ago. Lacustrine fine sand deposits often underlie the contemporary soil surface. After the lakes receded sand was blown into dunes that supported only sparse vegetation and were exposed to the surface during the driest climatic period. These areas are also unusually rich in dinosaur fossils. A detailed review of geomorphology and geology of the Amur-Heilong basin was undertaken by Ganzei (2004).

The basin is rich in biological diversity and supports thousands of species and many ecosystem types. This vast area is famous for rare waterfowl, big cats, and endemic fishes. The biological richness is explained by the great diversity of landscapes such as desert, steppe, grassland, tundra, mixed broadleaf-coniferous forest, and taiga.

High levels of landscape diversity in the Amur-Heilong River basin are largely the result of historic and spatial variability in conditions across the region. Altitudinal variation and horizontal zonation also help form numerous biogeographic regions. Situated on the east rim of Eurasia and abutting the Pacific Ocean, the basin is subject to the combined effects of monsoon climate conditions, oceanic currents, and mountains that direct air circulation patterns. The geology and terrain, with numerous mountain chains separated by lush valleys, present a variety of microclimate, soil, and vegetation conditions. These have yielded a broad range of landscapes and unusually high levels of species diversity for temperate latitudes.

Chapter 2

Climate and Weather

The eastern Amur-Heilong basin has a humid monsoon temperate climate, where monsoons reach their northernmost latitude on earth. The western basin (upper reach of the Amur-Heilong River) is sheltered from monsoon influence and is arid. The arid western portion of the basin is smaller than the more humid eastern portion.

Nearly two thirds of precipitation in the basin falls in the three months from June to August. May and September are transitional months while the dry season extends for 7 months from October until April when precipitation is only 15% of the annual total. Floods occur annually during the short three-month wet season when 84% of big storms occur. On the other hand, water is in short supply throughout most of the basin during the much longer dry season.

Severe cold in winter combined with low snow cover results in frozen soils to depths of over 2 m over much of the basin. Permafrost characterizes large parts of the basin in Russia.

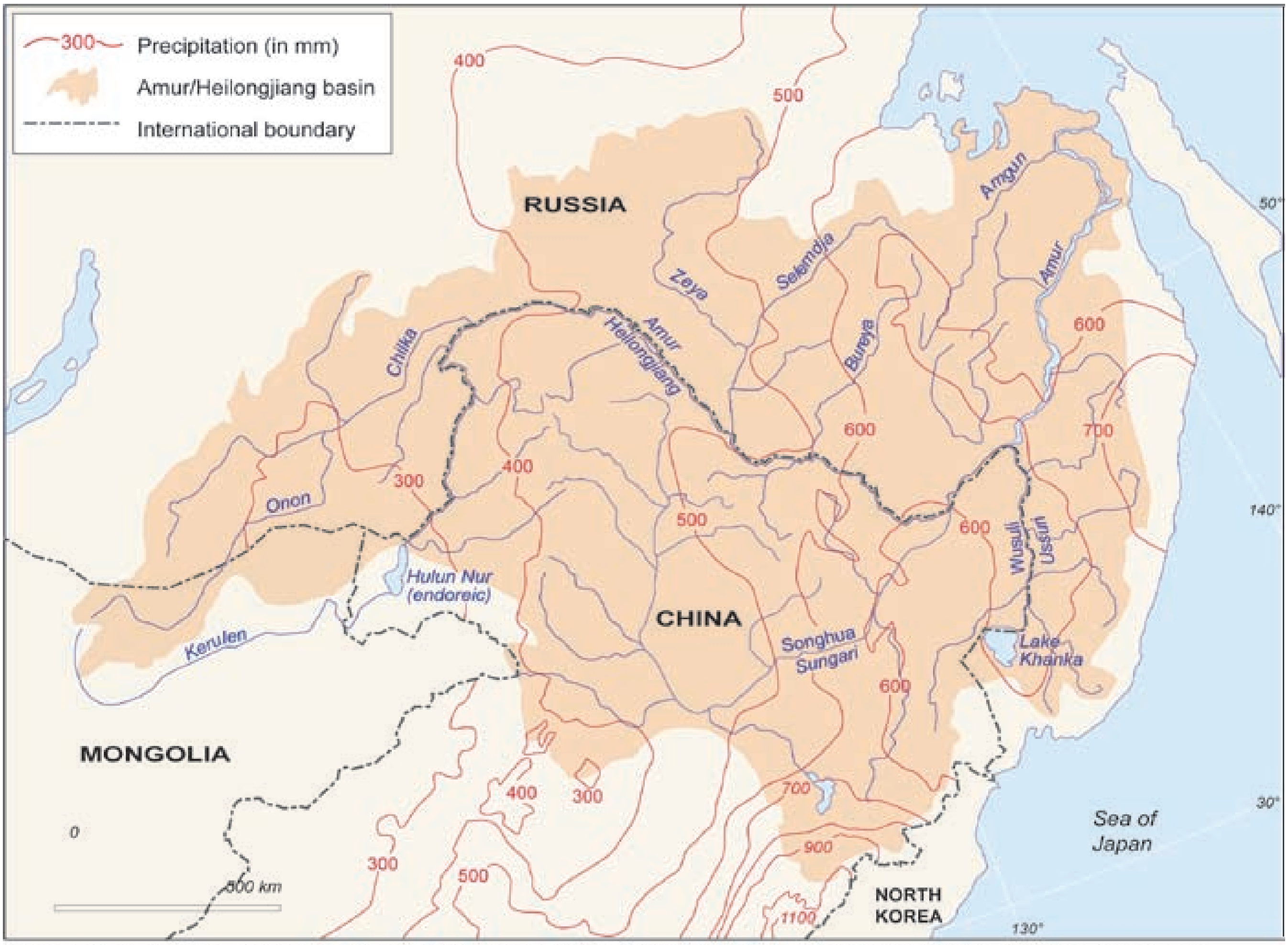
Temperature

Mean annual temperature varies from -7°C in the north to +6°C in the south. Mean January temperatures range from -12 to -32°C, but on the Pacific coast they are 10°C higher, moderated by the influence of the Seas of Okhotsk and Japan. January average temperatures are lower than -25°C in northern Heilongjiang Province but higher than -15°C in Changchun, the capital of Jilin Province, some 230 km further south. Temperatures in the south increase dramatically due to reduced elevation and latitude, and the mean January temperature difference between south and north can exceed 10°C. Summer temperatures are lower on the coast than in inland areas. Mean temperature in August, the warmest month, is 17 to 23°C. The annual temperature range is nearly 50°C. The warm summers allow for cultivation of maize, rice, soy beans, and sweet potatoes. The long, cold, and dry winters preclude planting of winter cereals such as wheat or rye, and make frost-intolerant fruit tree cultivation impossible.

In China's part of the basin July mean temperature is 16 to 18°C. The range of daily temperature is greater than 10 °C from early June to the end of August. Sunshine is abundant throughout the year and days are long in spring, summer, and autumn. The annual number of hours of sunshine is 2,800-3,000 in the Chinese plains where 60-70% of days are sunny. In the mountainous areas there are 2,400-2,600 hours of sunshine per year and fewer than 60% of days are sunny.

The Mongolian and most of the upper part of the basin is influenced by arctic weather from Siberia and to a much lesser extent by monsoons from the remote Pacific coast. As a result, Mongolia has a continental dry climate. Mean annual air temperature varies from $+0.5^0$ to 3^0C. Monthly mean temperature for January is between -20 to -24^0C and the monthly mean temperature in July is $+16^0$ to $+22^0$C. The lowest temperature is -40^0 to -47^0C and the warmest is $+39^0$ to $+40^0$C. The annual temperature amplitude may reach 70^0C. The number of days in a year when air temperature is below -30^0C in winter is 25-35 and the number of days in a year when air temperature is above $+30^0$C in summer is 10-25.

In the Mongolian winter, dry, cold air is carried inland and results in abrupt cooling. Heavy cold air accumulates in mountain valleys where inversions form and cause lower temperatures than on surrounding mountain slopes. This prevents growth of trees in some valleys where the vegetation is tundra and meadow wetlands, and confines forests to the higher altitudes. Climate varies widely across the basin. For example, the upstream parts of Onon, Ulz, and Kherlen Rivers and also in mountainous part of Khalkh Gol River basin are cooler than other parts of the basin. Long-term permafrost is only distributed at high altitudes of the Henti Mountain Ranges. Seasonal permafrost is distributed nearly ev-



Sources : Atlas of the People's Republic of China, Foreign Language Press, Beijing, 1989; Carmen Revenga, Siobhan Murray, Janet Abramovitz, and Allen Hammond, Watersheds of the World. Ecological Value and Vulnerability, World Resources Institute, Washington, 1998; Gerhard Heilig,China Food. Can China Feed Itself? (CD-Rom), IIASA, Laxenburg, 1999.

Map 1.4 Annual precipitation in the Amur-Heilong River basin (adapted from Lassere 2003)

erywhere from November to May. Frost can penetrate the soil to depths of up to 2.5-3.5 m.

Wind is a prominent feature of the eastern Mongolian Steppe where yearly average wind velocity is more than 3 m/sec. Wind velocity in winter is 2-5.4 m/sec, 2-6 m/sec in spring and summer, and 2-5 in autumn. Wind velocity increases in January and February and reaches its maximum in March to May. Summer months of July and August are relatively calm, with winds increasing again in September. Some 20-22 days each year are stormy and the strong winds often bring dust storms. The Kherlen and Khalkh River valleys are characterized by the highest frequency of storms.

Russia's part of the Amur-Heilong basin is colder on average than China's. All regions, except Primorsky Krai, have a typical continental climate. The annual temperature range exceeds 80°C. Near Pokrovka Village at the confluence of the Shilka and Argun Rivers, the annual temperature range reaches 98°C. Primorsky Krai and the southern and eastern parts of Khabarovsky Krai have a monsoon climate with slightly cooler summers and milder winters. However, while Khabarovsk City is at the same latitude as Paris, mean annual temperatures in the Amur are 7-8°C lower and mean winter temperatures are 19-20°C lower due to the influence of the Siberian anticyclone. The highest temperatures occur in July. Air temperatures reach +30 to 40°C with the maximum of +41°C recorded near Blagoveschensk City. The winters are cold with air temperature dropping to -30 to -50°C. In the upper reaches of Amur-Heilong the lowest minimum temperature ever recorded was -59°C.

Precipitation

Precipitation contours for the basin are shown in **Map 1.4**. Precipitation generally increases from west to east. At the western limit of the basin in the upper reaches of the Argun annual precipitation is less than 300 mm.

In the Mongolia basin, the Henti Mountain Range in the northwest and the Great Hinggan Mountains in the southeast are physical barriers stopping humid air from penetrating into eastern Mongolia. Only 200-295 mm of rain falls each year. The first persistent snow cover falls in mid to late November and lasts for 101-134 days. Snow cover is only 1-21 cm, allowing for year-round livestock grazing. During the warm season, 247 mm or 94% of annual precipitation falls as rain, while almost 14 mm or 6% of total precipitation falls as snow in the cold season. Local climatic variations are extreme here and this promotes diverse vegetation types from semi-desert to taiga forest. The Henti Range, and the Onon and Uldz River basins are more humid and the annual precipitation there varies from 300 to 400 mm. Due to

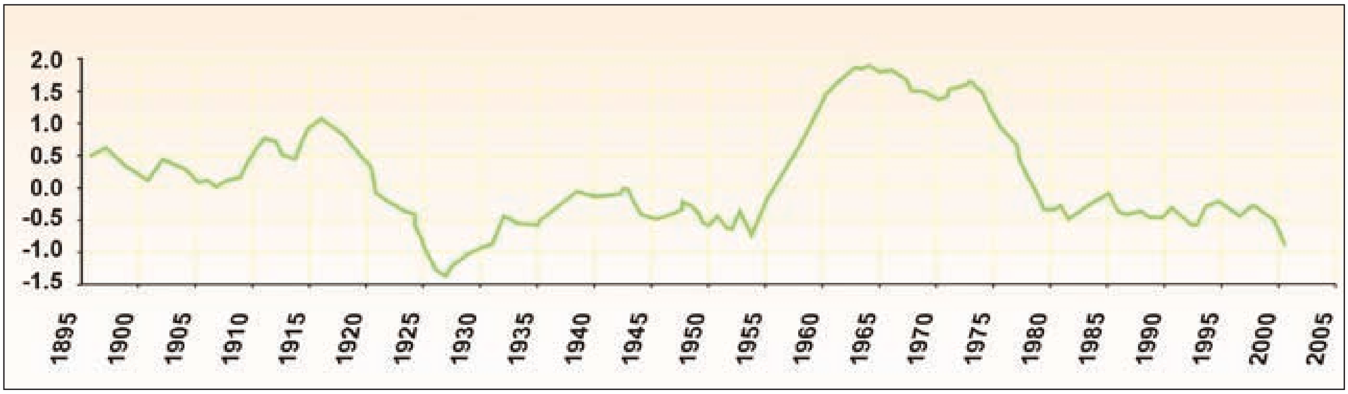


Figure 1.1 **Volume of Amur-Heilong River flow at Khabarovsk hydrological station 1895-2001 (Novorotsky 2002)**

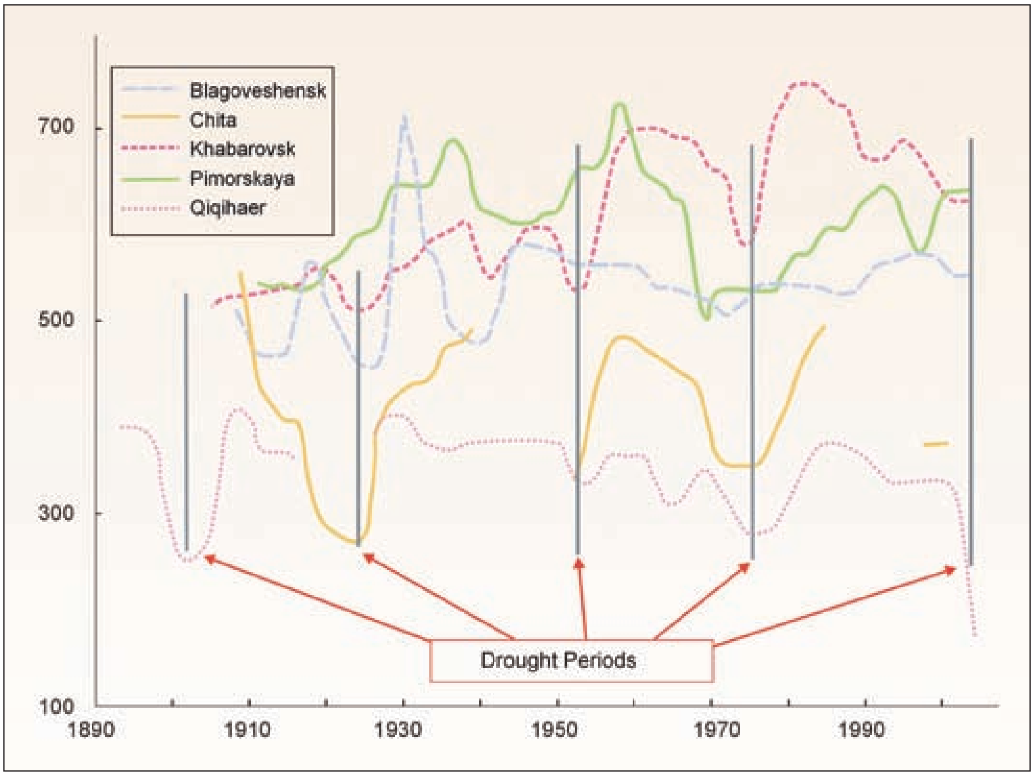
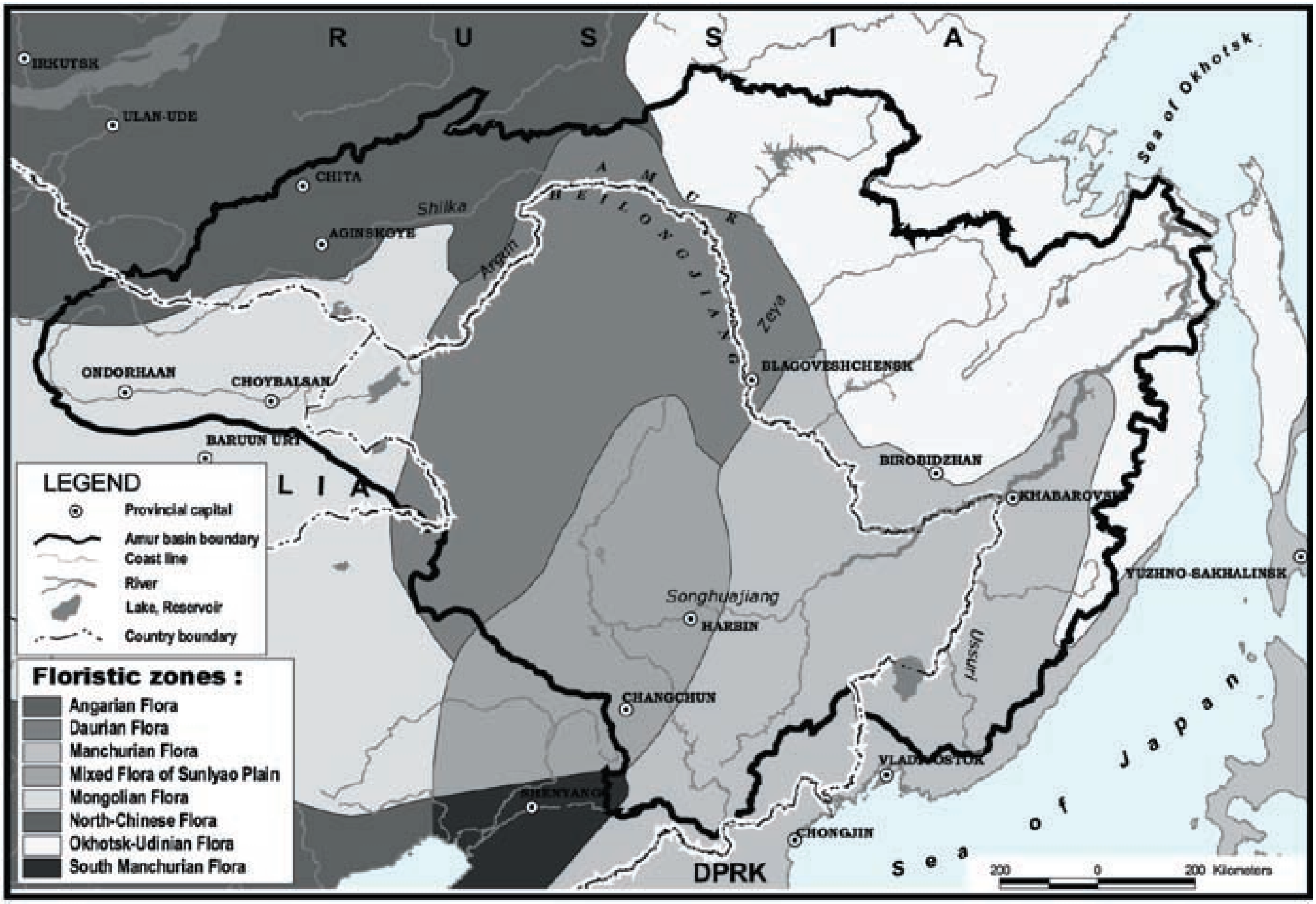


Figure 1.2 Long-term precipitation cycles in the Amur-Heilong basin (recording stations at Blagoveshensk, Chita, Khabarovsk, Primorsky, Qiqihaer) (Parilov et al. 2005). Red arrows show drought peaks.



Map 1.5 Floristic zones in the Amur-Heilong River basin

the monsoon influence, the Khalkh Gol River basin receives slightly more precipitation than the norm for the Mongolia basin, ranging from 280 to 350 mm per year

Downstream, but yet in the upper Amur-Heilong, precipitation ranges from 400-500 mm. In the middle reaches of the Amur-Heilong total precipitation increases to 500-700 mm. In humid areas of the Lower Amur-Heilong and Ussuri-Wusuli Rivers precipitation is abundant, exceeding 700-800 mm. Although typhoons are infrequent, they can bring rains of up to 400 mm in a single day. On the continental plains of the China basin annual precipitation is 450-600 mm. Snowfall is modest and snow cover rarely exceeds 20 cm. The shallow snow cover leads to freezing of the soil to depths of 2-4 meters. Due to the dry atmosphere and intense solar radiation most snow sublimates before spring melt. Rainfall accounts for 60-75% of annual precipitation, starting from 20 May to early June in all parts of the region, and ending during the last ten days of September.

In humid areas of the Lower Amur-Heilong and Ussuri-Wusuli Rivers, precipitation is abundant, exceeding 700-800 mm. Although typhoons are infrequent, they can bring rains of up to 400 mm in a single day

The lower Amur and Okhotsk seacoast are among the most snow-rich areas of the world with 1-2 meters of snow cover by the end of winter. Some valleys accumulate 3-4 meters.

Climatic Cycles

The most recent glaciation in north Asia occurred 70-12 thousand years ago, but most of the Amur-Heilong basin was ice-free during that time, leaving refugia where southern flora and fauna could survive and adapt to the cold climate. Formation of the cold Primorski current in the Sea of Japan allowed boreal-zone flora to extend southward to 44 degrees latitude, while

Box 1.1 Climate impacts on abundance and distribution of great bustards and white-naped cranes

Scientists at Dauria international Protected Area (DIPA) studied birds in the area from the Kherlen River in the south to the Ingoda and Shilka Rivers in the north, and from the sources of the Onon River in the west to the low reaches of the Argun River in the east. This research has produced extensive data on changes in abundance, distribution, and propagation success of many species of birds in Dauria in relation to climate changes. The most interesting results were obtained for great bustard (*Otis tarda dybowski*) and white-naped crane (*Grus vipio*).

Multiple census studies, verbal reports from hundreds of herders and hunters, interviews of villagers, and analysis of literature sources made it possible to describe the dynamics of great bustard abundance from the 1960s to the present and white-naped crane for a slightly shorter period. Researchers also analyzed weather data in Transbaikalia over the same time periods, leading to important conclusions about the relationships between bird numbers and climate.

Changes were seen in bird habitats when wet and dry periods alternated. Lakes and floodplains alternately ran dry in droughts and were filled in wet periods. Vegetation changed in response to availability of moisture. Abundance and distribution of birds changed as well. The overall dynamics of bustard and crane populations were similar. During wet periods birds were more abundant in the steppe zone but declined in forest-steppe. In contrast, dry periods showed the opposite trends. The summer population density of birds may change quickly (by factors up to four and more times within two years). The highest changes in abundance were seen in the steppe where, unlike in forests, habitat conditions can change from favorable (in wet years) to unsuitable (in dry years).

Numbers of nesting birds are much more stable and change slowly compared to numbers of non-nesting species. Immature birds are the most mobile part of the population as they are not bound to a breeding territory. This is why they are the first to leave unsuitable sites and occupy other parts of the region. This was especially characteristic of the swan soose (*Anser cygnoides*).

The research showed the existence of small-scale (within the region) and large-scale (in the vast area in Dauria and Eastern Asia) circulation of bird populations. This was attributed to adaptation of the species to the natural processes of almost constant change in habitat conditions in Dauria and the Amur-Heilong River basin. During dry years the most favorable conditions were in the relatively wet zone of steppe-forests and during wet years the best habitats were on the dry steppes.

Knowledge of the relationship between bird numbers and climate conditions enabled predictions of the most significant risks for cranes and bustards during unfavorable periods. The movement of bustards from Mongolian steppes to Russian forest-steppes during dry periods is accompanied by an increase in poaching. For white-naped cranes and many other species of waterfowl during dry years a big problem is disturbance by people and domestic cattle. In Dauria, cattle farming is very developed and grazing sites and human settlements are tied to sources of fresh water. In dry years people and their cattle concentrate near the remaining water bodies (which are crane habitats) and this increases the frequency of disturbance to birds. Also in dry years the number of spring steppe fires increases, causing losses in bird populations. Because of these factors, bustards, cranes, and other rare birds of Dauria require special protection measures in years of unfavorable habitat conditions.

in inland zones broadleaf forests extended northward to 51 degrees north (**Map 1.5**). The region has gone through cycles of long droughts and humid periods, the last drought occurring in eastern Mongolia and northeast China just 3,000 years ago, when Mongolian, Daurian, and Manchurian flora came in close contact. These paleoclimatic factors contributed to the richness, complexity and sharp contrasts in species composition of

Map 1.6 Natural vegetation 18,000 years ago

Map 1.7 Natural vegetation 14,000 years ago

Map 1.8 Natural vegetation 12,000 years ago

Map 1.9 Natural vegetation 10,000 years ago

Map 1.10 Natural vegetation 8,000 years ago

Map 1.11 Natural vegetation 4,000 years ago

the Amur-Heilong River Basin (Qiu Shanwen 1990; Yin Huaining 1998; Liu Xingtu and Ma Xuehui 2002). The shift of natural vegetation zones during the last 20,000 years is depicted in **Maps 1.6 to 1.11**.

Climatic fluctuations often show cyclical patterns within short timeframes. The most obvious example of this is the cyclical pattern of water-abundant and water-deficit periods in Amur-Heilong River flow data at Khabarovsk (Novorotsky 2002, see **Figure 1.1**). During the past 110 years, full cycles can be observed in the periods of 1924-1944, 1936-1955, and 1955-1979. Water-abundant periods occurred in 1896-1916, 1926-1943, 1955-1966, while water-deficit periods were 1917-1927, 1967-1980 (Novorotsky 2002, Mandych et al. 2006).

A more complicated pattern of precipitation cycles has been observed in analysis extending from eastern Mongolia to Lake Khanka (**Figure 1.2**). Small, 9-12 year cycles coincide with the intensity of solar radiation, while more pronounced 20-25 year cycles resulted in minimum precipitation in the beginning of the 20th Century, in the 1920s, mid-1950s, late 1970s, and the early 21st Century. While the tendency is uniform for the Amur-Heilong basin, the onset of some drought periods may be delayed for 2-3 years. Eastern monsoon regions enter drought periods later and return to wet periods earlier than western locations such as Chita, Mongolia, and Inner Mongolia. Nevertheless this coincides well with observations made in Khabarovsk by Novorotsky (2002). Population dynamics and migration patterns of many species are closely linked to these cycles, as demonstrated for cranes, stork, bustard, and musk deer (Parilov et al. 2005, Podolsky et al. 2005). **Box 1.1** describes research at the Dauria International Protected Area (DIPA), a transboundary protected area involving Mongolia, Russia, and China, where bird abundance and distribution were closely linked to variations in precipitation.

The 20th Century witnessed climate change occurring 20-100 times faster than the typical 0.02^{0}C change per century — the natural rate of change in interglacial periods. Global air temperatures have risen 0.6±0.2^{0}C during last century alone. Such rapid warming has been associated with more frequent and severe floods, droughts, and winter thaws. In the temperate zone of the Northern Hemisphere precipitation is now increasing by 0.5-1% each decade, and rainstorms and flood disasters are more frequent. Temperatures in the eastern Amur-Heilong basin have risen 0.6^{0}C , while, in the central and western basins, increases have reached +1.7^{0}C at Blagoveshensk and even more in Chitinskaya Province. Winter temperatures have increased 1.5 to 2.5^{0}C, while summer became only 0.2 to 0.8^{0}C warmer. Over the past 20 years annual precipitation in the lower Amur increased over 11%, and, over the observation period beginning in 1890, precipitation increased by 31%. Interestingly, Amur-Heilong flow volume declined over the past 20 years by 3-5%. This was probably due to greater water consumption, increased evaporation, and declining infiltration due to reduced vegetation cover. Consequences of climate change for the Amur-Heilong basin ecosystem are discussed in Part Three.

Chapter 3

Hydrological features

Rivers

The Amur-Heilong is an immense river system (**Tables 1.1 and 1.2, Map 1.12**). Some Amur-Heilong tributaries, such as the Zeya and Songhua Rivers, flow for thousands of kilometers and, at their confluences with the main stream, discharge water in volumes almost equivalent to those of the Amur-Heilong itself. The stream network is dense throughout the Amur-Heilong basin except in desert areas near the China-Mongolia border. There are more than 172,000 rivers and streams with a combined total length of 800,000 kilometers in the Russia basin alone. Some 95% of those watercourses are less than 10 kilometers long. In the Russia basin only 245 rivers are more than 100 kilometers long. Due to climate differences, land degradation, and agriculture development the natural river network is less extensive in China. The Mongolian part of the Amur-Heilong River basin supports four large rivers — the Onon, Ulz, Kherlen and Khalkh Gol — with more than 400 tributaries and a total length of permanent streams of about 2,000 km.

The Amur-Heilong average annual discharge into the Pacific is 364 km^3 (Makhinov 2005) and this enormous flow (equal to 77% of the Mekong River and 7 times greater than the Yellow River) carries 15-24 million tons of sediment, for an average of 55 g of sediment per m^3 of water. On first impression the water in the Amur-Heilong seems quite clear. The average sediment load in the Amur-Heilong is similar to that of the Congo (heavily forested) or the Columbia River (intensively dammed), but is only 0.15% of the average sediment load in the world's most sediment-laden river, China's Yellow River (36 kg/m^3). The Amur-Heilong carries only 1.4% of the sediments transported by the world's second-most sediment-laden River, the Ganges.

Russia's portion of the Amur-Heilong flow is 258 km^3 (71%), while China accounts for 104 km^3 (29%), and Mongolia only 2 km^3 (0.5%) (ABWMA 2003). In Mongolia, many closed basins do not contribute to Amur-Heilong volume through surface flow. The total water resource of these basins is estimated at 8.3 km^3 (WWF-MN unpublished report). While these closed basins contribute no surface water, topography suggests that groundwater could reach the Amur-Heilong so we include these basins as part of the total Amur-Heilong system.

Principle Rivers in Headwaters

The Mongolia basin has many small, short rivers, many of which are frequently dry. These include the Shud, Gal, Chono, Mukhar, Guunii, Azragiin, and Khaniin. The Shud and Gal Rivers originally appeared after the 1960s. They both flow into a large inland depression to create Yakhi Lake, an endorheic basin. The water volume in Yakhi Lake increased in the early 1960s to 97 km^2. In recent years the water level and volume have both declined. The most prominent closed basin is formed by the **Uldz River** that originates in Norovlin *soum* of Khentii *province (aimag)* and drains into Torey Lake in Russia, just across the national border. The total basin area is about 35,000 km^2 and total length is 420 km. Annual mean discharge is 7.7 m^3/sec at Ereentsav station and in some high flow years the river discharge may reach up to 575 m^3/sec.

The Kherlen River (Kelulunhe) is shared by Mongolia and China and is often considered part of the Argun/Erguna River watershed. The total length of the Kherlen River is 1,264 km and its watershed area is appoximately 80,000 km^2. The river originates from the confluence of the Bogd and Tsagaan Rivers at an elevation of 1,750 m asl in the Great Henti Mountain Range and flows 1,090 km within Mongolia. The Kherlen River drains into Dalai Lake in China. The basin area in Mongolian territory is 75,000 km^2. The Kherlen River flows mostly in the steppe region where there are very few tributaries and the river has runoff loss only


110°
120°
50°
40°
Irkutskaya
IRKUTSK
Buryatiya
ULAN-UDE
R
U
S
S
SAKHA
Chitinskaya
CHITA
AGINSKOYE
Aginskiy Buryatskiy
Tov
ULAANBAATAR
Hentiy
Domod
M
O
N
G
O
L
I
A
ONDORHAAN
CHOYBALSAN
Suhbaatar
BARUUN URT
HAILAR
Inner Mongolia
Heilongjiang
BLAGOVES
C
H
I
N
HARBIN
CHANGCHUN
Jilin
SHENYANG
Liaoning
DPRK
Yanggang-do
Changang-do
Hamgy
LEGEND
SETTLEMENTS
Provincial capital
City (prefecture)
Amur basin boundary
Coast line
River
Lake, Reservoir
State boundary
Province
(oblast, krai, aimag,
autonomous region) boundary

in its downstream reach. Annual mean discharge is 25 m^3/sec at Baganuur, decreasing to 19 m^3/sec at Choibalsan. Annual mean discharge decreases to just under 18 m^3/sec near the Mongolia-China border. Average annual discharge into Dalai Lake is 0.52 cubic km (16.4 m^3/sec). During frequent drought periods the water level in Dalainor Lake is too low for surface water to flow downstream to the Argun River and the flow from the Kherlen River remains in Dalainor Lake. For this reason most contemporary sources on hydrology do not include the Kherlen and Khalkh Rivers in the Amur-Heilong basin.

The **Khalkh (KhalkhInGol, Halh, Halahahe) River** originates from the western slopes of the Great Hinggan Mountains in China and is shared with Mongolia. The **Nomrog** (218 km) and **Degee Rivers** (56 km) are the largest tributaries of the Khalkh River. Basin area of the Khalkh River is about 25,000 km^2 and the Mongolian part of the basin covers 14,000 km^2. Total length of the river is 399 km, of which 264 km flow through Mongolia. The Shariljiin River separates from the Khalkh River just before entering Buir Lake (about 32 km from river delta) and drains into Dalai Lake via the **Orshun (Orxon) River**. Annual mean discharge of the Khalkh Gol River at Sumber station is just over 18 m^3/sec. Average annual discharge of Orshun River into Dalai Lake is 0.69km^3 (21.9 m^3/sec).

The **Onon River** originates on the northeastern slope of the Khenty Mountain Range with a total river basin area of 96,200 km^2, of which 30,000 km^2 are located within Mongolia. The total length of the Onon River is 808 km of which 298 km flow through Mongolia.

Map 1.12 Rivers of the Amur-Heilong River basin

Several rivers on the Russian side, such as the **Khuya, Ashinga, Balj, Agats, Kher and Teren** drain into upper reaches of the Onon River. The confluence of Ingoda River in Russian territory and the Onon River form the origin of the Shilka River, which drains into the Amur. Annual discharge of the river averages 164 m^3/sec.

The **Argun River** is the southern source of the Amur-Heilong with a length of 1,620 km and watershed of 164,000 km^2 (Dalai-Buir Lakes Basin not included). It flows from the western slopes of the Daxing'an Mountains in China. In the upper reaches, it is called the Hailar River but changes to the Argun (Erguna) downstream from its confluence with the Xinkaihe Channel (Mutnaya River), which connects it to Dalai Lake. In dry periods of the climate cycle part of the Argun River flow drains into Dalai Lake via Xinkai Channel, while in water abundant periods the lake drains into the Argun River.

At that point Hailar mean annual discharge is 3-3.7 cubic kilometers/year (115 m^3/sec), but beginning in 2001, due to draughts and intensive water use, it never exceeded 1.5 cubic kilometers/year. Some 1,000 kilometers downstream at the Shilka River confluence the annual mean discharge of Argun is approximately 11 cubic kilometers/year and barely reaches 6 cubic kilometers/year in dry years. This river is vulnerable to droughts and excessive water use.(data of Chita Province hydrometeorologyy department). A long reach of the Argun from Muntaya mouth to the confluence with the Shilka forms the border between China and Russia.

The **Shilka River** is the northern source of the Amur-Heilong, formed by the confluence of the Onon and Ingoda, and is 560 km in length. The watershed area is 206,000 km^2. The Shilka is also a typical mountain river with high abrupt banks, a pebble- or boulder-lined riverbed, rapids, and waterfalls. The average water discharge of the Shilka is approximately 506 m^3/sec, but during summer floods can reach 9,000 m^3/sec. In the winter, discharge can fall to as low as 1 m^3/sec.

The **Ingoda (Ingedee) River** is the largest left-bank tributary of the Shilka River. Its total length is 708 km, watershed area is 37,200 km^2, and average discharge is 109 m^3/sec.

Where the Shilka and Argun join they form the Amur-Heilong River main channel and the right bank lies in China all the way downstream to the Ussuri-Wusuli River mouth.

Principle left bank tributaries of Amur-Heilong

The **Zeya River** is the largest left-bank tributary of the Amur-Heilong. The total length of the Zeya is 1,242 km and the watershed covers 233,000 km^2. The Zeya originates at the southern slopes of the Stanovoy (Wai Xing'an) Mountain Range. In its upper reaches the Zeya is a mountain river flowing between high and abrupt mountain slopes, then, blocked by the Tukuringra Range it creates the Upper-Zeya lowlands, now almost flooded by the Zeya Hydropower Plant (HPP) Reservoir. After passing the Tukuringra Gorges and its confluence with the Selemzha River, the Zeya flows onto the plains where its current slows, the valley widens, and many tributaries enter the main flow. Average annual discharge is high at 1,810 m^3/sec. Spring and summer floods are characteristic, and can reach volumes of 14,200 m^3/sec. Winter discharge can drop to 1.5 m^3/sec. Water levels fluctuate over a range of 9-10 m from year to year and between seasons. The main Zeya tributaries are the **Gilyui River** (length 490 km, watershed area 21,600 km^2) and the **Selemzha River** (549 km, 70,900 km^2). The hydrologic regime and environment of the Zeya River were altered by the Zeya dam built in 1975, as discussed in Part Three.

The **Bureya River** is the second largest left-bank tributary of the Amur-Heilong. The Bureya originates on the northern slopes of the Bureinsky Mountain Range, is 739 km in length, and covers a watershed of about 70,700 km^2. In its upper reaches above Paikan Village the Bureya has a mountain-stream character, flowing at high velocities of 2 m/sec and higher. In its lower reaches it flows across the Zeya-Bureya plains where it braids into many channels. The annual average discharge of the Bureya is 932 m^3/sec. The largest Bureya tributary is the **Tyrma River** (length 313 km and watershed area 15,200 km^2). The water regime and environment of the Bureya were altered by the Bureya dam built in 2003 (see Part Three).

The **Amgun River** is a tributary of the Lower Amur nearest the river mouth and lies entirely in Russia. The Amgun originates in the northern part of Bureinsky Ridge and flows into the Amur-Heilong just upstream from the Russian city of Nikolaevsk. The Amgun is 723 km long and covers a watershed of about 55,500 km^2. Average annual discharge is 660 m^3/sec. In its upper reaches the Amgun is a typical mountain stream. Downstream from Osipenko Village, the Amgun grows wider and deeper, and the current slows.

Principle right bank tributaries of Amur-Heilong

The **Huma (Humahe, Kumara) River** is a large right-bank tributary of the Upper Amur-Heilong, draining the northeast slopes of the Great Hinggan (Daxing'anling) Mountain Range. It is only 524 kilometers in length, but discharges 7.6 km^3 annually. Its watershed was severely damaged by catastrophic fires in the 1980s and for the last 20 years it has been targeted for development of a hydropower cascade and subsequent water transfer to the Nen River basin.

The **Songhua River** flows from Tianchi (Pool of Heaven) Lake in the Changbai Mountains of Jilin Province, China. The lake is shared with North Korea, therefore many sources rightfully state that about 100 km^2 of the Amur-Heilong watershed lies within the Democratic Peoples Republic of Korea (DPRK). In the upper reaches it is called the Second Songhua River, and at its confluence with the Nen River it becomes the Songhua River for the last 939 km of its journey to join the Amur-Heilong.

The Songhua basin covers about 560,000 km^2 and annually discharges approximately 82 km^3. If the Nen River (northern source) is considered the main source, then the total river length is 2,309 km. In contrast, if the **Second Songhua River** (the southern source) is taken as the main source, then the total length is shortened to 1,897 km. The width of the river in the Song-Nen plain is 370-850 m, in the middle reaches, constrained by mountains, the width decreases to 290-330 m, and closer to its mouth in the Sanjiang Plain, it widens once again to 1,500-3,000 m. The Songhua is a typical river of plains with slow current and gently sloping banks. Based on its width, some ancient geographers described the Amur (ancient: "Shilkar") as a tributary of the Songhua River (ancient: "Shungal")(Nevelsky 1878).

The **Nen River** is the largest tributary of the Songhua basin. It originates in the Yilehuli Hills of the Great Hinggan (Daxing'anling) Range. The Nen River is 1,370 km long and its watershed covers 298,500 km^2, and includes 9,000 km^2 of closed basins. At its confluence with the Songhua River on the Song-Nen plain the Nen River discharges 29 km^3 annually, while the Second Songhua River contributes 16-17 km^3. By 2005 the upper reaches of both rivers were regulated by large dams.

The **Mudan River** is the largest right-bank tributary in the lower basin of the Songhua River. The Mudan originates in the Mudan Mountains in northern Jilin Province and exceeds 726 km in total length and 7.6 km^3 in annual discharge.

The Ussuri-Wusuli Border River

The **Ussuri-Wusuli River** is a Russia-China border river and the second largest right-bank tributary of the Amur-Heilong after the Songhua. It is called the Ussuri River in Russia and the Wusuli River in China. It originates in the southern Sikhote-Alin Ridge in Russia near Oblachnaya (Cloudy) Mountain. The watershed covers 193,000 km^2 of which about 30% lies within China with the remainder in Russia. The length of the River is 897 km. Because of its geographic location near the Pacific Ocean and its consequently abundant precipitation, the Ussuri-Wusuli is a water-rich tributary of the Amur-Heilong. Its average discharge is approximately 1,620 m^3/sec. The river width varies from 10 m to 2.5 km. In its upper reaches the Ussuri-Wusuli is very wide with many islands, wetlands, and meadows. The right bank in the middle reaches lies adjacent to mountains covered with dense taiga woods. In the lower reaches, some 140 km, from its mouth the Ussuri-Wusuli widens again with many braided channels, islands, and valleys. The main tributaries of the Ussuri-Wusuli are: the **Mulinghe, Naolihe, Songacha, Arsenievka (Daubihe), Bolshaya Ussurka (Yiman), Bikin, and Khor (Chord)**.

Lakes

The total natural lake area of the Amur-Heilong basin is well over 20,000 km^2. Russia's Amur-Heilong River basin has over 25,000 lakes and a total water surface area over 15,000 km^2 (71% of basin lake area). The vast majority of these are small floodplain lakes along the Amur and its main tributaries, each with surface areas less than 1 km^2. The largest lakes in the basin are: Khanka (shared with China), Barun-Torey, Zun-Torey, Bolon, Chukchagir, Evoron, Orel, and Udyl. China's portion of the Amur-Heilong River basin has approximately 10,000 lakes with a total area close to 4,500 km^2. The largest of these are: Khanka-Xingkai (shared with Russia), Dalai, Buir (shared with Mongolia), Chagan, and Jingpo. In Mongolia there are more than 400 smaller lakes covering a total area of about 1,450 km^2. Numbers, sizes and volumes of lakes in floodplain areas change with fluctuations of the flooding regime. Lakes in the Mongolian steppe and throughout the western part of the basin are characterized by dramatic fluctuations in volume and area. Often they are dry depressions, sometimes with salt marshes. The total area and volume of lakes and wetlands in Inner Mongolia and Mongolia also changes according to climatic cycles.

Barun-Torey Lake is located near the border between Russia and Mongolia in the Chitinskaya (Chita) Province of Russia. Its surface area is 550 km^2, maximum depth 4.6 m, and volume 1.38 km^3. Near Barun-Torey Lake is the smaller **Zun-Torey Lake** with a surface area of 285 km^2, maximum depth of 6.76 m, and volume of 1.62 km^3. During the last 200 years these lakes have nearly gone dry several times. Together with the Uldz River they form one of the endorheic basins that do not drain to the Amur-Heilong River.

Buir (Bei'erhu, Buyr Nuur) Lake is the largest lake in the Mongolia part of the Amur-Heilong basin and the fifth largest lake in Mongolia. The lake is located in the transboundary area of Mongolia and China and is fed by the Khalkh River. Water surface area of the lake is 615 km^2, and maximum depth is 10.4 m. The lake basin area is 25,000 km^2 and mean volume of the lake is 3.8 km^3. In low flow years, mean depth is about 5.7 m with a volume of 3.5 km^3. In high flow years the mean depth increases to nearly 7 m with a corresponding increase of volume to 4.3 km^3. In China, the Orshun River originates from the lake delta and drains into Dalai Lake. and thus the northeastern part of lake water is fresher. Lake mineralization varies from 180 mg/l in a high flow year to 375 mg/l in a low flow year. Buir Lake is very rich in plankton, benthic invertebrates, and other aquatic biota and is one of the most biologically rich lakes in Mongolia. Twenty nine species of fish inhabit Buir Lake. In relative warm and high mineralization years fish reproduction increases significantly.

Dalai (Hulunhu, Dalainor) Lake is the 5th largest lake in China. It lies between Manzhouli City and Xinba'erhuzuoqi County west of the Hulunbei'er grasslands of Inner Mongolia. The lake is 93 km long, 447 km in circumference, 32 km in average width, and 41 km at its greatest width. In water abundant years it contains up to 14 km^3 of water, with a surface area of 2,339 km^2 and average depth of 5.7 m. The largest river tributaries of Dalai Lake are the Kherlen and Orxon. The Dalai-Buir lakes basin covers about 140,000 km^2 if the Kherlen, Khalkh and Oshun Rivers are considered together. The Mutnaya River, later substituted by the man-made Xinkaihe channel connects Dalai Lake to the Argun watershed, although lake discharge is insignificant to the volume of the Argun, and in dry periods ceases completely. Since 2000 the water levels of Dalai Lake have dropped sharply, suggesting that it might again dry up into a network of shallow pools, similar to the situation observed in 1904 (see Chapter 5 for details)

The **Song-Nen Plain** near the confluence of the Nen and Second Songhua Rivers has several dozen large and many thousand small shallow lakes that fluctuate in area and depth with climate cycles. **Chagan Lake** in Jilin Province is the largest one. Prior to the construction of flood-control dykes to contain the Songhua and Nen Rivers these lakes filled during floods and provided habitats for millions of migrating and breeding waterfowl. After flood control blocked the supply of flood waters from the main river channels, these floodplain lakes dried and were often converted to farmlands (see Chapter 5).

Bolon Lake is located in the Lower Amur, south of the city of Komsomolsk-on-Amur in Khabarovsky Krai. Its surface area ranges from 324-612 km^2 depending upon the water level of the Amur-Heilong. Maximum depth is 5 m and the water volume is approximately 0.5 km^3 in dry years.

Hummy Lake is located downstream from Bolon along the right bank of the Amur-Heilong with a surface area of 117 km^2 and approximate volume of 0.2 km^3.

Lake Evoron (194 km^2 and approximately 0.2 km^3) and **Lake Chukchagir** (355 km^2 and approximately 0.7 km^3) are the main water bodies of the Evoron-Chukchagir Depression. Lake Evoron discharges to the Amur-Heilong via the Gorin River while Chukchagir Lake discharges via the Amgun River.

Lakes Udyl and Bolshoe Kizi are the two main water bodies downstream. Each is about 300 km^2 in surface area and 0.5 km^3 in volume.

The last group of large lakes downstream consists of **Orel Lake** with a surface area of 314 km^2 and volume of 0.3 km^3 and **Chlya Lake** with surface area of 140 km^2 and volume of 0.2 km^3. Both are located on the left bank near the Amur-Heilong mouth.

Khanka-Xingkai Lake is shared by Russia and China, is the largest lake in the Amur-Heilong River basin, and one of the largest freshwater lakes in East Asia. The lake is called Khanka in Russian and Xingkai in Chinese. There are 24 rivers and streams flowing into the lake with 4 cubic km inflow and only one — the Sung'acha River, a tributary of the Wusuli-Ussuri, flowing out. Eight tributaries of the lake are in China and the remaining 16 are in Russia. The lake is 90 km long by 70 km wide and covers 4,380 km^2 (1,080 km^2 or one fourth in China). The normal water volume ranges from 18-26 km^3 and the maximum depth is 11 m. The lake consists of two parts — Small Xingkai Lake and Big Khanka-Xingkai Lake. The watershed includes 1,163 additional small lakes in Russia. Small Xingkai Lake lies completely within China and has an area of 180 km^2 and maximum depth of 3 m. The Khanka Lake watershed covers 16,890 km^2, of which 15,370 km^2 lie within Russia.

The China portion of the basin has several famous volcanic lakes. One of these is the source of the Songhua River, **Tianchi** (Pool of Heaven) at the top of Chanbaishan, a peak of international cultural importance on the China-Korean border, a national nature reserve in China, and a UNESCO Man and the Biosphere Reserve. Others are **Jingbo Lake** in the upper reaches of the Mudan River, and a lake group called **Wudaliangchi** (Five Big Cool Pools) in the upper Nen River basin. All these locations are important destinations for nature tourism in China.

Reservoirs

By year-end 2000, there were more than 13,000 reservoirs (storage works) in the China part of the Amur-Heilong basin holding more than 35 km^3 of water (ADB 2005), or nearly 10% of the annual discharge of the Amur-Heilong River. Xiaofengman Dam near Jilin City is the oldest large dam on the Second Songhua and at least 20 other dams are now in operation on the Songhua. Another large dam, Ni'erji dam, was completed in 2005 on the Nen River upstream from Qiqiha'er City. There are approximately 300 reservoirs in the Russia basin, less than 3% the total number in China. However, just one of them, the "Zeya Sea," at 68 km^3 in volume, exceeds the entire storage volume in all reservoirs in the China portion of the basin. The Mongolia basin does not have any large reservoirs (see Chapter 3 for discussion of water infrastructure)

Wetlands

Wetlands other than rivers and lakes are also valuable components of the Amur-Heilong ecosystem. They regulate and mitigate floods, improve water quality, and provide food, habitat, and breeding sites for many animals, especially fish and waterfowl. Wetland formation is determined by uneven seasonal distribution of precipitation, permafrost, heavy and poorly drained clay soils, and well-developed floodplains. The distribution of wetlands across the Amur-Heilong basin is patchy according to variations in topography and climate. Most of them are inseparable parts of larger river and lake systems described above.

Lacustrine wetlands are located around lakes and include lake valleys. These wetlands form around permanent and temporary lakes, fresh and saltwater lakes. The largest wetlands of this type are located near lakes Khanka-Xingkai, Buir, Torey, Dalai, and lakes of the lower Amur floodplain.

Palustrine and swamp-meadow wetlands of the basin are mainly found in low-lying lands on the Song-Nen plain, Sanjiang plain, along the Orshun and Argun rivers, Zeya-Bureya plains, plains of the Lower Amur-Heilong, and Khanka lowlands. Most of those are sustained by flood regimes of large river systems.

Forest swamps in boreal larch forests are prominent features of the northern part of the basin. These occupy the largest areas in Amurskaya and Khabarovsky Provinces, but are also abundant in mountainous headwaters of most tributaries, especially in the eastern half of the basin. They often form along sedge hummock meadows in floodplains of mountain streams. Small peat bogs are found in headwaters of minor streams throughout the northern part of the basin and in all mountain ridges. However, these forest swamps typically are not inventoried as wetlands due to their small size.

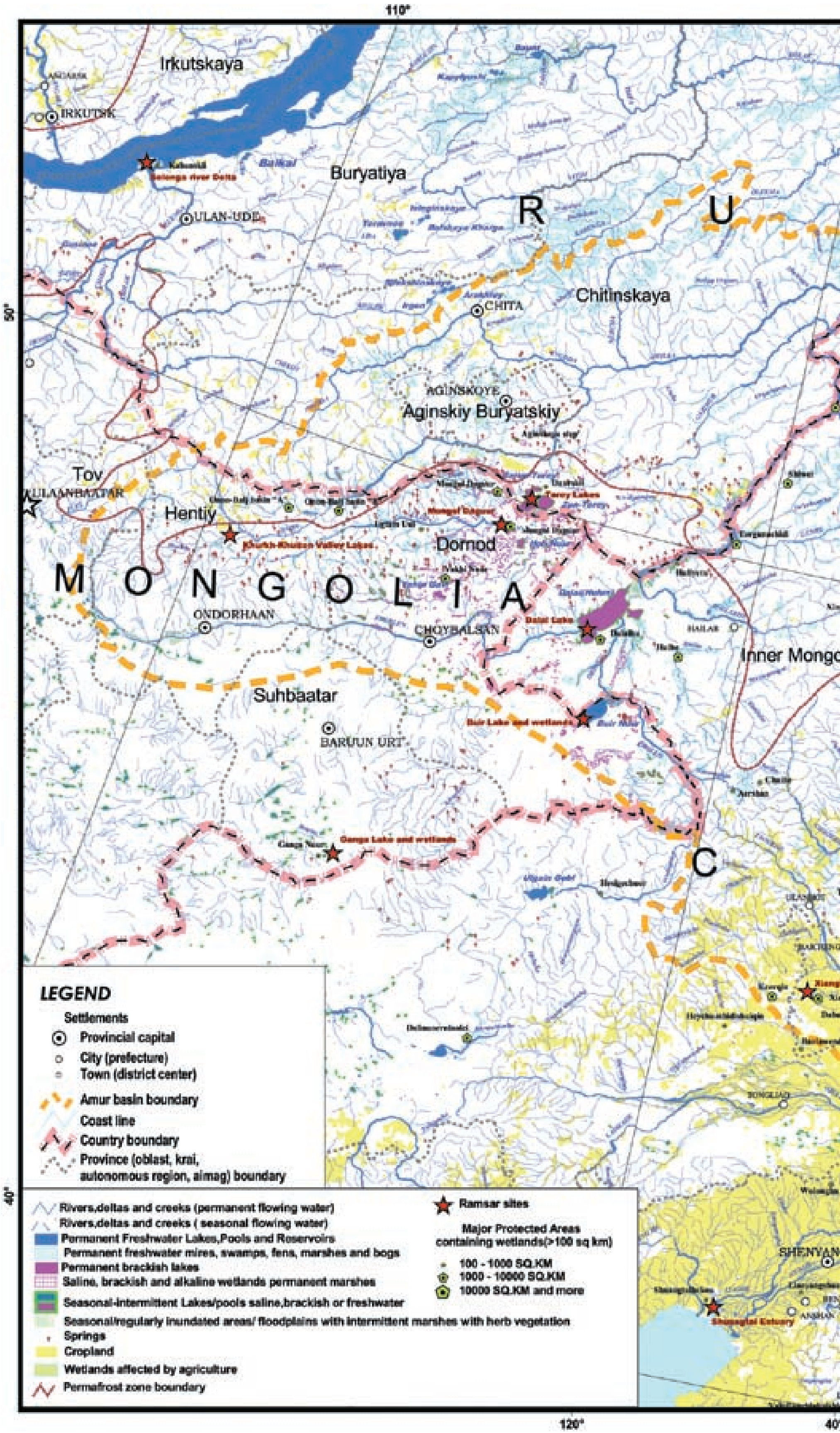
Permanent and seasonal pools, often brackish or alkaline, are prominent features of steppe areas in the western part of the Amur-Heilong basin.

Unfortunately no consistent comparative information is available on wetland types and their distribution in the transboundary basin due to the different approaches to land inventories in the three countries. Drought cycles also complicate the picture, since any given wetland will differ dramatically in area depending on water abundance in a given period. Due to legal requirements in China to protect all wetlands, China currently has more comprehensive inventories than the other two basin countries. However, only wetlands greater than 100 ha are subject to inventory and protection, which effectively excludes some wetland types. Detailed descriptions of basin wetlands are presented in recent reviews by Li Xiaomin (2006) and Bocharnickov (2005). Results of our own preliminary inventory of wetland distribution (based on available maps and databases) following very general wetland classification prescribed by Ramsar Convention is presented on **Map 1.13**.

According to the Chinese Academy of Engineering 2002 wetland inventory (CAE 2005), northeast China's wetlands cover 101,700 km^2. 29,300 km^2 of these are lakes and rivers, 65,700 km^2 are mires, fens and bogs, and 6,600 km^2 are maritime wetlands. Approximately 7-10% of these northeastern China wetlands and all maritime wetlands are found outside the Amur-Heilong basin and must be excluded from our consideration, leaving approximately 85,000 km^2 of wetland area within the basin. Of these, 45,200 km^2 are mountain wetlands (44%) and 56,500 km^2 are plains wetlands (56%). There are also 30,000 km^2 of rice paddies. Figures above correspond relatively well with a figure of 43,400 km^2 of natural wetlands in Heilongjiang Province (Kang Tiedong, unpubl. data 2006).

Total area of mires, fens and bogs (peatlands) in northeast China declined over 42% from 114,000 to 66,000 km^2 during the 50 year period prior to 2002.

In Russia peatland inventories contain reliable information but they do not cover other types of wetlands. According to the Amur Basin Water Management Authority (ABWMA), the entire basin includes at least 131,000 km^2 of peatlands with peat deposits thicker



Map 1.13 Ramsar sites, other wetlands, and land use

120°
130°
140°
SAKHA (Yakutia)
Sea of Okhotsk
Amurskaya
Khabarovskiy
Sakhalin
BLAGOVESHCHENSK
Zeya-Bureya Plains
BIROBIDZHAN
Yevreiskaya
KHABAROVSK
Heilongjiang
HARBIN
CHANGCHUN
Jilin
Primorskiy
VLADIVOSTOK
YUZHNO-SAKHALINSK
JAPAN
Sea of Japan
Liaoning
DPRK
CHONGJIN
Hamgyong-bukto
Yanggang-do
Changang-do
©WWF Russia 2006
©WWF China 2006
©WWF Mongol 2006
©TIGIS, PGI FEBRAS 2006
©Egidarev E.G. 2006
©Simonov E.A 2006
WWF
200 0 200 Kilometers

than 30 centimeters (**see Table 1.3**). Alternative estimates for Russia are available in a report on Russian Far East wetlands by Bocharnikov et al. (2005). Comparable figures for Mongolia do not exist because a systematic peatland inventory is still in progress (Minaeva 2005).

Table 1.3 Wetland (peatland) area in selected sub-basins in Russia

Russia river basin	Area (thousand km²)
Lower Amur	58.0
Zeya	49.2
Shilka	8.6
Ussuri	6.6
Bureya	5.5
Argun	3.1
Total in Russia:	131.0

(data from Russian Amur Basin Management Bureau 2003)

Given the immense importance of wetland ecosystems of Amur-Heilong Basin detailed inventory of wetland types and current status of wetland complexes in all major sub-basins is a necessary urgent task.

Flood regime

Water flow in the Amur-Heilong basin varies widely between seasons and years. At Komsomolsk City on the lower Amur average annual flow is 10,900 m^3/sec. This is shown in comparison to the world's ten largest rivers in **Table 1.4**. Maximum flow is 37,900 m^3/sec and minimum recorded flow is just 345 m^3/sec, less than 1% of the maximum. In Russia it is believed that large floods occur once every 11-13 years in the middle Amur-Heilong but recorded history shows a much more complicated, although cyclical pattern (**Figure 1.4**).

Summer monsoon rains occur in most of the basin and cause the floods that are common on most Amur-Heilong basin rivers. Floods are one of the most important natural processes and determine in part the diversity and productivity of the Amur-Heilong ecosystems. The shaping and dynamics of the vast floodplain wetlands, the major nutrient cycles, and the life-cycles of all aquatic flora and fauna depend primarily on the periodicity, volume, and other characteristics of floods.

In Mongolia annual distribution of precipitation shows that 70 percent of precipitation falls in July and August, although the period from June to the end of September is the rainy season. When daily rainfall reaches 40-60 mm, floods usually occur along the rivers. During the late-summer flood period there are 2-3 flood peaks along the Onon, Udlz, Khalkh Rivers and in the upstream basin of the Kherlen River. During the summer rainfall flood, annual maximum river discharge occurs. For example, flood discharge of the Udlz River reaches 575 m^3/sec, the Kherlen River 1,260 m^3/sec, and the Khalkh Gol River discharges up to 2,440 m^3/sec. Heavy rainfall not only produces floods along the big, permanent rivers but also in small rivers, and dry beds can produce heavy flooding, so called "flash floods" which also may cause severe property damage.

Table 1.4 Average discharge rate of the ten largest rivers of the world compared to the Amur-Heilong

River	Country	Average discharge rate ('000 m^3/second)
Amazon	Brazil	212.4
Congo	Congo	39.6
Yangtze	China	21.8
Brahmaputra	Bangladesh	19.8
Ganges	India	18.7
Yenisey	Russia	17.4
Mississippi	USA	17.3
Orinoco	Venezuela	17.0
Lena	Russia	15.5
Parana	Argentina	14.9
Amur-Heilong	**Russia-China**	**11.3**

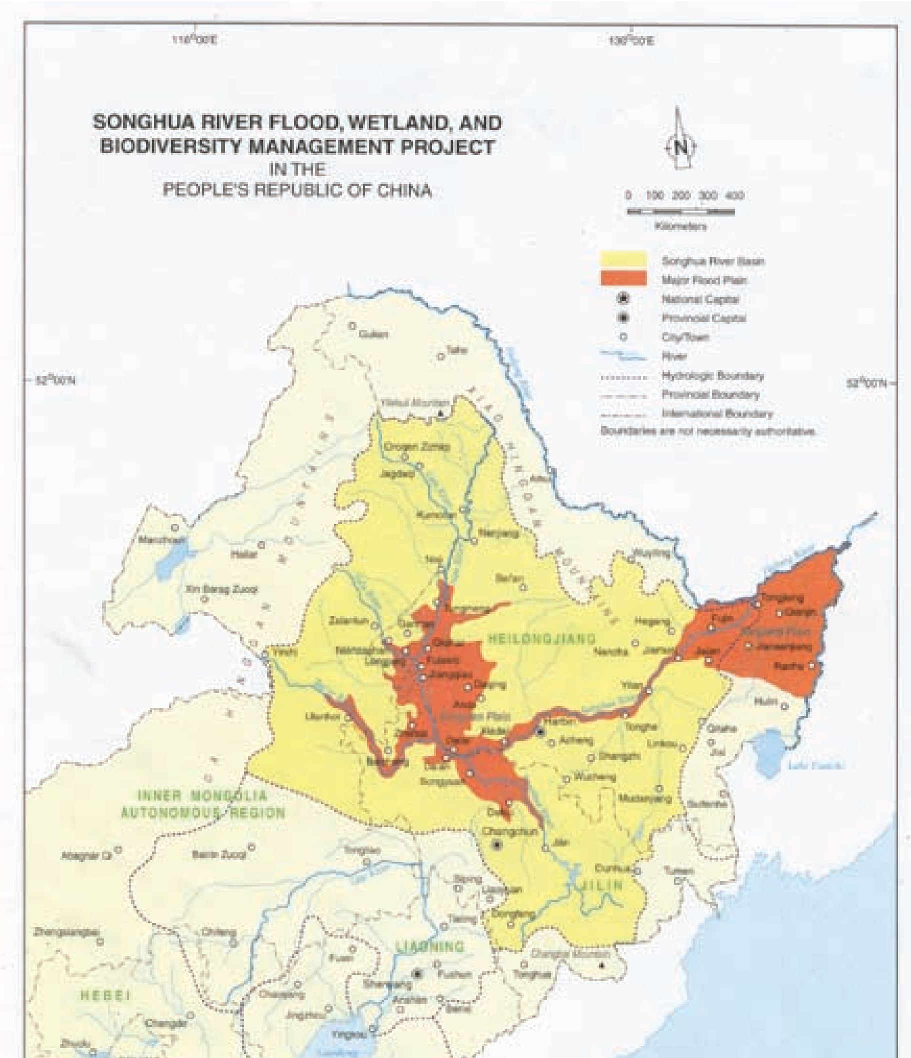
In the upper and middle reaches of the basin, water levels vary over a range of 10-14 m during the year. In the lower Amur, the water level range is 6-7 m. On average there are 4-6 floods each year, increasing to 6-9 on small rivers. During floods the water surface of the lower and middle Amur-Heilong may expand to widths of 10-25 km. Waters often remain on the floodplain for extended periods. For example, in 1993 the floodplain in the Chita region of Russia was inundated 0.7-1.5 m above the normal water level and the water remained at that level for nearly two months. Most floods occur in the latter part of summer and autumn, and are caused by monsoon rains. Spring floods are caused by snowmelt and occasional ice jams in the larger rivers. The spring floods are usually less damaging than those in summer.

Flooding is considered not only one of the most important ecological characteristics of the Songhua River basin, it is also the most important economic problem. Floods recur regularly on the Nen and Songhua plains and are the primary agent that shaped the plains and developed the extensive wetlands. Several million hectares of the largest inland freshwater wetlands of China are located on the Song-Nen plain in western Heilongjiang Province and on the Sanjiang plain in northeastern Heilongjiang Province, east of the Songhua River basin (**Map 1.14**).

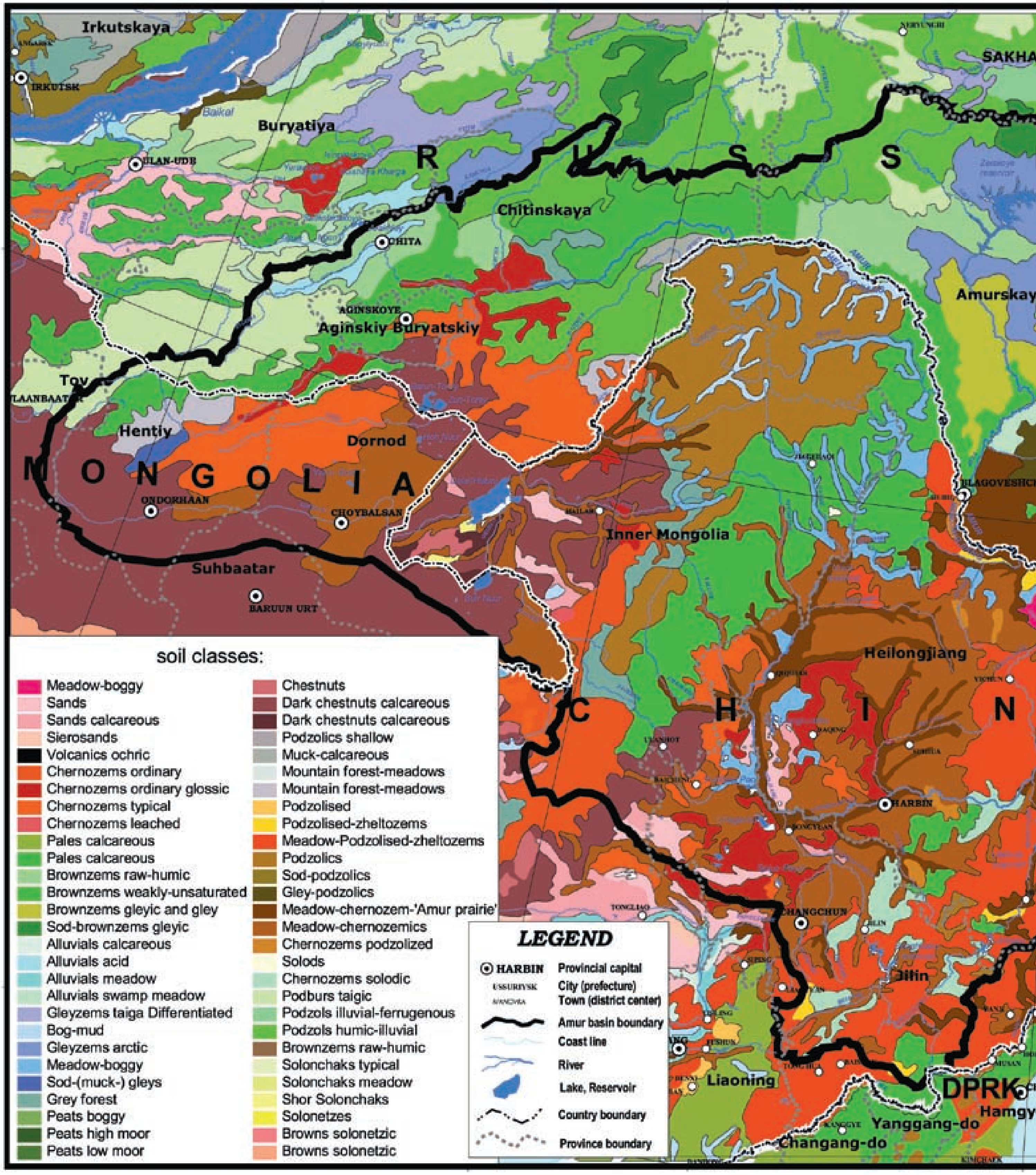
In June to August 1998, the most severe flooding on record in the Nen and Songhua River basins was caused by simultaneous monsoon rainfall in the headwaters of both rivers. Floods of this magnitude are estimated to recur on average only once in 150 years. The 1998 floods affected most of the Song-Nen plain in eastern Inner Mongolia Autonomous Region (IMAR), western Heilongjiang Province, and northern Jilin Province. The 1998 flood created lakes larger than 8,000 km^2 in Jilin and Heilongjiang Provinces. More than 7.54 million people were relocated to higher ground, some of whom were still waiting 6 months later for waters to recede before they could return to their homes and villages. Water-logging lasted for two years on some parts of the flood plain.

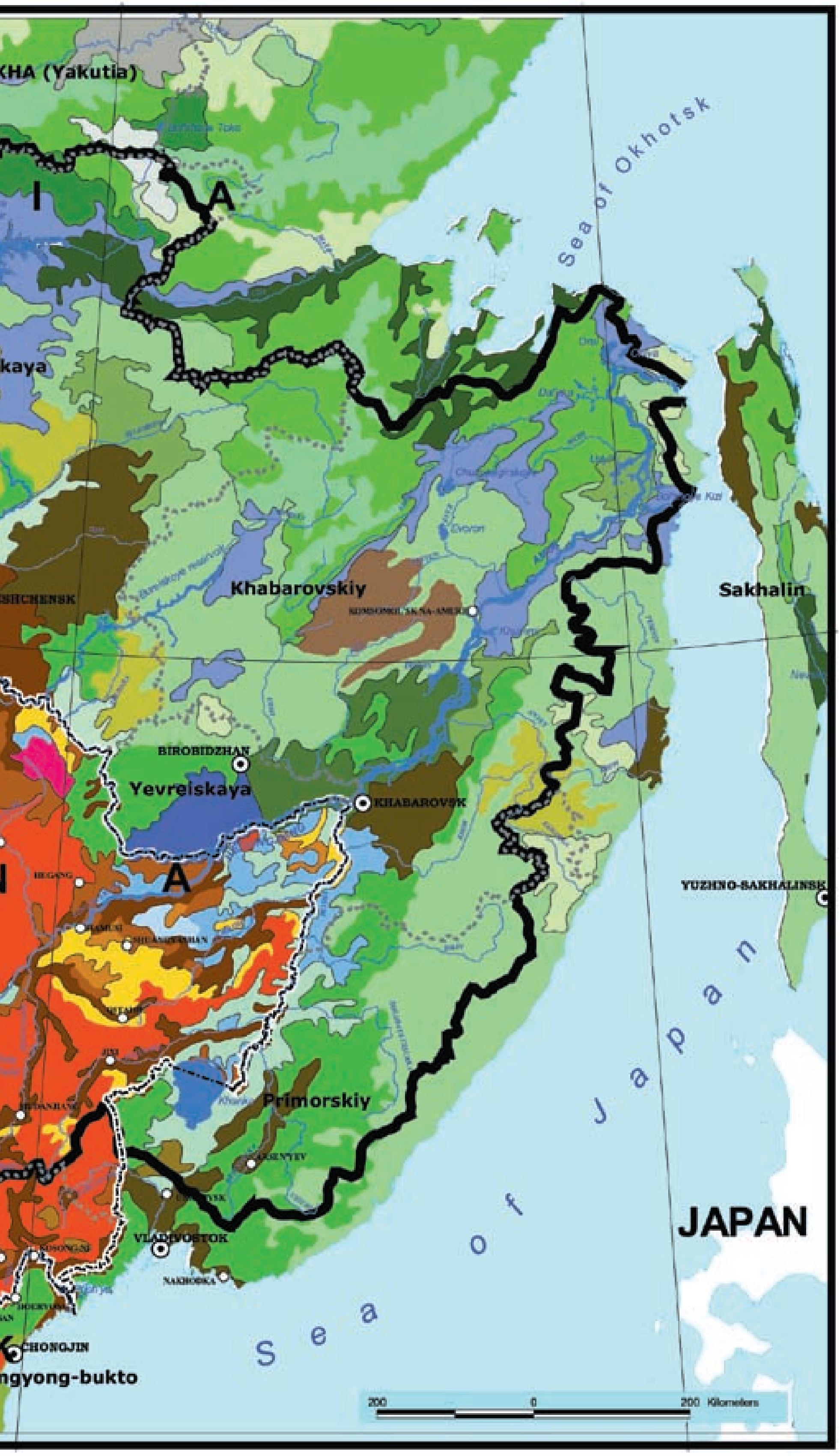
A total of 154 people lost their lives during the 1998 floods. The floods caused incomes of 1.8 million people in the three provinces to fall below the government poverty threshold. The floods disrupted social and economic activities of some 16.1 million people (6.5 million in IMAR, 8.5 million in Heilongjiang Province, and 1.1 million in Jilin Province). There was extensive damage to houses, crops, livestock, fish farms, commercial premises, and infrastructure including roads, bridges, railways, power transmission, irrigation systems, water storage and reticulation, sewerage reticulation, drainage systems, and flood protection facilities. Floods damaged over 937,000 hectares of farmland, 2,600,000 hectares of grasslands, 89,000 hectares of fish ponds and 126 water reservoirs (Beach 1999). Damage costs to IMAR, and Heilongjiang and Jilin Provinces were estimated at \$1.8 billion, \$3.6 billion, and \$1.7 billion, respectively.

The 1998 floods together with similar events in the Yangzi, Liao and other river basins pushed Chinese water management authorities to rethink the paradigm of "flood prevention" and to shift from engineering approaches toward adaptation to natural processes (see Part Three for detail on flood policies).



Map 1.14 Northeast China showing the Songhua River basin and its major floodplain (Source: ADB-GEF Songhua River Flood, Wetland and Biodiversity Management Project, Midterm Report 2000)


Irkutskaya
IRKUTSK
Baikal
Buryatiya
ULAN-UDE
R
U
S
S
SAKHA
Chitinskaya
CHITA
AGINSKOYE
Aginskiy Buryatskiy
Amurskay
Tov
Hentiy
Dornod
M O N G O L I A
ONDORHAAN
CHOYBALSAN
Suhbaatar
BARUUN URT
Inner Mongolia
BLAGOVESHCH
Heilongjiang
C
H
I
N
HARBIN
CHANGCHUN
Jilin
Liaoning
DPRK
Yanggang-do
Changang-do
Hamgy
soil classes:
Meadow-boggy
Sands
Sands calcareous
Sierosands
Volcanics ochric
Chernozems ordinary
Chernozems ordinary glossic
Chernozems typical
Chernozems leached
Pales calcareous
Pales calcareous
Brownzems raw-humic
Brownzems weakly-unsaturated
Brownzems gleyic and gley
Sod-brownzems gleyic
Alluvials calcareous
Alluvials acid
Alluvials meadow
Alluvials swamp meadow
Gleyzems taiga Differentiated
Bog-mud
Gleyzems arctic
Meadow-boggy
Sod-(muck-) gleys
Grey forest
Peats boggy
Peats high moor
Peats low moor
Chestnuts
Dark chestnuts calcareous
Dark chestnuts calcareous
Podzolics shallow
Muck-calcareous
Mountain forest-meadows
Mountain forest-meadows
Podzolised
Podzolised-zheltozems
Meadow-Podzolised-zheltozems
Podzolics
Sod-podzolics
Gley-podzolics
Meadow-chernozem-'Amur prairie'
Meadow-chernozemics
Chernozems podzolized
Solods
Chernozems solodic
Podburs taigic
Podzols illuvial-ferrugenous
Podzols humic-illuvial
Brownzems raw-humic
Solonchaks typical
Solonchaks meadow
Shor Solonchaks
Solonetzes
Browns solonetzic
Browns solonetzic
LEGEND
HARBIN Provincial capital
USSURIYSK City (prefecture)
Town (district center)
Amur basin boundary
Coast line
River
Lake, Reservoir
Country boundary
Province boundary



Chapter 4

Soils

Distribution of soils in the basin is determined by climate, geological history and topographic relief. On the floodplains and in the lowlands the dominant soils are alluvial, meadow, and swamp types. The first upper floodplain terrace is covered with meadow podsolic, meadow gley, and black soils. The second floodplain terrace is covered by brown and dark brown forest soils, meadow brown, meadow black, black, and grey forest soils. The lower elevations of the mountains are dominated by brown soils of coniferous forests and brown forest gleys, with podsolic and swamp podsolic soils also present. Higher mountains occasionally have mountain cryomorphic taiga soils found at elevations of 2,000 meter above sea level. The western grasslands are dominated by steppe kastanozem soils, which cover more than 64% of the Mongolian basin area. Intra-zonal solonchank and solonetzic soils are also widely distributed in the drier western part of the region.

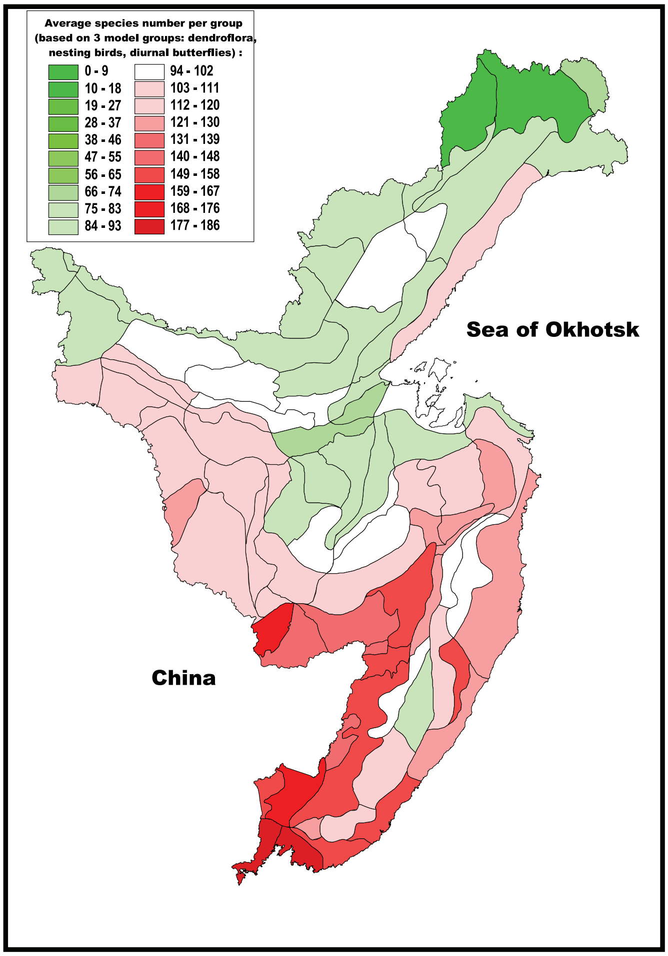
Soil classification systems differ in the three basin countries and this complicates description of soil types across the basin. One example of a cooperative soils classification scheme is the “Joint Russian-Chinese Scheme for Amur and Argun” of 1993 (Volume VI: Soils, attachments 2 and 3, V. F. Ladygin, Chief Engineer). Complex geomorphology and a highly variable climate have led to formation of generally diverse and complex soil profiles throughout the basin (**Map 1.15**).

Map 1.15
Classification of soils in the Amur-Heilong River basin

Chapter 5

Biodiversity and Biogeographic Zones

Compilation of this chapter has been a challenging task. We initially intended to take an academic approach by discussing diversity of major taxa and various schemes of plant geography. However, we soon discovered that transboundary communication has yet to be mastered even on these narrowly defined scientific subjects. Species lists and maps from the three basin countries still require a lot of collaborative work before they can be merged into one. For example, detailed biogeographic zoning and assessment of species diversity for conservation purposes has been completed for the Russian Far East (Martynenko et al. 2004), but comparable data are not available for China and Mongolia (**Map 1.16**).



Map 1.16 Species diversity indices in the Russian Far East

To provide a general idea of vegetation zoning and the status of land cover around 2000 we present here a phytogeography map based on the work of Sochava (1969), that despite inaccuracies, remains the best recognized classification system for the region and has been incorporated into many world-wide databases (**Map 1.17**). However, this map should be compared with more current maps based on interpretation of satellite imagery. Here we provide two of the most informative products currently used in world databases: One addresses vegetation/land cover types (**Map 1.18**), and the second, by University of Maryland, depicts vegetation cover density (**Map 1.19**). These maps are components of global databases and are generalized. More detailed regional analysis of land cover, vegetation and landscapes of the Amur-Heilong basin was undertaken beginning in 2005 by the Pacific Institute of Geography in Vladivostok, Russia and is expected to be available for public use shortly after completion of the project in 2008.

To put the Amur-Heilong basin in the context of world-wide discussions of biodiversity hotspots we include five maps showing relative species richness of taxonomic groups including mammals, vascular plants, breeding birds, and diurnal butterflies (**Maps 1.20, 1.21, 1.22 and 1.23**). All maps on animal species distribution show that the Amur-Heilong basin has outstanding species richness in comparison with surrounding expanses of Asia and is surpassed only at southern latitudes south of the Yangzi River. The distribution maps included here (except for distribution of butterflies) were all derived from continent–wide and/or global databases that show general trends in species richness distribution. Confirmation of these general trends through field studies shows different results, particularly at well-studied sites such as nature reserves and field research stations.

More importantly, we realized that compiling total species lists of all taxa across several biomes makes little scientific or practical sense in such a diverse area as the Amur-Heilong basin. In the future, the most applicable conservation research will be done within ecoregions or groups of ecoregions that are affected by similar natural and anthropogenic factors. Because of these difficulties, we confined our efforts to a comparative description of the main ecoregions and the most prominent threatened species within them. We hope that the simple descriptions of ecoregional features provided below will be very useful for understanding this incredibly biodiverse region.

Landscape Diversity and zoning

Several geographic factors contribute to the tremendous biological diversity of the Amur-Heilong River basin:

- from north to south the basin encompasses boreal and temperate zones and extends southward into the northern tip of the subtropics;
- from west to east there is a tremendous climatic gradient from cold continental to humid monsoon climates;
- during glacial periods, most of the basin had numerous refugia not covered by ice;
- mountain ranges cross the region longitudinally, latitudinally, and diagonally, thus adding landscape-scale diversity to the basin;
- large river systems are migration corridors, allowing for dispersal of flora and fauna, and resulting in a mixture of northern and southern species;
- tributary streams in various parts of the basin differ hydrologically and thus form distinct aquatic habitats.

Diverse forest habitat types in the basin include the rich Korean pine (*Pinus koraiensis*) mixed broadleaf forests of the Sikhote-Alin and Small Hinggan ranges, the depauperate larch (*Larix gmelini*) forests and moraines on permafrost in the north, and alpine tundra in the mountains of Changbai and other mountain ranges. Plateaus and lowlands exhibit equally diverse ranges of grassland and wetland habitats from the grassland prairies of the Khanka-Xingkai Lake lowlands to forest-meadows of the Middle Amur-Heilong, to forest-steppe and dry steppe landscapes in the western half of the region. Within each habitat type, there are more detailed levels of classification. Scientists recognize more than 100 types of forests.

Many authors have developed geographic zoning classifcations for the Amur-Heilong basin and there is no consensus on the subject. Ganzei (2004) undertook the most recent and most comprehensive review of works on physical geography, and also addressed trans-boundary geographic provinces shared by Russia and China. Unfortunately, Ganzei's review does not cover the western part of the basin. Therefore, to be consistent in a global context, we base the following description on delineation of Terrestrial ecoregions of the World, which is a much more general scheme covering all ecosystems of the world. It was developed by WWF and partners as a guide to nature conservation planning. Fifteen main habitat types are described within the Amur-Heilong basin by WWF within four major geographic zones of vegetation (Olson DM, Dinerstein E. 2001 http://www.nationalgeographic.com/wildworld/terrestrial.html).

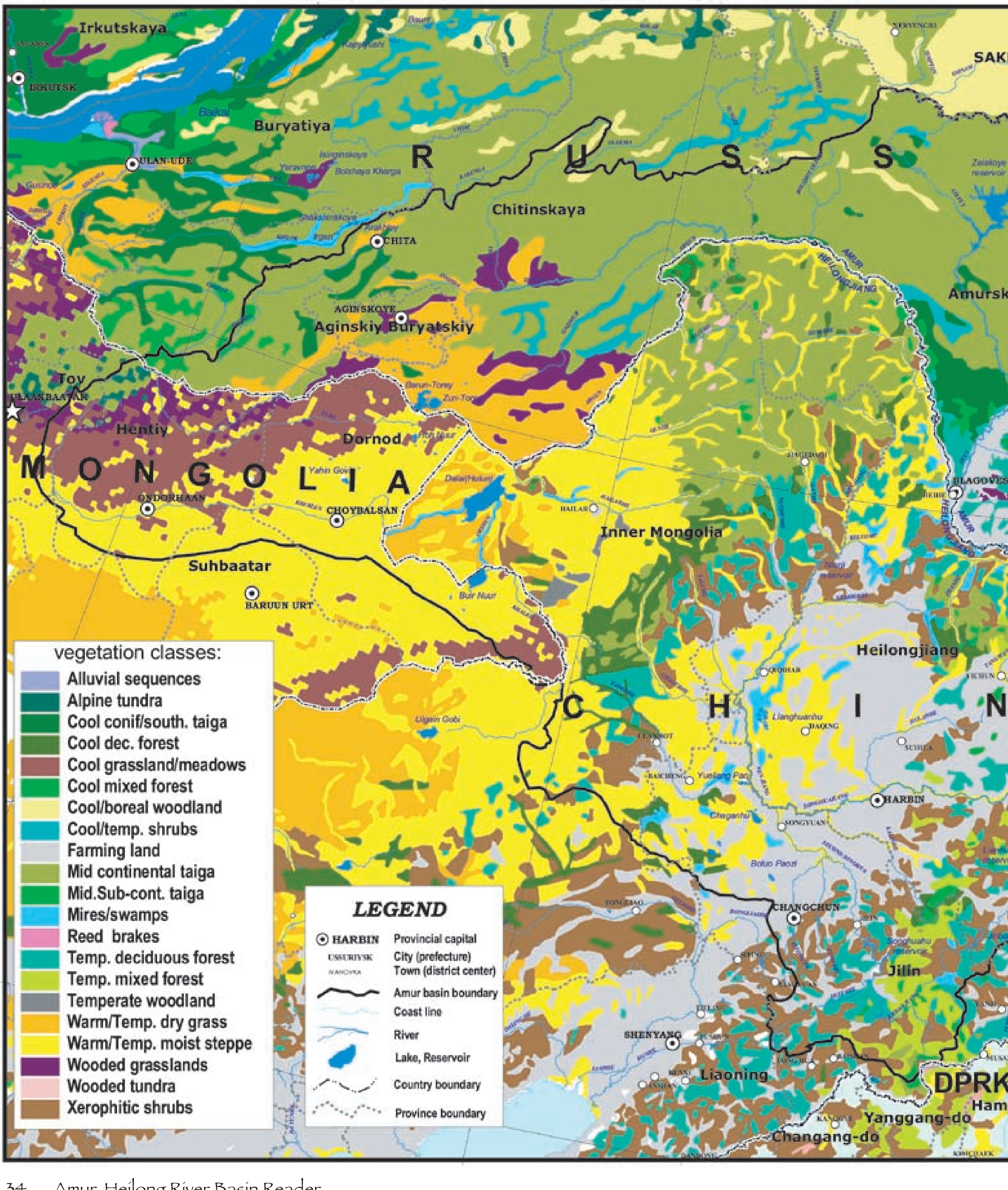
Terrestrial and freshwater ecoregions and boundaries

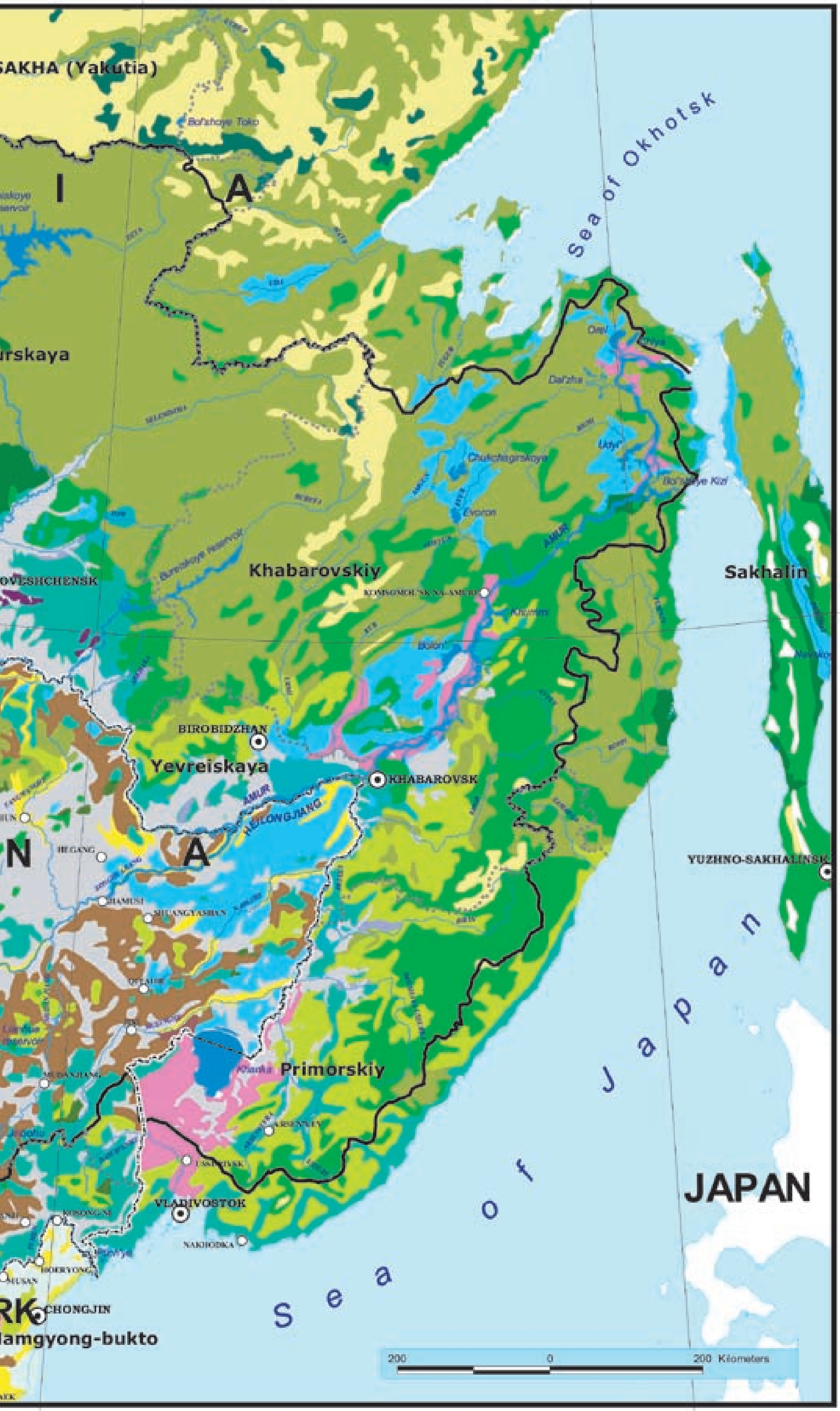
WWF defines an ecoregion as a large area of land or water that contains a geographically distinct assemblage of natural communities that:

- share a preponderance of their species and ecological dynamics;
- share similar environmental conditions, and;
- interact ecologically in ways that are critical for their long-term persistence.

The WWF Conservation Science Program has identified 825 terrestrial ecoregions across the globe, and a set of approximately 500 freshwater ecogregions is currently being developed.

WWF evaluated these ecoregions and identified


vegetation classes:
Alluvial sequences
Alpine tundra
Cool conif/south. taiga
Cool dec. forest
Cool grassland/meadows
Cool mixed forest
Cool/boreal woodland
Cool/temp. shrubs
Farming land
Mid continental taiga
Mid.Sub-cont. taiga
Mires/swamps
Reed brakes
Temp. deciduous forest
Temp. mixed forest
Temperate woodland
Warm/Temp. dry grass
Warm/Temp. moist steppe
Wooded grasslands
Wooded tundra
Xerophitic shrubs
LEGEND
HARBIN
Provincial capital
USSURIYSK
City (prefecture)
Town (district center)
Amur basin boundary
Coast line
River
Lake, Reservoir
Country boundary
Province boundary
Irkutskaya
IRKUTSK
Baikal
Buryatiya
ULAN-UDE
R U S S
Chitinskaya
CHITA
AGINSKOYE
Aginskiy Buryatskiy
Amursk
Toy
ULAANBAATAR
Hentiy
Dornod
M O N G O L I A
ONDORHAAN
CHOYBALSAN
Suhbaatar
BARUUN URT
Buir Nuur
HAILAR
Inner Mongolia
Heilongjiang
C H I N
HARBIN
CHANGCHUN
Jilin
SHENYANG
Liaoning
DPRK
Yanggang-do
Changang-do

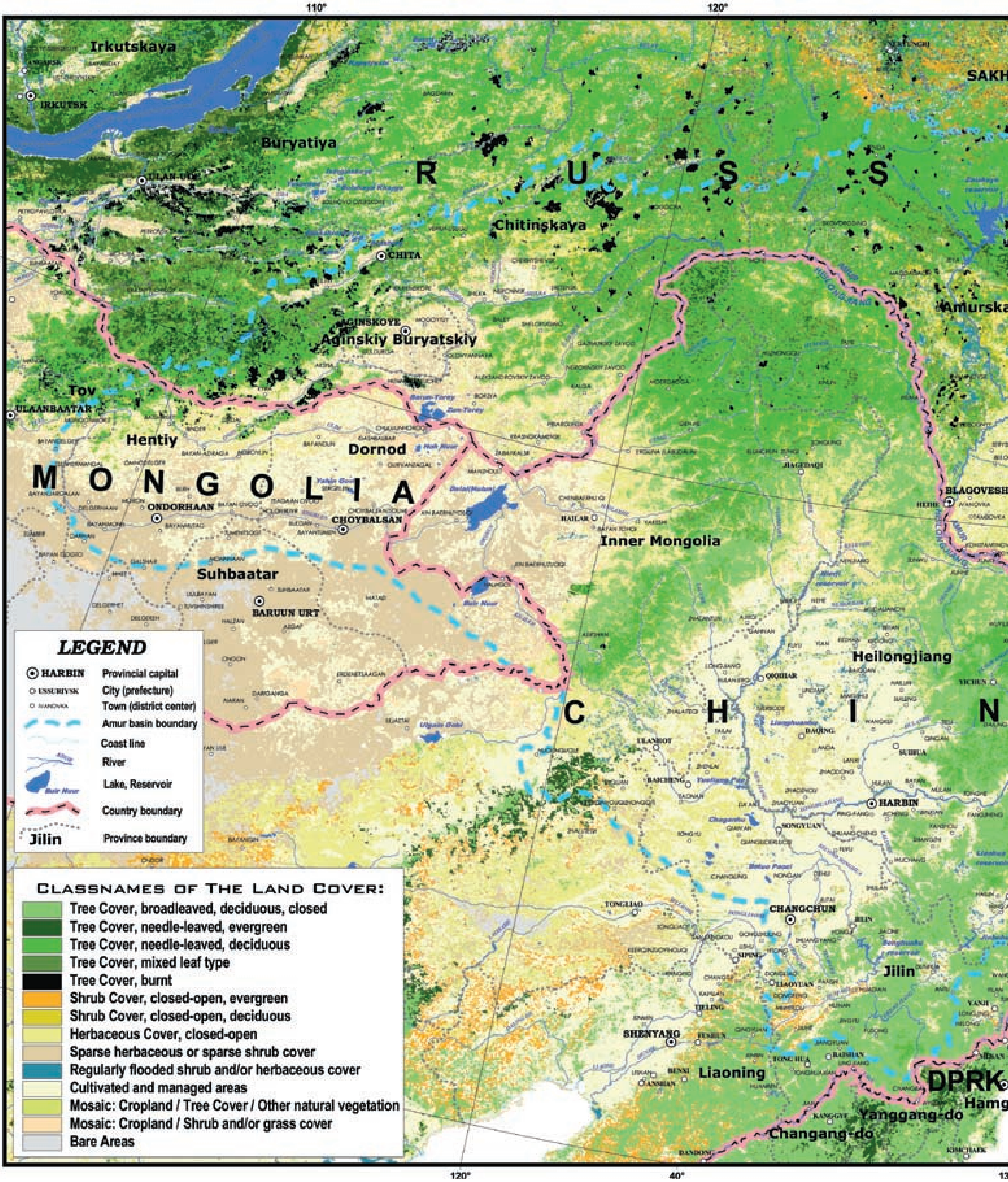


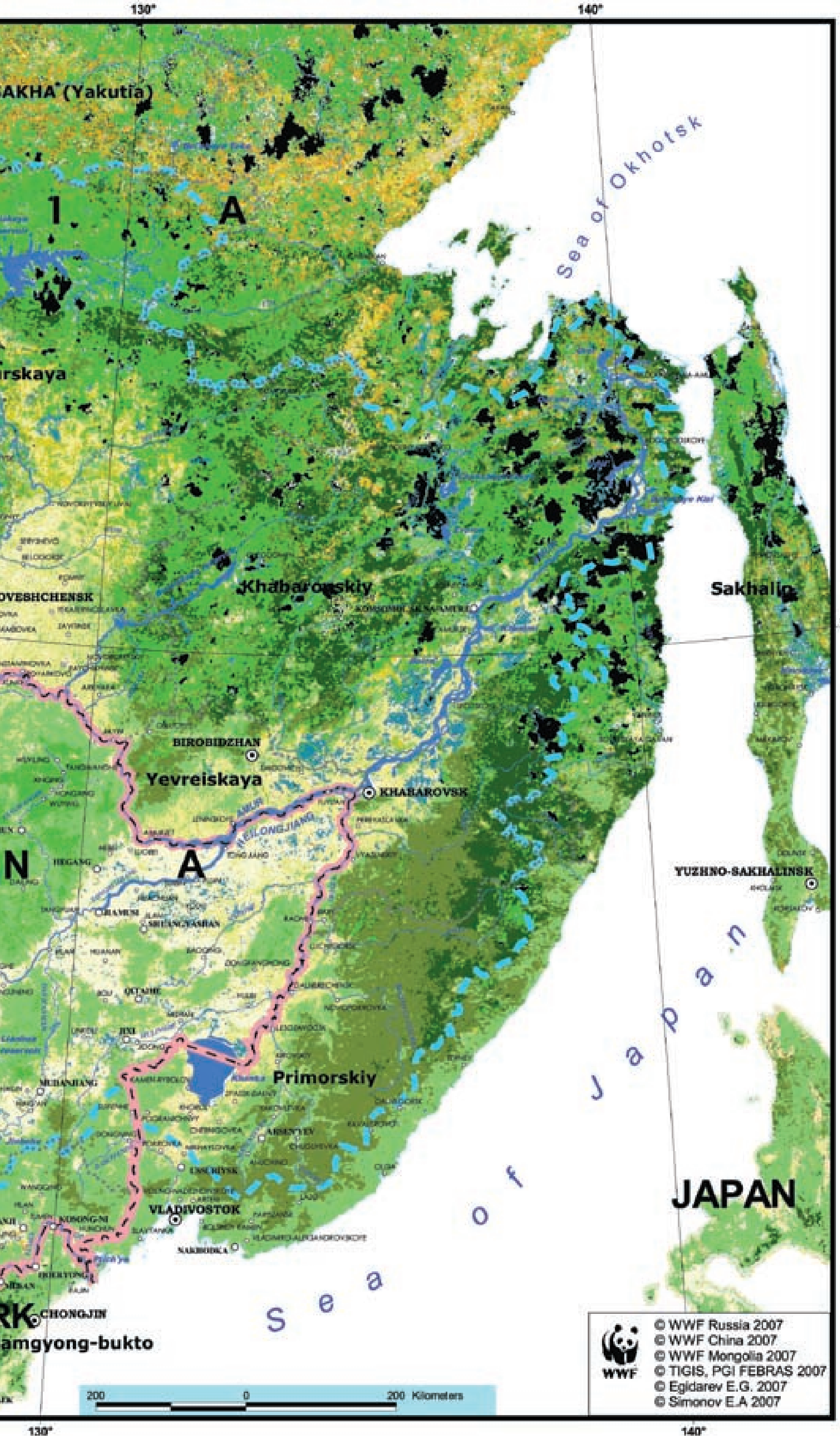
the Global 200 as the most biologically distinct and, in conservation terms, the most valuable terrestrial, freshwater, and marine ecoregions on the planet. Within these top-priority Global 200 ecoregions, WWF pursues ecoregion conservation, a unique, broad-scale approach that conserves species, habitats, and ecological processes. Ecoregion conservation is generally based on a biodiversity vision (or conceptual guide to desired conservation outcomes), which then identifies priority areas that are often referred to as landscapes. The next important step is to develop cost-effective, spatially-explicit strategies that meet the ecological needs of wildlife and habitats in a landscape while minimizing human-wildlife conflicts and maximizing benefits to communities.

The following description of ecoregions in the Amur-Heilong basin is based on the WWF database and arranged according to Global 200 and terrestrial ecoregional classification (with ecoregion numbers as assigned in these two classifications). These data were edited and expanded based on the Russian Far East Regional Ecoregion Conservation Action Plan (RFE-ECAP 2003) and other more recent reports.

The Amur-Heilong basin encompasses 15 terrestrial ecoregions (**Map 1.24**) and three globally important ecoregions were identified in this area: "East Siberian Taiga," "Mixed Broadleaf-Coniferous Forests of the Russian Far East," "Daurian Steppe" (**Map 1.26**), and the all-encompassing freshwater ecoregion "Rivers and Wetlands of the Russian Far East".

Map 1.17 Vegetation cover


110°
120°
50°
40°
Irkutskaya
IRKUTSK
Buryatiya
ULAN-UDE
R U S S
Chitinskaya
CHITA
AGINSKOYE
Aginskiy Buryatskiy
Amurska
SAKH
Tov
ULAANBAATAR
Hentiy
Dornod
M O N G O L I A
ONDORHAAN
CHOYBALSAN
HAILAR
Inner Mongolia
Suhbaatar
BARUUN URT
BLAGOVESH
Heilongjiang
QIQIHAR
C H I N
DAQING
HARBIN
ULANHOT
CHANGCHUN
TONGLIAO
Jilin
SHENYANG
Liaoning
DPRK
Yanggang-do
Changang-do
Hamg
LEGEND
HARBIN Provincial capital
USSURIYSK City (prefecture)
IVANOVKA Town (district center)
Amur basin boundary
Coast line
River
Lake, Reservoir
Country boundary
Jilin Province boundary
Classnames of The Land Cover:
Tree Cover, broadleaved, deciduous, closed
Tree Cover, needle-leaved, evergreen
Tree Cover, needle-leaved, deciduous
Tree Cover, mixed leaf type
Tree Cover, burnt
Shrub Cover, closed-open, evergreen
Shrub Cover, closed-open, deciduous
Herbaceous Cover, closed-open
Sparse herbaceous or sparse shrub cover
Regularly flooded shrub and/or herbaceous cover
Cultivated and managed areas
Mosaic: Cropland / Tree Cover / Other natural vegetation
Mosaic: Cropland / Shrub and/or grass cover
Bare Areas



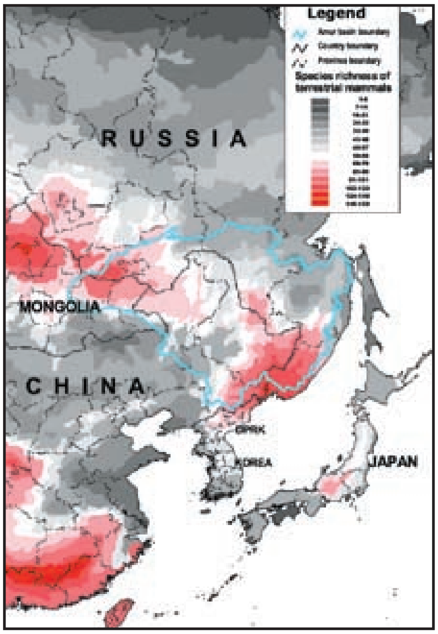
Delineation of freshwater ecoregions of the world is still being developed, so we take the liberty here of describing distinctive areas of wetlands within chapters on corresponding terrestrial ecoregion groups overlapping with them. Since freshwater wetlands also form distinctive groupings not necessarily fully confined to the boundaries of given ecoregions, each time we feel there is such a division we make special reference to it.

Although we recognize the many inaccuracies in ecoregion delineation carried out at a global level, we believe it provides a useful framework for discussion of conservation in the Amur-Heilong basin.

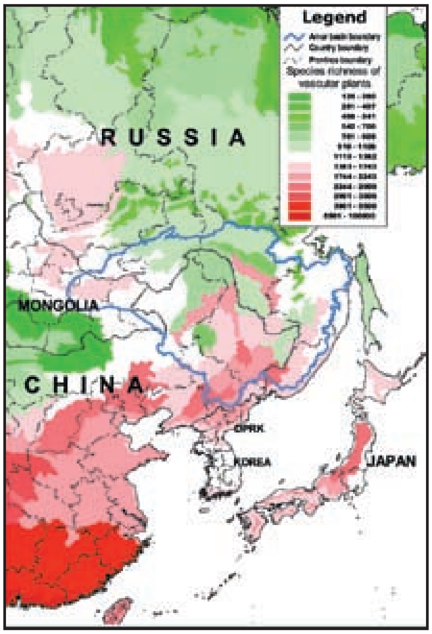
Since many ecoregions (including 3 of 4 Global 200 Ecoregions) overlap the boundaries of the Amur-Heilong basin, throughout this work we take into consideration not only the Amur-Heilong basin proper, but also a 200-300 kilometer buffer, thus avoiding exclusion and dissection of globally important biodiversity features. This means that the basin plus buffer area extends in the east to the Pacific coast, in the southeast to the Changbai Mountain ecoregion and adjacent Tumen River watershed, and in the southwest and west to the small, endorheic basins adjacent to the Amur-Heilong basin, and in the north more or less following mountain ridges forming the divide between the Pacific and Arctic Oceans. The location of the northeast border is debated. Many ornithologists argue that the Uda River basin draining into the Pacific

Map 1.18 Global land use/land cover according to 2000 satellite imagery

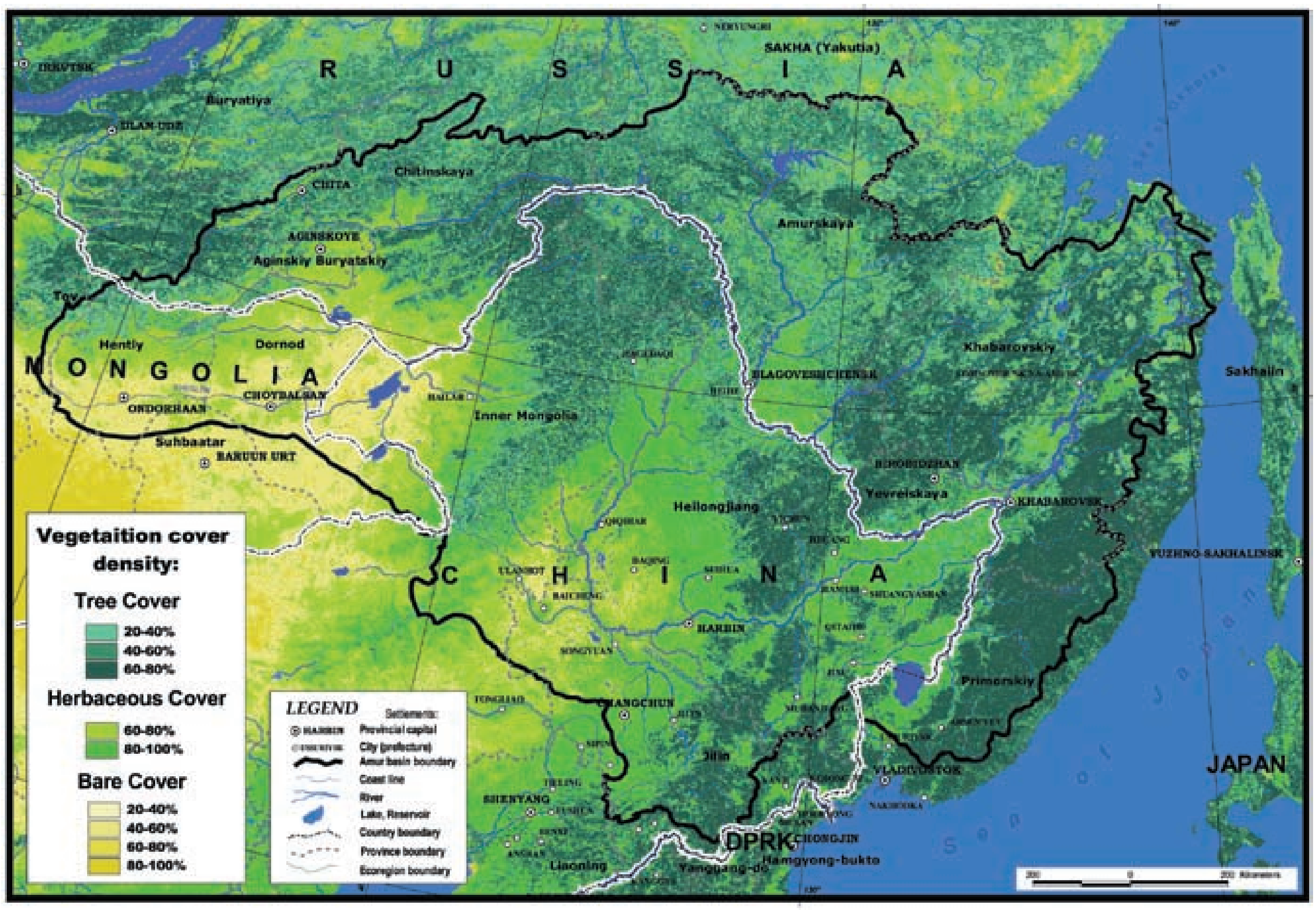
should be considered a part of the Amur-Heilong biogeographic area. Other experts opt for the watershed boundary along the Amur-Okhotsk divide between the Uda and Amgun Rivers. Following the abovementioned "rule on margins" we include the Uda River basin in our discussion of the Amur-Heilong.



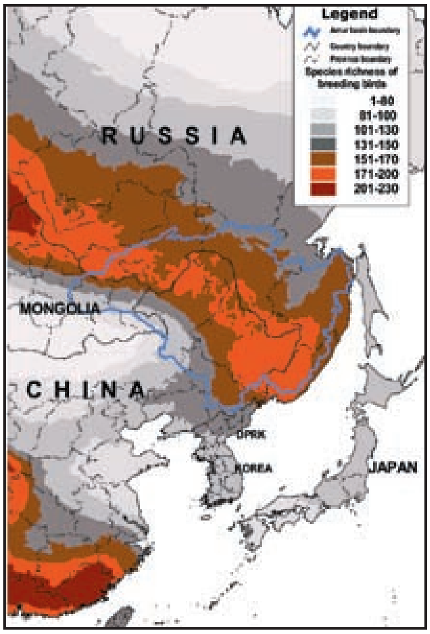
Map 1.20 Species richness of terrestrial mammals



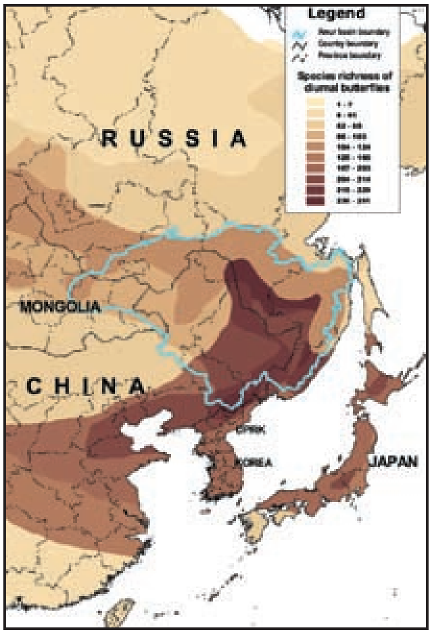
Map 1.21 Species richness of vascular plants



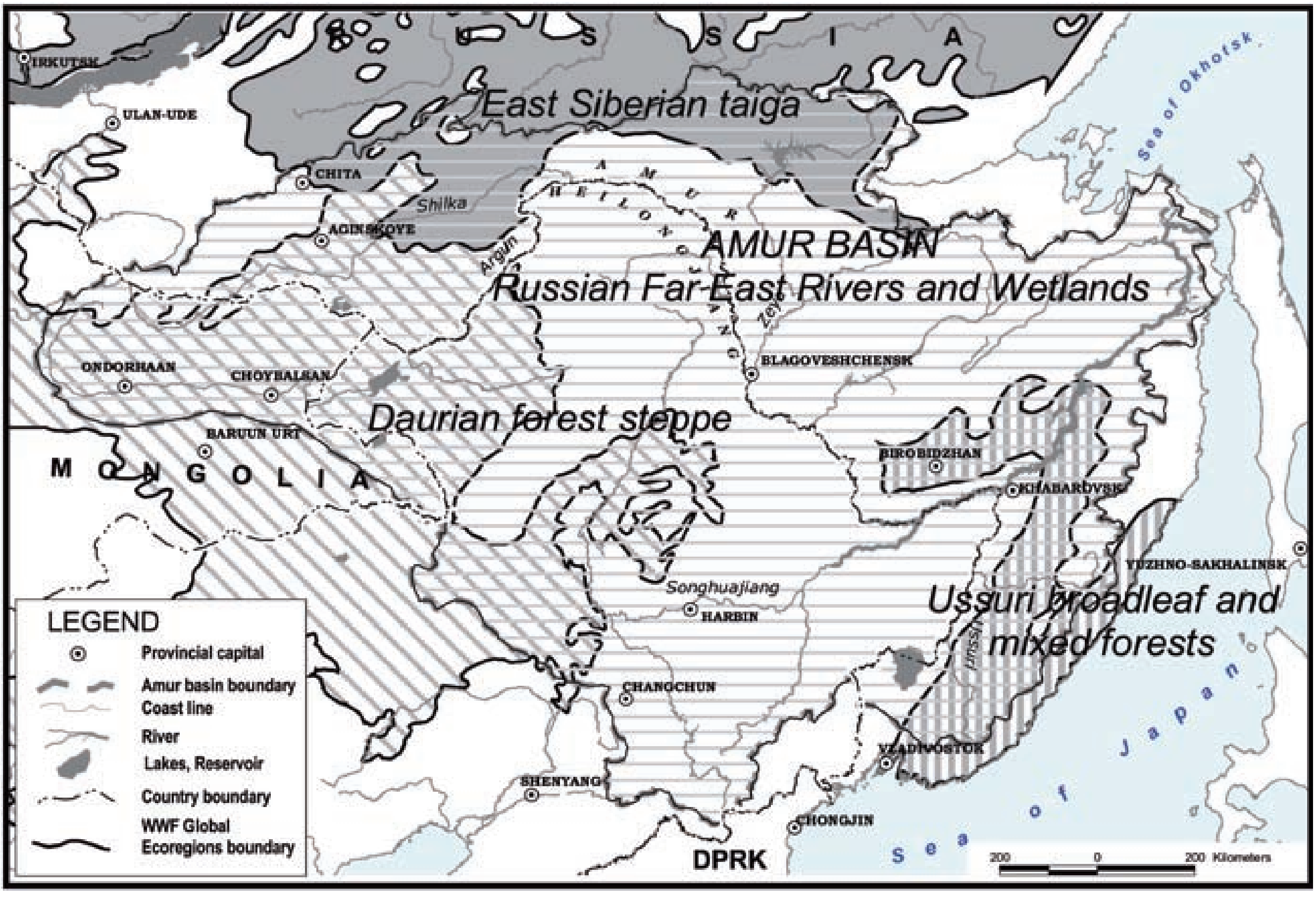
Map 1.19 Vegetation cover density



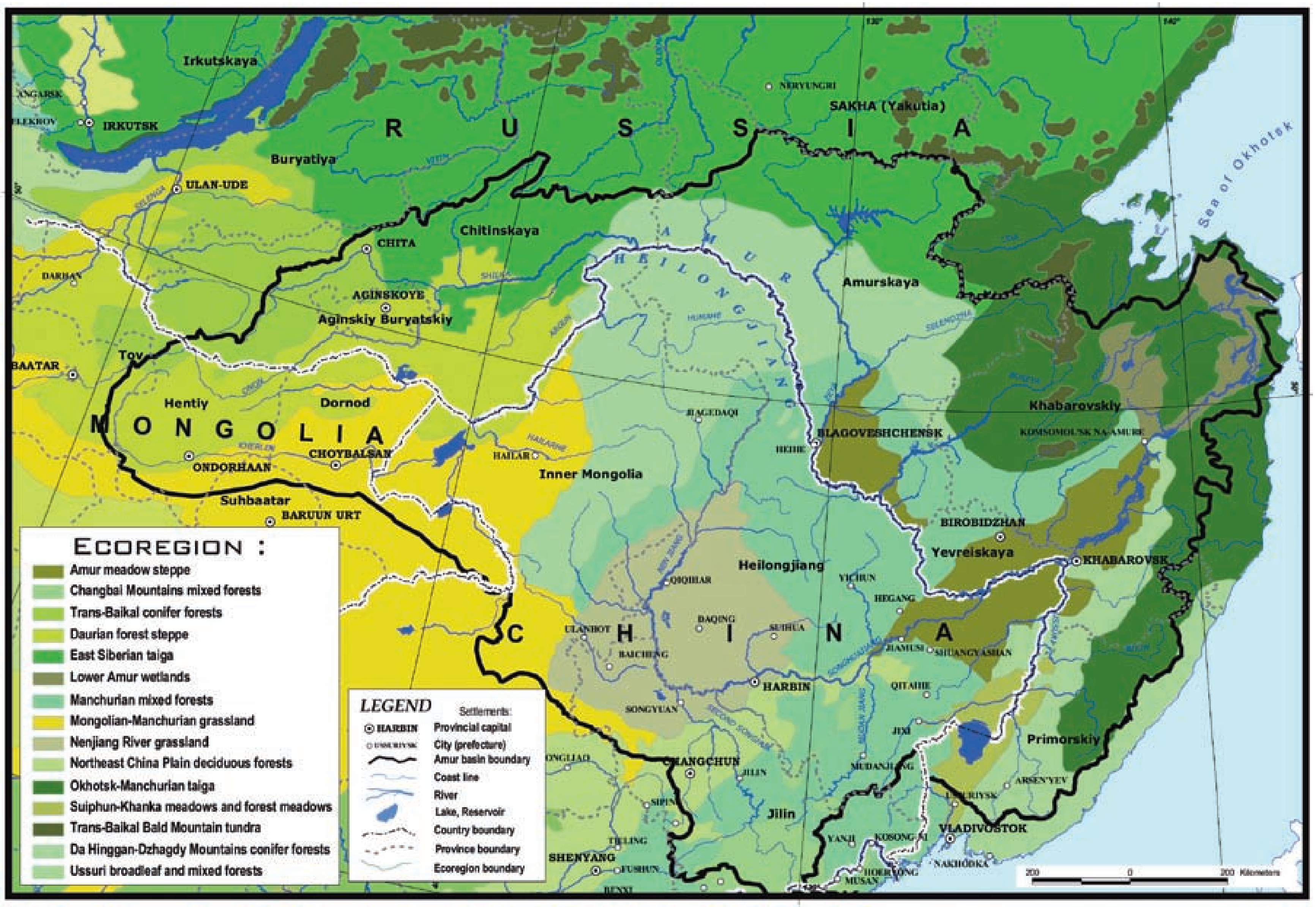
Map 1.22 Species richness of breeding birds



Map 1.23 Species richness of diurnal butterflies



Map 1.25 Global 200 Ecoregions in the Amur-Heilong basin (Standard #84-East Siberian Taiga, #71-Mixed broadleaf-coniferous forests of RFE, #181-Rivers and wetlands of RFE, #96-Daurian Steppe) East Siberian taiga (PA0601 in WWF's ecoregion classification codes)



Map 1.24 Terrestrial ecoregions of the Amur-Heilong basin (WWF US, corrected by Simonov-Egidarev)

Chapter 6

Boreal Zone Ecoregions

(The following descriptions of ecoregions include in their titles a code such as PA0601, which identifies the ecoregion in the WWF ecoregional classification.)

Taiga forests

The boreal forest is the largest tract of unbroken forest in the world. Several boreal ecoregions expand into the Amur-Heilong River basin. The large tract found in the northern Amur River basin is just a small portion of the boreal forest of Siberia as a whole. The cold temperatures that create permafrost and seasonal droughts favor coniferous forests of larch, spruce, fir, and pine. This is the world's largest remaining wilderness and a place that provides a secure home for many species of plants and animals. Russia's largest populations of brown bears, moose, wolves, reindeer, and other mammals inhabit these forests.

Due to its size and inhospitable environment most of the boreal forest has experienced relatively low levels of human influence. However, extensive coal and gold mining, logging, and oil and gas development are underway in the southern part of the boreal forest. Large areas of forests have been cut to fuel industrial processes such as metal smelting, paper production or degraded by air pollution and fires. The region is also threatened by plans for several major hydropower projects.

East Siberian Taiga (PA0601)

This ecoregion is vast, spanning over 20 degrees of latitude and 50 degrees of longitude. It is one of the most extensive natural forests remaining in the world. Larch forests dominate the region because they are able to withstand the extreme climate conditions. The ecoregion boundary corresponds to the central and sparse forest taiga in the Central Siberian forest province and the East Siberian forest province west of the Dzhugzhur Mountains in Kurnaev's (1990) forest map of the USSR. The ecoregion is located mainly within the Yenisey River and Lena River basins. Eastern Siberian floral communities, typical of permafrost taiga regions, are found in the upper reaches of the Zeya and Amur-Heilong Rivers. This community has comparatively low species diversity and forests are mainly composed of Siberian and Daurian larch (*Larix sibirica, L. dahurica*/*L.gmelini*). This formation occupies a larger area than any other forest type in Russia. The dark coniferous taiga is distributed in a mosaic pattern in the more-protected areas, with *Pinus sibirica, Picea obovata* and *Abies sibirica* dominating. To the south, the proportion of pine-larch and pine forests increases, and small-leaf forests with *Betula* and *Populus* begin to appear. Grass and dwarf shrub-grass as well as stepped pine and pine-larch forests are common in the tributaries of the upper Amur-Heilong. Meadow and floodplain plant communities dominate the terrain, forged by the large Zeya and Bureya Rivers, and other smaller rivers and streams. Forests in these communities include a number of temperate species: Mongolian oak (*Quercus mongolica*), Daurian birch (*Betula davurica*), Korean linden (*Tilia amurensis*), Amur grape, and kiwi vine (*Actinidia kolomikta*). The Prokhorov birch (*Betula prochorowii*) is endemic to this region, growing only on bald mountain areas near timberline. Rockfoil (*Saxifraga selemdzhensis*) is endemic to this region and occupies a narrow range of habitats. There are many endemics at the species and genus levels. The flora of eastern Siberia (including the mountains) consists of more than 2,300 species (Malyshev and Peshkova 1979). Nationally endangered plant species (15 species in total) include: *Cypripedium macranthon, Calypso bulbosa, Orchis militaris* and *Cotoneaster lucidus*.

Eastern Siberian faunal communities are found in the northern area of the Russian Far East between the Amur-Heilong and Zeya Rivers, in the upper half of the Zeya River basin, and the mountains of the Amur-Okhotsk divide. This group includes Eurasian species such as brown bear (*Ursus arctos*) and wolf (*Canis lupus*), ermine (*Mustela erminea*), Siberian weasel (*Mustela sibirica*), red squirrel (*Sciurus vulgaris*), Siberian jay

(*Perisoreus infaustus*), great spotted woodpecker (*Dendrocopos major*), as well as species characteristic of eastern Siberia such as moose (*Alces alces*), Amur lemming (*Lemmus amurensis*), and northern black grouse (*Lyrurus tetrix)*.

The fauna of the East Siberian taiga is considerably older than that of the western Siberia taiga. The Yenisey River is an important zoogeographical boundary because many taiga fauna species occur only to its east. These include: Siberian musk deer *Moschus moschiferus,* Japanese field mouse *Apodemus speciosus,* Siberian blue robin *Luscinia cyane,* rufous-tailed robin *L. sibilans,* Pallas's rosefinch *Carpodacus roseus,* Pacific swift *Apus pacificus,* rufous turtle dove *Streptopelia orientalis,* spotted capercaillie *Tetrao parvirostris,* Baikal teal *Anas formosa* and carrion crow *Corvus corone*. In contrast to the West Siberia taiga, the East Siberian taiga has a much denser population of hoofed animals, such as moose *Alces alces,* roe-deer *Capreolus capreolus,* wild boar *Sus scrofa* and red deer *Cervus elaphus*. There are 11 nationally threatened vertebrate species, including golden eagle *Aquila chrysaetos*, osprey *Pandion haliaetus*, peregrine falcon *Falco peregrinus,* black stork *Ciconia nigra* and hooded crane *Grus monacha*.

The East Siberian taiga still contains vast pristine habitats but only a fraction of these are located in protected areas and most lie outside the Amur River basin. Zeysky Zapovednik (National Nature Reserve or Strictly Protected Area) was founded in Amurskaya Province to study impacts of the Zeya reservoir on natural ecosystems. Substantial changes were recorded in adjacent forest ecosystems (Darman et al. 2000). The existing network of protected areas is not sufficient for such an extensive and pristine region. The diversity of the taiga ecosystem is not completely represented in protected areas and the few protected areas are separated by great distances.

The main threats to the ecoregion are widespread forest fires, intensive clear-cuts in the central and southern taiga sub-zones, and poaching.

Trans-Baikal coniferous forests (PA0609)

Trans-Baikal coniferous forest covers only a small area in the northwest Amur-Heilong basin in the Henti-Chikoy Mountain Range (elevation 1,500-2,300 m) and it is sheltered from the influence of Manchurian forests by a wide belt of Daurian grasslands. These taiga larch-pine forest ecosystems occupy drier mountainous areas adjacent to the Lake Baikal basin where taiga forest abuts and mixes with xeric steppe vegetation. The north slopes of the ranges are dominated by larch and pine forest. Southern slopes have mesophytic steppe vegetation at lower altitudes. High mountain peaks have sporadic tundra landscapes. The dominant vegetation types on lower altitudes of the southern slopes of hills are mesophyte types of steppe plants. Shrubs and short, bushy trees are dominant vegetation cover in narrow valleys of mountains. Small bogs feed mountain streams. Permafrost is distributed over a wide area in the eco-region.

A large portion of the Khentii Mountain Range is located within the Khan-Khentii Strictly Protected Area (SPA). There are over 50 species of mammals, 220 species of birds, and approximately 1,100 species of plants in the protected area, among which several are extremely rare (endangered) species. Dwarf pine *Pinus pumila,* is found in the upper Onon River while downstream is dominated by pine forest with moss cover, and abundant high mountain willow *(Salix glauca, S. arbuscula),* rhododendron *(R. chrysanthum),* bergenia-badaan *(B. srassifolia)*. Rhododendron *(R. dahuricum),* ledum *(L. palustre),* and vaccinium *(V. vitis idcea)* are quite common in the cedar–larch forest.

Total forest area in the Mongolian basin is 1.4 million ha but in recent years, the forest has suffered wildfire, pest outbreaks, and unregulated logging, which together with climate change are the greatest threats to this ecoregion. Gold-mining is a grave threat to streams and bogs, especially in Mongolia.

Khan-Khentii Nature Reserve, Onon-Balj National Park in Mongolia and Sokhondinsky Zapovednik in Russia, known collectively as the "Source of the Amur", are proposed for designation as an international protected area between the Trans-Baikal coniferous forest and the northern tip of the Daurian forest-steppe.

Two additional forest ecoregions in the boreal zone differ from the East Siberian taiga mainly because they experience greater influence of the "Manchurian/Daurian" biota to the south and are located in a somewhat warmer climate zone. These are discussed below.

Da Xing'an-Dzhagdy Mountains coniferous forests (PA0505)

This ecoregion is known for its unique "Daurian flora," which is transitional between Siberian and Manchurian floras. Thus many authors classify it as "coniferous temperate forest." We include it in the boreal realm due to the boreal origin of its dominant species, close similarity to undoubtedly boreal forests bordering it from the north, and cultural tradition, because even in some local dialects in China it is called "taijialin" or "taiga" boreal forest.

This ecoregion is concentrated in the Great Hinggan (Daxing'anling) Range in northeastern China and extends into sub-boreal forests with similar characteristics in the Amur-Heilong basin north of the Russia border. The CVMCC (1979) Vegetation Map of China identifies three classes of forest in this region: montane larch forests of Siberian origin (1); larch forests mixed with pine (2b); and larch-spruce forests (3a).

The Greater Hinggan Mountains support dense forest cover in some areas. Lower slopes have deciduous broadleaf forests dominated by Mongolian oak (*Quercus mongolica*), or a mixture of species including poplar (*Populus davidiana*, *P. suaveolens*), birch (*Betula platyphylla*), and willow (*Salix rorida*). Shrubs include members of the heath family (*Rhododendron macromulata, R. dahurica, and Vaccinium vitis-idaea*) and wild rosemary (*Ledum palustre*). Higher on the mountainside, spruce (*Picea obovata, P. microsperma*), larch (*Larix dahurica*), and Scotch pine (*Pinus sylvestris*), the most widely distributed of the world's pine species, cooccur in shady sites at 1,300 to 1,700 m. Stony slopes support Japanese stone pine (*Pinus pumila*). Sunny slopes at the same elevation support montane grassland communities.

In this ecoregion, there are over 1,200 species of vascular plants, two thirds of which are Siberian, and one third local Daurian, Mongolian and Manchurian. Daurian larch dominates at elevations over 500 masl, forming the typical landscape features. Mongolian oak, hazel, heterophyllous alder, silver and black birch, poplar, elm, Siberian apricot, and Siberian hawthorn are found here. This ecoregion represents the southern boundary for several rare mammals of the Palaearctic fauna, including wolverine (*Gulo gulo*), and elk/moose (*Alces alces*). This ecoregion supported a small resident population of Amur tiger (*Panthera tigris altaica*) less than 100 years ago, but due to human pressures tigers stopped breeding in this somewhat sub-optimal habitat. However, dispersing tigers occasionally reach this ecoregion.

Due to population pressures, which are much higher in China than in either Mongolia or Russia, this ecoregion is under the most intense human pressure. Deforestation by fires and logging, coupled with poor natural regeneration in a harsh cold and dry climate are serious obstacles to conservation.

Wuma, Moridaga and Erguna protected areas in Inner Mongolia include a large forest belt along the upper Amur-Heilong and Argun Rivers. This is the largest group of nature reserves in the ecoregion.

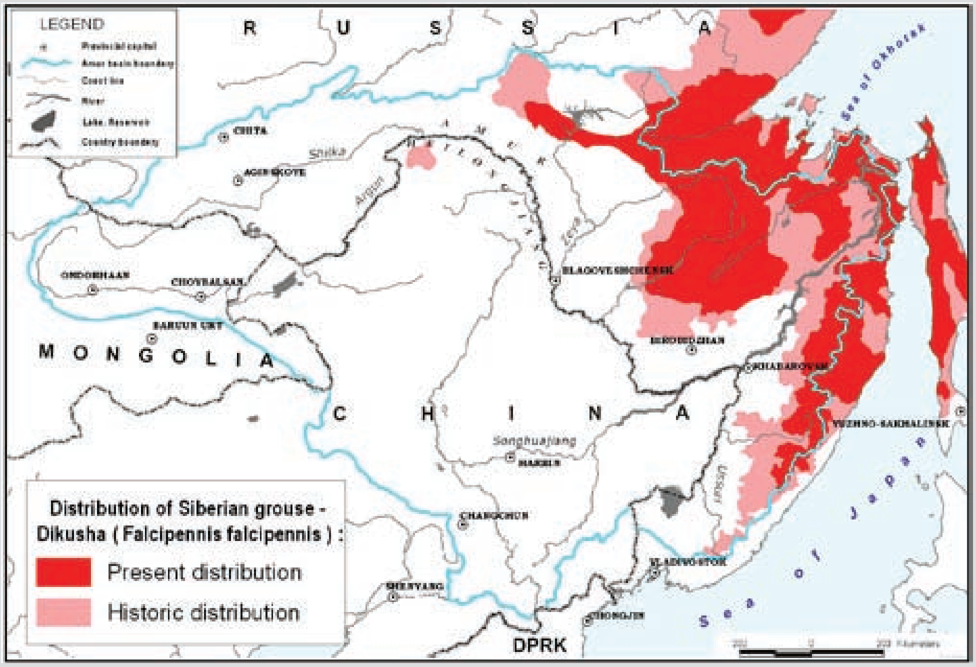
Okhotsk-Manchurian taiga (PA0606)

This ecoregion represents the northernmost extent of Manchurian species. It experiences climatic influence from the Pacific Ocean, therefore has somewhat warmer winters and cooler summers than ecoregions further inland. Ecoregion boundaries correspond to the central taiga in the Okhotsk-Manchurian forest province in Kurnaev's (1990) forest map of the USSR.

Okhotsk-Kamchatka floral communities are found in the lower Amur-Heilong River, on the west coast of the Okhotsk Sea. This flora has fewer species, but many are found in high mountain areas, including a large number of arctic-alpine and arctic species. Continental species are also prevalent close to the Okhotsk Sea coast. The mountain ranges hugging the Okhotsk Sea play a major role in buffering impacts from the ocean, allowing many of these plant communities to flourish. Endemics with very narrow ranges, such as two subspecies of rockfoil (*Saxifraga staminose*, *S. svetlanae*) are found here. Other endemics of the southern Okhotsk region include *Aconitum woroschilovii, Agrostis pauzhetica, Chrysosplenium pacificum, Oxytropis littoralis, Salix erythrocarpa, Taraxacum neokamtschaticum, Taraxacum rufum*, and *Thymus novograblenovii*.

Endemic plant species of the Sikhote-Alin region include *Artemisia punctigera, Astragalus sachalinensis,* and *Oxytropis helenae*. Many plants here are relics of the Tertiary Period. Typical species include Yeddo spruce (*Picea jezoensis*), Khingan fir (*Abies nephrolepis*), and Erman's birch (*Betula ermanii*). Rare species along the Okhotsk Sea coast include *Cypripedium macranthon, C. guttatum, Bergenia pacifica, and Paeonia obovata*.

Box 1.2 Endangered species profile, Boreal forest: Siberian spruce grouse *(Falcipennis falcipennis)*



Map 1.26 Distribution of Siberian spruce grouse

The rare Siberian spruce grouse (*Falcipennis falcipennis*) inhabits dense taiga forests in eastern Siberia and could well become an important symbol for protection of old growth boreal forests in the Russian Far East (**Map 1.26**). This non-migratory species nests in remote fir and deciduous forests, preferring to remain near swamps and other areas with abundant berry bushes. The males put on remarkable displays during the mating season in spring, fanning their tails, stretching their necks, and hopping up and down while singing their howling song.

The habitat and range of the Siberian spruce grouse is shrinking rapidly due to human pressures. In the Russian Far East, the bird is found in fragmented patches in Khabarovsky Province, and northern parts of Primorsky and Amurskaya Provinces. Numbers of spruce grouse are low throughout its range. However, the species is relatively common in remote and inaccessible areas of the Amur-Heilong basin, particularly in the upper reaches of the Selemdzha, Bureya, and Amgun Rivers and along the Okhotsk Sea coast.

The main reasons for the decline of the Siberian spruce grouse are logging in virgin dark conifer forests, forest fires, and illegal hunting, since the birds are easily approached and are unafraid of people.

Conservation of Siberian spruce grouse could be organized around a revival of legends in cultures of native peoples of the Russian Far East. The species could well be an indicator of the integrity of old growth boreal forests. This could yield far-reaching impacts similar to those associated with conserving the northern spotted owl in the Pacific Northwest of the United States.

Okhotsk-Kamchatka or Beringian faunal communities are found in the northeast Amur-Heilong basin. Their range extends southeast from the Okhotsk Sea coast following the western slopes of the Pribrezhny Range to the source of the Uda River, then southward to the upper reaches of the Selemdzha and Bureya Rivers. Representatives of this fauna group are also found on the slopes of the Sikhote-Alin Range and the mountains in the Lower Amur River. Dark coniferous taiga forests are important habitat for mammals such as brown bear, wolverine, and sable (*Martes zibellina*), and birds including black-billed capercaillie (*Tetrao urogalloides*) and spotted nutcracker (*Nucifraga caryocatactes*). Intact fir forests are the primary habitat of musk deer (*Moschus moschiferus*) and the only home for the endangered Siberian spruce grouse.

Bureisky Zapovednik is the largest nature reserve in the ecoregion and it includes fragments of the mountain tundra ecoregion, while Komsomolsky Zapovednik is the closest protected area to the banks of the Amur River.

Trans-Baikal Bald Mountain Tundra (PA1112)

Trans-Baikal mountain tundra is comprised of the bare summits, plateau tops, and gentle high altitude slopes of the Stanovoy, Aldanskii, and Dzhugzhur Ranges. Mapped ecoregion boundaries correspond to montane tundra in Central Siberian, East Siberian and Okhotsk-Manchurian vegetation provinces (Kurnaev 1990). The east-west orientation of these mountains provides a "trans-Siberian" route for floral dispersion in northern Asia. Most of the soils are subject to permafrost and the flora has adapted to severe winter winds by finding protection under thin snow.

In sub-alpine areas these are stone birch forests that support few mammals. Occasionally brown bear, wolverine, and mountain hare move into these forests from dark coniferous forests. Other mammals characteristic of this Trans-Baikal ecoregion include marmot and Siberian musk deer. Common birds in stone birch forests include Pallas' willow warbler (*Pylloscopus proregulus)*. Upland grassland ecosystems are home to reed bunting (*Emberiza schoensis*) and Eversmann's apollo beetle (*Dryopa eversmanni*). Dwarf alpine forests are inhabited by sable, northern pika (*Ochotona hyperborea*), and large-toothed red-backed vole (*Clethrionomys rufocanus*).

Due to the isolation and inaccessibility of these mountains, the tundra habitat remains largely intact but the network of protected areas needs to be strengthened and enlarged.

Wetlands of Lower Amur

The ***Lower Amur Mountain Valley Ecoregion*** was delineated by WWF as a representative ecoregion in the boreal zone due to its importance as breeding and stopover habitat for migratory waterfowl on the East Asian-Australasian Flyway. The Amgun River is the richest salmon river in the entire Russian Far East.

The Lower Amur is the most important habitat for all species of salmon and sturgeon in the Amur-Heilong basin, and still holds the richest freshwater fishery in the basin. The Lower Amur is the most critical habitat for the surviving population of Kaluga sturgeon and a species description is presented in **Box 1.4**.

The large inter-tidal zone of the Okhotsk Sea coast is an important habitat for wading birds while shallow bays provide some of the last feeding grounds for gray whales (*Eschrichtius gibbosus*).

The wide floodplain valley of the Amur-Heilong and its tributaries has many oxbows and lakes where the river is braided in many smaller streams forming thousands of islands. Surrounding grasslands and narrow strips of floodplain forests provide good shelter and for-

Box 1.3 Endangered species profile, Alpine ecosystem: Snow sheep *(Ovis nivicola potanini)*

Small, isolated populations of snow sheep (*Ovis nivicola potanini*) inhabit the Stanovoy and Dzhugzhur ranges of the Trans-Baikal Bald Mountain Tundra. The main habitat for snow sheep is in the alpine belt from 1,600 to 2,200 meters above sea level, mostly on sunny slopes with abundant cliffs. In winter, snow sheep migrate down to the upper forest belt, made up primarily of dark coniferous species such as fir. Expeditions to study snow sheep populations in the Stanovoy Range were led in 1991-1992 and in 2001 (Darman et al. ECAP RFE). The results show that snow sheep density is still high — up to 16.5 animals per km^2 of suitable habitat. The total number of this isolated population is estimated at 350-500 head.

For many years the only threat to snow sheep here was occasional hunting from nomadic Evenki, indigenous reindeer herders. In 2001, however, construction of a new railroad began across the Stanovoy Range to connect a huge coal deposit at Tokko Lake in Yakutia with the Baikal-Amur Railway. Thousands of construction workers and numerous cross-country vehicles and helicopters now pose a serious threat to the survival of these small populations of snow sheep. When finished, the railroad will open the gate for many people to colonize and otherwise exploit this remote region.

Box 1.4 Endangered Species Profile, Lower Amur Wetlands: Kaluga sturgeon *(Huso dauricus)*

Kaluga sturgeon, or simply Kaluga, (*Huso dauricus*) is endemic to the Amur-Heilong River. The Zeya-Bureya population is listed in Russia's Red Book under category 1 as a "disappearing population of an endemic species." The species listed as Endangered in the IUCN Red List of 2004 and trade in Kaluga is restricted by listing the species in CITES Appendix 2.

It was formerly believed that Kaluga was strictly a freshwater fish. However, it is now known that young fish (up to 30-50 kg) inhabit marine waters from the northern Sea of Okhotsk to Hokkaido Island. Fishermen also report catching kaluga in the Magadan region. Kaluga is caught in the north of Khabarovsky Krai and off Sakhalin Island. Young kaluga are found in rivers of southern Primorsky Province.

Most Kaluga inhabit the brackish bay at the mouth of the Amur-Heilong and the eastern part of Sakhalin Gulf. Here, Kaluga feed on pink and chum salmon, spawning herring, and smelt. Other prey includes marine fish, shrimps, and freshwater fish. The freshwater range of Kaluga is similar to that of the Amur sturgeon (Accipenser schrenkii) and stretches for several thousand kilometers into the Amur-Heilong basin. The Kaluga range includes the rivers Shilka, Argun, Zeya, Bureya, Songhua, Ussuri-Wusuli (and Khanka-Xingkai Lake), and Amgun. Kaluga is now virtually extinct in the Songhua and Ussuri-Wusuli Rivers due to overfishing in both rivers and water pollution in the Songhua.

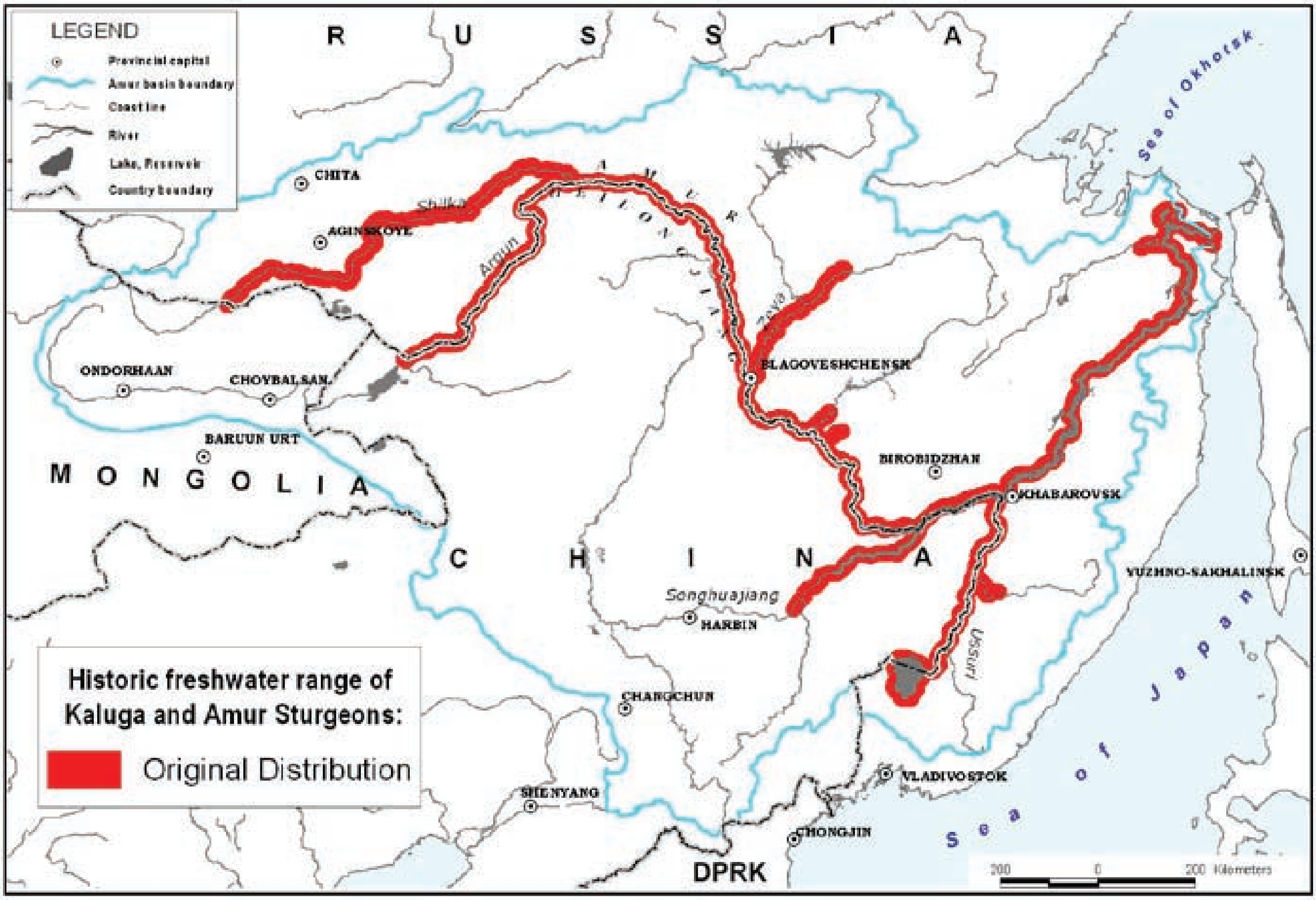
The spawning range of Kaluga is also similar to that of Amur sturgeon and its upstream range limit is not yet known. According to the Heilongjiang Province Department of Fisheries, mature Kaluga do not go upstream farther than Blagoveshensk/Heihe. However sightings and catches of mature fish were reported in Amur-Heilong tributaries in the Chita region all the way upstream to the Onon River during 2002-2003.

Kaluga is one of the world's largest freshwater fish, reaching a length of 5.6 meters and a weight of 1,140 kg. Females mature at 16-17 years of age, when their total length is over 2 meters. Males mature one or two years earlier than females. The life span of Kaluga is believed to be 48-55 years. Spawning occurs in gravel and sandy river beds at depths of three to seven meters. Spawning season begins in May and lasts through June. Fecundity may reach 4 million eggs. Fry are carried downstream in the current. Kaluga is a predatory species whose diet includes conspecifics. Spawning migration (at least the first) may be 1,000 km or more.

aging habitat for mammals. One of the major reasons for separating this ecoregion from the ecoregion of the Middle Amur-Heilong plain ("Amur steppe-meadow") is the different composition of resident species, especially fish and aquatic flora. Many relics of the Tertiary Period and southern aquatic species that reach the wetlands of the Middle Amur-Heilong River are absent in this downstream reach. Another reason is the composition of surrounding forests, which, in the downstream reach, are definitely representative of Okhotsk-Manchurian Taiga fauna. The third peculiarity is the relative abundance of large (ox-bow) lakes that are seasonally connected to the Amur-Heilong (Kizi, Hummi, Udyl, Orel, and Evoron Lakes). These provide important habitat for nesting and migrating waterfowl and spawning fish.

Main threats include overfishing, poaching, and pollution from upstream and from industries of the city of Komsomolsk-on-Amur. Logging in upstream reaches of tributaries also degrades this ecosystem.

Lake Udyl, the only designated Ramsar site in the ecoregion, is protected as a national (federal) game reserve (zakaznik). Other lakes are equally important for biodiversity conservation but have not been nominated for Ramsar listing. There are no protected areas at Amur Estuary or other important coastal wetlands (Uda River



Map 1.27 Kaluga and Amur sturgeon habitat in the Amur-Heilong River basin (WWF RFE 2004)

Mouth, Schastya Bay). Komsomolsky Zapovednik protects a small area of biodiverse wetlands near the Gorin River mouth. In general, wetlands of this ecoregion have been minimally protected in nature reserves. Less than 1% of the lower Amur floodplain is preserved in protected areas.

Various sources reported in 2000-01 that large maturing Kaluga sturgeon (age over 13 years, length over 180 cm, and weight at least 50 kg) numbered at least 60,000 fish with a total biomass of 5.5 thousand tons (at an average weight of 90 kg). During recent years a rapid decline in abundance has been reported. By some estimates, existing levels of official catch and poaching could represent up to 95% of the spawning population annually. At this rate, the number of mature fish in 2010 could be one tenth that of 2000. The main causes for decline are the same as for Amur sturgeon — licensed fishing in China and poaching in Russia. In China the Amur-Heilong population of Kaluga and Amur sturgeon is the main source of fry for farming sturgeon for meat in southern regions (unpublished report by Traffic East Asia). Water pollution is almost certainly negatively affecting Kaluga sturgeon reproduction, both the chronic levels of toxic compounds and the acute concentrations caused by accidental and intentional discharges in 2005 and 2006.

The trend in the Kaluga sturgeon population may be the best demonstration of the impossibility of protecting Amur-Heilong biodiversity through unilateral efforts. Unless an effective joint Russia-China program of sturgeon conservation is implemented in the near future the commercial fisheries (legal or not) are doomed and the species might face extinction (**Box 1.4, Map 1.27**).

Chapter 7

Temperate Zone Forest Ecoregions

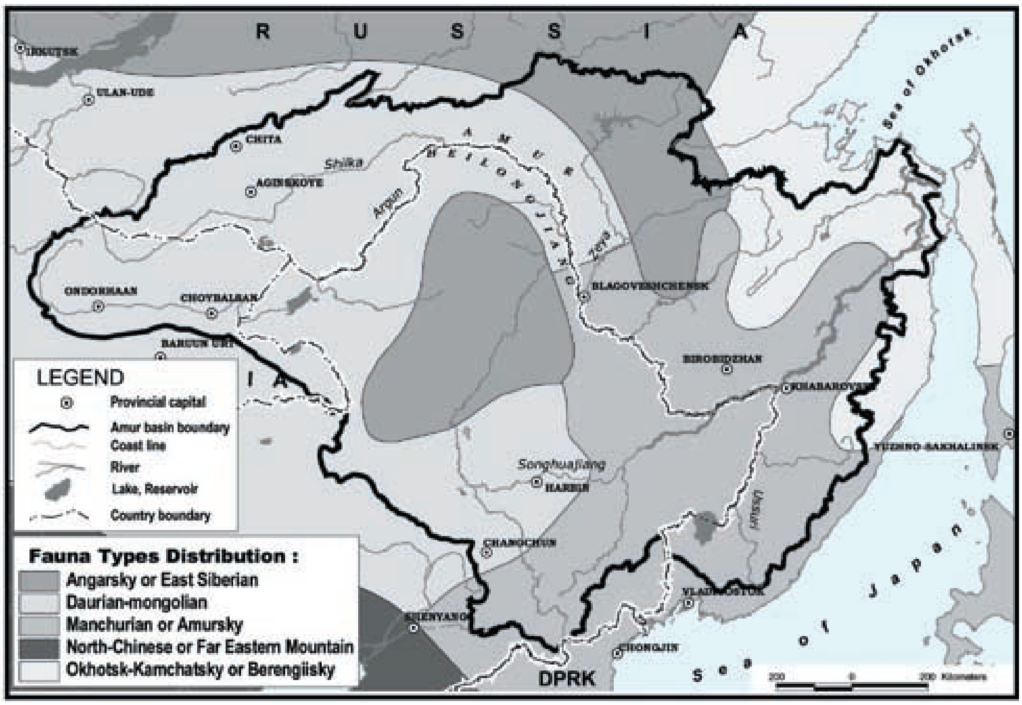
Temperate mixed forests of the Amur-Heilong River basin are the most biologically diverse temperate forests in Asia and possibly the world. Due to the basin's peculiar history of glaciation, which spared large portions from ice cover, and to the complex of river valleys and mountain ridges that cross the area in latitudinal and longitudinal directions, the basin became a crossroads for migration and dispersal. This resulted in a unique mix of species entering the basin from the north (central Siberia) and south (east China).

Manchurian floral communities harbor the greatest diversity of plant species. This type of vegetation is found mainly in southern Primorsky Province, in the Ussuri watershed, on the coast of the Sea of Japan, along the middle Amur-Heilong River and in northeast China. Manchurian flora consists primarily of forest species from the Tertiary Period that are adapted to warm temperatures. The closest relations of these species are found in the subtropics and, in some cases, in the tropics of East Asia. Forests of Manchurian species are dense, moist, and seemingly tropical with deciduous trees such as Mongolian oak (*Quercus mongolica*), Manchurian and Japanese elm (*Ulmus laciniata*, *U. propinqua*), Manchurian walnut (*Uglans mandshurica*), and Amur cork tree (*Phellodendron amurense*). Hanging tangled among the trees are climbing schizandra (*Schizandra chinensis*), Amur grape (*Vitis amurensis*), and tara vine (*Actinidia arguta*). Korean pine is the most prevalent conifer in mixed forests.

The large number of relic species in the temperate zone is due to the unique geological history of the region. The absence of total ice cover in the southern part of the region provided refugia for biota during the Pleistocene glaciation. For example, sixty species of forest orchids are found only in the Russian Far East. Yet the ranges of many of the relics found here have been steadily shrinking as a result of human pressures. In addition to those species that survived from ancient times, a number of plants originated in the region and are endemic to the southern Russian Far East. Three genera are endemic to Khabarovsky and Primorsky Provinces of Russia: *Microbiota, Astrocodon,* and *Popoviocodonia*. Rare species of Manchurian flora include the Japanese yew (*Taxus cuspidata*), Asian ginseng (*Panax ginseng*), sen (*Kalopanax septemlobus*), and two species of rhododendron (*Rhododendron sichotense*, *R. faurieri*). Alpine areas in the Badzhal, Bureya, Changbaishan and Sikhote-Alin mountain ranges are particularly rich in endemic species.

The variety of habitats in the basin supports a diverse fauna. One of the unique features is the weaving together of different species far from their geographical centers of origin. The most species-rich areas of the basin are those where ranges of northern taiga species overlap with those of southeastern Asian communities (Changbaishan, Small Hinggan Ridge, southern Primorsky Province, forests along the Amur-Heilong River, and along tributaries of the Ussuri-Wusuli River. Along biogeographic boundaries, brown bears coexist with Asiatic black bears, Amur tigers cross paths with lynx *(Felix lynx*), and both Manchurian and mountain hares (*Lepus mandschuricus, L. timidus*) scurry from predators.

Different authors assign these temperate forests to various biogeographic zones. This is often based more on convenience, scope, and objectives for specific studies rather than on distinctive natural features of the forests. According to standard biogeographic zoning of China (advocated primarily by zoologists), these temperate forests are assigned to only two categories, the (17) "Changbai Mountains-Xiao Xing'an hill coniferous/broadleaf" and (18) "Xiao Xing'anling mixed forest" units of the "Northeast China eastern hill coniferous/broadleaf and mixed forest sub-region"(Xie Yan et



Map 1.28 Distribution of fauna types

al. 2004). This system (**Figure 1.3**) does not recognize the "Manchurian forest" formation found on the WWF ecoregional map (**Map 1.24**). Practically the same general pattern of major zoogeographic divisions is displayed in standard zoning of "fauna types" advocated primarily by Russian scientists (**Map 1.28**).

In the delineation of Global-200 ecoregions, WWF scientists identified a category entitled "Ussuri broadleaf and mixed forests" (**Map 1.25**). We suggest that this ecoregion need not be confined to Russia because forest ecoregions of the temperate zone in several countries of the basin contribute to its outstanding biodiversity. Indeed, the Changbai Mountain range in China and North Korea is actually the most species diverse part of this global ecoregion.

The Global Ecoregions inventory of WWF dealt with a larger area and distinguishes "Manchurian forests," "Ussuri forests," "Chanbaishan forests," and "Northeast plain deciduous forests." Zoning conducted exclusively for Russia yields yet another classification system (see Martynenko et al 2004).

From the nature conservation prospective all mixed broadleaf-coniferous temperate forest ecoregions distinguished in the Amur-Heilong River basin share the following important features:

- Korean pine (*Pinus koraiensis*) is typically abundant and is always the dominant coniferous species;
- All have been optimal habitat for the northernmost subspecies of tiger (*Panthera tigris altaica*), with the best habitat in earlier times located in the foothills of the Changbai mountains;
- All lie in the historic range of ginseng (*Panax ginseng*); and
- All are the most species-rich temperate mixed broadleaf-coniferous forests in Asia.

Maps of species diversity based on many years of work by WWF and the scientific community of the Russian Far East unanimously agree that the most species-rich terrestrial communities are found in southern Primorsky Province, on the border with China and North Korea (**Map 1.16**), a map of species diversity from ECAP-RFE). And this suggests that the historic center of dissemination for many species was somewhere in this transboundary area. Conservation programs should therefore consider "Russia forest ecosystems" and "China forest ecosystems" along with adjacent forests in North Korea as a single ecosystem and must emphasize the importance of transboundary conservation efforts. However, to link biogeography with the history of ecosystem fragmentation caused by human activities,

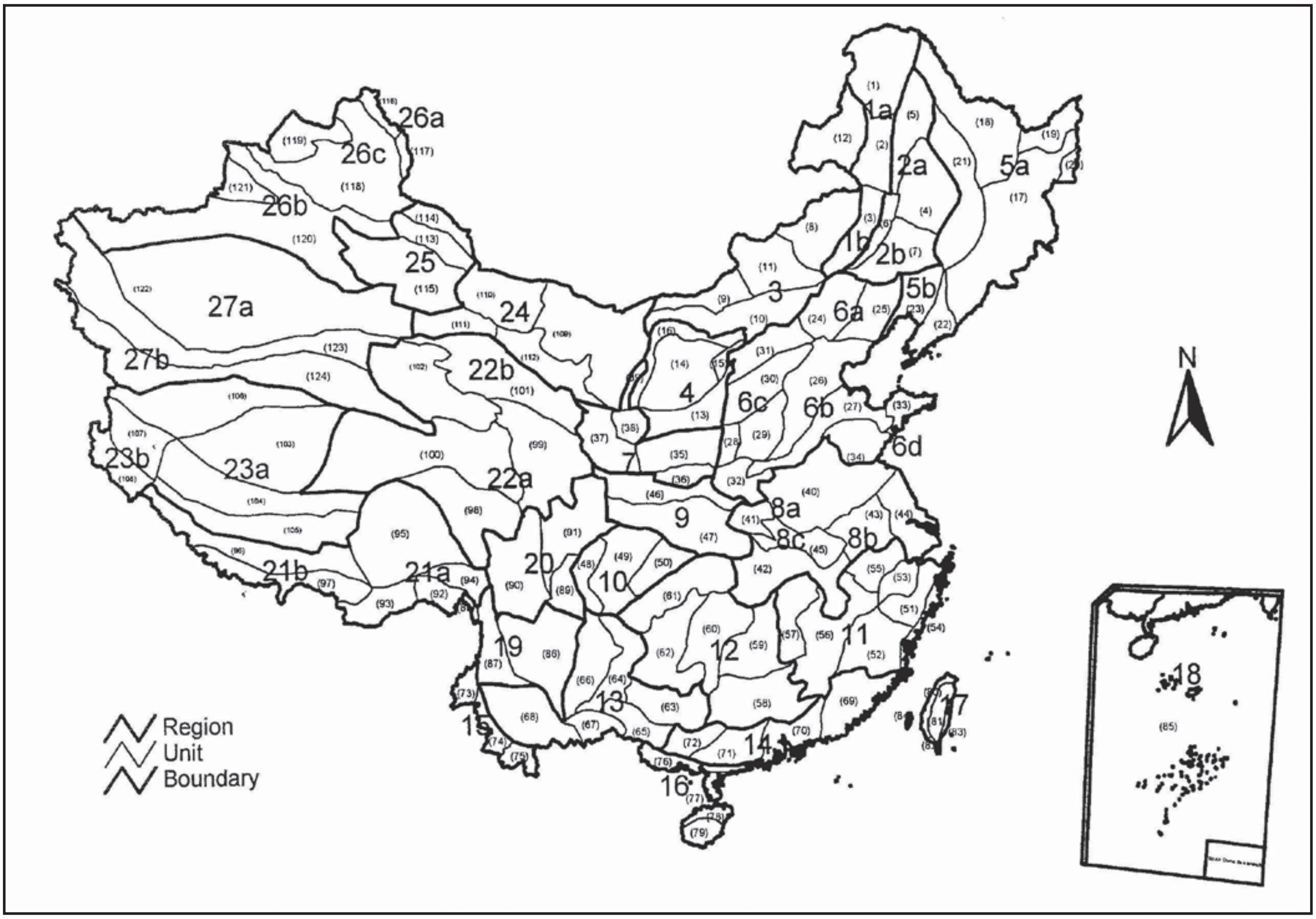


Figure 1.3 Biogeographical divisions of China (reproduced from Yan Xie et al. 2004)

Legend for northeast China divisions:

1a Da Xing'anling and North central Da Xing'an: (1) North Da Xing'anling mountain Northeast Inner-Mongolia coniferous forest; (2) Central Da Xing'an Ling mountain China area steppe and

1b South Da Xing'anling (3) South Da Xing'anling mountain northeast China plain grassland

2a Northeast China Plain (4) Songnen Plain northern forest grassland (5) North central Da Xing'anling eastern slope montane mesa

2b Xiliaohe River arid steppe (6) South Da Xing'anling Mountain front mesa (7) Xiliaohe Plain mountain front mesa

3 Inner-Mongolia arid (8) Inner-Mongolia Plateau eastern lowland steppe and desert (9) Ulan Qab Plateau grassland (10) Yinshan Mountains hill (11) Xilin Gol Plateau (12) Hulun Buir Plateau

5a Northeast China eastern (17) Changbai Mountains-Xiao Xing'an hill coniferous/broadleaf (18) Xiao Xing'anling mixed forest (19) Sanjiang Plain Changbai (20) Wusuli River Mulinghe Plain Mountains (21) Mountain front mesa

several ecoregions are distinguished in this area as discussed below.

Ussuri broadleaf and mixed forests (PA0443)

The ecoregion includes the area north and east of the Lake Khanka Lowlands, which separate it from the Changbaishan ecoregion. Mixed broadleaf-coniferous forests extend to the north Primorsky and South-east Khabarovsk Province of Russia, and in the west include the Wanda Mountains in the middle reach of the Wusuli-Ussuri River in China's Heilongjiang Province.

For most of the Sikhote-Alin Mountains, the lower forest belts (250-350 m elevation) are made up primarily of mixed broadleaf species such as Manchurian ash (*Fraxinus mandshurica*), Japanese elm, and Japanese poplar (*Populus maximowiczii*). Species composition changes abruptly to Korean pine (*Pinus koraiensis*) and broadleaf forests up to 700 m, while Siberian pine and Ajan spruce (*Picea ajanensis*) forests predominate up to 900 m. Typical groundcover in the forest understory includes ginseng (*Panax ginseng*), a highly sought-after medicinal plant that is now severely depleted. The highest elevation belt of true trees consists mainly of Khingan fir and Ajan spruce forests up to 1,300 m. Higher still — at about 1,400-1,500 m — stands of Erman's birch and dwarf shrubs are interspersed with Manchurian alder (*Alnus mandshurica*) and subalpine meadows. Mountain tundra of shrubs, lichens, and grasses is found on some of the tallest mountains in the region.

The Sikhote-Alin Mountains form the southern boundary for boreal species such as ermine (*Mustela erminea*), wolverine (*Gulo gulo*), adder (*Vipera berus*), and chestnut bunting (*Emberiza rutila*). At the same time, the mountains are the northernmost habitat of subtropical species such as the Amur tiger and the leopard cat (Felis leuptilura*Prionailurus bengalensis*).

This ecoregion is widely known as the last stronghold of Amur tiger, with about 400 animals (90% of the remaining wild population) residing within its bounds. However, historical records from the late 19th and early 20th centuries show that prior to large-scale human encroachment the more dense tiger populations inhabited the Changbaishan ecoregion (e.g. see Baikov 1915).

The three most prominent nature reserves involved in long-term research of the ecoregion are Sikhote-Alinsky Zapovednik in the north, Lazovsky Zapovednik on the Pacific seacoast, and Ussurisky Zapovednik in the south.

Manchurian mixed forests (PA0426)

Mixed forests of pine and deciduous broadleaf trees cover extensive, low-lying hills of northeast China and the Evreiskaya Autonomous Oblast of the Russian Far East. While some large forest tracts still remain in remote areas, logging has reduced forest cover in recent years.

Manchurian mixed forests occupy the low hills that extend from the northern Korean Peninsula into the Chinese provinces of Jilin and Liaoning and still further north into Heilongjiang and Amursky Province of the Russian Far East. This ecoregion encircles the broad river valleys of northeastern China, including the east slope of the Great Hinggan Mountains, the south and west slopes of the Small Hinggan Mountains, and the extensive lower elevation hill regions of the Changbai Mountains at the base of the Korean Peninsula.

Manchurian mixed forests are distinguished by higher frequency of conifers compared to the deciduous forests to the south. Cooler temperatures northward cause a distinct change in the forest vegetation composition from mainly deciduous broadleaf to mainly coniferous species.

Forests at 500 to 1,000 m elevation include both coniferous and broadleaved species. Conifers include Korean pine (*Pinus koraiensis*), a straight-trunked pine species that may attain a height of 35 to 40 m. Fir (*Abies holophylla*), and spruce *Picea obovata* also occur here. *P. obovata* is a sibling species of *Picea abies* and is very widespread across northern Eurasia. Broadleaf deciduous (hardwood) species include oaks (*Quercus mongolica*), ash (*Fraxinus mandshurica*), *Tilia amurensis*, birch (*Betula schmidtii*), Manchurian elm (*Ulmus laciniata*), maple (*Acer* spp.), and Manchurian walnut (*Juglans mandshurica*). Shrubs consist of Manchurian filbert (*Corylus mandshurica*) and *Lespedeza bicolor* at lower elevations in the southern region. The dominant Korean-pine mixed forest type often includes large patches of vegetation representative of more northern plant communities. Thus the western slope of the Small Hinggan has distinctive coniferous swamp forest interspersed with meadows dominated by grasses and sedges. These forests are dominated by larch (*Larix gmelini olgensis*) which may grow through a lower story of birch (*Betula japonica*).

Forests on the east slope of the Great Hinggan Mountains have a somewhat different composition. Broadleaf trees include birch (*Betula platyphylla*), poplar (*Populus* spp.), willow (*Salix rorida*) and Mongolian oak (*Quercus mongolica*). Conifer forests, dominated by *Pinus sylvestris* occur in sandier places.

Several rare mammals inhabit this ecoregion: Siberian tiger (*Panthera tigris altaica)*, sable (*Martes zibellina)*, Sika deer (*Cervus nippon)*, and leopard (*Panthera pardus)*. The ecoregion supports other large mammals such as lynx (*Lynx lynx*), musk deer (*Moschus moschiferus*), red deer (*Cervus elaphus*), black bear (*Selenarctos thibetanus)*, brown bear (Ursus arctos) and goral (*Nemorhaedus goral*). Common fish species are found in Amur-Heilong tributaries, including taimen (*Hucho taimen*), which can reach up to 50 kg, Manchurian trout (*Brachymystax lenok*), and Amur grayling (*Thymallus grubei*). The commercial fisheries potential of these species has been over-exploited but the tourism (fly fishing) market has not been developed. The latter industry could well be the key to restoration of the fishery. Larch forest swamps (the largest intact wetlands in North China), with secretive hooded crane (*Grus monacha)* nesting populations, occupy large areas in the upper and middle reaches of mountain rivers in the Small Hinggan Mountains *(Guo Yu Min 2005)* .

The mountainous part of Khingansky Zapovednik and Khingano-Arkharinsky Zakaznik in Amursky Province, and Bastak Zapovednik in Jewish Autonomous Oblast are good examples of this habitat type in this ecoregion in Russia. In China Fenglin, Wuyilin, Xinqing and Da Zhanhe Wetland nature reserves in Small Hinggan Mountains and Wanqin Nature Reserve in the Laoyelin mountains also support stands of Manchurian mixed forest. Hinggan Gorge of Amur-Heilong River is an important migration corridor between the Russian and Chinese parts of the ecoregion. Here a network of province-level nature reserves is being established on both sides (Taipingou NR in China, Dichun and Pompeevka NRs in Russia).

Changbai Mountains mixed forests (PA0414)

The low hills and mountains at the base of the Korean Peninsula support some of the most diverse forest ecosystems in northeast Asia. Vertical zonation is rather pronounced here, which accounts for the higher biodiversity. Communities identical to those in Manchurian Mixed Forests occupy the lower elevation hills that extend from the northern part of the Korean Peninsula northward through China to the Amur-Heilong River Basin in the Russian Far East. The ecoregion includes the higher elevation mountains where forests are dominated by conifers, and the landscape includes alpine meadows and rock slopes. Baiyun (White Cloud), the highest peak in northeast China, is a dormant volcano that reaches an elevation of 2,691 m. Because of its great range in elevation, this ecoregion includes well-defined bioclimatic zones from temperate vegetation in the valleys to alpine tundra on the upper slopes. Due to the isolation of these high-elevation habitats, the region also supports numerous endemic plant species.

The Changbai Mountains consist of low to middle elevation hills aligned southwest to northeast and include a volcanic plateau situated at an elevation over 2,600 m. This upland is the source of several major rivers of the region and supports a distinctive alpine flora.

Forests in the Changbai Mountains are the richest in northeast China. Low-elevation areas below 1,100 m support mixed stands of conifers and deciduous broadleaf trees. Conifers include Korean pine (*Pinus koraiensis*), fir (*Abies holophylla*), red pine (*Pinus densiflora*), and Japanese yew (*Taxus cuspidata* ssp. *Latifolia*). Deciduous broadleaf trees include Mongolian oak (*Quercus mongolica*), *Tilia amurensis*, ash (*Fraxinus mandschurica*), and dwarf birch (*Betula ermanii*). Plant species with a subtropical affinity also occur in these forests. Examples include woody climbers such as native Chinese gooseberry (*Actinidia* spp.), or kiwi fruit, and “Dutchman’s pipe” (*Aristolochia mandshuriensis*). These lower elevation forests are similar and transitional to the surrounding Manchurian Mixed Forests ecoregion. Understory vegetation includes economically important, and in some cases much depleted, species such as ginseng (*Panax ginseng*), Manchurian wild ginger (*Asarum heterotropoides*), and *Gastrodia* spp. which is used as an analgesic. *Panax ginseng* is nearly extinct throughout Chinese Manchuria on the Korean Peninsula, but it still occurs in Changbaishan National Nature Reserve.

The “dark conifer” forest zone at 1,100 to 1,900 m includes a species-rich assemblage of plants that trace their origins to Siberia, western Eurasia, Japan, and the Korean Peninsula. The forest here is cloaked in moss and supports an understory of forbs, grasses, and ferns. At 1,100 to 1,500 m, the forest consists of spruce (*Picea jezoensis, P. obovata*), fir (*Abies nephrolepis*), and larch (*Larix olgensis)*. At 1,500 to 1,900 m, the tree diversity declines to stands composed of *Picea jezoensis* and *Abies nephrolepis* with a reduced understory and dense moss layer. Sub-canopy vegetation in the dark conifer forest includes maple (*Acer ukurunduense*), birch (*Betula castata*), mountain ash (*Sorbus pohuashanensis*), and poplar (*Populus ussuriensis*).

Alpine elevations support a variety of forb species. Exposed sites support meadow, but in favorable locations where snow protects exposed buds during winter, woody shrubs such as willow (*Salix* spp.), *Vaccinium* spp., *Rhododendron* spp., and dwarf rock birch (*Betula ermannii*) form a low groundcover. Alpine plants of the summit plateau on Mount Baiyun are distinctive and include many endemic species because the Changbai Mountains are the only alpine peaks in this region of Asia.

More than 50 mammal species and 300 bird species have been recorded on Changbaishan. Mammals include Far East leopard (*Panthera pardus orientalis*), lynx (*Lynx lynx*), brown bear (*Ursus arctos*), Sika deer (*Cervus nippon*), red deer (*C. elaphus*), goral (*Nemorhaedus goral*), wild boar (*Sus scrofa*), otter (*Lutra lutra*), and sable (*Martes zibellina*).

Birds include rare species such as black stork (*Ciconia nigra*), Mandarin duck (*Aix galericulata*), and scaly-sided merganser (*Mergus squamatus*).

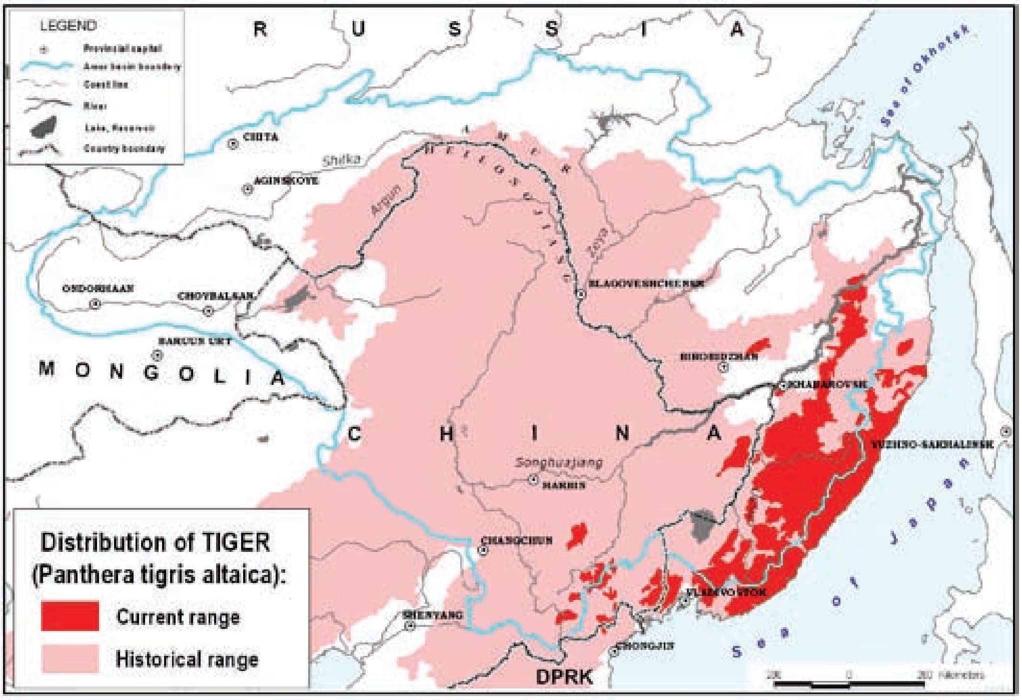
The internationally famous Changbaishan NNR is a Man and the Biosphere Reserve and the most prominent protected area in the ecoregion and the site of many research projects. On the North Korean side it borders Paekdusan National Park. On the northeastern border of this ecoregion there is a vital link in tiger and leopard habitat formed by Hunchun NNR in China and three border nature reserves in southern Primorsky Province in Russia.

Northeast China Plain deciduous forests (PA0430)

The Northeast China Plain consists of a low-lying alluvial basin that originates at the north end of the Bay of Bohai and extends northward, tracing the catchment of the Liao River. At the top of the Liao watershed, the lowlands extend across a low divide to follow the Songhua River toward its confluence with the Amur-Heilong River. Natural vegetation on the plain is deciduous broadleaf forest dominated by oak or a mixture of hardwood species. Many areas are fairly dry while others are prone to seasonal flooding. Natural plant communities here probably once included woodland, grassland and flooded grassland (swamp) components, with closed canopy forest restricted to the wetter, but well-drained sites. The landscape had a forest-steppe character (CAE 2005). At approximately 47° N latitude, the deciduous broadleaf forest undergoes a transition to a more boreal mixed conifer-deciduous formation, marking the northern limit of this ecoregion. The forest has almost entirely been cut and the plain is now farmed intensively. Mongolian oak (*Quercus mongolica*) remains as an important species with Daurian birch (*Betula dahurica*) and the shrubs bush clover (*Lespedeza bicolor*) and hazel (*Corylus heterophylla*) once dominated the plains along the Songhua River. Scrublands and the understory of drier more open forest stands support thorny shrubs such as Daurian buckthorn (*Rhamnus dahuricus*), hawthorn (*Crataegus pinnatifida*) and Daurian rose (*Rosa dahurica*).

Deciduous forests of the Northeast China Plain have been largely replaced by agriculture. Today, remnant forest patches can be seen in places where they have been protected for religious reasons, or where the land is steep and inaccessible. There is no remaining large example of this ecosystem in its natural state.

The Northeast China Plain has been targeted for afforestation by the Chinese Government. The Northeast Shelterbelt Project is intended to protect farmland by reducing wind deposition of sand from the loess hills to the west, and to help agricultural areas retain water. This is the eastern part of "a great green wall" planned to extend across northern China by 2050. Opportunities exist for planting this forest in a way that will promote restoration of native habitat, although this concept has yet to be adopted by project planners.



Map 1.29 Distribution of Siberian tiger.

Temperate forests endangered species profiles:

Boxes 1.4 through **1.7** profile the current status of four endangered species in the Amur-Heilong River basin.

Box 1.5 Siberian tiger (*Panthera tigris altaica*)

The Siberian tiger, the largest tiger in the world, together with the red-crowned Crane, oriental stork, and Amur leopard are perhaps the most prominent symbols of conservation efforts in the region. The tiger is also an important umbrella species because its conservation has potential to enhance the survival probability of a number of other species sharing the same habitats. The tiger is a keystone species (its presence determines ecosystem function) and a top predator, playing an important role in mixed conifer and broadleaf forest ecosystems. The tiger has been the subject of many research studies and conservation efforts. These have been led by the Wildlife Conservation Society (Miquelle et al. 1999, 2005), WWF, and regional governments. Successes have been achieved (particularly in the Russian Far East), but there are challenges to ensuring survival of the subspecies, especially in China. To paraphrase the Indian tiger conservationist, Valmik Thapar, what the tiger needs is total protection in large tracts of land with abundant prey.

The Amur tiger nearly disappeared from the region in the 1940s, when there were fewer than 40 individuals left in the wild. Over the last decade, the population in Russia has stabilized at 400-450 individuals (415 to 476 tigers in Russia, according to data gathered during a 1995-96 census and 431-529 in 2004-2005 census). The tiger's range now extends over an area of approximately 156,571 km^2 — less than a quarter of what it was 75 years ago (**Map 1.29**). The number of breeding female tigers on this territory is approximately 200. About 20-30 tigers remain in the species' historical range of northeast China and the Korean Peninsula. Between 2002-2006 tigers have been appearing in their former range on the left bank of the Amur-Heilong River and in Laoyeling.

The main reasons for the tiger's decline are poaching, and the lack of a sufficient prey base, primarily ungulates — Manchurian red deer (*Cervus elaphus xanthopygos*), sika deer, roe deer, and wild boar. Ungulate populations today are at less than carrying capacity over 70 percent of the tiger's range. These ungulates are also popular game species, and populations have been decimated near human settlements. While tigers are relatively tolerant of people, they are often forced to hunt domestic livestock near farms and settlements, due to the lack of prey in the wild. This increase in human-tiger conflict frequently leads to the killing of problem tigers and is a primary threat to the long-term integrity of the Amur tiger throughout its range.

Poaching has been a problem for the past decade due to the constant demand for tiger derivatives in oriental medicine combined with weak enforcement capabilities at Russian and Chinese border inspection stations. The situation has improved due to the efforts of anti-poaching brigades and increased awareness among government agencies on illegal trade in tiger parts. Tiger poaching is no longer as widespread as before, but tigers are still taken by poachers.

Logging is degrading tiger habitats and road construction is fragmenting what habitat remains. While roads themselves are not serious obstacles to tiger movements, an increase in logging, fires, and hunting of ungulates that accompany road development cause further fragmentation and pose direct threats to tigers. This process is particularly evident along the Khabarovsk-Vladivostok highway and the road being built between Khabarovsk and Nakhodka, where numbers of wild boar and deer have declined sharply. Due to fragmentation of tiger habitat, corridors are required to ensure that the population remains unified and can move freely throughout its range.

Additionally, key habitats of Korean pine, Mongolian oak, and riparian forest need to be protected to help restore parts of the species' former range. While WWF has been working to create an ecological network to link protected areas using corridors, such a network can realistically protect only 15 percent of the tiger's range. Therefore, programs for sustainable use of forest resources and game animals must be implemented in other important tiger habitats to create large-scale conservation landscapes over much of the species range.

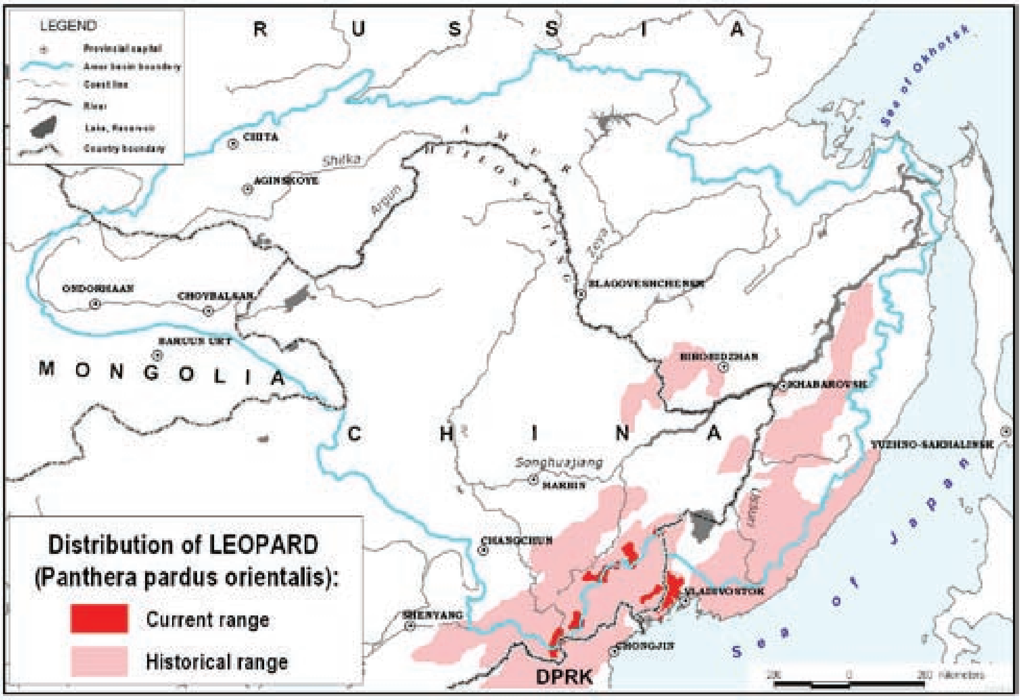
Box 1.6 Amur goral (*Naemorhedus caudatus raddeanus*)

The Amur or Korean goral is a rare ungulate in the Amur-Heilong basin. The species prefers sunny, southeastern rocky mountain slopes (60 to 80 degree incline) in rocky areas and cliffs, primarily along the coastal zones.

The Amur goral is included in the IUCN Redlist (Vulnerable), Russian Red Book, and international trade in the species is restricted by listing in Appendix II of CITES. In Russia, hunting of goral has been prohibited since 1924.

In Russia, goral inhabits coastal areas of the Sea of Japan from Lazovsky to Sikhote-Alinsky Zapovedniks, mostly just outside the Amur River basin. Historic goral range once extended through deciduous oak forests, including the Black Mountains, and the spurs of the Small Hinggan Mountain Range. In China there are several isolated populations of goral in the Small Hinggan and other mountain ranges; however it has not been seen for decades in suitable rocky habitats in the Hinggan straights area of the Amur-Heilong valley.

At the end of the 20th Century, the population of gorals numbered about 2,000 animals in the southern Russian Far East. The population began to decline in the 1920-30s. Today, stable populations in Russia are located only in the protected Sikhote-Alinsky and Lazovsky Zapovedniks. The populations there have been reported to number up to 500. The entire rocky coastline of Primorsky Province, which extends for about 400 km, constitutes potentially suitable habitat for expansion of the Amur goral. Today, the total range of the species in Russia is less than 1,000 square kilometers. The main threats to the goral are poaching and disturbance. Goral derivatives are also used in traditional oriental medicine. Natural threats include predators, disease, and deep snow cover. At least in one area in China goral disappeared due to tourism development.



Map 1.30
Distribution of the Far Eastern leopard

Box 1.7 Far Eastern leopard (*Panthera pardus orientalis*)

The Far Eastern leopard (also called Amur leopard) is on the brink of extinction. Fewer than three dozen animals roam the conifer and broadleaf forests in the southern tip of the Russian Far East and adjacent foothills of Changbai Mountains in China and North Korea. Efforts to save this charismatic umbrella species would help promote cooperation among Russia, China, and North Korea, since the only place the leopard remains is where the borders of these three countries meet.

The range (**Map 1.30**) and population of the leopard have decreased drastically in the last 50 years. In 1973, there were 38 to 46 leopards in the Russian population. By 2003, the population had decreased to 30 animals. In the Jilin Province of China, the leopard population decreased from 45 to 3-5 over the same time period. The leopard's current range comprises approximately 5,000 km^2. Of this, about 4,000 km^2 are located in southwest Primorsky Province.

Minimum area requirements indicate that even a doubling of the leopard population would only ensure short-term persistence. In order to guarantee long-term persistence, additional sub-populations of leopards must be created in new territories in former range.

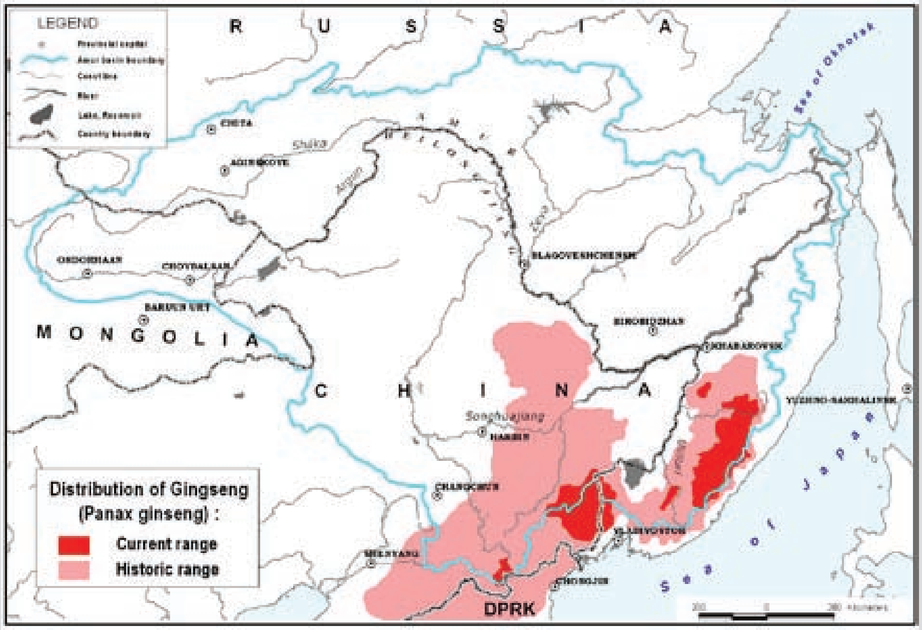
Leopards prefer mixed black fir, pine, and broadleaf forests in the middle and upper reaches of river basins, where rocks and cliffs provide safe dens. In Russia the existing Barsovyi and Borisovskoe Plateau sanctuaries and Kedrovaya Pad Zapovednik protect about 45 percent of leopard habitat, but the protection regime in the sanctuaries and the small size of the Zapovednik are insufficient to guarantee leopard survival.

The Far Eastern subspecies of leopard has been isolated for more than 50 years, and the problem of inbreeding is acute. As a result, the population could die out as a result of its limited genetic resources even without direct human pressures. The population could also be driven to extinction by disease.

The greatest anthropogenic threats to leopards in order of severity are forest fires, poaching, disturbance, logging, and mining. Bush fires ignited each year to burn dry leaves often burn out of control, compromising forest integrity. Poaching threatens the species, fueled by demand for leopard pelts and derivatives used in oriental medicines and for their beautiful fur for the fashion industry. Leopards are occasionally killed in traps set for other animals. Low ungulate numbers due to over hunting in the border region force leopards to hunt Sika deer on deer farms. These farms are fenced-off areas where deer are raised for their meat and velvet antlers, used in oriental medicines. Leopards are sometime shot by deer farm managers when caught on their property. Implementation of the Tumen River Economic Development Project in North Korea and Yanbian District of China is leading to increased human density and development of infrastructure in the region. Though timber resources in southwestern Primorsky Province are extremely limited, unorganized cutting continues, particularly in the border region.

A conservation strategy for the Far Eastern leopard was developed in 1996 with support from WWF. The main conservation target is to create and sustain a genetically viable population of at least 50 individuals. Restoration of leopard habitats is an important task, especially in the Changbai Mountains region. In accordance with the strategy, WWF has continued support of anti-poaching brigades to halt trade in leopard skins and derivatives. Other important measures in the strategy that should be a top priority for the Conservation Action Plan are establishing a transboundary protected area between Russia and China in prime leopard habitat and developing sustainable hunting estates as buffer zones and corridors.

Box 1.8 Asian ginseng (*Panax ginseng*)



Map 1.31 Distribution of ginseng

Asian ginseng is an endemic Manchurian perennial with a thick pulpy root and single stalk. Ginseng root consists of a bulb, a long neck, and a spindle-shaped root, which branches out in two shoots. The shape of the ginseng root often resembles that of a person. The plant's white flowers are gathered in a simple umbrella. Its fruit is red with flat, white seeds. The height of the root is 30-70 cm. Ginseng grows under the canopy of mixed coniferous-broadleaf forests. Ginseng is also cultivated on herb plantations.

The useful part of the ginseng plant is the root with accompanying rhizomes, which contain biologically active glycoside. Ginseng has been used for centuries in Chinese medicines and is now being increasingly sold on international markets to Europe and the U.S. Ginseng derivatives are used for producing food products, additives to beverages, tinctures, balsams, teas, and in perfume and cosmetics. Wild ginseng grows almost exclusively in Primorsky Province, though until the beginning of the 20th century its range extended south into China and North Korea, and north into Khabarovsky Province. Ginseng grows individually or in groups in the area between the Sikhote-Alin Mountains and the Ussuri River. Wild ginseng also grows in Heilongjiang Province and is collected in small quantities in the Wanda and Changbai mountain ridges. The range of ginseng has remained mostly unchanged for the last 70 years though habitat integrity has decreased substantially and many of the areas are fragmented (**Map 1.31**).

Two main factors have had a negative influence on wild ginseng: logging and harvesting. Logging has destroyed or fragmented much of ginseng habitat. Legally harvested ginseng in the USSR was for export. From the 1930s-1980s, wild ginseng sold for three times less than cultivated ginseng, though wild ginseng is considered to be three times as potent. Since 1991, illegal harvesting and trafficking of wild ginseng root increased with the opening of international markets, while demand for cultivated ginseng decreased. In 1998, the harvest of wild ginseng was banned in Russia, yet large quantities of wild ginseng continue to be smuggled to Asian markets. WWF/Traffic and customs officials estimated that more than 1,000 kg of raw ginseng are smuggled out of the country each year at a market value of $24-25 million (P. Fomenko 2005). Customs officials confiscate only a small proportion of the trade. WWF recently recommended that provision should be made to allow local people to employ traditional practices for assisting ginseng propagation in the wild. Before the collection ban, 50% of all Soviet harvest came from the Tazy indigenous group, who preserved the ancient art of sustainable exploitation of wild populations (so-called wild ginseng gardens). Presently all those who still practice this art are considered poachers and have no rights to the forests where they nurture ginseng.

Chapter 8

Global 200 Daurian Steppe

Since basic classification of freshwater ecoregions (which presumably should include wetlands) is yet to be completed, for the purpose of coherent description we merged the categories grassland and freshwater ecoregions, because they are inseparable features of the plains of the Amur-Heilong basin.

This group of ecoregions constitutes one of the best-preserved examples of Eurasian grassland, and still supports intact populations of larger vertebrates in some areas. It is also an important breeding and stopover site for millions of birds on several Asian flyways.

Many Amur-Heilong tributaries cross the region forming wetland-grassland landscapes, which withstand periodic droughts common in this climate. Some hill slopes and river banks support dense forest vegetation, but larger areas have savanna-like forest-steppe character with crooked elms (*Ulmus* sp.) sparsely distributed over the dominant grassland. Annual rainfall ranges from 400 mm in the east to 200 mm in the southwest, where ecosystems are especially vulnerable to climate change and wild fires. An increased frequency of droughts and human-induced water shortage, desertification, overgrazing, and wild fires are the most widespread and severe threats to regional ecosystems.

Many unusual mammals inhabit this area. When not in hibernation, Daurian hedgehogs feed on rodents, lizards, insects, and plants. Herds of Mongolian gazelles in the thousands gather to graze on the grassy hills. This is one of the last areas in the Palearctic that still supports stable herds of larger vertebrates. Short and stocky Pallas' cats stalk birds and small mammals. Only here one can simultaneously watch six species of cranes feeding in one patch of wetland. At least three distinctive ecoregions are found in this area.

Daurian forest steppe (PA0804)

The Daurian forest-steppe is a mosaic of grass and forest that straddles the border between Russian and east-central Mongolia. In Russia, ecoregion boundaries correspond to the northern steppe in the Tuva-Buryat-Mongolian, and Daurian-Mongolian vegetation provinces (Kurnaev 1990). In Mongolia, the ecoregion incorporates the mountain and forest steppe zone. The ecoregion includes a small part of China that supports sheep grass and needle thatch grassland in the Inner Mongolia Autonomous Region.

The Mongolian Daurian forest steppe covers marginal extensions of the Henti Mountain Range circling it in a half-ring (Ulziikhutag 1989). This ecoregion supports large rivers including the Onon and the Ulz. The average altitude of the mid-sized mountains reaches 1400-1800 m while the mean altitude of valleys is 1100-1200 m. Forest types found in this ecoregion include Siberian larch forest with numerous herb species, mixed forests of birch-pine and birch-larch trees, and birch and shrub forests. Aspen (*Populus tremula*) groves are found in marginal mountains. Steppe extends to the eastern part of the Henti Mountain Ranges along the Onon-Balj River basins where larch, pine, and birch forest dominate not only hill slopes, but there are also pure pine forests along the sandy river valleys.

Flora of this area is composed of representative species of Daurian forest and mountain steppe, but Mongolian steppe species dominate in the south. Distributed throughout the region is a variety of grass associations such as C*arex-Poaceae* meadow steppe, *Compositae-Gramineae*-herbs steppe and sandy versions of saltmarsh-tussock steppe. Bordering these associations are halophytic *Ahnaterum* and *Irridaceae-Puccinellia* meadows at lake edges. Also along the shores of the lakes are reed groves, groves of herbs, willow, and aspen (*Populus tremula*). *Carex-Phragmites* and *Carex*-halophytic herb marshes are found in low, wet depressions. The Red Data Book of Mongolia identifies a number of notable plant species in this ecoregion of which fifteen are considered very rare, four rare, eight endemic, and thirteen sub-endemic.

Groves of *Puccinellia-Typhaceae* are the main habitat for bearded parrotbill *(Panurus biarmicus)*, black-browed reed warbler *(Acrocephalus bistrigiceps)*, and great reed warbler *(Acrocephalus arundinaceus)*. A large population of white-naped (Daurian) crane nests in wet areas of the steppes in the Ulz and Onon River valleys and in other valleys, which are important habitats for five other species of cranes as well.

Many species of fish and other aquatic species (54 species) inhabit the Onon and Balj Rivers, including the Arctic lamprey eel *(Lampetra japonica),* Amur sturgeon *(Acipenser schrencki),* Khadary whitefish *(Coregonus chadary),* Haitej sculpin *(Mesocottus haitej), Paracottus kessleri*, river crayfish *(Cambaroides dauricus), Dahurinaina dahurica*, *Rana chensinensi,* and water snake *(Natrix natrix)*.

Grasslands are rich in small mammals such as Scilly shrew (*Crocidura sauveolens*), harvest mouse (*Micromys minutus*), long-tailed souslik (*Citellus undulatus*), Maximovich's vole (*Microtus maximowiczii*), Daurian pika (*Ochotona daurica*), Tolai hare (*Lepus tolai*), a number of hamster species (*Phodopus* spp.), Daurian zokor (*Myospalax aspalax*). Predators include wolf (*Canis lupus*), red fox (*Vulpes vulpes*), polecat (*Vormela pereguzna*), Eurasian badger (*Meles meles*), and Pallas' cat (*Otocolobus manul*).

About 10 species of mammals such as musk deer, Siberian moose, Daurian hedge-hog, raccoon dog, lynx, as well as 10 species of birds including white-tailed sea-eagle *(Haliaeetus albicilla),* white-naped crane *(Grus vipio),* black stork *(Ciconia nigra),* whooper swan *(Cygnus cygnus),* swan goose *(Anser cygnoides),* Baikal teal *(Anas formosa),* and great bustard *(Otis tarda)* are registered in Mongolia's Red Data Book and in the IUCN Redlist.

Detrimental human activities include unregulated road construction, unsustainable grazing practices, and illegal hunting. Increased frequency of droughts, human-induced water shortage, desertification, and wild fires are the most widespread and severe threats to these ecosystems.

The trans-boundary international protected-area network of Dauria interconnects forest steppe and steppe ecoregions. The forest steppe zone is protected by the forest-grassland fringe of Onon-Balj National Park and Ugtam Reserve in Mongolia in the west, and the mighty wetland delta of China's Erguna-Genhe Wetland Nature Reserve in the east. Marshes and *Phragmites* reed beds provide breeding habitat for the great crested grebe (*Podiceps cristatus*), and several species of crane. Two rare birds that breed on the adjoining plains are the great bustard (*Otis tarda*, IUCN Vulnerable) and oriental plover (*Charadrius veredus*). In Aginsky-Buryatsky Autonomous Province of Russia Aginskaya step wildlife refuge is an important waterfowl habitat, while Alkhanai National Park is the best example of forested hilly landscapes and the most important sacred place for all Buriat Buddhists.

Mongolian-Manchurian grassland (PA0813)

The Mongolian-Manchurian grassland includes more than a million square kilometers of temperate grasslands on the inland side of Manchuria's coastal mountain ranges and river basins. To the west are the desert regions of southern Mongolia and north-central China. The western arm of the Mongolian-Manchurian grassland ecoregion extends toward the Upper Selenga River Basin, which drains into Lake Baikal and then to the Arctic Ocean. A second arm extends southwest toward the deserts of north-central China. Much of the ecoregion consists of nearly flat or rolling grasslands. The southwestern uplands of the Great Hinggan Mountains are also included. Their western slopes are gently inclined toward Mongolia while the eastern slopes drop steeply to the Northeast China Plain.

Average elevation throughout the ecoregion is 1,000 to 1,300 m and the climate is temperate. The trans-montane grasslands northwest of the Great Hinggan Mountains have especially cold winters because there are no mountains to offer shelter from prevailing northwesterly winds. A "continental monsoon effect" — where low pressure over the South China Sea draws cold air toward the southeast from the high latitude regions of Central Asia — creates much colder winter temperatures than occur at other regions of similar latitude.

Dominant plant taxa in these grasslands include feather grass (*Stipa baicalensis, S. capillata,* and *S. grandis*), *Festuca ovina, Aneurolepidium chinense, Filifolium sibiricuman,* and *Cleistogenes sqarrosa*. Areas closer to the Gobi Desert support desert steppe and have lower productivity. Dominant species here include drought-resistant grasses (*Stipa gobica, S. breviflora,* and *S. glareosa*), forbs (*Reaumuria soongolica, Hippolytia trifida,* and *Ajania fruticosa*), and small, spiny shrubs that are well adapted to arid conditions (*Caragana microphylla, Ephedra equisetina,* and *E sinica*). Other plant communities include: *Kalidium gracile* in areas of saline soils and salt marshes dominated by *Scirpus rufus, S. planifolium, Ranunculus cymbalaria,* and *Phragmites communis*.

Several species of globally threatened mammals still occur on the Manchurian-Mongolian grasslands but these populations are severely fragmented. Asiatic wild ass (*Equus hemionus*, IUCN Vulnerable) may still occur in the Mongolia border regions. Bactrian camel (*Camelus bactrianus*, IUCN Critically Endangered), Przewalski's gazelle (*Procapra przewalskii*, IUCN Critically Endangered), and Przewalski's horse (*Equus przewalskii*) have been extirpated from this ecoregion as a result of hunting and displacement by domestic ungulates. Mongolian gazelle is the most abundant ungulate and in autumn and winter thousands of gazelle migrate and breed in these grasslands.

The western slope of the Great Hinggan Mountains, covering the Nomrog and Degee River basins on the Mongolia-China border, has many peculiar plants as *Polygonum valerii*, white peony *(Paeonia albiflora),* grand lady's slipper *(Cypripedium macranthum),* and gas plant *(Dictamnus Dasycarpus)*. In Nomrog Protected Area there are 46 species of mammals and 260 species of birds, among which Ussurian moose, *(Alces alces cameloides),* Daurian hedge-hog *(Erinaceus dauricus),* Eurasian otter *(Lutra lutra),* Manchurian zokor (*Mysospalax epsilanus*), Eurasian spoonbill *(Platalea leucorodia),* Baer's pochard *(Aythya baeri),* Mandarin duck *(Aix galericulata),* common pheasant *(Phasianus colchicus),* and Asiatic dowitcher *(Limnodromus semipalmatus)* are listed in the Red Data Book of Mongolia. Eurasian otter, Baer's pochard, and Asiatic dowitcher are IUCN listed as globally threatened.

Researchers have raised concerns about the possible effects of global climate change on the Manchurian-Mongolian grasslands. Studies by Xiao et al. (1995, 1996) indicate that the seasonal distribution and interannual variation in temperature and precipitation, especially during late summer, are important controls on temporal dynamics of plant biomass, rain-use efficiency, carbon flux, and carbon storage in these meadow steppe ecosystems.

Sheep-grazing is a dominant activity, although goats are more abundant in the rockier, mountainous areas. In recent years, the number of goats raised on the grasslands has increased considerably due to the high prices for cashmere wool, refined from goat fleeces. Because goats eat a wider range of plant species and forage more aggressively than sheep — and because goats consume the entire plant — this trend has contributed to the widespread degradation of these grasslands.

Wetland habitats (many brackish or saline) exist throughout these grasslands and many are important breeding habitat for oriental white stork (*Ciconia boyciana*, IUCN Endangered), red-crowned crane (*Grus japonensis*, IUCN Endangered), and relict gull (*Larus relictus*, IUCN Vulnerable). The Mongol Daguur Strictly Protected Area, which covers the lower Uldz River basin with 90 small lakes, rivers, springs and wetlands, is the breeding and stopover place for many migrating birds including several rare species of crane. A total of 256 species of birds have been recorded there, 211 of which are migrants and 131 are residents. Sixteen species of birds (black stork *(Ciconia nigra),* whooper swan *(Cygnus cygnus),* swan goose *(Anser cygnoides*, IUCN Endangered*),* Baikal teal *(Anas formosa*, IUCN Vulnerable*),* white-tailed sea-eagle *(Haliaeetus albicilla),* hooded crane *(Grus monacha*, IUCN Vulnerable*),* white-naped crane *(Grus vipio*, IUCN Vulnerable*),* Siberian crane *(Grus leucogeranus*, IUCN Endangered*),* great bustard *(Otis tarda*, IUCN Vulnerable*),* relict cull *(Larus relictus*, IUCN Vulnerable*)* are included in the Mongolia Red Data Book.

Threats to these areas include reed cutting, livestock breeding, excessive hunting, egg collection, and over-fishing. Steppe and forest-steppe ecoregions have close ecological interconnections that are especially evident in relation to cyclical climate changes (**Box 1.1**).

In 1994, the government departments of Russia, Mongolia, and China agreed to establish the China-Mongolia-Russia *Dauria* International Protected Area (DIPA). Three national reserves were included in this new transboundary protected area: Daursky Biosphere Reserve (Russia, 267,220 ha), Mongol Daguur Strictly Protected Area (Mongolia, 718,000 ha), and Dalai Lake Biosphere Reserve (China, 740,000 ha). With a total area of over 1.7 million ha, DIPA plays an important role in biodiversity conservation for the ecoregion. Managers of DIPA seek to protect floodplain wetlands in the middle reaches of the Argun River along the Russia-China border because these habitats merit urgent conservation measures as globally important breeding habitats for rare birds, and stop-over sites on East Asian flyways.

Among China's other nature reserves Huihe National Nature Reserve is especially important for supporting populations of swan goose, cranes, and other wetland birds. A gazelle reserve west of Dalai Lake was established in China, while several reserves in the Kherlen River and Yakhi Lake basin exist within the Amur-Heilong basin in Mongolia. In 2005, Dornod Province petitioned the central government of Mongolia to establish a nature reserve adjacent to Buir Lake on the border of the Mongolia-Manchuria grassland and the Daurian forest-steppe ecoregion.

Nen River grassland (PA0903)

The Nenjiang or Nen River ("Nonni" in Russian) originates in the low hills that define China's northeastern border with the Russian Far East. The Nen River basin is enclosed by low mountains, the Great Hinggan to the west and the Small Hinggan to the north and northeast. Higher mountains that form the base of the Korean Peninsula define the southern margin of the plain. The whole region drains into the Sea of Japan through the Songhua River.

Soils in the center of the basin have been partly deposited from rivers and lakes throughout the Quaternary period. These tend to be poorly drained, creating swampy, sometimes saline conditions in the low-lying areas, some of which have boggy peat soils. Westward, this swampy landscape undergoes a transition to the drier steppes of the Great Hinggan foothills. Eastward, near the Small Hinggan foothills, one finds a wide margin of famous rich black-soils (Chernozems) developed under forest-steppe vegetation. These soils have been almost completely converted to crop cultivation.

The Nen River has a continental monsoon climate and is warmer and drier than the surrounding mountains. Mean annual precipitation is 400 to 450 mm.

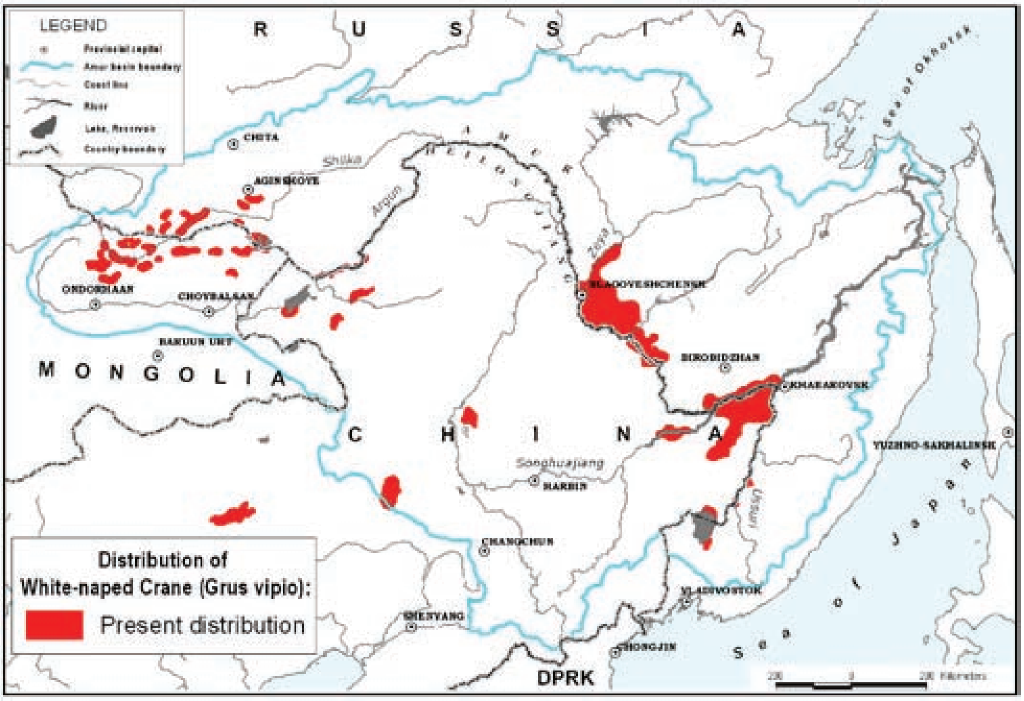
Typical landscapes are flooded meadows and shallow, reed-filled lakes, rivers and old river courses undergoing ecological succession to grassland. Lakes may be either fresh or brackish, and salt concentrations are increasing in many areas as a result of freshwater diversions for irrigation. Meadows are dominated by grasses such as (*Calamagrostis epigeios*) and (*C. langsdorfii*) that are adapted to flooded soils. These often grow as dense tussocks that emerge from flooded areas. Lakes are often filled or lined at the margin by the salt-tolerant reed, *Phragmites communis*. Upland areas are dominated by grasslands, forest-grasslands with crooked elms, and shrub groves of wild-apricot on the hilltops.

During the April-June breeding season, productivity is high, with abundant fish, frogs, mollusks, and aquatic insects, making this an ideal breeding area for waterfowl. More than 200 bird species have been recorded here, including at least six of the world's 15 crane species. The three species that breed here include red-crowned crane (*Grus japonensis*, IUCN Endangered), white-naped crane (*G. vipio*, IUCN Vulnerable), and Demoiselle crane (*Anthropoides virgo*). Three species stage here prior to migrating to their breeding habitat, the common crane (*G. grus*) Siberian crane (*G. leucogeranus*, IUCN Critically Endangered), and hooded crane (*G. monacha*, IUCN Vulnerable). Other rare bird species that breed here are oriental white stork (*Ciconia boyciana*, IUCN Endangered), black-headed ibis (*Threskiornis aethiopicus melanocephalus*), Mandarin duck (*Aix galericulata*), and Eurasian spoonbill (*Platalea leucorodia*). Common amphibians include toad (*Bufo raddei*), tree frog (*Hyla arborea*), frogs (*Rana nigromaculata, R. temporaria* and *Rana amurensi)s*.

Habitat degradation is caused by reed harvest, hunting, and collecting bird eggs. Salinization has become a problem in many areas as well. This occurs when demand for irrigation water is so high that insufficient fresh water passes through the system to thoroughly flush salts. However, direct desiccation of wetlands due to water diversion for agriculture, flood control, oil industry, municipal, and other needs is the largest problem. Wetlands in many nature reserves experience extended drought coupled with increasing frequency and acreage of wildfire. During the past 100 years the Nen River valley, the largest grassland-wetland of the Amur-Heilong basin, has been reduced to a series of isolated and shrinking wet grass habitats.

Numerous nature reserves have been established to protect the remaining Nen River valley wetlands: Zha-

Map 1.32 Distribution of white-naped crane



Box 1.9 White-naped crane *(Grus vipio)*

The white-naped crane prefers drier marshlands than those occupied by its relative, the red-crowned crane. It is also more tolerant of farmland. The breeding range of the species includes only the wetlands of the Amur-Heilong River in Mongolia, China, and Russia. The global population is about 5,500. White-naped cranes migrate from the Amur-Heilong basin to wintering grounds at Poyang Lake in east-central China, the Korean Peninsula, and Kyushu Island in Japan (**Map 1.32**).

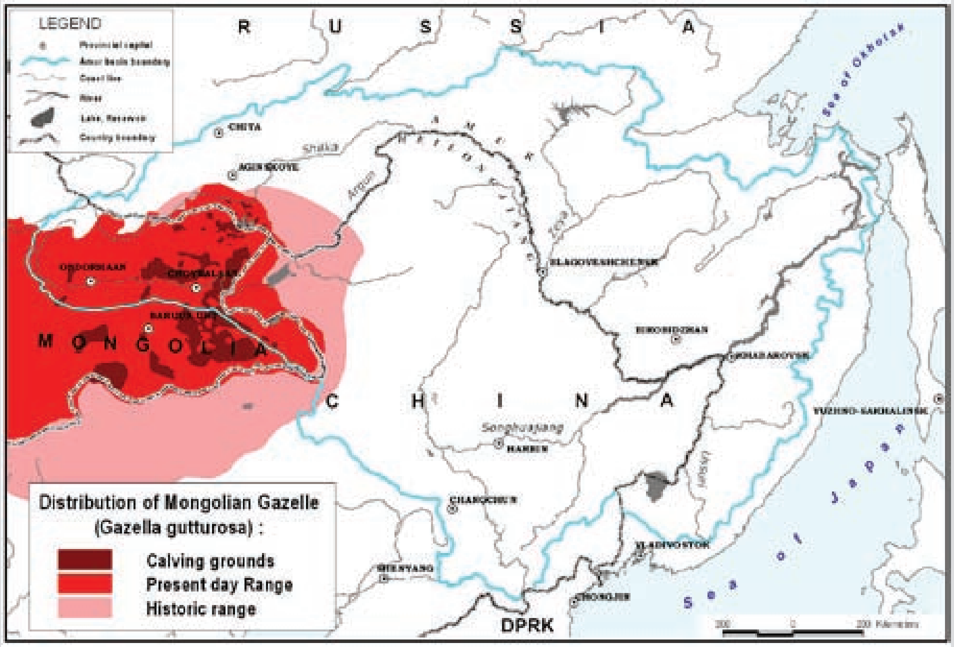
White-naped crane is listed in the Russian Red Book and IUCN Redlist as Vulnerable. Nesting habitats are protected in Khingansky, Khankaisky, and Daursky Zapovedniks, and in many refuges in Russia; in Dalaihu, Huihe, Zhalong, Xinkaihu and other reserves in China; and in Mongol-Daguur, Ugtam, and Onon-Balj protected areas in Mongolia. Depending on the particular phase of the local climatic cycle, birds regularly move between different breeding areas. The main threats are grass fires, human disturbance, and conversion of habitats to farmland.

long Nature Reserve (2,100 km^2), Momoge Nature Reserve (1,440 km^2), Xianghai National Nature Reserve, Ke'erqin National Nature Reserve, Tumuji National Nature Reserve (1,000 sq. km.), and others. Even so, there is no reliable regulatory mechanism to ensure sufficient and timely water supply to these wetlands. This leads to degradation of habitat due to desiccation and agricultural encroachment.

Endangered species profiles: Daurian ecoregion

Profiles of the white-naped crane and Mongolian gazelle are described in **Boxes 1.8 and 1.9**.

Box 1.10 Mongolian gazelle *(Procapra gutturosa)*



Map 1.33 Distribution of Mongolian gazelle and location of calving grounds (Dauria International Protected Area data)

The Mongolian gazelle is the main representative of the eastern Mongolian dry feather-grass steppe and one of the endemic ungulate species of Central Asia. Around 1-2 million Mongolian gazelles inhabit the eastern Mongolian steppe (Lhagvasuren and Milner 1989, Lhagvasuren 2000, Olson 2003, Kiriliuk 2006). The bulk of the population is located in Mongolia while a small resident herd has been reestablished in Russia (**Map 1.33**). Gazelles no longer migrate to China because a fence was constructed along the Mongolian border leaving few openings for gazelles to cross. Migration and distribution are thought to relate to drought cycles and other climatic phenomena, and are affected by human activities including hunting. Oil exploration in the vast steppe area of eastern Mongolia and a planned railway through the steppe are the most pressing threats to gazelles. Construction of the Ulaanbaatar-Zamyn Uud railway blocked the main migration route to western provinces. As a result, herds west of the railway stopped breeding and their range and numbers fell sharply (Lhagvasuren et al. 1985, Lhagvasuren 2000, Tsagaan 1980).

The population in Mongolia north of the Kherlen River was never less than 100,000 head, and in the mid 1990s, the autumn population reached 200-230,000. The largest (maternal) summer group inhabited the left bank of the Kherlen not far from Choibalsan. In the same region there was a calving ground or long-term area of mass calving of Mongolian gazelles spreading from east to west. Every year in September the group migrated in separate herds to winter pastures. During autumn and spring migration and in winter gazelles are usually widely distributed and often penetrate into the Chita region of Russia. During the last 10 years distribution of Mongolian gazelles shifted northwards to the southern border of the forest steppe across the Kherlen River (Kiriluk and Tseveenmyadag 1999). In the early 2000s, mostly due to drought, some gazelles from a maternity group in the north Kherlen population began to move to the northeast where a new large calving ground was formed near the China-Russia border. By 2004 there were more females there than in the main calving area.

Timely monitoring of migrations and measures for protection of gazelles in the *Daursky* Zapovednik (NNR) led to restoration of conditions for recovery of the species in Russia, and the breeding heard reached 500-600 individuals in 2005.

Since 2003 joint Mongolian expeditions to the international protected area on Mongolian gazelle research have been shifted to cover lands south of the Kherlen. The gazelle herd at this site will be studied to develop a species recovery program for China in the near future.

Chapter 9

Global 200: Russian Far East Rivers & Wetlands Ecoregion

The previous paragraphs have described the terrestrial ecoregions of the Amur-Heilong watershed, but the Amur-Heilong River basin itself is part of the Global 200 Freshwater ecoregion, which includes all salmon rivers of the Pacific watershed of Asia. This grouping is too general, so we use only the Amur-Heilong basin itself and the adjacent short rivers draining into the Sea of Japan and Sea of Okhotsk from Uda River in the north to the Tumen River in the south.

This Global 200 ecoregion was given a misleading name. The ecosystem actually extends into China and North Korea (Tumen River basin). It also includes the Lower Amur wetlands described in the boreal zone section, the middle reach of the Amur-Heilong and its major tributaries, the Ussuri-Wusuli River and Lake Khanka-Xingkai Lowlands, as well as many adjacent rivers independently draining into the Pacific Ocean (Uda, Siphon, Tumen, all streams draining the Eastern Slope of the Sikhote-Alin range and others). The delineation of this ecoregion is first of all important because it recognizes the integrity and unique conservation value of the mighty Amur-Heilong River system and the necessity of developing special approaches for conservation of its aquatic biodiversity. Wetlands must be simultaneously considered both in terrestrial and freshwater conservation strategies at once. For a detailed classification of more than a dozen wetland "landscape districts" in the Russian Far East part of the middle and lower Amur basin and corresponding to this Global 200 ecoregion see Volume 5 of Wetlands of Russia (2005).

Endangered species profiles: Amur basin rivers and wetlands ecoregion

Profiles of the salmonid fisheries, red-crowned crane, lotus, Chinese soft-shelled turtle, and oriental white stork are in **boxes 1.11 through 1.15**.

Map 1.34 Comparative diversity of fish by river basin

Fish biodiversity

The Amur-Heilong is important habitat for about 120 native freshwater fish species, and critical habitat for 18 species and one genus *(Pseudaspius)* that are endemic to the basin (WWF 2004). Eight species of fish are listed in the Russian Red Book, including upstream populations of the famous Amur sturgeon (*Accipenser*

Box 1.11 Endangered species profile: salmonid diversity

At 4,444 km, the Amur-Heilong is the longest salmon river in Asia. Three countries — Russia, China, and Mongolia — use the salmon resources of the enormous basin. Anadromous salmon are very abundant in the Lower Amur — autumn and summer chum (Oncorhynchus keta), pink (Oncorhynchus gorbuscha), and masu (Oncorhynchus masu). Coho (Oncorhynchus kisutsch) frequent the Amgun River. Anadromous chars (Salvelinus malma and Salvelinus leucomaenis) are abundant in rivers flowing to the Amur Bay, but in the Amur-Heilong do not swim more than 100 km upstream from the mouth. Few sockeye (Oncorhynchus nerka), chinook (Oncorhynchus tschawytscha — last time caught 150 km upstream from the mouth in 2001), and steelhead (Parasalmo mykiss) occasionally visit the Amur. Siberian taimen (Hucho taimen) and two species of lenoks (Brachymystax lenok and Brachymystax tumensis) are also quite abundant in the Lower Amur. Other Salmoniformes species in the Amur-Heilong include graylings (3 species) and whitefish (2 species). Resident Dolly Varden char (Salvelinus malma) occupy the Lower Amur basin up to the upper reaches of Ussury River tributaries. All of the above species are prized in commercial, amateur, sport, or subsistence fishing. The only anadromous salmon of the Middle (from Ussuri-Wusuli mouth to the confluence of Shilka and Argun rivers) and the Upper Amur-Heilong (Shilka and Amur basins) is fall chum, which is now scarce. Siberian taimen, lenoks, graylings, and whitefish are common throughout the basin. Distribution of salmonids in the basin is shown in **Map 1.35**.

All salmonids spawn on pebble stream beds. The female prepares a sort of a nest called a *redd* and spawns. The male fertilizes the eggs and then the female covers the eggs with pebbles to protect against predators. Lenoks and taimen spawn in the upper reaches of Amur-Heilong tributaries. Masu salmon spawn from the middle parts of tributary basins to the upper reaches. Pink salmon spawn in the middle reaches of the larger tributaries as do summer chum. Fall chum spawn near sources of underground water. All Pacific salmon species are monocyclic, which means they die after spawning (2-6 years). All other salmonids are polycyclic — spawning several times in a lifetime. Siberian taimen mature at the age of 6-7 years and live an average life span of 30 years.

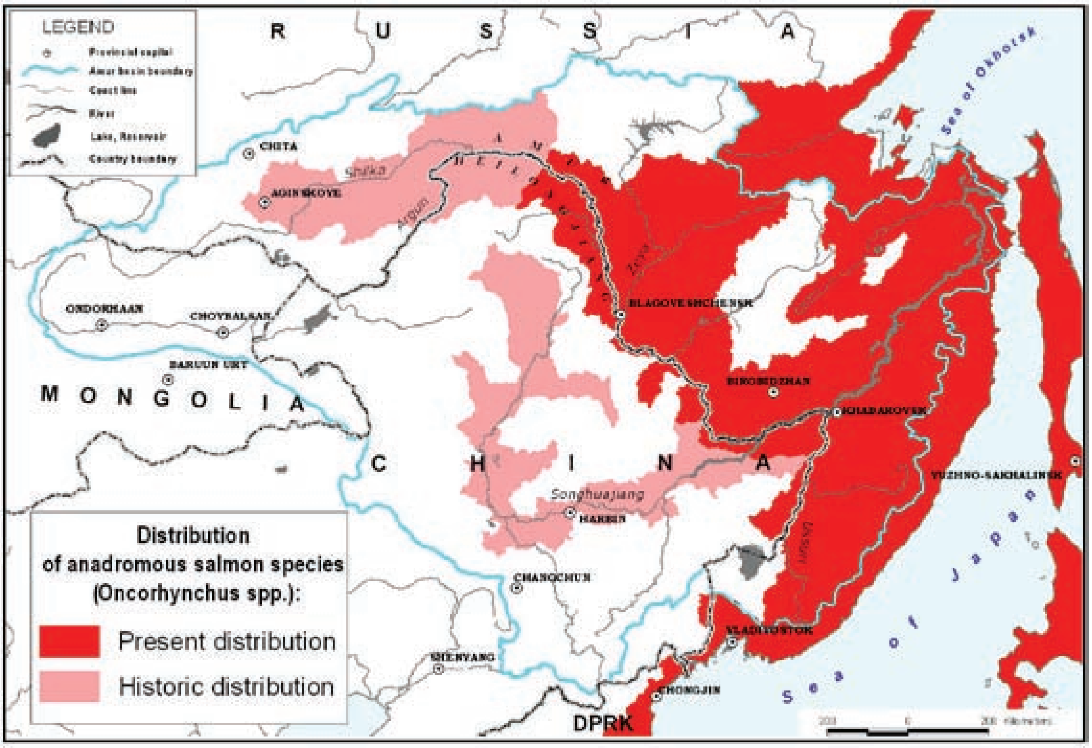
From ancient times, fishing and hunting fed people along the Amur-Heilong. The French missionary la Bruniere who visited the Amur-Heilong, Songhua, and Ussury-Wusuli in the 18th century described local populations as heavily dependent on chum. He wrote that the country suffered great hunger in unproductive years of this fish.

Although no species of salmon is known to have become extinct in the Amur-Heilong, many populations of fall chum disappeared from the Upper and Middle Amur-Heilong, and also from the Ussury-Wusuli River. In the 20th century, fall chum all but disappeared in China. In the Songhua River salmon habitats were severely depleted. In places where spawning grounds are still in good condition, chum does not spawn because those populations were exterminated by overfishing. Some populations of brook Dolly Varden disappeared in the Ussuri-Wusuli River basin. Many populations of Siberian taimen also disappeared. In the 20th century all populations of salmonids declined significantly, due primarily to overfishing. After reaching 93,500 tons in the early 1900s, the commercial catch of chum declined to 3,000 tons by the end of the 1990s, suggesting the population had collapsed. Even if subsistence fishing by local communities reached 9000 tons, this decline still represents a major problem.

schrencki) and Kaluga *(Huso dauricus*), both of which are listed as Endangered in the IUCN Red List of globally threatened species (see www.redlist.org). The Amur-Heilong River still supports tremendous resources of migratory salmon, including seven species, with O*ncorhynhus keta* being the most abundant.

Twenty-three fish species are thought to be introduced to the Amur-Heilong basin. Out of these, nine species not only acclimatized, but are also very abundant and widespread — possibly interfering with the survival of native species. One unsuccessful introduction involved the sockeye salmon, a species that did not

Map 1.35 Distribution of anadromous salmon species (*Oncorhynchus spp.*)



adapt to local conditions after its lease in the 1920s but continues to turn up sporadically as a vagrant species.

Moreover, the Amur estuary hosts additional 15 salt/brackish water fish species, and there are the occasional anadromous species, such as Sakhalin sturgeon, redfin, chinook, coho, steelhead, white-spotted char, and so on. Most of them, except starry flounder (*Platichthys stellatus)*, striped mullet (*Mugil cephalus*), and white-spotted char (*Salvelinus* sp.), are quite rare in the Amur-Heilong.

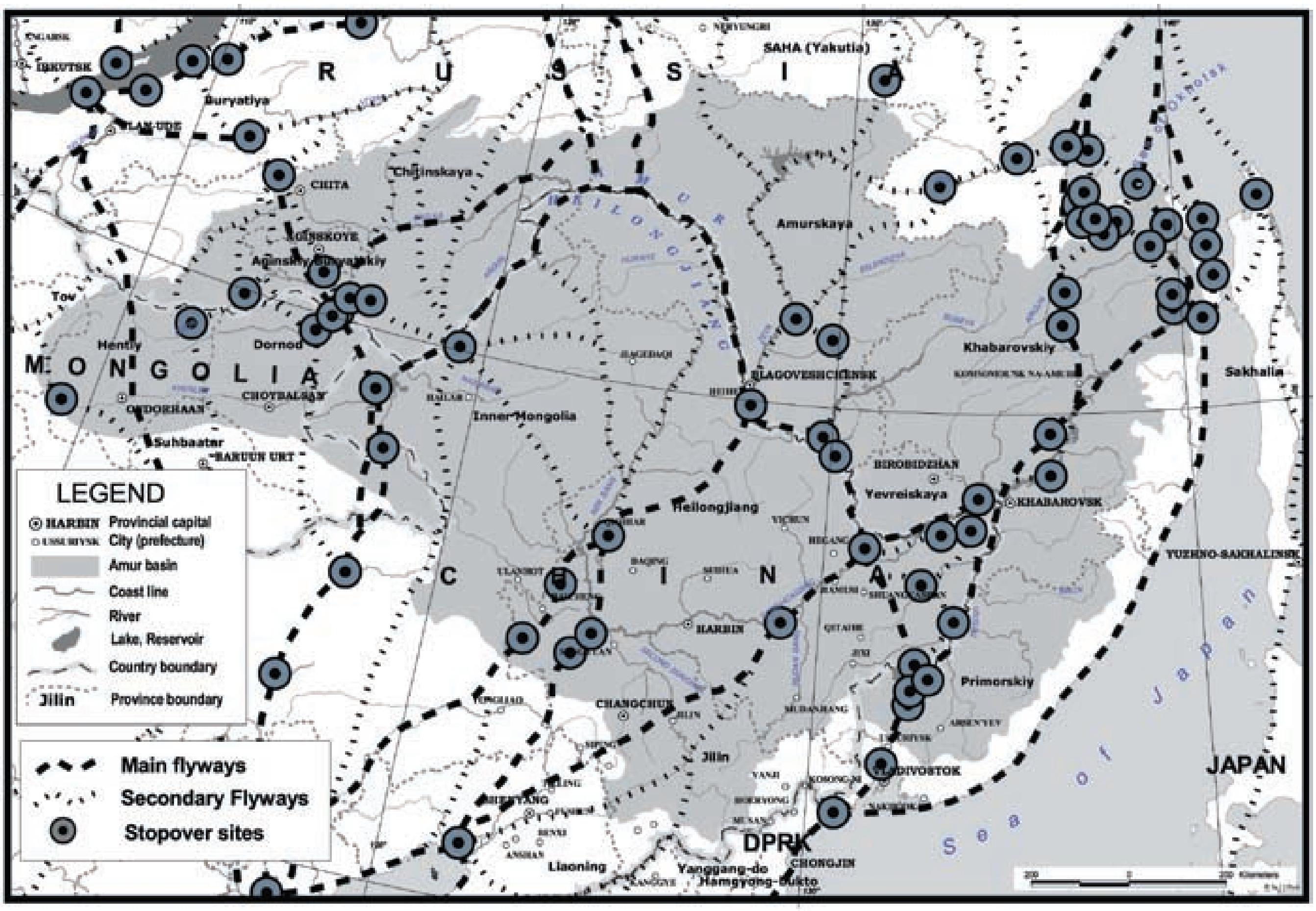
Both in Russia and Mongolia the Amur-Heilong River basin contains rich assemblages of fish species and freshwater organisms in general. When compared with other river basins of Eurasia at similar latitudes, the Amur-Heilong is richer in terms of fish species diversity and is more comparable larger river basins further south (**Map 1.34**).

Amur meadow steppe (PA0901)

The Amur meadow steppe covers riverine wetlands and grasslands of the middle Amur-Heilong River. The extensive meadows here are the result of river meandering over long periods of time across the alluvial deposits in the Amur-Heilong valley. The meadow steppe might also be a remnant of the large shallow lake that formerly filled the valleys. Flooding and a high water table appear to inhibit forest development (although current lack of forests is also due to logging and fires). In its pristine condition the area supported strips of diverse broadleaf forest and pines on the elongated dunes formed by river action. Because it was free of ice during the Pleistocene, the flora and fauna of the Amur-Heilong meadow steppe corresponds strongly with flora and fauna of more southern regions of East Asia. After recession of the most recent glaciers some 10-12,000 years ago, plant communities occupying the Pleistocene refugia would have provided sources of seed that contributed to the floristic diversity of the modern flora.

The ecoregion has two parts demarcated by a gorge in the Lesser Hinggan Mountains (Hinggan Straits). The northwest part of the Zeya-Bureya Plain was formed around the lower sections of these two large tributaries and the Amur-Heilong River mainstem. Together these rivers regularly flooded a tremendous area. Best preserved wetland ecosystems of this section are located in the Arkhara lowlands east of the Bureya River mouth.

The larger eastern part of the ecoregion was formed by even larger tributaries, the Songhua (Sungari) and



Map 1.36 Bird migration routes

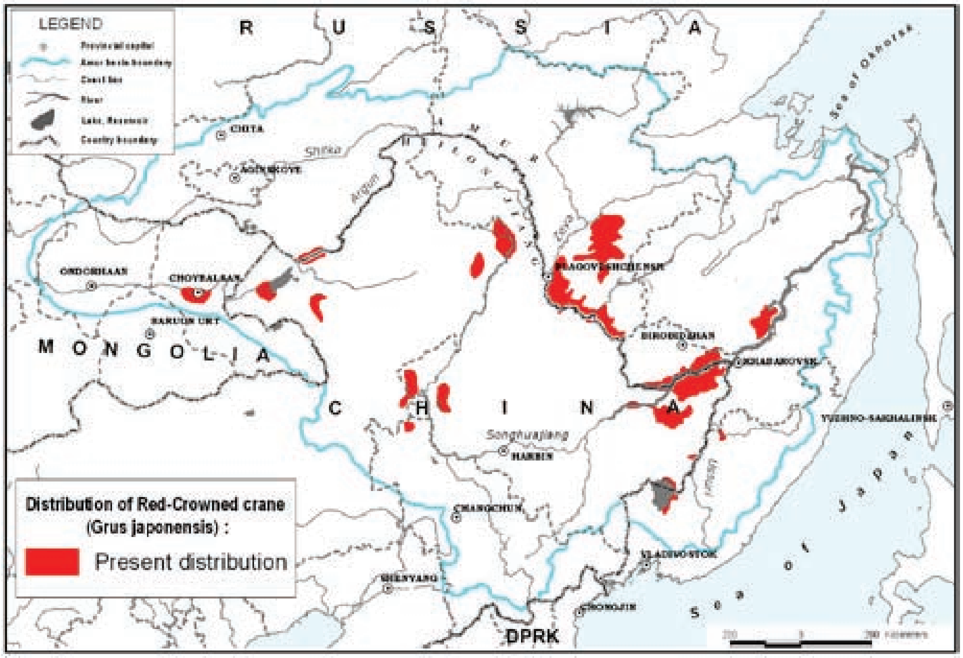
Ussuri-Wusuli Rivers. In Russia it is called the Middle Amur-Heilong Plain, in Chinese this area is called the Three Rivers or Sanjiang plain. We consider areas downstream from Bolon Lake to be a transition zone between this ecoregion and the Wetlands of the Lower Amur described in the section on the boreal region.

The seasonal flooding regime of the Amur-Heilong-Heilong River is a unique natural phenomenon of global significance. At present, no dams block the Amur-Heilong's main channel, which runs nearly 4,500 kilometers from Mongolia into the Tartar Strait of the Okhotsk Sea. In the upper and middle reaches of the Amur-Heilong, floods cause water level swings of 10-15 meters. Flood waters rise 6-7 meters in the lower reaches where the valley is wider and the river braided. The river floods its banks up to 4-6 times during the summer, mostly during the monsoon season in July and August, when it swells to 10-25 kilometers in width in years of heavy rainfall. In the lowlands of Amurskaya and Evreiskaya Provinces, from 5-30 percent of the territory is flooded each year, which accounts for the large diversity of wetland areas.

Hydropower dam has already been built on the Zeya and Bureya Rivers, they have changed hydrologic regimes and threatened the well-being of many endangered wetland species. This has been well documented for cranes and storks in Khingansky Zapovednik. Plans have been long proposed to build hydroelectric stations at three to nine sites on the Amur-Heilong main channel with at least five more dams on its tributaries. This would disrupt the natural flood regime and degrade the river ecosystem. Consequences would be severe for spawning salmon and sturgeon, and migrating and breeding birds. Pollution from human settlements and industry threatens the waters of the Amur-Heilong River, compromising the integrity of wetland ecosystems. Wetlands here have plant communities not found elsewhere in Russia. In the Amur-Heilong basin northern species grow alongside southern species, including exotic and tropical species of plants. Relic plant species include Komarov lotus (*Nelumbo nucifera*), water shield, and gorgon plant. Rare species found here also include sword-leaved iris (*Iris ensata*), candock (*Nuphar luteum*), and pygmy water lily.

Wetlands on the plains of the Amur-Heilong River are globally significant for migration of tens of thousands of geese and hundreds of thousands of ducks and waders. Endangered species such as Far Eastern curlew (*Numenius madagascarensis*), swan goose (*Anser cygnoides*), and Baikal teal (*Anas formosa*) depend on these stop-over areas. Each spring and autumn, birds stop here to feed and rest along the East Asian migration route between nesting areas in the north and wintering grounds in the Yangtze River valley in China and on the Korean Peninsula and the islands of Japan (**Map 1.36**).

About 20 species of rare and endangered birds use these wetlands for migration or breeding. Rapid development of riparian ecosystems throughout Northeast China means that the Amur-Heilong valley harbors some of the last remaining habitat for migratory and breeding waterfowl and plays a crucial role in their survival. Drainage of



Map 1.37 Distribution of red-crowned crane

Box 1.12 Red-crowned crane *(Grus japonensis)*

Red-crowned crane is a cultural symbol throughout northeast Asia. It is a beautiful bird that reaches 1.5 meters in height and has white plumage with a black neck and wing feathers. An isolated non-migratory population lives on Hokkaido, Japan, while the entire continental migratory population (1,600 birds) nests only in the Amur-Heilong River basin (**Map 1.37**). About 500 birds inhabit the grassy marshlands of the Zeya-Bureya and Middle Amur Plain, Ussuri River valley, and Khanka Lake in the Russian part of the Amur-Heilong basin. The remaining 1,100 birds nest in the China part of the basin. The Nen River wetlands once supported the greatest number of red-crowned cranes but numbers have declined in recent decades. Scientists from DIPA recently described globally important breeding habitats in the middle reaches of the transboundary Argun and Huihe River valleys. The red-crowned crane is listed in the Russian Red Book and listed as endangered by IUCN. Nesting habitats are protected in Khingansky, Khankaisky, and Bolonsky Zapovedniks and many refuges in Russia. Zhalong National Nature Reserve is the major stronghold in China for the red-crowned crane, and many larger wetland nature reserves of the Song-Nen and Sanjiang plains also support nesting pairs. Wintering grounds are situated in China (along the coastal zone north of the Yangtze River) and in the border demilitarized zone between North and South Korea. The main threats to the species are conversion of habitats to farmland, diversion of water from wetlands, and grass fires. During the past several years the global population has steadily declined.

Box 1.13 Lotus *(Nelumbo nucifera/komarovii)*

Nelumbonaceae is a family of aquatic plants with a long evolutionary history. They appeared some 135 million years ago. Only two species now survive, lotus (*Nelumbo nucifera* or *Nelumbium komarovii* in Russian sources) and American lotus (*Nelumbo lutea*). Lotus is an important economic crop and ornamental plant widely distributed in Asia and northern Oceania. The wild lotus is the source of cultivated lotus and the gene pool for new cultivar breeding. In China it is frequently cultivated for ornamental, food, or medicinal purposes.

Researchers from Daqing and Beijing recently analyzed the genetic structure of the remaining wild lotus populations in Heilongjiang Province and adjacent areas of Russia. The Amur-Heilong River valley is one of the cradles of wild lotus. Leaf fossils unearthed at Yilan County of Heilongjiang province dated to the Tertiary, which began some 65 million years ago. The wild lotus is distributed mainly along the Ussuri-Wusuli, Songhua, and the Amur-Heilong River valleys. In Heilongjiang Province Chinese researchers discovered 60 sites colonized by wild lotus. A similar number of sites was documented in adjacent areas of Russia. Although the evolutionary history of lotus in the Amur-Heilong basin is long, individual populations may be short-lived. Lotus is found in river valleys where rivers meander and lotus habitats are fragmented and isolated yet simultaneously recreated. Fluctuations of the wild lotus populations are consistent with climate changes. Wetlands are enlarged in years when precipitation is abundant and under these conditions lotus proliferates. When wetlands shrink during drought, wild lotus is restricted to only a few localities. Lotus grows in colonies that can expand through rhizome growth. Increases in the number of populations depends on dispersal of genets (rhizomes or fruits) that are dispersed by mainly rivers. Lotus fruit is also be dispersed by birds which feed on the lotus fruit. Lotus fruits have an extremely long life, enabling plants to reappear in some ponds after apparently disappearing for hundreds of years.

The wild lotus populations of the middle reaches of the Songhua River appear to be the center from which the species spread to the Ussuri-Wusuli and Amur-Heilong River valleys. The limited genetic diversity of wild lotus suggests that it experienced a severe bottleneck.

Populations of wild lotus in the Amur-Heilong basin are declining due to loss of wetland habitat and the genetic integrity of wild lotus is threatened by genetic invasion from cultivars. Conservation of wild lotus is urgent and important not only scientifically but also for economic, cultural and religious reasons. Conservation efforts should be focused on the middle reaches of the Songhua River, where several local extinctions were recently reported (Xue Jianhua et al. 2006).

wetlands, dam construction, human disturbance, grass fires, and sport hunting are the major threats in the East Asian Flyway.

Stop-over areas and rare bird habitats protected in the Amur-Heilong River valley include three of six existing Ramsar sites in the Russian portion of the Amur basin: Zeya-Bureya Plain (Muravievsky game refuge), Arkhara Lowlands (Khingansky Zapovednik), Bolon Lake (Bolonsky Zapovednik). Sanjiang National Nature Reserve and Honghe National Nature Reserve in China are also Ramsar sites. Several other prominent reserves have been established: Aldikon protected wetland (Amurskaya province), Zabelovsky refuge (Evreiskaya Autonomous region), Bachadao National Nature Reserve, Naolihe National Nature Reserve in Heilongjiang Province. While the Amur-Heilong and Ussuri-Wusuli floodplains are protected in large tracts within China's nature reserves, Russian reserves generally protect wetlands along smaller tributaries and much smaller areas of the Amur and Ussuri floodplains proper.

Suifen-Khanka meadows and forest meadows (PA0907)

In Russia, the mapped ecoregional boundary of the Suifen-Khanka meadows and forest meadows corre-

Box 1.14 Chinese soft-shelled turtle *(Pelodiscus sinensis)*

Chinese soft-shell turtle inhabits Russia, the Koreas, China, Indochina, and Japan, but here we discuss the unique north-eastern populations in the Amur-Heilong River basin, where the turtle was known to live as far north as Bolon Lake on the Lower Amur River in the north, and the lower Zeya River in the northwest. It is distributed in Primorsky, Khabarovsky, Evreiskaya, and Amurskaya provinces of Russia on the main channels of the Amur-Heilong and Ussuri Rivers and lower reaches of their tributaries. Since 2000 the species has been recognized by IUCN as vulnerable and wild populations are reported to be in decline throughout the range. It is included in red data books and protected species lists of four provinces of Russia, and wild populations are legally protected in Heilongjiang Province of China. This turtle is the only reptile specifically covered by the Russia-China Agreement on Amur Fisheries as a species in need of protection. The decline in Amur-Heilong populations of the turtle is well known, but poorly documented. Local fishermen note that over the past 20 years the range of soft-shelled turtles in the upper-middle Amur-Heilong shrank by 100 kilometers to the south-east from the Zeya River mouth to Konstantinovka village. According to estimates of local fishermen in China and Russia, the density of turtles declined substantially as measured by the frequency of accidental capture in fishing-nets.

The turtle inhabits rivers, lakes, ponds, and reservoirs where water flows slowly. It is fond of quiet, clear, sunlit shores with gentle slopes where turtles are active when exposed to the sun. Soft-shell turtles feed on snails, mollusks, fishes, shrimps, crabs, insects, frogs, and earthworms. Hibernation extends for 7 months from October until the following May in the mud of the river or lake bottom. Breeding season lasts from June to August on the Amur-Heilong. Oviparous, eggs are laid in loose soil or on sandy shores that are sunny and sheltered. Under natural conditions, hatching occurs after two months. Availability of suitable hatching habitat may be the most important limiting factor for soft-shells, since flooding season in the area coincides with incubation season.

Factors threatening turtle populations include: flooding regimes, human disturbance on shores, predation of eggs and young by foxes, raccoon dogs, and people, predation of young by waterbirds and birds of prey, habitat conversion and pollution mainly by agriculture, incidental take in fishing nets, limited access to breeding tributaries by nets and barbwire fences on the border. Most authoritative Russian experts believe that availability of breeding habitat and predation by man are two leading limiting factors for Amur-Heilong populations (Adnagulov and Tarasov 1998). Chinese soft-shelled turtle has been used for food for ages. It is also used in Chinese traditional medicine. Demand for Chinese soft-shelled turtle is strong. Lately, great success has been achieved in turtle farming in China, with millions of turtles bred and supplied to food and medicinal markets. Escape of farmed animals into wild populations is also common and has added to confusion regarding the genetic status of local populations. Chinese also often release turtles (or fishes, or birds) to honor spirits of a given place. As with most other species, turtles from the wild are considered superior to farmed turtles in their medicinal qualities, and market supply of farmed turtles is unable to offset demand for those taken from the wild.

Protection of the Amur-Heilong basin population is especially important since the species is at the northernmost point of its geographic range and thus more vulnerable to local extinction. Similar to the lotus, turtle is a wonderful indicator of cultural differences in the basin. For most Chinese it is a common food product, while for most Russians it is a unique exotic representative of tropical fauna in northern regions.

sponds to the Far Eastern sub-boreal humid lowlands and swamps surrounding Lake Khanka and the Song'acha and Ussuri-Wusuli Rivers. It also encompasses the flat, low-lying lands south of Lake Khanka in the Suifenhe (Razdolnaya) River basin since this area has a number of Red Book species in common with Lake Khanka to the north. Within China, the boundary corresponds to the swamp woodlands and grasslands just north of Lake Khanka. In the north these meadows are separated from the Middle Amur meadow-steppe by the Wanda Mountains. Lake Khanka is the largest North Asian Lake east of Baikal. The ecoregion is characterized by deforested or woodland landscapes near Lake Khanka and along the Song'acha and Ussuri-Wusuli Rivers. It extends downstream to the mouth of the Bikin River in the north (including the Anchan-Bikin wetlands) and along the valley of the Razdolnaya (Suifen) River in the south.

The reasons for the lack of forest are still a point of debate among biogeographers. Although climatic conditions favor forest development, devastating fires have occurred regularly since the appearance of the first civilizations more than 10 centuries ago. The Bohai and Zhurzhen (Nuzhen) civilizations may have contributed to the formation of fire tolerant meadows and Mongolian oak woodland communities. The valley was probably both a refuge and biogeographic "bridge" for many species during the late Pleistocene glaciation. This explains the very high level of species diversity and the presence of floral relics.

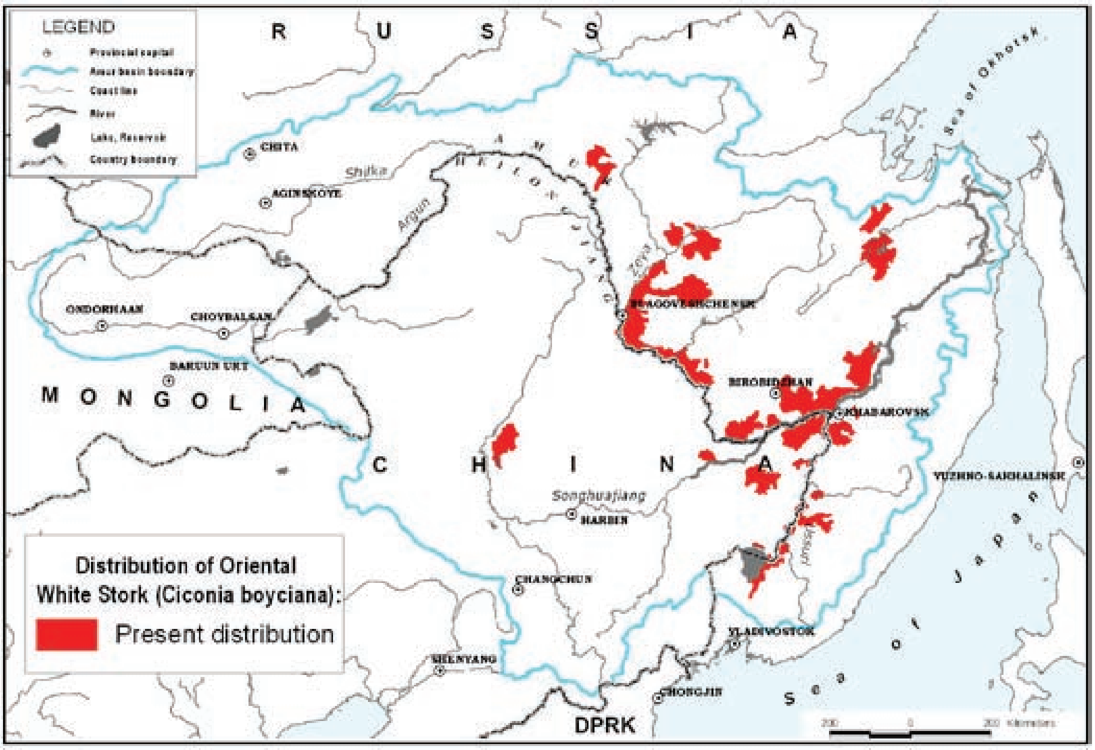
The ecoregion supports at least 70 species of fish, as well as endemic crustaceans and mollusks. Many fish are endemic to Lake Khanka-Xingkai. The Ussuri-Wusuli River and Lake Khanka are among the most important sites for migrating birds in all of East Asia. Globally rare cranes and ibises are summer residents here. Birds are well studied on this territory because of the great importance of Lake Khanka-Xingkai in their migration and reproduction. Of the 400 species recorded in the area, 44 species are included in the IUCN Redlist, and more than 80 are recommended for special protection in the Russian Far East. This area is also a biogeographic crossroad: Indian and Chinese species such as Mandarin duck (*Aix galericulata*) and softshell turtle (*Pelodiscus chinensis*) inhabit the same Ussuri waters as northern species such as chum salmon (*Oncorhynchus keta*).

The Khanka Lowlands are also a site of intensive rice cultivation. Around 80% of lowland wetlands here have been converted to farmlands. Lake Khanka-Xingkai is also affected by the indirect effects of farming, such as runoff of contaminants from fertilizers, pesticides, and biological waste of animal husbandry.

The International Nature Reserve uniting Lake Khanka National Nature Reserve in China (2,000 km^2) and Khankaisky Zapovednik in Russia (450 km^2) is the largest protected area in the region. However, the acreage of protected area does not reflect the quality of habitat. For example, on the China side fewer than 200 km^2 of wetlands remain unaltered by human activities. Another prominent conservation feature is a chain of nature reserves on the west side of the Song'acha and Ussuri River valleys along the international border (including Hutou NR, Zhenbaodao NNR, Dongfanghong Wetland NNR). These reserves typically protect the whole gradient from forested hilltops to floodplain wetland. Unfortunately there are no reserves established to protect the Russian half of the valley.

Endangered species profiles: Amur basin rivers and wetlands ecoregion

Profiles of the red-crowned crane, lotus, Chinese soft-shelled turtle, and oriental white stork are in **boxes: 1.11, 1.12, 1.13 and 1.14.**



Map 1.38 Distribution of oriental white stork breeding areas

Box 1.15 Endangered species profile: oriental white stork *(Ciconia boyciana)*

The Amur-Heilong basin floodplains are the last remaining nesting area for 95 percent of the world population of oriental white stork, an important indicator of wetland health. The birds breed only in the Amur-Heilong River basin and migrate south to China for the winter (**Map 1.38**). The global population of this endangered species (IUCN Redlist) has declined by 75% in the past four decades to fewer than 2,500 birds today. Outside Russia, the species nests only in northeastern China. Oriental white storks have disappeared completely from parts of their former range on the islands of Japan and the Korean Peninsula. The bird's nesting area in northeast China is also shrinking dramatically (slightly more than 120 pairs were reported in 2004). The bulk of the population — about 380 to 430 pairs — occupies wetlands in the southern part of the Russian Far East. The largest concentration of nests, about 100, is found in Amurskaya Province, around Khanka/Xinkhai Lake and in Honghe National Nature Reserve in the Sanjiang Plain in China.

Oriental white storks nest in areas near oxbow and wetland lakes, rivers, and streams surrounded by large open wetlands with islands of tree clumps or individual trees. They sometimes nest in groups. Storks feed on fish, invertebrates, and amphibians, placing the species at the top of the food chain and making it an important keystone species. The oriental white stork is also an indicator of wetland health, since it requires clean freshwater for survival.

Until recently, oriental white stork has not been the focus of conservation efforts in the region, despite the critical status of the population. No legends or traditions are associated with the oriental white stork in Asian cultures, as is the case with cranes. Most mortality occurs during migration and on wintering grounds. In Slavic culture, the stork is considered a guardian of the home and a symbol of happiness, which can help motivate local people to help conserve the species. Unlike the European white stork, which commonly nests in villages and even on chimneys, the oriental stork shies away from human settlements and this limits the availability of suitable nesting habitat, particularly in largely deforested areas such as the Amur-Heilong floodplain.

Part Two

Socio-Economics and Natural Resources

Cranes and agriculture in Zeya-Bureya Plain © WWF-Russia / Y. Darman

Horses grazing on the Daurian steppe / Oleg Goroshko

Chapter 10
Introduction

Understanding socio-economic conditions in the Amur-Heilong basin and predicting trends into the future is important for developing an effective biodiversity conservation strategy. In this chapter we describe demography, economic development patterns, and the legal and administrative framework for natural resource use in each of the three basin countries. Data on land-use patterns were derived from various national sources that do not always correspond well across national boundaries. Because land use is of such importance to nature conservation planning, we dealt with the discrepancies by abbreviating and translating a recent article on the subject (Sheingauz & Karakin 2004) as a summary section on land use. We then included some of the information derived from national sources for comparison. Concluding sections on international trade and investment and international environmental cooperation emphasize transboundary issues.

Land resources and land use patterns

Land resources in the Amur-Heilong basin are shared by Russia (the southern segment of the Russian Far East and Transbaikalia or Zabaikalie), the People's Republic of China (Jilin, Heilongjiang, and Inner Mongolia) and Mongolia (eastern Mongolia). In all three countries the areas within the Amur-Heilong basin are geopolitically and economically important. Land use administration and principles vary by country, as do ecological problems that are related primarily to agriculture and resource exploitation.

The Basin at a Glance

The short excerpt below presents comparative data from Sheingauz & Karakin (2004). This recent land-use research breaks new ground in transboundary analyses because the methods used were standardized

Table 2.1 Land-use in the Amur-Heilong basin and its vicinity by country and land-use category [million hectares (percent)]

Amur-Heilong basin portion	Land use category							
	Cropland	Forest	Urban	Nomadic pasture	Water	Waste-land	Other	Total
Russia	7.9 (4.4)	119.1 (66.7)	0.7 (0.4)	14.8 (8.3)	3.0 (1.7)	16.7 (9.0)	16.5 (9.2)	178.7
Mongolia	0.2 (0.7)	1.6 (5.6)	0.1 (0.3)	21.5 (75.2)	0.1 (0.4)	0.5 (1.7)	4.6 (16.1)	28.6
China	26.3 (27.7)	39.0 (41.0)	2.9 (3.0)	10.3 (10.8)	3.4 (3.6)	9.4 (9.9)	3.8 (4.0)	95.1
Basin total	34.4 (11.4)	159.7 (52.8)	3.7 (1.2)	46.6 (15.4)	9.8 (3.2)	26.6 (8.8)	21.6 (7.2)	302.4

Sources: Statistical yearbooks of respective countries 1997-2001, authors' calculations.

across national borders. The data differ somewhat from results typical of single-country studies but for comparative purposes the greater accuracy is a beneficial compromise. The official national and international statistics that were the main data sources relied on political boundaries rather than the boundaries of the Amur-Heilong basin. Consequently some data are included for portions of provinces located outside the basin. The two largest of these areas in Russia are the Baikal and Lena watersheds in Chita Province and the Okhotsk Sea coast in Khabarovsk Province. The total area evaluated by Karakin and Sheingauz was 3 million km^2, of which 2 million km^2 lie in the Amur-Heilong basin and 1.0 million km^2 lie adjacent to it (**Table 2.1**).

Natural and semi-natural ecosystems cover approximately half (1 million km^2) of the Amur-Heilong basin. Thus the basin as a whole still has potential to sustain biodiversity and natural processes on large geographic scales. A second important feature is the marked difference in population densities and land-use patterns between basin countries. This cannot be attributed entirely to varying environmental or natural resource conditions, but actually represents different development strategies pursued by neighboring countries.

Land Use in Russia

The Russian part of the Amur-Heilong watershed is mountainous. Plains occupy less than one quarter of the territory. Most population density and human activity are confined to the plains of the southern Russian Far East, where areas suited to economic development account for less than one third of the total (**Table 2.2**). Total land area of the six Russian provinces of the Amur-Heilong basin is 178.7 million hectares, with 67 percent forest, 8 percent pasture and just over 4 percent farmland.

Arable lands cover only 1.5 percent of the territory and population density averages just 0.5 ha/person. Per capita arable land ranges from 1.8 ha in Amursky Province to 0.07 ha in Khabarovsky Province. Approximately 75 percent of arable land is located in the southern riverine plains. Arable land is suitable for cultivation of potatoes, wheat, oats, maize, and even rice, but typically requires costly amelioration measures to achieve sustainable crop production. Permafrost areas cover a significant portion of these territories and are not arable.

Outside the southern riverine plains there are few sites with climatic and soil conditions suitable for potato farming, milk-production, or vegetable gardening. The upper Zeya River basin is the best example although farming here only supports the needs of remote settlements. Extensive pastures support cattle and sheep on grasslands of southern Chitinskaya, Amurskaya and Primorsky Provinces. Remnant reindeer herding persists in northern Amurskaya and a few other provinces.

Land Use in China

The China portion of the basin includes the majority of the intensively managed agricultural lands in the Amur-Heilong (**Tables 2.1 and 2.3**). In 1995 China ac-

Table 2.2 Land use in the Russian Amur-Heilong basin and its vicinity in million ha (percent of total land cover) (from Karakin & Sheingauz 2004)

	Land use category								
Area	Cropland	Percent Arable	Forest	Urban and infrastructure	Pasture	Water	Waste-land	Other	Total
Primorsky	1.6 (9.6)	0.6 (3.8)	11.3 (68.1)	0.2 (1.2)	–*	0.5 (3.0)	0.5 (3.0)	2.5 (15.1)	16.6
Khabarovsky	0.7 (0.9)	0.1 (0.1)	52.5 (66.6)	0.2 (0.3)	10.4 (13.2)	1.1 (1.4)	8.3 (10.5)	5.7 (7.1)	78.9
Amurskaya	2.7 (7.4)	1.2 (3.4)	22.5 (61.8)	0.2 (0.5)	0.6 (1.6)	1.1 (3.0)	4.9 (13.4)	4.4 (12.3)	36.4
Evreiskaya Autonomous	0.4 (11.3)	0.08 (2.2)	1.5 (41.7)	0.03 (1.0)	–*	0.03 (1.0)	1.0 (28)	0.6 (16.8)	3.6
South RFE subtotal	5.4 (4.0)	2.0 (1.5)	87.8 (64.8)	0.6 (0.4)	11.0 (8.1)	2.7 (2.0)	14.7 (10.8)	13.3 (9.8)	135.5
Chitinskaya	2.2 (5.3)	0.6 (1.5)	30.7 (74.3)	0.1 (0.2)	3.1 (7.5)	0.3 (0.7)	1.9 (3.2)	3.0 (7.3)	41.3
ABAR	0.3 (15.8)	0.1 (5.3)	0.6 (31.5)	0.01 (0.5)	0.7 (36.8)	0.01 (0.5)	0.1 (5.3)	0.2 (10.5)	1.9
Transbaikalia subtotal	2.5 (5.8)	0.7 (1.6)	31.3 (72.5)	0.1 (0.2)	3.8 (8.8)	0.3 (0.7)	2.0 (4.6)	3.2 (7.4)	43.2
Amur-Heilong basin provinces total	7.9 (4.4)	2.7 (1.5)	119.1 (66.7)	0.7 (0.4)	14.8 (8.3)	3.0 (1.7)	16.7 (9.0)	16.5 (9.2)	178.7 100

* - = no data

counted for more than 70 percent of all Amur-Heilong basin agricultural land and about 16 percent of China's national agricultural land. Despite the intense development of farmlands in China, forest cover remains extensive. **Table 2.3** lists data from Karakin and Sheingauz (2004) and, for comparison, data from "China's Northeast Water, Land and Environment" Report (CAE 2005), which is discussed in detail in Chapter 12.

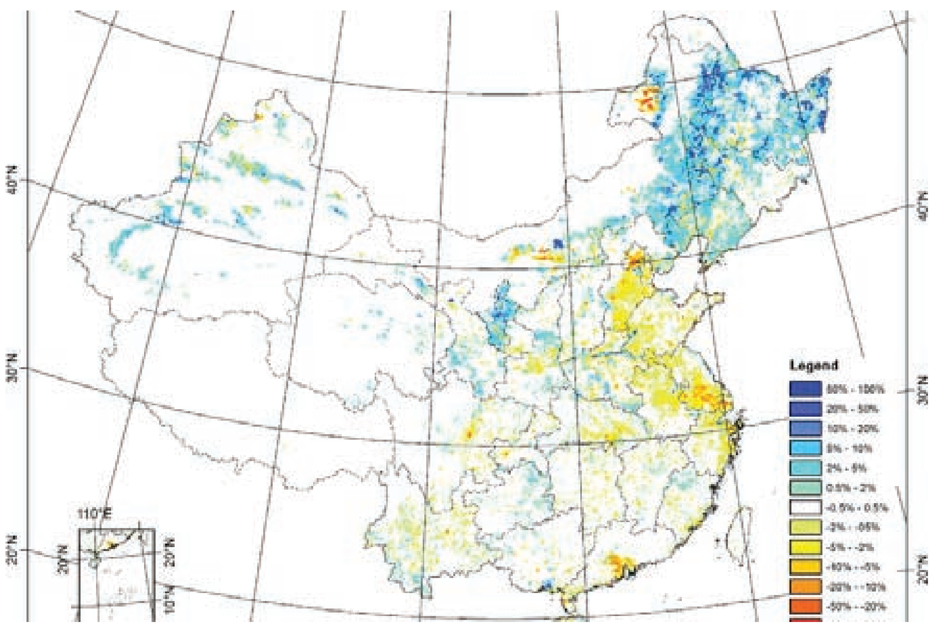


Figure 2.1 Percent cropland change in China during 1990-2000 (Liu et al. 2005)

More than half of China's portion of the basin lies in the Songhua River watershed, the most intensively developed portion of the basin. In the early 1990s, 14 percent of the Songhua basin was under cropland, 2 percent under orchards, 42 percent under forests, 14 percent under grasslands and 28 percent in other forms of landuse (ADB 2000). The forest cover in the Songhua basin ranges from 50 percent to 80 percent in the mountains (more forest at higher elevations) to about 20 per-

Area	Land use category							
	Cropland	Forest	Urban and infrastructure	Pasture	Water	Waste-land	Other	Total (100 percent)
Heilongjiang	16.3	19.2	1.6	no data	2.3	4.3	1.7	45.4
Jilin	7.9	8.0	1.1	no data	0.6	1.1	–	18.7
North East subtotal	24.2 (37.8)	27.20 (42.4)	2.7 (4.2)	no data	2.9 (4.6)	5.4 (8.4)	1.7 (2.6)	64.1
Hulunbei'er	1.3	10.4	0.1	8.3	0.3	2.5	0.3	23.2
Xing'an meng	0.8	1.4	0.1	2.0	0.2	1.5	1.8	7.8
Inner Mongolia subtotal	2.1 (6.9)	11.8 (38.1)	0.2 (0.6)	10.3 (33.2)	0.5 (1.4)	4.0 (12.9)	2.1 (6.9)	31.0
China basin total	26.3 (27.7)	39.2 (41.0)	2.9 (3.00)	10.3 (10.8)	3.4 (3.6)	9.4 (9.9)	3.8 (4.0)	95.1
North East (including Liaoning province, data from CAE 2005)	25.1 (20.2)	56.6 (45.6)		21.3 (17.1)	2.9 (2.3)	7.7(sand) (6.2)	10.6 (8.5)	124

Table 2.3 Land use in and near China's Amur-Heilong River basin [million ha (percent of total landcover)] (Karakin & Sheingauz 2004, CAE 2005)

cent on the lower slopes hills, and less than 10 percent on the plain (Meng Lingqin 2000). Forest cover, according to state statistics, is increasing due to extensive reforestation over the last three decades. Kauppi et al. (2006) showed that forest cover is increasing in China at a rate of 1.5 percent annually. However the single species stands of the replanted forests (essentially all larch and poplar in northeast China) preclude development of a diverse fauna. On the floodplains reforestation is mainly seen as tree shelterbelts between fields and along roads. Soil conservation or commercial plantations are located mainly on the lower mountain slopes.

Remote sensing shows a massive conversion of grasslands, wetlands, and forests to croplands in China's portion of the Amur-Heilong basin between 1990 and 2000 (Liu et al. 2005). Heilongjiang and Inner Mongolia accounted for 70 percent of this cropland increase (**Figure 2.1**). All told, at least two million hectares of new cropland were added in the Amur-Heilong basin over that period (Liu et al. 2005). Northeast China forest cover declined by 1.26 million ha, and grasslands shrank by two million ha due to conversion to farmland. Another 0.6 million ha of conversion resulted from "water" and "unused land" categories, consisting mostly of wetlands (Liu et al. 2005). The study concluded that both governmental statistics and remote sensing analyses conducted earlier by Chinese agencies show smaller areas of croplands and slower conversion rates.

Land Use in Mongolia

The Mongolian portion of the basin is covered by natural ecosystems ranging from high mountain taiga to forest-steppe, steppe, and semi-arid steppe. The landscape is highly varied with mountain tundra, taiga, forest, medium and low mountains, hills, steppes, river and streams, lakes and ponds, salt marsh basins, marsh, sand dunes with sparse vegetation, shrub grove, rocky cliff, caves, and volcano craters.

The northwest part of the basin is covered by mountainous taiga in the upper Onon and Kherlen Rivers that drain the northern and southern flanks of the Grand Khentii ranges. The north part of the basin resembles a combination of northern steppe or marsh and vast forest-steppe and small depressions between low hills of Mongolian Dauria. The central and eastern regions have features of the steppe and northern dry steppe with sinuous drainages and flat plateaus with abundant basins supporting salt-marshes. The southwestern portion is dominated by southern dry steppe in a combination of high plateau, mountains, and salt-marsh basins. The southern part or southern shore of Kherlen River consists of numerous remnant low mountains.

The plateau of eastern Mongolia is dominated by a large natural grassland on which 93 percent of the land area is used as pasture and cropland (**Table 2.4**). Of this agricultural land total, pastures account for 94 percent. Hay is harvested on five percent or 13,770 km^2. Croplands cover 7,730 km^2 (0.3 percent), 0.4 percent or 10,620 km^2 are abandoned croplands, and the remaining 0.3 percent are dedicated to other agricultural uses. Moving sands on degraded land (included in agriculture in **Table 2.4**.) cover 1.1 percent of Mongolian territory in the basin.

Table 2.4 Land use categories in eastern Mongolia

Land use categories	Total '000 ha	Percent
pasture, cropland	26,703	93
forest	1,640	6
surface water	124	<1
residential and mining area	91	<1
roads	55	<1
other	8	<1
		100

Source: NSO. Mongolia Statistical Yearbook 2005

Trends in Land Use

The contrasts in land use are large and widening among Amur-Heilong River basin countries. All three basin countries have already passed through or are now nearing the end of their "frontier development" periods that were characterized by frenzied exploitation without concern for or protection of natural resources. This leaves all three countries at the doorstep of an era during which land use must be driven by adjustment to natural and economic conditions if ecosystem collapse is to be avoided and valuable resources are to be recovered. Despite obvious indicators that highlight the unsustainability of past development strategies, recent decisions by national and local government continue to follow past practices. Examples of recent government actions that demonstrate a business as usual approach to development include:

- The continued extensive conversion of wildlands to farmlands and pasture in China, typically without full consideration of carrying capacity or adverse impacts to ecosystems;
- The degradation of nomadic traditions in Mongolia driven by rapid political changes in Mongolian society and concomitant resource degradation;
- The economic crisis in Russia, driven by a prolonged period of haphazard governmental reforms that has lead to chaos in the administration of natural resources.

Land is used much more intensively in China than in Russia or Mongolia. This is driven in part by differences in topography, climate, and soil conditions, but also in part by social and political processes. Variations in land use in the Amur-Heilong basin can be seen in arable land distribution, the high percent of unused arable land in Mongolia and Russia, and the high percent of degraded lands in Mongolia and China. Degradation and land transformation are more intense in the western parts of the basin, particularly in the Daurian Steppe Ecoregion.

Despite aggressive development throughout the 20th century, the region has retained vast areas of wildlands. These large and often contiguous tracts of forest, grasslands, and wetlands offer hope that an opportunity remains to preserve regional biodiversity in the face of continuing development.

Chapter 11

Socio-Economic Conditions in the Southern Russian Far East

A detailed socio-economic assessment for the Russian Far East Ecoregion Complex (Southern RFE) was carried out within the framework of the World Wide Fund for Nature (WWF) Ecosystem Conservation Action Plan (ECAP) (ECAP 2003, Part 1). It was confined to four provinces in southern RFE: Primorsky, Khabarovsky, Evreiskaya Autonomous Region, and Amurskaya, and did not address the other six northern provinces outside the Amur-Heilong basin. The following section summarizes parts of the socio-economic assessment, accentuating only those factors that directly impact biodiversity. The original study did not take into account parts of Chitinskaya Province and Aginsky-Buryatsky Autonomous Region (ABAR), both of which lie within the Amur-Heilong basin. However, since these areas follow the same general socio-economic trends described in the original study, only minimal adjustments were required here to account for the differences.

The Russian Far East is important to Russia and the Asia-Pacific region as a whole. Abutting the Pacific Ocean, the region neighbors the United States, Canada, Japan, China, Mongolia, and North Korea. The RFE is an important transit route from western Europe and countries in the Asia-Pacific region due to its year-round access to the sea and direct connection with the Trans-Siberian and Baikal-Amur railways. These two routes are economically important for international passenger traffic and for transport of raw materials for international trade. The many important ports on the Amur-Heilong River are open from May through November, serving Blagoveshensk, Khabarovsk, Komsomolsk-on-Amur, and Nikolaevsk-on-Amur for six to seven months each year.

Population

Population trends in the Russian Far East directly affect the conservation of biodiversity. Until the 1980s, the rate of population growth in RFE was two times the national average for Russia. From 1986 to 1990, the average annual population growth rate in the RFE dropped to 1.2 percent (the national rate remained at 0.7 percent). The total population of Russia in 2002 was about 145 million, of which some 5.5 to 6.5 million people lived in RFE provinces that overlap or lie within the Amur-Heilong basin (data from 1989 and 2002 censuses, see **Table 2.5**). In these provinces, about 4 to 4.5 million people actually lived in the Amur-Heilong basin and the remaining 2 million people lived outside the basin mainly on the Pacific coast and in the Lake Baikal area. The 2002 Amur-Heilong basin population census showed a decline of more than 10 percent from the early 1980s (some analysts argue the decline exceeded 15 percent). This was due mainly to emigration from the region to other parts of Russia and the former Soviet Union where standards of living are higher. This trend continued through 2006.

The population of the RFE is largely urbanized, with 76 percent of the people living in cities and towns. A large share of the population is either first-generation migrants or descendents of migrants from other regions of the former Soviet Union. The people of the RFE are a mix of nationalities, the majority being Russians, Ukrainians, and Byelorussians. Indigenous peoples make up 1.85 percent of the population and nearly a third live in cities. The remainder of indigenous ethnic groups live in communities along the middle and upper reaches of the Bikin River, in the Samarga Valley (Primorsky Prov-

Administrative Region	Area ('000 km^2)	1989 census ('000)	2002 census ('000)	Change '000 (percent)	Density 1999 (pers/km^2)	Gross Regional Product 1999 (million US$)
Chitinskaya province	413,0	1,301	1,084	-217 (-17)		
Aginskii Buryatskii Autonomous Region	19.6	77	72	-5 (-7)		
Amurskaya Province	363.7	1,058	903	-155 (-15)	2.8	941
Evreiskaya Autonomous Province	36.0	216	191	-25 (-12)	5.6	101
Khabarovsky Province	788.6	1,608	1,435	-173 (-11)	2.0	2.047
Primorsky Province	165.9	2,260	2,068	-192 (-9)	13.2	2.264
TOTAL		6,520	5,753	-767 (-12)		

Table 2.5 Area, population, and gross regional product of the six provinces in the Russian Far East (population data from Tarkhov 2004)

ince), in the Khor (Chord) River basin (Khabarovsky Province), in Aginsky-Buryatsky Autonomous Region (ABAR), and in the northern mountain boreal areas of Khabarovsky and Amurskaya Provinces. Despite the occasional efforts of federal and regional governments to provide assistance to indigenous ethnic minorities, their standards of living remain lower than those of most other ethnic groups that arrived over the last three centuries. This is in part attributable to the deterioration of environmental and natural resources on which the indigenous minority depends. Crisis is evident along lower reaches of the Amur-Heilong River where the depletion of fish stocks and increases in water pollution have severely affected the Nanai ethnic minority (called Hezhe in Chinese) and other aboriginal peoples.

Immigration from the surrounding countries of northeast Asia, especially China and Korea, has been an important factor in RFE policy and economy for at least three centuries. Government has generally lacked the capacity to control the numbers, activities, and economic influence of these immigrants. The Russian Empire developed various policies to suppress and regulate the influx of Asian nationals who were generally better adapted to local conditions than settlers from European Russia and Siberia. Nevertheless, by the early 20th century, a population of 500,000 Chinese and Korean nationals was involved in agriculture, trade, various extractive industries, and even public construction works in the RFE. During that time several hundred thousand Russians moved to northeast China in conjunction with the East China Railway development. After the Socialist Revolution of 1917 Soviet governments occasionally expelled Asian immigrants. But transboundary movements of people have been and continue to be natural responses to economic opportunities. This leaves the 21st century RFE deciding whether to adapt to the potentially advantageous influx of work-hungry immigrants or to persist with ineffective prohibitive policies in the interest of protecting the territorial and economic sovereignty of an area many Russians wish to leave. Immigrants to Russia are mainly seasonal workers and short-term residents. Their numbers rarely exceed 300,000 in any year but their economic impact is much greater and has a profound influence on regional trade and natural resource use.

Three broad demographic zones — south, central, and north — are evident in the eastern part of RFE based on population density, length of settlement, ethnic composition, population dynamics, and living conditions (**Table 2.6**). In general, both population density and numbers of cities decline from south to north. While the southern zone has 24 cities, the northern zone has none. Similarly, population density is nearly 15/km^2 in the south, but only 0.5/km^2 in the north. The average population density in southern RFE is 3.5/km^2 (Ganzei 2004).

The southern zone accounts for nearly 20 percent

Table 2.6 Population zones in four RFE Amur-Heilong basin provinces (Primorsky, Khabarovsky, Evreiskaya Autonomous Region, Amurskaya Provinces)

Demographic Zone	Area		Population (1999 census)		Population Density 1999 (pers/km²)	Gross Regional Product 1999 (million $)
	1000 km²	Percent of Eastern RFE	'000	Percent of Eastern RFE		
Southern Zone	272.2	19.6	4,009	81.0	14.7	4.1
Central Zone	658.9	49.1	919	18.5	1.4	1.2
Northern Zone	423.3	31.3	21	0.4	0.1	58.0
Total	1,354.2	100	4,949	100	3.7	5.4

of the territory of the RFE and supports the richest floral and faunal biodiversity in the RFE. Eighty percent of the population lives in the south where the economic and natural resource potential is greatest. The south also has well-developed infrastructure (natural resource exploitation and processing, transportation, and social), so much of the future economic development of the Ecoregion Complex will likely be concentrated here.

The central demographic zone covers nearly half of the RFE and includes almost one-fifth of the population. This zone lies entirely within the Amur-Heilong Ecoregion (AHE), when the oceanic slope is included. This region consists mainly of middle and southern boreal forests where much of the forest resource of the RFE is located. In the future, unless government intervenes, forestry and mining will be the only industries to continue to develop in this zone. Measures to promote sustainable forestry practices and sustainable collection of non-timber forest products are needed to ensure conservation of biodiversity in the forests of the central zone.

The northern zone occupies approximately one fifth of the RFE part of the basin. Less than 0.4 percent of the population lives there. Most residents are indigenous people and are involved in mining and traditional resource extraction. Economic development in the future will likely be limited to local mining of globally important mineral and metal deposits, along with the exploitation of biological resources of the coastal zone. Important tasks for biodiversity conservation in this zone will be setting aside intact ecosystems in protected areas and supporting traditional uses of natural resources.

The western demographic zone is represented by Chitinskaya Oblast and Aginsky Buryatsky Autonomous Region (ABAR). Recent depopulation in these provinces is particularly severe in the south, a pattern distinct from that in the other demographic zones. This is mainly because settlements and infrastructure in Chita province, like the other Russian Amur Basin provinces, are located along the Tran-Siberian Railroad.

About 60 percent of the population of the RFE as a whole is of working age. The average life span in the region is 62 years — 56 years for men and 69 years for women — one to two years less than the average for Russia. Per capita income in the RFE has always been 1.3 to 1.4 times the average for Russia, but real income per capita has declined during economic reforms due to high inflation, devaluation of the Ruble, and changes in consumer spending. The per capita gross regional product in 1996 in the RFE was $3,100, or 1.2 times the average Russian output. In 1996, 11 percent of the economically active population of Khabarovsky Province was unemployed, as compared to 12.3 percent in Primorsky Province and 18.4 percent in Amurskaya Province. In 2001 the average unemployment rate in southern RFE was 10.2 percent (Ganzei 2004). Towns and small cities have especially high levels of unemployment. These communities were typically created to serve industries related to natural resource exploitation. Real unemployment is two to three times higher than reported because many people are not officially registered as unemployed.

A particular feature of the RFE is that despite the large share of people living in cities, most are closely linked to natural resource use by:

- direct or indirect (through a member of the family) participation in the natural resource sector of the economy (nearly half of the population);
- traditional natural resource use by indigenous peoples (one percent of the population);

• leisure time and vacations in nature, sport hunting, and collecting berries and mushrooms for personal use and for sale (one-third of the urban population and nearly all of the rural population); and

• growing vegetables for personal use and to sell on plots outside the city (one third of the urban population and nearly all of the rural population).

Economy

Economic development in the RFE has had three main goals since the Russian Empire first began to settle the Far East: 1) to create and strengthen a military presence to defend the eastern border of the country; 2) to develop natural resources; and 3) to develop ties with northeast Asia and the Asia Pacific Region.

The focus of natural resource development changed over time from furs to agricultural lands to precious metals to timber to fish to non-ferrous metals. The economy of the region was founded on resource exploitation and many suffered when the economy began to value other commodities. Centers of economic activity were generally restricted to certain parts of the region. As noted above, in the RFE as a whole, the southern area is developed and the north is relatively undeveloped. In Primorsky Province, the southern (coastal, near Vladivostok) and western (nearest China) regions are more developed than the north and east.

Under the Soviet regime, production in the RFE aimed to meet domestic needs. The government was the sole provider of supplies and funding to maintain the economy. Efficiency of resource use was seldom assessed in comparison with market economies. Rather, the main strategy was to meet the country's needs by exploiting the most valuable resources in the region with little regard for market or ecological consequences. Only excess goods were exported to partially compensate the losses incurred from uneconomical production.

Today, the economy of the RFE and of Russia as a whole is in transition. Due to its location remote from Russia's capital, the RFE is one of the most expensive regions in Russia to develop. Production of many types of goods for distant markets in European Russia is no longer economically viable in the RFE. In spite of rapid economic growth in Russia as a whole (average of greater than 6 percent annual GDP growth in 2001-2005), the RFE is now experiencing a deep economic crisis, where basic needs such as heat and electricity are often lacking and where wages frequently go unpaid. As a result, both social and economic sectors suffer.

While the system governing resource use in the post-Soviet economy is undergoing change, the end result — unsustainable exploitation of natural resources — has not changed. The extended period of protectionist economics under the Soviet government was replaced with a policy of economic non-intervention in the 1990s. This disrupted supplies of raw materials and consumer goods, invalidating any guarantee on delivery of regional commodities to domestic and export markets.

Ganzei (2004) listed the following reasons for prolonged economic crisis in the RFE:

• The rise in energy and transport costs, to which all economic sectors in this remote region are very sensitive;

• Migration and resulting population loss, due mainly to deteriorating socio-economic conditions and weakening ties to European Russia;

• The disruption of supplies from central Russia, which accounted for 85 percent of resources used by local industry in Soviet times;

• The lack of state investment in regional development programs, leading to bankruptcy of many state-owned industries and deterioration of infrastructure;

• Weak and diffuse local markets that are insufficient to provide stable demand for locally produced goods; and

• Persistent inefficient use of natural resources, despite the transition from state to private ownership.

Prior to economic reform, the region had an explicit system of resource use. The main industries were raw material extraction (non-ferrous and precious metals and precious stones), timber production, and fishing (gradually shifting from regional waterways to international waters). Industry and infrastructure related to the military also had a prominent role. In parts of the RFE, resource use differed from these main trends. In the Khanka Lake lowlands and Zeya-Bureya plains, agricultural goods predominated, in Primorsky Province coal mining was emphasized, and in Khabarovsky Province forestry played the leading role.

Before the administrative reform of 2004, provincial administrations played a major role in determining social and economic policies. The post-reform approach has generally followed similar lines — crisis management and shifting priorities and opportunities, most of which are not compatible with biodiversity conservation. Natural resources are still owned by government and only small parcels of land can be privatized for personal use.

Since economic reforms began in 1991, the RFE has become almost entirely a producer of raw materials. Industrial production has shifted toward fossil fuel, hydroelectric energy, and the extraction of non-ferrous metals. These are the only industries in which the RFE's share of overall production in Russia has increased. The RFE's share of all other industries has declined, including those considered traditional to the region (e.g., timber and fish products).

In summary, government policy — both before and after reform — has led to unsustainable and exhaustive natural resource use. This is caused by selective exploitation of the most readily extracted natural resources during the initial stages of development combined with losses of raw materials during transport, processing, and storage. In spite of this pattern of resource abuse, there remain vast, virtually intact ecosystems that have yet to be exploited simply because of the sheer size of the RFE and the richness of its natural resources. In some of the more intensively developed areas, the transformation of natural resources and landscapes over the decades has led to:

- decreased productivity of agricultural lands;
- changes in species composition of forests;
- reduced density and quality of timber resources;
- a decrease in freshwater and coastal fish populations, especially salmon, reduced size of fish, changes in species composition, decreased catches;
- the devastation of mountain areas by mining and the abundant abandoned mines, some of which still have economically accessible deposits;
- large-scale pollution of freshwater; and
- other disturbances to biodiversity, natural resources, and the environment in general.

RFE industry and agriculture play a modest role in Russia's total economy, though the RFE has the largest land area of any region in the country. The RFE accounts for less than seven percent of gross national product, less than five percent of agricultural production, and under five percent of industrial production despite more than 7,000 industrial plants registered on its territory in 2000. The four southern provinces of the RFE are the most productive, producing well over 50 percent of all major industrial and agricultural commodities in the RFE Federal District, which includes 10 provinces in total.

Natural resource use accounted for 31 percent of industrial production and 14 percent of the work force in the RFE in 1997. Industries based on natural resource exploitation support nearly half of the population. If all branches of industry that depend on raw materials are included in the calculations, the share of this sector in the regional economy is even higher: 68 percent in Evreiskaya Province; 76 percent in Khabarovsky Province; 82 percent in Primorsky Province; and 90 percent in Amurskaya Province.

Natural resources have always been used extensively and inefficiently in the RFE. By the economic crisis following the collapse of the Soviet Union, all suitable wildlands had been converted to agriculture, nearly all forests in the Amur-Heilong basin south of the Baikal-Amur Railroad had been logged, and almost all of the known gold and coal deposits had been developed. At the same time, the least efficient methods were often used in resource exploitation: Clearcutting remains widespread in forestry and open mining and dredging are still prevalent in the mining and fuel industries. Extraction of useful constituents from raw materials reaches only 20-30 percent in mining and 60 percent in forestry.

The economic reforms of the post-Soviet era have brought a decrease in the regulation and monitoring of resource use. The economic crisis and intensifying pursuit of profits have encouraged natural resource users to employ plundering methods of resource development. The difficult economic situation is causing industrial enterprises to take on greater burdens of debt. Industries cannot pay for natural resource extraction and, consequently, no funds are being devoted to the regeneration of renewable resources such as forests. The economic crisis caused many factories to simply close their doors

Table 2.7 Output of the natural resource sector in the RFE

Commodity	Maximum Output			1997 Output	
	Year	Units	Volume (x 1000)	Volume (x 1000)	Percent of Maximum
Coal	1988	ton	30,571	18,303	60
Raw timber	1986	m^3	27,664	6,666	24
Lumber	1986	m^3	4,612	328	7
Cellulose	1987	ton	308	0	0
Cardboard	1988	ton	175	3	2
Fish and marine products	1990	ton	2,202	1,741	79
Grains*	1986-1990	ton	1,087	542	50
Potatoes	1997	ton	1,125	1,125	100
Meat*	1986-1990	ton	220	90	41

Source: Institute of Economic Research of the Russian Far East Division of the Academy Sciences.
* = average

— by 1997 industrial production had declined to 40 percent of 1990 levels (**Table 2.7**). During those seven years the area of land used for mining remained virtually unchanged.

While the decline in industrial production has its benefits for nature conservation, the increase in unemployment and incentives for producers to use cheap and inefficient methods of resource exploitation have adversely affected biodiversity. The only way out of this economic crisis will be to modernize industrial practices and this will require large-scale investments.

To emphasize the profound differences between economies of neighboring provinces in Russia and China we present data in **Table 2.8** from a recent monograph by Ganzei (2004). In summary, while natural resources are much more abundant in RFE, the intensity of use and production volumes are much higher in Heilongjiang.

Russia's legal system and nature conservation

Russia's legal system before 2004

Russian legislation does not clearly distinguish between natural resource management and environmental protection. The primary environmental legislation addresses both the exploitation of natural resources and their protection. The legal system of the country is code law, where each body of law has its own code of regulations. The main principles of development and protection of natural resources are written in the 1993 Constitution and all aspects are addressed in the five natural resource codes: Code of Air (1997), Code of Water (1996), Code of Land (2001), Forest Code (1997, 2006), and Law of Wildlife (1995). The basis of nature protection is the Federal Law of Environmental Protection (FLEP; also known as the Nature Protection Act of 2002). Violations of these laws are prosecuted according to the Administrative Code and Criminal Code. Issues not addressed in these laws and additional environmental procedures and principles were incorporated in 1991 and amended in the 1992 and 2002 Law of Environmental Protection. This is the main environmental legislation in the country and was the first comprehensive legislation to regulate the protection of nature and guide environmental policy. Subsequently, the Constitution of 1993 was the first main law of the country to recognize the right of the citizens to a clean natural environment. The Federal Law of Protection of Citizens' Health (1993) regulates protection of human health in environmentally unsafe areas and supports the right of people to a clean environment. Although subjects (republics, oblasts, krais, and districts) of the Russian Federation and local authorities are allowed and encouraged to adopt their own legislation to regulate environmental protection, this is developing very slowly.

Political perturbations of Russia in the 20th century produced a dozen different constitutions for the country. Every new leader of Russia and the Soviet Union adopted a new constitution that best suited his interests. Although Lenin in 1922 spoke of the necessity to protect nature and declared some environmental principles, the Constitution of 1993 (also referred to as the *Yeltsin Constitution*) was the first main law of the country to state that people have the right to live in a clean environment. That constitution states (article 42) that "everybody has the right to live in a benign environment, to receive factual information about environmental quality, and to be compensated for health or property damage caused by violations of environmental legislation." Article 58 states that "everyone is obliged to preserve nature and the environment, and to carefully treat the wealth of nature." Article nine adds that "land and all other natural resources are used and protected in the Russian Federation as a basis of life of the people…".

The Constitution was adopted on 12 December 1993 by national referendum. This gives this Constitu-

Table 2.8 Socio-economic statistics for Heilongjiang Province (China) and averages of four Russian Far East provinces (Primorsky, Khabarovsky, Amurskaya and Evreiskaya Autonomy) in 2000 (after Ganzei 2004)

Item	Heilongjiang	RFE	Item	Heilongjiang	RFE
Population (millions)	36.9	4.9	Population density (person/km^2)	83.9	3.6
GDP billion USD	40.7	8.1	Per capita GDP USD	1,102	1,659
Road density (km/1000 km^2)	106.9	28.3	Electricity generation (kWH/person)	1.1	4.8
Wood productivity (100 m^3/km^2 forest)	36	10	Wood production (m^3/person)	0.18	1.8
Tractors/1000 ha arable land	8.1	13.6	Protected areas (ha/person)	0.09	2.31
Mineral fertilizers (kg/ha)	130.3	20.1	Wastewater discharge m^3 per person	293.4	2048
Organic fertilizers (kg/ha)	171.1	290.7	Meat production (kg/person)	42.0	14.1
Sawn wood production (m^3/ha forest)	0.016	0.005	Sawn wood production (m^3/person)	0.008	0.09
Crop productivity (100 kg/ha)			Harvest (kg/person)		
wheat	16.2	9.7	grain	500	60
rice	81.4	18.6	soy beans	120	50
potato	20.7	110.2	potato	20	230
soy-beans	15.7	9.2	vegetables	350	80
Annual air pollution discharge: tons/km^2	1.8	0.4	International trade volume $/person	2.2	357.5

tion the highest degree of legislative authority because it was the first fundamental law of the country to be adopted by a vote of the people. An important feature of the constitution of 1993 is that it claimed to be a Constitution of "direct effect." This meant that, even in the absence of federal law to outline procedures for implementation, courts are authorized to implement the content of the Constitution.

Article 15 of the Constitution states that international agreements of the Russian Federation have higher authority than the laws of Russia.

The body of Federal Laws is the next tier of legal authority under the Constitution and its Constitutional Laws and international agreements. All other legislation or regulation is inferior to international agreements, the Federal Constitution, and Constitutional and Federal Laws (article 76). Examples include decrees of a President's Administration or of the federal or regional governments and regional laws.

The Federal Law of Environmental Protection (FLEP) was adopted by the parliament of the Russian Federation in December 2001. President Putin signed the FLEP into law on 10 January 2002. It is the most recent version of the primary environmental policy act of the country, a policy which was first adopted in 1991 and later amended in 1992. FLEP replaces the Law of Environmental Protection of 1992, although some articles of the old law regulating administrative liability remain active until a new Administrative Code is adopted. The 2002 FLEP regulates all aspects of nature protection but does not describe in detail procedures for important issues such as environmental impact assessment and environmental crises or emergencies.

Article 3 of FLEP describes the principles of environmental protection. Among these are:

- the right of people to a benign environment;
- the right of people to favorable living conditions;
- balancing the ecological, economic, and social interests of people, society, and the state aiming for sustainable development and a benign environment;
- the administration of the Russian Federation, administrations of subjects of the Russian Federation, and local authorities are to provide for a benign natural environment and environmental safety;
- that impacts of industrial or other activities on the natural environment must be in accordance with the requirements of nature protection;
- to reduce negative effects of industrial or other

activities on the natural environment according to the norms of environmental protection achievable with best available technology, accounting for economic and social factors;

- the provision for an integrated and individual approach to setting requirements for environmental protection for subjects involved in industrial or other activities or planning of such;

- the right of citizens to reliable and factual information about the environment, and their ability to participate in making decisions about environment in accordance with the legislation of the Russian Federation;

- the administration is to organize and develop a system of ecological education; and

- the administration is to ensure international cooperation of the Russian Federation in environmental protection.

These principles are important because they provide a framework for the formulation of environmental policy at federal, regional, and local levels of government.

According to Article 5 of FLEP, the administration of the Russian Federation is obliged to provide factual and reliable information about environmental quality, organize systems for environmental education, work with polluters such as factories that degrade the environment, and cooperate internationally in environmental protection.

Article 6 of FLEP defines powers of the regional authorities in environmental issues. Agencies of subjects of the Russian Federation (regions) have the right to develop, authorize, and implement environmental projects and programs. Regional administrations are also authorized to implement measures to improve environmental quality in zones of ecological disaster, as well as provide populations with information about environmental quality. State authorities at federal and regional levels are obliged to cooperate with citizens and public non-profit organizations and to help them exercise their rights in environmental protection.

According to FLEP Article 39, individuals and organizations must achieve standards of environmental quality using the best available technology, and conduct restoration of the natural environment and rehabilitation-cultivation of land or restoration of abandoned farmland and resumption of farming. Article 77 explains that if an individual or organization harms nature by destroying, polluting, or exhausting any resource, damages are to be compensated in full. Also, health and property damages caused to citizens by harmful impacts to the environment resulting from activities of individuals and/or organizations are to be fully compensated.

Natural resource management

During the 1990s, Russia built an impressive system of government institutions for natural resource management and protection. However, since 2000 there has been a steady decline in government support for nature conservation and deterioration of virtually all federal institutions and policies intended to ensure nature conservation.

In late 1999 the State Duma abolished the Federal Ecological Fund that was to accumulate fines and resource-use fees and redirect them for use in environmental protection and resource conservation programs. It took four years to fully dismantle this system of funding for environmental programs. As late as 2003 many regional governments still retained this system, although it was no longer encouraged at the national level. Pressure from the federal government and leading polluters (Norilsk Nickel Co. and others) greatly weakened the system. Another important source of environmental funding, the "Federal Environmental Programs" have been in steady decline since the late 1990s, and were finally abolished by administrative reform in August 2004. From that date, only the general Federal budget remains as a major source of environmental funding. Due to regular budget surpluses, funding levels increased from 2001 to 2004. However, effectiveness declined because Federal funds were not focused on specific objectives, as were the Federal environmental programs and the ecological funds. The "polluter-pays" principle is now no longer in effect and all environmental expenses are now funded directly from tax revenues. The volume of tax revenues is determined by natural resource export trade volume rather than by individual taxpayer remittances. This gives government financial incentives to exploit rather than protect the environment.

The State Committee on Environmental Protection (SCEP) was, until 2000, the federal executive agency for environmental protection, conservation of biological diversity, environmental control, environmental impact assessment (EIA), and management of protected areas.

The Federal Forest Service (FFS) was in charge of forest use, plantation and protection. According to Russian law, these two agencies were responsible for control and enforcement of most of the regulations and procedures related to biodiversity conservation. The Ministry of Natural Resources was responsible for policy in research, use and protection of natural resources, mineral resources, and water use and protection. In 2000 both SCEP and FFS were transformed into departments within the Ministry of Natural Resources (MNR) with significant reductions of staff and management units in the field (**Figure 2.2**). These changes cut the federal government's capacity to carry out its legal mandate regarding biological resources. For example, one directorate of the Ministry of Natural Resources was in 2003 responsible for about 200 federal protected areas. However, this directorate was severely understaffed, with just 12 employees responsible for coordination and oversight of these protected areas.

Further changes during 2001-2003 eroded the capability of MNR to manage and coordinate its many functions. This was due mainly to a massive drain of conservation professionals from the MNR system caused by regular lay-offs throughout the country.

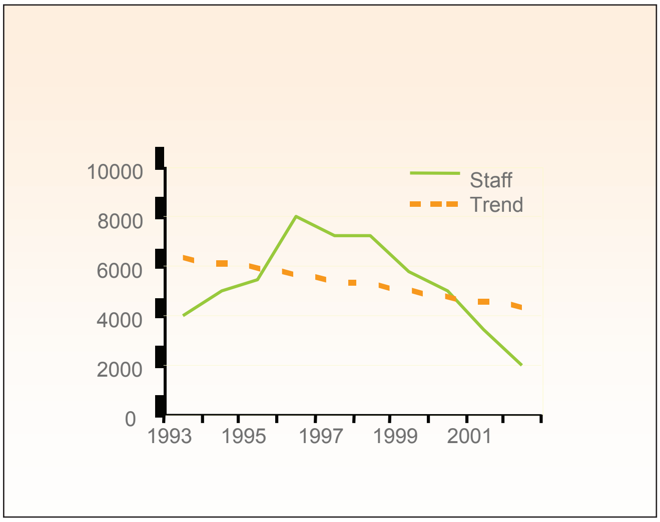


Figure 2.2 Enforcement staff changes in MNR system (Chestin et al. 2003)

Major signs of deterioration in the overall environmental protection system are:

- a standstill in preparation of new environmental legislation since 2000 (except for adoption of a new weaker law "On Environmental Protection" in 2002, and an amendment allowing import of nuclear waste);
- a 75-80 percent decrease in numbers of enforcement staff and enforcement activities (**Figure 2.2**), and increasing violations of environmental regulations;
- steep declines in numbers of EIAs undertaken by MNR at all levels and increases in the proportion of EIAs in which regulatory authorities required no amendments to proposed projects;
- a standstill in the establishment of new protected areas despite the many proposed parks already agreed with regional authorities and listed in governmental planning documents;
- an increase in pollution levels consistently outpacing increases in production among polluting industries.

Finally, the recent history of MNR was tainted by association with high-profile scandals related to licensing of mineral deposits for exploitation. This severely eroded MNR's credibility.

Provincial governments (oblasts, krais and republics) also have responsibilities for the management and protection of biological resources. In contrast, regional government agencies have little or ambiguous authority over biological resources. Despite this ambiguity, some local governments enacted laws, defined policies, specified management and enforcement procedures, and hired personnel. For example, in Khabarovsk the regional administration created two new divisions in its Department (Ministry) of Natural Resources to make up for capacities lost through the dissolution of federal environmental agencies. Some of these changes were responses to the apparent decline of federal activities in these areas. Thus, the Khabarovsk MNRU (the provincial Ministry of Nature Resource Use, not to be confused with a branch of the Federal MNR in the same province) employed up to 20 enforcement officers, who collected in 2003-4 more than 3 million rubles ($100,000) in pollution fees and other environmental payments. The MNRU also supervises the regional department of forestry, administers lease agreements, and requires concession-holders to install processing facilities. An important achievement was the increase from 14 percent in 2003 to 16.5 percent in 2004 of the proportion of processed timber exports. The MNRU was also instrumental in setting up an Inter-regional Coordination Committee for sustainable development of the Amur-Heilong River basin that brought together six provinces. MNRU also assisted federal agencies to develop and coordinate environmental policies and programs.

Regional governments also undertake the management and protection of parts of the network of protected areas. Many biodiversity planning, financing, and management activities, for example, are undertaken at the regional level. Thus, since 1994, regional governments established 50 nature parks (a category established and financed exclusively by regional authorities) covering a total area of 14.3 million hectares nation-wide or 8 percent of the nation's protected areas.

Municipal levels of government have little role in biodiversity conservation and resource management because their activities are mostly linked to urban and developed agricultural areas. As such, forest, water, and mineral resources lie outside their jurisdictions.

Consequences of administrative reforms for natural resource governance

The general direction of the administrative reform was laid out in President Putin's address to the nation in May 2004:

"Each level of state power should only have the property that it needs to exercise its designated public functions, and no more than that. We should also be ready to introduce a new distribution of revenue collection powers and spending commitments between the different levels of the country's budget system. The regions and the municipalities should know exactly which functions they are supposed to exercise and which public services they are responsible for. They also need to know the sources of funding for these services."

In practice, reform aims to:

- remove regulatory barriers that obstruct economic activities (including those in nature resource management);

- concentrate regulatory power and property rights at the federal level of government;

- remove regulatory and management responsibilities in environmental and natural resource management from provincial governments;

- avoid dual jurisdiction over property-related issues, by cancellation of participation of regional institutions in these issues; and

- abolish government responsibility over many social and stewardship services.

A recent amendment that gives the President power to replace provincial governors who were previously elected by the population cannot be considered a temporary measure imposed during a crisis period, but rather a fundamental part of the same reform process. This reform will have profound impacts on all governmental institutions. It has thrown the administration into a state of confusion in many sectors of government, including environment and nature resource management.

Recent reforms have had two aspects: institutional and legal. According to the original plan, all executive bodies of the federal government were to be segregated into ministries responsible for drafting policy, agencies that manage property and provide services, and services responsible for control and enforcement. Shortly after this reorganization it was discovered that complex functions of government could not always be reshuffled to this simplistic scheme, and, accordingly, certain adjustments were then made. However, by that time, irreversible damage had been inflicted throughout the system.

The Ministry of Natural Resources was divided into five related agencies:

- The Ministry of Natural Resources (a policy-making agency in environmental and natural resource management);

- Service for Control in the Field of Natural Resources (SCFNR) (enforcement agency in the same field);

- Forestry Agency;

- Water Agency; and

- Mineral Deposits Agency

According to this proposed structure, the latter three agencies were to manage federal property and provide services.

As a result of the reorganization, the Forestry Agency has a Forest Protection Department that shoulders "all forest protection responsibilities, except controls and enforcement" (quote from the FA Charter).

Federal protected areas did not fit into any category of the new organization. There was one attempt to establish a "Protected Areas Agency" that was undertaken with support of Parliamentary Chairman Mironov, but this was unsuccessful. Instead, protected areas were "temporarily given under management of the Service, until further decision by the government." But the new MNR also contains two divisions entitled to draft policy related to protected areas. Beginning in late 2004, key federal officials within the MNR, including the Minister, publicly proposed several times to create a specialized agency to manage federal protected areas. To date this has not happened.

In addition to the structure outlined above, the new government has a Service for Nuclear, Technological, and Environmental Control (SNTEC), which is independent from the MNR. This service is to be responsible for enforcement of all "brown" environmental issues. According to new regulations, it is the only service that has "enforcement of environmental legislation" explicitly written into its charter.

Both the MNR and SNTEC have responsibility to undertake Environmental Impact Assessments (EIAs). This means that any large development proposal will be divided into two parts and must undergo EIAs at two agencies. For example, in the case of a logging concession, the plan for logging operations would be reviewed by the MNR, while the plan for construction of roads and facilities would be reviewed by SNTEC. From 2006 most EIAs are carried out by SNTEC.

In both the MNR and SCFNR staffing levels declined dramatically. For example, the Federal Division of Protected Areas at SCFNR retained only five staff positions to oversee the management of almost 200 federal protected areas, while the overall SNTEC branch for Khabarovsk region has 23 positions to regulate around 70,000 enterprises.

Following the declines in staff, the last cohort of experienced environmental officials within these agencies and services are being systematically pushed out. The vacated positions are typically filled by former KGB officers, heads of municipalities, public relations experts, and others who lack technical qualifications and experience relevant to environmental protection.

Up until 2004, fisheries management was overseen by the State Committee for Fisheries and headed by a former governor of Primorsky Krai. Game Management (of all legally harvestable terrestrial wildlife) was under the Department of Game in the Ministry of Agriculture. Over the course of the reform, both agencies were re-assigned to the Department of Veterinary Control under the Ministry of Agriculture along with three other unrelated departments.

In addition, it is clear that resource managers in the field are being deprived of necessary enforcement authority. Since 2001 the number of government employees that have legal authority to prevent poaching, illegal logging, encroachment on protected areas, and other crimes has steadily declined. Continuing reform will further deplete the ranks of federal enforcement officers and prevent regional agencies from any enforcement activities in the environmental field.

For the time being, most pre-reform nature resource management offices created by federal and regional governments are temporarily given permission to continue their work, including enforcement (which is clearly in conflict with new laws); however the time period and range of responsibilities remain undefined. By mid-2006, provinces regained most responsibilities they had before. By the beginning of 2007 they assumed responsibility over forests and many other natural resources, while their capacity to manage and protect those resources remains fairly limited.

Legislators and the President hurriedly passed a package of amendments to approximately 235 laws, all linked to two basic acts, "General principles of Regional Government" and "General Principles of Local Self-Government" passed early in 2004. These amendments deprived regional (provincial) authorities of their rights to influence decisions on what had previously been "matters for joint decision-making by federal and regional authorities" (thus violating articles 72 and 76 of the Russian Constitution calling for shared authority). Other amendments abolish "federal funding programs", which were previously the primary mechanism for designing and supporting policies in many fields including environment and natural resource management.

Consequences for key environmental laws include:

- The 2002 Law on Environmental Protection formed the basis for environmental legislation, defining standards for environmental quality, and the EIA process. The 2002 law was substantially weaker than its predecessor, the 1991 Law. Amendments cancel rights of provincial governments to undertake or participate in environmental issues including EIAs, enforcement of national environmental legislation, and planning.

- The Federal law on Environmental Impact Assessments of 1996 requires impact assessments of many economic development projects. The law also covers environmental protection and use of fauna and habitats. Amendments exclude regional governments from the EIA process and authorize any federal agencies appointed by government to undertake EIAs where previously there was only one authorized EIA agency.

- The Forest Code of 1997. Amendments exclude provincial governments from decision-making, remove environmental requirements that should be written into lease (concession) agreements, and abolish licensing of forest use. Further amendment is expected soon, and it may simplify planning and management procedures at the expense of the environment. The worst scenario would be the abolishment of local-level forest management units, with their conversion into for-profit logging enterprises. This is the opposite direction of the path taken by forestry reform legislation in neighboring China.

- The Federal Law on the Russian Federation Continental Shelf (1995) provides protection mechanisms for marine biodiversity on the continental shelf. Amendments lift prohibition to undertake exploration of mineral deposits on designated protected areas.

- The Water Code (1995) provides protection of aquatic ecosystems from pollution and land-based degradation. Amendments prevent provincial authorities from owning and managing water bodies and remove the requirement to reinvest water-use fees into water-management programs. The Water Code also incorporates new provisions for more holistic integrated river basin management (harmonizing it with the EU Water Directive); the new version yet to be adopted will call for establishment of Basin Councils that will be consultative bodies comprised of all major stakeholders.

- The Federal "Law on the Animal World." Amendments abolish financial incentives for enforcement. Enforcement officers were previously entitled to a share of fines taken from poachers and other violators.

- Federal "Protected Area Law." Amendments prevent regional authorities from managing and planning federal protected areas, including nature parks and botanical gardens upgraded to the federal level by the same piece of legislation. Amendments remove the requirement for fair compensation to land owners and users when a protected area is created.

By the close of 2006, the newly adopted Forest Code, Water Code, and amendments to the Municipal Construction Code further weakened environmental regulations. Thus, most construction and nature resource extraction projects became exempt from EIAs in the name of removing regulatory barriers.

To date, reform has greatly complicated natural resource management. A new wave of amendments and institutional changes are likely to occur and their impacts will be difficult to predict in detail. Since the Russian economy relies heavily on the export of natural resources these changes are unlikely to restore favorable conditions for nature conservation that were sustained in the 1990s. The most recent trend has been to shift the burden of natural resource and environmental management to provincial governments, while still limiting their enforcement capacities. The most disappointing trend is that the constant flux of rights and responsibilities between different agencies is preventing all levels of government from developing the capacity for effective nature resource protection and management.

Agriculture

Agricultural land occupies only 4.4 percent of the territory of the Russian portion of the Amur-Heilong basin (excluding unmanaged grasslands used occasionally for grazing). Although soy-beans, wheat, and potatoes are now the most widespread crops, in Soviet times the Lake Khanka plains produced large crops of domestic rice. Because of lower inputs of labor and fertilizer, yield per unit area in Russia is one half to one third that in China (**see Table 2.8**). Harsh climatic conditions in this area mean that agriculture requires costly technologies. Thus costs per unit of production in the Amur-Heilong basin have always been higher than the national average. Livestock production (cattle and sheep) is most common in the western part of the basin where maximum stocking densities of 10 cattle and 25 sheep per 100 hectares are standard in Aginsky Buryatsky Autonomous Region. Remnant reindeer herding still persists in northern Amurskaya Province (10,000 deer).

The Zeya-Bureya Plains are the most extensive

Table 2.9 Agriculture land structure in Russia in 2002 ('000 hectares)

Province	Agriculture lands total	Agriculture lands arable	Drained/ irrigated	Planted Cropland	Nomadic Pastures
Primorsky	997	607	286	406	–
Khabarovsky	274	100	83	102	10,422
Amurskaya	1,788	1,187	246	647	554
Evreiskaya Autonomy	168	86	88	85	–
Chitinskaya	1,443	583	36	320	3,142
ABAR	173	97	7	31	699
Russia basin provinces total	4,844	2,660	746	1,591	14,817

Source: Karakin & Sheingauz 2004

lowlands of Russia's Amur basin, encompassing more than three million ha, and including more than 50 percent of the most productive agricultural lands of the RFE. One-third of the economy of Amurskaya Province is agricultural production, primarily soybeans and wheat. This is the largest cropland area in the Russian Amur basin (**Table 2.9**) and is considered by Russia, China, and Japan to be a strategically important source of food supply for the future (**Map 2.1**). Another major enclave of agriculture is the lowland around the transboundary Lake Khanka-Xingkai in Primorsky Province. A significant portion of grain and livestock production in the western basin is produced in the Argun River valley in Chitinskaya Province.

Agricultural development has been heavily subsidized, consisting of large state-owned and collective farms. When reforms were implemented from 1990 to 1997, government subsidies were reduced or eliminated. Crop and livestock production dropped by more than one third during this time.

Karakin and Sheingauz (2004) assessed the impact of government reforms on farm production in Russia's Amur-Heilong basin. They reported that from 1990 to 2001 the area managed for agricultural production declined 19 percent, arable land under cultivation declined by 48 percent, and the area under grain cultivation declined by 63 percent. Conversion of wildland to farmland effectively ceased as did the renovation of drainage systems. Use of fertilizers declined by 90 percent. However, by the time the old system collapsed the original ecosystems of the Zeya-Bureya plains and Khanka lowlands were already in serious need of ecological restoration.

Cropland productivity varies greatly depending on climate and other abiotic factors. Thus yields vary among different regions of the basin by a factor of 1.6 for potatoes and 1.9 for soy beans (**Table 2.10**). The rural economy in most agricultural regions is in serious crisis. Since 1990, rural communities have experienced substantial declines in living standards, which by 2006 had resulted in high levels of unemployment, lack of means for income generation among villagers, unreliable and unaffordable energy supplies, and deteriorating health conditions. Yet in the first years of the 21st century some former collective farms adopted more efficient management practices and even developed limited food-processing capacity. However, several collectives from the old Soviet-style system have not yet transformed into modern agricultural enterprises. As a result, most have gloomy prospects. Smaller farms owned by families have experienced even greater difficulties. The economic future for many small- and mid-sized farm families in the Russian Amur-Heilong is uncertain.

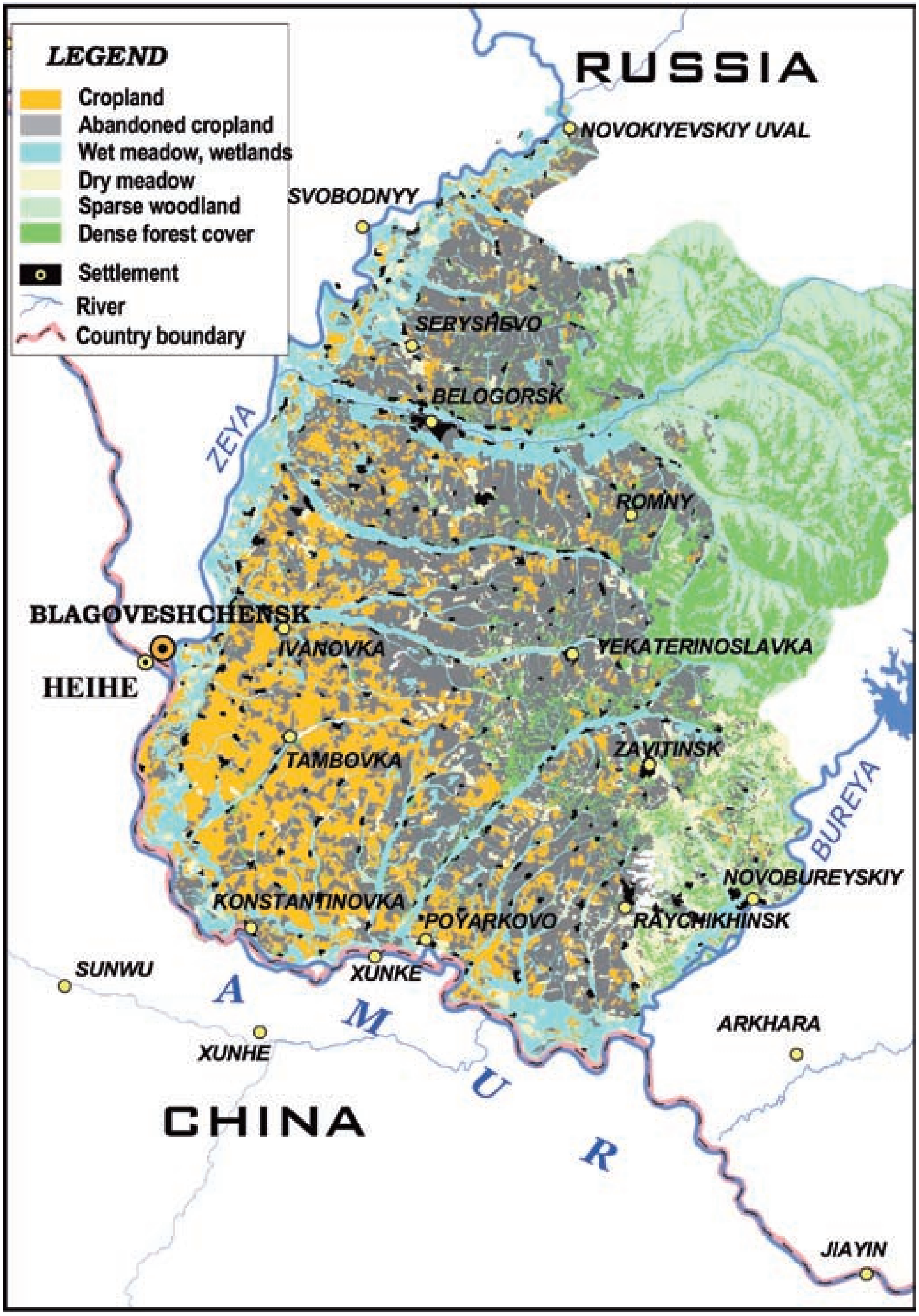
The rural economy to this day depends on large-scale production of a very small number of crop vari-

Table 2.10 Southern RFE agriculture production in 2001 (Ganzei 2004)

Region	Grain	Sunflower seed	Potato	Vege-table	Meat	Milk	Eggs	Non-swine live- stock	Swine	Honey	Total cropland
	'000 tons	'000 tons	'000 tons	'000 tons	'000 tons	'000 tons	million	'000 head	'000 head	'000 tons	'000 ha
Primorsky	134.9	0.8	433.7	114.6	16.6	136.1	177.1	97.1	42.2	1.756	448.1
Khabarovsky	27	0.1	326	140.4	15.4	80.8	232.9	52.3	70.5	0.467	102.6
Amurskaya	190.3	0.3	491.2	112.1	22.5	174.4	165.3	129.7	71.4	1.744	695.5
Evreiskaya Autonomy	29	0	103.9	29.7	2.9	30.1	13.6	20.4	13.1	0.024	79.7
South RFE total	381.2	1.2	1354.8	396.8	57.4	421.4	588.9	299.5	197.2	3.991	1322.9

eties, predominantly soybeans, and is vulnerable to changing market demands and prices. Under rapidly changing national and world market conditions, such an agribusiness system is unlikely to sustain desirable living standards in rural communities.

Colonization of the Russian Far East has for centuries been subsidized by the Russian government. One form of subsidy is the supply of surplus agricultural products from more developed regions to make up for shortfalls in less developed localities. Since the 1850s Russian colonists began to settle the Zeya-Burey plains and quickly developed a flourishing local economy. These are the richest soils east of Baikal and produce good yields despite a growing season that only starts in June. But these high yields are almost entirely dependent on the natural fertility of the soil, rather than on inputs of technology, investment, or knowledge by farmers. In addition to Russian agricultural settlers who came en-mass from Ukraine and Southern Russia in search of land, the region had multiple Chinese and Korean agricultural enclaves even before large-scale Russian colonization.



Map 2.1 Abandoned croplands of the Zeya-Bureya plain in early 21st century

Russian settlers both competed and cooperated with Chinese farmers, who during certain periods, such as the beginning of the 20th century, produced a large share of local crops, and always the bulk of the vegetables. From time to time the Russian government, fearing potential future loss of control over land, expelled all of these Chinese farmers. A few decades later the Chinese gradually returned and the status quo was reestablished. In all previous periods in the Amur-Heilong basin, Russian agricultural practices usually lost in competition with those of the Chinese whose farming methods were more labor intensive but whose labor costs were lower.

After re-establishment of constructive Sino-Russian relations in 1991, Chinese settlers and small-scale investors in agriculture again began to arrive in small numbers on the Zeya-Bureya Plains in Amurskaya Province, Evreiskaya Autonomous Region, and the Khanka-Xingkai lowlands and started cultivating a variety of crops. Although farms with significant shares of Chinese investment and Chinese managers are a recent phenomenon, in Amurskaya Province these farms produce most of the locally grown market vegetables, and their competitive presence is already viewed by some village communities and agricultural officials as encroachment on the rights of the local populace. More far-sighted local farmers are trying to learn intensive vegetable-growing technologies from incoming Chinese. Would-be Chinese settlers are often marginalized by bureaucratic barriers to immigration, land-lease rights, information and language, and access to services. As a result they often unwittingly violate environmental and other regulations. At the same time they are often largely left to themselves, on small plots of three to 10 ha of intensively cultivated soil in the midst of hundreds of km^2 of weedy wastelands. In comparison with the situation in the Chinese portion of the Amur-Heilong basin, Chinese farmers on the Zeya-Bureya plains enjoy less rigorous oversight by government authorities and land leases at 1/2-1/5 the prevailing rate in China (Belova 2003, Simonov 2005, WWF RFE field research, unpublished).

Recent reforms of the "General Principles of Local Self-Government" and the associated administrative system force municipal authorities to rely on taxes on agricultural land leases as their main source of local public funds. Unused arable land is now more than ever viewed by authorities both as lost tax revenue and a sign of poor administration. Along with other factors this creates incentives for municipal authorities to quickly lease all such lands. For example, in Leninsky and Oktyabrsky districts of Evreiskaya Autonomy on the left bank of the Amur-Heilong this led to rapid leasing of lands by Chinese farmers, who mainly grow soybeans. Ownership of these lands has not yet been legally decided because, by law, they should be divided in shares between former members of collective farms. This uncertainty over ownership limits leases to one to two year agreements that do not encourage lessees to undertake long-term obligations for land restoration, environmental protection, or infrastructure improvement. Sustained over decades, such a situation could cause many economic, social, and environmental problems. But in the short term Chinese farmers are increasingly becoming the most important taxpayers and sources of public subsidies in Amur-Heilong left-bank municipalities. The current arrangement is highly unlikely to result in sustainable economic development. This obvious concern worries Chinese lessees who are interested in greater economic sustainability, but seems almost irrelevant to Russian officials preoccupied with generating funds for social expenditures (Simonov 2005, unpublished field research). Chinese authorities express optimism, stressing that a migrant farmer earns 10,000 Yuan (US$1,250) in a season in Russia. That same farmer might make 1/3 of that by staying at home. In 2005 about 140,000 farmers from Heilongjiang Province labored outside China, many of those in RFE where they can farm more land per farmer than at home and lease costs are less than half. A 30 percent increase in migrant workers from 2004 to 2005 indicated good potential for further expansion. The Labor Force Transfer Center of Heilongjiang Agricultural Commission established training programs for future migrant farmers at two designated "Russian-Chinese agriculture cooperation districts" (Li Fangchao 2006).

According to the Heilongjiang Committee for Agriculture, by autumn 2004 more than 20 district governments sent teams totaling 34,000 people to work on 60 agricultural projects in Russia. Those farmers planted 350,000 hectares of grain/beans, raised 35,000 pigs, and engaged in trade and processing of agricultural products. Agreements signed between governments of Chinese and Russian districts led to the successful transfer of technology, investment, and agricultural machinery across the border. Total revenue from Chinese agricultural operations in Russia in 2004 exceeded 400 million Yuan ($50 million), and is more advantageous and less risky than export of agricultural produce from China to Russia.

Inevitable changes in Russian land-use policies and agricultural production will probably lead to an even greater influx of Chinese peasants into the agricultural regions of the RFE. In 2001, in Harbin at the First Conference on Chinese-Russian Cooperation in Technology and Trade, Chinese diplomats proposed to send up to one million farmers to help reinstate farming on the vast area of abandoned agricultural lands of the

RFE. Presently on the Russian side there are no policies or management measures to secure environmental and economic advantages from such a scheme, or to avoid potential negative impacts.

Analyses by Chinese experts indicate that currently the RFE has a 30 percent deficiency of seasonal farm workers and 50 percent of Russian machinery is obsolete or not serviceable. One third of arable land lies fallow, with 1.4 million ha of unused land in Primorsky and 1.3 million in Amurskaya Province. Currently agricultural production in the RFE is not adequate to meet local needs, producing 15 percent of consumed grain, 50 percent of vegetables, 20 percent of fruits, and 52 percent of milk. The rest is imported from outside the region, mostly from China.

Forestry

This section is adapted mainly from the work of A. S. Sheingauz (2002, 2004, 2006), who for decades has carried out detailed research on the forest industry of the RFE.

Forestry is a major source of income in the RFE where federally managed forest reserves cover well over 100 million hectares of the Amur-Heilong basin. The State Forest Fund, which includes a mix of forested and non-forested lands within one management jurisdiction, includes an additional total of at least 130 million hectares of which 110 million ha are forested. Timber resources in the region are estimated at 10 billion m^3, accounting for at least 12 percent of the standing timber resources in all of Russia.

By law all forests are segregated into three management groups. The first group makes up about 13 percent of the total forest reserves in Russia and includes protected forests, forests adjacent to rivers and other waterways, forest belts around industrial cities, and tracts of highly valuable tree species. In southern RFE the percentage of first-group forests is higher than in other regions and reaches a maximum of 32 percent in Primorsky Province.

The second group makes up three percent of the forest reserves in the RFE. These forests are located in densely populated areas where they are partially protected but available for small-scale timber operations.

The third group accounts for 85 percent of reserves and these are commercial forests that supply timber to the nation and to export markets. Clearcutting is only occasionally permitted in first- and second-group forests but is the standard harvest method in third-group forests.

Forests in Russia are state owned and about 95 percent of forested lands are under federal jurisdiction. The Forest Code of 1997 determines the framework for forestry in the country including use, protection, conservation, and regeneration of forest resources. In addition, each regional government develops its own provincial legislation. In Primorsky province, for example, the number of forestry related laws exceeds 100. A new federal forest code has been in debate since 2002. Over 20 draft codes have been proposed. Each new draft puts forward fundamentally new approaches and most of these are more liberal market approaches to manage forest use. At the same time, most laws almost completely ignore the biological and environmental fundamentals of forest use. Proposed drafts have also ignored the national tradition of forest management by proposing to convert lay units of the forest management agency into quasi-commercial enterprises. This has elicited justified criticism from both professional foresters and environmental NGOs. The Federal Forestry Service, founded over 200 years ago and recently merged with the Ministry of Natural Resources, manages the lion's share of Russia's forest fund. In each administrative region, the Ministry's Forest Service has regional forestry committees that manage dozens of forestry management districts (*lekhoz*), which are further divided into lay forest management units (*lesnichestvo*). With the recent economic crisis, federal funding for forest management has plummeted, forcing regional administrations to shoulder an increasing share of forest management costs.

Any analysis of the management system for forests is complicated by periodic and inconsistent changes in the structure and dynamics of in the forest sector in the Russian Federation in general, and in the RFE in particular. These changes resulted from the socio-economic reforms in Russia over recent years. The forestry sector is faced with a contradiction. Federal forest managers, long recognized as authorities, are losing their jobs due to funding cuts and resulting personnel reductions. But from 2000-2006 the authority of provinces has been transferred to the depleted ranks of professional foresters at the Federal level. Then in mid 2006 an abrupt shift occurred returning most authority back to the somewhat unprepared regional governments. With the new Forest

Code of 2007 we are yet to learn who controls forest fires, who pays for this, and who oversees vast loggging concessions to avoid envrionmental losses. By now the haphazard administrative reform already resulting in the destruction of the long-standing traditions of forest administration and a substantial weakening of management.

Current levels of Forest Service funding do not cover the costs of basic forest management. In 2002 the RFE average expenditure on the Forest Service was US$0.78 per 100 km^2. During the Soviet era the state funded 90–95 percent of costs as compared to a mere 25–30 percent today. The Forest Service finances the balance from profits made on intermediate cuttings. This forces foresters to switch from a regime where intermediate cutting improves the forest to one where short-term commercial high-grading is a financial necessity.

A second incentive for short-term management is that intermediate cutting provides the opportunity to cut the most valuable species under the guise of forest improvement. These species are protected so they cannot be cut later during commercial harvests. By managing the intermediate harvests, the lay Forest Service personnel who are responsible for management, enforcement, and security, have become flagrant violators of forest regulations. From the early planning stages of intermediate cuttings, much of the extracted timber is destined for export, mainly to China.

Information on forest resources is gathered by forest inventory enterprises once every 10 to 20 years. The official method for calculating the annual allowable cut (AAC) has been applied without fundamental modification since World War II. It is based on the forest area distribution by age class and average volume of trees. The final decision must take into account the economic development of the district and some economic features of the nearest logging enterprises. The former AAC is now called "Total AAC". Since 1990, a second calculation has also been made, the so called "Accessible AAC." To calculate Accessible AAC, some forest stands are excluded from the Total AAC. The excluded stands typically have very low volumes of standing timber, low density of forest cover, and very low annual productivity. These excluded stands are commercially unprofitable, therefore considered inaccessible. The area of these inaccessible stands is typically some 30 percent of the Total AAC, leaving approximately 70 percent of the reserve as Accessible AAC. However, in reality, only about half of the Accessible AAC is economically harvestable. To harvest the other half would require high-tech equipment and road networks that are beyond the means of local timber companies.

Official statistics show that even the accessible AAC is not fully utilized. In 2002 the average exploitation rate was 20.5 percent, increasing in southern regions nearer China and Japan such as Khabarovsky and Primorsky Provinces where use rates ranged from 41–43 percent. In general, the four southern provinces of the RFE account for 95 percent of total forest sector production from all provinces of the RFE.

Current inventory procedures do not provide accurate information on the quantities or dynamics of RFE forest resources. Nevertheless, several trends are apparent. Despite the impact of forest fires and timber harvests, forest cover increased gradually from 1966 (the first reliable State Forest Inventory) through 1998 (**Table 2.11**). During 1978–1998 it rose slowly but steadily by 8 percent over the 20-year period. This trend was reversed in the past five years during which there was a slight decline in forest cover due to forest fires even though legal harvesting rates declined. Forest planting is so limited in scope and so inefficient that it has no influence on forest cover dynamics.

The area of commercial timber harvest in the southern regions of the RFE in 2002, where 95 percent of the industrial harvest takes place, was 120,400 ha, including 78,800 ha of clear cuts (65 percent). During the same period, the southern regions thinned 1.5 million m^3 of timber, or 12 percent of the harvest volume. The annual area under commercial harvest is very small, less than 0.4 percent of forest lands.

The average annual forest area destroyed by anthropogenic forest fires is twice this size. Fires are the main source of disturbance and degradation of forests. Catastrophic fires, more frequent in recently cut areas, are especially harmful, occurring at roughly ten year intervals. They are usually four to five times larger than typical forest fires (see Part Three for forest fire details).

The average annual area of thinning for the 1998-2002 period differs greatly from those listed in forest management documents (**Table 2.12**). Various

Table 2.11 Development, dynamics and disturbance of the RFE forests (Sheingauz)

Territory	Average Annual Production Area 1999-2001 (official data, '000 ha)			Mean Burned Area 1991–2000 (official data '000 ha)	Forest land subject to logging and fire impact annually ('000 ha(percent))	Trends 1998–2003 (official data)		Average Percent of Forest Disturbance (assessed)
	Harvest	Interim cutting	Planted			Forested area change ('000 ha)	Standing timber change ('000 m^3)	
Evreiskaya Autonomous Province	1.0	3.7	0.8	2.7	8.2(0.5)	33.6	4.4	60
Primorsky Province	23.4	37.5	4.0	17.9	82.8(0.7)	38	-17.5	43
Khabarovsky Province	69.8	39.7	12.5	235.0	357(0.6)	-1579.3	-230.7	40
Amurskaya Province	11.4	13.3	3.0	63.7	91.4(0.4)	194.7	8.4	46

Source: Data Base of the ERI, 2003 and Sheingauz' (2004).

types of thinning make up most of the harvest. These harvest methods accounted for more than half of the volume set in forest management documents. Thinning is widely used in Khabarovsky (49 percent) and Primorsky Provinces (23 percent).

Table 2.12 Intermediate Thinning Area (Sheingauz 2006)

Cutting type	Demand set by forest management plans ('000 ha)		Average annual cut in 1998-2002	
	Total	annual	'000 ha	Percent of demand
Clearing and Cleaning	1091.6	59.6	32.2	54.0
Thinning	677.8	31.4	1.4	4.5
Pass Through Harvest	1375.8	57.5	9.8	17.0
Renewal and Stand Formation Harvest	184.9	11.1	13.3	119.8
Total Maintenance Harvest	3330.1	159.6	56.7	35.5
Salvage Logging	3648.7	68.9	13.4	19.4
Reforestation Harvest	240.9	11.2	1.4	12.5
Total Intermediate Thinning	7219.7	239.7	71.5	29.8

The areas of pass-through harvest, renewal and stand formation harvest, and salvage logging, which are the basic sources of timber for the *leskhoz*, was 36,500 ha for the RFE (10 provinces) as whole, and renewal and stand formation harvests exceeded plans by 20 percent. The largest percentage of pass through harvest is in Primorsky Krai (72 percent of RFE volume) and the largest percentage of renewal and stand formation — Khabarovsky Krai (54 percent of RFE volume). *Leskhoz* preference for these methods is explained by the opportunity to harvest commercial grade timber during these treatments. Other types of intermediate cuttings fall considerable behind prescribed annual norms.

Since the 1990s, the volume of commercial timber cut in intermediate treatments has steadily increased although the total area affected is slowly decreasing. This means that more timber is being harvested from a smaller area. In Primorsky Krai, from 2000 to 2003, commercial timber harvest volumes via intermediate treatments increased 44 percent, from 568,100 to 815,400 m^3; in Khabarovsky Krai — 28 percent, from 395,600 to 507,100 m^3; in Evreiskaya Autonomous Oblast — 149 percent, from 18,400 up to 45,800 m^3. The reasons for these increases are:

- *Leskhozes* must find additional sources of revenue to close budget gaps;
- A shift in emphasis toward earning profits from commercial timber through exports;
- Intermediate treatments enable harvest of valuable forest species that cannot be legally cut and/or are located on forest lands where harvest is otherwise prohibited or limited (coastal protection zones, and pine nut zones).

Intermediate cuts produce a large share of Russia's hardwood supply, especially among protected or trade-restricted species such as ash (*Fraxinus mandshurica*) and linden (*Tilia* spp.). Korean pine/Cedar pine (*Pinus*

Territory	1980	1986	1990	1998	2000	2003
Primorsky Province	6,063	6382	4,789	1,449	2,218	2,900
Khabarovsky Province	13,705	14,719	11,593	3,325	5,825	7,817
Amurskaya Province	4,726	6,188	5,571	602	896	1,259
Evreiskaya Autonomous Province	337	375	341	12	26	133

Table 2.13 Timber Harvest in the Russian Far East ('000 m^3)

Source: Database of RAS FEB ERE, 2005.(Sheingauz 2005)

koraiensis), which has been banned from commercial harvest since 1991, is now extracted under the guise of intermediate cutting. As a result, intermediate cutting that is promoted ostensibly to improve the stand is indeed the most damaging method.

The forest industries of the Russian Far East and Siberia have had an interesting history of growth, crisis, and change. The RFE's forest industry began in the 1870s as commercial harvesting and sawn timber production for the construction of new settlements during the initial development of the region. After World War II, the forest industry defined a clear organizational structure comprised of two main components. The Ministry of Forest Industry of the USSR supervised logging and wood processing. Cellulose, paper, and cardboard plants came under the direction of the Ministry of Cellulose-Paper Industry of the USSR.

Centralized state control of most forest production provided opportunities for the sector in terms of financing, stable markets, centralized supply, and steady employment. Development of the forest sector in RFE and Siberia was prescribed by state plans and was strongly supported by state investment. Additionally, there was a directive "to shift the forest industry development emphasis from the European-Ural region to the Asian region of the USSR" (i.e. into Siberia and the RFE). This was successful. New logging and wood processing plants were established, production increased continuously, and pristine forests were commercially exploited until the mid 1980s.

Symptoms of a RFE's forest sector crisis appeared for the first time in the mid-1970s. The central authorities of the former USSR did not recognize the developing crisis and they prolonged the use of obsolete and damaging methods. This caused a rapid decline in production during the 1980s (**Table 2.13**). Logging peaked in 1986 at a total of 36.7 million m^3 of harvested timber and 28.8 million m^3 of commercial wood produced.

Logging in Khabarovsky Province was generally profitable from 1975 to 1981, when about 15-16 million m^3 of timber were produced annually. In Primorsky Province, the peak occurred in 1973-1977 at seven million m^3 per year. The peak in Amurskaya Province was from 1987-1990 at six million m^3 per year. After 1990, logging levels dropped dramatically. In 1997, the area of industrial logging in the RFE fell to a third of what it was in 1990, while production declined to one fourth of 1990 levels (**Figure 2.3**).

The crisis of technologies and management in the forest sector was magnified by Russia's general economic crisis of the 1990s. As the sector was beginning to unravel, it was hit harder than other sectors by the economic crisis and the onset of recession came sooner. This caused a sharp decline in the forest sector's role in the economy. From the early 1980s until 1991, the forest sector provided 10 percent of the industrial commodity output and employed up to 13 percent of the labor force in the RFE. In 1998, at the lowest point of the slump, forest sector employment had declined from 13 to a mere 2.6 percent of the labor force.

The already unsteady forest sector slumped further still as the domestic demand for timber declined. Before the crisis, a blossoming regional market had consumed 50–60 percent of domestically produced timber; about 25 percent was exported to other regions of the USSR (mostly to Central Asia); 20–25 percent was exported

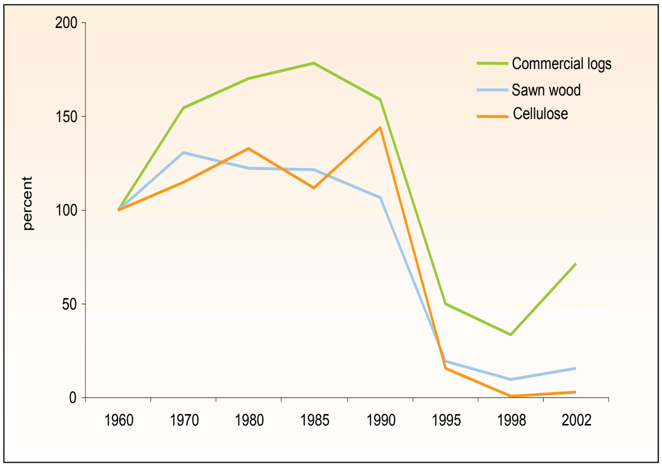


Figure 2.3 Changes in production in the RFE forest sector (1960=100 percent) (Source: Data Base of the ERI, 2003; Sheingauz 2003)

(mostly to Japan). Domestic consumption was primarily for house-building and construction of industrial enterprises, roads, and other facilities. All of these activities ground to a halt during the crisis of the 1990s. At the same time the Japanese recession temporarily reduced demand for timber imports. The present growth of production is driven by demand from the Chinese economy.

During the transition from crisis the production sector became less concentrated. In the 1980s, about 70 percent of timber was produced by state-owned logging enterprises (*lespromkhozes*). In the transition period forest enterprises increased four to five times in number while their average capacity declined to 10-12 percent of the 1980s levels. Previously a *lespromkhoz* was the only logging unit in a settlement, sometimes the only one in several settlements. Now it is common to find two, three, or more small logging firms operating in each settlement, all successors of the original *lespromkhoz* and each with a portion of its obsolete equipment. The new enterprises do not have the resources to buy new equipment or acquire new technologies, contribute to the social infrastructure of their settlement, or fulfill any of the other roles important to supporting the local communities.

For the timber industry, Khabarovsky Krai is the RFE's most important province. In the early 1980s, prior to the beginning of the transition period, 40 *lespromkhozes* (forest industry bureaus) produced 11 to 12 million m^3 of timber per year. This was 88 percent of province-wide production. By 2002 the Khabarovsk Krai Committee of State Statistics counted 558 logging enterprises, an increase of 518 firms or nearly 1,300 percent over the 20-year period (*Lesnoy komplex* 2003).

The number of wood processing enterprises in 2001 was 104 in Khabarovsky Krai and 43 in Primorsky Krai (official provincial data). Thus, the average wood processing enterprise had annual production of 3.5 thousand m^3 in Khabarovsky Krai and 2.3 thousand m^3 in Primorsky Krai.

Growing numbers of logging, trading, and processing firms are directly related to the widely discussed problem of illegal logging. Illegal logging is growing because the origins of timber and wood products are no longer traceable. Discrepancies in quantities of timber at different links in the chain of custody often do not arouse the attention of enforcement authorities. (see Part Three for discussion of illegal logging).

Throughout the era of Russia's planned economy, there was growth in the production of fiberboard, chipboard, and wood chips in particular. Now wood chips are produced by only two enterprises, one at the sea port of Plastun (Primorsky Krai) and one at Vanino (Khabarovsky Krai). Only one plant, situated in Khabarovsky Krai, produces chipboard at a volume of 9,900 m^3/year (although some new furniture plants produce chipboard as an intermediate stage in their production process).

Production has stopped completely for the following types of mills: fiberboard (seven plants closed in Khabarovsky and Primorsky Krais); plywood (three mills closed in Khabarovsky and Primorsky Krais); matches (one plant closed in Amurskaya oblast); formaldehyde, nutrient yeast and hydrolytic spirit (three plants closed in Khabarovsky and Primorsky Krais). Despite the seven fiberboard mill closures, a new plant in Amurskaya Oblast began operating in 1998.

Khabarovsky Krai's forest sector contributed 6.4 percent of the total income of provincial and municipal budgets in 1999 and 5.7 percent in 2000. The forest sector ranked third out of Khabarovsky Krai's industries in tax payments for the year 2000. The share of the forest sector in the total income of provincial and municipal budgets of Primorsky Krai was 3.2 percent in 1999, 2.7 percent in 2000, and 2.4 percent in 2001. The forest sector ranked fourth among tax payers of all industries in Primorsky Krai (Sheingauz 2004).

Although timber processing levels in the RFE forest industry are very low both in general and relative to pre-crisis volumes (**Figure 2.4**), lumber production increased by 30 percent from 2000 to 2003 and reached one million cubic meters. 2003 estimates for timber processing are 18 percent for the RFE as a whole, with 23 percent for Primorsky Krai, 12 percent for Khabarovsky Krai, 11 percent for Amurskaya Oblast .

Low processing levels in the RFE forest industry and the fact that high quality raw materials are mostly exported remain significant barriers to improving regional forest sector economies.

Non-timber forest products (after RFE-ECAP 2003 and Sheingauz 2006)

NTFPs have always played a modest role in the region's economy. Forests of the RFE are rich in species composition and hold large numbers of valuable species. More than 20 species of unique and valuable

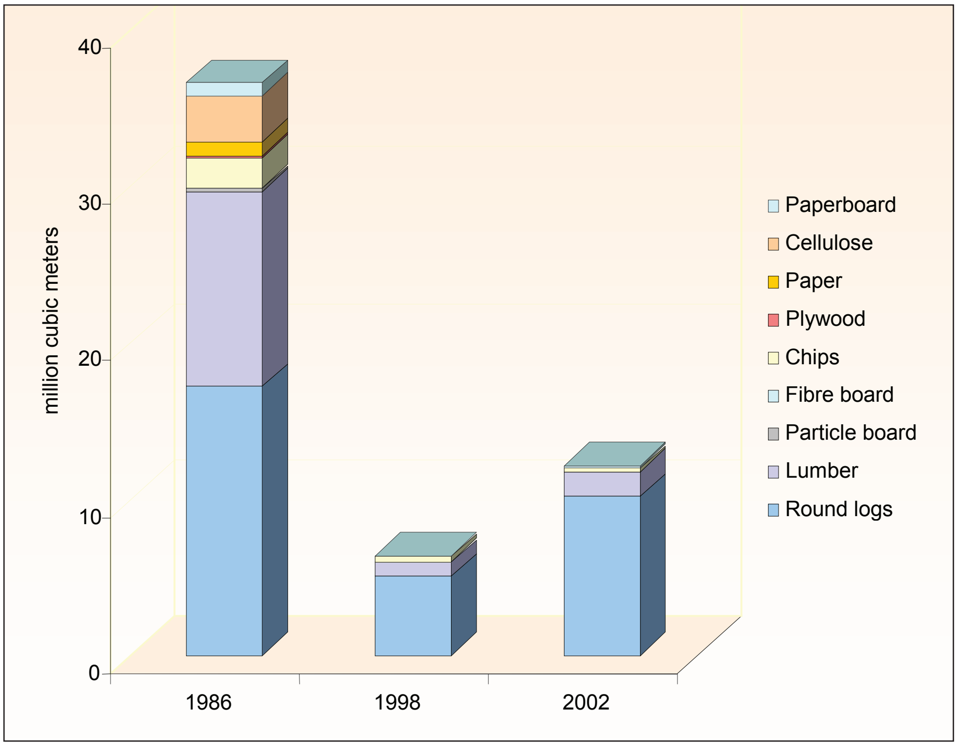


Figure 2.4 Forest Product Market Structure in the RFE (Source: Regions of Russia 2002)

plants grow within Russia in natural conditions only in the RFE, including Japanese angelica tree (*Aralia elata*), Asian ginseng, Siberian ginseng (*Eleutherococcus senticosus*), Devil's club (*Oplopanax elatus*), snakeroot (*Aristolochia manshuriensis*), and rose root (*Rodiola rosea*). Many of these species have populations large enough to support widespread collection and processing. Altogether, more than 3,000 species of vascular plants are found in the Amur-Heilong Ecoregion Complex, of which 1,200 have been used to some degree as medicinal, technical, or food products. Most of the plants are used for medicinal purposes and have either received official approval or are widely used by the public and experimental pharmaceutical industries. Several dozen species are suitable for use as food products. Edible nuts include Korean pine, mountain pine, and Manchurian walnut (*Juglans mandshurica*). Popular berries include cowberry (*Vaccinium vitis-idaea*), bog bilberry (*Vaccinium uliginosum*), and bearberry honeysuckle (*Lonicera edulis*). Edible vegetables and mushrooms, such as wild garlic (*Allium ursinum*), fiddlehead fern (*Pteridium aquilinum*), edible bolete (*Boletus edulis*), honey fungus (*Armillariella mellea*), and milk agaric (*Lactarius deliciosus*), are widely distributed over the RFE. If plants used in honey production and teas are added to these, the number of economically valuable plants becomes much higher.

Non-timber forest products (NTFPs) have been used by indigenous peoples for centuries. During the Soviet period, dozens of species of wild forest plants were used in the food, cosmetic, and chemical industries and in medicine. Some of these, such as fern and cowberry were processed for export and were important sources of hard currency for many towns located in remote areas far from industrial centers.

Since the collapse of the Soviet planned economy, many enterprises curtailed or stopped harvesting and processing non-timber forest products. This aggravated the economic situation in small forest villages, where unemployment is a chronic problem. The majority of enterprises that remained active were privatized early in the reform period. The 1997 Forest Code allows private enterprise to take certain responsibilities from the federal forestry authorities under long-term forest leases or concessions. While this clause provides an opportunity to create private or community-managed plots where non-timber forest products are harvested, the process is still in the infant stages and no practical experience is yet available. Khabarovsk province developed special regulations for collection and use of NTFPs, but they are usually not enforced.

Most NTFPs are collected for subsistence, and only a small fraction is registered by government statistics. Polls among local residents in 2002-2005 showed that a family in a forest settlement of the Sikhote-Alin Mountains collects 46 kilograms of NTFPs annually (**Table 2.14**). Extrapolating for the whole RFE yields a total annual harvest of 90,000 tons. This is a substantial, ecologically benign supplement to the diets and economies of local people.

Statistics on Korean (and Siberian) pine nuts, which are extremely important for local economies and thus better studied, suggest that for some exported products the extrapolation used in **Table 2.14** does not capture the full volume of harvest. Russian customs data show that about 11.8 thousand tons of pine nuts were exported to China in 2000-2004. This suggests that actual harvest is 15-17 thousand tons, or 35-40 percent of natural productivity of Korean pine stands in RFE (Sheingauz 2006).

Table 2.14 Estimated annual NTFP harvest volumes in the RFE 2002/2005 (After Sheingauz, Sukhomirov 2005, quoted from Sheingauz 2006)

Products	Average harvest per family, kg/year (2002 and 2005 only)	Total estimated harvest '000 tons
Nuts	3.5	7.1
Berries	11.8	24.0
Mushrooms	17.1	34.6
Fern	9.7	16.1
Bear garlic	3.4	6.9
Medical and technical raw materials	0.8	1.5
Total	46.3	90.2

Melliferous plant use, lime or linden tree (*Tilia* sp.) being the primary species, dropped sharply in the 1990s. The number of bee colonies in the RFE decreased by half to around 250,000. Average annual honey production in the last half of the 1990s dropped 45 percent (from 10,300 tons in 1991-1995 to 5,700 tons in 1996-2000). Total RFE honey production for that period decreased from 26 to 11 percent of total Russian production. Volumes in the RFE continued to decline in the 2001-2003 period. Average annual honey production dropped to 3,300 tons, or only 7 percent of total Russian production. In the 1980s the RFE was first place in Russia for honey production, now it is fifth. Flora and especially forest resources in the RFE make it possible to keep at least one million bee colonies and to produce 30,000 tons of commercial grade honey. In comparison, China, with eight million bee colonies, produces 250,000 tons of commercial grade honey and about 1,000 tons of royal jelly (Sheingauz 2006).

Although it is difficult to estimate the total volume of exports, China is certainly the fastest growing market for Russian non-timber forest products. The number of species used is increasing since in similar ecosystems of northeast China a much greater spectrum of species is harvested for commercial use. For example *Osmundia* fern has no particular use for Russians, but is a highly prized delicacy by Chinese and Japanese, and some specialized "tourist groups" come from China to border regions to harvest this fern. The predominant mode of supply is a wide web of purchase points in rural regions, where Chinese traders can buy products directly from forest communities and advise them what commodities will be in demand in coming seasons.

Fisheries

Capture Fishery

The fishing industry has been an important sector in regional economic development for two centuries. Salmon and sturgeon were initially the most sought after species: a record 100,000 tons of salmon were caught in 1910. By the 1990s, however, the catch in Russia had declined to only one tenth of this level. Beginning in the 1960s, overfishing and water pollution from Russian and Chinese industrial and agricultural sources have caused catastrophic declines in the productivity of commercial species.

During the past decade, 90 percent of the fishing industry in the RFE relied on ocean reserves (Minakir 2002). Yet commercial fishing in freshwater rivers and lakes still plays an important role in the regional economy and in the cultural traditions of indigenous peoples. The global demand for black and red caviar, sturgeon, salmon, and other fish encourages overfishing and poaching. Illegal fishing rose to unprecedented levels in the 1990s, exceeding legal catches by three to four times. Illegal sturgeon catches in the Lower Amur, estimated at up to 750 tons, bring in an estimated $9-11 million annually.

About 1.2 million kg of sturgeon were caught in 1891; by 2001 only 100,000 kg were allowed to be netted and this was for scientific research. The officially registered harvest of other fishes has also declined over 95 percent (**Figure 2.5**).

Over-exploitation by both China and Russia was the primary threat to the fishery for at least the past 65 years. KhoTINRO (2002) estimated the spawning population of Amur sturgeon at 1,290 tons and Kaluga at 2,873 tons, for a combined total of just over 4,000 tons in 2002. Current estimates place the combined legal and illegal Russia-China catch at 973 tons annually. This

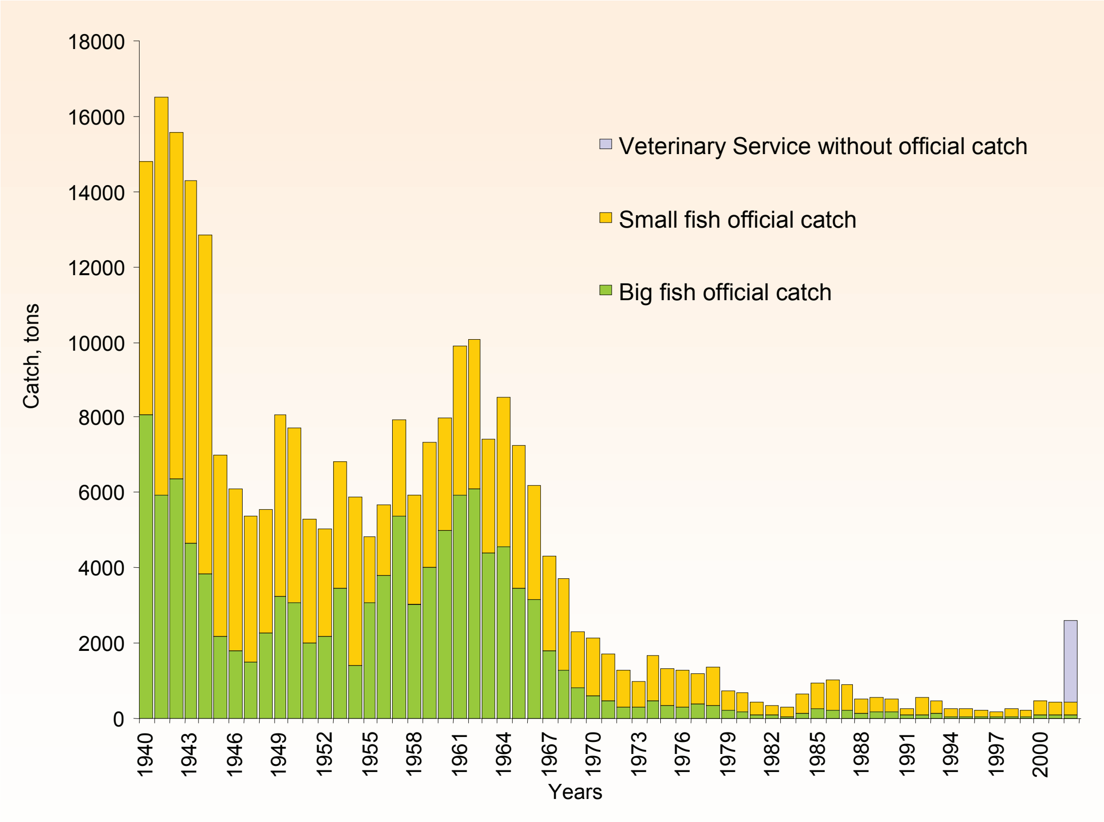


Figure 2.5 Total fish catch from 1940 through 2002 (source: WWF-RFE 2004)

means that nearly one of four mature sturgeon is caught every year, an exploitation rate that could only lead to extinction of both species in the near future.

With increasing industrialization of the Amur-Heilong basin, particularly in China, a new threat has emerged: chemical contamination of river waters by the discharge of untreated industrial waste and runoff of agrichemicals from farmlands. The magnitude of this threat was emphasized by the November 2005 explosion of a chemical plant in China's Jilin Province, where highly toxic organic compounds were washed into the Second Songhua River and eventually reached the Amur-Heilong. Amur-Heilong River waters downstream of the Songhua River confluence are so severely polluted that riverine communities in Russia are advised against using river water for drinking or preparing food, and against eating fish or other wildlife taken from the river.

The fishing industry is on the verge of collapse and at least 25,000 indigenous people are left without a means of subsistence. In the 1960s, there were 168 settlements of indigenous groups on the Lower Amur-Heilong. In the last two decades, nearly a third of these have disappeared and fishing quotas for the remainder have been reduced to one tenth of former levels. The decline in fish reserves has had tragic consequences for the Nivkhi, Nanai (Hezhe), and Ulchi indigenous tribes: people of these ethnic groups have either no fish resources or only contaminated fish to support their traditional livelihoods. International efforts are required to preserve the biodiversity of the Amur-Heilong River basin and help fish populations recover in the region.

In 2004-2006 world-wide discussion of the fate of sturgeon fisheries was spurred by a United States Fish & Wildlife Service attempt to ban Caspian and Black Sea caviar exports to USA[1].

In the wake of that ban, the Russian government assessed the state of fisheries and found that state revenues from the sector declined to 1 percent of the pre-reform total. The fish catch declined from seven to three million tons, production of canned fish dropped to 20 percent of pre-ban levels, and 90 percent of the lucra-

[1] US Department of Interior, Fish and Wildlife Service, 50 CFR Part 17 RIN 1018–AI11, Endangered and Threatened Wildlife and Plants; Final Determination of Threatened Status for the Beluga Sturgeon (*Huso huso*), ACTION: Final rule. Federal Register / Vol. 69, No. 77 / Wednesday, April 21, 2004 / Rules and Regulations.

tive sturgeon and salmon trade had been taken over by illegal markets (Anon 2006a).

After adoption of the “Law on fisheries and protection of aquatic bioresources” in 2004, and the “Law on coastal fisheries” in 2005, the State Duma is preparing a “Law on trade and operations in valuable fish products,” which has already been nicknamed the “Caviar Bill” because it relates to sturgeon and salmon roe and sturgeon meat. The objective of the new legislation is to subject all operations in the production network to licensing, from catch to retail. Unfortunately, prospects for success are limited because Russia has a poor history of licensing and controlling trade in lucrative commodities. For example, alcohol trade licensing in Russia involves unimaginable levels of corruption.

Experts and analysts stress that the new law misses the point of recovery of dwindling fisheries: It is not the caviar trade that needs licensing but rather the wild sturgeon and salmon that need protecting (Anon 2006b). Whether this debate yields more restrictions on trade in fish products or better protection for wild fishes, the outcome will directly affect the condition and future trend of Amur-Heilong fisheries.

Fish Farming in Russia

Fish farming is not widespread in the Russian Amur Heilong basin due to the general availability of wild fish and the typically slow growth rates of farmed fish in cold northern waters. At thermal power stations where there is year-round discharge of warm water from cooling systems, medium-scale commercial farming of carp, sturgeon, and other species is more common. The sturgeon nursery recently built in Vladimirovka (Evreiskaya Autonomy) has great potential to become one of primary suppliers of live sturgeon to China, where mature fish is in high demand at fish farms.

In Chitinskaya/ABAR Baikal Omul (or Baikal Cisco) farming technology based on natural floodplain lakes is rapidly developing. These shallow lakes get extremely warm in summer and produce abundant zoobenthos for which there are almost no predators. Industrious locals buy fry of Baikal Omul (*Coregonus autumnalis migratorius*) at Lake Baikal Omul nurseries and then transport them to the lakes on the Argun and Onon floodplains where the fry are released. Within the second to third year the fish reach lengths that could not be attained naturally in five to six years in the cold waters of Lake Baikal. Baikal Omul is related to other salmon in the family Salmonidae and its meat is a delicacy prized over salmon and sturgeon meat, which means the industry is potentially lucrative. Current operations at just 10 lakes optimistically estimate profits of more than $0.5 million annually. A serious and as yet unstudied issue is the influence of introduced fish on floodplain lake ecosystems. The largest operation to date is at Nozhyi Lake in Aginsky-Buryatsky Autonomous Region (ABAR), the location of the recently established Aginskaya Steppe wetland-steppe protected area (*zakaznik*) and important habitat for millions of migrating waterfowl (I. Mikheev, Chita Research Institute, pers. comm.).

Export of fish and other marine products has been a source of income for the RFE for decades. In 1998 fish products were exported to 24 countries around the world. Fresh fish is exported to Japan, China, and Korea, in addition to caviar, frozen fish, crabs, shrimp, mussels, and aquatic plants. Outside of Asia, frozen fish and fish filets are sent to Germany, Poland, the United Kingdom, and other countries in Europe. The USA and Canada have recently begun to import fish products from the RFE.

Amur-Heilong basin trade in sturgeon, salmon, and several freshwater species extremely popular in world markets is most important. There is stable demand from neighboring regions of China for salmon, sturgeon, snakehead, whitefish, and other freshwater fish. China and Russia annually apply for CITES quotas for sturgeon exports. Available data on sturgeon trade in China are discussed in this chapter in the case study on Heilongjiang fisheries. Lake fisheries on the Sino-Mongolian border are discussed in the Mongolia case-studies of this chapter. More information on sturgeon, salmon, and other species in Russia can be found in a recent WWF study (Amur Fish: Wealth and Crisis, 2004) and in Part Three.

Mining

Resources and production

Mines in the RFE produce rare and lucrative metals and precious stones, as well as more common commodities such as antimony, tin, iron, boron, lead, and zinc. Platinum and palladium deposits in Khabarovsk Province produce a significant portion of two of Russia's most lucrative exports. Primorsky produces 100 percent of Russia's boric products, 80 percent of its fluorite, 40 percent of its zinc, lead, and tungsten, 20 percent of its tin, and 10 percent of its coal. Amurskaya has vast gold and coal mining operations. Chitinskaya and ABAR have the oldest mining operations in the region in iron ore, coal, non-ferrous metals, gold, and the most important uranium mines in Russia. For over 150 years, Evreiskaya Autonomy, despite its tiny size, has exploited globally important deposits of brushite (magnesium extraction), tin, coal, iron and many small placer deposits of gold (Newell & Gordon 2004, in Newell 2004).

Mining production declined throughout the 1990s, partly due to lower demand for ferrous and nonferrous minerals from the industry's major buyer, the RFE's military-industrial complex. But shipping to traditional processing sites in the former Soviet states and other parts of Russia is no longer feasible because of high energy and transport costs. The RFE mining industry today exports the most valuable products (diamonds, gold, platinum).

Like other RFE extractive industries, mining wastes enormous amounts of raw material. During extraction, at least 20 percent of the mined minerals are wasted. During the enrichment process, losses average 50 percent. This waste accelerates the depletion of deposits at existing mines, and developing new ones may not be profitable: Between 30 to 70 percent of all nonferrous metal ore deposits are unprofitable to develop due to wasteful mining methods and obsolete technology. As with the timber industry, the privatization of mining fragmented the large state-owned mining enterprises into numerous smaller and private companies. These small firms generally lack sufficient funds to modernize so many small independent mining teams or "cartels" were created to pool funds for purchase of needed equipment.

Determining the size of untapped reserves also requires expensive geological surveys. To increase production, the industry hopes to attract foreign companies and their technology and capital. Industry representatives are pressing the Russian government to reform burdensome mining laws and regulations (especially production sharing agreement legislation) and to streamline the tax structure. President Putin, however, wants to reestablish federal control over the mining industry through legal reforms, with particular reference to the Law on Mineral Deposits. Despite such obstacles, foreign joint ventures (mostly for gold and silver mining) have emerged in almost every region of the RFE. Low production costs (about 60 percent of average costs elsewhere) continue to draw investors. Some ventures mine existing reserves, such as the Dukat silver mine, but most are developing new deposits. Many of the new deposits are located in wilderness areas, often where other land-use interests compete. Environmentalists fear foreign firms may shirk environmental precautions and procedures to cut costs.

The 10 provinces of RFE Federal District also produce about 60 to 70 percent of Russia's gold. Magadan and Sakha (Yakutia) Provinces (outside the Amur-Heilong River basin) are traditionally the biggest producers, while Khabarovsk Krai is now starting to expand production. Economic turmoil led to sharp production declines in Sakha, but production in Magadan, Amur, and Khabarovsk remained fairly stable throughout the 1990s. Nationwide, gold production declined less than many other industries. The most productive mines in the southern RFE are Mnogovershinnoe in Khabarovsk Krai, which produces 2–3 metric tons annually and Pokrovka in Amur Oblast, which produced 2.8 metric tons in 2001. In 2001, Russia produced about 154 metric tons, making the country one of the world's largest gold producers. Of this total, Russia exported about 90 metric tons, jewelers and other manufacturers used between 15 and 20 metric tons, and Gokhran, the state repository for gold and precious metals, bought the balance of 35-40 tons. In an era where companies continue to deplete placer mines, continued growth in the gold industry depends on developing lode deposits. Unlike placer operations, lode mines can operate year-round, an attractive feature for foreign investors.

Environmental concerns

From the standpoint of environmental and public health, regulation of mining in the RFE has always been weak. Mining operations have left rock piles and toxic tailings throughout the region. Restoration of topography and/or vegetation on mined areas is rare at best: disturbed areas are left damaged after exploitation. Damage is particularly evident in the north, where the extreme cold slows recovery of fragile northern ecosystems.

Placer mining (hydraulic washing or dredging of gravel or sand) accounts for two-thirds of RFE mining and causes many environmental problems, including increasing suspended particle loads in rivers, altering riverbeds, and blocking migrating salmon from reaching spawning grounds. Mining contaminants pollute rivers and streams for long distances (extending environmental damage beyond the mine area by distances of seven to 20 times). During extraction, water temperatures rise in settling basins and dissolved oxygen levels decline, further impacting fish productivity. In addition to reducing fish populations and polluting rivers, Russian ecologists have documented areas where mining has caused decreased forest cover and erosion, impacted a wide variety of fauna, altered hydrological regimes of rivers and underground streams, and changed microclimates.

Most gold mines release large quantities of tailings relative to the amount of gold produced. Each year in the southern RFE alone, mining operations produce more than 30 million m^3 of tailings. The use of heavy and toxic metals pollutes soil, water, and air. This is especially true of the continued use of mercury to separate gold, despite regulations passed in 1988 outlawing its use. Mercury-contaminated waste piles line the banks of mined riverbeds. Preliminary studies in Amur Oblast have documented mercury groundwater contamination near mined areas. Thus far, placer mining has destroyed some 150 small rivers (up to 200 km in length) with a total watershed area of approximately 12,000 km^2. Consequently, some valuable river valley ecosystems have been lost. People in these areas continue to garden, fish, raise cattle, and drink the water. In Evreiskaya Autonomy the total amount of gold extracted since mining began in the 19^{th} century has been approximately 20 tons. As a result of placer mining there, more than 40,000,000 tons of tailings were dumped in the Sutara River basin, destroying the original landscape.

Government agencies lack funds to clean up abandoned mines. Holding enterprises responsible for abandoned mines is virtually impossible as many have gone bankrupt or changed ownership, and joint ventures are unwilling to accept responsibility for cleanup at existing sites. Some propose a special tax on mineral production to clean up abandoned mines.

To ensure that new mines are properly developed, environmental groups are calling for mining companies to adhere to the highest international environmental standards: detailed reclamation plans, prevention of groundwater pollution, installment of reliable and safe tailings impoundment systems, and financial assurance for all environmental measures, including toxic spill prevention, reclamation, and mine closure. In case of accidents, emergency response plans, including medical response, need to be in place for both the local government and the public.

Foreign investment in mining in Russia

The rich mineral resources of the RFE region and have already received international attention. However, most international (Canada, USA, UK) investment goes not to the Amur-Heilong basin, but to developing the richest deposits of the north such as Magadan and Sakha-Yakutia.

Uranium produced at Krasnokamensk (Chita Region) has probably been the most important export commodity from the Russian part of the basin. The mine at this site relied on foreign investments from Swedish companies in the 1990s.

According to the Natural Resource Ministry, Russia requires approximately 15,000 tons of uranium each year to run its power stations, fuel its nuclear submarines, and meet its export agreements (C. Belton, Dependence on a Man-Made Disaster, International Herald Tribune, Thursday 12 Jan. 2006). The shortfall in supply from the Krasnokamensk mine is partly supplied by recycling fuel and uranium ore imports.

After a continuous decline in production during the late 20^{th} century, Russia wants to double uranium production from the current 2,200-2,500 tones to 4,000-4,500 tones by 2010. This production increase is mainly needed to meet increasing domestic demand, but, according to the Russian Chemical Technology Institute, exports would continue. This direction coincides with new plans for nuclear power plant construction and other nuclear-related cooperation with neighboring countries, including China.

The Russian Natural Resources Ministry's Federal Resource Management Agency announced bidding for the right to exploit the Zherlovskoye, Pyatiletneye, and Argunskoye uranium deposits in Chita Region. The state-owned TVEL corporation is considered the only candidate capable of exploiting them (Kommersant Daily, 9 June 2005). The firm operating the mines (and owning shares in Mongolian Mardai mines as well) is JSC Priargunsky Production Mining and Chemical Association (PPGHO). This operation was reported to account for 32 percent of the value of all exports from Siberia and the Russian Far East in 1993. Historically, it has a poor record of environmental planning and management, and appeared to be a "maze of open pits, waste piles, and processing plants[2]." Krasnokamensk is the last major uranium mine still operating in Russia. These immense facilities sprawling across the steppe are the most extensive uranium operations in Asia and among the few largest uranium mining and milling facilities in the world. The operations produced approximately five million pounds of uranium in 1995 — along with millions of tons of tailings, waste rock, mine water, and mill processing water in the waste streams generated by the uranium recovery technology (see detail in water pollution section in Part Three).

China's Policy for Revitalizing the Northeast and Other Old Industrial Bases includes incentives for Chinese firms to explore mineral resources of neighboring countries to compensate for depleted domestic deposits. Many mineral deposits of ferrous and non-ferrous metals, gold, and graphite in Chita, Amurskaya, Evreiskaya Autonomous provinces are leased or are being prepared for lease by Chinese mining companies.

There is strong transboundary interest in gold mining in the streams of the Lesser Hinggan Mountains (Xiaoxing'anling). By the beginning of this century gold mined from the small tributaries on the China bank of the Amur-Heilong became a subject of environmental criticism in Heilongjiang Province. As a result, at least in Luobei County, mining was strongly discouraged and even prohibited by local authorities. Subsequently, local gold mining companies obtained leases on similar tributaries on the Russia bank in Evreiskaya Autonomous Province (EAP). By 2003 miners moved there with the same outdated equipment and technology that led to the virtual devastation of mountain streams in China. By 2006 two companies had obtained permits for operation and 10 more gold mining sites were auctioned primarily to Chinese bidders in Lesser Hinggan. This is an early example of the movement of "dirty industries" into countries with less rigid environmental standards. It reveals the growing environmental awareness in China and the failure of Russian authorities and society to face these new challenges.

Water resources management

Water resources management has evolved continuously in Russia since the 1990s (see Chapter 3) and the official version of current conditions is best described by government documents. The Regulations on the Federal Water Resources Agency approved by Resolution of the Government of the Russian Federation Number 282, dated 16 June 2004 is summarized below.

"The Federal Water Resources Agency is a federal executive body performing the functions related to rendering State services and federal property management in the sphere of water resources. The Federal Water Resources Agency is under the authority of the Ministry of Natural Resources of the Russian Federation. The Federal Water Resources Agency within the specified scope of its activity exercises the following authorities:

- organizes the redistribution of water resources of federally-owned water bodies;
- organizes the development, conclusion, and realization of basin agreements on the restoration and conservation of water bodies;
- organizes preparation and implementation of flood-control measures, measures concerning designing and establishment of water protection zones of water bodies and their littoral protective zones, as well as measures to prevent and eliminate the harmful effects of water;
- organizes State examination of the integrated use and conservation of water resources, as well as feasibility study and project documentation for construction and reconstruction of utility and other facilities having an impact on the condition of water bodies;
- holds tenders and makes state contracts on placement of orders for the delivery of goods, execution of work, rendering of services, conduct of research, development, and evaluation work for the state needs;
- performs the functions of the state customer of interstate, federal target-oriented, scientific and technical, and innovation programs and projects within the scope of activity of the Agency."

Russia is divided into several water management jurisdictions called Basin Authorities. The largest of these is the Amur Basin Water Management Authority (ABWMA), which is responsible for the Amur-Heilong basin and temporarily oversees many other smaller river courses draining into the Pacific Ocean.

The total number of ABWMA personnel does not exceed 130 and is dwindling due to low salaries and unstable working environments. Agency headquarters at Khabarovsk employ 35 personnel, and each province is represented by five to seven water management officials. From the federal to the municipal authorities there should be five tiers of water resource management

[2] Robinson, P. 1999. A report on Existing Problems at Baley and Krasnokamensk and Policy Needs in the Region. Southwest Research and Information Center, Albuquerque, NM, USA.

agencies, but in reality most municipalities do not have offices.

ABWMA shares water resource management responsibilities with many other agencies. This is due to the multiple overlaps, contradictions, and dissolved authority typical for contemporary Russian nature resources law and management systems. It is also attributable to the inherently multi-sectoral nature of water resource management. The following agencies cooperate with ABWMA to manage water resources:

- RFE Federal District Inspectorate of Federal Service for Control in the Field of Natural Resources (SCFNR) is the coordination branch of the enforcement agency overseeing all MNR branches in the Federal District);
- Six provincial branches of SCFNR are the enforcement agencies in the same field and are tasked with environmental law enforcement in provinces;
- Six provincial branches of the Federal Service for Nuclear, Technological and Environmental Control (SNTEC), which is responsible for pollution control and safety of water infrastructure;
- Provincial branches of the Federal Ministry of Emergency that has overlapping responsibilities in preventing flood damage;
- Six provincial agencies for natural resources and environment — branches of provincial governments with different responsibilities written into provincial legislation;
- Far East Center and provincial centers of Federal Hydro-Meteorology Agency (Goskomgidromet), responsible for monitoring of hydrology and pollution levels in natural water bodies; and
- Various branches of UES State Energy Company, responsible for functioning of Zeya and Bureya Hydropower dams.

ABWMA is not in charge of any of the above agencies, has more or less equal standing with them in the government hierarchy, and therefore often has competing and conflicting relationships with them. In terms of routine tasks to be carried out in 2005, ABWMA is more or less responsible for:

- collecting data on the condition of water resources and publishing a yearly State Report;
- developing regional instructions for application of the Federal Water Code and related legislation and advising the Federal Water Agency on new legislation;
- regulating collection of water taxes and fees, issuance of various water use licenses;
- keeping "State water resource use inventory and monitoring records", largely based on data from other agencies;
- supporting engineering and scientific research on priority problems and development of various improvement schemes (dredging, embankments, water protection zones); and
- managing federal funds for water-related public works, organizing bidding and supervision of subcontractors.

In all other spheres ABWMA can implement activities only in close coordination with some of the above agencies.

The “Basin Agreement” signed by all provinces of the basin is one important auxiliary tool helping ABWMA support of provincial governments. The agreement is for five years and amendments to it are signed in a separate protocol annually. This is a master plan of all water-related public works that have some federal funding (improvement of supply, protection of water resources, regulation of water flow, and flood-prevention). Total funds used under the agreement in 2003 were roughly US$7 million, with federal, provincial, and private investment funds in a ratio of 4:11:1. The new Water Code to be enacted from January 2007 prescribes the creation of “Basin Councils” on the foundation of existing basin agreements.

Important Amur-Heilong River basin water resource issues are discussed in Chapter 12 and Part Three.

Chapter 12

Socio-Economic Conditions in Northeast China

Population

China's population is approximately 1.3 billion with grows at a rate of 0.9 percent per year. 7.6 million people are now added each year to the nation's population. The population growth rate is predicted to reach zero by 2040 which will force the population to stabilize at 1.5 billion people. Approximately two thirds of China's people dwell in rural areas.

The Amur-Heilong basin in China includes almost all of Heilongjiang Province and large parts of Jilin Province and Inner Mongolia Autonomous Region. In 1998, Heilongjiang had a population of nearly 38 million, the highest of the three provinces. This was followed by Jilin (26 million) and Inner Mongolia (23.5 million). The 2005 total population in the China portion of the Amur basin was at least 65-70 million, or 5-6 percent of China's population. During 2000-2004 the three provinces grew by 0.34 percent, which is significantly less than the national average of 0.9 percent. The average population growth rate of Heilongjiang is lowest at 0.26 percent. Current population growth rates add approximately 100,000 people per year to Heilongjiang Province alone.

Population density varies from 20 people/km^2 in IMAR (with 44 percent urban dwellers), to 84 people/km^2 in Heilongjiang (53 percent urban), to 141 people/km^2 in Jilin (50 percent urban). The highest population density is on the Song-Nen plain, the lowest in the Greater Hinggan (Da Xing'anling) Mountains (**Map 2.2**). Average population density in the China portion of the basin is approximately 90 people/km^2 (as compared to 35 people/km^2 in the basin as a whole and 3.5 people/km^2 in RFE). Half of China's basin population resides in rural areas.

Describing the standard of living of these populations can be done with the net income of rural households and disposable incomes of urbanites. From 2000 to 2002, the three provinces all experienced gains in both indices, with Heilongjiang ranking first, followed by Jilin and Inner Mongolia (**Table 2.15**). None of the three provinces have indices that exceeded national averages, especially for per capita disposable income of urban residents. The disposable income per urban resident grew much faster than did the income of rural households in all three provinces, thus the livelihood gap between urban and rural households is increasing.

Table 2.15 Growth in average net income per capita in China (Yuan) (ADB 2005)

Area	Rural in 2000	Rural in 2002	Urban in 2000	Urban in 2002
Heilongjiang	2,148	2,405	4,913	6,101
Jilin	2,023	2,361	5,340 (in 2001)	6,260
Inner Mongolia	2,038	2,086	5,129	6,051
National	2,253	2,476	6,280	7,703

In recent decades, layoffs in heavy industry has caused a spike of unemployment throughout the basin with averages among the highest in China. As a result, urban poverty persists throughout the region. However, rural areas have traditionally had greater poverty-related problems. In the Songhua River basin, for example, there are 28 national and provincial level poverty counties, including 16 national level poverty counties (districts) and 12 provincial level poverty counties. The per capita income in poverty and non-poverty counties was ¥1,000 ($125) and ¥2,000 ($250), respectively (**Table 2.16**). In 1994, Heilongjiang Province reported 2.3 million poor (6 percent of the total population of 37.7 million). Only 460,000 people (1.2 percent) lived below the poverty line in 1998, a figure that rose again to 1.2 million (3.2 percent) after the dramatic flood of the same year (Asian Development Bank 2001). Incidence of poverty in 2000 was estimated by ADB at 8 percent based on a threshold of ¥800 ($100) or less for

Item	Jilin	Heilongjiang	IMAR	Overall
Number of counties	38	70	17	125
percent of incomes >¥800	6.3	8.8	10.8	8.0
percent of incomes ¥800-1000	3.8	6.7	6.5	5.6
percent of incomes ¥1000-1500	16.9	18.9	23.2	18.5
percent of incomes >¥1500	27.0	34.4	40.3	32.0

Table 2.16 Rural resident income distribution in the Songhua River basin

Table 2.17 2001 Economic growth (from "China in 2001", "China in 2004-5" Institute of Oriental Studies, Moscow 2002, 2005)

Economic sector	Annual increase 2001 (percent)	Annual increase 2004 (percent)	GDP (percent)
Primary Sector (agriculture, forestry, fisheries)	2.8	6.3	15.2
Secondary Sector (industry and construction)	8.7	11.1	51.2
Tertiary Sector (transport, trade, communication, other services)	7.4	8.3	33.6

rural people and 13.6 percent based on a per capita income of 1000. Based on the ¥1,000 poverty line ($125), the poverty incidence was highest in Inner Mongolia at about 17.3 percent, and lowest in Jilin Province at 10.1 percent. Household surveys showed that 18.5 percent of the population or 6.5 million persons belonged to the near-poor at ¥1,000-1,500/year ($125-$188). Poor and near poor families combined make up approximately 32 percent of the total population.

The poverty counties of the Songhua basin are primarily located along the banks of the Nen River and its tributaries. While population density is higher in the middle basin, the concentration of poor people is higher in areas close to the rivers, indicating a fundamental association between poverty and flooding (Asian Development Bank 2005). Floods typically affect the poor to a greater extent because they are often constrained to live in ecologically fragile and vulnerable areas and have limited ability to cope with losses or to reinstate their earning capability and livelihoods following a flood.

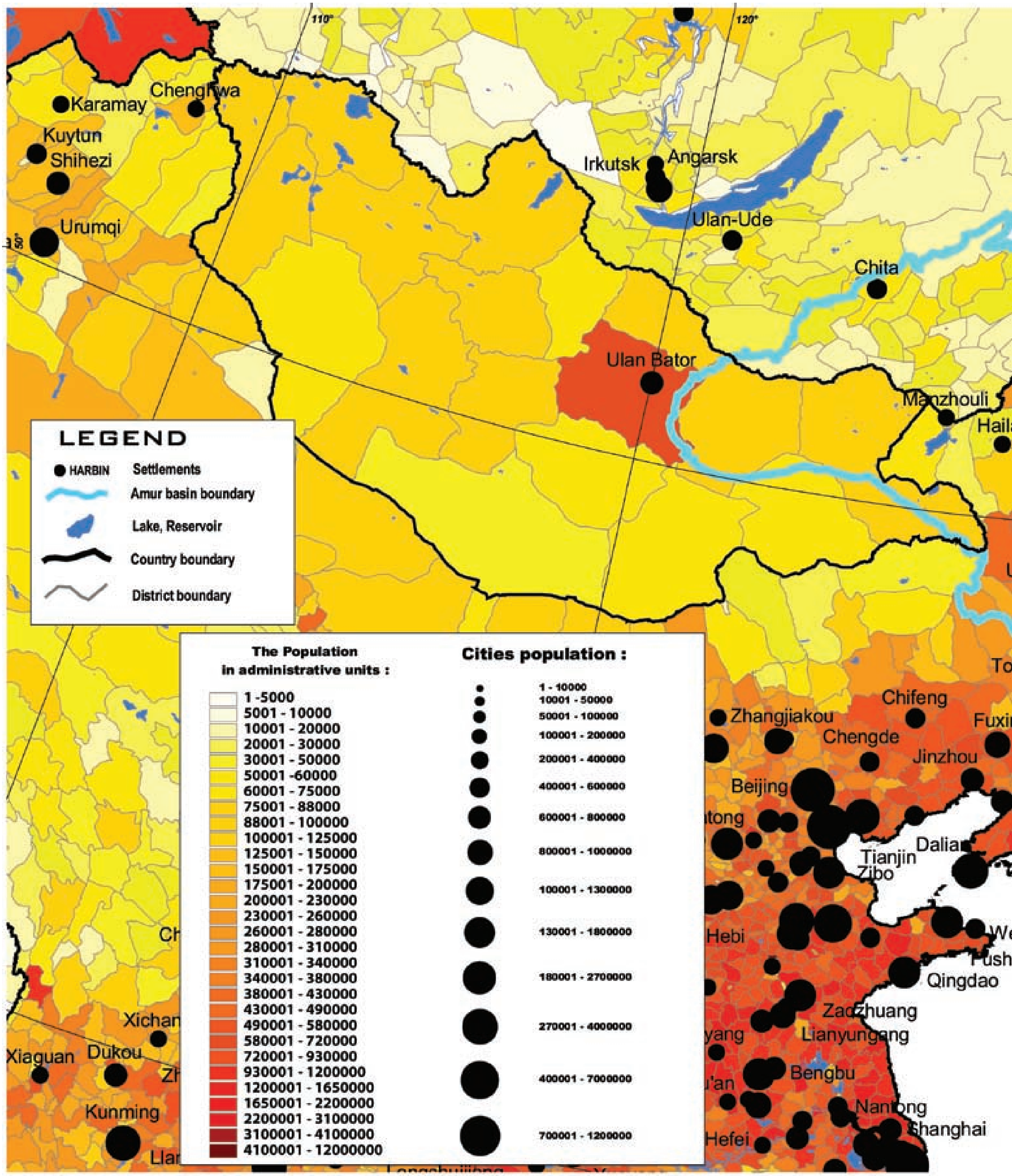
Nearly half of the very poor in the rural areas are ethnic minorities. Many of these minorities live below or close to the poverty line because of the remoteness of villages, poor natural conditions, low education, lack of marketable skills, and poor access to markets and social services. As a result, they have not benefited from the current economic growth; nor have they increased standards of living experienced by others. Per capita urban income is at least twice that in rural areas (Asian Development Bank 2005).

Several minority populations live in the region, 47 minority groups in Heilongjiang (6 percent of the population). Ten of these minorities (Manchu, Korean, Hui, Mongol, Daur, Xibe, Olunchun, Owenk, Hezhe, and Kirgiz) have long histories in Heilongjiang. Of the 56 minorities of China the Hezhe (Nanai) ethnicity is the smallest, and is found only in Heilongjiang Province (and adjacent Khabarovsky Province of Russia). The Hezhe minority occupies thee townships in Tongjiang and Raohe Counties in the lower reach of the Amur-Heilong and Ussuri-Wusuli Rivers. The total officially registered Hezhe population is only 1,363 (however Hezhe from Raohe insist the total number is closer to 4,000 people). The Hezhe traditional lifestyle is based on fishing and is now severely threatened by the decline in fish stocks and water pollution. The 43 minorities in Jilin Province represent 10 percent of the provincial population. The two largest minority groups are the Koreans and Manchu (each with over 1 million people). Inner Mongolia is a minority autonomous region with a 20 percent minority population. Among various groups in Inner Mongolia, the Mongols cover vast areas in search of grazing for their sheep and goats. The minority groups have a rich knowledge of and experience in grassland and natural resource management, including having local rules and regulations to protect forestlands.[1]

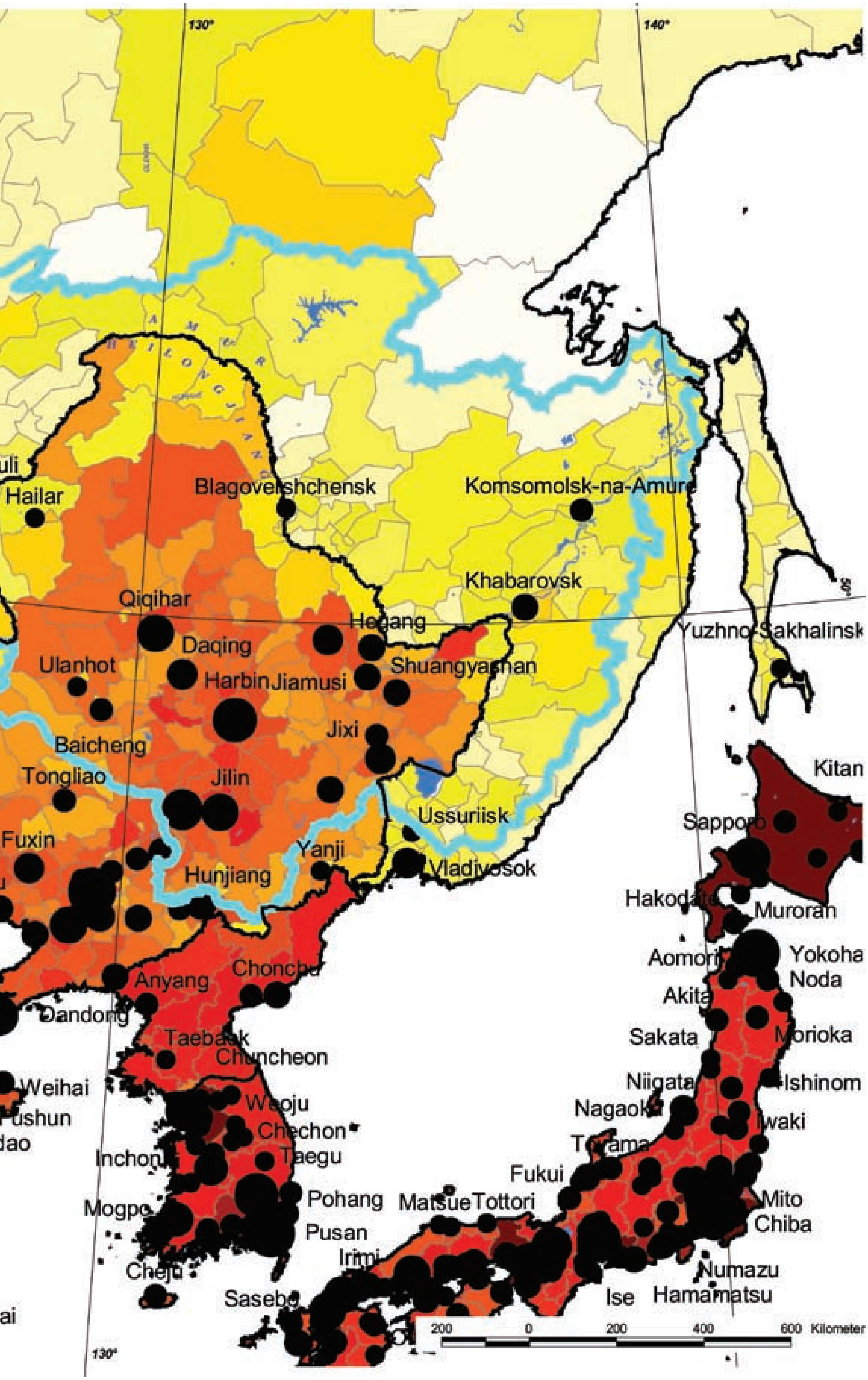
Economy

Annual GDP growth in China in recent years has ranged from 9-11 percent, somewhat lower than in the

[1] Zhang Weiping (edited), " The Contribution of National Minorities to Biodiversity Conservation", in *China's Biodiversity: A Country Study*, China Environmental Science Press, Beijing, 1998.



110°
120°
Karamay
Kuytun
Shihezi
Urumqi
Irkutsk
Angarsk
Ulan-Ude
Chita
Ulan Bator
Manzhouli
LEGEND
HARBIN Settlements
Amur basin boundary
Lake, Reservoir
Country boundary
District boundary
The Population in administrative units :
1 -5000
5001 - 10000
10001 - 20000
20001 - 30000
30001 - 50000
50001 -60000
60001 - 75000
75001 - 88000
88001 - 100000
100001 - 125000
125001 - 150000
150001 - 175000
175001 - 200000
200001 - 230000
230001 - 260000
260001 - 280000
280001 - 310000
310001 - 340000
340001 - 380000
380001 - 430000
430001 - 490000
490001 - 580000
580001 - 720000
720001 - 930000
930001 - 1200000
1200001 - 1650000
1650001 - 2200000
2200001 - 3100000
3100001 - 4100000
4100001 - 12000000
Cities population :
1 - 10000
10001 - 50000
50001 - 100000
100001 - 200000
200001 - 400000
400001 - 600000
600001 - 800000
800001 - 1000000
100001 - 1300000
130001 - 1800000
180001 - 2700000
270001 - 4000000
400001 - 7000000
700001 - 1200000
Zhangjiakou
Chifeng
Chengde
Jinzhou
Beijing
Tianjin
Zibo
Hebi
Qingdao
Lianyungang
Bengbu
Shanghai
Hefei
Xiaguan
Dukou
Kunming



previous decade of reforms but very high by world standards. State investment in infrastructure development (roads, dams, rails) and large industrial projects account for a significant part of this growth. The fastest increase in investments is observed in real estate development (up to 25 percent a year). Large construction projects are favored by the government partly because they help to fight unemployment, which is growing rapidly as a result of economic reforms and bankruptcy of inefficient enterprises.

Economic growth is very uneven, with the agriculture and forestry sectors lagging far behind industry and services (**Table 2.17**).

Local Economy and Economic Trends

China's northeast is considered a "gateway" to Russia and Northeast Asia. A good transportation network of inland waterways, railways, highways, and airlines provides access to the region, particularly to Harbin, Qiqihar, Daqing, Jilin City, and Changchun — the key centers of economic development. Harbin and Jiamusi are the principal ports on the Songhua River.

Changchun is the home of the automobile industry in northeast China. Other industrial concerns include chemical, food processing, and a host

Map 2.2 Amur-Heilong River basin human population in the 1990s

of secondary and tertiary industries. Jilin has become a key location for the national chemical industry, producing inorganic and organic chemicals. Harbin, Daqing, and Qiqihar have heavy electric, chemical, oil/gas, chemical fiber, plastic, lumber, and textile industries. Daqing is best known for its oilfields, the largest in China. Qiqihar has metallurgy, machine tool, gold mine, and other industries. The Sanjiang Plain is primarily agricultural, dominated by wheat, rice, and soy bean production by the State Farms, and the forest and lumber industries. Tourism potential is high but undeveloped. Coal mining is important in Hegang, Qitaihe, and other municipalities of Heilongjiang and is becoming an important sector in Inner Mongolia where 150 mines are already in operation in small Xing'anmeng Prefecture. Inner Mongolia ranks third in China in terms of mineral reserves. Inner Mongolia's economy is typically agricultural, limited terraced cultivation, combined with forestry and animal husbandry. The basin's economic development is a mix of heavy industries and industrialized agricultural. Modern agricultural equipment (small tractors, combine harvesters, multi-purpose tractors) is increasingly used for field preparation and harvesting. Nearly one fifth of agricultural land is irrigated, much lower than China's national average. Agriculture in central and southwestern parts of the basin in China is heavily dependent on irrigation. Cultivated land per person in the Amur-Heilong basin is two to three times the national average of 0.08 ha (1995) (0.24 ha in Heilongjiang, 0.24 ha in Inner Mongolia, and 0.15 ha in Jilin).[2]

Heilongjiang surpasses the other two provinces both in terms of GDP and annual gross value of industrial and agricultural output. This is mainly due to outputs of heavy industries and the largest oilfield in the country at Daqing. It has a larger land area than the other two provinces and has more natural resources.

The northeast region played a major role in modern China's industrial development. It produced the first steel, machine tools, locomotives, and planes after the founding of the People's Republic in 1949 and still has potential in these industries. The central government launched 150 state-level key heavy industry projects during the first several years after the founding of the PRC, one-third of which were built in this region. These projects were in the iron and steel, chemicals, heavy machinery, automobiles, and defense industries.

However, many of the traditional industrial enterprises were established in the 1950s when China operated under a planned economy. These have since become less competitive. At least 70 percent of enterprises in Heilongjiang, Jilin, and Inner Mongolia are state owned enterprises (SOEs), which are notoriously uncompetitive. Some have been losing money for nearly 30 years while China transformed its planned economy into a market economy.

The region's contribution to national industrial output has declined to 9 percent from its former high of 17 percent. Some declining SOEs have closed, resulting in massive unemployment. Mineral reserves in approximately 20 northeastern cities are nearly depleted, resulting in local economic crisis due to closure of the mines and associated service industries.

From 2000 to 2002, GDP per capita increased in all three provinces, reaching ¥8,893 ($1,112), which is 9 percent higher than the national average. Per capita GDP in Heilongjiang and Jilin is higher than the national average, while Inner Mongolia is slightly lower. The structure of the industrial sector in the three provinces is dominated by secondary industry. The share of primary industry in Heilongjiang is much lower than in the two other provinces and lower than the national average while secondary industry in Heilongjiang is higher than in the two other provinces and also higher than the national average. Total output for the secondary industry in the three provinces reached ¥388 billion ($48 billion) in 2002, accounting for about half of the GDP (see **Table 2.18** adapted from ADB 2005).

Policy for Revitalizing Old Industrial Bases of North East China

Since late 2003 China has considered the revival of northeastern industries as its third most important long-term regional strategy, following the opening of the southeast 20 years ago and the western development policy five years ago. This policy is focused on but not limited to Liaoning, Heilongjiang, and Jilin provinces and will be implemented at least through 2010.

Prime Minister Wen Jiabao chairs the Leading Group for Revitalizing the Northeast and Other Old Industrial Bases, which pushes for institutional innovation and reform of SOEs as the main path toward revitalization. He advised that the old industrial bases should

2 Provincial Statistical Yearbooks and China Yearbook

Table 2.18 Industrial sector comparison-2002

Economic sector	Heilong-jiang	Jilin	IMAR	Three province average	National
GDP per capita (Yuan)	10,181	8,478	7,291	8,893	8,158
Primary Sector (agriculture, forestry, fisheries) percent	11.5	19.9	21.6	16.1	15.4
Secondary Sector (industry and construction) percent	55.9	43.6	42.0	49.3	51.1
Tertiary Sector (transport, trade, communications, other services) percent	32.6	36.6	36.4	34.6	33.5

continue to develop those sectors that are well-adapted pillar industries, and strive to advance modern agriculture and consolidate a position as major grain producers and suppliers. The old industrial bases, Prime Minister Wen Jiabo suggests, should continue to open their economies to other parts of the country and the world. China aims to build the northeast into a national and even a world-class industrial base for equipment manufacturing and important raw materials.

China issued 11 special decrees and regulations to support implementation of this new policy. These provide special rights and preferences to participating provinces in value-added tax deduction, social insurance, and other easements.

In terms of resources, the central government has announced that it will issue development bonds worth ¥60 billion ($7.5 billion), to finance the revitalization of 100 projects in the three provinces. However, this represents only a small proportion of the funding necessary to realize the strategy: significant funding sources must be found from elsewhere, and it is hoped these will include direct investment (local and foreign). International commentaries of the plan suggest that the strategies are most likely to succeed by emphasizing the role of direct investment and strengthening the growing economic cooperation with countries of North East Asia, notably Russia, the DPRK, the Republic of Korea, Japan and Mongolia (ADB 2005).

General advantages of the northeast in implementing the new policy are seen in:

- the close integration of research and new technology development centers into planning and implementing economic policies and projects;
- good energy resource potential and prospects for expansion in thermal and hydropower both domestically and through imports from neighboring countries; and
- the formation of corporations able to compete in international markets.

Each province has its own advantages in the revitalization process. We omit Liaoning Province from this discussion because it lies outside the Amur-Heilong basin although it has the greatest economic potential in northeast China.

Revitalization in Jilin Province focuses on building five industrial parks, including automobile manufacturing, petrochemical, and high-technology. Private enterprises have been allowed to buy and own large industrial infrastructure and many administrative barriers inhibiting establishment of enterprises are being removed. By 2005, Jilin accomplished modernization of 816 state enterprises. In September 2005 an industrial exhibit "Jilin-North East Asia" was held in Chanchun with strong support from the State Council to publicize new policies welcome investments.

Heilongjiang Province set the establishment of six industrial bases as its target: equipment manufacturing, petrochemical and chemical industries, energy supply, agri-products processing, medicine, and forestry.

To date Heilongjiang's policy is most sophisticated and has been most successful in attracting investment from large trans-national corporations and other major investors. Siemens, IBM, Sony, and other global corporations participated in the official ceremony launching the new policy, which includes:

- Cooperation on real estate purchase and leasing, with easements for investors often framed as a municipal government's share of investment costs;
- Support to investors from outside the province through varying scales and durations of easements, particularly in water, electricity and gas supply fees;

• Further easements and preferential treatment for exceptionally beneficial investments in new and high technology development, deep processing, other unique benefits on project-by-project bases;

• Use of public funds as a share of capital for investment projects in identified priority areas;

• Drawing on savings of the populace to support new projects, through issuing stocks and other forms of financing;

• Increased cooperation with neighbors, first of all with Russia, Japan, the Koreas, and drawing investment from Hong Kong, Taiwan, and Macao;

• Development of a technology park in sub-urban Harbin; and

• Support of exporting enterprises by use of government funds for infrastructure development, insurance, anti-dumping litigation, and international certification of products.

In 2003, North East China (including Liaoning Province) and adjacent Inner Mongolia attracted $7.2 billion in foreign investment, with Heilongjiang alone attracting $1.3 billion. In 2004 Heilongjiang received $1.8 billion and Jilin about $1.5 billion in direct foreign investment. Total foreign investment in the northeast increased 83 percent between 2003 and 2005. Altogether in 2004 international corporations bought shares in 12 industrial enterprises, including a USA purchase of Harbin Beer, Korean and Japanese investment in Heilongjiang Longmei Mining Group, and Volkswagen's investment in Changchun.

In 2005 Jilin Province industrial enterprises had received $1.6 billion in investments, and its export trade volume totaled $7.5 billion. Total value of projects implemented by the Jilin workforce abroad has reached $300 million, while numbers of migrating workers reached 17,000.

Hong Kong is also an important investor in the northeast. Hong Kong investments in Jilin grew by 400 percent from 2004 to 2005, and the accumulated investment value reached $1.23 billion..

Heilongjiang Province has by far the largest economy in the Amur-Heilong basin. In 2005 the province GDP was ¥551 billion, and its enterprises received ¥179 billion in investments. Heilongjiang industry produced ¥270 billion in added value in 2005. Trade volume with the outside world came to $9.57 billion of which $5.68 billion was trade with Russia.

To coordinate activities and lessen negative consequences of competition, city governments of Changchun, Harbin, Dalian, and Shenyang signed an agreement entitled "On Cooperative implementation of the Northeast Revitalization Policy." The agreement covers many cooperative undertakings, including environmental monitoring, science and technology, building a high-speed Harbin-Dalian railway and East-East railway connecting a Russian border crossing with East Port in Liaoning Province.

In Heilongjiang Province, large projects such as diversification of the petrochemical industry, development of the Harbin-Daqing-Qiqiha'er industrial belt, and Sanjiang agricultural development are also intrinsic parts of the "revitalization strategy." The "Harbin-Daqin-Qiqiha'er Industrial Belt," for example, is a strategy to expand Harbin industrial capacity to western parts of the province, using lands already unsuitable for agriculture.

Although Inner Mongolia has received less attention in the "Revitalization" policy framework, one priority development is already underway to strengthen and diversify the Manzhouli transport corridor to Russian Siberia and the processing industries located there.

Strategic environmental assessment of the "Revitalization Policy"

All these new development policies and projects will have profound impacts on use of natural resources, levels of pollution, and development of transborder trade and infrastructure in the Amur-Heilong basin. In 2006, the Chinese Academy of Engineering in February released its report on "Some strategic considerations on water and land resources allocation, ecological environmental protection and sustainable development in northeast China" (CAE 2005). The following section presents a brief summary of the report (the report was published in ten volumes in early 2007).

The report was prepared in 2004-2006 by the Chinese Academy of Engineering on request of China's State Council to provide scientific guidance for State policy on "Revitalizing Old Industrial Bases of the Northeast" declared in 2003. The study area covered Liaoning, Jilin, and Heilongjiang Provinces, as well as four eastern prefectures of Inner Mongolia. The study area covered 1,240,000 km^2 and included 119 million people. Geographically it includes the Liao River (30 percent) and Amur-Heilong River (70 percent) basins.

The study area is not only an important industrial region but also includes China's largest timber production area, best grasslands, and largest center for grain production.

Inefficient development over many decades and rapid growth of production capacity has led to degradation of some industrial and agricultural resources and severe damage to the environment. The damage is most vividly manifested in: the exhaustion of timber resources, the degradation of grasslands, desertification and alkalinization, severe loss of black soils on arable lands, severe water pollution, drying of streams and rivers, over-exploitation of groundwater, loss of large areas of wetlands, and damage to mountain landscapes in mining regions.

The research concluded that the process of "Revitalizing Old Industrial Bases of the Northeast" will require early decisions to change means of increasing industrial production and building a resource-saving environmentally friendly society.

The research team consisted of 31 academics and 260 researchers, and was divided into 10 research groups: water resources and water supply; natural history and conditions; water and environmental protection; agriculture and land use; forest and wetland protection and forestry development; urbanization; mineral resources; mineral energy sources (coal, oil, gas); water pollution; and large water infrastructure projects. The results most relevant to the Amur-Heilong basin are summarized in the the six sections below under their original headings of water resources; water pollution; agriculture, soils, desertification and land degradation; forestry; urbanization; and strategy recommendations.

Water resources

Distribution of water resources is uneven across the basin. While in the Amur-Heilong River basin 5,505 m^3/year of water are available per person, this drops to only 1,789 m^3/year in the Songhua River basin, and, in smaller basins in Liaoning Province, to less than 500 m^3/year. In border rivers the index of water use is low, ranging from 1 percent in the Argun to 16 percent in the Amur-Heilong main channel. In contrast, in the Liao River water use is 67 percent, far exceeding a sustainable level. The average water use index is 24-27.5 percent, with 70 percent consumed by agriculture, 18 percent by industry, 8 percent by city dwellers, and 4 percent by rural households. From 1980 to 2000 total water consumption increased by 50 percent.

In the Liao River basin, 16 rivers dried completely, while in the Amur-Heilong River basin, the Huolin River and 5 other tributaries of the Nen and Songhua Rivers regularly run dry before reaching their river mouths. Overexploitation of groundwater is especially evident in urban areas of Harbin and Daqing, leading to water shortages, depletion of aquifers, and even deformation of the land surface.

In 2002, wetlands of all types occupied 101,700 km^2 or just over 8 percent of total land area, with 29,300 km^2 of lakes and watercourses, 65,700 km^2 of mires, fens and bogs, and 6,600 km^2 of maritime wetlands. Of these 45,200 km^2 are mountain wetlands (44 percent) and 56,500 km^2 are plains wetlands (56 percent). There were 30,000 km^2 of rice paddies. Total area of mires, fens and bogs in the Northeast has declined over 42 percent in 50 years from 114,000 km^2 to 66,000 km^2. Wetlands at Sanjiang, Momoge, Zhalong, and Xianghai are all drying up, severely threatening resources in corresponding nature reserves. Thus in 1949 the Sanjiang Plain had 53,500 km^2 of wetlands, and today it has only 13,000 km^2. Direct conversion to agriculture and dessication due to crop irrigation seem to be the two leading factors in wetland degradation in the Sanjiang Plain.

Wetland water demand could be met by various measures depending on the type of wetland. Large wetlands, like Zhalong, can and sometimes do receive water transfers through canals. Small riverine wetlands in the semi-arid zone could be sustained by altering reservoir management regimes in the headwaters. Wetlands on the Sanjiang Plain, can be saved only if surrounding irrigation systems change water supply sources from groundwater to the main surface channels or the Amur-Heilong and Ussuri-Wusuli Rivers. The current total water storage capacity of all kinds of freshwater wetlands is about 12.3 km^3, or 9 percent of the total water resource of northeast China. This should be taken into account when making water allocation decisions.

Maintenance of ecological functions of Songhua basin rivers and wetlands upstream from Harbin requires

14 km^3 in a dry year (41 percent of total flow) and 20-30 km^3 in an average year (45-60 percent of total flow). Analysis of data collected from 1956 to 2000 revealed that during 16 of these 45 years winter demand (550 m^3 per second) could not be met given the prevailing standards of water use and flow regulation. By 2030 the area of irrigated land is predicted to increase from 3.3 to 5.6 million ha, and total socio-economic water demand is to increase from 39 to 53 km^3. With this predicted increase the socio-economic water use index should not exceed 40 percent of total available volume to conserve in-stream flows for ecological functions. However, if all presently considered water infrastructure projects are implemented, the 2030 supply still falls 1.5 km^3 short of projected total demand. If economic growth is to continue at current rates, water conservation measures will be needed in addition to transfers of at least 2-3 km^3/year from the Huma River to the Nen River, plus future transfers from water-abundant boundary rivers. Several smaller projects are recommended to use Nen River waters for supply to Zhenlai District, Daqing and Qiqiha'er Prefectures, and development of irrigation systems adjacent to the newly constructed Ni'erji reservoir. On the Sanjiang Plain waters of the Amur-Heilong and Ussuri-Wusuli Rivers should be used for development of irrigation systems as a substitute for depleted groundwater. Water transfers should also facilitate replenishment and restoration of drying wetlands.

The Liao River basin faces a more critical situation with a current annual shortfall of 2 km^3. In 2003 only 6.6 km^3 of river flow reached the sea, far short of the required 10 km^3, a figure defined by ecological demand. The water shortage caused degradation of estuary ecosystems. It is proposed to transfer 1.6 km^3 from the Yalu River on the Korean border, 0.4 km^3 from the Nen River tributary Chao'er River, and 0.3 km^3 from a reservoir on the Second Songhua River to make up for the Liao River deficit. However without effective measures for saving and reusing existing water resources, these projects will not alleviate the shortage.

A "Scheme for comprehensive use of transboundary water resources of the Argun and Amur-Heilong transboundary rivers" was developed in the 1980s and was approved by China and Russia. It focused on joint development of hydropower totaling 55 billion kWh (of which 26 billion kWh would be technologically feasible). The scheme noted the severe lack of energy in northeast China, and concluded that this cooperative project should be implemented as soon as possible starting with building Taipinggou hydropower plant in Hegang prefecture on the Amur-Heilong main channel. It will be difficult to protect the free-flowing Amur-Heilong from such projects.

Water pollution

Water pollution is the most serious environmental problem in northeast China. Discharge of pollutants far exceeds the purification capacity of rivers, lakes, and reservoirs, damages aquatic ecosystems, severely affects water supplies of cities, and influences quality of ground water and even soils. Polluted runoff from farmlands increases continuously and will continue to do so because of the large reservoirs of nutrients stored in the soils that will be released slowly over decades if not centuries.

According to 2003 data from 72 monitoring points on the Songhua River 42 percent of samples had water quality of class 5 or worse (on a scale of 1 to 5 where 1 is best and 5 is worst). At Harbin's intake point for city water supply, water quality in the Songhua averaged class 4 and there is concern over the dangers of high concentrations of some organic substances and heavy metals. In groundwater beneath the Sanjiang Plain, 15 percent of the total area had water quality of classes 4-5, while beneath the Song-Nen Plain class 4-5 water quality was found in 28 percent of the area.

Official statistics show that 90 percent of industrial wastewater discharge is treated to standards, but this is unlikely. The main polluting industries are troubled with financial difficulties and restructuring, and have no capacity to install equipment for waste water treatment. The small and most polluting industrial facilities with high water consumption repeatedly re-emerge after being shut down for violations. As a result, prohibition of illegal wastewater discharge often fails. Industries known to produce massive pollution in other regions of China are moving their production facilities to the northeast, further complicating the situation.

Non-point source pollution has been long neglected and still has not been studied thoroughly. No reliable estimates are available of its contribution to total water pollution. Sources are farm fields, rural settlements, animal farms, solid waste dumps, and eroded land. Few methods are available to monitor and control these sources of pollution.

Agriculture, soils, desertification and land degradation

The northeast region has 25 million hectares of ploughed land, around 20 percent of the regional land area. One fifth of farmlands are irrigated (compared with the national average of 45 percent). Black soils occupy 11 million ha or 9 percent of the land area, and of those 8 million ha are reclaimed for agriculture. By 2003 the northeast had become the largest grain and bean production region in China, yielding 70 million tons of grain and beans. Of total national production the northeast produces 45 percent of soybeans, 34 percent of corn and nearly 10 percent of rice. Natural grasslands occupy 20 million ha, or 17 percent of the area, providing a suitable base for livestock breeding.

Land degradation takes many forms, including desertification, alkalinization, salinization, and erosion. Desertification affected 80,000 km^2 in three western parts of the Amur-Heilong basin: Ke'erqin (62,431 km^2), Song-Nen Plain (7,849 km^2) and Hulunbei'er (7,435 km^2) where rainfall averages less than 450 mm/year. This process is facilitated by the tertiary geological structure, where thick deposits of fine sand left at ancient lake beds are covered by thin soil layers. In the last 10,000 years the area changed many times from grassland to sandy semi-desert depending on climate fluctuations. In historic times livestock grazing, crop cultivation, and fire wood collection have also inspired the desertification of vast areas. Due to tree planting and grassland restoration, some limited success in reversing desertification has been achieved only in the south of the Ke'erqin area. Excessive planting of fast growing water-dependent trees like poplar has caused many additional problems and now many land managers have turned to shrubs and weeds to control moving sands.

Areas of salinization and alkalinization in the Song-Nen plain have reached 37,000 km^2, and the situation worsens as desertification continues. In the northeast, erosion is spread over 280,000 km^2, occupying nearly 23 percent of the total land area, and 34 percent of the black-soil zone, where approximately half of the black soil layer has been lost during the past 50 years.

Forestry

The Northeast includes the largest remaining forests in China. 56 million ha of forests occupy 46 percent of the total area, of which 44 million ha contain 3.4 billion m^3 of standing timber.

Forests were severely depleted prior to the 1980s, and today remain far from full recovery. The "Natural Forest Protection Programme," which is partly responsible for a nation-wide decrease in timber-production from 18 million m^3 in 1997 to 11 million m^3 in 2003, creates incentives to diversify the forest industry beyond timber production. It promotes wood processing, NTFP production, and forest tourism, and drives the forest industry to comprehensive use of natural productive potential of the forest ecosystem. But forest age structure was severely altered in the past, and continues to deteriorate, as does the quality of harvested timber. More than 60 percent of the present harvest consists of young and under-aged trees. This still exceeds the regrowth capacity of natural forests and cannot lead to sustainability in the future. Economic alternatives to logging are still in the early stages of development, often have poor technological foundations, and lack professional guidance. Finally, management of state owned forest industry bureaus, which combine all functions of business and government in one organization, leads to gross inefficiency of all reform efforts. This is further complicated by the overpopulation of forested areas by people earning low wages and suffering from high levels of unemployment.

Urbanization

China's northeast has reached a record of 47 percent urban population (versus the national average of 40 percent). There are 30 cities of more than half a million people. Heavy industry's share in this development is disproportionately high because the lure of jobs that have attracted many rural people to cities. This has led to huge economic and social losses during the reform period. Unemployment rose with the closure of many heavy industrial firms that were no longer profitable in the new market economy. Mining towns are exemplary: in four major mining cities of Heilongjiang Province 110,000 miners were without jobs.

Most large cities are aligned along the axis from Harbin to Dalian. On 8.5 percent of the total land area we find 30 percent of cities and 50 percent of the population of the northeast, with the urban populations almost 5 times denser than the national average. Inadequate water quality and quantity is one of main problems in the urban areas. By 2010 the proportion of urbanites in the northeast will increase to 55 percent, required municipal water supply will exceed 10 km^3, and municipal wastewater discharge will reach 7.4 km^3.

Strategy Recommendations

After research and policy review and analysis of the main topics, the CAE research team developed eight strategic recommendations for future development in the northeast:

1. Land use: Arable land area should not be increased; forest, grassland and wetland areas should not decline any further; and use of land for mining and urbanization should be controlled.

2. Agriculture: Given its obvious advantages the area should become the biggest grain producing region in the country (which it has already accomplished), with the proportion of irrigated land increasing where conditions allow.

3. Forestry: Continue along the already selected course of reforms and protections to ensure sustainability of forest use.

4. Urbanization: Healthy development of cities requires solving the crisis in water quality and geological dangers from coal mining.

5. Mineral resource base: Increase efforts in geological survey to ensure greater availability of mineral resources, increase mining operations in neighboring countries.

6. Water quality: Protect water quality and aquatic environments; prevent pollution as a major task of "Revitalizing Old Industrial Bases of the Northeast"

7. Water limitation in the west: The western part of the region needs measures to limit use of water for homes and industries, and to protect the water supply to maintain ecological functions.

8. Water reallocation for harmony with nature: Distribution of water resources should satisfy the needs of harmonious development of man and nature. Ecosystem carrying capacity is already exceeded by the levels of industrial and agricultural development in some areas. On the basis of comprehensive water-saving measures, we should carefully proceed with water transfer projects in priority areas.

In Part Four we discuss the possible consequences of these recommendations for the Amur Basin at large.

China laws and institutions for natural resource management

Legal framework for conservation and river basin management

The highest laws in the People's Republic of China are the constitution and the laws adopted by the Standing Committee of the National Peoples' Congress (NPC Standing Committee). The 1982 Constitution as amended in 1999 established fundamental legal principles that must be respected by all central and local government laws, policies, and regulations; the Constitution is the "law of the land." Deviation from the Constitution is not permissible, although reinterpretation of the Constitution in response to changing conditions is possible and provides some legal flexibility. Since its adoption in 1982, the Constitution has been amended a number of times to reflect changing conditions of the country, technology, and globalization. The most recent and perhaps most significant change with respect to natural resources occurred during the 2nd Session of the Standing Committee of the 9th NPC (March 1999) with the amendment requiring the application of the *"rule of law"* to implement the Constitution and all laws of the nation.

The Constitution contains three articles that specifically address natural resources. Article 9 provides that "all mineral resources, waters, forests, mountains, grasslands, unreclaimed land, beaches, and other natural resources are owned by the state…" except for forests, mountains, grasslands and unreclaimed land and beaches owned by collectives by law, and further provides that the "state ensures rational use of natural resources, protects rare animals and plants, and prohibit any forms of encroachment and damage to the natural resources by any groups or individual." Article 10 provides the fundamental principle that "land in cities is owned by the state," but "land in the rural areas and suburban areas is owned by collectives" including house sites and privately farmed plots of cropland and hilly land, except land that belongs to the state under the law. The Constitution further provides in Article 26 that "The state protects and improves the environment in which people live and the ecological environment. It prevents and controls pollution and other public hazards" and "the state organizes and encourages afforestation and the protection of forests."

China's systems of legislation and regulation are complex but can be classified into five general categories:

- National Laws adopted by the National Peoples' Congress;
- State Council Decrees;
- Ministerial Regulations and Rules;
- Provincial and local implementing regulations; and
- International Agreements and Conventions.

The body of law and regulation that addresses issues related to integrated river basin management (IRBM) covers water quantity and quality, land, environment, flood control, wildlife, nature reserves, wetlands, and biodiversity. In 2000 this body of law consisted of:

- 13 key Laws of People's Republic of China: Grasslands Law 1985; Land Law (amended) 1998; Mineral Resources Law (revised 1996); Flood Control Law of 1997, Environmental Protection Law of 1989; Forest Law of 1984; and Law on Land Administration of 1987;

- 37 State Council Decrees and Regulations: State Council General Order Strictly Protecting Rare Wild Animals, 1983; Regulations for Aquatic Resources Conservation, 1979; Temporary Regulations on Management of Scenic Spots, 1985; Regulations for the Implementation of the Fishery Law, 1987; Industry Policies for the Water Sector, 1997; Regulations for Protection & Admin. of Wild Medicinal Material Resources, 1987; Measures for Settling Disputes on the Ownership of Forest Tree and Woodland;

- 84 Ministerial/Inter-Ministerial specific regulations, directives and stipulations: Regulations on Water Quality Administration for Water Withdrawal Permit; Notice on the Administration of Water Withdrawal Permit System for International Cross Border Rivers, International Bordering Rivers, and Inter-Province/Region Inland Rivers; Managing measures of water conservancy statistics;

- 36 Provincial Regulations on water, related resources, environment and wildlife: Regulations of managing river courses in Heilongjiang; Regulations of managing water conservancy engineering; Regulations for Management of Grasslands in Inner Mongolia; Provisional Rules for Management of Wildlife in Jilin Province; and

- 15 International agreements and conventions: Ramsar Convention, to which China acceded in 1992); Convention on Biological Diversity (acceded in 1993); World Heritage Convention (China acceded in 1985); UN Convention to Combat Desertification (China acceded in 1994); Sino-Mongolian Cooperative Agreement on Conservation of the Natural Environment (1990).

Rapid economic changes and continuous reforms have led to frequent amendments in legislation and the development of new legislation and regulations at all levels. For instance, new land administration law was designed to coordinate the many agencies involved in preparation of the Overall Land Utilization Plan. This body of law is supported by numerous State Council Decrees, Ministerial and Inter-Ministerial Regulations and provincial regulations. One such provincial regulation is the Heilongjiang Provincial Regulation of Land Management. This was passed by the Standing Committee of Heilongjiang Provincial People's Congress on 8 December 1999 and took effect on 1 January 2000. The regulation specifies the ownership and user rights of the lands within Heilongjiang Province; specifies master planning of land use; emphasizes protection of croplands; specifies lands for infrastructure; specifies trade of land user rights; specifies authorities for supervision and inspection; and defines legal responsibilities.

China has an extensive body of law governing water and related nature and wildlife resources. There is also an extensive body of implementing regulations, and a full range of organizations to implement the laws. However, some regulations are ambiguous, inadequate, inconsistent, out-dated, or are lacking entirely. As a result, these regulations create legal gaps, cause overlapping or conflicting jurisdictions, contribute to poor standards, criteria, planning, and inadequacy of work programs. The unavailability or lack of access to data is a major constraint to the implementation of water and water-related laws, and to integrated basin planning, operation, and management. The current delegation of authority and responsibility under the laws and present organizational structures complicate implementation due to the confusion caused by overlapping responsibilities, institutional barriers, and the lack of capacity to implement and enforce.

Administrative structure and division of authority

The government in China is structured at four levels: national, provincial (including cities directly under the central government and the autonomous regions), county-district, and township-village. Prefectures-municipalities may exist for administrative purposes intermediate between the province and county. In China's Amur-Heilong River basin there are two provinces (Heilongjiang and Jilin) and one autonomous region (Inner Mongolia).

For the purpose of implementing laws or regulations, China has a well-developed system of agencies structured horizontally across the broad spectrum of natural resources and vertically from the central to local levels. The system of administration, in theory, covers all the bases of natural resource management, focusing on water, land, environment, and forests. In practice, the ways people use natural resources pose an almost insurmountable challenge to manage the resources sustainably. The laws and associated implementation agencies must be flexible and adaptable to adjust to varying geographic, geo-climatic, and economic development conditions.

The main national-level organizations with mandates that directly affect river resources, biodiversity, and the environment of the Amur-Heilong River basin are illustrated in **Figure 2.6** (adopted from ADB 2001). There are numerous other agencies with indirect involvement, such as the Ministry of Construction, which is charged with construction of some parts of the flood management infrastructure that impact watercourse operations, wetlands, and nature reserves. These have been omitted from **Figure 2.6**.

At the provincial level in Jilin, Heilongjiang, and Inner Mongolia, each of the key ministries has operational jurisdiction over its policies, laws, and regulations through the corresponding provincial departments (formerly bureaus). The following decision-making agencies at provincial, municipal, and county levels are particularly important in natural resource management: Environmental Protection Departments; Forestry Departments; Water Resource Departments; Agriculture Departments; Planning Commissions; Finance Departments; Economic and Trade Commissions; Land Management Departments; Education Departments; Farm Management Departments; and Poverty Alleviation Offices.

Water resources governance and management

Water management laws & institutions

Compared to many other nations China has a modern and extensive body of laws, regulations, and implementing agencies for water resources. If fully implemented, these would be sufficient to achieve sustainable management of water resources. Water and related laws in China have evolved from the early 1980s. A Water Pollution Control Law was adopted in 1984 and revised in 1996. This was followed by the 1988 Water Law that was further amended in 2000 and 2005. In 1989 the Environmental Protection Law was passed, to be followed by the 1991 Water and Soil Conservation Law, and the 1997 Flood Control Law. In 2003 new pieces of legislation envisioning more integrated river basin management were submitted to the National People's Congress or State Council.

Even the earliest pieces of legislation, such as the

Figure 2.6 China key government organizations for river basin management (Source: ADB 2001)

Water Law of 1988, contain many provisions essential for integrated river basin management:

Article 1: To control development, use and protect water resources, avoid water disasters, fully derive benefits from water resources, and meet the needs of national economic development and peoples' livelihoods.

Article 5: The State shall protect water resources and preserve natural flora, plant trees and grow grass, conserve water sources, control water and soil losses and improve the ecological environment.

Article 6: Governments at various levels shall prevent water pollution.

Article 7: Water allocation to be planned and water strictly conserved. Advanced technology to be used to conserve and recycle water.

Article 9: Unify water resource administration under the State Council.

Article 10: Base water resources management on science.

Article 11: Planning shall be undertaken with river basins or regions as basic units. Plans to be formulated by the department of water administration under the State Council in conjunction with agencies of provinces, autonomous regions and municipalities directly under the Central Government. Plans shall be approved by the State Council. Plans shall be coordinated with the National Land Plan.

Article 15: Develop irrigation, drainage and water and soil conservation according to local conditions to promote stable and high agricultural yield. In dry areas, adopt water-saving irrigation.

Article 21: For inter-basin diversion, integrated planning and scientific justification must be undertaken, considering water demands of both basins, and adverse impacts on the ecological environment must be averted.

Article 27: Reclaiming parts of lakes or river beaches for farmland is prohibited. In case of necessity, scientific justification is mandatory and must be approved by government at or above the province level.

Article 31: In runoff regulation and water allocation, consider water demands from upstream and downstream, both sides of the river, and bamboo and log rafting, fishery and ecological protection. Allocation plans to be formulated by government at the next higher level after consulting with the local governments, and to be implemented after approved by government.

Article 50: Any department representative who neglects his duty, abuses power, plays favoritism or commits irregularities, shall be punished; whoever causes heavy losses to public properties or to interests of the State and the people shall be investigated in accordance with Criminal Law.

Article 51: Where an international treaty or agreement to which China is a signatory is relevant to international and border rivers or lakes, and, provides differently from the law of the PRC, the provisions of the international treaty or agreement shall prevail, with the exception of those clauses on which China has declared reservation.

The Water Law of the People's Republic of China was adopted at the Twenty Fourth Meeting of the Standing Committee of the Sixth National People's Congress on January 21, 1988. The Water Law was substantially revised in 2000-2, approved by the National People's Congress in August 2002, and became active on 1 October 2002. The revised law requires improved efficiency in water use. It highlights saving, protection, and wise use of water resources to promote balance between resources, social, and economic development, and the environment.

Mandate of the Ministry of Water Resources

In accordance with the stipulations of the State Council of China, the Ministry of Water Resources (MWR) is given the mandates listed below (For current policy concerns of MWR see water use section of Chapter 3).

1. Formulate water-related policies, development strategies and plans, including water conservation and demand management.

2. Draft and implement enabling legislation and design water regulations. Implement the water-drawing permit system and the water fee system, and mediate and arbitrate inter-sector and inter-province water disputes.

3. Implement integrated management of water resources, including atmospheric water, surface water and groundwater. This includes:

- formulate national and inter-provincial development plans for water supply, demand and allocation;

- supervise implementation of the above plans and schemes;

- assess water resources, flood risk and flood mitigation measures in relation to overall planning for the national economy, urban planning and major construction projects;

- publish research and developments in hydrology; and

- guide national research and development in hydrology.

4. Formulate water resource protection plans in accordance with national laws, regulations and standards concerning resource and environment protection; demarcate functional water areas and control discharge of wastewater to water areas; monitor the quantity and quality of water of rivers, lakes and reservoirs, review and approve the pollution loading capacities of water bodies and propose limits for wastewater discharge.

5. Formulate economic regulatory measures for the water sector; exercise macroeconomic regulation on use of funds in the water industry; provide guidance to economic activities related to water supply, hydropower and diversified development within the water sector; recommend economic regulation of water pricing, taxation, credit and financial affairs.

6. Draft and review proposals and feasibility study reports on large and medium-sized capital construction projects in the water sector.

7. Draft and supervise the implementation of technical standards for the water sector and specifications and codes for water works; implement key hydrology research projects and popularize and disseminate water-related technologies.

8. Protect hydraulic facilities, water areas, dykes and coasts, and manage regulation, reclamation and development of major rivers, major lakes and beaches; handle foreign affairs in relation to international rivers between China and its neighboring countries; construct and manage key controlling and inter-province hydro-projects; direct the monitoring and management of the safety of reservoirs and dams of hydropower stations.

9. Provide guidance on rural water resources; organize and coordinate capital construction of farmland drainage and irrigation, rural electrification, and water supply for townships and villages.

10. Organize water and soil conservation nationwide.

11. Manage science, technology and foreign affairs related to water resources, and develop a competent work force for the water sector.

12. Manage the State Flood Control and Drought Relief Headquarters, organize, coordinate, supervise and direct nationwide flood control, and execute operations of flood control and drought prevention for major river basins and key water projects.

Song-Liao Water Resource Commission

The Song-Liao Water Resource Commission (SWRC) is an agency of the Ministry of Water Resources with responsibilities in the Amur-Heilong, the Liao, the basins of international rivers, and the rivers draining directly to the sea in northeast China (i.e. Tumen and Yalu Rivers). It is one of seven such water resource commissions in China. The state government empowers the commissions to exercise their administrative functions and powers within drainage basins. The SWRC serves to manage the water resources and river courses of the basin in a "unified" manner and is responsible for "comprehensive harnessing, developing and managing major water control structures, doing the planning, management, coordination, supervision, and service to promote river harnessing and the comprehensive development, utilization and protection of water resources". The SWRC has the following functions (**see Figure 2.7**):

- Implementation, supervision, and inspection of the "Water Law," "Soil and Water Conservation Law," and other laws and regulations; draw up policies, laws and regulations for the basin.

- Formulate a strategic water resource development plan and mid- and long-term master plans for Song-Liao basin jointly with the related agencies and provincial and regional governments; supervise and implement the master plans upon their approval.

- Manage water resources of the Song-Liao basin in a unified manner; monitor, survey, and assess water

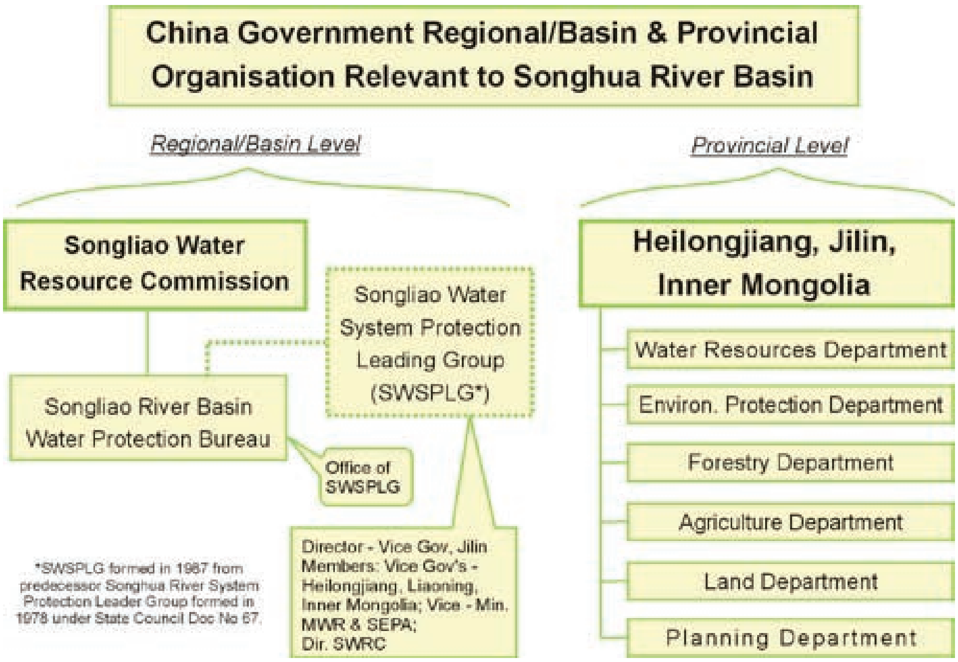


Figure 2.7 SWRC and provincial water management organizations, showing the two coordinating bodies associated with the SWRC with members from the three provinces- Song-Liao River Basin Water Protection Bureau and the Song-Liao Water Systems Protection Leading Group (ADB 2001)

resources in the basin; draw up a long-term inter-provincial and inter-regional water demand and supply plan and water allocation plan for the basin, supervise and manage the plan; administer the implementation of the water withdrawal permit system; supervise and manage protection of water resources within the basin.

- Manage the rivers, lakes, river mouths, and beach lands in a unified manner; manage river courses.

- Formulate and review plan(s) for flood control for the basin and the international river basins; coordinate flood and draught control; advise on safety and construction in the flood storage and detention areas.

- Manage water disputes between agencies, provinces, or provinces and regions.

- Manage soil erosion and advise communities on soil and water conservation.

- Review proposals, feasibility study reports, and preliminary designs of projects; draw up annual proposed plans for investments for the basin by the MWR and implement plans upon their approval.

- ”Comprehensively harness and develop” the basin including river mouths; construct and manage key water structures and major inter-province/region water works; work with related agencies on water cooperation and foreign affairs concerning international river basins.

- Advise with regard to local rural water conservancy, urban water conservancy, water works management, hydropower, and rural electrification.

The Song-Liao Water Resource Commission coordinates the provincial governments in the Northeast region (Liaoning, Heilongjiang, Jilin, and Inner Mongolia) to implement the Water Law and regulations and protect the water resource in the Northeast region. SWRC cooperates with many agencies but lacks the authority to command any of them. The structure of the water management sector suggests that all water departments of provincial and local governments are subordinate to SWRC to some extent. However, to a much greater extent they are linked to their own provincial or local governments. This means that SWRC must work through many links between agencies and committees to manage water in the basin.

Interesting enough, it is forestry rather than the water sector that takes charge of wetland management. Although there is a network of specialized wetland management bureaus in forestry offices, these are not directly related to SWRC, the basin water resource commission (**Figure 2.7**). Besides the Songhua basin proper, which requires most of its attention and effort, the SWRC is also responsible for all other tributaries of the Amur-Heilong draining through China. The scope of issues faced by SWRC is defined by natural features and economic development patterns of the basin. Water in most basins is typically in short supply for half of each year. There are frequent droughts and occasionally dramatic floods, such as in 1998.

With continued economic development and population increase the need for water increases proportionally. In 2000, water demand exceeded supply by 2.5 km^3, and by 2005 this discrepancy approached 4 km^3. During the dry-season, water allocation must be prioritized among competing users. Logically the priority is to supply water to towns for domestic and industrial use. Agriculture is also a priority, as is the need for minimum river flows for navigation. Previously there was no legal provision for allocating water to wetlands and other natural areas: Regulations allocated water rights only to economic activities. A growing understanding of the ecological importance of wetlands has recently resulted in change of policies. Prior to 2000 water was only allocated to wetlands for reed production and fisheries, but since 2000 many wetlands have received an "ecological supply" of water delivered through a system of canals.

Water pollution in the basin is more serious than in most other basins in the nation, with Songhua River water quality declining year by year. Management of water supply and water utilization is still inefficient and there is serious waste of water. The cooperation for water management between the provinces on the one hand and the various administrations on the other is complex and difficult. SWRC has no formal communication with its Russian peer ABWMA, thus there is currently little scope for transboundary cooperation in the management of water pollution in border rivers. In 2004 the government budget allocated to water projects within the jurisdiction of SWRC was ¥3.2 billion ($400 million) compared to US$7 million spent in the Russian Amur Basin.

Agriculture

History of development

Agricultural development in northeast China has been the highest priority over the past 250 years. For example, land reclamation on the Sanjiang plain started in 1743 when a public granary of 450 hectares was established to provide assistance to the armies. By the end of the 19th century, grain from northeast China was already out-competing domestically produced grain in the Russian Far East. However, agricultural development was not accelerated until after 1949.

Large-scale land development began in the early 1950s, just after the foundation of the People's Republic of China. In 1954, the Soviet Union provided a grant to China to establish a farm of 20,000 hectares named Friendship Farm in Youyi (Friendship) County in the western part of the Sanjiang Plain. This was the first large mechanized state-owned farm and one of the 177 large projects funded by the Soviet Union in China during the 1950s.

Since the 1950s northeast China's "Great Northern Wilderness" has become a key grain-producing region and is listed as one of eight national bases for grain production in China. National priorities for agricultural development have been the main force driving conversion of wetland to farmland. During the early stages of development, the great northern wilderness was critical for rebuilding an economy destroyed by civil war. From the 1950s to the mid-1960s the Chinese government issued policies to stimulate agricultural development, including creating the agricultural cooperatives (1953), the Great Leap, and People's Commune (1958). A fundamental intention of these aggressive policies was to stimulate agricultural production by expanding the size of the production units. Building on this foundation, agricultural development in newly developed areas like the Sanjiang Plain focused on establishing large state owned farms. In 1956 the Party Committee of Heilongjiang Province developed criteria to specify the size and capacity of the new farms. One result was to encourage local governments to convert more wetlands to larger farms. By 1956 Heilongjiang Province had converted over 266,000 hectares of wilderness to farmland.

A second important factor that speeded agricultural development of the Sanjiang Plain in the 1950s was the end of the Korean War. The demobilized armies were sent to the sparsely populated northeast to satisfy the demand for farm workers and implement the policy for development of the agricultural sector.

International aid has made important impacts on development in various ways from the "Friendship Farm" funded by the former Soviet Union to the Japanese funded Honghe Farm to the farms aided by World Bank loans. Even in proposals prepared by local authorities, agricultural development was defined as the primary measure to guarantee national security. All factors mentioned above (the development of large areas, quasi-military management, introduction and utilization of

Table 2.19 Grain production in northeast China compared to China as a whole (NEC includes Liaoning Province, outside the Amur-Heilong basin)

Item	China	NEC*	NEC as percent of China total	Heilongjiang percent national/national rank	Jilin percent national/ national rank
Area ('000 ha)					
1985	17,694	4,454	25	8.9 / 6	9.5 / 3
1999	25,904	6,705	26	10.2 / 3	9.2 / 4
Production ('000 tons)					
1985	63,826	16,532	26	6.5 / 7	12.4 / 2
1999	128,086	39,064	31	9.6 / 3	13.2 / 1
Area ('000 ha)					
1985	32,070	1,194	4	1.2 / 15	1.0 / 16
1999	31,284	2,582	8	5.2 / 10	1.5 / 17
Production ('000 tons)					
1985	16,857	6,100	4	1.0 / 16	1.1 / 15
1999	19,849	17,648	9	4.8 / 10	2.0 / 16

Source: Motoki Ya. Changes in the structure of agricultural land use in Northeast China, with special reference to the role of rice paddy production. Study on the processes and impact of land-use change in China: Final report of the Land Use for Global Environmental Conservation (LU/GEC),2nd phase (1998-2000) / NIES. Tsukuba, Japan, 2002. P. 131-145. (http://www.cger.nies.go.jp/lugec/Report_percent20IIXpercent20Contents.htm)
*NEC = Northeast China
Adopted with adjustments from Karakin and Sheingaus 2004

advanced equipment, and strong political commitment) have been the dominating forces in the development of agriculture in northeast China (Anon 1984).

However, intensive development has not yielded the anticipated economic benefits. Most large state-owned farms have incurred heavy debts imposed by the international and domestic banks. For example, Honghe Farm, established in the early 1980s with a loan from Nichimen Corporation and formerly considered a model of international cooperation in converting wetlands, has incurred debts amounting to over $12 million. Although this burdensome debt situation is caused by many factors, it suggests that conventional farming on converted wetlands is of questionable profitability based on traditional economic evaluation.

Recent status

In the late 1990s agricultural crop production entered an "adjustment period" during which the most advantageous crops and methods of cultivation in each region were identified and promoted. For instance, for Heilongjiang Province rice, maize (corn), and soybeans were identified as the most promising crops and their cultivation was assigned top priority. In practice this type of adjustment often led to a decline in the variety of crops cultivated in a given area.

A distinctive regional advantage of northeastern agriculture is its relative "environmental quality." In comparison with other Chinese provinces fewer synthetic agrochemicals are used in plant cultivation and livestock feeding. The region is known for "organic produce" and its products are valued for "natural quality" in Beijing and overseas. The production of "green products" receives serious attention at the level of the provincial government and has received investment from Hong Kong, Japan, and other economically developed areas.

Despite the intention of making soybean a primary crop, maize, rice, and wheat are the three main crops, with wheat acreage steadily declining and rice acreage steadily increasing (also see Part Three section on climate change). **Table 2.19** shows yields from the northeast as a significant share of China's total grain production. Soybean is also widely cultivated. The range of crops in northeast China is much broader than in RFE and includes crops such as peanuts and tobacco.

Although agriculture continues to occupy a priority position in overall national development, it is not keeping pace with the growth of other sectors. Annual production of grain declined in 2000-2003. In 2000, with a view to meeting standards imposed by its impending admission to the WTO, China began phasing out procurement prices that guaranteed fixed incomes to grain farmers. Due to this and world market pressures on prices, profitability from grain farming has declined and large grain areas have either been converted to cash-crops or left fallow. China's production of wheat, corn, rice and other food grain dipped from a record high of 512 million tons in 1998 to 435 million tons in 2003. Grain output reportedly fell by as much as 59 percent in northeast China (Heilongjiang, Jilin, Liaoning and Inner Mongolia) for spring wheat production (Lasserre 2003). As a consequence per capita net income of rural workers in Heilongjiang, Jilin, and Inner Mongolia declined for four consecutive years to around ¥2000 ($250). This compares to over ¥3,500 ($438) in Jiangsu and Guangdong Provinces where farmers focus on cash crops.

Grain First! Policy

In late 2003 the government of China implemented measures to increase national grain output to 455 million tons by 2004. This target was surpassed. In Heilongjiang Province total grain output reached 31.35 million tons in 2004, a yearly increase of 6.23 million tons or 25 percent, eclipsing the record high production of 1997. In 2004 grain producers were exempt from agricultural tax, received assistance to improve irrigation, received new technology and quality seeds, and even received direct subsidies based on planted area. Jilin Province implemented tax easements recently granted by the National Tax Bureau:

- peasants producing agricultural products were fully exempt from personal income tax;
- low-income peasants paid no added value tax; and
- street merchants in rural areas were not required to be licensed.

Another key measure was a sharp rise in grain prices, which were then controlled by government: average grain prices were increased by 20 percent year-on-year, adding nearly ¥3 billion ($360 million) to farm incomes. According to provincial authorities the per capita net income of grain farmers reached an unprecedented ¥3,000 Yuan per year ($360). In 2005, Heilongjiang Province had 9.3 million ha planted to crops, with 87 percent of that in grain. That acreage produced 36 million tons of grain. Livestock industry output in the same year was worth ¥46 billion ($6 billion). Income per rural dweller equaled ¥3,221 ($400). In addition to the increases in grain production and incomes, an obvious result of the first two years of this new grain policy was increased pressure on natural ecosystems, especially floodplain wetlands. Much of the grain production is happening on former wetlands of the Sanjiang Plain in northeast China.

North East Asia agricultural cooperation

Much of the agricultural produce of northeast China is exported to developed countries of the region. After entering the WTO, farmers in northeast China must meet strict standards for chemical residues on agricultural products in international trade. This might slow the growth in exports of agricultural produce. Excess chemical fertilizer use increases product cost and decreases net income of farmland by 10 percent to 30 percent (ADB 2005).

This is already an issue in the case of exports from Jilin to Japan. Japan's government adopted stricter standards for residual chemicals (insecticides, metals) in imported produce from May 2006. While the old standards related to 130 types of products and 9,000 substances, new stricter standards would regulate 135 types of products and 19,000 substances. Most agricultural producers currently exporting to Japan would not be able to meet the new requirements. The adjustment period will take approximately three years and positive results cannot be guaranteed because of residual soil and water contamination from the previous use of agricultural chemicals. One solution would be to shift the cultivation of produce destined for Japan to developing Chinese agricultural enclaves in Primorsky or other Russian provinces where soils are less contaminated. The produce from northeast China that does not meet Japanese standards could then be exported to Russia and other countries that lack such strict regulations.

A second example of cooperation in agriculture comes from the Heilongjiang Agriculture Institute, which is involved in a wide ranging cooperative programs with a variety of Russian partners. Part of this program is to transfer new Chinese agricultural technologies and crop varieties to Russia.. Another component of this plan is the implementation of Russian innovations in China. Since 1992 the Institute has distributed a growth stimulator for soy bean that was invented at the Russian Institute of Soya Crops. The application of this growth stimulator already yielded economic benefits totaling $19 million in China.

The underlying reason for agricultural cooperation is the relative scarcity of land for agriculture in Northeast Asia. Most such lands are located in the Amur-Heilong basin. A model of future demand for and supply of food is described in **Box 2.1**.

BOX 2.1 Land-use modeling for China conducted by International Institute for Applied Systems Analysis

Hubacek and Sun (1999) predict that over next 30 years China will be unable to support increased demand for land-intensive products without a significant improvement in land productivity and/or increasing imports. Their model considers scenarios based on combinations of generally accepted predictions for population growth, changes in lifestyles, levels of migration, and economic growth for the next 30 years, and demonstrates how these might affect demand for different types of land in China. The modeled increases in consumer and producer demand and sectoral outputs would cause land requirements to exceed the available land area. The most severe shortfall would be for cropland, which is a consequence of population and economic growth, as well as the enormous anticipated increase in demand for livestock products and feed-crops. Assuming that China continues to strive for self-sufficiency in grain and food, and that adequate expanses of new farmland will not be available, productivity on existing farms must increase at an annual rate of about two percent, a rate higher than generally foreseen during the coming 30 years. Furthermore, greater productivity is also required to compensate for the loss and degradation of available land. With reforestation and improved soil management, the chances of substantially eliminating erosion have increased. The loss of cultivated land, forestland, and grassland, especially around urban areas, poses a severe problem in many provinces. Because of uncertainties over the effect of climate change, it was not included in the forecast. There is no agreement in the literature on how climate change will affect the various regions of China. For example, recent findings of NASA indicate that land productivity in the North, the North-East, and the North-West will be positively affected by climate change, whereas south China might face negative effects on land productivity (Tang et al. 1999).

Fisheries in Heilongjiang Province

Heilongjiang Province is the second largest producer of freshwater fish in northern China, second only to Liaoning Province. Heilongjiang has 654,000 ha of water bodies suitable for fisheries and aquaculture. The province is rich in fisheries resources with 105 species of fish, of which 40 species are economically valuable and more than 30 species are cultured. These include common carp, crucian carp, grass carp, silver carp, spotted silver carp, and black carp. In 1991, the composition of provincial cultivated fish species included spotted silver carp and silver carp (accounting for 56 percent of total provincial fish output), common carp (27 percent), grass carp (8 percent), crucian carp (7 percent) and other species accounting for 3 percent. Large–bodied, wild, economically important fish are becoming less abundant. Some species have disappeared entirely.

There is a rich but overexploited water resource in the Songhua River basin and portions of the basin are used for aquaculture. Since 1949 the fishing industry in Heilongjiang Province developed rapidly, increasing output from 16,500 tons in 1952 to 320,000 tons in 1997. Of the 1997 total, 270,000 tons (81 percent) were from fish farms and the remaining 50,000 tons (19 percent) from natural rivers and lakes.

The fisheries sector plays an increasingly important role in the economy of Heilongjiang Province. It contributes not only to Provincial income, foreign exchange earnings, and employment, but also to food security and nutritional needs of the people. The value of aquatic products accounted for about three percent of the total value of agricultural output in 2002. Export earnings from the fisheries sector reached $1.5 million in 2002, while 159,000 people are employed in the sector and 259,000 people of 74,000 households earn incomes from fisheries and aquaculture.

The share of the fisheries sector in the gross value of agricultural output rose from less than one percent before the mid-1980s to about three percent after 2000 (**Table**

Table 2.20 Composition (percent) of agricultural output value, Heilongjiang Province, 1980-2002

	1980	1985	1990	1995	2000	2002
Farming	81	74	75	74	66	63
Forestry	4	6	3	2	3	2
Livestock	14	19	20	22	28	33
Fisheries	<1	1	2	2	3	3
Total	100	100	100	100	100	100

Source: Heilongjiang Provincial Bureau of Statistics.

2.20). Despite its small share of total agricultural output, the fisheries sector has grown rapidly for the last two decades.

The rising fisheries sector is accompanied by significant structural change in fisheries and aquaculture. Captured-fish production accounted for 86 percent of total production in 1970, declined to 40-50 percent in the mid-1980s, to about 30 percent in the early 1990s, and remained at less than 20 percent after the mid-1990s (**Table 2.21**). In contrast to the declining share of captured-fish production, aquaculture production has increased from less than 15 percent in 1970 to 68 percent in 1990, and nearly 88 percent in 2002.

Technological change was the main engine for the rapid growth of the fisheries sector in Heilongjiang Province during the last two decades. The province has a strong fisheries research system that has generated technologies adopted by thousands of fishermen to meet the increasing demand for fish. Fisheries research is generally conducted in public institutions. The province had about 160 professionals who engaged in fisheries research at six public fisheries research institutes in 2002. Fisheries technology extension work is usually coordinated by the Fisheries Bureau of Heilongjiang Province. There were a total of 69 fisheries technology extension stations with 463 personnel in 2002 throughout the province. The provincial fisheries technology extension system is designed to provide technical assistance, professional training, information exchange, disease control, breeding and introduction of fry.

Table 2.21 Changes in the structure (percent) of fisheries production 1970-2002

Year	Capture fishery percent	Culture fishery percent
1970	86	14
1975	77	23
1980	56	44
1985	46	55
1990	32	67
1995	21	79
2000	15	85
2002	13	87

Source: Fisheries Bureau, Ministry of Agriculture, PRC and Heilongjiang Provincial Fisheries Bureau

To regulate fishing intensity and promote sustainable development of the fisheries sector in Heilongjiang Province, the Fisheries Bureau planned to reduce the number of fishing boats from 5,200 in 2000 to 4,000 by 2015. There is, however, no provision to limit the tonnage of catch per boat, the types of equipment permitted for use, or the duration of the fishing season. International agreements on fisheries have been signed, implemented, revised, and updated over recent decades between China and the Russian Federation.

Declining Fisheries in the Sanjiang Plain

The salmon catch in China declined from 1.3 million fish with a total weight of 4,501 tons in 1963 to an average 0.2-0.3 million fish before the mid-1990s, and 20,000-30,000 fish after 1996, and 10,000 fish in the final years of the last decade. The main reason for this rapid decline in production is depletion of wild salmon stocks caused by over-fishing in both China and Russia.

It is impossible for China acting alone to protect and recover salmon resources because of the effects salmon reproductive biology combined with the political geography and fishing practices in the Lower Amur River. Salmon are anadromous fishes, maturing at sea and breeding in freshwater in the Lower and Middle reaches of the Amur-Heilong. Before the mature fish can arrive at their upstream breeding habitats in waters shared by China and Russia they must navigate the Lower Amur River, a reach 1,000 km in length from the Pacific Ocean upstream to the confluence of the Wusuli-Ussuri and Amur-Heilong at Khabarovsk. The lower reach of the river is entirely in Russian territory and it is here that Russian fishermen can capture salmon during their spring upstream migration before they reach the middle and upper reaches of the basin. Until the governments of Russia and China (and Mongolia when considering taimen and lenok) are all cooperatively involved in salmonid research and management in all reaches of the river system, the issues of salmonid migration, political boundaries, and unilateral fishing practices will continue to hold the entire salmon fishery at risk of collapse.

The Amur/Heilong River is the main habitat for Kaluga sturgeon (*Huso dauricus*) and Amur sturgeon (*Acipenser schrenckii*), both of which are generally called sturgeon. These two species have been over-fished to the extent that they have both been designated by IUCN World Conservation Union as globally endangered.

The region near the Amur-Heilong River is the largest sturgeon producing area in China with a current annual output of more than 100 tons. The catch of sturgeon fell from 452 tons in 1987 to 140 tons in 2002. Few sturgeon can now be found in the Ussuri/Wusuli and the two species are thought to be extinct in the Songhua River. Both rivers supported sturgeon in the recent past.

Wild Amur sturgeon is the major source of fry for sturgeon aquaculture throughout China, accounting for 70 percent of all fry used for cultivation. The major cultured species in China, *A. schrenckii*, *H. dauricus,* and hybrids of *A. schrenckii* × *H. dauricus* (or reverse cross), are derived from artificial propagation using wild spawners caught in the Amur-Heilong River. Adult sturgeon caught by licensed fishermen are collected by hatcheries, which produce caviar in addition to sturgeon fry. Some fish are selected for breeding and the rest are processed for caviar. The largest facility is located in Fuyuan, Heilongjiang Province, produces 10 million fry, and has a total capacity of 30 million fry. In total, 26 million and 43 million fertilized eggs and fry of Amur sturgeon or Kaluga/Amur hybrids were produced in Heilongjiang in 2001 and 2002, respectively. The survival rate of fertilized eggs to fry is estimated at around 50 percent.

Every spring and summer since 1998, fertilized eggs, embryos, or fry from Heilongjiang (from one of seven hatcheries) have been delivered to south and central China by air. Fingerlings are reared primarily in Guangdong, Fujian, Hubei, Shanghai, Jiangsu, Beijing and Shandong and then sold or distributed to sturgeon farms.

All cultured Amur and Kaluga sturgeons and their hybrids were spawned in Heilongjiang from eggs obtained from wild fish. Most fertilized eggs are quickly transported to provinces in the south of China for incubation. Despite the government requirement for licenses for transportation, culture, and sale of sturgeon, obtaining detailed information on the transporting process and distribution is difficult.

The quantity of sturgeon produced by aquaculture in China appears to have been the largest in the world since 2000. Estimated total capacity of production from all aquaculture facilities combined is about 15,700 tons of fish averaging 0.75 kg each. Hybrids are reported to have faster growth thus are preferred by fish farmers. The current annual fingerling production for all sturgeon species and hybrids is about 18 million, and the captive biomass of fish over one year old is about 1,500 tons. This accounts for nearly 40 percent of the 2002 estimate of just over 4,000 tons of Amur and Kaluga sturgeon alive in the wild. Pond production of 0.75 kg fish was planned to exceed 6,000 tons by May 2003, assuming 50 percent survival of fingerlings.

Consumer demand in China calls for whole fish that can be served on a dish in a traditional manner. Adult sturgeon are too large for this purpose but immature sturgeon are acceptable. This traditional preference for plate-sized fish drives the market for live sturgeon of around 0.75 kg in weight, most of which are immature. Selling these small, immature fish brings very low or negative profits and is a waste of resources: Sale of fewer larger fish would yield greater profits for fish farmers because larger fish convert feed to body mass more efficiently. Because the number of sturgeon farms and the production of fish have increased rapidly, the price for sturgeon has dropped sharply in the last five years due to an oversupply of small fish (Wei 2002a, 2002b). Meanwhile, the price of caviar (which comes only from mature fish) has continued to increase due to international bans on imports of caviar from some fisheries in the interest of sturgeon conservation. Chinese aquaculturists are selling the small, captive-bed sturgeon at low profit before they enter the most profitable stage of their life cycle while simultaneously ignoring the potentially larger profits to be realized from the sale of mature fish and/or caviar.

China's international trade in sturgeon meat is limited to whole fish and a small number of exported live fish. All of the exported fish prepared for meat are from aquaculture. Seven and a half tons of Siberian sturgeon, Russian sturgeon *Acipenser gueldenstaedti* and Amur sturgeon were exported to Singapore (2.5 tons) and Hong Kong in 2000. The exported volume increased by 2002 to 123 tons which included Amur hybrids, Siberian sturgeon, Russian sturgeon, Amur sturgeon, and sterlet.

The only legal sturgeon caviar trade in China is the export of caviar from the wild population of *Acipenser*

Table 2.22 Sturgeon caviar exports from China in 2000 and 2001 (from Fisheries Bureau of Ministry of Agriculture)

Destination Country	Species	2000	2001
		Quantity (kg)	
Germany	*Accipenser schrenckii*	970	205
	Huso dauricus	1,230	345
USA	*A. schrenckii*	230	0
	H. dauricus	270	0
Japan	*A. schrenckii*	1,255	960
	H. dauricus	1,420	1,490
Total		5,375	3,000

schrenckii and *Huso dauricus* from the Chinese fishery in the Amur-Heilong River.

Fuyuan County is located along the lower part of the midstream of the Heilong River and is now the largest sturgeon producer in China with a total output of more than 100 tons in 2002. The output of sturgeon from the State Fish Farm of Fuyuan County accounted for more than 80 percent of the county total. The county is also the largest exporter of sturgeon roe in China. However, exports of sturgeon roe are limited by the quota set by CITES. According to the Ministry of Agriculture (MoA), the export of 5,375 kg of caviar (2,920 kg from Amur sturgeon, 2,455 kg from Kaluga) was permitted to Germany, USA, and Japan in 2000 and the permitted and exported volume was 3,000 kg in 2001 (**Table 2.22**). The quotas established for 2000 by CITES were 2,510 kg from Amur sturgeon and 3,140 kg from Kaluga (**Table 2.23**).

Due to their high commercial value, sturgeon were over-fished in the Amur-Heilong River beginning from the mid-1900s when Russian fishers exerted the greatest pressure. Poachers in Russia are estimated to take as much as 750 tons per year, which exceeds all other forms of harvest (legal in Russia and China, and poaching in China) by a factor of nearly four (Novomodny et al. 2004). Beginning in the mid-1980s, and following the market liberalizations in China that began with the Open Door Policy of 1978, Chinese fishers added greatly to the pressure on sturgeon. As a result, sturgeon populations have declined rapidly. In 1997, both Amur and Kaluga sturgeon were listed by the International Union for Conservation of Nature and Natural Resources (IUCN - World Conservation Union) as globally endangered. In 1998 trade in both species was restricted by their listing in Appendix II of the Convention on International Trade in Endangered Species (CITES). According to the Fisheries Law and the Regulations on Protection of Aquatic Wild Animals, the Heilongjiang Provincial Government announced a resolution regarding the management and conservation of sturgeon resources on 9 April 2001. The resolution banned capture of sturgeon unless approved by the Provincial Fisheries Bureau. Only individuals and/or public agencies possessing a Fisheries Bureau permit are allowed to take part in sturgeon fishing, propagating and culturing, transporting, selling, procuring, processing, importing, and exporting (**Table 2.24**).

Table 2.23 Quota for exports of sturgeon roe, China, 2000-2003

		Amount of Sturgeon Roe (kg)	
Year	Total	Huso (Kaluga) Sturgeon (Huso dauricus)	Amur Sturgeon (Acipenser schrenckii)
2000	5,650	3,140	2,510
2001	5,940	3,430	2,510
2002	5,940	3,430	2,510
2003	5,940	3,430	2,510

Source: The Heilongjiang Provincial Fisheries Bureau

Table 2.24 Sturgeon hatcheries licensed by the Heilongjiang Fisheries Bureau

	Name	Location
1	Fuyuan Sturgeon Propagation Station	Fuyuan County
2	Qindeli Sturgeon Propagation Station	Qindeli Farm
3	Heilongjiang Provincial Endemic Fish Institute	Jiamusi City
4	Heilongjiang Global Fisheries Inc.	Harbin City
5	Jixi Fisheries Research Institute	Jixi City
6	Tongjiang Bacha Sturgeon Base	Bacha Town, Tongjiang City
7	Tongjiang Yinchuan Sturgeon Base	Tongjiang City

Source: Heilongjiang Fisheries Bureau (July 2002)

Restocking status and sustainability

The first sturgeon hatchery on the Chinese side of the Amur-Heilong was set up at Qindeli in 1988, just upstream from the confluence of the Wusuli-Ussuri and Heilong-Amur Rivers. About 900,000 fry and 168,000 juveniles were released into the Amur-Heilong River from 1988 to 1991. According to an official report by the Heilongjiang Fisheries Bureau, a total of 3.8 million fry and juveniles were stocked into the Amur-Heilong River by the Qindeli station. In the last three years, the hatchery has not done any stocking because it has not had sufficient funding and was also focusing on commercial sale of eggs. A sturgeon hatchery was established at Fuyuan County in 1999 at a former salmon hatchery. The station is the largest sturgeon hatchery on the Amur-Heilong River and it is nearest to the sturgeon fishing ground where it can more easily obtain brood stock.

Trade in sturgeon fry can be very profitable. This explains the rapid and uncontrolled growth in artificial propagation of sturgeon since 1999. Live sturgeon and/or sturgeon eggs are now used for breeding or rearing rather than for caviar. Standard practice is to catch or poach mature fish and inject them with hormones to stimulate breeding, or simply collected fertilized eggs. It is difficult to estimate how many people or farms are engaged in captive propagation. The government tried to control this situation by issuing special licenses. To date, seven hatcheries in Heilongjiang have been licensed to propagate sturgeon (**Table 2.24**). Most of these hatcheries raise sturgeon primarily for commercial purposes; two (**No. 1 and No. 3 in Table 2.24**) also do some stocking. However, all hatcheries granted licenses are required by the Heilongjiang Fisheries Bureau to stock fingerlings into the Amur-Heilong River. A fee of US$5.80 per one thousand fertilized eggs is levied by the Fisheries Bureau if fertilized eggs or embryos are sold.

Fishermen have increased the live sturgeon price nearly to the level of that for unprocessed roe. A healthy female *Acipenser schrenckii* suitable for breeding cost approximately US$157/kg in 2001 and US$240/kg in 2002. High prices for brood fish caused many hatcheries to lose money. To maximize incomes, the stations had to sell nearly all fingerlings to fish farms. Thus the numbers of fingerlings available for release accounted for less than one percent of total production. A stocking ceremony took place in Heilongjiang in 2001, sponsored by the Heilongjiang Government, the Heilongjiang Fisheries Bureau, and the Fisheries Bureau of Fuyuan County. Twenty thousand Kaluga, 130,000 Amur sturgeon fingerlings (5-10 cm in length) and three thousand Amur sturgeon juveniles (1.5 kg) were released into the Amur-Heilong River. This was the first release of Kaluga, a critically endangered species. Fifty thousand Amur sturgeon juveniles (5 cm length) were released into the Amur-Heilong River in 2002. These were provided by the Fuyuan Sturgeon Hatchery and Heilongjiang Provincial Endemic Fish Institute at Jiamusi, Heilongjiang. In 2005-2006 at Fuwuyuan 500,000 unspecified sturgeon fingerlings were released each year at a "fish release ceremony" that is becoming a local tradition.

Scientific stock assessment is lacking for Amur sturgeon and Kaluga in the Amur-Heilong River. The harvest records of the Heilongjiang Fisheries Bureau show declining numbers for both species and Kaluga may be near extinction. It is difficult to estimate how many fish could now be caught without harming the wild populations.

Currently the rearing facilities in Heilongjiang are sufficient to produce sturgeon for stocking. According to the Ministry of Agriculture it is possible to release millions of fingerlings if the hatchery infrastructure is expanded and a government commitment is made to restocking the wild populations.

While hatchery production and release of fingerlings have been undertaken to recover and increase sturgeon numbers, these efforts offer little or no potential to remove threats to the two species populations. There are several reasons for this. First, the primary threats to sturgeon are over-fishing and water pollution. The release of fingerlings from hatcheries does nothing to remove or reduce these threats. Second, hatchery-produced fingerlings are typically poorly adapted to conditions in wild rivers. As a result mortality among released fingerlings is much higher than among wild-reared fish. Higher mortality results from a number of potential factors including poor genetic fitness, hatchery-induced diseases, and inability of released fingerlings to avoid predation. Third, productivity among wild sturgeon is high (600 000-1,500,000 eggs per female for Kaluga). When wild adult females are protected and able to breed in successive seasons (breeding seasons for female sturgeon typically occur at intervals of five calendar years), populations can recover with no support from hatcheries. Fourth, focus on hatchery production tends to divert financial, administrative and intellectual resources from the important tasks of fishery regulation and pollution control, leaving these critical and difficult tasks undone and the fishery still under threat.

China and Russia face the same problems with declining capture fisheries on which local livelihoods depend. However the two countries implement different and uncoordinated fisheries management programs and thus have little chance to achieve sustainable results for the transboundary basin.

Chapter 13

Socio-Economic Conditions in Eastern Mongolia

Population and livelihood

The population of the Mongolian Amur-Heilong River basin

Mongolia is divided into eastern, central, western and southern regions. The Amur-Heilong River basin lies only in the eastern region. The *aimags* (provinces) of the central and western regions are more densely populated than those in the eastern region where population density is below the national average. However, the eastern region is more populous than the Gobi desert region by a factor of two (**Map 2.2**).

The Mongolian section of the Amur-Heilong River basin encompasses almost all of Khentii and Dornod *aimag*s and parts of Sukhbaatar and Tov *aimag*s (**Maps 1.2 and 1.3**). This includes all 14 *soum*s (districts) of Dornod *aimag*; whole territories of 17 out of 19 *soum*s, and 50-60 percent of the territories of remaining Galshir and Darhad *soum*s of Khentii *aimag*; all of Bayndelger *soum*, as well as Baynjargalan (90 percent), Mongonmorit (65 percent), and Erdene (30 percent) *soum*s of Tov *aimag*; and all the territory of Tumentsogt *soum* and parts of Erdenetsagaan (85 percent), Sukhbaatar (55 percent), and Munkhkhaan (5 percent) *soum*s of Sukhbaatar *aimag*.

At the end of the 2005, the population of the Mongolian part of Amur-Heilong River basin was 165 thousand people (**Table 2.25**). This included 74,000 in Dornod *aimag*, 66,800 in Khentii *aimag*, 8,100 in Tov *aimag*, and 16,200 in Sukhbaatar *aimag*. The basin population is estimated to be 6.7 percent of the national total.

Population density and urbanization rate

Eastern Mongolia's population density is 0.83 persons per km^2, as compared to approximately three to four persons per km^2 in Russia and close to 100 persons per km^2 in China.

More than half of the population of this region (65 percent) is dependent on livestock, intensive users of natural resources, especially water and pasture. Herders are primary stakeholders with interests in sustainable management and conservation of these and other natural resources.

Because of increasing rural to urban migration, only 34 percent of the households in the region (39 *soum*s of four *aimag*s) are herders (14,695 households) who practice the traditional nomadic style of life in the countryside (**Table 2.26**). This is especially evident in Dornod *aimag* where 51 percent of the population now lives in towns and cities (**Table 2.27**).

Natural population dynamics and migration

The population of eastern Mongolia doubled from 1960-1990. Beginning in 1991 the population decreased due to emigration to the central region and to larger cit-

Aimags (provinces)	Soums		Territory		Population in Basin (thousand)	Persons per km	*Aimag* center
	Number	percent	Km^2	percent			
Dornod	14	100	123.6	100	74	0.59	Choibalsan
Khentii	19	94	80.3	100	67	0.88	Ondorkhaan
Tuv	4	10	9.3	13	8	1.18	Zuunmod
Sukhbaatar	4	45	35.6	43	16	0.68	Baruun-Urt
Total	41		248.8		165	0.83	

Source: Mongolian Statistical Yearbook 2005

Table 2.25 Land and population of Mongolian part of the Amur-Heilong River basin

ies such as Ulanbatar, Darkhan, and Erdenet. This was a result of the privatization of state agricultural and economic entities, and the introduction of free choice of employment since 1990 (Altantsetseg et al. 2002).

Table 2.26 Herders households

Aimag	No. of households	Herding households
Dornod	17,800	4,628
Sukhbaatar	2,660	1,590
Khentii	17,700	6,925
Tov	2,250	1,552
Total	42,660	14,695

Source: NSO. Mongolia Statistical Yearbook 2005

Table 2.27 Urban and rural residents as proportions of the total population in four aimags and Mongolia as a whole

Aimag	2005	
	urban (percent)	rural (percent)
Dornod	51	49
Sukhbaatar	21	79
Khentii	42	58
Tuv	15	85
Total Mongolia	57	43

Source: NSO. Mongolia Statistical Yearbook 2005

In the last five years Dornod, Khentii, and Sukhbaatar *aimag* populations declined by 0.1-2.6 percent and the population of Tov *aimag* dropped by 12 percent. This reflects the impacts of low birth rates and emigration (**Table 2.28**).

Table 2.28 Mongolian population changes in the Amur-Heilong River basin provinces (figures relate to whole population of each province)

	Resident population ('000)			1995-2000	2000-2005
Aimag	1995	2000	2005		
Dornod	84.6	75.4	73.4	-10.8	-2.6
Khentii	75.2	70.9	70.8	-5.7	-0.1
Tuv	110.9	99.3	87.4	-10.4	-11.9
Sukhbaatar	59.1	56.2	56.0	-4.9	-0.4

Source: Mongolian Statistical Yearbook 1995-2005

In 2005, natural population growth was 1.2 percent. Annual average natural population growth of Amur-Heilong basin *aimag*s is typically lower than the Mongolia national average and has decreased in recent years. Overall the birth rate in the basin between 1995 and 2005 declined by 16-33 percent except in Dornod *aimag,* where it fell by 34-47 percent. Not only did the birth rate decline, but the death rate declined as well. Population growth remains low due to the low birth rate. General living standards have dropped, education and employment of women have increased, and abortion is legal, all factors that have caused birth rates to decline.

One of the main determinants of population dynamics in recent years is migration (**Table 2.29**). Increased external and internal migration has influenced population growth at the national and regional levels. Migration increases as families search for a job, try to improve standards of living by improving access to markets, and hope for a better future for their children through access to better education. The return of people to historical places of residence in the west from sites where large groups were relocated during the socialist era has also contributed to migration from eastern *aimags*.

Table 2.29 Migration in Mongolian part of Amur River basin (2000-2004)

	Migration			
Aimag	In	Out	Change	Change per 1000 persons
Dornod	2,820	11,704	-8,884	-8.9
Khentii	4,536	10,339	-5,801	-5.8
Tuv	8,762	31,287	-22,525	-22.5
Sukhbaatar	485	5,920	--5,435	-5.4

Table 2.30 Ethnic composition in the Mongolian part of the Amur River basin (percent)

Ethnic Group	Dornod	Khentii	Tuv	Sukhbaatar
Khalkh	67.6	86.5	94.3	51.9
Buriat	22.8	-	-	-
Other	9.6	13.5	5.7	48.1

Ethnic composition

Seventy percent of the residents of the Amur-Heilong River basin in Mongolia are Khalh Mongols, and the remainder belong to the Buriat, Barga, Dariganga, and Uzemchin ethnic groups (**Table 2.30**). Buriats live in Dornod and Khentii *aimag*s that border Russia. Compared with other true nomadic ethnic groups, the Buriats adopted a settled way of life many years earlier and practiced intensified farming. In 1947, one thousand Barga people came from northeast of China and settled on the north side of the Kherlen River in Dornod *aimag*. In 1945, Uzemchins came from Shiliin Gol *Aimag* of Inner Mongolia and settled on the south side of the Kherlen River in Dornod *aimag* and Erdenetsagaan sum of Sukhbaatar *aimag*.

Darigangas, whose language is the same as Khalkh, comprise most of the 48 percent non-Khalkh ethnic groups living in Suhbaatar *aimag*. These two groups are distinguishable only by slight differences in traditional dress.

Employment

Mongolia's economic shift to a market economy has changed employment conditions in sectors such as heavy industry, building, transport, and communication. Employment in those sectors has declined severely, but the number of jobs in trading and agriculture has increased. The number of employed residents in the Mongolian portion of the basin increased during 2000-2005 by nearly 16 percent, reaching 112,500. Approximately 61 percent were employed in agriculture, hunting, and forestry, and 39 percent in health, education, public administration, defense, and social work. The numbers of employed persons at the province level are different. Employment in agriculture, hunting, and forestry in Sukhbaatar Province was 73 percent, with 17 percent in health, education, public administration, defense, and social sectors. In Dornod Province employment was lower at 45 percent and 30 percent respectively. In Khentii and Tuv Provinces employment in agriculture, hunting, and forestry was around 61-63 percent, and in health, education, public administration, defense, and social work sectors, around 15-17 percent.

The unemployment index is decreasing across the country, but not at consistent rates in all *aimag*s. For example, unemployment in Khentii and Tuv *Aimag*s is steadily decreasing, while in Dornod and Sukhbaatar *Aimags,* numbers of unemployed have increased (**Table 2.31**). Around 66-76 percent of unemployed workers are uneducated.

Table 2.31 Numbers of unemployed and unemployment rate ('000 people in 2005)

Aimag	Dornod	Khentii	Tuv	Sukhbaatar
Unemployment	1,044	764	685	703
Unemployment rate (percent)	5.0	2.9	1.6	2.8

Source: Mongolian Statistical Yearbook 2005

The 15-19 year old age group has the highest unemployment rate due to a lack of access to higher education in the eastern region. Unemployment among women (56-60 percent) is similar to that in other *aimag*s. Unemployment can also be effected by the large number of herding families and severe weather conditions.

Poverty

The prevalence of poverty is generally lower in the eastern economic region than in other regions of Mongolia. More than half of the population of the western economic region, two fifths of the population of the Khangai economic region, and one third of the populations of the central and eastern economic regions live in poverty. The western economic region accounts for one fourth of poverty at the national level, whereas the eastern economic region has one tenth of the population living in poverty (Report on living standard 2002-2003, UB 2004).

Although herding is the main livelihood in all rural regions, other livelihood options are pursued depending upon geography and weather conditions. For example, in the eastern economic region herding is the predominant source of income but people also engage in hunting, crafts, and sewing. Hunting income is 10-20 percent of total income for poor households. Hunting income is predicted to increase in future, and this has already begun to threaten wildlife populations (see Part Three).

Political and Legal Environment

The administrative and territorial system of Mongolia divides the country into jurisdictions called *aimags* (provinces), soums (districts/counties,) and bags (local administrations). *Aimags* and *soums* are governed by Citizen Representative Meetings, to which representatives are elected for four year terms. The Mongolian Prime Minister and governors of *aimags* and *soums* are appointed by Citizen Representative meetings.

Mongolian laws on nature and environment were largely influenced by traditions of a nomadic livelihood deeply influenced by religion. The hierarchy of environmental legislation in Mongolia has five layers:

(i) The Constitution;

(ii) International treaties (e.g., Convention on International Trade in Endangered Species, Ramsar Convention, and others);

(iii) A general environmental law (e.g., Law on Environmental Protection 1995);

(iv) A 1998 Law on Environmental Impact Assessment and laws relating to natural resources (e.g., water, forest, air, land, fauna, hunting, strictly protected areas, natural plants, buffer zones, underground resources, petroleum, and mining laws); and

(v) Fee-related laws (water fees, hunting fees, forest use fees, natural plants fees, and a law on the reinvestment of natural resource use fees for conservation and restoration of natural resources).

Most laws are supplemented by more detailed orders, regulations, requirements, or standards. Overall, there are 29 laws relating to environmental management in Mongolia and some 150 associated regulatory documents (more than 40 for forests and 20 for water).

During the relatively short period of political and economic transition to a market economy, successive Mongolian governments readily assimilated the global mainstream environmental agenda and adapted it to Mongolia's conditions. The process has combined Mongolia's perception of its development needs, its embrace of international environmental conventions, and the obligations of funding associated with these conventions. The Ministry of Nature and Environment (MNE) developed the following documents during the 1990s to deal with key areas of environmental management:

- The National Environmental Action Plan of 1996;
- The State Environmental Policy 46 of 1997;
- The National Action Plan to Combat Desertification;
- The Biodiversity Conservation Action Plan;
- The National Action Plan for Protected Areas; and
- The Mongolian Action Program for the 21st century.

Subordinate *aimag* development plans were developed by the National Council for Sustainable Development (NCSD). The National Environmental Action Plan was updated in 2000. The National Action Plan for Climate Change was added in the same year, and several program documents (e.g., National Water Program, National Forestry Program, Program of Protection of Air, Environmental Education, Special Protected Areas, and Protection of Ozone Layer) were also completed at the turn of the decade. Other guidance documents with important environmental repercussions were developed by the Ministry of Food and Agriculture and other ministries including master plans for roads, power, tourism, and renewable energy.

The Ministry of Nature and Environment is responsible for formulating and promoting environmental policies, laws, procedures, and conventions. MNE was reorganized in 2003. Its present structure includes: (i) the State Administration and Monitoring Department; (ii) the Strategic Planning Department; (iii) the Policy Implementation and Coordination Department; (iv) the Sustainable Development and Environment Department (primarily responsible for environmental impact assessment); (v) the Finance and Budget Division; (vi) the International Cooperation Division; and (vii) Protected Area Division. Similar to the Russian MNR, the MNE supervises the water, forest, and natural resource agencies. Since 2001, the Mongolian government assigned field responsibilities for all protected areas to the MNE and simultaneously removed the MNE's oversight of other land resources that are now the sole responsibility of local governments.

Other Ministries and Agencies with environmental regulatory roles are (ADB-CEA 2005):

- The Administration of Land Affairs, Geodesy and Cartography (ALAGaC);
- The State Inspection Agency (700 environmental inspectors); and
- The Ministry of Finance and Economy, Ministry of Food and Agriculture, Ministry of Industry and Trade, Ministry of Infrastructure, Ministry of Justice and Internal Affairs, and Ministry of Health;
- The Coal Agency and Tourism Agency in the Ministry of Infrastructure;
- The Mineral Resource, Petroleum in the Ministry of Industry and Trade;
- The State Reserve Agency in the Ministry of Food and Agriculture;
- The State Border Patrol, Police Department in the Ministry of Justice and Internal Affairs; and

- The State Customs Agency in the Ministry of Finance and Economy.

The revised Water Law was approved in April 2004. It clarifies the responsibilities of the Ministry of Infrastructure, MNE, and Ministry of Health, and it introduces the principle of water basin management. The law sets out principles for charging different classes of water users. It institutionalizes water conservation policies and calls for environmental impact assessments for specified classes of water use projects. The revised Water Law coexists with the Water Use Taxation Law of 1996.

A new water policy designates river basins as the focus of water resource management. Continuity is apparent in the commitment to more fully use existing surface water resources (for electricity generation and other uses) and support renewable energy and nuclear energy development. All soum centers and settlements are to be provided with safe drinking water during the term of the new government. The policy seeks to increase the use of surface water relative to groundwater. The implications of the policy for irrigation rehabilitation, hydropower development, and nature conservation have not been fully studied but institutional capacity to implement the new policy is weak.

Attempts to rehabilitate portions of the old irrigation network were sporadic during the past decade and were frustrated by the continuing uncertainty regarding the ownership structure of former state farms. That structure has become clearer recently and new land legislation has created conditions under which rehabilitation of parts of the former irrigation network could be viable. There is a greater willingness on the part of the Ministry of Food and Agriculture to approach irrigation rehabilitation in a pragmatic manner and in a way that would divide the cost between government and water users.

The government's focus on integrated river basin management is new in Mongolia. Policy regulations are needed, as is training of government workers at the central and river basin levels.

Policy for forest management outside protected areas is weak and forest management is weaker still. There is no agreed approach for dealing with illegal logging, which accounts for around two thirds of the total (ADB EIA 2005). The new policy calls for international cooperation to fight desertification through reforestation by local communities. Unfortunately, the policy offers no new guidance on stopping illegal logging.

Despite some conflicts with other laws, the new Minerals Law is considered sound and conducive to further expansion of exploration and production. Rehabilitation of mining areas and management of mine tailings are the primary environmental concerns.

A new and rapid expansion of poorly regulated or unregulated small-scale gold mining has taken place in the last few years. Over 100,000 people are now involved and this changes the dynamics of rural employment and patterns of settlements. Less destructive production methods in placer areas coexist with highly damaging methods of extracting gold used in hard-rock mining (e.g., mercury heap-leach), making this an important public health issue. Use of mercury by a segment of the mushrooming small-scale gold mining sector in the last few years has created a major public health hazard (e.g., the threat of Minamata disease from mercury exposure). Nevertheless, small-scale gold mining has recently become something of a savior of many rural economies and one route to escape from poverty.

The MNE has increased its profile recently, but faces a number of challenges. First, centralization of all Global Environment Facility (GEF) activities in the MNE has added to the Ministry's coordination workload. This is because most GEF activities require inter-agency cooperation that is often new and therefore demanding of time and capacity.

Second, several key policies are unlikely to be better developed and articulated in the near future. An example is the forest policy, which clearly needs to define a set of mechanisms to stop illegal logging. Some national action plans need to gain more support outside the MNE. The greater role given to the MNE in water and land management is well ahead of its institutional capacity, especially at the local level. Environment is a growing priority in Mongolia.

Third, the main mechanisms used to facilitate cross-sector coordination are the National Council for Sustainable Development, national coordination committees (for most natural resources, land reform, public health, and all international environmental conventions), and ad hoc working groups. The committees are headed by different ministries (the Ministry of Food and Agriculture, the MNE, and the MOH), according to the underlying concern. The effectiveness of the committees varies and their work often stops short of substantive policy issues.

The opening of the Mongolian economy to the People's Republic of China and the Organization for Economic Co-operation and Development countries has led to well documented changes such as those discussed above for the livestock industry and the rapid expansion of mining and mineral exploration. Other less well known changes have also occurred, such as the emergence of export markets for scrap metal. Similarly, foreign investment in mining, loss of traditional rural earning opportunities, and other factors are behind the explosion in informal gold mining that started only several years ago but which has already changed the dynamics of rural employment and the patterns of settlement in several regions of Mongolia, apart from having environmental repercussions.

Agriculture and Land Use

Agricultural development

Animal husbandry accounts for approximately 70 percent of national agricultural production but productivity of natural pastures is low (0.3 ton/hectare) due to the naturally dry climate and long history of poor grazing practice. Livestock number approximately 30 million head, all of which are vulnerable to natural disasters. In 1999-2000 more than three million head were lost to disease and in winter 2001, an additional 0.6 million head were lost to disease (Data from http//www.fao.org/docrep/004/x9523e00.htm).

The per capita area of agricultural land has been in steady decline nationwide due to population growth. It fell from 242 hectares per capita in 1919 to 64 hectares in 1997. The nationwide total conversion of pasture to cropland peaked in 1990 at 1,385,000 hectares.

From May 2003 land privatization began in Mongolia with an allowance to each urban family of 0.07 hectares. Rural households were allotted from 0.35 to 0.5 hectare. If all 550,000 households of the country claim their land allotment, this would account only for 0.9 percent of the total land area of the country. Around 80 percent of nation-wide croplands produce grains (primarily wheat) at an average yield of one ton/hectare (1998). The remaining 20 percent produces forage crops at an average yield of three tons/hectare, or ten times that of pasture.

From 1990 there has been a continuous shortage of grain because of economic reform and mismanagement. New private farms cannot secure loans or technical assistance; they also lack management personnel. Yield per unit area, acreage of cultivated land, and total production have all declined. As a result, agricultural production in Mongolia declined from 1990 to 2000. In 1995-7 arable land used for grain production did not exceed 12 percent of total arable land. From 1989 to 2000 total wheat production fell from 690,000 to 200,000 tons (Karakin & Sheingauz 2004, FAO-web site). Since 2000, crop cultivation has undergone a resurgence aided by international involvement. In Dornod *aimag* in 2001 a South Korean company started soybean production on a farm that will ultimately cover 10,000 hectares. Crop cultivation is confined to river valleys and production could be enhanced by irrigation if funding were available to install systems.

There are numerous agreements between governments and other entities in Mongolia with the Autonomous Region of Inner Mongolia (ARIM) of China, particularly with Xing'anmeng County of ARIM. These agreements typically cover agricultural production, trade in agricultural products, infrastructure development and joint measures to improve land management (e.g. combat desertification). Differences between adjacent provinces of Mongolia and China are compared in **Table 2.32**.

Table 2.32 Population, economy, and land-use in neighboring *aimags* of Mongolia and provinces of China in 2000 (adopted from Karakin & Sheingauz 2004)

Parameter	IMAR Xing'anmeng prefecture	Aimags of Eastern Mongolia
Area (km^2)	60,000	287,500
Population count	162,000	210,000
Population per km^2	27.0	0.7
GDP mln USD	767.5	28.9
GDP/person USD	476.6	300.0
Percent arable	11.1	0.8
Livestock (mln).	4.2	3.35
Livestock/100 ha	70	11.9

Original source : Strategic development outline for economic cooperation between the PRC and Mongolia (project area: Xing'anmeng Prefecture in the Inner Mongolia Autonomous Region of the PRC and the provinces of Dornod, Hentiy, Suhbaatar of Mongolia). ADB, Manila, Philippines, 2002.

Agricultural land structure

The Mongolian portion of the Amur River basin includes a variety of natural ecosystems ranging from high mountain taiga to forest steppe, steppe, and semi-arid steppe. The landscape is varied with mountain tundra, taiga, forest, medium and low mountains, hills, steppes, river and streams, lakes and ponds, salt marsh hollows, marsh, sandy places, sand dunes with sparse vegetation, rocky cliffs, cave, and volcano craters.

Land use categories in the Mongolian Amur River basin include agricultural land (93 percent), forested area (6 percent), wetland (0.4 percent), urbanized area (0.3 percent), roads (0.2 percent), mountains tundra, rocks, and mountain top, sandy places (<0.1 percent) (**Table 2.1**). Agricultural land is virtually all pasture (94 percent) or hay meadow (5 percent), both of which support livestock husbandry (**Table 2.33**).

Table 2.33 Agriculture land categories in the Mongolia basin

Land use categories	Total ('000 ha)	Percent
Pasture land	25,139	94
Hay production	1,377	5
Abandoned cropland	106	0.4
Croplands	77	0.3
Timber forest	0.1	<0.1
Agriculture infrastructure	4	0.1
	26,703	100

Source: NSO. Mongolia Statistical Yearbook 2005

Nomadic grazing and overgrazing

Herders have adapted to the various ecosystems of this area (forest, meadow steppe, and dry steppe) by developing nomadic grazing systems which, if properly managed, can result in sustainable use of the land. There are two major patterns of herder and livestock movement, one in the northern part of the region and one in the south.

The main pattern of movement in the north is camping during winter and spring seasons on the banks of major rivers such as the Kherlen, Onon, or Ulz, or on the slopes of medium and low mountains at 1000-1200 m above sea level. Herders move to higher elevations in the open valleys of the rivers in summer and autumn (1300-1400 m). The winter/spring and summer/autumn camping grounds are very near, separated by an average distance of only 10 km. The short distance separating the seasonal ranges is compensated by the storage of hay for winter and spring seasons. Almost every herding household has equipment for cutting hay and claims a hay meadow near the winter and spring shelters.

The second type of movement pattern, used in the southern region is based on using the landscape to protect livestock from strong winds especially in winter and spring. The main winter and spring grounds are located on the southern slopes of the hilly areas at elevations of 1000-1100 m above sea level. In summer the herders move to the open steppe at elevations of 900-1000 m where winds are normally calm. In autumn, herders move to the south to reach the steppe and dry pasture which are not subject to early snow falls. The distance between the winter-spring camp and the summer-autumn camp averages 40-50 km.

In general, the movements of the herders in eastern *aimag*s do not change as much by season as do those of the Mongols. However, in some cases the herders shift to more distant locations or increase frequency of movements. This can be explained by low numbers of livestock per household and also the increasing tendency of herders to opt for a more sedentary and comfortable living.

The mid and low mountain valleys and river valleys are the main types of pasture in the steppes. Surveys by national specialists showed pasture yields per hectare of 350-470 kg per year. This is around 50 percent higher than yields in other economic regions of Mongolia. However, only 30-63 percent of pasture capacity is used. Water supply for livestock is a determining factor for the use and productivity of grazing lands. Therefore, pastures in the larger river valleys that are near streams, springs, lakes, ponds, and wells are intensively grazed almost year-round.

Some pastures are heavily overgrazed due to current socio-economic conditions. Reduction of social service outreach to rural areas and the concentration of services in major settlements have caused the nomadic population movement patterns to center around settlements such as Choibalsan, Ondorkhaan, and Sukhbaatar. Similar concentrations are found around Baganuur, Berkh, and the main transport line which connects Choibalsan with Ulaanbaatar. The concentration of services and herders in village centers has resulted in greater areas of overgrazing at these locations. Of the total pastoral land 12 percent is grazed at low intensity, 67 percent at moderate intensity, 18 percent is heavily overgrazed and three percent of the pastoral land is severely overgrazed.

Livestock and composition of herd

Similar to other regions of Mongolia, the economy of the Mongolian Amur-Heilong River basin is based on export of agricultural products. This economic sector involves 45 percent of the labor force compared with the national average of 38 percent.

The eastern region has always had one of the lowest counts of livestock when compared to other regional averages. This is one reason that biodiversity has not been degraded by livestock grazing. Low densities of livestock have helped to conserve grasslands of the Mongolian Amur-Heilong basin in comparison with pastures in other regions of the country. Numbers of livestock have been stable or slightly increasing across the eastern region (**Table 2.34**).

Table 2.34 Livestock numbers ('000 head)

Aimag	1990	1995	2000	2005
Dornod	944	591	826	978
Sukhbaatar	1,005	1,016	1,493	517
Khentii	1,499	1,101	1,462	1,690
Tov*	109	127	164	197
Total	3,556	2,835	3,945	3,381

* includes four eastern *soums* only
Source: NSO. Mongolia Statistical Yearbook 2005

Herd structure has changed somewhat due to economic pressures, and the general nationwide trend is low but increasing numbers of livestock. Only the camel and cattle populations remained unchanged over recent years. Within the last 10 years the number of horses increased by 21 percent, sheep by 31 percent and goats by 162 percent. Such a rapid increase of goats is explained by increasing demand for high priced cashmere.

However, the herd structure is still dominated by sheep (47 percent) which adapt better to this region than do goats (**Table 2.35**). Due to ecological conditions, the northern part of the eastern region is better suited to a livestock economy mainly based on cattle and sheep, while the southern part of the region is best suited for producing sheep. The eastern region has nearly eight percent of all camels in Mongolia, 18 percent of cattle, 18 percent horses, 13 percent of sheep, and eight percent of goats (Mongolia Statistical Yearbook, 2005).

Table 2.35 Livestock numbers ('000) in core *aimag*s (2005)

	Camel	Horse	Cattle	Sheep	Goat	Total
Dornod	6.3	128.7	99.8	469.9	273.7	978.5
Sukhbaatar*	4.3	74	53	219.8	165.8	516.8
Khentii	5.1	171.0	148.2	782.3	583.1	1689.7
Tuv **	0.5	25.2	16.2	119.2	72.4	233.5
Total	16.2	398.9	317.2	1591.2	1095	3418.5
In percent	0.5	11.6	9.3	46.5	32.0	100

* includes northern five soums only
**includes eastern four soums only
Source: NSO. Mongolia Statistical Yearbook 2005

Hay production

Eastern Mongolia produces 65-68 percent of the hay for supplemental feeding of animals in Mongolia. Most of the hay meadows are located in Dornod *aimag* which accounts for more than 50 percent of regional hay production. Neighboring Khentii *aimag* accounts for 30 percent.

Natural hay meadows are cut over large areas in the Onon, Ulz, and Kherlen River valleys. In 2005, Khentii *aimag* alone prepared 99,500 tons of natural hay, while Dornod *aimag* prepared 41,100 tons, and Sukhbaatar *aimag* prepared 4,600 tons (Mongolia Statistical Yearbook 2005).

Production of hay at the household level is traditional in this region. After the collapse of the communal hay production system, herders began to prepare and store hay on a household basis. Hay is used to feed livestock mainly in winter and spring to help weak animals survive the harsh weather conditions and concomitant limited forage availability.

Cropland

Twelve percent of the total crop land of Mongolia is located in the eastern region. In previous years a maximum of 183,000 hectares of eastern Mongolia were used for cultivating crops. Today only 45 percent of this total is farmed. Since the beginning of the economic transition to a market economy, grain production declined by 84 percent from 103,570 tons in 1990 to 14,692 tons in 2005 (**Table 2.36**). All farming areas are located in the basins of the Kherlen, Onon, and Ulz Rivers.

Table 2.36 Main crops in 2005 (tons)

	Grain	Potato	Vegetable
Dornod	3,320	219	125
Sukhbaatar	-	31	18
Khentii	11,372	381	174
Total	**14,692**	**631**	**317**

Source: NSO. Mongolia Statistical Yearbook 2005, and *Aimag* Statistical Yearbook 2005

Along the Ulz River, the Buriat have a long tradition of cultivating vegetables for household consumption. Under the government's green revolution program and new land laws that allow households to own land for farming, the number of households growing vegetables has increased.

Industry and infrastructure

Over the last 25 years development of industry has intensified in eastern Mongolia. State sponsored heavy industries developed food processing, construction materials, and light and heavy manufacturing. Most of the plants are located in Choibalsan, Berkh, and Bor-Undur. Beginning in 1990 state-run factories were privatized and the manufacturing sector began to gradually shift from large to small and medium-sized enterprises. By the end of 2000 90 percent of 850 new production and service enterprises in all three *aimags* were in the private sector. Of these, 35 percent were in trade, 15 percent in processing, and 14 percent in agriculture, forestry, and hunting (Altantsetseg et al. 2002). Industrial output per person is 85 percent of the national average. In Khentii and Dornod *aimag*s, approximately 82-86 percent of manufacturing is in mining and processing, whereas in Sukhbaatar *aimag* manufacturing accounts for a smaller than average share of the economy.

Dornod *aimag* in the eastern economic region has a thermo-power station, flour, meat, and wool factories, a coal mine at Aduunchuluun, and a sawmill. Khentii *aimag* has a flour mill, Chandagan Valley has a coalmine, Bor-Undur and Berkh have a flouride plant, and Batshireet has a sawmill. Sukhbaatar *aimag* has a coalmine at Talbulag in addition to several other small factories.

The eastern region has a well developed transportation sector relative to other parts of Mongolia. It has railroad connections with Russia and provides train service connecting with the Trans-Siberian system and other outside markets. The total length of railroads is more than 250 km. In 2006 the railway did not operate at full capacity, nor did it carry passengers across the border.

The 300 km paved road connecting Ulaanbaatar with Khentii also enhances potential for development of the region. This can already be seen in areas where new settlements line the road. The increased settlement of the nomadic population in locations near the main road connecting eastern Mongolia with central Mongolia demonstrates the economic stimulus provided by the roadway.

The region also has regular air connections linking Ulaanbaatar and Choibalsan.

Livestock processing production

State-sponsored development of industry in the eastern region includes food processing and light and heavy manufacturing. However, beginning in 1990, the manufacturing sector began to gradually shift from large factories to small and medium sized enterprises. Currently 90 percent of enterprises are in the private sector. These enterprises employ nearly 30 percent of the working population.

The eastern region supports a new and well developed livestock processing industry centered at the capital of Dornod *aimag*, Choibalsan. The abattoir at Choibalsan processes almost all livestock from the eastern region. However, the abattoir struggles with financial difficulties and in 2006, it operated at only 10 percent of capacity. Choibalsan also has one large wool processing plant and a carpet factory, both established before 1990, and both operating far below capacity.

The reason for the low output of these plants is the economic disruption caused by the breaking of the strong economic links between Mongolia's eastern region and Russia's Chita Province established during the socialist period. Until the 1990s, large quantities of meat from Dornod *aimag* were processed in the Borzya Meat Processing factory in Russia's Chita Province, while wool from Chita Province was processed in Choibalsan. After the 1990s Choibalsan's relationship with Chita was broken. This left Choibalsan without easy access to a Russian meat market, and in possession of a wool-processing factory with inadequate supply of raw materials because the importation of Russian fleeces was cut off.

Despite operating below capacity, the eastern region accounts for substantial portions of Mongolia national meat exports (**Table 2.37**)

Table 2.37 Meat export capacity of the Eastern *aimags*

	Meat exports (tons)	Percent of national exports
Horse	2510	21
Beef	2435	17
Lamb	1408	15
Goat meat	501	10
Total	6853	

The eastern region supplies just over 29 percent (8,400 tons) of all Mongolian exports of wool and cashmere. This represents 15 percent of Mongolian sheep wool, eight percent of camel wool, 10 percent of cashmere, and 18 percent of horse and cow hair (**Table 2.38**)

Table 2.38 Export of wool and cashmere

	Tons	Percent of the national total
Sheep wool	2,607	15
Camel wool	115	8
Cashmere	245	10
Horse hair	117	10
Cow hair	97	8

Electric and thermal energy industries

The region has more than 1,126 km of electric and thermal energy lines, or 10 percent of all lines in Mongolia. Thirteen percent of these lines carry 110 kWt, and four percent carry 35 kWt. The region has a high density of power lines relative to the national average.

The main thermo-power station is located in Choibalsan. It is connected to five *soums* in Dornod *aimag* and three *soums* in Sukhbaatar *aimag* by a 35 kWt transmission line, and to Baruun-Urt, capital of Sukhbaatar *aimag*, by a 110 kWt line. The center of Khentii *aimag* and 13 nearby *soums* are connected with electricity by 110k Wt line. The *soums* of Tov *aimag* are supplied electricity by a 35k line Wt from Ulaanbataar.

Less than fifty percent of *soum*s of the eastern region have central electric systems and 15-20 percent of herders have reliable renewable energy sources.

Mining

Mining has become the most economically important sector in the Mongolian portion of the Amur-Heilong River basin. The region has rich mineral resources including feldspar, oil, lead, uranium, zinc, gold, and silver. Coal is a key raw material for electricity production. The eastern region has the most diverse deposits of poli-metal, spar, silver, and other kinds of minerals at 349 sites. One hundred of these are confirmed deposits of nine different minerals and rest are potential deposits not yet confirmed. Twenty mining sites of varying sizes have been developed in the Mongolian Amur-Heilong River basin (placer-mining for gold not included). Mineral exploration and exploitation licenses have been approved for 75 areas (Altantsetseg et al. 2002).

Ondortsagaan, in southern Omnodelger *soum*, Khentii *aimag* has 0.2 million tons of tungsten, 26,000 tons of molybdenum, and 7,000 tons of white lead. This deposit is the largest in the country. Nearby, there are 31.5 million tons of metallic silver-mixture at Mongon-Undur. Extractive and concentrating factories could be established in future at these two sites.

Mongon-Undur also has resources of 4,524 tons of silver, 227,000 tons of zinc, and 286,000 tons of black lead. It is the second largest mine in the country. The eastern region holds 18 percent of confirmed silver reserves.

Tsav, Ulaan, and Mukhar have the most confirmed resources, behind Mongon-Undur. Ulaan has 38 million tons of metal compounds in Dashbalbar *soum* of Dornod *aimag*. This site has 2,125 tons of silver, 1,448 tons of gold, 0.4 million tons of black lead, and 0.7 million tons of zinc and is the third largest site in the country. This site also has the richest gold reserves in the region and in the country as a whole.

Bayandun *soum* of Dornod has gold deposits at Tsagaanchuluut, currently producing 6.5 tons. Tomortei Hill of Sukhbaatar *soum*, Sukhbaatar *aimag* has resources of 7.6 million tons of metal and one million tons of zinc. This is the biggest zinc deposit in the country and is mined by Chinese investors.

The eastern region supports 90 percent of the country's tungsten reserves. Eguzer in Erdenetsagaan *soum*, Sukhbaatar *aimag* has 21 tons of tungsten reserves. Most of Mongolia's tungsten reserves are located at these two sites.

The region has 30 percent or 89 million tons of fluoride mostly in Khentii *aimag*. Bor-Ondor, Khajuu-Ulaan, and Berkh deposits are mined because of good geographical locations and transportation connections. Half of Mongolia's fluoride resources are in Bor-Ondor, Darkhan *soum*, Khentii *aimag*, and 19 percent are at Adag.

Mongolia's geological survey found uranium deposits at Gurvan bulag, Nemer and Mardai in Dornod aimag. The total uranium reserve is estimated at 49,000 tons, or 36 percent of the national total. Russian, Canadian, and American investors recently expressed interest and bought rights to one old uranium mine 120 kilometers north of Choibalsan where 700,000 tons of ore were extracted in 1989-1995 for processing in Russia.

Aduunchuluun Company coal mine at Choibalsan has an annual capacity of 600,000 tons and now produces 250,000 tons. It was once negotiating sale of 500,000 tons per year to Russian Chitinskaya and Primorsky Provinces. The Bulan site in Khalkhgol *soum* is thought to hold 29-56 percent of all coal reserves in the region

One of three petroleum sites in the basin is Tamsagbulag on the border of Khalkhgol and Matad *soums*. USA SOKO International and Australian Rock Oil Companies were producing oil in Tamsagbulag of Dornod aimag and Dornogobi aimag. Officials claim that Tamsag may have 1.5 billion barrels of oil, and one area of Dornod aimag may contain as much as 50 million barrels of oil. The SOKO International Company, which developed the 19-22nd contract field of the Tamsag basin, made an investment of $7.4 million, drilled four exploration and evaluation wells between 1994-2002, and extracted 300 barrels of crude oil a day. The joint group of the Australian Rock Oil and Chinese Dongsheng companies drilled two exploration wells in 2002. By 2006 all oil concessions in Dornod were purchased by China's Daqing oil company.

Analysts believe that regional economic development will be based on mineral resources. Developing the mining industry and producing products in local factories should help to reduce unemployment and poverty.

Land use case studies: fishing, hunting, and forestry

Mongolia fisheries case study

Although surface water is limited in the Mongolian Amur-Heilong basin, the Kherlen, Onon, Ulz, Balj, Numrug, Degee, Azraga, and Khalkh Rivers and Buir, Duruu, Khukh and Yakhi Lakes are very important for the conservation of aquatic biota. Seventeen species of fishes in the rivers and lakes of the basin are economically important to the fishing industry. Commercial fishing is conducted in Buir and Khukh Lakes. Buir Lake is located at the border of Mongolia and China, and fishing is conducted here without clear bilateral agreements to prevent overfishing. A separate clause was even written into a Sino-Mongolian agreement on the management of transboundary water bodies to hold separate consultations on Buir Lake fishing (**Table 2.39**).

Year	Tons
1954-1964	4,344
1965-1974	1,410
1975-1984	1,332
1985-1993	1,467

Table 2.39 Buir Lake fish catch during 40 years from 1954-1993

Table 2.39 paints an interesting picture and reflects two sets of data, one from fishing by Chinese fishermen in 1954-1964 and the second from fishing by Mongolian fishermen from 1965 onward. A government agreement between Mongolia and the People's Republic of China permitted Chinese fishermen to conduct all fishing at Buir Lake in 1954-1964. Beginning in 1965 Mongolian fishermen also fished Buir Lake, but at a lower intensity than the Chinese fishermen in the previous decade.

Buir Lake straddles the Mongolia-China border, with 92 percent or 566 km^2 of the lake area in Mongolia and eight percent or 49 km^2 in China. The Chinese fished in Buir Lake for 14 years from 1973-1986 to supply food to the military. **Table 2.40** compares the fish catch in Mongolia with that in China during this period (Baasanjav and Tsen-Ayush 2001). It is clear that the catch is dependent on the skills of specialized fishermen and the types of fishing gear used. An additional factor determining the size of the catch is that Mongolian fishermen were active only from November to March of every year.

Table 2.40 Buir Lake fish catch during 14 years from 1973-1986

Years	Mongolia	China	Total catch
catch (tons)	1,840	10,834	12,674
percent of catch	15	86	100

Researchers have noted that protection and the sustainable use of fish and other aquatic fauna in the rivers and lakes of the Pacific basin of eastern Mongolia face many challenges. These include breaches of fishing rules or regulations, uncontrolled catch during winter concentrations, exceeding annual quotas, discarding fish nets in lakes in large numbers causing increased mortality of fish and birds, killing of lake-bottom plants and disturbing of sediments by fish nets and loosening roots of aquatic plants, thereby degrading the lake ecosystem.

Mongolia forestry case study

Mongolia's forests grow in isolated stands along the mountain ranges of Khangai, Khentii, and Khuvsgul, and part the grand taiga of Siberia and Transbaikalia from the Central Asian steppe and deserts. The forests protect the taiga from desiccation and other negative impacts. The forest is adapted to the harsh continental climate and resource limitations. Rates of tree growth are slow. The forest is also slow to colonize adjacent lands and is vulnerable to insect damage and human exploitation.

In 2000 the area of Mongolian forest was 12.9 million hectares or 8.1 percent of the total land area. Deciduous and coniferous forests covered 10.5 million hectares while 2.0 million hectares were *Haloxilon ammodendron* (saxoul - trees of desert areas) forest and 381,400 hectares were covered by brush and shrubs (Statistical Book of Mongolia 2002).

The standing volume of Mongolian forests was estimated at 1.38 million cubic meters of which 58 percent was larch, five percent pine, eight percent cedar-pine, nine percent spruce and fir, three percent birch, and 16 percent saksaul. Stands of poplar, willow, aspen, and elm cover small, isolated areas.

An average of 270,000 hectares of forest was burned each year while 70,000 hectares were lost to insect damage over the last two decades. The wild fire of 1996 burned 2.3 million hectares of forest, an area equivalent to the total forested area of Selenge *aimag*. Of this area some 230,000 hectares lost most of its ecological value and has not recovered (Bayarsaikhan *et. al* 2002).

The forests of the Mongolian Amur-Heilong basin have been degraded by fire, insect damage, disease, and human activities including unregulated cutting. This has degraded the ecological resource of the region and reduced the ability of the forest to provide natural services such as water storage and soil stabilization.

Reforestation has been carried out under state planning since 1971. Some 69,400 hectares have been planted, on about 20 percent of the total area harvested during this period. Facilitating natural regrowth is much more efficient than planting forests in most Mongolian habitats (ADB-CEA 2005).

In recent years there has been a shift from forest management by the state government toward management at the lower administrative levels of *aimags*, *soums,* and regions. Various laws and regulations are guiding this shift in forest management including the Forest Law, Procedure for Forest Organization, Rule for Forest Organization, Instruction for Forest Organization, and the National Program for Forests, which includes forest management plans and forest cover maps. Forest survey data are now being used to plan local timber harvests. Forests are now managed mainly by the forest exploration and project centers under the jurisdiction of the Ministry of Nature and Environment. Private professional organizations have also been established in recent years to carry out forest research and survey.

The forestry sector has been elevated within the new MNE organizational structure, yet remains ineffective. The forestry sector in Mongolia is rapidly approaching a crisis for which it seems largely unprepared (ADB 2005):

- The estimated levels of forest harvesting are unsustainable, being at least four times the sustainable Annual Allowable Cut in any designated Utilization Zone and at least 1.75 times the sustainable Annual Allowable Cut if about 25 percent of the Protected Zone were made available for commercial harvest.

- The forest area zoned for utilization is inadequate to support a viable domestic wood-based industry or to attract the capital it needs to modernize for greater efficiency.

- Between 36 and 80 percent of the total harvest is illegal (ADB EIA 2005). The Government receives no royalties or taxes from illegal harvest and it severely distorts domestic prices for both construction wood and fuelwood. The legal harvest in 2002 was 40,000 cubic meters of roundwood and 580,000 cubic meters of fuelwood, about one fourth of actual consumption.

- Market forces and prices are not reflected in the allocation of cutting quotas or in the setting of stumpage fees.

- Fuelwood currently constitutes between 65 and 80 percent of the total wood harvest and is used by many poor rural and urban households for both cooking and residential heating. If alternative sources of domestic fuel are not developed and current levels of forest depletion continue unabated, serious fuelwood shortages will begin to be experienced in urban areas by the end of this decade.

- Instead of dealing constructively with the primary problem of unsustainable resource exploitation, the Government has tended to focus on peripheral issues, such as an outmoded forest inventory system, fire control, insect and disease control, and reforestation, for which neither an ecological nor an economic rationale is apparent.

- Top-down enforcement of regulations has been ineffective.

Meanwhile MNE in 2005 actively promoted the "Green Belt of Mongolia" program, envisioning major reforestation efforts in steppe areas, with use of a wide variety of native species and shrubs. The main rationale for the effort is to combat desertification and deforestation.

Mongolia hunting case study

A summary report was prepared on hunting in the steppe regions of Dornod, Khentii and Sukhbaatar aimags by Scharf & Enkhbold (2002). Their main findings are summarized here to describe hunting in the Mongolian portion of the Amur-Heilong basin

The harvest of wildlife for pelts and meat has long been an important part of Mongolian herders' subsistence. With the increased incorporation of the Mongolian economy into global wildlife trade, hunting has become more intensive and commercial. In terms of the numbers of animals killed, the wildlife harvest may have peaked in the mid-20th century under Mongolia's socialist government. Since then, wildlife populations and annual harvests have generally declined.

Mongolia's transition to democracy and a market economy in the early 1990s brought about profound changes in the wildlife harvest. The political and economic transition dismantled hunting management institutions while creating economic hardship that encouraged people to return to subsistence activities such as herding and hunting. The expansion of trade with China and the opening of four-season border trading points between Inner Mongolia and eastern Mongolia exposed the eastern steppe to the vigorous Chinese market for furs and game meat. This encouraged non-professional hunters to begin hunting eastern Mongolian wildlife for the commercial market.

Between November 2000 and March 2001 *soum*-level environmental inspectors and protected area rangers in the eastern steppe region reported 1,076 incidents of hunting. 41 percent of these cases involved the harvest of Siberian marmots (mean harvest = 15 marmots), and 33 percent of the cases involved Mongolian gazelle hunting (mean harvest = 21 gazelles). Most marmot hunting incidents occurred between July-September 2001. Mongolian gazelle hunting occurred throughout the year, but the largest harvests were reported between Jan-Feb 2001.

Rangers reported that gazelle hunters using trucks (Russian ZIL-131) harvested a statistically higher average than did hunters using any other method: 31.6 gazelles per truck-aided incident, versus 9.3 for hunters overall. Soldiers (n = 6) harvested an average of 84.9 gazelles per incident, versus 9.8 by gazelle hunters overall (n = 152). Local residents were responsible for the vast majority of fox or wolf hunting.

Monitoring teams working in the Choibalsan, Baruun Urt, and Ondorkhaan markets regularly observed wildlife trade from January 2001-March 2002. For the 2001 calendar year, the value of the observed trade in all three markets came to 211 million MNT, with more than half of that revenue generated in the Choibalsan market. In 2001 monitoring teams observed skins, meat, and other products:

- Siberian marmots (Mean price = 2209 MNT);
- 515 Mongolian gazelles (mean price = 3270 MNT);
- 335 Grey wolves (mean price = 6561 MNT);
- 796 Red foxes (mean price = 5532 MNT);
- 2,544 Corsac foxes (mean price = 1994 MNT);
- 13 tons of fish (mean price = 250 MNT/kg), and various other wildlife in the eastern *aimag* markets.

For Siberian marmots, the *observed* trade volume alone was almost three times the hunting quota approved for all three *aimags*, and four times the number of licenses sold. Although the marmot-hunting season extended until the beginning of October, observed trade volumes had exceeded the *aimag* hunting quota by September 28 in the major Choibalsan market.

Market monitors reported that approximately 12 percent of Siberian marmot skins observed in the eastern *aimag* markets were harvested out of season, during the spring breeding period. Another eight percent were from immature marmots.

Although Mongolian gazelle carcasses were not counted in large numbers in the open markets, a survey of 350 Choibalsan residents in October 2001 showed that the average Choibalsan household (4.71 persons) consumed 25.4 kg of Mongolian gazelle meat annually, equal to approximately 2.5 gazelles per household. If all Choibalsan households consumed gazelles at this rate, the city's annual consumption would equal roughly 16,000 gazelles.

Surveyed Choibalsan residents reported an annual household consumption of 24.7 kg of Siberian marmot meat, and 10.3 kg of fish. Wild game and fish thus comprised about 13 percent of average household meat consumption. Forty-three percent of respondents (n = 151 households) reported eating gazelle, 45 percent (n = 159) reported eating marmot, and 39 percent (n = 35) reported eating fish.

About half of those Choibalsan residents who reported eating gazelle or marmot meat hunted it themselves. Friends, relatives, and the Choibalsan market were also common sources of both types of wild game. In contrast, most respondents who reported eating fish bought it in the Choibalsan market. Overall, respondents preferred domestic meat to wild game in terms of quality and taste, but indicated that game meat was cheaper than domestic meat.

A sociological study of six representative townships (*bags*) in the eastern *aimags* was conducted between April-September 2001 to assess hunting practices of Mongolian herders. Almost half of all households (303 of 675) engaged in hunting; 98 percent of these households hunted Siberian marmots, 39 percent hunted Mongolian gazelle, and 24 percent hunted other species.

The relaxation of gun control laws and an increase in imports of firearms inspired a sharp increase in the number of herder-hunters owning hunting rifles in recent years. Of the gun-owning herder-hunters interviewed, 41 percent obtained their firearm after 1995. The proportion of registered gun-owning households in the study sites ranged from six to 40 percent of the total population. Herder-hunters were more likely to use traps than guns when hunting Siberian marmots.

The percent of herder-hunter households among very poor households is low (42 percent hunt marmot and 14 percent hunt gazelle) when compared with wealthy households (78 percent hunt marmots and 64 percent hunt gazelle). Wealthy households, however, are a minority in the total population (36 of 377). Most hunters are in the middle and poor income classes. Hunters from "middle" income classes are estimated to harvest more marmots—averaging 90 per season compared to 30-50 for other classes—than poorer or wealthier hunters. This is due to their better access to transport and hunting equipment (c.f. poor households) and comparatively higher amount of leisure time (c.f. wealthy households with large herds to tend). For middle income herder-hunter households, hunting was estimated to contribute about 15 percent of the household income.

Of 147 interviewed herder-hunters, 89 percent admitted that they hunt Siberian marmots without a license. This information roughly matched the records of *soum* administration license sales, which showed only about 16 percent of hunting households purchased licenses. Interviewed herder-hunters who did buy hunting licenses indicated that they usually take two to three times the amount of wildlife permitted on the license: 50-80 marmots and 4-5 gazelles, compared to the average license size of 15-25 marmots and 1-2 gazelles.

About 34 percent of herder-hunters interviewed reported that they hunt illegally during closed seasons. Poverty appears to be the major driver of illegal hunting, particularly for households that subsist on marmot meat throughout spring, summer, and autumn.

Soum environmental inspectors reported that poor transport and inadequate funding for enforcement patrols are the major hindrances to their ability to enforce hunting regulations.

Chapter 14

Trade, International Investment and Tourism

Trade overlaps all sectors of the economy. Many examples have been discussed in their environmental contexts throughout this book and there is no need for repetition in this subchapter. Rather, we use a few examples from Russia and Mongolia to illustrate current trends in the region.

Environmental analysis should take an integrated catchment approach and treat as "transboundary trade" all items traded across the border of the Amur-Heilong basin rather than to discuss only trade that crosses international borders. However available information addresses only international trade, so in this overview we are unable to provide a picture of import-export trade for the Amur-Heilong basin as an economic unit. However, when possible, we make very crude estimates of total exports from the basin for particular goods.

Below we present overview of international trade from Russia and Mongolia and several sector-specific case-studies.

Foreign investment & trade in Russia, and China-Russia cooperation

Foreign investment in the RFE to date is minimal and most is related to natural resource use. Income from exported goods is an important component of the regional economy. Most of the exports from the RFE are sold to countries in the Asia Pacific Region and consist of machinery and raw materials. In 2000 southern RFE exports totaled $3,608 million, of which 44 percent was machinery, 24 percent fuel and energy, 21 percent timber and wood products, six percent metal, four percent food products (Ganzei 2004). Imports in the same year were much lower at just $615 million and 31 percent were food products (ibid.). China is a major trading partner for Russia as a whole (**Figure 2.8**), and particularly for southern RFE, and in Chitinskaya Province China trade accounts for 96 percent of foreign trade volume.

If we look more closely at Russia-China trade, we find that the proportions of raw materials and fuel have increased sharply. The following graphs were developed by the Center for Economic and Financial Research in Moscow to show 1992-2004 trends in trade and the composition of export trade for the two countries in 2002 compared to their worldwide exports (**Figures 2.9 and 2.10**). China trade composition is similar to that expected in a developed economy, whereas Russian trade is typical of a developing economy.

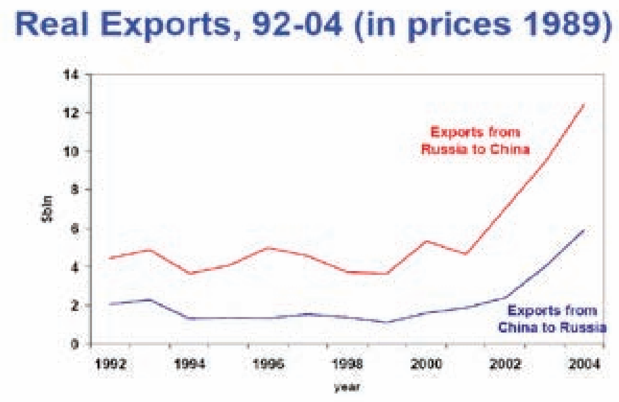


Figure 2.8 Russia-China import-export trade 1992-2004 in 1989 prices (Volchkova 2005)

In 2004, trade in oil ($2.9 billion) and roundwood ($1.4 billion) was increasing rapidly, along with ore, fish, cellulose, and fertilizers. Machinery dropped to 4.8 percent of total exports. From 2004 to 2005 trade increased 37 percent and hit an all-time high of nearly $30 billion. Arms sales are also a big factor in bilateral relations and economics. In September 2005, China contracted to buy 38 aircraft (Ilyushin Il-76 transport aircraft and Il-78 refueling planes), for a total of about $1.5 billion.

In March 2006 Hu Jintao announced that China

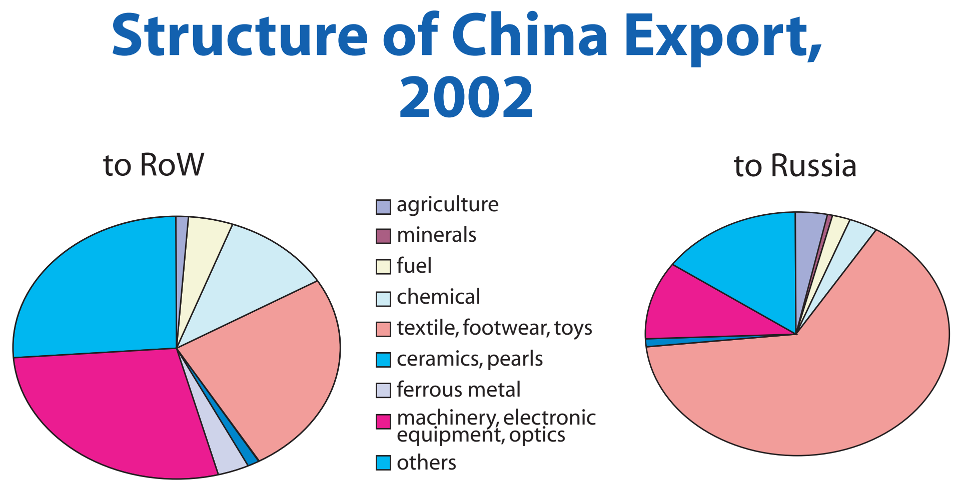


Figure 2.9 Structure of China exports in 2002

(Source: Volchkova, N. 2005. China-Russia Trade in Goods: What We Can Infer From It. CEFIR, Moscow, www.cefir.ru.)

would immediately invest $2 billion in the Russian economy across 20 projects. An additional $18 billion would be invested by 2020. Many of these projects involve oil and gas exploration and extraction and processing of raw materials for export to China.

The policy of neighboring Heilongjiang Province is somewhat similar to that of China as whole but more focused on RFE. In 2005, trade volume was $5.68 billion, or 60 percent of the province's foreign trade. Some Chinese traders claim that percentage profits from trade with Russia can reach 100-200 percent. In 2000-2005 total trade volume of Heilongjiang Province with Russia was $16.4 billion. There were 96 production bases specializing in Russian exports and 374 construction and migrant workforce contracts in 2000-2005. Seventy four new enterprises were established in Russia with $280 million in capital investment of which $220 million was the Chinese share. According to official sources, Heilongjiang province has strategic advantages as a "gateway to Russia" because of:

- geographic proximity and 25 crossing points;
- historic and cultural ties;
- developed business ties;
- mutual adjustment of banking systems; and
- extensive cooperation in technology and science.

Based on these advantages Heilongjiang attracts investment from south China and abroad for joint development of the "new northern frontier". In 2006 Heilongjiang plans to increase trade volume by 20-30 percent and by 2010 achieve a target of $14 billion. Exports would be diversified by adding more electronics, cars and construction materials. All border provinces are developing zones for processing imported raw ma-

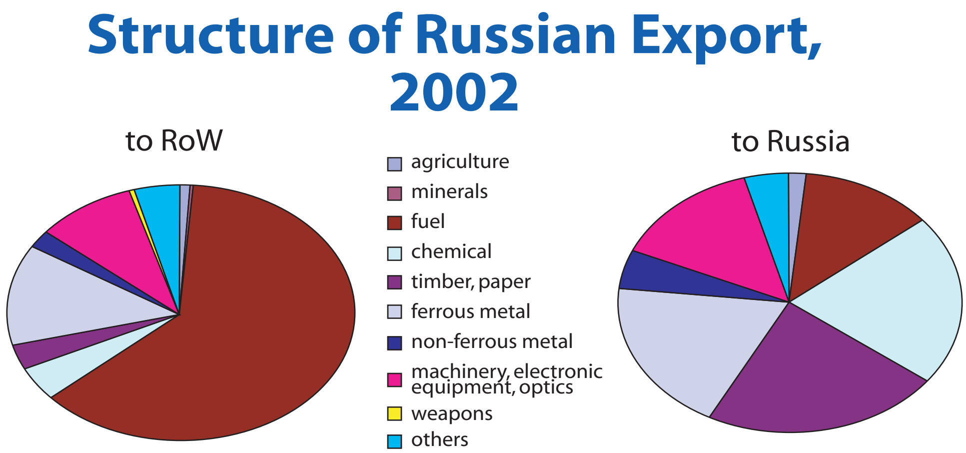


Figure 2.10 Structure of Russian exports in 2002

(Source: Volchkova, N. 2005. China-Russia Trade in Goods: What We Can Infer From It. CEFIR, Moscow, www.cefir.ru.)

terials (mainly timber and oil), with Suifenhe already achieving capacity to process 30-50 percent of timber crossing the border into value-added products. Substantial governmental subsidies are channeled to develop such border trade zones, and the China-Russia Bingxi "Technology park" in suburban Harbin.

Effective implementation of China's policy to increase the importation of raw materials and increase the export of finished goods has stimulated Russia's president to voice concern about this "unfavorable tendency" at the Beijing Summit in 2006, but this is unlikely to change the current trend.

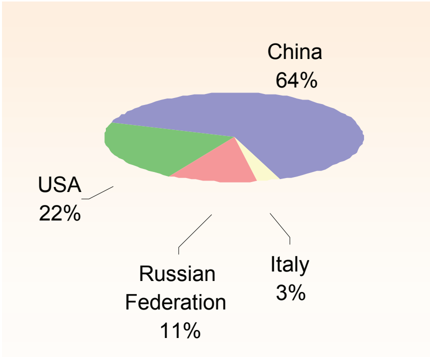


Figure 2.11 Percent of Mongolia exports purchased by China, USA, Russia and Italy in 2003

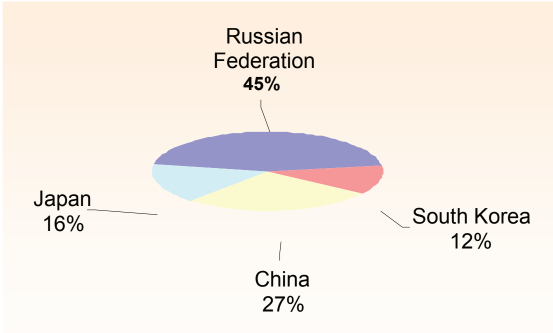


Figure 2.12 Mongolian imports from Russia, China, Japan and South Korea as a percent of total imports

Mongolia Foreign Trade and Foreign Investment

Foreign Trade

Since the beginning of its transition to a market economy, Mongolia has carried out its policy to promote foreign trade and investment. Mongolia has worked to find its place in the international arena and renew its economic system with the support of donor countries and international organizations. Compared to other countries in transition, Mongolia has achieved tangible results in trade liberalization. Mongolia's accedence to the World Trade Organization (WTO) in January 1997 highlights its success in pursuing economic reforms and developing a new trade regime in line with international trading principles. WTO membership has enabled Mongolia to engage in global trade, to access information on WTO member countries and to benefit from human resource development in international trade. Membership has also subjected Mongolia to all environmental threats associated with a free trade regime.

Until 1991, Mongolia traded primarily with former socialist countries, especially the Soviet Union. Today, Mongolia trades with over 80 countries and more than 80 percent of trade volume is with Russia, China, USA, Japan, and South Korea (**Figures 2.11 and 2.12**.) In 2002, foreign trade exceeded $1.2 billion, of which exports were $524.0 million and imports $691 million. Although trade volume increases annually, Mongolia's foreign trade balance has been negative, mainly due to low world prices for its key export products such as copper, gold, and cashmere. But metal prices increased dramatically in 2005-6, and this bodes well for Mongolia's producers and traders.

Mongolia is a poor country as measured by standards of living. The country is rich, however, in raw materials such as gold, copper, and coal, and the demand for these commodities in China is increasing rapidly. These quickly growing extractive industries need specialized equipment to expand production and many of these can be imported conveniently from Russia. In mining and other basic industries western technologies are considered to be superior. Although Russian and Chinese technologies can reach western levels of efficiency in many sectors, they have not yet reached western standards in ecological protection. This is one area where western companies might develop market opportunities in Mongolia (Mitropolitski 2005).

China is Mongolia's largest export market, consuming 64 percent of Mongolian exports. China is the main importer of Mongolian copper and molybdenum concentrate (**Figure 2.13**). Most of Mongolia's cashmere and hides are also sold to China. The United States is the second largest export market, accounting for 22 percent of total Mongolian exports. Mongolian exports to USA are mainly garments, textiles and cashmere products. Mongolia enjoys an annual tax-exempt

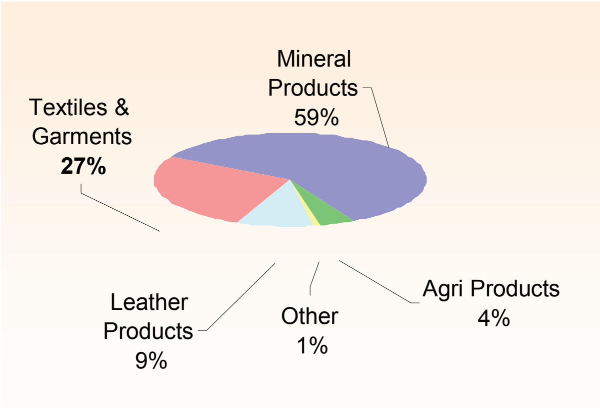


Figure 2.13 Mongolia exports by category in 2003

textile quota with the United States and the EU under a bi-lateral textiles trade agreement. The Russian Federation is the third largest export market, buying 11 percent of total Mongolian exports. Russia is the main importer of fluorspar concentrate and Mongolian meat products. Trade turnover between Mongolia and Russia in 2004 reached $280 million, a 17 percent or $36 million increase from 2003. The bulk of Mongolia's export to Russia are fluorspar (64 per cent), and beef and horse meat (22 per cent).

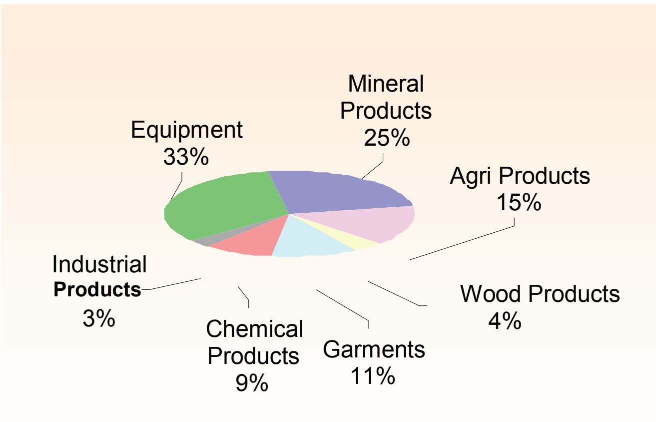


Figure 2.14 Mongolia imports by category in 2003

Russia and China are the largest exporters to Mongolia, together accounting for 72 percent of Mongolian imports (**Figure 2.14**). Russia has long been a trade partner of Mongolia and is the dominant supplier to Mongolia. Russian products account for 45 percent of total Mongolian imports. Russia supplies almost all of Mongolia's petroleum, as well as electricity and processed foods. Second to Russia, China is becoming the most important trade partner for Mongolia. China's exports to Mongolia account for 27 percent of total Mongolian imports, and this share is expected to increase. Manufactured goods and consumer products are China's main exports to Mongolia. Mongolia's imports of Japanese and Korean goods account for 16 and 12 percent of total imports, respectively. Similar to China's exports, Japan and Korea sell manufactured goods and consumer products to Mongolia.

Exports of mineral products in 2003 accounted for almost 60 percent of total Mongolian exports. Gold, copper and tungsten are the main minerals sold abroad. Copper accounts for over 50 percent of the value of all Mongolian exports, 25 percent of GDP and 15 percent of tax revenue. The dominance of copper was declining as gold production increased, but this trend will be interesting to watch as the prices for both copper and gold rose dramatically in 2005-6.

Textiles and garments represent 27 percent of Mongolian exports. Major Mongolian imports are agricultural products (45 percent), equipment (33 percent), and minerals (25 percent).

Trade and Foreign Investment

Foreign investment is a major stimulus of economic growth in Mongolia. Since 1990 over 2,400 companies from more than 70 countries invested $800 million in the Mongolian economy. Foreign direct investment created about 67,000 new jobs in Mongolia. Many world-famous corporations, such as Caterpillar, Samsung, Sumitomo, Coca-Cola, Itochu, Komatsu, Hyundai, Procter & Gamble, Ford, Mercedes-Benz, and others are now doing business in Mongolia. Mining, tourism, infrastructure and agricultural processing are major sectors attracting foreign investment.

About 15-16 percent of Mongolian territory is used for mining. Of total world production, the Mongolian mining sector accounts for one percent of copper, 3.3 percent of feldspar, 1.3 percent of molybdenum, 0.1 percent of steel and 0.5 percent of gold. In total 94,682 hectares of land have been granted to companies and enterprises under 527 licenses to exploit Mongolia's minerals. Nearly one third (28,000 ha) is used for mining. Ninety-eight percent of Mongolian energy is produced by burning coal from Mongolia's mines. Ores account for 60 percent of the country's export trade and these also are mined. The mineral resource law of 1997 was reformed and some restrictions were relaxed. As a result many foreign and Mongolian companies began new exploration projects. Before 1997 about 400 mining licenses were issued as compared to over 2,000 today. The Petroleum Law of 1991 also provided a favorable legal environment for investors. Mining is a major export industry for eastern Mongolia. There is a long history of exporting minerals to Russia and cooperation continues with China on a variety of minerals.

A total of 597,000 tons of feldspar is mined annually by Bor Undur Mining, which is a joint venture owned by the Mongolia-Russia Monrostsvetnmet Company. Feldspar is also extracted in Befkh, Khar Airag, Urgun and Khajuu Ulaan mines. Bor Undur operates a gold mine that has capacity to wash 1 million tons of sand per year. It also has open-pit coal mines with annual capacity of 100,000 tons and operates a geological exploration group.

Oil

The oil sector in Mongolia is characterized by high risk in exploration. Large investments are required for production. In spite of these obstacles, 22 oil contracts covering 538,000 km^2 have been agreed. American, Australian, and Chinese oil companies are now operating six contracts under production sharing agreements. The foreign investors have drilled 27 exploration and evaluation wells since 1993 at a total cost of about $120 million. Mongolia began to export oil in 1997 during testing of the exploration wells. Mongolia exported about 30,000 tons of oil between 1999 and 2002.

Mongolia has invested heavily in the energy sector and developed a number of technological innovations. Foreign investment was permitted to ensure reliable delivery of electric power through a unified network to rural areas. To achieve this objective, hydropower plants will be built in Gobi-Altai, Zavkhan, Khovd, and Bulgan Provinces, and the transmission network will be extended throughout the country.

To support these initiatives Mongolia is reforming institutions in preparation for privatizing state properties in the energy sector. Construction of the Ulaanboom hydropower plant began in 2004 with a $13 million loan from the Abu Dhabi Fund (United Arab Emirates). Completion was planned by 2005. In August 2006 at the regular meeting of Russia-Mongolia Commission on Transboundary Waters, Mongolia officially informed Russia about construction of a hydropower plant on a tributary of a Selenge River draining into Lake Baikal. It is expected that Russian firms will bid for construction services and/or supply of machinery.

Tourism in the Amur/Heilong Basin

Development of tourism is an important part of the "Revitalizing the North East Policy in China. In August 2005, an agreement was signed by five major cities of northeast China to "Establish a common tourism zone" from the Sea of Bohai to the Russia border. Nature tourism is especially important for Heilongjiang, Inner Mongolia, and Jilin, all of which lack cultural attractions.

The famous scenic spots in the Amur-Heilong River basin are mostly in nature reserves. For instance, Changbai Mountain, at the origin of the Second Songhua River, a famous nature reserve, with rich biodiversity. Xianghai, Zhalong, and Wudalianchi Nature Reserves are also important environmental education tourism destinations. In comparison with many other China regions that are rich in historic relics and relatively poor in wilderness, northeast China is viewed as a destination for nature tourism. The attractiveness of many tourist spots, like Xingkai-Khanka Lake Nature Reserve could be greatly increased by extending domestic tourism routes into neighboring regions of Russia. Numbers of Chinese tourists visiting the Russian Far East or passing through is growing steadily and in 2002 exceeded 800,000. By 2005 it probably exceeded 1,000,000.

However rewarding, the increase in tourism has a flip side. Many nature reserves in China have suffered biodiversity losses from poorly managed tourism development including excessive infrastructure, direct impacts from multitudes of tourists, and pollution. To date, the Chinese government has inappropriately provided incentives to nature reserves and national parks to maximize profits from tourism. Tourism is poorly managed because environmental awareness and related skills of tour operators are minimal.

Tourist programs are often designed without appreciation of key ecological processes at a given nature reserve (i.e. Dalai Lake NNR in Inner Mongolia, where establishment of tourist facilities at a lake shore with highly fluctuating water regime is a major reason for water transfer from neighbouring Hailar river to stabilize water level.)

Russian private tour operators and nature reserves are unprepared to design and implement proper programs tailored to Chinese tourists. Nature tourism in Russia follows a western model with small groups and minimal impacts, and this is not popular among Chinese tour operators entering Russia. Although nature and scientific tourism theoretically hold promise for building mutual trust and appreciation of nature, this has not been realized in practice.

China tourism to the border cities of Russia is typically focused on site-seeing in large cities, shopping, and night-club entertainment. This model is unlikely to achieve long-term success. A potential compromise solution is to develop activities at resorts, mineral springs, and other "health oriented" sites that include environmental education components. Given the unique variety of experiences to be enjoyed in the RFE, which lacks historic monuments and cultural attractions, nature tourism will inevitably find its way across the border. The Amur-Heilong River itself has potential to become a major tourist attraction as soon as boats are available to ferry tourists through the gorges to the Pacific Ocean. The government of Heilongjiang Province, in its recent proposals to Russian partners, strongly emphasized development of nature tourism as a focus of cooperative projects.

Although wild nature is the main attraction for tourists, the Amur-Heilong basin also has special spiritual places, such as Changbai Mountain, the cradle of the Korean nation. Buddhist pilgrimage is important for Aginsky-Buriat Autonomous Region of Russia, with Alkhanay National Park established to protect landscapes of world-famous Buddhist sacred place. To prepare for anticipated demand local governments have developed modern tourist facilities, interpretation centers and services, and have completed a tourism resource inventory for Chita Province and Aginsky-Buriat Autonomous Region.

In Mongolia international nature tourism and culture tourism have recently emerged as growth industries. These sectors are becoming popular among USA and European tour operators and their clientele. Although this type of tourism is expected to be environmentally benign, safeguards are often lacking and the industry has not yet benefited local nature conservation. A notable exception to this pattern is Mongolia River Outfitters, an excellent example of an organization whose profits from tourism benefit local communities.

There were 205,000 visitor arrivals in Mongolia in 2003, up from 158,000 in 2000. Around 180,000 of these were private visitors not in tour groups. Most came from China and Russia, which taken together accounted for 144,000 arrivals or around 80 percent. Only 22,000 visitors stated that tourism was the main reason for entering the country, but many visitors are believed to mix tourism with other activities. Nature reserves and national parks are the main destinations for nature tourists who represent a potential source of funding for sustainable management of these sites. Despite Mongolia's relatively isolated location and short tourism season, arrivals are increasing. Assuming the number of tourists and part-time tourists to be 50,000, and average spending to be $500 per visit, around $25 million in revenue is generated. This compares with the total 2003 budget allocation for protected area management of $0.28 million. Trophy hunters are small in number but their spending is large. This sector is poorly documented so it is impossible to accurately gauge the impact of hunters on the national economy (ADB CEA 2005).

China's Inner Mongolia Autonomous Region views nature tourism as an important sector for cooperation with eastern Mongolia (ADB 2002). The scenic landscapes in the Upper Onon and Kherlen basins are known as the birthplace of Genghis Khan, so they will probably become a major tourism destination. The consequences for landscape preservation are unpredictable. Development of international tri-country nature tours in the Daurian Steppe is impeded by bureaucratic barriers including permits for border crossings, especially in Russia, and lack of appropriate tourism infrastructure.

Chapter 15

Case Study: Russia-China Cooperation in Forestry

Main concerns

Timber trade was the most likely issue behind Russian President Putin's expressed dissatisfaction with "unfavorable trends in trade balance and conduct" in March 2006. The International Workshop on Sino-Russian Timber Trade in September 2006 addressed the Baikal Economic Forum and other stakeholders in the Russian Far East, Siberia, and China. The workshop highlighted three concerns:

1) "Booming log trade between Russia and China: China has become the number one importer of timber products in the world over the past seven year, and Russia has become the number one supplier to China, supplying approximately 26.4 million m^3 (or 50 percent) of China's total timber product imports. The majority of Russian timber exports to China are unprocessed (90 percent of Russia log exports are to China), prompting the Russian government to impose log export taxes in 2006;

2) Uncertainty about the Russian forest resource base: Only a small amount of commercially valuable timber remains within economically accessible zones. Degraded forests dominate today's forest landscapes, which are increasingly susceptible to fire and other agents of damage, due in part to poor logging practices. At current harvest rates, the Russian Far East could be logged out in 20 years. The large capacity processing industries developing on the Chinese side of the border could be left with little raw material input.

3) Uncertainty over the legal status of timber exports: Estimates of the extent of illegal logging in Siberia and the Russian Far East range from 15 to 70 percent, depending on the definition and methodologies used. Recent research tracking an illegal Russian log sold at the border for US$140 per m^3 shows that bribe-takers and foreign middlemen take the majority of the profit (**Figure 2.15**) with little or no revenue generation for local government and communities (New Scientist 2006). This illegal trade results in higher prices and reputation risk for China-based entrepreneurs, especially those wishing to invest in Russia or to re-export to environmentally sensitive markets in Japan, Europe and North America[1].

Russian Timber Exports

The southern parts of eastern Siberia and the Russian Far East are the main timber producing regions exporting roundwood to China, Japan, USA, and the Republic of Korea. An approximate border dividing the western from the eastern directions of Russian timber exports can be drawn along western border of Krasnoyarsk Province.

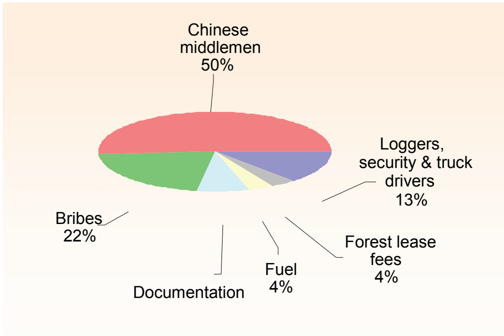


Figure 2.15 Percentage benefits from the sale of 1 m^3 of illegally harvested Russian timber (price = US$140/$m^3$ at the Russia-China border)(adapted from: Stakeholder Statement to the Baikal Economic Forum, September 2006)

Trade and investment in the timber industry date back to the first decade of the twentieth century, but large-scale investment began only in the late 1960s when the Japanese government and some of Japan's largest corporations orchestrated a series of long-term agreements with the Soviet government that provided Japanese tech-

[1] Stakeholder Statement to the Baikal Economic Forum. September 2006.

nology and low-interest government loans in exchange for raw materials. These agreements helped the Soviets develop large-scale regional production complexes in the RFE and Siberia along with the export infrastructure needed to serve the Japanese market. Although such government agreements are no longer maintained, they paved the way for similar arrangements between Russian and Japanese private sector companies and were instrumental in developing the industries that dominate the economy today.

The first government-arranged agreement was the KS-Sangyo Project, designed to exploit the region's vast forests. Signed in 1968, KS Sangyo (named after the consortium of Japanese companies it represented) called for the export of more than eight million m^3 of raw logs to Japan in exchange for bulldozers, logging machinery, steel pipes, and other equipment over a five-year period. The Japanese government would also provide soft, low-interest loans that the Soviets could re-pay using raw materials. This powerful agreement catalyzed Japanese-Russian trade: by 1970, 63 percent of all Japanese machinery and metal goods trade with the USSR was facilitated by this agreement, and Japan had emerged as the USSR's largest trading partner. Two more KS-Sangyo projects followed, and together they provided for the export of more than 32 million m^3 of timber to Japan. More importantly, the agreements gave the RFE a continuous supply of timber-cutting, hauling, and road-building machinery for the duration of the three projects (1969–1985). Missing in these agreements, however, was a significant percentage of Japanese wood-processing equipment.

Although beneficial for Moscow and Japan and selected corporations, these long-term agreements reinforced the extractive orientation of industries by facilitating the export of raw materials rather than manufactured goods. In the process, the agreements restricted opportunities for the RFE to make structural economic changes. (Newell 2004).

Timber products — primarily round wood — are a large share of goods exported from the Russian Amur-Heilong basin. The largest importers of timber in the Asia Pacific Region are Japan, China, and Korea (**Figure 2.16**). The RFE is geographically the closest supplier of timber products to these countries.

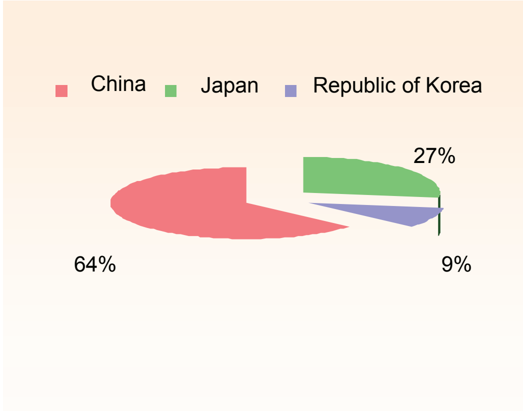


Figure 2.16 Main consuming countries of Russian raw logs in Asia-Pacific in 2002 by volume (After D. Smirnov 2004,Report at TRN Conference)

Until 2001 Japan was the key importer of timber from the RFE. Japan has now conceded this role to China where markets are more elastic with respect to prices and timber quality. Given high domestic milling costs, Japan is increasing its imports of lumber and other processed timber products. The China timber market was totally reorganized following the 1998 government reform of the Chinese forestry system and this reorganization led to significant harvest restrictions. The timber harvest in China declined 30 percent from 68 million m^3 in mid-1996 to 48 million m^3 in 2003. Wood products imports to China, in round wood equivalents, were 82 million m^3 in 2003, or 1.7 times higher than domestic timber production (Sun et al. 2004).

Russia, Malaysia, and Indonesia have been the three leading suppliers by volume of timber products to China since 1997 (Forest Trends 2004). Total imports of timber products from these three countries accounted for over 50 percent of China's total each year between 1997 and 2002. In 2002 China's combined timber product imports from the three totaled approximately 23.6 million m^3 RWE (round wood equivalent) valued at $2.1 billion.

For the past eight years Russia, like other timber exporting countries, faced China's rocketing demand for wood (**Figure 2.17**). The rise in Russian imports over recent years has been even sharper and Russia is now the top timber product supplier by volume to China. In 1997, Russian timber product imports were 970,000 m^3 RWE valued at $93 million. By 2002, import volume had risen to 15.8 million RWE, with a value of $1.06

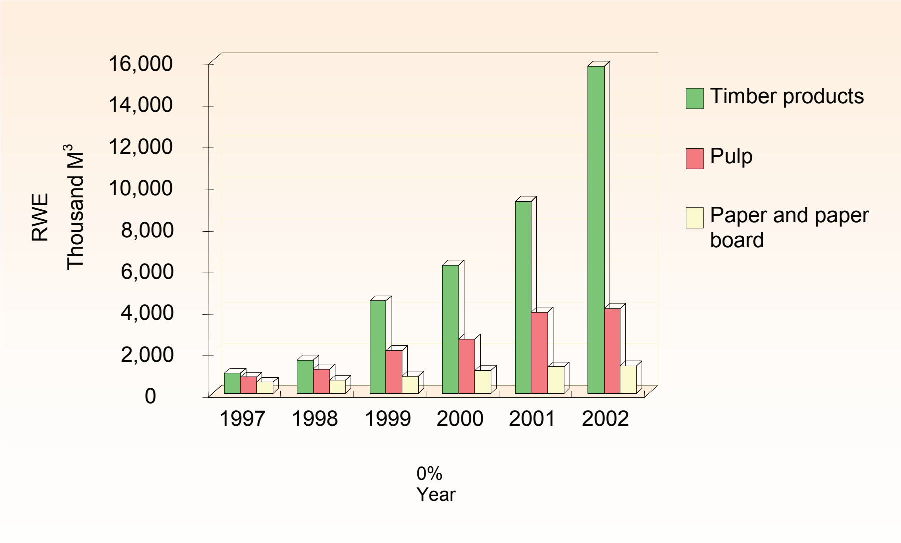


Figure 2.17 Russia supply of forest products to China (Source: Sun, Katsigris & White 2003, Forest trends report)

billion, and three years later has risen another 70 percent surpassing 25 million m^3.

In 2003, 26 Russian regions exported wood products to China. Seven leading regions (Krasnoyarsk, Irkutskaya, Buryatia, Chitinskaya provinces in Eastern Siberia, and Amurskaya, Khabarovsky and Primorsky provinces in Russian Far East) accounted for 96 percent of total Russian forest product exports to China (**Figure 2.18**). Some regions bordering China, such as Chitinskaya, Amurskaya, Evreiskaya Provinces exported over 98 percent of their total wood exports to China. Approximately 35-40 percent of this timber was produced in Russian provinces of the Amur-Heilong basin.

Given its close proximity to Asian markets, southern RFE timber has always had a price advantage over timber from other Russian regions. In spite of this competitive advantage, its market share has declined due to increases in production and transportation costs, both in rubles and in dollars. Siberian timber that is produced at companies with comparatively lower electricity costs is successfully displacing southern RFE timber on export markets, with the volume of timber exported to China almost doubling that exported from southern RFE. Note that Siberian export volumes are inflated to some extent

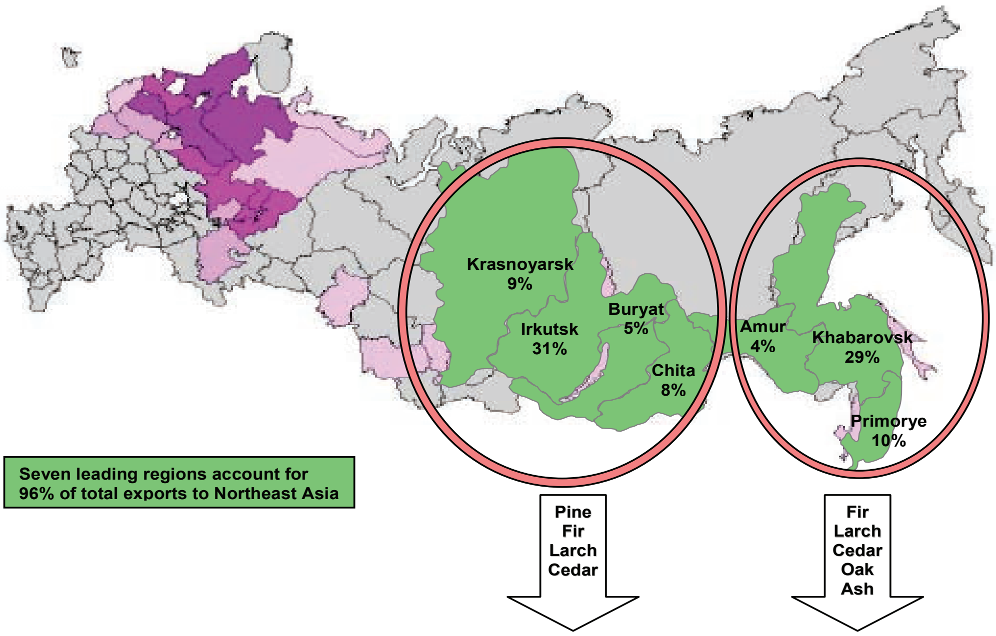


Figure 2.18 Russia timber exports (logs & lumber) to China by main regions (shares in total value) and main exported species in 2003

because Chita Province is included in Russian Statistics as part of Siberia whereas in this book it is part of the Amur-Heilong basin.

The State earns little revenue from the forest industry because of the low level of processing, which is characteristic of present-day Russia. Industrial roundwood dominates wood product exports, leading by export value and to a greater extent by quantity (**Figure 2.19**).

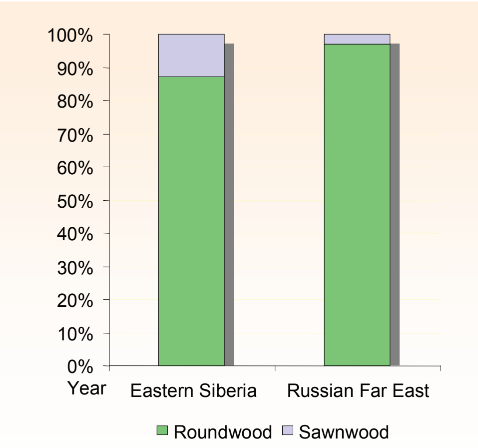


Figure 2.19 Industrial roundwood and sawnwood exports by percent in 2003

Exports of round wood do not earn returns adequate to fund proper forest management or ensure the prosperity of local communities. At the same time, selective logging for export of commercial high-grade timber leads to rapid expansion of cutting areas and quickly exhausts available forest tracts for further profitable use.

The main wood processing plants in eastern Siberia and the RFE have antiquated equipment that cannot produce high quality, competitive sawn wood. There are some new plants with modern equipment that produce modern high-grade sawn wood, but these are not competitive in price with Chinese processing plants. The close proximity of the RFE to China and its cheap processing and labor costs offers little chance to develop processing industries in RFE.

The upcoming entry of Russia to the WTO will complicate the competitive positions of processing industries in eastern Siberia, and especially in the RFE. It will also bring about the relaxation of administrative measures to control timber exports and other commerce in the border areas of China and Russia. This does not bode well for natural resource conservation in the RFE unless there are substantive changes in the regulatory and enforcement regimes.

Southern Russian Far East

The situation in the southern Russian Far East was studied by Sheingauz (2006). The RFE forest sector has almost always focused on forest product markets in adjacent countries, and first of all on timber markets. Since the 1990s the RFE forest sector has sold almost all its product abroad. **Table 2.41** shows very high export quotas (exports as a percent of total production) for round logs and lumber: 86 percent for both products. Lumber quotas are not high (24 percent) because 2/3 to 3/4 of the lumber is used domestically. Export quotas exceeding 100 percent might be explained by transit exports from other regions. Alternatively, some illegal timber is not statistically accounted for as production and passes the border as “laundered” product, and is first entered into customs data and then into government statistics.

Table 2.41 Timber exports from the RFE (Sheingauz 2006)

Territory	Exports (‘000 m^3)		Export quota (percent)	
	timber	lumber	timber	lumber
Primorsky Krai	2,486	74	86	36
Khabarovsky Krai	6,738	130	86	30
Amurskaya Oblast	1,321	5	105	7
Evreiskaya Autonomous Oblast	128	15	96	112
RFE	10,673	224	86	25

Sources: Amurskaya Oblast Statistical Yearbook (2003); Primorsky Krai Forest Industry (2004); Statistical Yearbook of Evreiskaya Autonomous Oblast (2004); RF Customs Committee, 2005.

Driven by market demand, the composition of export species evolved rapidly from 1998-2003 (**Table 2.42**). During 1998-2003, export volumes of birch round wood increased 13.5 times, for aspen and poplar — 28.5 times, and for linden — 128.6 times. The percentage harvested of ash, oak, birch, linden and aspen was higher than their representation in mature forests, meaning that these species are being depleted.

In addition to market demand, the situation has also been influenced by depletion of some species and by the onset of felling in larch forests that were never before exploited. The gradual decrease in the percentage of pine, despite an increase in demand for pine on foreign markets, is associated with the depletion of pine forests in the southern RFE. The drop in Korean pine exports is tied to the decrease in its volume in regional forests where it is harvested as an associate species in what are the most productive mixed forests in southern RFE (Sheingauz 2006).

Table 2.42 Species of round log exports from the RFE, and mature timber in natural forests, percent (Sheingauz 2006)

Timber species	Export percent by year			Species percent share in natural forest stands
	1998	2000	2003	2003
Larch	29	34	57	65
Spruce and Fir	45	50	20	8
Pine	6	4	3.7	5
Siberian and Korean pine	1.4	1.5	0.7	0.3
Ash and Elm	12	3.9	4.7	0.3
Birch	0.7	1.8	4.6	8
Oak	3.3	3.5	3.2	0.9
Lime	<0.1	0.5	3.2	0.6
Poplar and Aspen	0.2	0.6	2.4	0.8
Miscellaneous	2.1	0.4	0.3	11
Total	100	100	100	100

Timber trade with China

The timber deficit in China has forced China to rapidly increase its imports of RFE timber (**Table 2.43, Figure 2.20**). Export volumes from RFE increased 9.3 times in five years (1998-2003). China not only imports most of the timber exported from the RFE, it also buys the majority of the most valuable tree species. China is the primary purchaser of species that are either limited or banned from harvest in the RFE. 81,000 m^3 of Korean pine, 5,000 m^3 of Manchurian walnut and over 300,000 m^3 of lime were exported to China in 2003, which is 64 percent, 88 percent and 97 percent of total export for each of these species, respectively.

The primary destinations for Russian timber are the northeastern provinces of China where forests are similar to the forests in the southern RFE and where local timber mills and end product consumers are experiencing raw material shortages.

China conducts a coordinated timber trade and price policy. The Chinese market for imported wood has few buyers and many sellers. Consequently, the buyers dictate prices to timber suppliers who compete with each other and this drives prices downward (**Figure 2.21**). Base prices are set in accordance with the volumes of forest resources that timber producers can produce at existing costs. Commerce regulation through forest exporter associations and government support is needed to coordinate export prices to confront this huge foreign influence that is externally determining options for development of the RFE forest sector. There is no such policy as yet and the increasing number of exporters is creating chaotic conditions for sellers. Moreover, unethical competition, local dumping and other disrep-

Table 2.43 Importers of RFE timber in 1998, 2000 and 2003 (Sheingauz 2006)

Country	1998		2000		2003	
	Volume in roundwood equivalents ('000 m^3)	Cost (10^6 USD)	Volume in roundwood equivalents, thousand m^3	Cost, (10^6 USD)	Volume in roundwood equivalents, thousand m^3	Cost (million USD)
China	697.9	75.35	2,350.2	18.35	6,494.8	341.59
Japan	3,362.7	201.22	4,312.0	252.84	4,167.6	273.73
Republic of Korea	689.1	24.72	1,673.0	63.64	1,691.5	71.58
Vietnam	-	-	7.7	0.51	8.9	0.75
People's Dem. Rep. Korea	26.5	0.26	9.9	0.36	4.6	0.35
Canada	0.4	0.07	-	-	1.5	0.14
USA	0.9	0.07	6.0	0.46	1.0	0.12
Taiwan	0.04	0.01	3.5	0.18	0.1	0.01
Malaysia	-	-	-	-	0.03	0.0003
Total	4,777.6	301.69	8,362.4	336.34	12,370.1	688.29

Note. Totals in Table 2.43 differ slightly from data in previous tables due to discrepancies in declarations.
Source: RF Customs Committee materials, 2005.

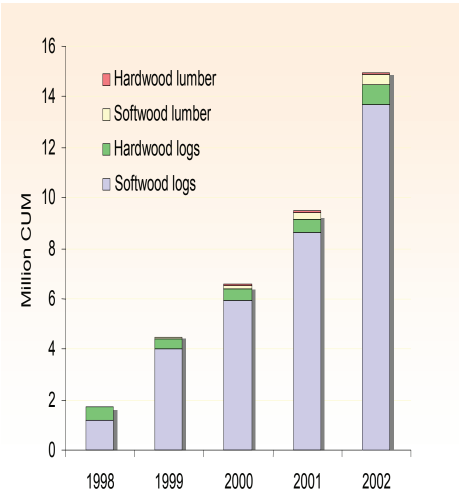


Figure 2.20 Dynamics of Russian timber exports to China in1998-2002 (from Lankin 2003)

utable actions that disrupt the market are widely used among numerous wood-selling companies (Sheingauz 2006).

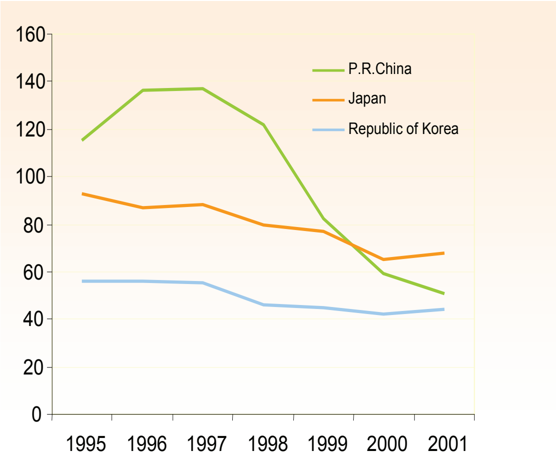


Figure 2.21 Price trends on Russian timber in northeast Asian countries ($/m3) (from Lankin 2003)

Research by Lankin (2003) explains how the rapid growth in trade volume coincided with declines in timber prices in the China market that were steeper than in other Asian markets (**Figure 2.21**).

Growing quantities of exports coupled with declining prices can be explained by various factors, but the most probable are two. First is a surplus of supply over demand primarily because of the growth in number of Russian exporters. Second is coordination among the principal Chinese importers on price policy together with aggressive marketing by Chinese traders in Russia.

The limited commercial effectiveness of Russia's timber exports to China is aggravated by the great number of exporters, most of whom are small and unprofessional firms. From 1998 to 2002 their total number grew from 615 to 2,381, or nearly four times (**Figure 2.22**). The numbers of joint-stock companies and private companies of limited liability grew most significantly.

Most of the small exporters are in early phases of capital accumulation, have no production or export infrastructure, and act as simple intermediaries depending on large Chinese trading companies to support them. These small exporters and private entrepreneurs are interested in quick profits, not environmental or social issues. Sometimes they cooperate with criminals to avoid taxes. Over 90 percent of them are net traders. In these cases no revenue return to government to fund forest management.

Meanwhile, in China, the number of Chinese importers increased 2.5 times, from 190 in 1998 to 475 in 2002 (as declared by Russian exporters). This growing gap between large numbers of Russian exporters and relatively few Chinese importers is due to an influx of mainly unprofessional exporters into border regions in Russia, and the contrasting relatively stable society of experienced importers across the border in China. This difference explains the falling prices for Russian timber after 1999: Disorganized and spontaneous mass offers of timber from the markets of Russia were met by coordinated and relatively disciplined purchasing behavior in China.

The vast majority of Chinese importers occupy small cities and towns along the Russia-China border, mainly in Inner Mongolia (Manzhouli, Erlian Huote) and Heilongjiang (Suifenhe). Until recently all these companies were traders who sold imported Russian logs in the numerous wholesale markets in northeast China. These traders came from the larger, former state foreign trade companies or joined forces in small trading companies created by provincial or local governments. Frequently the latter are off-shoots of State Forest Industry Bureaus established to compensate for abrupt declines in domestic production by importing roundwood from Russia. Although these trading companies are private with limited liability, most retain some level of state control through shares owned by provincial and local governments, or forest industry bureaus.

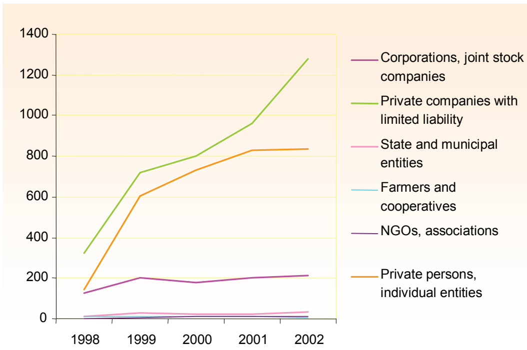


Figure 2.22 Growing numbers of RFE forest products exporters to China (from Lankin 2003)

The monopolistic trade intermediaries in northeast China are an obstacle to increased profits for Russian timber exporters. Northeast China provincial authorities and trading businesses do not wish to see new trading companies set up by immigrants from China's hinterland because this would increase competition for established importers. This restricts the number of potential buyers for Russia's exports and reduces price flexibility. Meanwhile, Russian exporters cannot directly enter the timber market in northeast China because Russian exporters cannot supply timber to China without being represented by a Chinese export-import trading company (Lankin 2003).

In September 2000, governments of Russia and China signed an agreement to jointly develop forest resources and timber trade. The agreement was aimed at obtaining concessions from Russia and enabling Chinese investments to flow into the Russian forest sector. To date, few investments have been made in the remote areas of the RFE but the agreement increased the pressure on Russian forests along the Russia-China border and Trans-Siberian railway where access and transport infrastructure are better.

Another concern is potential competition between provinces of the RFE and Eastern Siberia to supply the well-coordinated Chinese market. This might result in diminishing environmental standards in an effort to reduce production costs of logging enterprises.

Growth in Chinese investment in Russia characterizes the second half of the 1990s and the early 2000s. The Chinese typically establish companies without Russian participation, and the total investment in the forestry industry has been limited. For example, only six percent of Chinese investments in the Khabarovsky Krai economy in 2002 went to the forest industry. By 2003 several Chinese timber enterprises were registered in Primorsky Krai, three in Amurskaya Oblast, five in Sakhalinskaya Oblast, and three in Evreiskaya Autonomous Oblast. Two large timber mills with Japanese capital and seven saw mills with Chinese capital were operating in Primorsky Krai in 2003 (Korchagin 2004).

The percentage of foreign investment in the RFE forest sector is insignificant. Khabarovsky Krai is an exception, with two large timber joint ventures ("Arkaim" and "Sovgavan-Les") and three foreign companies owned by the Malaysia-China company "Rimbunan Khidzhau". In 2003 they produced 17 percent of the Khabarovki timber production total.

There are also several small Chinese saw mills in Khabarovsky Krai. Despite their small production, Chinese funded timber companies have also become an integral part of the forest sector in Evreiskaya Autonomous Oblast in recent years. Some Chinese investment escapes official reporting because it is based on barter-deals without signed contracts. The Chinese provide Russian contractors with equipment under conditions to repay costs and interest in timber over three to five years, and with only a slight allowance for price fluctuations, with all production going to the investor (Sheingauz 2006).

In recent years many concerns have been raised about plans for Chinese government organizations and multinational corporations to invest heavily in Russia's pulp and paper industry. Asia Pulp & Paper (APP) has conducted negotiations with administrations of a number of forest provinces in Siberia and the RFE to invest USD1.35 billion in pulp mills. Chinese investments are conditional based on the issuance of long-term timber concessions. While Russia is willing to allot such concessions in remote and undeveloped areas in Siberia, China investors usually have no interest in such concessions because of lack of roads.

A recent promise from China leaders to jointly develop processing in Russia, could have negative environmental and social impacts. In Citinskaya Province heated debate began in 2003 over an obscure pulp mill "Amazar/Mogocha cellulose plant" project. In 2003 three China enterprises planned to jointly invest ¥2.3 billion (around $300 million) in a lumber and wood processing plant in Russia. Under an agreement signed in July 2003, Heilongjiang Star Paper Co., Zhuhai Zhenrong Company (from a Special Economic Zone near Macao in southern Guangdong Province) and Heilongjiang Huacheng International Economic & Technological Cooperation Co. planned to begin the project in Russia's Chita region in the second half of 2003. The project, scheduled for completion in 2008, was to have a lumber capacity of two million m^3 per year. Some 1.5 million m^3 of logs would be processed locally for the production of 300,000 m^3 of quality timber and 400,000 tons of quality paper pulp.

According to estimates of local experts there is not sufficient quality or quantity of timber supply in the area for a large cellulose plant. Excessive logging to supply such a plant would probably lead to negative changes in forest ecosystems bordering steppe areas. There is also no local workforce to operate the proposed plant and of 1,500 proposed workers, 1,200 would come from China.

To date development has been limited to intensified logging near the confluence of the Argun and Shilka Rivers and construction of a bridge to move logs across the border. This leads local observers to believe that the proposed "cellulose plant" is a front for more intensive export of round timber. Similar vague plans for a cellulose plant and a preliminary agreement exist for the Khor (Chord) River watershed in Khabarovsk Province.

Impacts of the timber trade have recently been the subject of rigorous analyses by various NGOs, international think-tanks, governmental offices, and others. As a result, the environmental impacts are well studied. In the early years of the China-Russia timber trade local communities and regional administrations had high hopes for recovering economic and social standards on the vast forested territories of eastern Siberia and Russian Far East through wood product exports to the huge China market. However, the trade ultimately became an environmental burden on the forests, especially in regions bordering China or in proximity to railways and seaports. Little revenue found its way back to local economies. During these years several forces combined to trigger shadow businesses, illegal logging, corruption and other negative practices. These included Chinese timber merchant efforts to obtain cheap prices by making cash purchases, and economic liberalization under depressed social and economic conditions in Russia.

Chapter 16

Case Study: China-Russia Cooperation in Energy

China is interested in greater international cooperation in development of energy supplies, particularly oil and natural gas, and Russia is the most promising partner. Japan, China, and North and South Korea depend to a large extent on imported fuels: oil, natural gas, and coal. Their demand for imported fuels and electric power is likely to increase in the future. Current exports of fossil fuels to these countries from and through the RFE are small but growing.

If we consider the oilfields at Daqing, which supply up to 40 percent of China's domestic oil, as well as growing production in Jilin, Inner Mongolia, and Dornod, Mongolia, the entire basin will be influenced by the growing potential for environmental damage by the oil industry. Indeed, the basin already faces problems associated with oil-fields and refineries. These include pollution, disruption of water regimes, and degradation of wetlands in the Song-Nen Plain. There are also tremendous risks associated with oil transport infrastructure of pipelines, railways and ports. These are discussed in Part Three. A brief discussion of energy demand and supply is presented below using China-Russia ties as an example.

China Energy Demand

A brief discussion of energy demand is presented below using China as an example. According to the State of the World 2006 report, China is facing tremendous challenges to meet its rapidly growing energy demands (**Figure 2.23**). China currently relies on coal-fired power plants which degrade air quality in all major cities. Meanwhile use of oil remains low on a per capita basis (**Table 2.44**). China's use of nuclear, hydroelectric, and alternative energy sources increased sharply from 1991 to 2004. By 2004 China's use of hydroelectric and alternative energy exceeded Japan, Korea, and the United States on a percentage basis (**Table 2.45**).

The main reasons for the rapid increase in energy demand beginning in 2000 (**Figure 2.23**) were growth in the manufacturing industry, increased development of housing and office buildings, and a sharp increase in use of private vehicles. The rapidly increasing sales of private automobiles and household appliances have been responsible for huge increases in household energy consumption.

Electricity Shortages

During the summers of 2004 and 2005, China's power demand exceeded supply and transmission capacity in many regions, forcing electric grid managers to subject most of the country's cities to rolling blackouts. This disrupted home and office life and forced factories to curtail operations. Many companies responded by buying inefficient diesel generators, compounding the

Table 2.44 Oil and coal use in China, India, Germany, Japan, and USA in 2004

Country or Region	Coal use (million tons of oil equivalent)	Oil use (million barrels)	Oil use per person (barrels per capita)	Net oil imports (million barrels per day)	Share of Imported Oil (percent)
China	957	6.7	1.9	3.2	48
India	205	2.6	0.9	1.7	65
Germany	86	2.6	11.9	2.6	100
Japan	121	5.3	15.2	5.3	100
USA	564	20.5	25.3	13.3	65

Table 2.45 Percent of primary energy consumption by source, 1991 and 2004

Energy Source	China 1991	China 2004	Japan 2004	Korea 2004	USA 2004	World 2004
Oil	17.7	22.3	46.9	48.3	40.2	36.8
Natural gas	2.1	2.5	12.6	13.1	25.0	23.7
Coal	78.7	69.0	23.5	24.4	24.2	27.2
Nuclear	0.0	0.8	12.6	13.6	8.1	6.1
Hydroelectric and others	1.5	5.4	4.4	0.6	2.6	6.2
Total	100.0	100.0	100.0	100.0	100.0	100.0

Sources: BP (2005) and APERC (2004)

pressure on oil supplies. In addition to the power-saving measures advocated by the power-experts, a louder appeal is heard daily to strengthen government regulation of the electric power prices. However, even the most conservative scenario predicts rocketing growth in total consumption for years to come.

From 2003 to 2004 China's power use increased by 15 percent. New generation capacity totaled 49.3 million kW and the total installed capacity exceeded 440 million kW. Although China's total installed capacity equals the combined total for Britain, France, and Germany, and exceeds Japan's 280 million kW, the GDP created with it lagged far behind because the economy is burdened by too many sectors using and wasting too much energy.

Due to an insatiable thirst for energy, the China energy market is expected to change radically in coming years. This will be based in part on the development of renewable energy. China promulgated a new law on renewable energy in February 2005, which took effect in January 2006. Mid- and long-term development projects for renewable energy designed by the National Development and Reform Commission (NDRC) and related departments are planned to meet China's energy requirements through 2020, and achieve government's targets for production of renewable energy. Mechanisms will include financial and tax incentives to encourage the development of renewable energy sources including wind, methane and bio-energy. According to the Natural Resources Defense Council, wind power has become increasingly popular in China. By the end of 2005, China's wind power capacity had reached nearly two million kW or 0.5 percent of the total installed capacity in 2004.

China has also seen progress in the development and use of bio-energy, solar power, and geothermal energy in the past five years. At the end of 2005, nearly 17 million Chinese rural families were using methane and the number of major methane projects exceeded 2,000. China's annual methane consumption has reached eight billion m^3. Experimental bio-

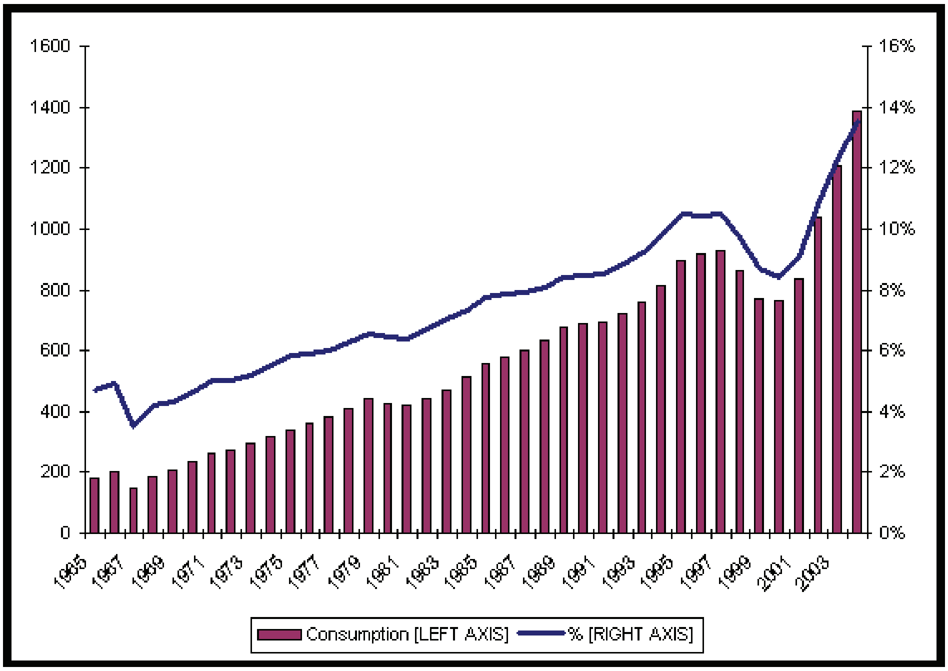


Figure 2.23 Energy consumption in China from 1965-2004 (million tons of oil equivalent and percentage of world consumption) (Source: BP 2005)

power projects involving burning agricultural residues have started in Hebei, Heilongjiang, Shandong, and Jiangsu Provinces.

By year-end 2005, the absorptive surface area of China's solar water heaters had reached 80 million m^2. The energy produced was equivalent to burning 10 million tons of standard coal. China's consumption of renewable energy in the year 2005 was equal to 160 million tons of standard coal, accounting for seven percent of national energy consumption.

Even greater attention is paid to energy saving and more efficient use of electricity. Industries of the northeast are tasked to design and produce more energy efficient equipment for households and industrial use. The northeast electricity market and united regional grid are being introduced in 2003-2006 to overcome inefficiency and losses. Thermal plants will joint the market first and will be followed shortly by hydropower plants.

Oil consumption

China doubled its oil consumption between 1995 and 2005 when world demand grew by a relatively modest 20 percent. Since 2003 China has consumed more oil than Japan and in 1993 China became a net importer. China's current foreign purchases account for more than half its consumption. More than a third of these imports are from the Middle East.

China imported 123 million tons of crude oil in 2004, up 34.8 percent over 2003. China was the world's third largest importer, after the United States (12.9 million bbl/d), and Japan (5.2 million bbl/d). China is expected to more than double its oil consumption and triple its imports in the next twenty five years. Consumption could reach 11 million bbl/d in 2030 (IEA 2004). Imports as a percent of total oil consumption will rise from 51 percent in 2004 to 60 percent in 2010, to 66 percent in 2020, and to 85 percent in 2030.

Growth factors include: China's still low per capita consumption, the strong projected increase in registered automobiles (the number of which could rise tenfold, to 200 million units in 2030), its growing strategic reserve (initiated in 2005), and the need to reduce the amount of inefficient and polluting coal it uses as a proportion of its overall primary energy consumption.

Russia supply

From Russia's perspective, exporting oil and energy is the highest priority in international trade. Implementation of large multi-regional oil and gas projects will enable Russia to expand its geopolitical reach in the Pacific region (**Map 2.3**). Large projects will also help develop the suspended oil reserves of Yakutiya, Irkutskaya, Krasnoyarsky, and Evenkiya Provinces. Export of electricity could also become a priority, given that the RFE has huge surplus generation capacity, which even in 2009, will exceed domestic demand by 0.5 Gwt. Tentative plans to redirect electricity and hydrocarbon exports to East Asia are already used by Russian leadership as levers in negotiations with clients in Europe (see Kramer, A. Russia threatens to send energy exports east. New York Times, 27 April 2006).

Electricity export: Stratetic plans and first steps

Most electricity in Russia is generated and transmitted by the export branch of the state-owned monopoly United Energy Systems also known as "JSC RAO UES International," or simply "UES International." After the split of the USSR, exports remained a core activity for UES. In 2004, exports accounted for about 50 percent of electricity sales. Electricity exports by UES in 2004 amounted to 24.13 billion kWh (**Table 2.46**).

Table 2.46 Electricity exports by JSC "RAO UES International" in 2002-2005

	Electricity Exports kWh x 10^9			
	2002	2003	2004	2005
TOTAL Sales	0.85	19.16	24.13	28.83
CIS states:	0.70	7.02	5.46	9.19
Belarus		3.53	1.51	4.68
Azerbaijan		0.05	0.07	1.00
Georgia	0.10	0.80	0.73	0.79
Kazakhstan	0.60	1.76	2.23	1.92
Moldova		0.88	0.92	0.80
Distant exports:	0.15	0.89	4.52	11.74
China		0.16	0.34	0.49
Mongolia		0.04	0.04	0.17
Latvia			0.69	0.53
Finland	0.13	0.51	3.26	9.72
Lithuania	0.02		0.003	0.61
Norway		0.18	0.19	0.22
Supplies not transiting Russia:	0.00	5.44	4.55	1.19
Lithuania - Belarus		4.04	2.54	0.13
Latvia - Belarus				0.12
Lithuania - Poland		0.49	0.21	
Tajikistan - Kazakhstan		0.19		
Kyrgyz - Kazakhstan		0.71	1.80	0.94

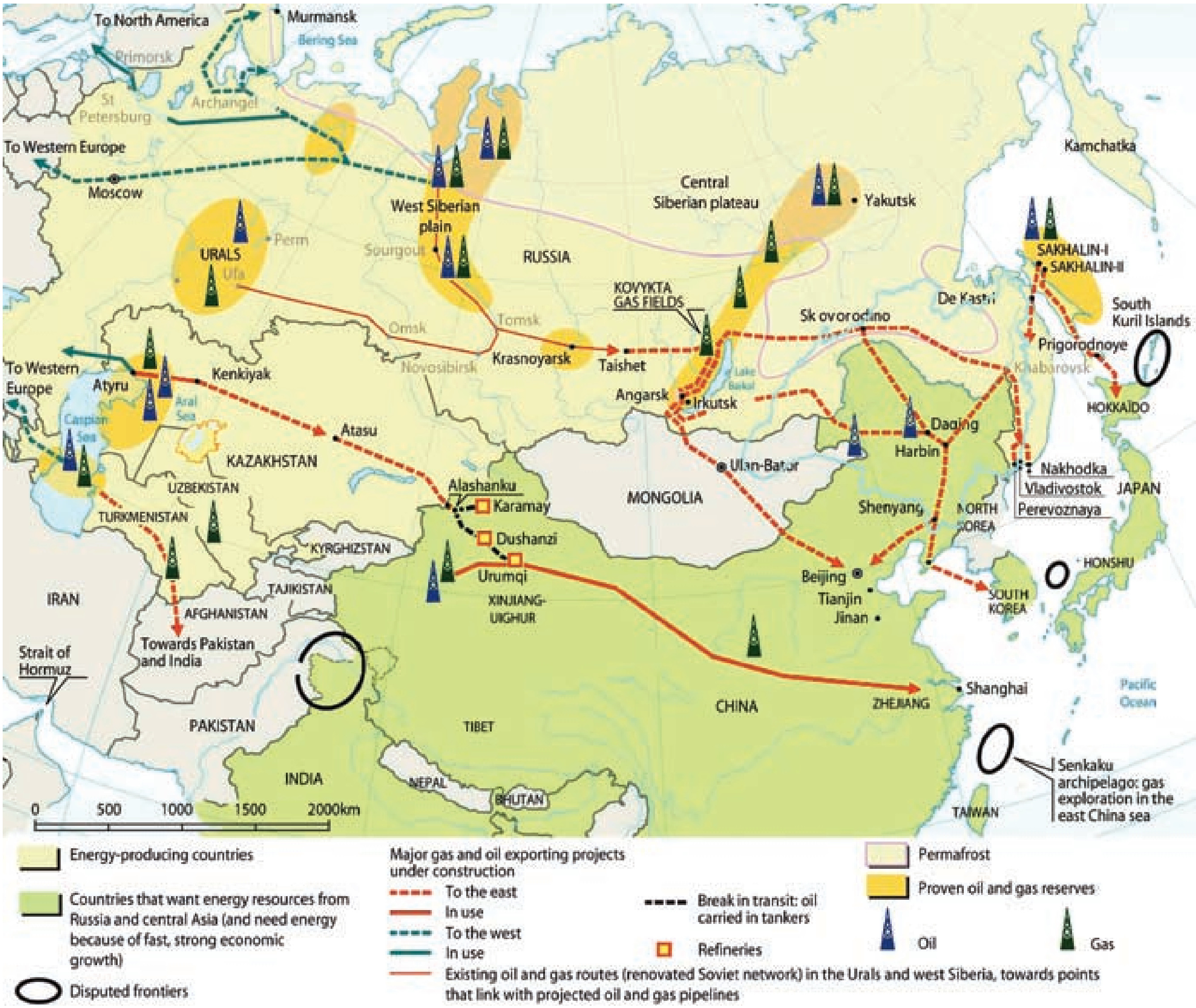
Many projects have potential to supply electricity from Russia to other countries in Northeast Asia (**Table 2.47**). Some of these have already undergone extensive planning while others remain speculative. Six projects

Table 2.47 Planned electricity exports from east Russia to other northeast Asia countries

Option Number	Generation Site/ End Use Site	Fuel	Time Frame (year)	Length (km)	Capacity (GW)	Electricity (TWh/year)
1	Bratsk / Beijing	hydro	before 2015	2,600	3.0	18.0
2	Bureya / Harbin	hydro	before 2015	700	1.0	3.0
3	Primorye / KPRK Primorye / ROK	nuclear	2015-2025	700 1,100	4.0 8.0	8.5
4	Sakhalin / Japan	NGCC*	2015-2025	470	4.0	23.0
5	RFE / PRC-ROK	nuclear	after 2025	2,300	2.5	18.0
6	Uchursk / PRC-ROK	hydro	after 2025	3,500	3.5	17.0

are listed in **Table 2.47**; others are likely to be proposed in future. Of the currently listed potential projects, three would supply hydroelectricity, two would produce nuclear power, and one would be a natural-gas combined-cycle (NGCC) power plant. The near-term options 1 (Bratsk to Beijing) and 2 (Bureya to Harbin) would supply two Chinese cities and would be implemented before 2015. More ambitious options to supply electricity to DPRK, ROK, and Japan are conceived for the post-2015 period.

Map 2.3 Oil and Gas resources and infrastructure



The Korean power supply project (Option 5 from Table 2.47, RFE/DPRK-ROK) promises benefits to both Russia and Korea due to seasonal variation of maximum loads in electric power systems of the RFE, DPRK and ROK. This may yield substantial benefits by connecting the power systems to exploit seasonal surplus capacities. There are difficulties in finding locations for power facilities in ROK due to environmental concerns and the scarcity of suitable sites. This might be alleviated by purchasing electricity from transnational power grids. Use of the DPRK hydropower surplus capacity to meet the demand in southern Russian Far East could complement the transmission of surplus hydropower from northwest RFE to DPRK some 1,500 km away. A complementary scheme might also reduce overall environmental impacts of power plants in the region due to increased efficiency (Podkovalnikov 2002).

Hydropower has been favored by UES since 2001. In its 2005 strategic plan it earmarked a subset of planned hydropower stations specifically to serve China with 12 GWt and 50 GWt exports beginning around 2020 (Main Strategic Directions for the Federal Hydrogeneration Company until 2010 and Prospects Through 2020. Moscow, 2005). However by 2006 a new even more ambitious plan was proposed to develop network of thermal plants on Siberian coal to supply China's demand in the near future.

In 2003 Russia's UES contracted with Heihe Prefecture in northern Heilongjiang Province for export of electricity. Planned deliveries were 0.5 billion kWH/year by 2006, 1.5 billion kWh/year by 2008, and 2 billion kWh/year after 2009. Thus Option 2 from **Table 2.47** is already partly realized. According to China sources, this supported the creation of more than 1,000 jobs and production of $36.6 million in goods (Renmin Ribao 21 September 2005).

A second power transmission line was near completion in 2005 from Zavitinsk (east of Blagoveshensk) to Sunke (east of Heihe) also for export of electricity to China. Among the industries that China seeks to develop in Heihe and Sunke most frequently mentioned in the media is petrochemicals.

In addition to the electricity exports from Amurskaya Province to Heihe Prefecture, there are continuing negotiations for Chinese investment in Russian hydropower plants (HPPs). Two HPPs most frequently discussed in 2004-2005 were the Lower Bureya River (an Amur-Heilong River tributary) and Boguchanskaya River in Eastern Siberia. However, following the March 2006 talks in Beijing at the opening of "Russia Year" in China, a wider agreement was signed by UES. It included fixed prices for exported electricity, Russia exports of 60 billion Kwh by 2015, and sizable China investment in power generation in Russia, with a list of power plants and power lines to be agreed later (ITAR TASS 21-23 March 2006). A potential impediment to the flow of Chinese funds into Russian hydropower construction is the history of schemes to build up to six large dams on the main channel of the Amur-Heilong River. These would enable greater control and benefits for China than would be the case if new HPPs were built in Russia. Another obstacle is government regulation of the electric power market. Such controls set the export price of ¥0.025/kWH in 2005, which was actually less than the market price in RFE (see environmental consequences of hydropower schemes in Part Three).

Despite the lack of agreement on pricing in 2007, Russia's government announced a new "Roadmap" for the energy sector, making exports to China one of top priorities in decades to come.

Oil export plans

The highly publicized Siberia-Pacific Oil Pipeline (SPOP; also called ESPO for East Siberia-Pacific Ocean) is estimated to cost $15-16 billion and will eventually run from Taishet in central Siberia, to a port on the Pacific coast near the Russia-China border (see "Transneft" alignments on **Map 2.4**). Russian Prime Minster Mikhail Fradkov signed a resolution on 31 December 2004, to build and provide rail transport for the SPOP with a total capacity of up to 80 million tonnes/year of crude. The first stage of the project would construct a 2,400-km oil pipeline from Taishet in Eastern Siberia to Skovorodino near the Chinese border. The second phase, depending on the development of eastern Siberian oil fields, would involve construction of a further link between Skovorodino and Russia's Pacific Coast. Russia would also build a rail oil terminal at the

Pacific coast at a cost of $7.9 billion. Russian plans publicized in 2004-2005 suggested the pipeline to the Pacific would be completed around 2010 and the Skovorodino-Daqing route would be built by 2020. China looks to import as much as 30 million tons/year of crude oil if the Skovordino-Daqing spur is built, while supplies along the Skovorodino-Pacific route would come to 50 million tons/year, with exports mostly to Japan.

When President Putin visited China in March 2006, China National Petroleum promised to pay $400 million to Transneft, the Russian state-owned oil pipeline company, for design work on a planned spur from the 1.6 million bbl/day SPOP to Daqing, and Russian officials announced that the pipeline to China would be finished by 2008. Achieving this schedule will require speedy design and quick environmental clearance. "Statement on intended investment" for a such a pipeline crossing Amur at Dzhalinda village has been announced in Amurskaya Province in September 2006.

In 2007 development of a branch pipeline to the Pacific Coast was delayed, reportedly due to unconfirmed supply capacity of East-Siberian oil-fields.

Gas export plans

Several gas pipeline proposals have been put forward recently to transport gas from Irkutskaya Province, Yakutia, and Sakhalin Island to consumers in northeast Asia. Khabarovsky Province and the Association of the RFE and Transbaikalia Provinces strongly favor the "KoRus" gas pipeline scheme (**Map 2.4**), a project that is being partially implemented by building the Sakhalin-Komsomolsk-Khabarovsk section (first stage of 500 km completed in Khabarovsk Province). The pipeline is planned to transport 25 billion m^3/year and will cost at least $3 billion to build (A. Vasenyov, BISNIS Khabarovsk, 2005). South Korea, Japan, and China are prospective consumers of the new gas supply. Some domestic RFE processing is also proposed. Another large gas pipeline is planned from the rich Kovykta field in Irkutskaya Province through Buriatia and Chita Provinces to China, following the southern route of the ill-fated Yukos-sponored Siberia-Daqin oil pipeline, and threatening integrity of Tunkinsky National Park and Lake Baikal World Heritage Site (see discussion of environmental and legal implications in Part Three).

Contracts for oil & gas

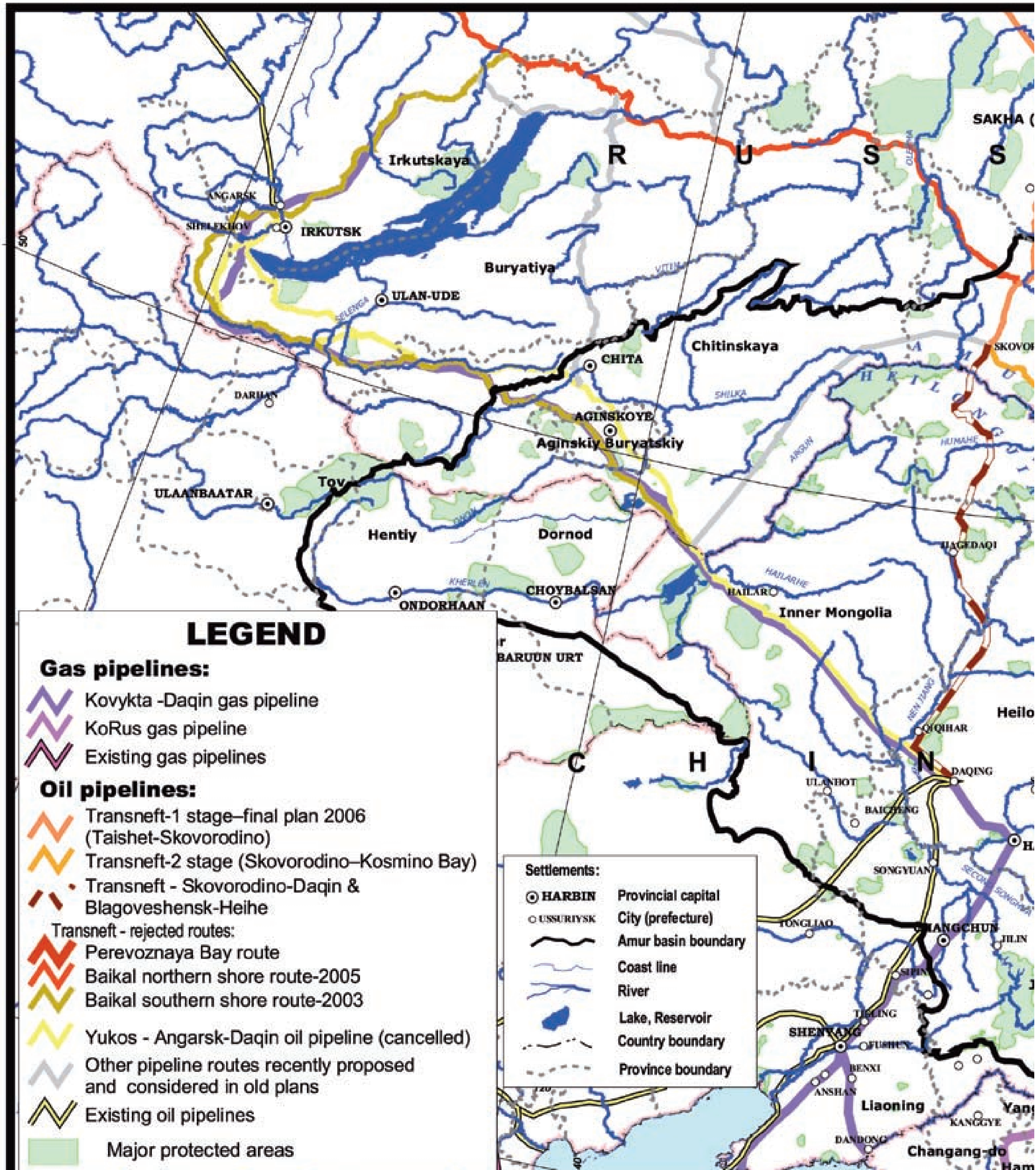
China and Russia agreed in 2004 that it was in the interest of both countries to increase cooperation in production of oil and gas.

Until the pipeline to Daqing is complete, Russia has promised to supply by rail 385,000 bbl/day to China and 192,000 bbl/day to Japan starting in 2008[1]. Russia exported 10 million tons of oil to China in 2005 and promised 15 million tons by 2006. Most of Russia's oil delivered to date passed through Zabaikalsk/Manzhouli and supplied China's northeastern refineries. The principal supplier was Yuganskneftegaz, now owned by the state-owned Rosneft Oil Co., which has assumed Yukos company contracts to export oil to China. Deliveries to China fell slightly short of the 10 million tons promised in 2005, presumably because Rosneft did not supply enough oil. In 2005 China purchased around 9 percent of its oil imports from Russia, while Japan supplied only 1 percent (see http://www.dumaem.ru 13.03.2006). Thus in 2005 Russia became China's fifth largest supplier of oil.

Capacity of the railway system will increase to 15 million tons/yr by 2007. In 2008 the Siberia-Skovorodino pipeline with its feeder to the south will begin delivering oil near the China border and conditions will be favorable to increase imports gradually to the 30 million ton target, presumably by 2010. Given the projected growth of China demand this is likely to fall short of China's expectations and we might soon see additional import schemes.

Chinese companies have for years been willing to cooperate with Russian companies in prospecting, exploiting and developing oil, promising up to $12 billion for the most promising projects. However, the early bids by Chinese companies for exploration of oil and gas fields in Russia have not been successful. By 2006 the situation changed and now the Russian company Rosneft is also engaged in talks with Chinese companies to open a network of gasoline stations in China in exchange for selling a 5-10 percent stake in Rosneft to the Chinese. Rosneft's capitalization is estimated at about $60 billion, which would value the possible Chinese share at $3-6 billion. The two companies plan joint exploration and

[1] China to Get First Track at Russian Oil: Putin, *Asia Times*, 15 July 2005


LEGEND
Gas pipelines:
Kovykta -Daqin gas pipeline
KoRus gas pipeline
Existing gas pipelines
Oil pipelines:
Transneft-1 stage–final plan 2006 (Taishet-Skovorodino)
Transneft-2 stage (Skovorodino–Kosmino Bay)
Transneft - Skovorodino-Daqin & Blagoveshensk-Heihe
Transneft - rejected routes:
Perevoznaya Bay route
Baikal northern shore route-2005
Baikal southern shore route-2003
Yukos - Angarsk-Daqin oil pipeline (cancelled)
Other pipeline routes recently proposed and considered in old plans
Existing oil pipelines
Major protected areas
Settlements:
HARBIN
Provincial capital
USSURIYSK
City (prefecture)
Amur basin boundary
Coast line
River
Lake, Reservoir
Country boundary
Province boundary
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SAKHA (
Irkutskaya
ANGARSK
SHELEKHOV
IRKUTSK
Buryatiya
ULAN-UDE
Chitinskaya
CHITA
AGINSKOYE
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CHOYBALSAN
BARUUN URT
HAILAR
Inner Mongolia
HAGEDAQI
QIQIHAR
DAQING
Heilo
ULANHOT
BAICHENG
SONGYUAN
TONGLIAO
CHANGCHUN
JILIN
SIPING
TIELING
SHENYANG
FUSHUN
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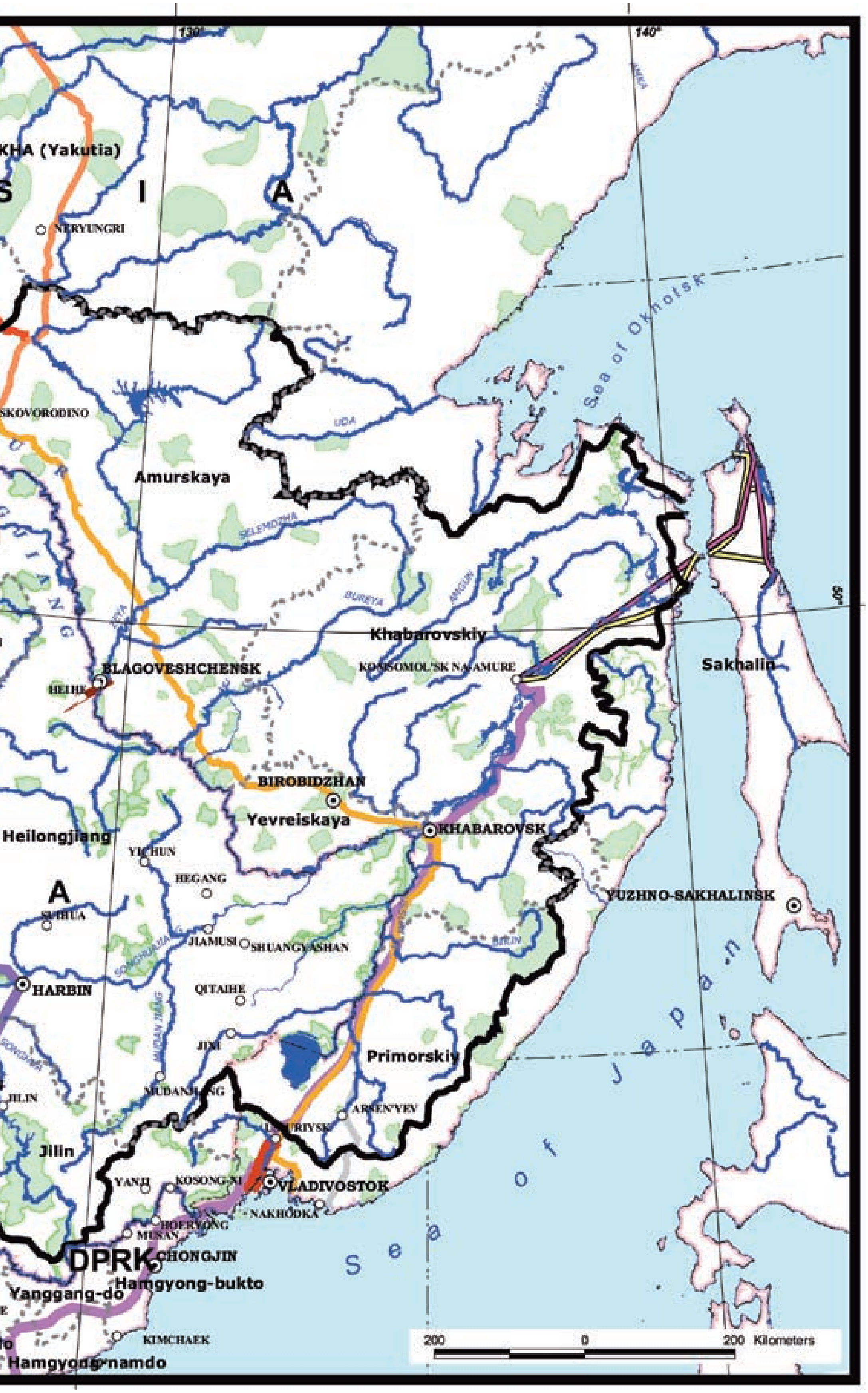
production in Russia, transport to China, and processing and sales in China and other northeast Asia countries. In March 2006 Russia agreed to expedite construction of two natural gas pipelines to China with a combined annual capacity of 68 billion m^3. A western route from Kovykta fields would be built first.



Map 2.4 Existing and planned oil and gas pipelines in the Amur-Heilong River basin

Chapter 17

Conclusion

The China provinces of the Amur-Heilong basin, particularly Heilongjiang and Jilin, are economically well developed. Urbanization, per capita GDP, and primary healthcare indicators exceed the national averages. The middle of the Songhua River basin, shared largely by Jilin and Heilongjiang, is one of the most developed agricultural and industrial areas in the country. However, the prevalence of heavy industry, state-owned enterprises, and large scale agriculture slows economic development and makes it excessively dependent on large government investments that are not sustainable. Beginning in 2003, an aggressive new policy was implemented to revitalize the "Old Industrial Bases." This will inevitably result in much more rapid economic development. This policy promotes the restructuring and growth of those traditional sectors of the economy that in previous waves of industrialization already contributed significantly to the degradation of natural ecosystems. This new stage of restructuring already has partially depleted the natural-resource base. In this context, a timely warning should receive close attention. It was raised by the Chinese Academy of Engineering in their report on Strategic Assessment of Natural Resources and the Environment of the Northeast and was delivered in early 2006. Extensive economic development requires a growing amount of raw materials and energy imports; Mongolia and Russia, as close neighbors and resource-rich countries, are the first choice markets to look for natural resources that can be extracted.

The socio-economic future for Asian Russia depends to a large extent on trade and policy relations with its Asian neighbors, first of all China. Unless a new "iron curtain" is erected to isolate the RFE from the rest of the world, its economy, politics, and demography will always be subject to the dominating influences of more populous and industrious neighbors. Given that valuable ecosystems of the basin are not confined to Russian territory it makes most sense to discuss the future of the region as a single economic and natural entity, of course with full recognition of tremendous differences in cultures, policy and aspirations of different nations of the region.

Mongolia is a traditional society rapidly integrating into global markets and acquiring international standards for natural resource management. At first glance its population, economy, and resulting impacts on the environment are minimal in comparison with two giant neighbors. However, the fragility of arid ecosystems and fast pace of socio-economic change puts the supply of many traditional resources, including water, at risk. International demand for minerals has become leading force for economic change, which might threaten sustainability of the country's economy over the medium term. In general Mongolia is vulnerable to political and economic pressures from Russia and China.

Trade and international economic cooperation between basin countries is almost solely based on natural resource extraction. Mongolia and Russia are major sources of raw materials processed in Northeast China and, with time, more Chinese capital will be invested to secure extraction-processing chains. Given the poor condition of local economies and their remoteness from major development centers, both Russian and Mongolian portions of the basin will increasingly rely on China as a source of investment, technological innovation, and a major market. In these conditions, we can expect a greater influx of Chinese immigrants into adjacent areas. At the same time, outdated and conservative administrations with poor enforcement capability leaves Mongolia and Russia with little hope for adequate environmental oversight of resource extraction processes.

Medium and long-term resource exhaustion is unlikely to be a major concern for pragmatic policy-makers in China who have focused on solving acute domestic problems. Other major underlying sources of environmental degradation influencing development trends in China are internal. Therefore, while China's economy has an overriding influence on the region's environment, policies designed domestically to protect China's environment are unlikely to address cross-border environmental issues. Some of these policies are intended to secure access to foreign resources by increasing pressure on the neighboring transboundary regions.

No matter how advanced China's domestic environmental policies might be, taken alone they are unlikely to contribute to the formation of a more sustainable resource-use pattern throughout the basin. Only by involving Russia and Mongolia can China help drive a more environmentally sustainable future.

Part Three

Threats to Biodiversity

Sandstorm in Hulunbeier Steppe / Guo Yumin

Construction of Bureya Hydropower Plant © WWF-Russia / Z. Taigi

Chapter 18

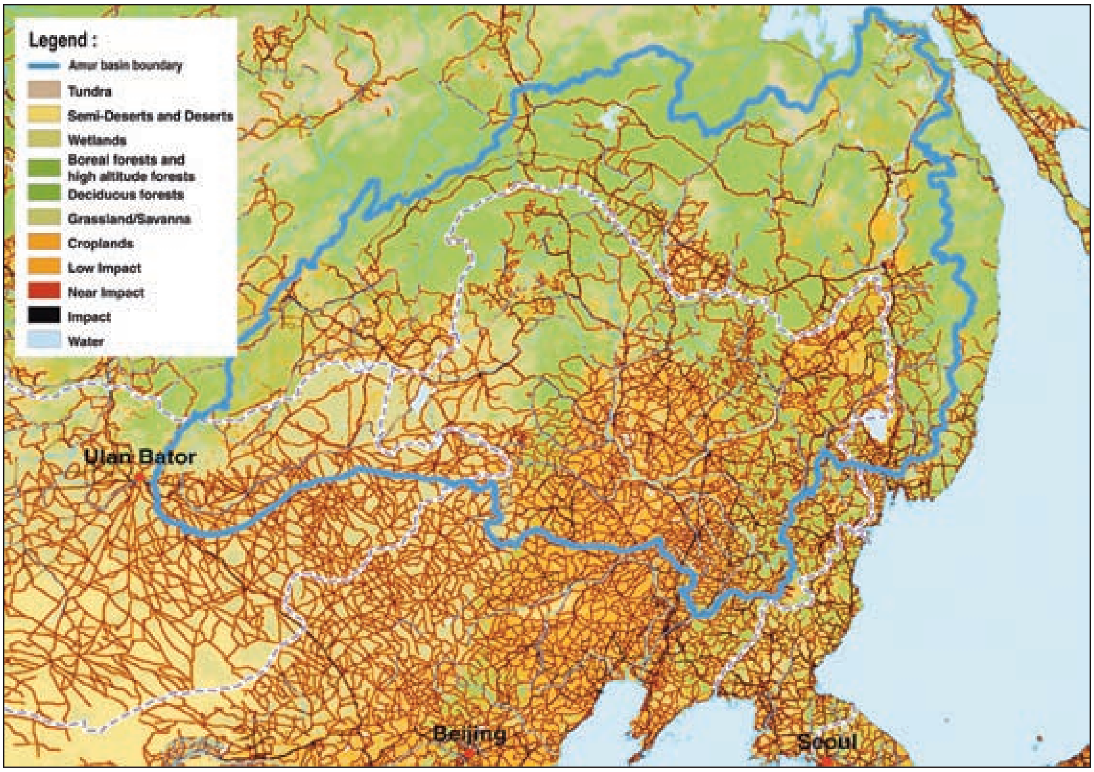
This Review and Previous Threats Analyses

The Amur-Heilong River basin has become an arena for economic cooperation and competition between countries of Northeast Asia. This has increased human-induced pressures on ecosystems and species. Repeated reports at the beginning of the 21st century describing degraded or lost biodiversity, habitats, water quality and other natural resources raise concerns over how much more human pressure these ecoregions can bear without losing potential for natural recovery.

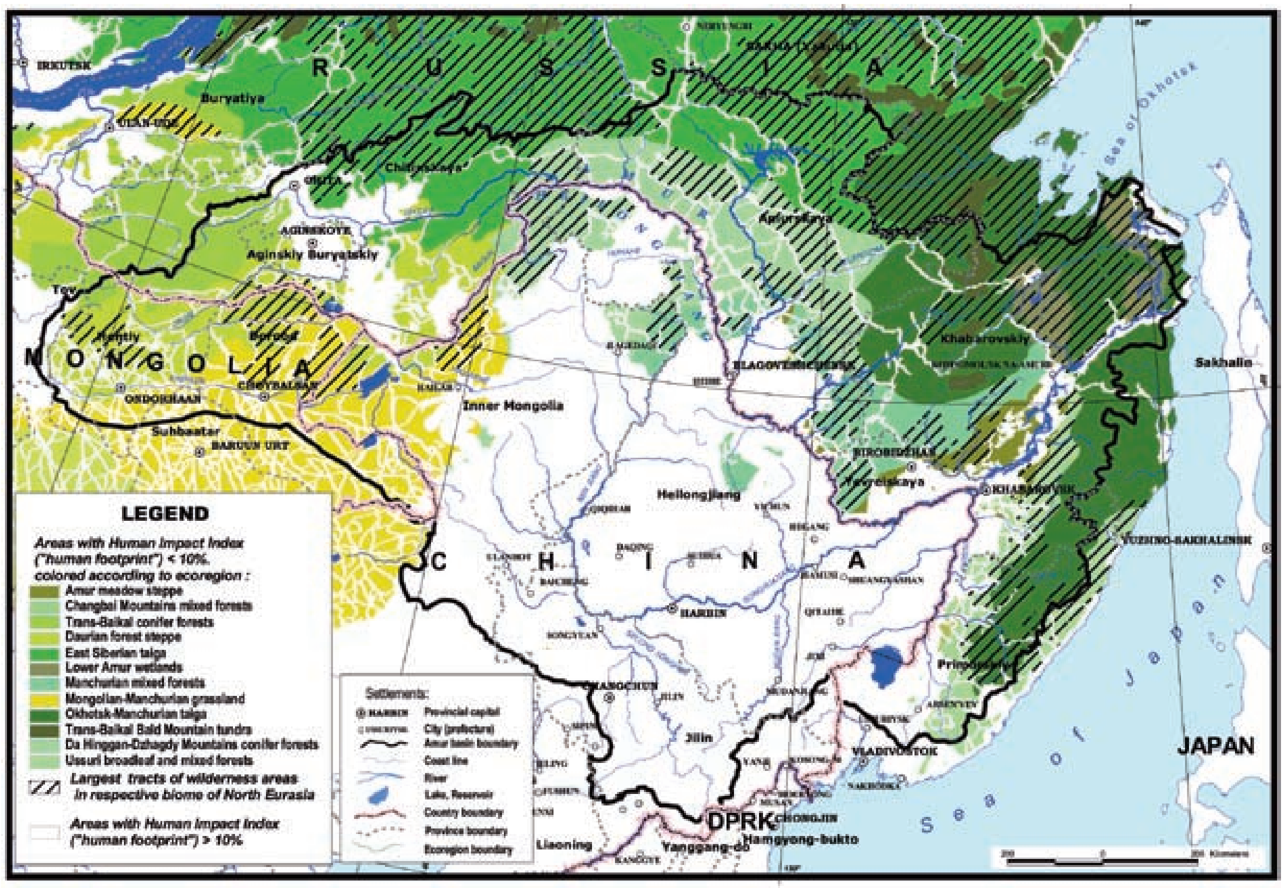
In Parts One and Two of the Reader we discussed the tremendous natural and socio-economic diversity in the Amur-Heilong River basin. Methodological approaches to assessment of threats and impacts for a region with such diversity presents certain problems. A given impact might have a different effect in Russia where the population density is 1-14 people/km^2 than in China where there are 50-100 people/km^2. Monitoring of environmental and ecological parameters has been historically sporadic and at present there is little reliable information covering the whole basin. Reliable and uniformly presented data on biodiversity trends are especially lacking. Therefore, in this chapter we present a wide range of data on known and potential threats to the region's biodiversity, but refrain from making judgments on their relative importance. Since river ecosystems lie at the heart of our study, we focus attention on water related issues. We limit our attention to selected threats for which comparable transboundary data exist. By doing so we hope to inspire future research on transboundary ecosystems or ecoregions, rather than on a single country or province.

World-wide assessments of human impact, produced in the late 1990s early 2000s provide general but useful information on the current status of the Amur-Heilong River basin. One fragment of the Asia-wide Globio assessment map (**Map 3.1**) vividly shows distribution patterns of major human activities across the basin (GLOBIO, Global methodology for mapping human impacts on the biosphere. UNEP/DEWA, 2001).

Another map derived from "The Human Footprint" assessment shows all remaining areas of the Amur-Heilong basin ecoregions where human impact is still relatively low and that are classified as "wilderness" areas (E. W. Sanderson et al., 2002) (**Map 3.2**). From these maps we see that no extensive "wilderness areas"

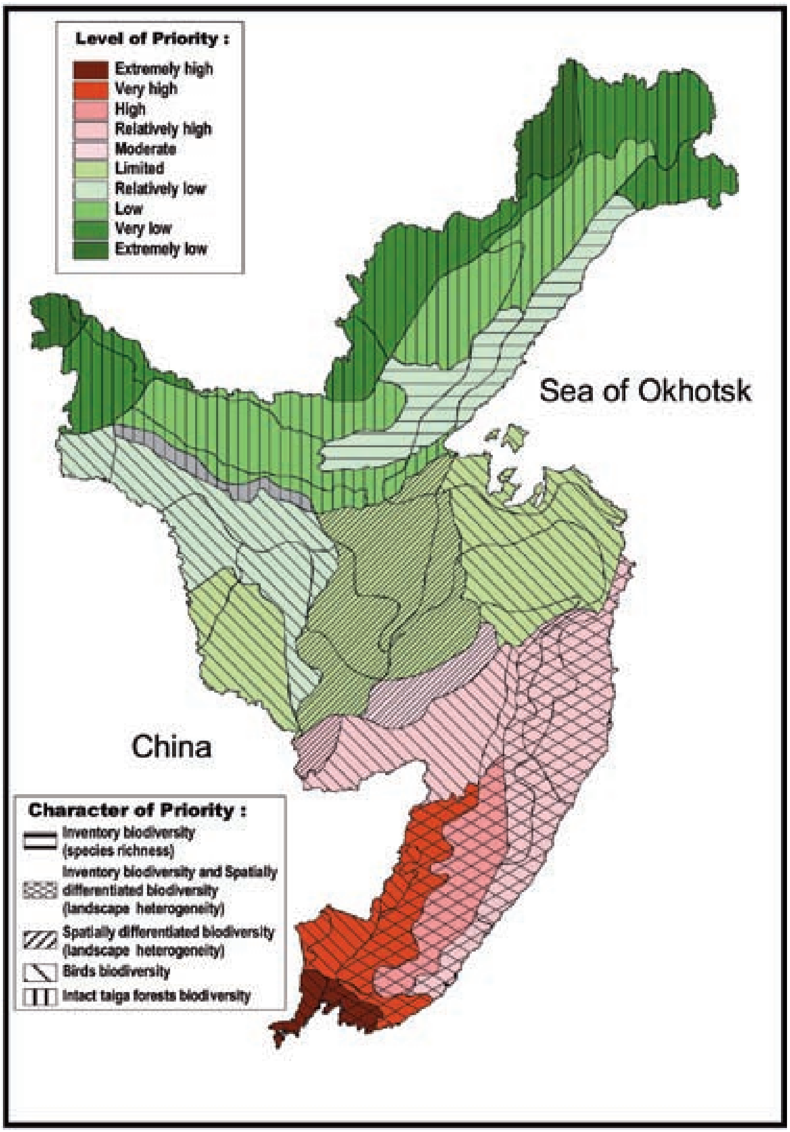


Map 3.1 Distribution patterns of major human activities across the Amur-Heilong River basin



Map 3.2 Remaining areas in Amur Basin's ecoregions with low human impact and classified as wilderness

Map 3.3 Intensity of threats to biodiversity in the southern Russian Far East



Map 3.4 Ecoregion Conservation Action Plan for Russian Far East Ecoregional Complex of 2003

remain in four of the fifteen ecoregions of the basin.

We also present a map on the intensity of threats to biodiversity in the southern Russian Far East (RFE) (**Map 3.3**), which, together with maps of species richness presented in Part One, were used to produce the map of conservation priorities for the southern RFE (**Map 3.4**), the basis for the Ecoregion Conservation Action Plan for Russian Far East Ecoregional Complex of 2003 (ECAP RFE 2003).

ECAP-RFE lists the predominant threats to biodiversity in the RFE as fires in forests, meadows, and peatlands; hunting and poaching; patch logging and clearcutting; fragmentation of non-developed areas by communications and transport infrastructure; use of chemicals in agriculture; and conversion of wetlands to farmlands. **Table 3.1** gives an overview of the major threats, the ecosystems they impact, and the primary sources of the threats. **Table 3.2** shows the extent to which some of these threats have affected forested areas

After completion of the ECAP-RFE, Sheingauz (2006) refined and updated information on major anthropogenic impacts on forests in Russian provinces (**Table 3.3**). These are even more alarming than the 2000 data shown in **Table 3.2**. The 2005 calculations are based on provincial rather than basin statistics so they include at least 30 million hectares north of the Amur-Heilong basin, where the severity of anthropogenic impacts is much lower than within the basin itself.

In the same monograph, Sheingauz (2006) applied an alternate methodology based on rates of regeneration of disturbed forest measured over forest life cycles, that

Table 3.1 Threats to major ecosystems in the Russian Far East Ecoregion Complex and their primary sources

Ecosystem	Major Threat	Source	Outcome
Aquatic habitats of the Amur River and its larger tributaries	Pollution	• Population growth, economic development, and lack of sanitation facilities, especially in Heilongjiang Province of China; insufficient sanitation facilities in large Russian cities	• contamination of waterways by phenols from decomposition of organic materials; declining abundance of aquatic fauna
	Energy development	• Construction of the Bureya hydroelectric station; plans for new hydroelectric stations on the Amur and other rivers	• Disruption of natural hydrological regimes; loss of seasonal habitats for aquatic fauna
	Overfishing	• Salmon fishing by commercial marine fishers; unrestricted fishing in China; inadequate legislation and lack of enforcement mechanisms in Russia; absence of socio-economic conditions to introduce sustainable fishing mechanisms	• Declining fish stocks; inability of fish populations to recover; loss of livelihood for minority communities; potential extinction of commercially valuable species
Wetlands of the Amur-Heilong River basin	Energy development& water manage-ment	• Regulation of water flow from hydroelectric stations and dams • dyke construction along river banks, • excessive water consumption by agriculture.	• wetland dehydration, habitat loss & degradation • loss of seasonal waterfowl breeding and fish spawning habitats • loss of aquifer recharge capacity of wetlands
	Fires in floodplain forest-grassland habitats	• Traditional annual burning of pastures and hay fields, thought to increase productivity	• Destruction of nestlings of ground-nesting birds, especially cranes; loss of nesting and brood-rearing habitats; mortality of woody seedlings inhibits forest recovery
	Timber harvest	• Cutting of remnant relic forests for firewood by local people	• Reduction of forest cover
	Agriculture and animal husbandry	• Wildland conversion to farmland • Wind erosion of humus layer from agricultural lands; overgrazing • runoff of soils and animal waste from farms	• Loss of wildland area • Increased soil loss and water turbidity • Eutrophication of water bodies
	Over-exploitation of wildlife	• Unregulated hunting of migratory birds in wintering areas in China; poaching and non-sustainable use of game resources in Russia; increasing numbers of crows	• Decrease in numbers of wild animals
	Anthro-pogenic wildfire	• Decrease and fragmentation of nesting habitat; birds killed by fires and poachers	• Disappearance of rare birds of prey
Coniferous-broadleaf forests	Timber production	• Clearcutting and unsustainable logging	• Decline in area of old-growth forests
		• Selective cutting of valuable species	• Ecosystem degradation
	Over-exploitation of resources	• Illegal hunting and collecting	• Disappearance of rare species of plants and animals • Decrease in prey base for large predators • conflicts between humans and large predators • habitat loss
Eastern Siberian boreal forests	Unregulated resource exploitation	• Commercial mining • Energy development	• Transformation of native ecosystems • Reduction of floodplain forests during gold mining operations • flooding of forests with creation of the Bureya hydroelectric station
	Timber production	• Pioneer-style unsustainable logging practices; anthropogenic forest fires	• Disappearance of forests after clearcutting on unstable mountain or permafrost soils; • Ecosystem degradation • Declining forest cover; declining forest wildlife • increased erosion, impacts on water bodies

Source: ECAP RFE 2003

is, through silvicultural and biological forest parameters. In this feature it differs from other metrics that use artificial or subjective indicators (such as human-calculated logging and fire statistics). Application of this alternate approach to 2003 state forest assessment data showed percent disturbance as 60 percent in Evreiskaya Autonomous Region, 46 percent in Amurskaya Oblast, 43 percent in Primorsky Krai, and 40 percent in Khabarovsky Krai. This analysis shows the connection between levels of territorial disturbance and territorial development. These forest cover disturbance indicators exceed data on the level of anthropogenic impact for the post-war period given in **Table 3.3**. This confirms that anthropogenic impacts disturb forests not only at sites of direct impact, but also well beyond them. The analysis also indicates that anthropogenic impacts on forest cover are not addressed accurately by existing methodologies and that the extent of impacts is indeed much greater (ibid.). For example, a separate study using subjective indicators showed that in Primorsky Province only 27 percent of forested lands suffered low levels of disturbance and the rest had clear signs of human-induced impacts (WWF-RFE 2005).

Table 3.2 Impact of economic activity on forest ecosystems of the Southern RFE

Type of Nature Use	Estimated Annual Impact (Percent of forested area)	
	1989	1999
Conversion threats:		
Clearing of forests for mining	0.002	0.005
Clearcutting and patch logging	0.3	0.1
Clearing of forests for agriculture	0.1	.05
Expansion of agricultural lands	0.4	0
Industrial, housing, and road construction	0.2	0.1
Degradation threats:		
Firewood collection	0.2	0.3
Selective and improvement logging	0.1	0.1
Route tourism	0.05	0.03
Unorganized recreation	0.7	0.7
Domestic deer grazing	0.6	0.5
Cattle grazing	0.05	0.05
Haymaking	0.02	0.05
Forest fires	0.3	0.3
Industrial waste discharge	0.5	0.4
Wildlife Exploitation:		
Hunting	90	70

Source: Sheingauz 2000

Table 3.3 Major human-induced impacts on forest ecosystems of RFE (data from Sheingauz 2005)

Province	Forested land (million hectares)	Industrial logging / Clear-cutting and patch logging/ annual average 1991-2000 (ha)	Industrial logging cumulative 1946-2002 ('000 ha)	Forest fires annual average 1991-2000 ('000 ha)	Forest fires cumulative 1946-2002 ('000 ha)	"Intermediate logging" / Selective and improvement logging / annual average 1991-2000 ('000 ha)	All major impacts (forest plantations included) annual average 1991-2000 ('000 ha)	All major impacts(forest plantations included) average annual 1991-2000 (percent forest area)	All major impacts (forest plantations included) cumulative 1946-2002 ('000 ha)	All major impacts (forest plantations included) cumulative 1946-2002 (percent forest area)
Primorsky	11.5	23,400	2,530,000	17,900	481,000	37,500	82,800	0.7	3,353,000	29
Khabarovsky	57.8	69,800	4,372,000	23,5000	8,629,000	39,700	357,000	0.6	13,455,000	23
Amursky	25.5	11,400	2,414,000	63,700	2,666,000	13,300	91,400	0.4	5,312,000	21
Evreiskaya	1.6	1,000	244,000	2,700	480,000	3,700	8,200	0.5	816,000	50
RFE total (10 provinces)	353	12,0000	15,384,000	501,500	17,178,000	123,600	769,500	0.2	34,135,000	10
South RFE total (4 provinces)	110.8	10,5600	9,560,000	319,300	12,256,000	94,200	539,400		22,936,000	20.7
South RFE percent forest area (calculated from above)		0.1	8.6	0.3	11.0	0.08	0.5		20.7	

Chapter 19

Water Use and Water Infrastructure

Water crises and policies of Amur-Heilong countries

The World and the Amur-Heilong

More than one billion people worldwide live without access to clean freshwater. More than two billion do not have adequate sanitation services. The annual death toll from water-borne diseases is estimated at more than five million. In addition to degrading the quality of human life, poor water quality also affects wildlife. The past 30 years have seen a 50 percent decline in populations of freshwater wildlife, a rate faster than in either marine or terrestrial ecosystems. Whereas the 20th Century was dominated by concerns over oil, the 21st Century is anticipated to be the century of water. While energy shortages drive costs higher, water shortages can shift the balance between life and death: alternatives to oil are now rapidly developed and improved but there are no substitutes for water.

Dams are still viewed by some governments as ultimate solutions to water crises because dams store water and generate hydro-electricity. During the last several decades they have been marketed to society and international aid institutions as "green energy alternatives". There are over 48,000 large dams in operation worldwide. Many of these, and many under construction, threaten the world's largest and most important rivers. Over 60 per cent of the world's 227 largest rivers have been fragmented by dams, leading to the destruction of wetlands, declines in numbers of freshwater species including river dolphins, fish, and birds, and the forced displacement of millions of people (Pittock 2006). Losses of natural wetlands, in part due to dam building, are thought to lead to concentrations of wild waterbirds on man-made wetlands where domestic fowl are often raised. Close association of wild and domestic fowl on man-made wetlands may encourage transmission of diseases from domestic to wild fowl. The most current and frightening example of this is HPAI (or highly pathogenic avian influenza, subtype H5N1, or "bird flu").

While dams can be important providers of hydropower, they do not always guarantee reliable supplies of water and electricity. Moreover, they are costly to build and much less cost-effective than measures to reduce demand by using water and electricity more efficiently.

At the end of the 20th Century an attempt was made by United Nations and many governments, industries, and NGOs to define limits for large dam construction. In 2001 the World Commission on Dams (WCD 2000) released recommendations advising governments to opt for non-structural alternatives to dam building. The WCD advised that wherever dams must be built, they should meet stringent guidelines to mitigate risks. Since dam building is politically attractive to both politicians and industry, WCD recommendations were largely ignored in many countries (including China and Russia) and were energetically ridiculed by water engineers worldwide.

Meanwhile, humankind is already using 54 per cent of the world's accessible freshwater, with agriculture accounting for 70 per cent of that portion. Of the farmers' 70 per cent, more than half is wasted through inefficient irrigation. In countries where some of the world's "thirstiest" crops (cotton, rice, and sugar) are

Table 3.4 Selected national freshwater statistics of Amur-Heilong River basin countries [2000-3 data of FAO and EIA (GEO database of the United Nations)]

	China	Mongolia	Russia
Available freshwater resources (km^3)	2,812	34.8	4,312
Water use total (km^3)	630	0.44	77
Water use per person (m^3/person)	492	178	527
Share of agriculture in water use (percent)	68	52	18
Percent of population with improved drinking water supply	77	62	96
Catch of freshwater aquatic organisms (metric tons)	2,247,926	129	13,951
Hydropower supply: 1000 tons of oil equivalent	19,127	0	13,950

grown, new farm practices are developed to ensure that scarce water resources are being used in more productive ways.

Responsible governments should be quick to implement cheaper, long-lasting solutions to managing water supplies. Sadly, many governments still believe large-scale infrastructure projects such as dams deliver results quicker than small-scale, community-based efforts. Governments have also failed to implement previously agreed upon national and global frameworks for sustainable water management.

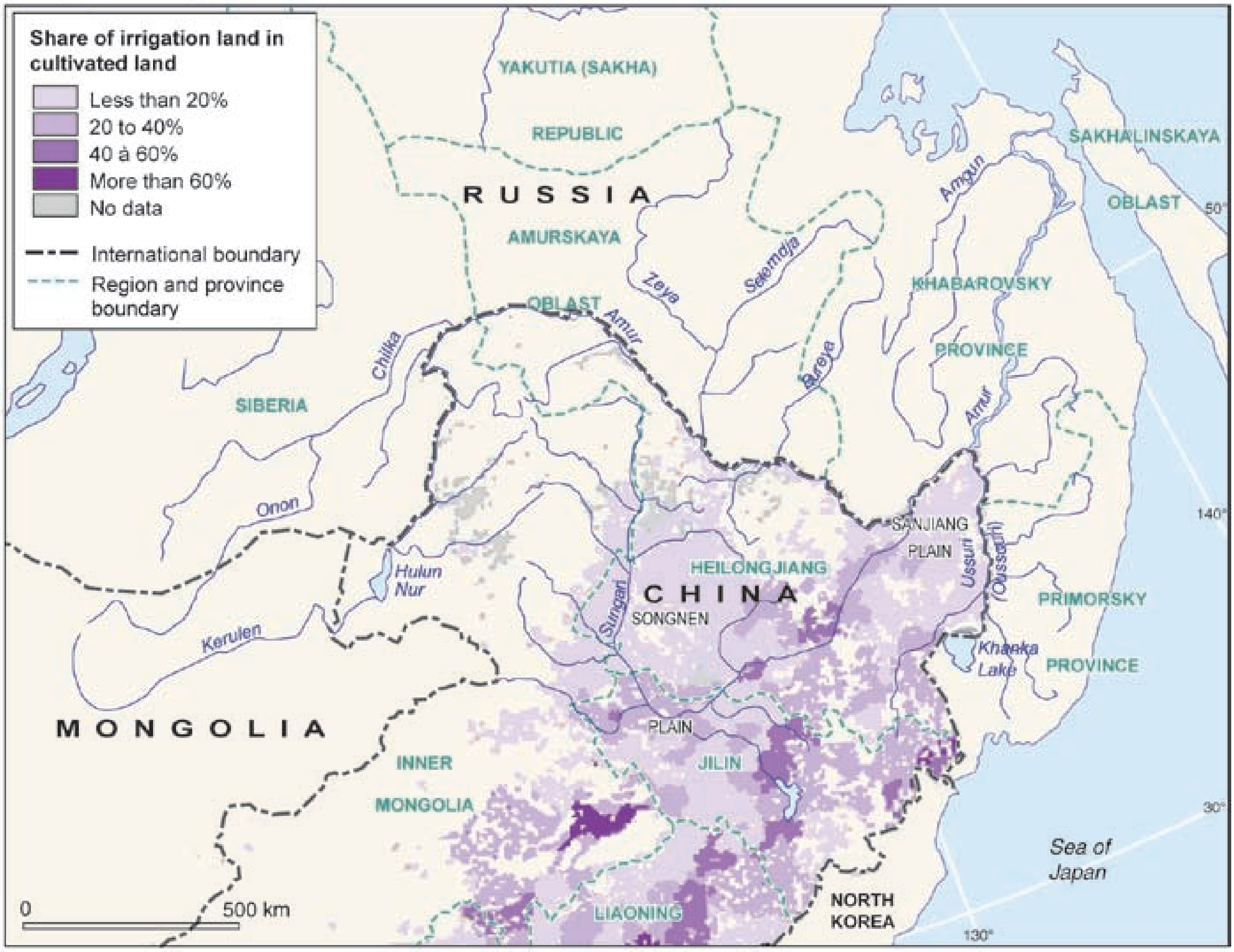
Amur-Heilong River basin countries have different histories and patterns of water use shaped by cultures that evolved in different natural environments (**Table 3.4**). Differences in water use between neighboring nations have profound impacts on how they treat other common resources and environments in shared river basins.

In the Amur-Heilong basin there are many incentives to build dams. First, the tremendous seasonal variation in volume of flow is viewed as an impediment to agriculture, water supply, and other uses. Second, hydropower resources are increasingly important as demand for energy in northeast Asia grows. Third, from a short-term perspective, water infrastructure is seen as the quickest and most obvious tool to regulate natural floods, which are viewed as the major recurring natural disaster in the region. Fourth, at least in Russia and China, the very notion of "water management" is, in the eyes of water authorities, firmly associated with building and operating dams and dykes: If you do not build them, you are not managing water. Fifth, rivers meander, often causing disputes where rivers demarcate national borders. Authorities often attempt to constrain river meandering by engineering. Sixth, over the longer term, the Amur-Heilong basin is a border between increasingly thirsty northern China and Mongolia, and water-abundant Russia. As the water crisis intensifies, pressure to withdraw and transfer Russia's water southward could increase dramatically. Based on these influences, it is not surprising that water infrastructure development has become a tool of international politics comparable in influence to oil and gas. These are the reasons why water infrastructure development is one of the most pressing concerns for those trying to protect the Amur-Heilong ecosystem. If transboundary integrated river basin management (IRBM) is to be accepted, it must offer technologies to manage the inevitable compromises between natural river processes and water resource distribution.

China

Energy and water are security issues in China. This is true domestically, regionally, and globally. Domestically, China has been able to support 20 percent of the world's population on only 7 percent of the Earth's arable land and less than one fourth of the average global per capita allotment of water. As economic growth continues at double-digit rates (China was the fastest growing economy in Asia for the past 20 years), arable land disappears under concrete and China is required to confront ever more pressing environmental concerns. Lack of adequate water supply will be a major impediment to the country's social and economic development over the next 30 years.

Chinese civilization has a 3,000 year history of aggressively managing rivers (Ma Jun 2004). Dykes, dams, and canals are accepted parts of the human environment. They are thought to ensure stable agricultural production, and, in terms of governing great numbers of



Source : Gerhard Heilig, ChinaFood. Can China Feed Itself? (CR-Rom), IIASA, Laxenburg, 1999.

Map 3.5 Irrigation in northeast China (from Lasserre 2003)

people, sustain order and provide large-scale employment on public works projects. China has the world's largest area of irrigated land (more than 50 million ha) and the total increases annually. From 1995 through 2004 irrigated land area in China increased 12 percent from over 50 million hectares to over 56 million hectares. The proportion of irrigated cropland ranges from 20-40 percent over much of northeast China (**Map 3.5**).

Central China's north plain was much warmer and wetter in earlier millennia than it is today, with elephants, rhinoceroses, and crocodiles living north of the Yangzi River. Several thousand years of cutting forests and draining marshes, coupled with climate fluctuations have changed the landscapes to low-productivity semi-arid lands. According to the World Bank, China has the highest ratio of actual to potential desertified land in the world. The rate of environmental change is most evident in the Yellow River basin, the "mother river" of Han Chinese civilization, where river waters no longer reach the sea during many months of most years (Ma Jun 2004).

The large-scale water projects that shape landscapes on China's plains necessarily serve multiple needs. Some of the water projects in China today are the most ambitious ever undertaken. These include the dams on the Yangzi and Lancang (Mekong) Rivers, and several large water transfer projects. In the largest water-diversion plan in history, China will build a canal north from the Three Gorges Dam that will flow in a tunnel beneath the Yellow River to bring water to the dry northern regions of China. The US$50 billion South-to-North Water Diversion scheme will require the resettlement of up to 400,000 villagers along the three potential routes. Already 1.8 million people have been resettled to build the Three Gorges project. In 2004 China re-stated its firm commitment to construction of large hydropower dams to alleviate energy shortages. This occurred two years after the publication of the final report by the World Commission on Dams (WCD 2000), which revealed the tendency for hydropower dams to under perform expectations while causing adverse environmental and social impacts.

A shift from the dominating "technocracy" mode of environmental problem solving (see Shapiro 2005) occurred after the devastating 1998 floods. This led to implementation of new policies that complemented the infrastructure-building approach with more systematic measures for forest and wetland protection and rehabilitation, and reinforced basin-wide river management planning.

To confront growing problems certain institutional and economic measures were implemented. Thus, China's Ministry of Water Resources (MWR) reports that the Yellow and Hai River basins have implemented total water intake volume control, 17 provinces have adopted water quota management, and over 10 provinces, including Heilongjiang, have implemented tiered systems for water pricing. In 2004, the annual per capita water use in China was 427 m^3, or less than half the estimated requirement for a developed economy. Water use per ¥10,000 of GDP was 399 m^3. Water use per mu of irrigated farmland was 450 m^3 (6,750 m^3/ha), and water use per ¥10,000 of added industrial output value was 196 m^3 (157 m^3/US$1,000). Since 1997 water use per ¥10,000 of GDP has declined sharply. The required annual water use to gain an increase of ¥10,000 of industrial production was reduced by 40 percent during the five years from 2000-2004 (MWR 2005).

Problems on larger scales have become evident. In typical years MWR estimates the national water shortage at 40 billion m^3 or about 80 percent of the total Yellow River annual discharge in recent years. Research sponsored by Ministry of Science and Technology revealed that the direct economic losses caused by insufficient water supply and inefficient water use across China are 2.5 times those caused by flooding, and total ¥280 billion (US$35 billion) annually (Xinhuanet, http://www.xinhuanet.com 2006-2-20). Water shortage, pollution, and inefficient management also result in growing resentment among different population strata, particularly poor farmers, thus threatening social stability and undermining the "harmonious society'" policy pursued by government leaders.

In late 2005, after the Songhua River chemical plant explosion and chemical spill, the highest governmental leaders again declared dwindling quantity and quality of water resources as major limiting factors on economic growth, and reiterated the need to address water issues in an integrated manner. In a 2006 interview, the Minister of Water Resources stated that "water-related problems such as droughts, floods, water pollution, and water and soil losses not only reveal that water resources do not match the economic and social sustainable development, but also expose the truth that long-term economic growth does not match conditions of water resources and water environment[1]".

A mix of measures has been promised for the 2006-2010 period of China's 11th five-year plan to deal with water issues: (i) institutional reforms in water management oriented toward serving the needs of the population and more open public participation; (ii) greater emphasis on preserving river ecosystems and mitigating negative effects of infrastructure projects; and (iii) establishing a water-saving national economic system and water-saving society.

Hydroelectricity is extremely important for China's booming economy. While hydropower provides a cleaner alternative to the disease and pollution caused by coal, large scale hydropower development disrupts natural ecosystems and river-dependent local economies. It also forces the relocation of thousands of farmers and villagers who are becoming increasingly vocal and informed about their legal options.

China's hydroelectric power capacity reached 115 million kilowatts by year-end 2005, according to the State Development and Reform Commission (SDRC). Between 2000 and 2005, China increased its hydroelectric power capacity by 36 million kW. Construction of the Three Gorges Project progressed during the 10th Five Year Plan period (2001-5) and is expected to be completed in the 11th Five-Year Plan period (2006-2010). The development of substantial hydroelectric power projects

[1] Wang Shucheng, Minister of Water Resources. Four uncertainties threatening water resources in China. 2006-2-21

capable of producing 70 million kW (70 GW) of power began during the 10th Five-Year Plan period, including some large projects in west China as well as the major project linking the power-rich west to the energy-thirsty east.

The proportion of hydropower in newly approved energy projects increased substantially during 2005. According to SDRC, between January 2004 and July 2005, only 9.5 percent of approved capacity expansion consisted of hydropower projects. Ninety percent consisted of coal-fired power. In marked contrast, power projects with a total installed capacity of 45,874 MW were approved between August and December 2005, and almost half of these were hydropower (Interfax 16 March 2006 from Three Gorges Probe, http://www.threegorgesprobe.org). These figures demonstrate the extent of China's commitment to hydropower for the future.

It is apparent from public speeches by MWR officials that in the near future environmental requirements for river management will increase substantially. When addressing a conference entitled "Hydropower in China" in early 2006 the Minister for Water Resources stated that hydropower development in China progressed through three periods defined by the three primary constraints of technology, supply of funds, and market demand. Now it faces a fourth constraint of ecological conservation. Without appropriate management of ecosystems and environment, hydropower development will be hindered. MWR called for the development and application of quantitative standards for allowable impacts on river ecosystems in the land-use planning process. The MWR stated that hydrologic systems should be maintained in good ecological condition, regardless of the need for flood control, hydropower generation, water supply and navigation. Water distribution should be managed according to an "acceptable level of ecological demand" and management should balance water uses among regions, population centers, industries, and agriculture. The MWR promised to commission studies of water infrastructure impacts on rivers and stated that stream restoration will not only focus on sediment treatment but will also consider water pollution. Water derived from watersheds should be treated and cleaned. MWR is most concerned with building institutional systems for water-saving and responding to natural disasters and human-induced accidents[2].

It is reasonable to expect that China will vigorously pursue a blend of strict environmental policies with ambitious plans for infrastructure development, both spurred by increasing scarcity of basic resources and continuing deterioration of environmental conditions. It is still unclear how new policies will influence massive water infrastructure development plans.

Russia

Water management history in Russia is 2,500 years shorter than in China. Although water management began later in Russia, it is typically much more intensive at any given site. In many less populated regions it is typical to have a single large water project in a given basin rather than many multipurpose water projects on several watercourses as in China.

Historically, much of the attention of water managers was focused on the Volga River — Russia's "Mother River". The Volga basin was converted during the 20th Century into a continuous chain of multi-purpose reservoirs with drastically altered ecosystems and ruined natural fisheries.

Hydropower was the main reason for most water infrastructure development in the former USSR and in Russia. Shortly after establishment of the USSR, the new government supported hydropower projects that built hundreds of small, medium, and even large dams during the 1920s in European Russia. Attention then shifted to large dams, which were developed on major rivers in Europe and Siberia. Another important development, facilitated by the free workforce at labor camps of the Stalin era, was the building of numerous canals connecting major river basins. Most of the economic and developmental significance of these canals has now been lost. While in Russia irrigated agriculture is mainly limited to the southern European part of the country, massive projects were implemented in southern Soviet republics, leading to the well known dessication of the Aral Sea and salinization of large agricultural areas specialized for cotton production. The USSR also provided extensive foreign aid to help the developing world build dams, the Aswan Dam on the Nile in Egypt being the best example.

One of the most noteworthy hydropower projects in Russia is the cascade of dams on the Angara River, the outlet of Lake Baikal. Lake Baikal itself is used as an enormous natural water reservoir to produce the

2 Minister of Water Resources, address to a meeting of Science and Technology Commission of MWR 2006-2-9

cheapest energy in Russia, if not the world. Since the 1960s the debate over protection versus development of the Lake Baikal environment became and remains the most publicized environmental battleground of USSR-Russia.

The Ministry of Water Resources of the USSR was formerly an influential institution, evolving as an off-shoot of the Ministry of National Security and the forced labor camp system. By the 1980s it had networks of research and planning institutions that produced plans for "nature improvement" covering large areas. Some of the best research of the time on natural resources and the environment was done within this system. However, its inefficiency and arrogance, coupled with its problematic origins, made it one of the first victims of the democratization process. In 1985, yielding to growing public pressure, a special decree of the Communist Party's Central Committee dismissed the largest of the planned projects that called for massive water transfer from Siberian Rivers to Central Asia and from the European north to the Volga-Caspian Basin. Subsequently this agency became a favorite scapegoat of the growing environmental movement and its influence rapidly declined along with the disaggregation of the USSR into more than 15 countries.

Environmental impacts and economic inefficiencies of large water infrastructure projects were the center of attention of Russia's scientific, literary, and conservation communities from the 1960s until the late 1980s. Famous literary pieces featured the decline of local culture and nature, along with the "death of the river", and had significant influence on public perception of large-scale dam building in Russia.

Economic turmoil in the new Russia stopped all major infrastructure projects and reduced power demand. By 2000, hydropower production was slightly less that in 1990, but still contributed 20 percent of the country's electricity. Russia now has more than 50 large hydropower stations, 49 of them belonging to JSC "United Energy Systems Russia" (UES), and many in desperate need of repair. Many of the largest projects were stopped in mid-construction and have not been finished. The Water Resources Agency has undergone a long evolution and has been reduced to a subordinate bureau of the Ministry of Natural Resources. Here it has had little influence or capacity. However, many ex-MWR off-shoot planning and research institutions survived, especially those that could carry on planning dams and irrigation systems for foreign governments. Due to fragmentation of authority and continual shifting of responsibilities between numerous agencies, the Water Resources Agency has limited authority over environmental issues and avoids this field whenever possible.

Lately the state-owned power-generating monopoly UES, headed by the mastermind of Russian privatization Mr. Chubais (UES controls most electricity production and major power grids of the country), became an outspoken proponent of hydropower. UES controls 22.9 GW of hydroelectricity production, with its closest domestic rival, Irkutsk Energo, controlling only nine GW, and no other producer approaching such capacity. UES is a business driven by market demand. It has modern management and it develops projects to maximize profit, not necessarily to do public good.

The half-built Bureya hydropower plant became a testing ground for UES's capability to restart large infrastructure development. The company managed to avoid many environmental and social liabilities and has completed the project. Most of the company's plans for hydropower are in energy self-sufficient Siberia and Russia's Far East, despite the fact that power shortages and black-outs increasingly occur in European Russia, some 5,300 km to the west. Being export-oriented and forward-looking, UES hopes to build an environmental image and embrace "corporate responsibility". In 2005 it initiated a dialogue with several leading environmental NGOs on an environmental strategy and, in its 10-year development plan, committed to avoid developing hydropower on rivers that are sensitive due to environmental and social values. However, in some projects, UES seems to be less environmentally friendly. For future construction it hopes to resurrect large dam projects conceived during the last century. Because it is well endowed with legal talent, UES manages to avoid full-scale EIAs on the premise that these older projects were approved prior to the emergence of formal EIA requirements.

In recent years, export sales of water have become a recurrent issue. The infamous Siberian rivers water transfer project reemerged in 2002, supported by the influential joint lobby of the Mayor of Moscow together with several Central Asian country leaders. Environmental groups reacted promptly and fiercely and this is partly why this project submerged again without resolution. In mid 2005 the Irkutsk business community proposed the construction of a pipeline that would bring 10 km^3 of Baikal water through Mongolia to Inner Mongolia and Beijing. A subsequent Russia-China scientific expedition to the Lake Baikal area was perceived by the media as an exploratory mission for this project, but China authorities later issued an official disclaimer. No matter how obtuse and unfathomable the projects might be, these anecdotes show that the abundant water resources in Russia are considered a valuable commodity for future international trade.

Mongolia

Water issues in Mongolia are dictated by climate, ecosystems, and history, much the same as in Russia and China. However, due to natural water scarcity, water issues in Mongolia differ radically from those in neighboring Russia and China where water resources are more abundant.

In Mongolia, improvement of groundwater wells is the most widespread structural measure for exploitation of water resources. This was previously employed by Russian cooperation agencies, and is now recommended by international development aid agencies. In rural areas, the key issue has been large-scale abandonment of engineered deepwater wells in the wake of dissolution of the *negdels* (collective farms). About two thirds of all engineered wells ceased to operate between 1990 and 2000. By 2000, at least 60 percent of the roughly 35,000 engineered wells constructed before 1990 were out of operation. Since then, several partner-funded development projects have tried to restore engineered wells and create sustainable management regimes involving herder groups and county (soum) authorities. The process is linked with broader efforts to institute new sustainable pasture management regimes. In 2003, 307 of 468 wells were rehabilitated (ADB-CEA 2005). Repair of wells can have either positive or negative consequences for biodiversity conservation depending on how planning accounts for the water requirements and spatial distribution of wildlife. For example, too many wells evenly distributed across the Eastern Steppe would support greater numbers of livestock, which would compete with Mongolian gazelles for forage. Gazelles are more able than livestock to withstand water shortages, so gazelles thrive in pastures without wells where livestock cannot. In such a situation the absence of wells would be positive for gazelles, but negative for livestock. Presence of wells would have the opposite effects. Alternatively, concentrating well sites near wetlands might attract unsustainable numbers of livestock to these locations and increase grazing and trampling pressure on these habitats.

Agriculture is the dominant water user and causes negative impacts on scarce local water resources. A recent extended drought significantly increased pressure on dwindling water resources and riverine ecosystems, primarily due to concentrations of livestock near remaining water bodies.

In the Mongolia Amur-Heilong basin we are not aware of any sizable water management infrastructure. However, two small hydropower stations were recently completed in Khovt Aimag (Chanterekh River) and Goby-Altai Aimag (Zavkhun River), each with generating capacity of about 40-50 MW. Mongolian experts report plans for a small dam on the Orkhon River and a larger 100 MW dam on Egiin-gol, a tributary of the Selenge River, the largest river flowing into Lake Baikal. In some river basins (Kherlen, Uldz and Onon included) irrigation schemes are under consideration and would be funded using financial assistance from Japan, China, and international development agencies. A plan for water transfer from the Selenge and other rivers to the Gobi Desert is probably the most controversial of all currently known projects and may involve the Onon River basin. The draft resolution of the Parliament on the *Development of Proposals for the Transfer of River Waters to the Gobi and the Steppe Areas Through Flow Adjustment in the Selenge, Onon, and Balj Rivers* was discussed in March 2006. The Mongolian Water Management Agency (part of MONE) has already tentatively approved a plan for water transfer from the Kherlen River to the Gobi. The plan is designed to supply water to settlements near recently developed industrial mining sites and to support large-scale planting of a "green shelterbelt" along the edge of the desert (Badarkh, T., Director, Mongolian Water Management Agency, pers. comm. with E. Simonov, 2006). The plan (a part of the legacy of Soviet water engineering schemes of the 1970s) is being renovated and pushed forward by private companies linked to international mining interests. The plan appears to be impracticable because of water scarcity in the Kherlen River basin. If implemented, the plan might trigger ecological degradation and water crisis in the Upper Amur-Heilong basin shared by three countries and eliminate opportunities to establish coordinated water-conservation policies in this thirsty region.

Dams in the Amur-Heilong basin and generic environmental impacts

Dams and reservoirs in China

Although the Amur-Heilong river is the longest undammed river in the Eastern Hemisphere, in China, the basin's abundant water resources are all subject to intensive management (**Part One, Map 1.12**). The basin has been explored for hydropower feasibility since the 1930s with the first large dam of the basin, the Xiao Fengman Dam, completed by 1940. Practically all townships have reservoirs, typically small ones used for municipal and agricultural water supply, and other supplementary uses such as aquaculture and recreation. Plains also have networks of irrigation canals to supply expanding production of rice and other cereals, and fishponds. Large reservoirs are built in the mountain areas and their primary uses are hydropower generation and flood control, the latter emerging as a major concern following the catastrophic floods of 1998.

In Heilongjiang Province there are 19 large, 59 mid-sized, and 553 small reservoirs and dams. Jilin Province has 13 large, 87 mid-sized, and 1,371 small reservoirs and dams. Inner Mongolia has only one large dam-reservoir and 41 mid-sized dams-reservoirs. These figures are conservative in comparison to the 2005 Songhua Pollution Prevention Project report of than 13,000 "storage works" with a total of 35 km^3 storage capacity in the Songhua basin alone (ADB 2005).

Several reservoirs have already been built on the main tributaries of the Amur-Heilong basin (Xiao Fengman and Baishan Reservoirs on the Second Songhua River, Charsen Reservoir on the Tao'er River, Lianhua on the Mudan River and Ni'erji on the Nen River). Several smaller reservoirs were also built in wetlands, many of which store water for irrigation schemes such as Xianghai Reservoir on the Tao'er River, Dongsheng Reservoir on the Wuyu'er River system, and Nanyin Reservoir at Pangtou Pond. All of these are located within or near Ramsar listed wetlands (**Map 3.6**). In the following paragraphs we review water infrastructure projects in each sub-basin.

Second Songhua River
Xiaofengman Reservoir (Songhua Lake)

The earliest of the larger hydropower stations built in northeast China, Xiaofengman is located 24 km from Jilin on the upper reaches of the Second Songhua River and 250 km downstream from the Baishan Hydropower Station (see below). Fengman Hydropower Station controls a drainage area of 42,500 km^2. As well as generating power and preventing floods, the dam supplies water for irrigation, industrial and domestic use, and cultivation of aquatic products. Fengman Reservoir, also known as Songhua Lake, is 180 km long and has a surface area of 550 km^2. The widest point is 10 km, the deepest section is 75 meters, the area of the reservoir

Table 3.5 Major dams on the Second Songhua River and its tributaries

River	DAM/HPP	Function	River flow at dam site (km^3)	Normal water level	Reservoir capacity (km^3)	Reservoir regulatory capacity (km^3)	Power capacity (MW)	Annual production: (million kWh)
Second Songhua River	1 Baishan	power, flood	7.54	413	6.43	4.86	1500	1700
	2 Hongshi	power, flood	8.14	290	0.15	0.01	200+115	440
	3 Fengman	power, flood, irrigation, municipal	13.8	261	10.80	5.35	1004	2030
Songjiang River	Songjiang cascade: 4 Shuanggou, 5 Xiaoshan, 6 Shilong	power	0.88	585	0.39	0.15	500	840
Erdao River, Fu'er River	Erdao Cascade: 7 Liangjiang, 8 Sihugou、9 Xijingou, 10 Xijiang	power					260 total 60 150 30 20	total 641
Total: ... 10 dams ...					**18+**	**11+**	**3779**	**5651**


110°
120°
50°
40°
Irkutskaya
IRKUTSK
Baikal
Buryatiya
ULAN-UDE
R
U
S
S
SAKH
Chitinskaya
CHITA
AGINSKOYE
Aginskiy Buryatskiy
Tov
ULAANBAATAR
Hentiy
Dornod
M
O
N
G
O
L
I
A
ONDORHAAN
CHOYBALSAN
Suhbaatar
BARUUN URT
Inner Mongolia
HAILAR
BLAGOVES
Heilongjiang
QIQIHAR
DAQING
HARBIN
C
H
I
N
SONGYUAN
CHANGCHUN
JILIN
Jilin
TONGLIAO
SHENYANG
Liaoning
DPRK
Yanggang-do
Changang-do
Hamgy
LEGEND
SETTLEMENTS
Provincial capital
City (prefecture)
Amur basin boundary
Coast line
River
Lake, Reservoir
State boundary
Province
(oblast, krai, aimag, autonomous region) boundary
MAJOR WATER TRANSFER INFRASTRUCTURE
Existing infrastructure
Projects under construction
Proposed projects
Conceptive water transfer schemes
DAMS AND RESERVOIRS
Dam status:
Reservoir volume (in cubic kilometers):
Existing
20 - more
Volume Unknown
Under construction
10 - 20
Volume Unknown
Proposed in recent plan (after 2000)
3 - 10
Volume Unknown
Conceptive dam location (in plans before 2000)
0.5 - 3
Volume Unknown
Status unknown
0.1 - 0.5
Volume Unknown
Hydro-power plants
2500 MW =Power capacity (Megawatt), existing
=Power capacity (Megawatt), planning

lake reaches 500 km² and maximum storage capacity is 10.8 km³. Total installed power generation capacity is 1,004 MW, with average annual output of 2.03 billion kWh. After the 2005 Jilin City chemical factory explosion and subsequent spill into the Second Songhua River, Xiaofengman and the newly completed Ni'erji Reservoir released additional water to alleviate impacts of the toxic chemicals by diluting their concentrations.

Baishan Hydropower Station

Upstream from Fengman Dam on the Second Songhua River at the town of Huadian, Jilin Province, the Baishan Hydropower Station built in 1975-1992 is the largest in the northeast grid. It has an installed generating capacity of 1,500 MW. The station controls a drainage area of 19,000 square kilometers. In addition to generating power the station controls floods and provides other services. The dam is 423.5 meters above sea level and the reservoir has a storage capacity of 6.43 km³ with 4.86 km³ of regulatory capacity.

Hydropower resources were considered to be especially rich in the Second Songhua River in the reach upstream of Fengman and Baishan hydropower plants. Because of the abundant water and gradient of the river this reach was developed as a cascade of 10 hydropower stations. Details of major dams on the Second Songhua are listed in **Table 3.5**. Remaining hydropower development opportunities on the Second

Map 3.6 Existing and planned dams and water diversions on major steams in the Amur-Heilong River basin

Table 3.6 Ni'erji hydropower project water allocation (units: $10^6 m^3$)

Water Use	Water supplied by Ni'erji Reservoir	Water supplied by other sources	Total
Environmental protection	841	4,362	5,203
Navigation	1,259	7,494	8,753
Industrial and urban domestic	1,116	1,872	2,988
Paddy field	1,053	1,274	2,327
Dry farm	366	422	788
Wetland	220	719	939
Trans-basin diversion	756	881	1,637
Power generation	208		208
Annual average water supply	5,819	17,024	22,843

Songhua River are limited now that the total generating capacity of 3,779 MW has been installed at 10 large hydropower plants.

There are plans to build a reservoir in the lower Second Songhua River (near the city of Songyuan) for storage and diversion of some 300 m^3/s of water towards the Liao River basin. Plans are scheduled for after 2030 (ADB 2005).

Lianhua Hydropower Station and other Mudan River HPPs

Lianhua was the first large modern water conservancy project in Heilongjiang Province, located at Lianhua Township, Linkou County, Mudanjiang. The station has four generating units with total capacity of 550 MW and was built at a total cost of ¥4.7 billion. During construction more than 40,000 people were resettled. The first generating unit was connected to the local grid in December 1996 and the remaining three units became operational on 28 September 1998. Lianhua Reservoir on the Mudan River has total volume of 4.18 km^3 with regulating capacity of 1.59 km^3.

The upper reaches of the Mudan River have been targeted for development of a three-dam cascade (Erdaogou, Bailongxiao, Changjiangtun) with total generating capacity of 225 MW and with the mountain Lake Jinbo serving as a reservoir for a power plant with 96 MW generating capacity.

Ni'erji Water Control Project and other developments on the Nen River

The middle reaches of the Nen River run from mountains to rolling terrain and gradually onto the Song-Nen plain, a large flatland in central Heilongjiang Province named for the confluence of the Second Songhua and Nen Rivers. This is where the devastating floods of 1998 started with torrential summer rains on the deforested Great Hinggan Mountains. The Song-Nen Plain is a well-developed industrial and agriculture region in the western Songhua River basin. Water demand here is large and flood control is important. The Ni'erji Water Control Project lies in the middle reach of the Nen River on the border of Heilongjiang Province and Inner Mongolia. It is a multi-purpose project for flood-control, urban and suburban water supply, hydropower, irrigation and navigation. The reservoir will have a storage capacity of 8.61 km^3 with 2.3 km^3 of flood storage capacity. The power station will have an installed capacity of 250 MW. Ni'erji reservoir was drawn down to increase water flow in the Songhua River during the chemical spill incident in November 2005. After the Ni'erji project is completed, flood-control capacity in Qiqihar City will be upgraded from a 50-year to a 100-year standard.

Water resources in the Songhua River basin are less depleted than in the Liao River basin to the south. There is a plan to divert 1.6-5.3 billion cubic meters of water from the Songhua River to the Liao River basin in 2015 to solve the problem of serious water shortages in the middle and lower Liao River basin (**Table 3.6**).

In contrast to the situation in the Second Songhua River, where rainfall in the upper reaches is abundant, the Song-Nen plain has just of 450 mm of precipitation annually and already suffers from desertification and dessication of wetlands due to inappropriate management of water for agriculture and flood control. The environmental crisis seen today in the neighboring Liao River basin is rapidly extending northward and is affecting the Song-Nen plain. For this reason the planned water transfer from the Songhua to the Liao basin might be postponed or cancelled.

Surface water is often allocated to rivers to prevent degradation of riverine ecology and to avoid losses of ecological functions such as natural water purification and aquifer recharge. In contrast to this natural system, water allocated to wetlands on the Song-Nen plain is often pumped from aquifers back to the surface. This causes depletion of aquifers and reduced groundwater levels. Cha'ersen multipurpose reservoir is a hydropower station on the Tao'er River, a tributary of the Nen River in Inner Mongolia. It was built for flood control, irrigation, and power generation, and has only 12 MW generation capacity.

There are plans to develop at least four more hydropower plants on the upper Nen River tributaries with total generation capacity of 560 MW. Another plan calls for construction of the multipurpose 1.6 km^3 Wendegen reservoir on the Chao'er River downstream from Ni'erji dam. In combination with the ubiquitous but smaller irrigation reservoirs these large hydropower projects might contribute significantly to on-going environmental degradation on the Song-Nen plain. There are substantive and multi-faceted environmental concerns regarding further plans for hydropower development and reservoir construction.

Songhua River

The topography of the Songhua basin is too flat to build a large reservoir. However, there is a plan to build two dams to improve conditions for navigation. Dadingzishan reservoir, behind a 9-10 meter dam on the river's main stem, is planned to start operation in 2008 just 46 kilometers downstream from Harbin (ADB 2005). As reported by the Heilongjiang Environmental Protection Department's (HEPD) Mr. Liu Feng Kai (personal communication, December 2003), this new reservoir would have active capacity of 1.7 km^3 and a surface area of 340 km^2. Its primary purpose would be to maintain waters of the Songhua River at high navigable levels in the city of Harbin all year round. The second project would create the Yilan reservoir further downstream. Operation is planned to begin in 2011. Too little information is available at the moment, but there are important questions regarding the influence of such reservoirs on accumulation of pollutants, on the downstream flood regime, and on migration or movement of aquatic wildlife.

In 2003, ADB approved a US$100 million loan to help build a 42-meter high, 356 million m^3 reservoir at Mopanshan, on the upper reaches of the Lalin River, about 175 km from Harbin. The project, estimated to cost a total of $400 million, involves the construction of a tunnel and river outlet, a water pipeline to Harbin, and a new treatment plant, as well as the rehabilitation of the distribution system.

Ussuri-Wusuli River Basin

Similar to the main trunk of the Songhua River, the topography of the Ussuri-Wusuli River basin is too flat for hydropower dams. However, small generation capacity may be installed on irrigation/flood control reservoirs such as the 0.64 km^3 Longtouqiao Dam on the Naoli River (left-bank tributary of the Ussuri-Wusuli River) in Baoqing County in the foothills of the Wandashan range. The trend toward increased use of irrigation on farmlands in the Sanjiang Plain of eastern Heilongjiang Province has led to proliferation of small and medium-size reservoirs. In the Naoli River basin, from 1970 to the 1990s, irrigation increased threefold and required 0.6 km^3 of water annually. To meet this need, reservoirs were constructed on 12 of the 15 main tributaries of the Naoli River (Cui Bao Shan and Liu Xingtu 2001).

Large water regulation infrastructure that altered the water level of Xiao Xingkai Lake (Small Khanka Lake) was installed in Mishan City at Xingkai Lake during the years of Japanese occupation. It now supports a huge rice growing enclave surrounded by Xingkai Lake National Nature Reserve, a Ramsar site.

Argun (Erguna) River

Two fairly alarming projects were proposed in 2004-2006 by the Song-Liao Water Resource Commission (SWRC), one of China's seven basin management authorities, and the national authority for the Amur-Heilong basin in China.

One proposal calls for construction of a reservoir in the upper reaches of the Yiminhe River near Honghua'erji Nature Reserve. Development of any infrastructure upstream will most likely lead to deterioration of Hailar-Argun River floodplain wetlands located downstream, which are known as an important stopover site of migrating waterbirds and breeding habitats of red-crowned crane and swan goose. Both species are listed by the World Conservation Union as globally threatened.

A second proposal would "sustain" Dalai Lake water levels, which, during the current drought period, are rapidly dropping, as they have done many times throughout history. The project theme is "environmental safety", but the design was influenced by concerns for the short-term protection of fisheries and urban water-supply. Torey Lakes in the adjacent Uldz River basin in Russia have a very similar hydrological cycle and become dry on average once every 50 years. Oscillating lakes generally support higher fisheries productivity than do lakes with stable water levels providing that the range of water level variation is held within certain limits. Although ecosystem responses are well documented by researchers working in Daursky Zapovednik, questions regarding changes in productivity and resilience of freshwater ecosystems in different phases of drought cycles require additional study. The proposed project, for which an EIA was approved in early 2006, calls for diverting 1-2 km^3 annually from Hailar River (the upstream name for the Argun River) into Dalai Lake. If implemented, this would severely damage large transboundary floodplain wetlands on both sides of the middle Argun River, and might also have severe implications on water pollution and border delineation issues. To date the progress of these two proposed projects is not publicly known. The main ecological problem is that lakes and lacustrine wetlands of the region are adapted to much wider variations in flow and water levels than are the Argun and Hui Rivers and their surrounding wetlands. The main environmental policy concern is that if Mongolia diverts the Kherlen River and Onon Rivers into the Gobi desert and China diverts the Haila'er to Dalai Lake, this would preclude any future opportunity to harmonize water management and biodiversity conservation in the upper Amur-Heilong basin, and would reinforce unsustainable and uncoordinated water development in the region.

Smaller Amur-Heilong tributaries

China's policy for "Revitalization of Old industrial Bases is likely to intensify dam construction to provide power and water for the revitalized industries. Ambitious but haphazard plans for further dam construction for the period 2005-2015 have been proposed by different prefectures of Heilongjiang Province. These call for dam construction on all suitable tributaries of the Amur-Heilong River. Recent maps show that several reservoirs similar to those on the Ku'erbin and Fabiela Rivers are already built. On the Gongbiela tributary, Heihe Prefecture plans to reconstruct the old Xigou reservoir to become a pump storage hydropower plant, and simultaneously seeks investment to build the 27 MW Sanwan hydropower plant on Fabiela River. Construction of the planned 100 MW Xihe hydropower plant on the Zhan River in Sunke County could adversely affect Da Zhanhe Wetland National Nature Reserve — the largest intact tract of wetlands in Heilongjiang Province and the best nesting habitat of hooded crane (*Grus monacha*) in China.

Huma Prefecture has long sought to develop a cascade of 400 MW hydropower projects on the Huma River, which is a well-known nature reserve and one of the northernmost reaches of spawning salmon on the Amur-Heilong River. In light of these development plans, recent reports from local authorities on extinction of salmon in the Huma River should be thoroughly checked by independent ichthyologists. Should salmon still survive here, this site would become an important test case for conservation of biodiversity that is potentially of great economic value. A recent report of Chinese Academy of Engineering on the North East Resources and Environment (Some Strategic Questions 2006) strongly emphasizes, that unless the water deficit tendency is reversed in the Nen River Basin, the most viable replenishment option is water transfer from the Huma into the Nen River.

Conclusion on China dams

In 2003 the Ministry of Water Resources reported that, by 2005, potential hydropower generation capacity in the northeast would already be 40 percent exploited. This is a substantial portion of the total capacity, particularly given that environmental concerns are not accounted for in these engineering calculations. There are 500 known potential locations for hydropower dam construction in northeast China (Jilin, Heilongjiang, and Inner Mongolia). Among those, there are 122 locations that could support hydropower plants of more than 10 MW generating capacity (**Table 3.7**). Since approximately half of the promising large dams sites are found only on the Amur-Heilong main channel, the hydropower development community in China will certainly strive to exploit this opportunity. These reservoirs might also enable subsequent water transfers to the Nen River basin and to the Liao River basin further south, where water shortage is already severe (For a detailed discussion see the "Joint Scheme" case-study below). Increasing water-scarcity will also lead to construction of a large number of small multipurpose reservoirs, providing for irrigation, municipal water supply, and flood control. An ADB report on Songhua Water Pollution (ADB 2005) lists several dozen such projects, and even

Table 3.7 Suitable hydropower sites and potential generation capacity for hydropower plants larger than 10 MW in the Amur-Heilong River basin in China

Province	Potential Dam Sites	Potential Generation Capacity (MW)	Installed Generation Capacity (MW)	Installed percent of potential
Jilin*	51	4,100 (545 of that on Yalu River)	3,700 (395 of that on Yalu River)	90
Heilongjiang	53	7,160 (4,000 of that on Amur River mainstream)	769	11
Inner Mongolia	18	1,530	13	<1
Total	122	12,790	4,682	37

*Jilin figures include the Yalu River which is shared with North Korea outside the Amur Basin. The Argun River in Inner Mongolia is shared with Russia and is part of the Amur-Heilong River basin.

advocates development of reservoirs to "sustain minimal ecological flows".

Russia

Although hydropower exploration in the Russian Far East started in mid 20th Century, only two large hydropower dams have been built to date. However, in terms of their flood regulating capacity and impacts on the Amur-Heilong River ecosystem these two Russia dams might well be equivalent to all of China's hydropower facilities in the basin combined. This is because the impacts of large hydropower plants on nature are orders of magnitude larger than those of smaller reservoirs that are typically used to store water for irrigation, fish farming or flood management.

In addition to the hydropower plants on the plains along the Amur-Heilong River and in the upper Ussuri basin, there are small reservoirs built for water supply and irrigation. Only three to six of these exceed 0.1 km^3 in volume. Many are poorly managed and partially destroyed due to recent declines in agriculture in this part of Russia. Out of 189 registered reservoirs, only 22 were actively used in 2003. The Zeya-Bureya plain in Amurskaya region has the most reservoirs with around 114 in total. Reservoirs built to store industrial tailings (14 sites with total volume of 100 million m^3) and waste water (19 sites with total volume of 190 million m^3) are of great concern because of their high risks of pollution.

Hydropower Plants

In 2004 WWF-RFE commissioned a study of plans for hydropower development in the Russia portion of the Amur-Heilong basin. This was carried out by Gotvansky (2005). The following sections are adapted mainly from that study.

Zeyskaya HPP Reservoir. The giant Zeya Dam was completed in 1975 on the second largest tributary of the Amur River, the Zeya River. The dam has 1,330 MW capacity and produces about 4,900 million kilowatt-hours of electricity. The reservoir covers 240,000 hectares and has a volume of 68.4 km^3 (approaching the volume of the Three Gorges Reservoir on China's Yangzi River). At its widest point the reservoir is 24 km across. It is known locally as "Zeya Sea" and its water quality is seriously affected by 3.9 million cubic meters of unsalvaged wood and 98,000 hectares of peatlands that are slowly decomposing on the reservoir bed.

Bureyskaya Hydropower Reservoir. Immediately after completion of Zeya Dam in 1975 construction began on the Bureya Dam in the Bureya River. Construction was halted for decades until 1999, when RAO-UES, the Russian state-owned monopoly for electric power generation, rejuvenated the project and arranged its swift completion.

Bureyskaya is even larger than the older facility on the Zeya River, with planned capacity of 2,000 MW and 7,100 million kWh of annual output. However, Bureyskaya reservoir is smaller, with only 20.9 km^3 of capacity (full volume to be reached by 2008). The surface area of the reservoir is planned to exceed 600 km^2. This will increase the total volume of Russian reservoirs to over 90 km^3. In the near future RAO-UES plans to build the **Lower Bureya Reservoir** immediately downstream of the Bureya Dam and with a smaller reservoir capacity. Bureya reservoir is 1/3 the size of the Zeya reservoir, but follows the same devastating pattern in which wide mountain valleys that are critically important habitat for many species of wildlife are submerged and then become an additional source of long-term pollution because of decomposing vegetation on the former river valley.

The Zeya and Bureya dams altered the hydraulic and river-bed formation processes, and blocked migration paths for many species of aquatic and terrestrial wildlife. Zeya Dam alone controls about 40 percent of the total Zeya River basin and accumulates 71 percent of the upper Zeya waters in its giant reservoir. Operation of the Zeya dam has altered downstream water levels. After power generation began at the Zeya hydropower plant, flood levels declined in the middle Amur-Heilong River by about 2.8 meters. In contrast, winter flows in the Zeya River increased nine-fold in February-March, and even the remote Komsomolsk-on-Amur City experiences a two-fold increase in March flows (IWEP 2002, Gotvansky 2005). These increases are due to discharge from the reservoirs to generate power during winter. Increased winter flow is generally considered the main cause of drastic change of sedimentation and bank erosion patterns occurring for up to 1,000 km downstream.

Reduced flood levels have led to significant alteration of floodplain wetlands and meadows within a range of 1,200 km downstream from the dams. Zeya reservoir had a profound influence on floodplain wetlands downstream, with many floodplain ponds degrading, disappearing, or suffering accelerated sediment deposition, and reduced concentrations of dissolved oxygen, thus degrading conditions for aquatic biota (ABWMA 2003). The downstream effects of the Bureya Dam in this respect compound the effects of the Zeya Dam but remain poorly documented.

Environmental effects of the dam have been studied from the late 1970s by various academic institutions. However, despite the long history of planning and legal requirements, no formal environmental impact assessment has ever been published to document the downstream effects of the hydropower facilities on river ecology.

The socio-economic impacts of the two dams are also problematic. The Bureya Dam exemplifies the reemergence of the old large-dam mentality despite all recent predictions of severe negative consequences. As with most large dams, benefits accrue to energy producing companies while long-term negative environmental and socio-economic consequences rest with nature and local people (WCD 2000). Even the costs of maintaining the reservoir are covered by public funds, while energy companies limit their responsibilities to maintaining a dam and paying modest water taxes. RAO-UES has superior litigation capability and is at constant odds with the Amurskaya regional government and NGOs, as well as with the Amur Basin Water Management Authority, navigation authorities, and others. In 2005 UES refused to release water to allow shipment of goods and fuel to remote upstream settlements. During Soviet times, utility companies were required to help develop social infrastructure, but this has changed such that RAO-UES power plants now distance themselves from supporting local social causes. Following the launch of Bureyskaya Dam, local prices for electricity increased and ultimately exceeded the national average price by wide margins.

But the underlying irony is that these hydropower plants produce electricity for which no market exists in the Russian Far East. Creation of large hydropower plants did not encourage development of local industries to consume electricity and develop regional or local economies. The result is surplus generation capacity which is not welcome in Russian Far East energy markets. Increasing production of unwanted power could ultimately lead to closure of many thermal-generation plants in Amurskaya, Primorsky and Khabarovsky Provinces unless efforts to export electric power to China are successful.

Planned hydropower plants

Altogether more than 100 locations have been recommended by Russian engineers for large dam construction in the Amur-Heilong basin. Advanced planning for 15-20 of these sites was undertaken and subjected to public comment in the late 1980s and early 1990s. This resulted in the cancellation of at least three proposed dams in Amurskaya and Primorsky Provinces due to heated public discussion launched by the academic community and environmental NGOs. Another important factor was the lack of government financial capacity to implement these projects. However, plans for these dams are only dormant and could yet resurface if financing for construction becomes available. Availability of financing will probably depend on international interest in export of electricity to China and other countries of northeast Asia, because Russian entities have little capital to invest and there is no shortage of domestic electricity supply in RFE for the foreseeable future.

In 2006 UES was the only domestic entity capable of implementing large hydropower projects in Russia. In 2005 it released a new development strategy for the Russian Far East focusing on export of energy to northeast Asia (RAO-UES, Khristenko 2005). The 2005 Strategy, when compared to that of 2003, seems to

Table 3.8 Reservoirs in the Russian Amur-Heilong basin (Includes built and planned facilities)

River (discharge outlet)	# No.	DAM/HPP	Location	Function	Normal water level (m)	Reservoir (km^3)	Reservoir regulatory capacity (km^3)	Power capacity (MW)	Annual production (million kWh)	Project status: C (completed), UC (under construction), UES (included in UES plans) P (planned in earlier schemes)
Zeya (Amur)	1	Zeya HPP	Amurskaya	power flood		68.4	32.1	1330	4900	C-1975
Bureya (Amur)	2	Bureiskaya HPP	Amurskaya Heilongjiang	power flood	256	20.9	10.7	2000 (1005 in 2005)	7100	C(2003) UC (2008)
Bureya (Amur)	3	Nizhne-Bureisky	Amurskaya	power		2.03	0.07		1600	UES(2005)
Zeya River (Amur)	4-6	Nizhne-zeysky Cascade:	Amurskaya	power				3 HPPs 349 MW	3 HPPs 2120 kWh	UES(2005)
Giluy (Zeya)	7	Giluyskaya	Amurskaya	power		6.13	3.25	380	1150	UES(2005)
Niman (Bureya)	8	Urgalskaya	Amurskaya	power		13.5	8.3	600	1800	UES(2005)
Selemdzha (Zeya)	9	Rusinovskaya	Amurskaya	power flood		8.8	4.46		1510	P(1987)
Shilka (Amur)	10	Shilkinsky	Chita	power	395	20.0			3700	P(1990)
Bolshaya Ussurka (Ussuri)	11	Dalne-Rechensky Cascade:	Primorsky	power flood		10.5+0.96	4.3	595+250	1400+540	P(1988)
Tugursky Bay (Sea of Okhotsk)	12	Tugursky Tide HPP	Khabarovski					7980	20000	UES(2005)
Small HPP in RFE			Far East					30-50		UES(2010-2020)

be slightly less threatening to the Amur-Heilong basin environment. A number of earlier proposed locations, including the most damaging Khingansky-Taipinggou dam on the main trunk of the Amur-Heilong River, were replaced by an ambitious plan to develop the massive HPP cascade on Timpton River in the Lena basin of Sakha-Yakutia Province. The most impressive project in the 2005 portfolio calls for development of Tugursky Tide HPP in Tugursky Bay (Khabarovsk Province, Sea of Okhotsk), a site that meets Ramsar Convention criteria for wetlands of international importance. Even wind and small-scale hydropower plants have a modest role in the agenda for the future. UES has developed an environmental strategy, but it does not clearly define its regional dimension, nor does it call for strategic environmental assessment of future energy generation options in the region. **Table 3.8** lists major dams built in and planned for the Amur-Heilong River basin.

The future environmental policy of RAO-UES depends on factors outside the Amur-Heilong region, including:

- The ever changing Russian policy on monopolies that may lead to dissolution of RAO-UES in the near future;
- China policy on electric power imports coupled with its strategic water policies and border policies;
- International mechanisms such as the Kyoto Protocol and criteria for acceptance of large HPPs in international development assistance programs;
- Development of alternative routes for electric power exports in northeast Asia (mainly the Koreas and Japan).

There is little reason for optimism. Whatever future developments unfold we must note that a single hydropower plant built in Russia has been the environmental equivalent of a dozen in China in terms of magnitude of impact. Despite the fact that the Russian Far East is especially well-suited to small-scale hydropower plants and other "environmentally-friendly" generation possibilities, the only projects realized to date have been large scale dams with catastrophic impacts. According to the Sovintervod Hydro-Engineering Institute, the Zeya and Bureya HPPs combined are responsible for 90 percent of the decline in Amur-Heilong basin fisheries over the last 30 years. Although this estimate could be biased, objective environmental impact assessment of the cumulative impacts of these two dams might reveal that the Amur-Heilong ecosystem is only just able to endure the abuse from the facilities already constructed. Development of new dams on another as yet un-dammed Amur tributary might lead to cumulative losses unsupportable by the Amur-Heilong ecosystem regardless of the environmental standards applied. The most damaging scenario of HPP development on the main trunk of the Amur-Heilong is discussed with reference to a separate case study in the section below.

Case Study on international planning: "Joint Comprehensive Scheme on Amur and Argun Rivers"

Russia and China have shared many special relationships throughout history, including one in natural resources management. This is partly because the two countries share the river basin along the main stem of the Amur-Heilong River. While China has been slow to sign binding transboundary water resource agreements with other neighbors, it signed the first such agreement with Russia in 1915. This agreement settled some border issues, clarified protocols for use of existing infrastructure, and outlined a future equitable division of water resources (Ilomaki 1999).

In 1956 China and Russia signed an Agreement for cooperative research on Amur River natural resources. This agreement launched what was known as the "Heilongjiang" and "Amur" Expeditions of China and Russia Academies of Science", or the "Grand Amur Scheme". In this undertaking, from 1956-1962, China and Russia explored opportunities for cooperative natural resource management in virtually every field from agriculture to fisheries and from industry development to wildlife management.

One design dating from 1962 focused on water infrastructure and suggested development of a cascade of four reservoirs in the upper and middle Amur-Heilong with total storage volume of more than 250 km^3 and surface area of 6,000 km^2 (Gotvansky 2005). The main benefits were predicted to be flood prevention and hydropower generation, and early consideration was given to the possibility of water transfer from the Amur-Heilong to the Nen River. Environmental consequences were scarcely considered and ecological values were fully sacrificed to development of an "unbreakable friendship". In the 1960s relationships between the two countries deteriorated and this plan was never implemented. Meanwhile both countries proceeded aggressively with uncoordinated development of water resources of the Amur-Heilong within their national territories.

Bilateral relationships improved in 1986 and a new agreement was signed by China and the USSR to resume interrupted work. The "Russia-China Joint Comprehensive Scheme for Water Development in Transboundary Waters of the Argun and Amur Rivers" solidified this later agreement The Scheme was a bilateral overview of developments planned by the water and energy authorities of China and Russia. Several dozen research and planning institutes participated in drafting the overview and the project was led by the Song-Liao Water Resource Commission of China and Sovintervod Hydro-engineering Institute of USSR Water Resources Ministry (presently ZAO Sovintervod).

Environmental issues were not high on the agenda when this planning exercise started. The initial intent was to review development opportunities in hydropower, flood prevention, fisheries, and clean water supply. However, baseline conditions in the two countries were notably different. China clearly prioritized hydropower and was thus inclined to avoid or dismiss any modifications that threatened electricity outputs. Russia was eager to explore relationships between all sectors of the economy and sought compromise. Nevertheless three amendments initiated by China and accepted by Russia biased the resulting scheme toward hydropower:

- The project area was demarcated to exclude the reach of the Amur-Heilong between the Songhua and Ussuri River mouths. The upstream boundary of this excluded area was located upstream from the Songhua River mouth, thereby designing the Songhua River out of the scheme and avoiding the need to explore trans-

Table 3.9 Mainstream transboundary dams "Joint Comprehensive Scheme on Amur and Argun rivers" (1990-s) (difference in figures in Russian version of the Scheme shown in brackets)

River	# No.	Dam or Hydropower Plant	Location	Function	River flow at dam site (m3/sec)	Normal water level (m)	Reservoir Volume (km3)	Reservoir regulatory capacity (km3)	Power capacity (MW)	Annual production: (million kW*h)
Amur	1	Amazarsky/ Mohe	Amur-Heilong Russia	power	902	400? (Russia:390)	31.2? (Russia:23.55)	18.7? (Russia:13.66)	2000? (Russia:1500)	5800? (Russia:4900)
	2	Dzhalindinsky/ Lianyin	Amur-Heilong Russia	power	1109	298? (Russia:303)	5.7? (Russia:7.86)	1.62? (Russia:1.82)	1000? (Russia:600	3100? (Russia:3000)
	3	Tolbuzinsky/ Oupu	Amur-Heilong Russia	power	1281	253	29.2 (Russia:4.97)	15.6 (Russia:0)	1600 (Russia:600	5100 (Russia:2450
	4	Kuznetsovsky/ Huma	Amur-Heilong Russia	power water transfer	1327	191 (Russia:220	0.33 (Russia:3.58)	0.03 (Russia:0)	300 (Russia:500	1000 (Russia:2200
	5	Heihe (China plan)	Amur-Heilong Russia (China plan)	power, irrigation water transfer	1597.5	165	14.5	3.59	1400	4100
	5a	Novo-voskresenovsky (Russia plan)	Amur-Heilong (Russia plan)	power	1345	191	0.35	0	200	950
	6	Khingansky / Taipinggou	Amur-Heilong Russia	power, water supply, flood prevention, irrigation	4903	83? (84.4)? (Russia: single 80/ cascade 78)	1.74? (2.17) ? (Russia:1.14)	0.5? (Russia: 0)	1800? (Russia:1200)	7100? (Russia: single5800/ cascade6000)
Argun	7	Gorbunovsky	Amur-Heilong Russia	power	153	495	2.4	1.36	50	220
Argun	8	Belogubovsky	Amur-Heilong Russia	power	185	460	0.7	0.46	80	320
Argun	9	Cheremukhovsky	Amur-Heilong Russia	power	266	430	0.23	0	70	250

boundary pollution issues arising from the Songhua River;

• Flood-prevention was deleted from the common agenda and subsequently handled by each country independently. This opened the way for uncoordinated dyke-building along national river-banks, causing tremendous hydrological problems. Similar treatment resulted for all issues related to "water used within national territories";

• Evaluation of one alternative plan to dam tributaries while leaving the main channel of the Amur-Heilong River free-flowing was deliberately deleted from the agenda, despite resentment of many Russian experts on this issue (after Gotvansky 2005).

This version of the Scheme (most actively developed in 1989-1993 and finally half-completed in 1999) proposed up to 10 dams on the Amur-Heilong River and its tributaries, while the Argun River was to be developed in a large cascade. Three dam locations: Khingansky, Dzhalindinsky and Amazarsky were agreed to be more feasible than the other and thus were called "first-stage dams" (**Table 3.9**). Russia and China failed to agree on many issues including dam height, location, reservoir volume and regime, mitigation of impact on fish stocks, and many other environmental issues. Finally they declined to approve the document, agreeing only on its 100-page synopsis ("Joint Comprehensive Scheme" 2000) with many points of disagreement listed in the text. Since 1992, and in parallel to the above process, Russia has continually proposed that the two countries sign an agreement on protection and use of transboundary rivers. This is cited in documents of the Russia-China Commission as a precondition for further work on the dam proposals.

By 1996 Russia had passed a law requiring environmental impact assessments and required the Scheme to be subjected to an EIA. However, because of the Scheme's technical problems, it was not recommended for EIA or subsequent governmental review in Russia. Regardless of whether the Scheme has been evaluated in China, in 2000 the China-Russia Commission for the Joint Scheme convened its most recent (6th) meeting and all resulting materials were shelved.

Implementation of this scheme would result in radical alteration of hydrological and ecosystem processes throughout the basin. The most notable effects include radical changes in sedimentation patterns in the Lower Amur, creation of an impenetrable barrier for migrating fish, and significant alteration of the wetland hydrological regime of the Amur-Heilong valley downstream.

The Scheme evoked considerable public debate in Russia in the mid-1990s because it was intended to dam the main trunk of the Amur-Heilong River for electricity generation, but did not carefully review alternatives for river basin management and socio-economic development. On the positive side, these planning efforts yielded an extensive and diverse volume of research materials on the Amur-Heilong River basin ("Joint Comprehensive Scheme" 1993, 1999, 2000). Unfortunately, these materials are much less detailed than those compiled during the 1950-1960s. However, because the scheme was at least half-finished, official plans for future cooperation between China and Russia on any Amur-Heilong River basin management initiative will have to assess it and use its abundant and relevant data to develop alternatives and/or major adjustments.

Khingansky-Taipinggou Dam in the Evreiskaya Autonomous Region was recently considered the most promising by RAO-UES (2003) yet this dam is predicted to have the most detrimental environmental effects. No mention of Amur mainstream dams was found in 2006 programs of the company.

Talks in September 2003 between Hegang Prefecture and Evreiskaya Autonomous Province resulted in a vague agreement to jointly promote construction of Khingansky-Taipinggou dam ("Priamurskie Vedomosti" Newspaper, 24 Sept 2003, quoted on Echo-DV web site). This might explain why Khingansky Dam was advertised by Hegang City as an attractive investment opportunity at an international exhibition in Japan in 2005, and was recommended for inclusion into the program for "Revitalization of Old Industrial Bases in North-East" to be subsidized by the central governmental of China (CAE 2006). According to Hegang Water Resources Bureau, all preparatory work and assessment should be completed by 2008. Construction could begin immediately thereafter because investment funds are available and Russia has agreed to the plan. The Evreiskaya Autonomous Region that occupies the Amur River bank opposite to Hegang Prefecture was the only province in 1993 that fully agreed to the Scheme. Agreement was presumably based on the prospect of substantial short-term investment in dam construction, and the opportunity to open an attractive trade corridor to China. There are no bridges uniting the two countries across this reach of the River so the new dam, to be used simultaneously as a bridge, would improve cross-border traffic. Officials from the Evreiskaya Autonomous Region denied in 2005-2006 that any progress had been made in these negotiations.

All proposed dams on the Amur-Heilong mainstream are included in the official list of future hydropower construction sites featured on web-sites associated with the China Ministry of Water Resources (**Figure 3.1**). However, the much smaller Argun River dams are not found there. Khingansky/Taipinggou, Dzhalindinsky/Lianyin and Amazarsky/Mohe are given first priority (as was first stated in the early 1990s). According to these plans construction of mainstream dams should start before 2020.

The most recent reemergence of these dam proposals in Russia occurred in 2004-2005 when ZAO Sovintervod, a company that survived national economic turmoil by undertaking Syrian and Iraqi irrigation contracts, was chosen by Amur Basin Water Management Authority to develop a new Comprehensive Strategy for Water Development and Protection in Amur River Basin for the period 2005-2015. Development of the strategy is supported by Russian Water Code, and the required subordinate technical requirements for basin schemes were developed by ZAO Sovintervod. These received provisional approval by the Federal Water Service in late 2005 (ZAO Sovintervod 2004). Development of only six pilot basin schemes was commissioned for 2004-2008 in Russia. In contrast to earlier initiatives, the financial and institutional resources devoted to each basin scheme, including the Amur-Heilong Scheme, were much less than in the previous two bilateral attempts. Given limited resources the only viable option left to ZAO Sovintervod was to renovate the voluminous but outdated bi-lateral Scheme materials and try to adjust them to new socio-economic conditions.

In early 2005 all province governments of Russia's Amur basin received a slightly revised synopsis of the 1999 Joint Scheme and were requested to pro-

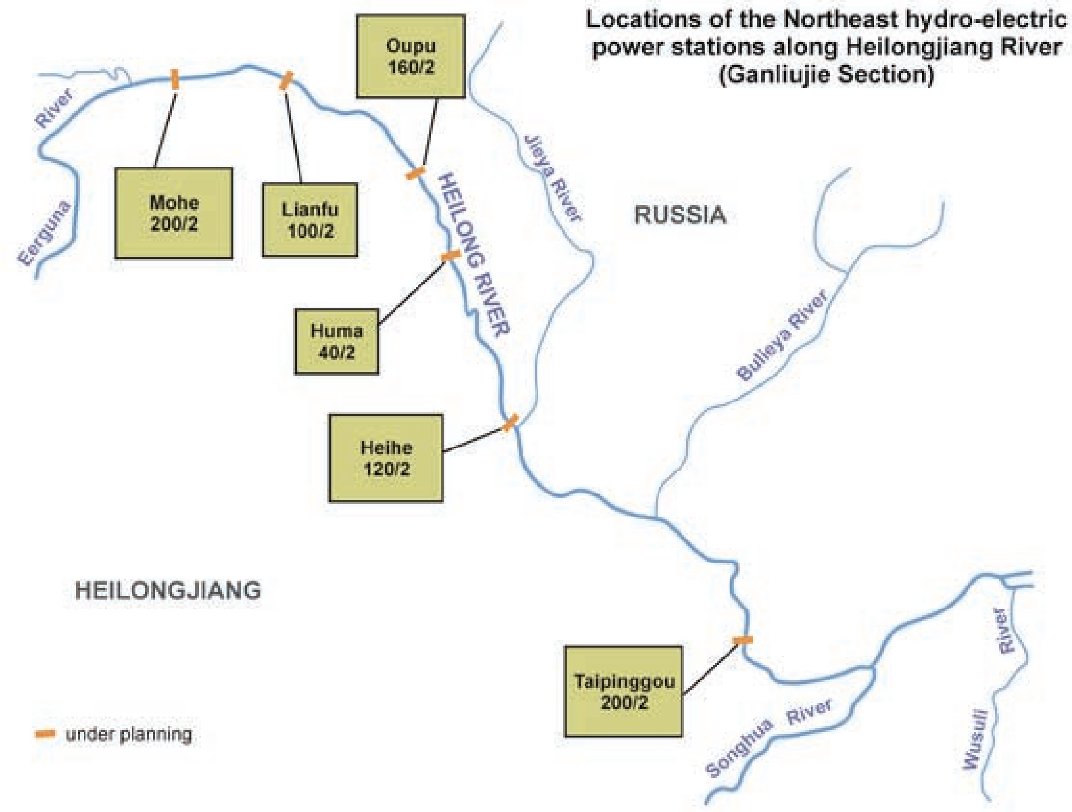


Figure 3.1. The 20-Year plan for hydropower development in China dated 2002:"Dam sites in the North-east hydropower development base (Main stem of transboundary Heilong River)". Features six proposed dams on the Amur-Heilong main channel (China Hydroconsultants web-site 2003); also see Map 3.6.

vide their economic development plans. In the 2005 scheme ZAO Sovintervod stated that the 1999 Scheme had been endorsed by international agreement and that Sino-Russian cooperation on hydro-power development beginning in 2005 would offer a unique opportunity to solve all Amur-related problems not addressed by previous schemes, such as flood management, river course alteration, and even water pollution. While the claim of international endorsement was false, the promise to solve problems at least raised an important concept: Construction of massive water infrastructure in the main stream would result in catastrophic alteration of the entire Amur-Heilong ecosystem, and thus the unresolved problems of yesterday and today would be replaced by new ones in future. The new problems would likely be much more acute, and the two countries would have little choice but to try to solve them cooperatively. In 2006 WWF launched a campaign to ensure public participation in review of this new Scheme. In April 2006 the Scientific-Technical Board of ABWMA gathered to provide guidance on further development of the new Scheme. Its decision clearly recommended to ZAO "Sovintervod" to remove from its list of proposed water projects any dams in the Amur main channel, and not to base its policy recommendations on outdated decisions made in 2000 by a Russia-China commission. However, this decision does not mean that dams proposed for the main channel could not re-emerge either in a subsequent edition of the Scheme, or even worse, in a RAP-UES list of power plants intended to deliver 60 billion KWh to China by 2015.

Drought and flood prevention

Drought and flood recur annually and naturally in the Amur-Heilong basin. The annual drought begins in late autumn and lasts through winter until the rains begin the following mid-summer. Minor flooding accompanies the spring thaw when ice-jams form in the rivers. Floods of larger magnitude and duration accompany the late summer rains. Overlaying this annual cycle there are longer term periods of abnormally low or high precipitation that might last for years or decades. Not only are the climatic regime and topography naturally predisposed to flooding, but this natural hydrologic regime has been made even more flood-prone by human effort. In pre-human times the magnitude of annual floods was probably lower in most parts of the basin because of two conditions that do not prevail today. First, because the basin was densely vegetated, rain water was held in vegetation and soils, and surface runoff was low. Second the river valleys included vast marshes that absorbed and held runoff, releasing it slowly back to the main river channels over late summer and autumn. Human efforts have removed the protective vegetation and drained the marshes. The result is soils that do not absorb rainfall because they are exposed and dry. The towns and farms that replaced the marshes cannot absorb flood waters but instead suffer tremendous losses of life, property and crops. The result is that floods are now considered the most serious type of disaster in the Amur-Heilong River basin. Although Russia accounts for more than 2/3 of Amur-Heilong discharge volume, property damage caused by floods is less severe in Russia than in China mostly because logging, fires, and agriculture have not yet claimed such a large share of the catchment water retention capacity in Russia as in China. The following sections describe the various approaches to management of floods and droughts in the basin.

China's dykes

In China the traditional foundation of river management in the catchment is construction of embankments (dykes) along both banks of rivers to contain flood waters. The dykes are aligned near the river channel to minimize the channel width while maximizing the width of a band of former floodplain that can be safely farmed landward of the dykes. The strips of former floodplain are farmed because they are among the more fertile regional soils. This is true mainly because of the many annual small floods that formerly delivered sediments containing nutrients and organic matter (in pre-dyke times). The dykes block this natural process by confining the floodwaters to the embanked river channels and preventing deposition of sediments on the former floodplain. The consequence is alkalinization of soils, as well as severe impacts to wetland hydrology and ecology, and to the people who depend upon wetlands for food, energy, and materials. Flood control measures in China are heavily biased toward construction of dykes to contain riverine floods and dams to temporarily store them. There were more than 16,000 km of embankments in the Songhua River Basin in China by 2000[3] (**Figure 3.2** and ADB 2001).

Extreme flooding events such as those in 1998 caused catastrophic economic losses. Dykes along the Songhua River provided little protection in 1998. However, catastrophic floods on average recur once in 100 or 200 years. This is not the case for water shortage, which recurs every year. A 100-year flood (like the flood in 1998) leaves an indelible mark in the community memory, but this is often not so for drought. Drought affects family incomes, but homes and other property remain largely intact. Losses are mainly of crops that were planted that year. Although people adapt more easily to drought, it might exert a greater impact than floods on long term economic development.

In reaction to the losses and suffering among the populace, China's water management has traditionally focused on floods rather than droughts. Flood control relies mainly on construction of reservoirs, detention basins, water diversion and dykes. This is partly strengthened by non-structural approaches such as flood warning and flood forecasting systems. The current flood management strategy is based on new man-made reservoirs and on the raising of dyke elevations to increase the flood protection standard from 1-in-20 to 1-in-30 or 1-in-50 year events. The development of all these measures represents a considerable financial investment shared by the central and local governments.

The options considered to date do not address the need for a combination of flood protection in the wet season and water storage and recharge during the dry period. Rather, they focus mainly on reducing the extent of areas flooded while ensuring that floods move rapidly downstream. This approach precludes storage of surface water and recharge of aquifers through reflooding of riverine wetlands. Thus the infrastructure approach exacerbates drought severity while providing less than perfect protection against floods.

Dyke construction reduces upstream flood storage capacity on natural floodplains and confines flows to the narrow channel between the dykes. Because people raise crops and occupy homes outside dykes, the con-

[3] Of the total 16,000 km, 8,274 km lengths are major river dykes, including 3,053 km length of mainstream dykes and 1,317 km length of major distributaries. See, Review and Assessment of Flood Control Plan of the Songhua River Basin, SWRC, June 2000.

sequences are even more severe when catastrophic floods overwhelm the dykes. The accepted strategy to develop new reservoirs and to raise the heights of dykes is not sustainable in the long term without a complementary non-structural strategy. In the planning process many important issues such as economy, socio-cultural conditions, demographic and ecological processes have been ignored, resulting in unsustainable technical solutions for flood preparedness, management and mitigation[4,5].

Figure 3.2 Locations of flood control projects in Songhua River basin (Source: ADB 2001)

The ecological crisis generated by the 1998 flood stimulated a national debate and interest in finding a more sustainable approach to flood management in China. There is a new awareness among policy makers of alternative measures for reduction of natural disasters in favor of sustainable development. After the 1998 floods the government of China issued the so-called "32-character policy" prescribing a comprehensive approach to flood management: reforestation of river sources and slopes, abandonment of flood-prone areas and reestablishment of water-detention wetlands. Implementation has been slow due to many factors among which high population densities on the floodplains is preeminent. WWF-China is currently implementing several pilot projects in other river basins such as the Yangzi, helping communities to develop sustainable lifestyles compatible with natural flood regimes. While reforestation efforts in the China portion of the Amur-Heilong basin are well under way, floodplain restoration has only begun.

Russia's river banks

Dyke construction along rivers in Russia is mainly to protect settlements and industrial infrastructure, and is on a much smaller scale than in China. This is due to Russia's lower population density and large expanses of arable land above the floodplains. However, similar to China, the approach to flood management in Russia has been biased toward structures. According to ABWMA (2003) less than 10 percent of flood-prone populated

[4] ADB-funded (TA 2817-PRC) Strategic Options for the Water Sector (July 1999) raised these and other interrelated issues and recommended a shift towards an integrated and comprehensive approach to flood problems.

[5] The China Agenda 21 discusses various measures for reduction of natural disasters. See, China's Agenda 21: White Paper on China's Population, Environment and Development in the 21st Century, Beijing, 1994.

areas are protected by 66 km of dykes in Primorsky, 220 km of dykes in Khabarovsky, 65 km of dykes in Amurskaya, and 75 km of dykes in Evreiskaya Autonomous Province. This is equivalent to only three percent of all dykes in China's Songhua River basin. A special flood protection and water infrastructure safety inspection was institutionalized within ABWMA to inspect structures, draft recommendations for upgrading and enlarging facilities, and to interact with local authorities on flood-preparedness. However, government plans emphasize construction of dykes to prevent floods and bank erosion, and constrain river meandering. The Joint Russia-China Scheme discussed in the previous subchapter contained a separate complementary flood-protection volume developed unilaterally by Russian engineers and calling for construction of 1,300 km of dykes along the middle and upper Amur (see Volume 10 of the Joint Scheme, 1993).

Over the last 10-15 years in Russia, local floods have been caused by forest cutting and wildfires in the valleys of small and medium rivers. This abuse of valley forests has negatively affected economies in tributary basins. Floods have occurred during the last five years in Bikin, Khor, Bolshaya Ussurka, Sililnka, Bira and other rivers (UNEP 2003). Russia has already reduced the magnitude of floods in the Amur-Heilong main stream by operating the giant Zeya and Bureya reservoirs. Recently there has been a widely welcomed policy shift toward greater balance between structural and non-structural flood management.

The 2003 ABWMA report stressed repair and construction of dykes (a program heavily reliant on federal funding), and a variety of non-structural measures. The latter included decommissioning abandoned facilities or assigning their management to a land-user with a vested interest in efficient operation. Other non-structural measures include improving the flood-forecast system, cooperating with local governments on action plans in times of flood, and increasing financing for protection and rehabilitation of water bodies. It is important that flood response plans are no longer referred to as "emergency plans", a change that helps authorities recognize floods as regular natural processes.

The greatest non-structural measure is planning and enforcement of "water-protection zones", specially protected natural areas to be established along streams and other water-bodies. During Soviet times water management legislation included regulations for water protection zones that specified activities to reduce water pollution and erosion, and to prevent direct encroachment by preserving undeveloped belts of habitat along shorelines of rivers and lakes. Since then the water protection zone has become a multi-purpose environmental regulation tool to protect riparian forests, wetlands, and recreational amenities. Corresponding regulations were written into forestry law to provide for "water-protection forests", which were protected by bans on industrial logging in river corridors and on lake shores. Even more strict and specific regulations protect "spawning rivers". Chinese forestry regulations also include a forest zone for water protection. Regulations are inflexible in that they relate the width of the protection zone to the length (or area) of a water body while ignoring its unique natural characteristics. However they play a crucial role in safeguarding critical riparian habitats and aquatic ecosystems.

New water legislation stresses that wetlands provide environmental services that merit establishment of water protection zones similar to those established for municipal water supplies. This policy has been difficult to implement because the regulations for delineation of water protection zones are 10-20 years old and provide no guidance on treatment of floodplain wetlands or forest swamps. A new Russia Water Code would reduce the width of water protection zones by 50-70 percent and fail to provide guidance on how zones should be demarcated with reference to the natural and unique hydrologic conditions of a given water body. By law the zones would restrict some land uses such as construction of permanent buildings or commercial logging. Regulations also mandate reduction of pollution and restrict agriculture while preventing waste disposal. Implementation of these regulations in urban areas is difficult because only some of the clauses can be enforced. In rural areas water protection zones could be important elements in a protection scheme for ecological networks such as riparian and lake corridors.

Since 2002 ABWMA has actively promoted planning and development of water protection zones along the Amur-Heilong and its many tributaries. By 2003 plans were developed for zones on several rivers covering a total length of 910 km, or less than 5 percent of all zones that are to be established and controlled by ABWMA.

In its 2003 report ABWMA claimed that delimitation of water protection zones on the Amur-Heilong basin floodplains should be based not on existing regulations, but rather on natural parameters such as the zone of 25 percent flooding (i.e. the area flooded on average once in four years). Plans currently in force address the regulations and flood frequency by delimiting two zone boundaries, one to show the existing regulatory limit, and a second to depict flood history. In 2003-2004 WWF-RFE collaborated with ABWMA and local authorities in the Zeya-Bureya plain to develop such a pilot plan for one district. Two additional and similar plans were developed by other institutions in Primorsky Province and Evreiskaya Autonomous Province. Implementation of these plans has been complicated by the need to negotiate with land-users issues such as zone boundaries and enforcement of regulations. Despite devoting much of its resources to realizing the goal of effective water protection zones ABWMA lacks capacity to administer the few existing zones even though these protect only a small fraction of the total area of sensitive floodplain wetland.

Recent trends among regulatory agencies in the Amur-Heilong basin reflect a new awareness of the need to "live with floods". This is a hopeful shift in the institutional approach to river basin management. However, only the first practical steps have been taken. Much remains to be done to revise regulations and adjust institutions to enable them to effectively implement this critical aspect of water management.

Policy aspects of infrastructure versus natural river dynamics

For several thousand kilometers the China-Russia border follows river courses where natural riverbed processes are intensified by wide variations in seasonal flows and the annual cycle of freeze and thaw. Maximum speed of erosion reaches 50 meters per year, and the average rate is between 6-12 meters per year. Until the 1970s, the most intensive erosion affected the right bank (looking downstream). Later the left bank was eroded due to construction of anti-flood dykes and protective dams on the right bank, and sand extraction, cutting of shore vegetation and other economic activities (UNEP 2003).

Embankments and other engineering works in these reaches generate a range of international consequences. For example, among authorities in Russia's Amursky Province it is widely held that construction of embankments on the right bank of the river (in China) significantly contributed to subsequent flooding and erosion in Russia. As yet there is no mutually accepted transboundary practice to resolve disputes arising from this type of claim. Rivers naturally change course over time by meandering across their floodplains. In the Amur-Heilong River basin, as in most boundary river basins, this natural process is often raises the issue of national sovereignty.

Water management infrastructure and associated engineering works are routinely undertaken with the objective of "stabilizing river banks". Appropriation of national funds is often done under the premise of "protecting the national interest". For example, engineering works are repeatedly discussed and periodically undertaken in both China and Russia near Tarabarovy Islands, where border disputes were complicated by natural meandering of the river course. One of many factors reinforcing this natural process is increased water flow in winter due to operation of the Zeya hydropower plant. China allegedly sank scrap ships on the south bank of the Amur-Heilong to protect river banks and accelerate sedimentation, thereby increasing land area in China. Meanwhile, Russia planned to remove sediments by dredging to prevent an island being physically connected with China territory. Dredging was planned for one of several parallel river channels (Protoka Kazakevicha) that are naturally transforming into oxbows and would ultimately cause islands to be linked to lands China. The dispute was settled in 2004 by dividing the islands between the two countries but we are yet to see any change in water infrastructure policy. This dispute erupted again after China authorities, acting on Russia's request, closed one river channel (Protoka Kazakevicha) by building a "temporary dam" to protect Khabarovsk from pollution caused by the November 2005 chemical spill into the Second Songhua River in Jilin. On this occasion it was widely believed by the general public and by authorities in Russia that provisions for dam removal after the emergency were not properly agreed with China. Thus this industrial disaster might provide China an opportunity to claim greater territory during the demarcation process.

The reach of the Amur-Heilong River near Khabarovsk has a much more obvious problem because here the river is shifting westward from the city in a natural process of developing two new channels (Protoka

Beshenaya and Protoka Pemzenskaya). This would ultimately leave Khabarovsk, the capital of the Russian Far East, on the edge of a spectacular but shallow wetland rather than on the right bank of a mighty river, a prospect that does not inspire local authorities. The same process threatens the only bridge across the Amur, disrupts the water supply system of Khabarovsk, and could require relocation of the largest Amur-Heilong port to another site. National and provincial budgets allocate funds annually for prevention measures. The 2005 Songhua chemical spill emergency was used to justify accelerated building of dams across many recently developed channels even though it was unclear whether and how this might help solve the problem. Natural shifting of the channel at any of the sharp bends in the Amur-Heilong River could well suggest to authorities that great investments are needed to tame the River. This lasting standoff "Khabarovsk vs. Amur" already consumes large portions of the ABWMA annual budget. It is obvious that such calls for action will be made repeatedly, and most will be to the ultimate detriment of water, river, wetland and biodiversity conservation. This suggests that other options that are compatible with natural river basin hydrology would be more sustainable both financially and environmentally.

The point at which China's Argun River enters Russia is another troubled area. Here authorities of Russia's Chita Region appealed to the federal government in Moscow to invest in embankments to avoid the potential loss of 55 km^2 of land area to China. This potential loss is said to result from changes in the river course caused by earlier embankment construction in China.

The process of drafting the "Joint Scheme for water resource use of transboundary reaches of the Argun and Amur Rivers" in 1986-1999 led to a semi-official agreement that flood-prevention and embankment construction are not issues for bi-lateral resolution but rather must be addressed unilaterally, each side acting independently, without need for coordination across the water. This arguably led to substantial losses of land in Russia and natural ecosystems on both sides. China, having the much denser population and more developed farmland along the river banks, took full advantage of this unilateral approach by not coordinating actions with Russia and not undertaking environmental impact assessments that covered both banks of the river. Russia did not counter the massive embankment construction in China by engineering projects of its own for two reasons. First, Russia had no pressing need to protect the largely unoccupied riverine lands. Second Russia lacked the needed financial resources. The imbalance in dyke construction on the two sides of the River has caused more frequent and intense flooding, and subsequent erosion of the left bank. The large embankments in China definitely contribute to these problems and exacerbate the temporal redistribution of water caused by Russia's dams. However, if Russia were to adopt the same policies and methods as China, construction of embankments on both sides would greatly increase the frequency and severity of catastrophic floods in future. This is part of what led to the disastrous floods in the Songhua River in 1998. Only the unplanned failure of embankments upstream from Harbin allowed flood waters to escape to the floodplain where they did little damage except to crops. Had these upstream embankments not failed, Harbin would have felt the full force of the floods. Losses of life and property would have escalated exponentially. As long as China continues to employ engineering solutions to water management on the south bank of the Amur-Heilong, the only option for Russia is to adopt a non-symmetrical response, including use of vast floodplain wetlands as flood detention basins while trying to agree with China more coordinated approaches for future action. The latter approaches would have the benefit of being less expensive to implement.

Final demarcation of the border might greatly assist more balanced, nature-friendly resolution of such issues, and formation of better policies. It has been difficult to gain support for practical approaches to basin management in an atmosphere of "patriotic action to confront attempts to encroach on sovereignty of the motherland", which for many years dominated debates in Russia on how to manage the meandering Amur. In world-wide practice there are already some examples of transboundary river management where joint enthusiasm for preserving meandering process essential for natural river ecosystem prevailed over concerns about "territorial integrity". Following a natural meander breach on the Oder River in 1997, the Czech-Polish Border Water Commission allowed WWF to carry out a study and produce forecasts for further development of the border meanders. Upon receipt of the WWF report it cancelled a plan to fill newly developing riverbeds to restore the status quo and instead recommended the two governments apply for inclusion of the border area in the list of NATURA 2000 ecological networks. However introduction of provisions for free meandering of rivers in the border agreement of two nations will probably take 7-10 years. (Obdrlik & Nieznansky 2003). There is a hope that peaceful coexistence on China-Russia border will lead someday to similarly wise decisions.

Much depends on how current talks on border demarcation account for two issues. First is the simple fact that this great river will not stop changing its course after issues between countries are resolved. Second is the urgent need to incorporate forecasts of natural processes into future policies, which so far are designed as if the river stays in one place. If policies for future border delineation and international practice for clarification of disputes do not fully account for natural river processes, this will result in additional tensions, unnecessary expenditures and further damage to the river ecosystem. The same holds for any type of urban and industrial development along riverbanks.

Water Shortages and Ecological Needs

The Amur-Heilong River system is both blessed and doomed by its division between countries. As we have seen in previous sub-chapters most of the Amur-Heilong Basin is two different parts where thinking and policies on water management are developed independently according to national priorities in Russia and China. The third part is distinct from China and Russia, and lies in the naturally water-deficient Mongolia. The fundamental problem is that the Amur-Heilong basin is only one natural system and it has limited remaining capacity to withstand further independent experiments in "water management" by three neighboring nations.

Although data on water use and shortages are somewhat unreliable, we present and analyze them in this section to demonstrate yet another contrast of the River basin and try to speculate on future development scenarios.

People and wetlands need water

The Songhua River basin faces water shortages. Per capita surface water is only 1,568 m^3, or slightly more than half the national average, but much more than is naturally available in dry western China (CAE 2006). Surface water resources are not evenly distributed over the basin, with more in the east and less in the west, more in the mountains and less on the plains. The distribution of surface water also varies greatly over time. Precipitation and run-off differ significantly year to year. Run-off in July to September accounts for 70 percent of the annual total, and varies greatly between years. Making sense of available statistics is difficult because "Songhua" in some cases means the actual river basin, with runoff of 68-80 km^3 per year (**Table 3.10**). In other cases, typically related to water management issues, it means the "Songhua management section of the Song-Liao Water Resources Commission", which is equivalent to the entire Amur-Heilong basin area within China (Songhua plus Ussuri, Argun, Huma, and Amur main channels) with adjacent Tumen and Suifen river basins added (**Table 3.10**). These additional subcatchment and catchments are often called "International watersheds since they are shared with Russia, Mongolia, or North Korea. Since the reader is equally likely to encounter either of these approaches in subsequent tables we present possible data for both units whenever available (**Tables 3.10 and 3.11**).

Although the Songhua River is not usually considered critically depleted in comparison with the Yellow, Liao or Huai Rivers, it now shows all prerequisites for development of a water crisis similar to these basins. Average annual Songhua River natural discharge into the Amur-Heilong is approximately 80 km^3 and total available water resources are about 96 km^3 (**Table 3.10**). The data in **Table 3.12** show that water use in 2003 was 69 percent of the total available resource, or nearly 40 percent of total Songhua River discharge. The more important point is that total water withdrawal in the basin was nearly equal to average river flow in a dry year (36,85 cubic km. or so called 95% availability — low flow volume occurring once in 20 years). (ADB 2005). Data from China also indicate that from overall withdrawal/supply, 53 percent of supplied water was used entirely at its point of extraction, and only 473 percent was returned to the stream with wastewater. Therefore in an average year at least 12% of total Songhua River flow is consumed entirely. This also means that 2003 water consumption surpassed 50% of total river flow in dry years. This is evident in years of low water when deficits of 2.5-4 km^3 occur. Shortage of water is already a key issue in many sectors including agriculture, municipal supply, and most important, sustaining environmental flows and key ecological processes.

Agriculture is the main user of ground and surface water, accounting for almost 70 percent of the total wa-

Table 3.10 Water resources utilization in Songhua River management district in 2003 (after CAE 2007, Water Resources volume)

Parameter \ Sub-basin		Nen	2nd Songhua	Songhua Total	Argun-Erguna	Amur -Heilong Main channel	Wusuli-Ussuri	All International Catchments	"Songhua" District Total
Area	('000 km^2)	299	73	561	164	117	60	374	935
Precipitation ann. avg.	km^3	138.45	51.07	301.5	59.03	60.06	32.93	170.37	471.88
Precipitation	(mm)	464	696	537	359	513	551	456	505
Amount of surface water resource	annual average km^3	29.38	16.42	81.77	12.03	21.19*	7.86*	47.8	129.57
Amount of Groundwater resources	annual average km^3	13.73	5.7	32.38	4.33	5.24	4.42	15.41	47.79
Total water resource	annual average km^3	36.77	18.15	96.08	13.58	22.6	10.15	53.09	149.14
Population 2003	million			53.7				10.4	64.1
GDP-2003	billion Yuan			602.6				86.2	688.8
Grain production 2003	'000 ton			36070				7090	43160
Irrigated cropland 2003	'000 mu/'000 ha			39160/2610				12020/801	51180/3412
Supply of surface water-2003	km^3	5.3	4.4	17.6	0(!!)	0.6	2.7	4.0	21.6
Supply of groundwater-2003	km^3	4.2	1.4	9.5	0.2	1.0	3.0	4.4	13.9
Total supply -2003: Including	km^3	9.53	5.84	27.19	0.2	1.6	5.7	8.3	35.5
Irrigation, agriculture	km^3	6	3.1	17.7	0.03	1.3	4.9	6.8	24.5
Industry	km^3	2.4	1.8	6.4	0.07	0.2	0.6	1.0	7.4
Urban supply	km^3	0.7	0.6	1.9	0.04	0.07	0.1	0.3	2.3
Rural domestic supply	km^3	0.4	0.3	1.1	0.04	0.05	0.1	0.2	1.3
Total water consumption 2003	km^3 (% from total water resource)	5.2 (14%)	2.5 (14%)	13.6 (14%)	0.1 (1%)	0.9 (4%)	3.2 (32%)	4.6 (9%)	18.2 (12%)

*Data probably represent only the China contribution

ter use in the Songhua basin (**Figure 3.3**). Recommended irrigation water applications are often doubled in the field. The frequently high losses along the distribution channels (possibly up to 50 percent of the water volume conveyed) and the low tariff for agricultural water in Jilin and Heilongjiang Provinces (0.02 to 0.08 RMB/m^3) provide no incentive to save water (ADB 2005). To satisfy the high dry-season demand underground resources are frequently overexploited to compensate for the deficit in surface water availability. In most of the large cities in the basin, groundwater is overexploited for urban water supply to compensate for surface water that cannot be used because it is too contaminated. The cones of depression in aquifers are thus expanding and

Table 3.11 Comparative water resources data for China and the China portion of the Amur-Heilong basin (compiled from MWR, Water Resources Bulletin 2004, China Water Press 2005)

Item		China	Songhua district River Basin
Precipitation (km3)	2004	5,688	385
	deviation from annual average (percent)	-7	-18
Surface water resource	2004 (km^3)	2,312	79.4
	deviation from annual average (percent)	-13	-22
Groundwater resource (km3)		744	43
Total water resource		2,413	119
Actual water supply (km3)	surface water (km3)	450	22
	Groundwater	103	15
	total supply	555	37
Actual water usage (km3)	farm irrigation	359	26.5
	Ecological	8	0.3
	Domestic	65	3.4
	Industrial	123	7
	total usage	555	37
Water consumption	water consumption amount (km3)	300	19.57
	water consumption rate (percent of supply)	54	53
Water use indices	annual per capita water use(m^3)	427	576
	water use per 10 000 Yuan GDP -m^3	399	447
	water use per mu of irrigated farmland-m^3	450	517
	water use per 10,000 Yuan industrial added output value -m^3	196	180
	Domestic urban water use liter/day	212	174
	GDP per capita 1000 Yuan	10.53	12.78

Water use in China as a whole in 2004 is compared with that in the Amur-Heilong basin Songhua water management district in Table 3.11. We present detailed data on the Songhua basin proper, an amazing amount of water storage, water diversion and pumping facilities were in operation by 2000. By the year 2000, the Songhua basin had 13,460 water storage projects, 1,192 diversion works and 4,648 pumping facilities, with a total water supply capacity estimated at about 35 billion m3. (ADB 2005). This also shows skyrocketing 8-fold growth in reservoir construction, since in 1980 only 1778 "storage works" were registered (CAE 2007. Water resources volume)

exceed 20 m depth beneath most cities. Depletion of groundwater is particularly serious in Daqing and Harbin. This means that in future, additional withdrawal will be available primarily, if not exclusively, from surface water sources.

Of interest from a pollution viewpoint is the comparison between total industrial and domestic water consumption and low flows during the winter period. Total industrial and domestic (urban) water use in 2000 approached 280 m^3/s. This approaches the 1 in 10 year low flow recorded at Jiamusi (ADB 2005).

Water demand is likely to increase rapidly due to the rapid pace of economic development and the demands for irrigation (ADB 2005). According to ADB, the total water demand in the Songhua River basin will reach 45.5 billion m^3 in 2020, a net increase of over 14 billion m^3 from 2006. The net increase of the domestic water demand is estimated at only 850 million m^3, or some 6 percent of the total increase. The net increase for industry, construction and the tertiary industry sector is 2.9 billion m^3 or 20 percent; while the remaining increase of 74 percent or 10.6 billion m^3 is for agriculture (ADB 2005). An alternative conservative estimate from the CAE Study is shown in **Table 3.12**.

During the next 25 years total estimated water consumption will approach and surpass the total available water resource for the 1 in 20 year return period. Given that the hydrological records indicate that droughts are becoming more frequent, it can be concluded that there is a significant risk of chronic water shortages in future if water consumption increases as projected (ADB 2005).

According to conservative estimates, in 2020, the inflow water quantity at the confluence of the Nen and Second Songhua Rivers will decline by 178 m^3/s, ac-

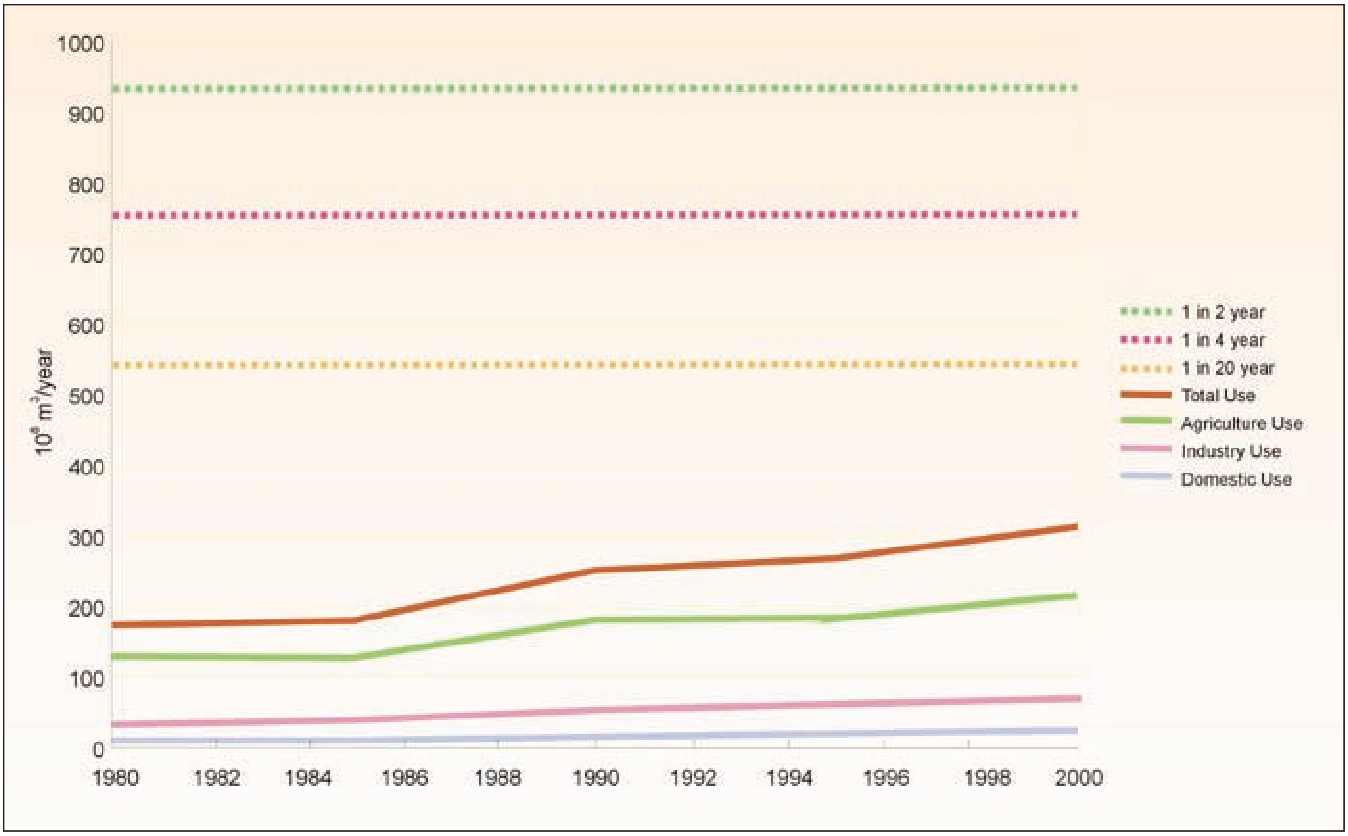


Figure 3.3 Trends in water resource use compared to availability in 2000 (ADB 2005) (Upper dotted lines represent availability of water in years with different annual flow volume, while continuous lines below represent growing use by sector and in total.)

counting for 13 percent of the total surface water resources upstream of the Sancha estuary at the confluence. The outflow water quantity of the Songhua River will decline by 243 m^3/s (8.5 billion m^3/year), accounting for nine percent of the total surface water resources of Songhua River Basin (ADB 2005).

The unfolding water crisis is a very real one if viewed in the context of north China agricultural production. Lasserre (2003) observed the following:

"Opening new agriculture fronts is already a priority, because of the severe water problem in Northern China[19]. In the medium-term, it could also be that China could seriously consider the transfer of water from the Amur/Heilongjiang basin to northern China. Far from being marked by a mere problem of border communities, relations between China and Russia could prove complicated by new resource stakes: water and irrigated lands. At the heart of the problem: the sheer size of irrigation use in northern China. Located in the northern China plain, the basins of the rivers Huang, Hai and Huai (3H basin) account for about 44 percent of corn, 67 percent of wheat, 72 percent of millet, 40 percent of cotton and 24 percent of vegetable oil production. Irrigation in the 3H basin is relying on a growing number of deeper and deeper tube wells, so as to pump into aquifers. The global level of the water table fell by 1.5 meter per year between 1993 and 1998, according to a study by the Agriculture University of Beijing[20]. With most aquifers being depleted, China is now reconsidering its options for reestablishing a balance between water use and supply, since the destruction of these very aquifers would bring a severe blow to agriculture in this region, given its dependence on groundwater. The China Ministry of Water Resources estimates show that expanding resource exploitation in the north China plain is not an option: even with increased aquifer pumping, total supply would, with 95 percent probability, increase from 122 billion m^3 in 1997 to 133 billion m^3 in 2050, an increase of 9 percent. On the other hand, demand change,

Table 3.12 Projected water resources utilization in Songhua River management district in 2003-2030 (after CAE 2007, Water Resources chapter)

Parameter \ Source		Nen	2nd Songhua	Songhua total	Argun-Erguna	Amur -Heilong main channel	Wusuli-Ussuri	All International catchments	"Songhua" district total
Precipitation ann. avg.	km^3	138.45	51.07	301.5	59.03	60.06	32.93	170.37	471.88
Amount of surface water resource	annual average km^3	29.38	16.42	81.77	12.03	21.19*	7.86*	47.8	129.57
Moderate low flow: 75%	occurs once in 4 years km^3	20	12.3	57.3	9.2	16.3*	4.6*		101.7
Low flow 95%	occurs once in 20 years km^3	11.8	8.2	36.9	6.5	11.4*	2.3*		73
Amount of Groundwater resource	annual average km^3	13.73	5.7	32.38	4.33	5.24	4.42	15.41	47.79
Total water resource	annual average km^3	36.77	18.15	96.08	13.58	22.6	10.15	53.09	149.14
Irrigated cropland 2003	'000 mu/ '000ha			39160/2610				12020/801	51180/3412
Planned cropland 2030	'000 mu/ '000 ha			60760/4051				22420/1495	83180/5545
Supply of surface water-2003	km^3	5.3	4.4	17.6	0*	0.6	2.7	4.0	21.6
Total supply 2003	km^3	9.53	5.84	27.19	0.2	1.6	5.7	8.3	35.5
Projected total demand 2030	km^3	17.3	9.8	42.6	1.01	4	8.5	14.5	57
Predicted surface water withdrawal	km^3	11.0	7.3	27.8	0.6	2.3	4.7	8.5	36.3
Irrigation, argi-2030	km^3			30				11.9	41.9
Industry and urban/rural supply 2030	km^3			12.6				2.6	15.2
Total increase 2003-2030	km^3	7.77	3.96	15.41	0.81	2.4	2.7	6.2	21.5
Total share of water consumption 2030	(% from total water resource)	29	26	24	6	8	44	14	21

*Data represent contribution only from the China side

taking into account a 10 percent efficiency improvement in agriculture and industry, a strong price increase and the development of water reuse, would, with 95 percent probability, jump from 191 billion m^3 in 1997 to 208 billion m^3, also a 9 percent increase: thus, envisioned measures would merely slow down the demand increase to a similar pace as water supply, without closing a widening gap of 69 billion m^3 in 1997 and 75 billion m^3 in 2050[21]. This is why irrigated agriculture really is at a crossroads in northern China: although more efficient techniques are slowly spreading, accounting for the stabilization of water withdrawals, the level of water pumped underground and withdrawn from surface streams is often not sustainable. Moreover, poor drainage caused salinization that affected 20 percent of the 3H basin cultivated land in 1982 and about 25 percent in 1996. Thus, relative water scarcity is really becoming the one factor that is limiting agriculture growth in northern China."

A recent and reliable study predicts that the Sanjiang plain and other northeast areas are destined to become the most important grain production region in China (CAE 2006). The study warns against expanding agricultural land area by converting wetlands to croplands. As an alternative the study advocates increasing the area of irrigated rice cultivation on existing croplands, an approach that would conserve wetland area but risk wetland degradation because it would necessitate use of more water for farming, leaving less for wetlands. The only source that could realistically supply the increased water demands would be the Amur-Heilong main channel.

The deficiency of water in wetlands is also a significant issue in China because large dams and channels built in recent years intercept the water supply to wetlands. Agriculture and industry compete with wetlands for surface water allocations. Pumping of irrigation water from wetlands and aquifers also causes deficiency in water supply to wetlands. Some drainage and transport projects sever the natural connections between rivers, lakes and marshes. Drainage channels and ditches dehydrate wetlands, altering their hydrologic conditions. Some wetlands no longer provide normal functions and some wetlands have disappeared entirely after being drained by channels and ditches for conversion to farmland. The water depths in reed ponds in Halahai wetland were 30-50 cm according to 1999 surveys, but dropped to 80 cm below the ground surface in 2000. The water depth of Qingma Lake dropped to less than 1 m and the lake dried entirely according to a 2001 survey. One ecological consequence of this was loss of waterbirds: red-crowned and white-naped cranes numbered over 10 pairs before 1990, but no birds were seen in 2003. Songliao Water Resource Commission (SWRC) estimates that the Wuyu'er catchment on the Song-Nen plain now supplies around 60 percent of its flow to basin wetlands, the balance being diverted for agriculture and urban consumption. The 40 percent reduction in water supply to wetlands has negatively affected Zhalong National Nature Reserve (ADB 2005).

Many drainage channels for agricultural development were constructed adjacent to Honghe National Nature Reserve in Sanjiang Plain, Heilongjiang Province. The channels encircle the reserve and have changed the course of the Nong River, the main surface water supply for Honghe National Nature Reserve. After construction of the channels rainfall was the only remaining water supply to the reserve and it is inadequate to maintain the wetlands and biodiversity that justified listing Honghe as one of China's 30 Ramsar sites.

At Xianghai National Nature Reserve water storage in Xianghai Reservoir in the upper reaches in dry years led to a serious shortage of water downstream, with the result that most wetlands disappeared. This also had dramatic impacts on the numbers and diversity of migrant and resident birds. Their numbers declined generally, but most importantly for endangered species such as the breeding red-crowned crane, whose population has dropped to fewer than 10 pairs at Xianghai National Nature Reserve. In 2004 this crisis required water delivery to Xianghai from Cha'ersen reservoir via canal in the amount of 60 million m^3, and to Longfeng wetland from Liming River in Daqing prefecture in the amount of 15 million m^3 (MWR, Water Resources Bulletin 2004, China Water Press 2005).

Extensive rice cultivation in Heilongjiang and Jilin Provinces competes for water with wetlands and leads to declining water levels and reduced total area of wetlands. Wherever surface water in the Sanjiang Plain was found inadequate for irrigation, wetlands were drained and converted to farmlands, and then ground water was pumped for irrigation. This also lowered water tables in local areas. In 853 Farm and 597 Farm in the Sanjiang Plain the water table drops at the rate of two to three cm per year because of massive rice cultivation and overuse of underground water for irrigation. Irrigation wells were drilled to depths of around 20 m in 1997 but now wells of over 60 m do not find water in adequate quantities. As a result of such intensive use of groundwater the water table beneath wetlands in these areas has dropped dramatically and in some cases aquifers have been depleted.

A five to six month drought recurs annually in the basin and extended cycles of drought are not uncommon, especially in the west. These patterns of annual, seasonal drought and frequent longer-term droughts are not adequately considered in basin water management.

Table 3.13 Volume of water used in the Russia Amur River basin in 2002-2003 (excluding Chita province)(after ABWMA 2003 with adjustments)

	Annual Volume of Water Use in 2002-2003 (million m^3)				
	Farming	Industry	Household	Other	Total
Volume of Water Use	51	460	450	39	1000
Percentage of Use	5.1	46	45	3.9	100

Against this backdrop of natural drought the continued increase in consumption of water by agriculture and other sectors poses an extreme threat to natural ecosystems.

Water deficits in other sub-basins of the Amur-Heilong within China territory are less pronounced, but current trends of unsustainable water use in the Songhua basin might force China to claim its share of water resources from the main channel of the Amur-Heilong River. If the proportion of water use in the main channel approached that recorded in the Songhua basin, this would cause severe ecosystem changes and would probably trigger ecological degradation of the Amur-Heilong wetland ecosystem.

Russia water abundance and disrupted flows

Russia's portion of the basin has a water supply situation very different from that in China. Water is plentiful and use minimal (less than 3 percent of that in the Songhua basin). Water use does not exceed 2.3 percent of available resources in the most water deficient winter season. Main water users are industries and households (**Table 3.13**). Approximately 66 percent (658 million m^3) of used water returns to the Amur-Heilong Basin with wastewater discharge. Around 80 percent (487 million m^3) of that is untreated (**Table 3.14**) and only 16 percent (63 million m^3) is treated to national standards. This is why the ABWMA (2003) report concludes that although there is no lack of water per se, there are already notable deficiencies of clean water in some areas.

Despite the abundance of water in Russia, ecological flows have been disrupted and shortages are evident especially for fisheries and floodplain wetlands. This results from the impact of the Zeya and Bureya dams, which reduce flood peaks thereby reducing flood frequency in many wetlands. This is a common issue on the floodplains of the Zeya River and on the Amur-Heilong main channel from the mouth of the Zeya to Komsomolsk in Khabarovsk region.

Data are not available to quantify the total surface area of floodplain wetlands dehydrated to date. Nor are there data to list those wetlands that will be affected when Bureya dam reaches design capacity in 2008. However, we know that detectable changes in flood levels can be traced at least 1,200 kilometers downstream from the dams (IWEP 2003).

Extensive research at Khingansky Zapovednik has documented changes in crane and stork wetland habitat under the cumulative impacts of the Zeya and Bu-

Table 3.14 Water use in Russia in 2002-2003 in sub basins (10^6 m^3)

Item	Year	Argun and Shilka (Chita)	Amur	Zeya	Bureya	Ussuri	Lake Khanka	Amur basin total
Total water supply	2002		701	109	33	69	82	1,467
	2003	469	687	104	31	64	85	
Total water use	2002		556	74	12	50	62	
	2003		543	71	11	47	63	
Wastewater discharge total	2002		488	66	26	41	36	1,057
	2003	399	483	65	25	38	31	
Including under-treated wastewater discharge	2002		343	60	26	39	21	807
	2003	320*	338	56	25	37	19	

(ABWMA 2003. Chita Province included with 2003 data from different source) (Source for Chita: MNR database. http://www.geol.irk.ru/baikal/rep_2003/pdf/baikal2003_p1-4-11.pdf)
*estimated as 80% of total wastewater discharge

reya dams. Wetlands on the upper floodplain that were shaped by large floods that recurred at average intervals of 10 years will in future be flooded only once in a century. This will render wetland habitats unsuitable for crane nesting and feeding. Costly mitigation measures are proposed to create small artificial ponds, but such measures would hardly be applicable for the full 1,200 km stretch of affected habitats along the river below the dams.

Most indigenous species of freshwater fish in the Amur-Heilong River spawn in shallow water in seasonally flooded areas. Anadromous species (those that mature at sea and breed in fresh water) need small tributary streams for spawning, and access to these depends on water levels. Both fish groups spawn more successfully in years when floods are frequent and large. Dams that reduce the flooded land area effectively reduce available spawning habitat and create obstacles barring access to some tributaries. While these impacts degrade habitat quality for spawning fish, dams might also improve fish survival rates in winter. Release of water stored behind dams for power generation in winter increases waterflow downstream in the main rivers. This might promote increased survival of fish wintering beneath the ice in the Amur-Heilong main channel. The negative impacts of reduced flood frequency and intensity in the spawning season have been studied but the potential benefit to fish survival from increased winter flows has not.

A regulatory framework for sustaining "environmental flows" exists in Russian regulations. However, this framework is virtually impossible to use as a basis for management due to the absence of critical data and unclear division of responsibility between managing institutions.

A River Between: Concluding notes from an environmental perspective

Water management in the Amur-Heilong River basin is largely unsustainable in all three basin countries and is based on different premises and policies.

The most obvious immediate threat is a series of water transfers planned from the already water-deficient Upper Amur Basin (Kherlen, Onon, Argun/Haila'er Rivers). The potential consequences of these transfers have not been adequately studied, therefore are not predictable. We can be reasonably sure that even modest water transfers would threaten globally important wetland ecosystems, water sources and probably even boundary demarcation where the Argun River forms the China-Russia border. Consequences would certainly be apparent within two to five years after the onset of periodic water transfers.

In contrast to these aggressive water transfer schemes, a more appropriate use of the Upper Amur-Heilong would be as a testing ground for international cooperation in adapting water use and conservation measures to large ecosystems characterized by periodic droughts. The form ultimately taken for the international water management regime for the Amur-Heilong basin as a whole depends to a large extent on which of the above two options is implemented in the upper basin in the near future.

The main long-term threat to the ecosystem, spurred by any of the most likely climate change scenarios, is tapping main channel water resources to alleviate the growing water crisis in the southwest portion of the basin. This would be driven mainly by China's inability to reverse unsustainable patterns of resource use, and Russia's willingness to increase exports of natural resources to serve China's growing needs. This would result in the spread of the water crisis now unfolding in neighboring China basins (Liao, Yellow and Huai Rivers) into the Amur-Heilong Basin.

Development of hydropower in the main channel of the Amur-Heilong would facilitate this scenario and could serve as a first step toward its implementation. In doing so it would catastrophically alter the basin ecosystem.

Development of additional hydropower stations on yet untapped tributaries in Russia would also lead to massive degradation of the basin ecosystem, including loss of its biological productivity and biodiversity. Development would be driven by the same Russian orientation toward unlimited natural resource exports to China. This would probably be supported by China, where there is limited remaining scope to unilaterally develop large-scale hydropower.

The lack of cooperation between countries, and the highly technocratic mode of this cooperation when it occurs, increases the threat of the most negative development scenarios. No joint environmental agencies, research institutions, or environmental databases with comprehensive data on the Amur-Heilong River basin are shared by neighboring countries. Common knowledge is mainly produced in highly destructive joint development attempts such as the "Joint Comprehensive Scheme for Water Resource Management of Transboundary Parts of Argun and Amur-Heilong Rivers".

Current policies on flood-prevention and riverbank development largely neglect natural processes of river ecosystems. This leads to ever greater losses of valuable habitats and natural systems and greater investments in water infrastructure that often fail in catastrophic floods. In China and Russia, new and more environment-oriented thinking has emerged for land-use planning in river basins that are frequently flooded. While this is prevalent at higher levels of management agencies, it is slow to enter the sphere of international relations. For this reason it has not yet been applied or even discussed with respect to the critical issue of development along boundary rivers. It is mainly in the transboundary locations where the two governments continue to use outdated solutions to river management. Unless Russia and China agree to a common strategy for adapting to the flood regime and meandering river channel, it is probable that the pattern of unsustainable development will persist. The most likely outcome would be increasing damage from catastrophic floods along the main channel, after its ecosystem values are further degraded by more embankments. This would be followed by increasing demand to build larger dams to control these floods. The ultimate economic cost of an engineering-led development scenario is likely to be higher than that of a cooperative, non-structural option. In this respect Russia has made the greater investment in "non-structural" measures because it has lower population density and less urbanization on the floodplains.

"Hot spots" of water infrastructure impacts and sites where the greatest tension and problems occur and should be expected to occur are in the following regions:

- Argun, Kherlen Rivers and Dalai Lake which may suffer first from water diversion and ecosystem degradation;

- Nen River basin and Song-Nen Plain, where desertification is already problematic, and plans for water infrastructure development remain extensive; and

- Hinggan Gorge (Khingansky Sheki) and stretches of floodplains upstream and downstream from it (from the Bureya River mouth to the Songhua River mouth), where the cumulative impact of the Zeya and Bureya HPPs is most evident, and a site is selected for Taipinggou/Khingansky Dam, which is expected to have the most detrimental environmental impacts of all planned HPPs.

Many other threatened areas within the basin are described in the preceding chapter. The situation at each site is exacerbated by the cumulative impact of factors such as pollution, agricultural development, fishing, and anthropogenic fires.

Prevailing trends in formulation of development policy for water infrastructure are alarming. All presently implemented and planned projects are based on outdated concepts and standards, have not been subjected to satisfactory environmental impact assessments, and give little consideration to alternatives that protect ecosystem processes. The report of the World Commission on Dams is virtually unknown to decision-makers in the region. From this report there are several broad guidelines that should be followed in the Amur-Heilong region:

- Use of water resources in the basin should be based on assessment of needs and opportunities of all interested sectors of society (stakeholders) and the needs of natural riverine ecosystems. No longer can all other needs be sacrificed for the sake of electricity production;

- Cumulative environmental and socio-economic effects of the Bureya and Zeya dams and dams in the Songhua basin, should be subject to detailed assessment and monitoring. Mitigation and compensatory measures should be planned and implemented at the expense of energy companies.

- Large-dam projects planned in the past should not be implemented, especially those planned for the main channel of the Amur-Heilong River. Strategic environmental assessment of many available options is needed before any further hydropower development plans go ahead in the Amur-Heilong basin.

- The roles of floods and wetlands in sustaining environmental quality and ecosystem productivity should be integrated into land-use planning, and land-use plans should be adapted to this beneficial feature of the Amur-Heilong ecosystem.

Chapter 20

Water Pollution

"Natural" does not mean "clean"

In the Amur-Heilong basin the problem of human-induced pollution is complicated by the fact that the Amur-Heilong is naturally rich in many organic compounds commonly considered water pollutants. According to Institute of Water and Ecological Problems (IWEP, Khabarovsk) leading scientist Alexey Makhinov, the Amur-Heilong ranks among rivers with high natural pollution levels. It discharges approximately 24 million tons of suspended matter annually into the Sea of Okhotsk. Average water turbidity is 90 g/m^3.

Human activities cause rates of sediment transport to increase. The large-scale expansion of agriculture during the 1950s was particularly damaging in terms of river sedimentation. Discharge of suspended solids increased by 14 percent in the past 15-20 years as the result of human activities. As a result of the 1998 Songhua River floods, turbidity reached a maximum of over 400 g/m^3.

Terrigenous material in the Amur-Heilong River is explained by several factors, the most significant being river-bed deformations and unstable river banks. Average bank erosion rate is 50 m/year as compared to an average for non-erosive banks of 6-12 meters. Most intensive erosion occurs in the lowland river reaches where the stream is constantly redistributed between numerous sub-channels. Most bank erosion occurs in areas of economic development (Khabarovsk, Komsomolsk-on-the-Amur, Poyarkovo), and at the confluences of major dammed tributaries (Bureya and Songhua Rivers). Discharge of sediments increases due to farming, timber harvest, fires, dams, and embankment construction. Floodplain ecosystems undergo different transformations as the mainstem subdivides into channels, large shoals are formed, and water current variations and run-off volumes increase. Chemical composition of the water has also changed. Annually the river discharges 18.3 million tons of dissolved solids and 5.5 million tons of organic matter into the sea. The Songhua River also discharges tons of dissolved materials. Its share in overall lower Amur pollution ranges from 60 to 90 percent (Makhinov 2003, 2005).

High concentrations of phenols are often believed to be produced by degrading plant matter, particularly, in forest swamps. Phenols, iron, and other metals routinely found in Amur-Heilong waters could be attributed to its natural hydrochemistry. Although these natural pollutants may also violate uniform country-wide sanitary standards set by governments, they do not necessarily harm the ecosystem. For example, beginning in 2004 an international study funded by Japan investigated sources and patterns of cycling of some compounds containing iron in the Amur-Heilong Basin. These compounds are believed to support high biological productivity in the Sea of Okhotsk. Scientists seek to produce guidelines for sustainable land-use in the Amur-Heilong River basin to maintain the present ecosystem in the Sea of Okhotsk and northern North Pacific (Nakatsuka 2005).

Levels of pollution in rivers are greatly influenced by seasonal and long-term variation in flow volume and by impacts of water infrastructure (See Chapter 19 on water resources and water infrastructure). Floods and monsoon rains erode into streams thousands of tonnes of materials, causing peak concentrations of some pollutants during the wet season. Minimal winter flows increase concentrations of substances derived from point-source pollution. The point and non-point pollution sources in the basin work against a complex background of natural factors.

The developing economies of Russia and China — industrial giants of continental northeast Asia during the 20th century — were little concerned with the problems of pollution. The main goal of these socialist countries was economic development. During their races with the capitalist world for faster industrial growth such problems as deterioration of natural ecosystems and threats to community health were not taken seriously enough by the political leaders on either side of the Amur-Heilong. Beginning in the 1970s the world paid increasing attention to problems of air and water quality, but at that time it was difficult for the Soviet economy to comply with real pollution standards and achieve acceptable environmental (especially water) quality in the basin.

Since the collapse of the Soviet Union, Russia has lacked the political will to simultaneously maintain or increase industrial production while fighting pollution and shifting toward clean production and zero emissions. Over the past 10 years declines in industrial production have had a diminishing role in reducing pollution because of the deterioration in treatment facilities and operational discipline that accompanied the industrial decline.

On the south bank of the Amur-Heilong, economic growth in China surpassed that in Russia, and the problem of overpopulation made coping with pollution even more difficult than in Russia. Both countries either lack the capacity or have failed to make the commitment to solve increasingly serious pollution problems, many of which are now labeled “crises” in Russia. There are many environmentally dangerous industries in the basin: oil-processing, pulp and paper mills, mining, and production of chemical fibers, plastic, and synthetic rubber. In shared parts of the basin the problem is further complicated by the absence of transboundary pollution prevention standards and the tendency toward mutual blame for polluting transboundary waters. For monitoring purposes Russia assigns seven grades of water pollution, while China assigns five (lower rank means better water quality). Both sides assign Amur-Heilong water “high marks” indicating trouble. The Russian Federation has not recently pressed China to improve water quality by enforcing regulations on pollution prevention and control. An underlying reason is that Russia, having dismantled the enforcement and monitoring capabilities of the State Committee for Environment (Goscomecologia) is itself unprepared to adhere to strict standards.

Despite being repeatedly discussed as a policy issue, basin-wide pollution is insufficiently studied. For example there is a lack of detailed trustworthy data on such critical issues as non-point source pollution, cumulative impacts of gold-mining on hydrochemistry, or statistics on accidental factory spills and other technogenic incidents. Available data are distorted not only by low quality work, but also because pollution is a very sensitive international policy issue and objective analysis is often constrained by political tensions. Due to these limitations on quantity and reliability of water quality data we can only illustrate the role of water pollution in the Amur-Heilong ecosystem and how this pollution is approached from policy.

Journey downstream: Selected reaches of river system

No matter how bright the future of the mighty Amur as an ecotourism attraction, after the 2005 Songhua spill it is most famous for the pollution of its water. Therefore we invite readers to join a tour that highlights water pollution issues.

Argun River- status and threats

In Mongolia, in the upper reaches of the Amur-Heilong, mineralization in the Kherlen River is low (32-190 mg/l), the water is soft, and turbidity is low (56 mg/l). In the middle and lower reaches, mineralization and turbidity increase. For example, both mineralization and turbidity at Choibalsan (428 mg/l) and Undorkhaan (154 mg/l) are high. Thus, water quality declines in downstream reaches. Mineralization of the Khalkh Gol River during the winter low period varies from 200 to 300 mg/l, but during the rainy summer period declines to 100-200 mg/l, when mineralization of the river is average and water is soft. These rivers discharge into Dalai and Buir lakes, from which there has been no outflow into the Argun River for many years.

The key pollution sources in the Argun River basin in China are Manzhouli and Haila’er City, Haila’er paper plant, Yakeshi City, Yimin Gas Power Corporation, and Zha’nuo Mineral Bureau (UNEP 2003). The mining industry is a fast growing source of water pollution, with numerous new large mines developed after 2000, that discharge untreated water directly into major streams. The Argun River accumulates a high pollution load as it flows out of the Greater Xing’an Mountains through rural areas of Hulunbei’er prefecture in Inner Mongolia to the China-Russia border. Since the early 1990s water quality has deteriorated where the river enters Russia. Lack of dissolved oxygen has caused repeated and massive die-offs of fish in winter, eliminating opportunities for commercial fisheries. Naturally contaminated ground water has disrupted supply to several settlements that lack alternate water sources. Pollutants recorded in Russian monitoring reports of 2003-2005 include hydrocarbons, magnesium, zinc, copper, phosphates, phenols, and other organic compounds at concentrations well beyond allowable national standards. Against this backdrop of high baseline pollution, high concentrations of selected pollutants are periodically recorded. These probably indicate accidental spills and are registered several times each year. After flowing approximately 1,000 kilometers to its confluence with the Shilka River the Argun River carries a somewhat reduced load of pollutants (unpubl. report, Rosprirodnadzor 2006).

In addition to chemical pollutants, there is some evidence that disease pathogens are transported by river waters. Russian sources suggest that foot-and-mouth disease of cattle in early 2006 might have resulted from contaminated river waters.

According to the Amur Coordination Committee for Sustainable Development, the Middle Argun is one of three most polluted reaches in the Russian portion of the basin. The main pollutants include nitrites, phenols, and hydrocarbons. During winter, alkaline pollution has also been observed. Water quality was assessed as class five of seven (ACC 2005). The main monitoring station in China is at Heishantou at the downstream end of this polluted reach. Here the water quality is often characterized as class five of five.

In the framework of the 2002 interprovincial, transboundary Agreement on Cooperation between Inner Mongolia Autonomous Region and Chita Province a special protocol was signed for monitoring of transboundary waters. By 2005 the cooperation framework had evolved into a protocol on environmental protection and biodiversity conservation in the transboundary Argun River Basin. Although there is marked progress in communication, to date there has been little reduction of pollution loads.

Potential threat: Uranium mines

Although pollution arising from Russia and Mongolia has not been severe, mainly due to sparse populations and low levels of economic activity, there is potential for a major pollution disaster. The basin is rich in uranium and is peppered with important mines. The Krasnokamensk and Baley mines supply most of Russia's demand, while the promising Dornod mines are leased from Mongolia by an international consortium. No information is available on the environmental effects of Mongolian mines, but Russian mines have been a subject of concern for more than a decade.

The last full-scale environmental study on uranium mines was conducted in the early 1990s. Scientific investigation was stopped after results were smuggled to scientists in Sweden and shared with Greenpeace activists, who used the data as part of a widely publicized report in 1994 on the dangerous conditions in Krasnokamensk.

Uranium mining is normally a local environmental disaster and health hazard. But there are also two potentially important pollution impacts on the wider water ecosystem caused by discharges from mines and/or associated processing facilities:

- mine water: the water removed from the ground to depressurize or dewater the mine; and
- tailings liquids: the mixture of process chemicals, finely ground tailings solids and water which is released from the uranium recovery processing plant or mill.

Contamination from one mine water discharge point in the 1990s could be detected 10 km downstream at Bambakai. Treatment of this mine effluent now includes use of ion-exchange technology to remove uranium, resulting in recovery of 10 tons per year of uranium. The content of other contaminants was not measured or disclosed. At the 150 m^3/hour effluent discharge rate for 17 years, the total amount of untreated waste water released was more than 22,300,000 m^3. Based on the 150 microroentgen/hour radioactive emission rate, the released mine water represents a total emission source of more than 197 roentgens/yr and more than 3,350 roentgens during the full 17-year discharge period. No information was provided on the concentrations of heavy metal or radioactive pollutants other than the microroentgen emission rate.

Tailings are an even more acute issue. If uranium production of 5,000,000 pounds/year (in 1995) is extrapolated over a 30 year period, and an average ore grade of 0.1 percent uranium is assumed, Krasnokamensk would have generated 75,000,000 tons of tailings, at a rate of 2,500,000 tons per year — a rate which is only 56 percent of full operational capacity. Production over the 17-year period at these rates would have yielded 50,000,000 tons of tailings.

The immense size of the Krasnokamensk operations, the enormous volume of untreated effluent, and the leaking tailings pond present a major challenge for remediation. Seepage from the acidic tailings is an environmental problem that will require extensive and expensive remediation. The acidic tailings seepage is the most contaminated of the materials released by uranium mills because it is derived from the mixture of acidic mill chemicals and the crushed ore which contains the highest concentrations of uranium decay products and associated heavy metals (Robinson 1996; Belton 2006).

There is no direct evidence if and in what amounts uranium-mine pollutants were transported to the streams of the Argun River basin. However, given the close proximity of the streams and the Argun itself, and the poor condition of the facility from 1996 to 2006, it is reasonable to consider the possibility of accidental or chronic pollution from the site. This is especially important given the likely increase in production in coming years.

In 2005, a local ichthyologist was called in by local fishermen to inspect "mutant" fish, which were raised in wastewater ponds around the mine. The carp showed many deviations from morphological norms and quicker growth rates near the mine than in other water bodies. Mine-reared carp are probably sold in Chita markets by unemployed locals who rear the fish in the mine ponds (Mikheev, pers. comm. with Simonov, 2006).

Upper Amur: Gold, fire, and oil impacts

Fragmented water quality data are available for the Upper Amur (above Blagoveshensk-Heihe). Water quality at the Upper Amur Cherniaevo monitoring station is reported as class four of seven with phenols 12 times higher than the allowable standard, and zinc 1.3 times the standard (ABWMA 2003). It was reported in 2005 as class five of five by monitoring stations in China (ADB 2005). In general about 75% of the Amur-Heilong main channel meets Class 5 or even worse standard according to 1999 monitoring in China.

The Upper Amur-Heilong has sparse populations in all countries and slow economic development. In Mongolia there is little mineralization in the Onon River, pollution is low and the river water is soft, although widespread gold-mining probably has had some impacts on water quality. The Onon drains into the Shilka River which may surpass the Argun in terms of anthropogenic pollution because it drains through old industrial development areas of Chita Province. Pollution loads of the Shilka in 1995 included oil, zinc, iron, phosphates, and nitrogen among the most common contaminants. Therefore at its point of origin — the confluence of Argun and Shilka — the Amur-Heilong already carries a substantial load of contaminants. The Huma River (a right-bank tributary) might also carry growing pollution loads arising from Tahe and Huma districts of Heilongjiang Province.

Gold mining in streams, a principal industry of the mountainous area in China and Russia, has been an important source of pollution on both sides of the River. Gold mining in stream beds causes 2 percent of soils in stream valleys to be washed downstream and turbidity to increase by 20-5,000 times natural levels. Often, no fertile topsoil is left after mining on wide transformed banks. Gold mining technology is highly destructive, causing virtual death of a stream valley for 30-50 years after mining stops. Before 1990, mercury was an essential chemical agent used in the gold leaching process. Now mercury is seldom used, but reprocessing of tailings using improved technology still leads to release of mercury into streams. Inspection of 46 gold mines revealed 57 violations of the water law (ABWMA 2003). Large gold mines operate on dozens of tributaries in Russia and China, and this will intensify with rising gold prices. Mining could be partly responsible for disappearance of salmon runs from dozens of tributaries and the crash of the local fishing industry downstream to the end of the Hinggan Gorge in the Middle Amur-Heilong.

Forest and grass fires are another agent of pollution. They have complex consequences for stream water quality, raise concentrations of polyaromatic hydrocarbons (e.g. benzoperene), increase erosion and turbidity, deposit mineral substances to stream-beds leading to eutrophication, and transform composition of plankton communities that purify the system (Kondratieva 2005). Hydrochemical impacts of forest fires are detectable in the year after a fire as higher concentrations of phenols and organic compounds. These might persist for five to six years. Mountains of the Upper Amur Basin have recurrent forest fires, suggesting that high natural phenol loads might be attributed not only to runoff from wetlands, but also to wildfires. Even in years with high water levels concentrations of phenols regularly surpass allowable standards.

In late 2006 the Siberia-Pacific oil pipeline was planned to fork at Skovorovino and cross the Amur-Heilong channel at Dzhalinda village. This agreement substantially increases the risk of oil spill as one component of the many problems in this portion of the pipeline. Details of the alignment through the rugged terrain of the Greater Hinggan range are unknown to us, but the pipeline is likely to cross at a minimum the Huma and Nen Rivers and many smaller streams on its way to the Qiqihar-Daqing-Harbin industrial belt. An even more dangerous scenario has been put forward to construct several cross-river pipelines at different sections (see oil pipeline case study in Chapter 21).

Middle Amur-Heilong (Blagoveshensk to the Songhua River confluence)

The Middle Amur-Heilong begins at Blagoveshensk (in Russia) and Heihe (in China) cities, both large population centers, and extends downstream to the mouth of the Songhua River. Heihe City has experienced sky-rocketing economic growth for at least the past fifteen years. Heihe's total wastewater discharge in 1997 was one million tons and the total amount of pollutants was 18,672 tons, of which COD_{cr} was 15,694 tons and suspended matter was 2,977 tons (UNEP 2003). Heihe City discharges untreated municipal wastewater and waste from a cement plant into the Amur-Heilong main channel within the city boundary. This led to a joint investigation by the Heihe and Blagoveshensk municipalities after warm wastewater threatened the border-crossing ice-road during winter 2002-3.

Hydrocarbons are a real concern for water quality at Blagoveshensk. As in the upper Amur-Heilong, phenols are also a problem (ABWMA 2003).

In 2001, Russia's Amurskaya Province discharged 100 million tons of wastewater containing pollutants, including: organic substances (2,490 tons); oil products (80 tons); nitrogen-containing substances (1,147 tons); and phenols (2.5 tons). The municipal sewage treatment plant in Blagoveshensk City has the largest wastewater discharge volume of Middle Amur-Heilong cities, and the influent is not sufficiently treated due to inadequate capacity of the facility.

Among the most important concerns for future water quality are oil pipelines under design in 2006 to supply China. In 2005 a potentially problematic option was put forward by a private Chinese company. Russian oil would be shipped by rail to the north bank of the river, then loaded into a pipe to cross the Amur-Heilong into China, and then reloaded into rail cars on the south bank (City of Heihe web-site, Investment opportunities section, January 2006).

Heihe Prefecture has also advertised an investment opportunity to develop two new petrochemical facilities at Heihe and Sunke (on the China riverbank). These would process imported oil at the border to add value for subsequent shipments. This would inevitably lead to higher oil pollution loads and rising risks of accident. Varying levels of oil pollution appear to be the primary concerns at this location in future.

The main tributaries of the Middle Amur-Heilong are the Zeya River, which is mainly polluted by municipal wastewater from three district centers, and the Bureya River, which is polluted by municipal centers and industries, including those associated with the Bureya hydropower plant. These two tributaries are also influenced by the Zeya and Bureya reservoirs, each with decomposing vegetation at the bottom (see section on Water Use and Infrastructure). Banned pesticides are stored in obsolete storage facilities on the Zeya-Bureya floodplain, a flood-prone area located between the two rivers. This has been a long term concern for Amurskaya Province, and is known to have polluted local ponds and small streams. Whether this causes detectable pollution of the Amur-Heilong River remains unclear.

Missile-launch sites near Svobodny City in the Zeya River basin present the most vivid example of hazards associated with the abundant military facilities throughout the region. Runoff from the site is known to contain highly toxic rocket fuel (heptil) (ABWMA 2003). This was one reason for massive public protests of environmental groups and several subsequent EIAs that postponed reopening the site for commercial and "civil" rocket launches in 2001-5. Enforcement branches of environmental agencies revealed more than 90 violations of water laws on military facilities in the Amur-Heilong basin in 2003 (ABWMA 2003).

Runoff in the Khingan River draining the Russian part of the Small Hinggan (Malyi Khingan) mountains is a concern because of the mines and tailings of JSC "Khingan Olovo" that produce tin and other metals. Facilities are in poor condition, lack investment, constantly change owners, and have regular accidents. A 2003 leak from tailings caused pollution of the river by lead, iron and zinc (AWBMA 2003).

Downstream from the Khingan River mouth near the Pashkovo-Jiayin border crossing the Amur-Heilong River enters the spectacular 150-kilometer long Hinggan Gorges. Here the flow accelerates and turbulent waters are enriched by oxygen, which improves water quality and purification capacity. The primary pollution hazard in this reach has for many years been gold mining in tributaries. In 2002-4 many local governments in China forcefully purged mining vessels from right-bank tributaries, since environmental losses outweighed decreasing profits from this destructive form of land use. However, the industry did not die. Chinese firms won multiple mining auctions in Russia and leased similar tributaries on the left bank in Evreiskaya Autonomous Region, where they use the same obsolete technology with the same destructive results. Thus the overall negative impact of gold mining on the Small Hinggan and Amur ecosystems has not declined.

Cumulative impacts on the main channel of the Amur-Heilong River have not been as significant as downstream from Songhua River mouth. This is shown by the results of the Joint Russia-China water quality monitoring program described below. However cumulative impacts may increase dramatically as oil transport infrastructure and raw material processing increases in upstream reaches in the near future.

Middle Amur in Sanjiang Plain: Collaborative Russian and Chinese research

In 2002 representatives of Khabarovsky Krai, Evreiskaya Autonomous Region (Russian Federation), and Heilongjiang Province (China) agreed to implement complex monitoring projects for pollution in the transboundary waters of the Amur-Heilong and Ussuri-Wusuli Rivers. Three locations were selected for monitoring: Pashkovo (Jiayin), Kozakevichevo (Fuyuan), and Nizhneleninskoe (Tongjiang). Water samples were analyzed for 25 physical and chemical characteristics and also zooplankton and benthic organisms. Samples were analyzed in Khabarovsk and Harbin. Russian and Chinese scientists exchanged results, which showed 60 percent coincidence at the beginning of the project in May 2002, and up to 80 percent coincidence by project end in October 2002.

From the water sampling results the specialists concluded the following:

- the quality of Amur water at Pashkovo station ("background" or "conditionally clean") is influenced primarily by natural factors (weather conditions and surface runoff);
- at the Nizhneleninskoe station (located 40 kilometers downstream from the confluence of the Songhua and Amur-Heilong Rivers) deterioration of water quality was found: compared to values at Pashkovo, biological oxygen demand (BOD) increased 1.5 times; nitrites increased 2-4 times; nitrates 6.7 times (at the bottom level 1.4 times); suspended solids 2 times; and phosphates 1.6 times (at the river bottom).

These changes of water quality were especially significant during spring floods (May) and in the rainy season (August). Levels of water pollution in the Ussuri-Wusuli were considerably lower than in the Amur-Heilong.

Monitoring continued in 2003 with a change from the 2002 protocol: The background sampling point was shifted downstream to a station near Amurzet/Luobei and the lower end of Hinggan Gorge. The results of the 2003 work were similar to the results from the previous year, except during August. The floods in August 2003 significantly changed the hydrological situation and as a result:

- the concentration of suspended particles was 125 mg/dl at Nizhneleninskoe, compared to 25.6 mg/dl at Amurzet (background);
- pollution of by hydrocarbons increased 6 times and nitrates 11.8 times; and
- concentrations of nitrites, chlorides, and phosphates, and BOD increased (Gavrilov 2004, ABWMA 2003)

Since pollution criteria differ greatly in China and Russia, it was also suggested to use characteristics of water from Hinggan Gorge (Pashkovo-Jiayin, Amurzet-Mingshan) as a control or baseline, and judge pollution levels against this standard. The last suggestion might not be valid several years from now, when new industrial centers at Heihe and Sunke (upstream from Hinggan Gorge), begin processing raw materials imported from Russia and discharging more pollution than at present.

Although joint monitoring helped to build trust and agree on baseline data, it yielded little new information. Rather, it supported the data collected previously and independently by the two sides (Kondratieva 2006; See her essay number three on pollution risk management in Part Four). Unfortunately coordinated monitoring stopped in 2003 and was not renewed until the November 2005 Songhua chemical spill required a completely new framework for cooperation.

These results revealed that the Songhua River is an important source of water pollution in the Amur-Heilong River. It became obvious that the anthropogenic impact on the Songhua River was high as seen in the contamination of bottom sediments and the water column by fertilizers and pesticides used in agriculture (nitrates, nitrites, phosphates, suspended particles), and discharges of cities and city industries (oil products, biogenic elements elevating BOD levels). The fact that maximum pollutant concentrations are seen in flood seasons suggests the importantance of non-point pollution sources in the overall pollution load.

The 250 km reach from the Songhua-Amur-Heilong confluence downstream is among the three most polluted rivers known in Russia's part of the basin. The main pollutants are: nitrogen (all forms with concentrations up to 52 times the acceptable level in winter), phosphates, chlororganic compounds — pesticides (including DDT) and chlorphenols — and oil products. Water quality is class 6, or "highly polluted" (ACCSD 2005).

Songhua River pollution monitored by China

This section draws heavily on the ADB (2005) Songhua River pollution study and the ADB-GEF (2000) Midterm Report for the Songhua River Flood, Wetland and Biodiversity Management Project.

The average population density in the Songhua River basin is 99 people/km^2, and the forest coverage rate is 36 percent. The water quality in the upper Songhua River is quite good because population density is lower than average and forest cover higher. Water quality deteriorates in the middle reaches of the river as population density increases and forest cover declines. Pollution is of particular concern near cities. The main pollutants are organic materials, for instance, chemical oxygen demand (COD), or biological oxygen demand (BOD_5), ammoniacal nitrogen, and volatile hydrocarbons. The COD index has limited usefulness for our purposes since this is a method of indexing contamination that relates not to amounts of pollution, but rather to amounts of oxygen needed to degrade organic substances. Therefore, it poorly reflects actual amounts of some pollutants, especially those that are persistent due to slow oxidization.

There are about 200 water quality monitoring stations distributed all over the China basin, mostly in the Songhua River basin, half of them belonging to environmental protection bureaus and half to water resource bureaus. SEPA operates four automatic monitoring stations in SRB, two in Jilin and two in Heilongjiang.

Surface water quality in China is ranked according to a 5 Class System from Class I (the best) to Class V (the worst) — these levels being defined by the standard values of several selected parameters, distributed into basic, additional and specific parameters. For some waters there is a sixth class for waters unable to meet Class V. There are 109 parameters considered, of which 24 basic parameters are applicable to any surface water body, 5 additional and 80 specific parameters applicable to water sources for drinking water supply. Initially promulgated in 1983, the Environmental Quality Standards for Surface Water were amended in 1988, 1999 and in 2002 (for this reason the pre-2002 data are not readily comparable with 2005 data).

In this section we rely mainly on the recent study of Songhua River pollution conducted by ADB (2005). For selected stations, data from EPB and WRB are compared, both in terms of water quality parameters and water quality classes. The following observations emerged from this evaluation:

- There is a long-term shift in various river reaches from better water quality to worse

- Short term trends are not obvious over the 10th Five Year Planning Period (2001-5); But the percent of river length per quality class increased for poorer classes during 2000-2003, revealing degradation of the main streams; This is further supported by trends of individual parameters which show degradation over at least the last ten years;

- Today the upper reaches of the Nen River are typically clean to moderately polluted;

- Songhua River waters are becoming polluted to severely polluted levels—In reaches downstream from major cities most of the mainstream of the Songhua is at Class V or worse;

- Comparison of data collected by WRB and EPB at the same locations revealed many discrepancies caused mainly by differences in sampling frequencies

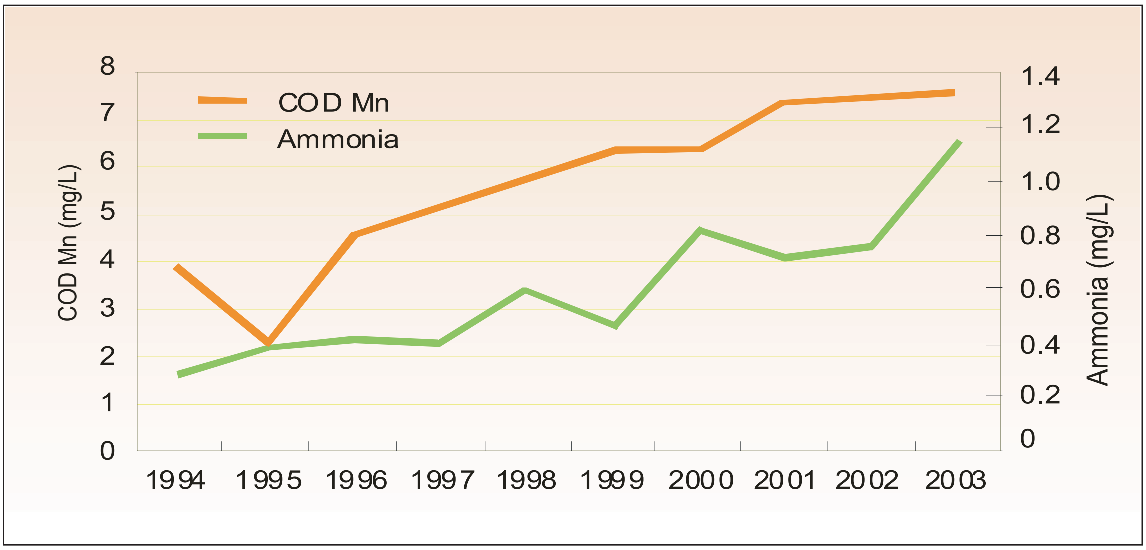


Figure 3.4 Trend of average COD and ammonia at the outlet of the Songhua River basin (ADB 2005)

and periods, suggesting that data from EPB and WRB cannot be combined in analyses;

- Pollutant loads cannot be computed by linking EPB water quality data to WRB flow data because agencies do not exchange information;

- Concentrations of pollutants increased in the river in winter due to the combined effects of low flows and limited degradation of organic pollution both in treatment plants and in the rivers due to low ambient temperatures; Winter is characterized by especially high concentrations of micro-organic pollutants, which cannot decompose, volatilize or photolyze.

The water quality in rivers improves following large floods such as in 1998. According to reports from SEPA, Songhua River pollution in 2001-2003 was worse than that in the Yangzi and was deteriorating annually (see Basin Summary below for waste water treatment details). According to MWR in 2004, the water quality was relatively good in 75 percent of monitoring sites in the China basin (class 3 of 5 or better). Lower reaches of the Second Songhua, Lalin and Mudan Rivers were the most polluted sites (MWR 2005).

Figure 3.4 shows average COD and ammonia at the outlet of the Songhua River basin over the period 1994-2003. These data show a 10-year trend of declining water quality.

The Heilongjiang Provincial Environmental Scientific Research Institute carried out research from 1997 to 1999 in which 178 pollutants were identified in water samples from the Sifangtai section of the Songhua. Presence of micro-organic pollutants in the Songhua River was revealed by several studies conducted mainly in Heilongjiang Province by the EPB Provincial Research Institute in 2000, 2002 and 2004. These studies confirmed the increasing levels of hazardous contamination in the River and in the hydrologically linked drinking water sources. Investigations in Heilongjiang documented pollution of the river water and of Harbin's drinking water by several toxic micro-organic pollutants generated by the industrial sector (**Table 3.15**, and ADB 2005).

Table 3.15 Main micro-organic pollutants found in Harbin drinking water sources

Chemical Groups	Type Number	Percent of Total
Hydrocarbons	21	11.8
Phthalein acid ester	8	4.5
Phenol	6	9.0
Alcohol ether	4	2.2
Aldehyde and ketone	20	11.2
Organic acid ester	5	2.8
Halohydrocarbons	9	5.1
Chlorobenzenes	30	16.9
Amines	17	9.6
PAH	40	22.5
Heterocyclic compounds	8	4.5

Industrial and municipal wastewaters are the primary sources of water pollution in the Songhua River basin in winter when surface runoff is minimal. Some of the industrial wastewater and nearly 90 percent of the municipal sewage is discharged without treatment. Cooling water from thermal power plants adds thermal pollution to rivers. The cities of Jilin and Changchun on the Second Songhua River, Qiqihar on the Nen River, and Harbin and Jiamusi on the Songhua River are major industrial cities in China. Their large populations and factories are the main sources of water pollution.

The Songhua River basin, especially in its middle and downstream reaches, is industrialized by large and medium-sized enterprises of polluting industries. Paper-making, chemicals, electricity generation, petrochemicals, equipment manufacturing, metallurgy, oil exploitation, foodstuffs, and fibers, are the major industries discharging wastewater into the Songhua River basin. Their discharge volume accounts for 89 percent of the basin's total industrial wastewater discharge. The COD load from paper-making, oil refining, chemistry, foodstuff, medicine, equipment manufacture, electricity generation, fiber, and construction accounts for 97 percent of the basin's industrial COD load. The NH3-N load from petrochemicals, chemistry, paper-making, electric power plants, fiber, equipment manufacture, and foodstuffs accounts for 58 percent of the basin total. These polluting industries are not able to reach the national standards for industrial effluents. Industrial wastewater discharge therefore causes water pollution that threatens the ecological security of the Songhua River basin (ADB 2005).

Organic pollution increases at the beginning of the flood season as a consequence of fertilizer transport from farmland by surface runoff. This plays an important role in the organic pollution of river in the Songhua River basin and throughout China (Ma Jun 2004). Agrochemicals are used in large quantities but with low utilization ratios (around 30 to 35 percent for fertilizers per ADB 2005) thus increasing N and P concentrated in water bodies. ADB's (2005) study quotes a report that estimates average fertilizer use in the Jilin part of the Songhua basin at 45.1 kg/mu (equivalent to 677 kg/ha), well above the world average, but comparable to use rates in other areas of China (ADB-GEF 2006, UNEP 2005). Use of fertilizers and pesticides has also increased in Heilongjiang Province where, during the past 10 years, the use of pesticide doubled from 12,500 tons in 1990 to 27,700 tons in 2000. Per hectare use increased 46 percent from 2.5 kg/ha to 3.7 kg/ha.

Livestock breeding developed rapidly in recent years with swine and cattle breeding farms in Jilin and Heilongjiang Provinces. Total numbers of livestock in the Songhua River basin almost doubled from 25.6 million head in 1980 to 44.3 million head in 2000. Untreated manure from livestock breeding farms represents a major pollution source for water bodies, estimated at about 11,000 tons of COD and 2,260 tons of NH3-N in the Second Songhua River, and 790 tons of COD and 163 tons of NH3-N in the Nen River basin annually.

Both point and non-point sources discharge nitrogen and phosphorus into lakes and reservoirs, with a consequent risk of eutrophication. These nutrients stimulate the growth of floating or suspended algae, attached algae and macrophytes. Excessive growth of these aquatic plants degrades water for use in domestic and industrial water supply, irrigation, fisheries and recreation. More than 60 percent of the reservoir water in the Songhua River basin is classified as eutrophic with the remaining 40 percent mesotrophic. The situation is most serious in the lower Songhua River basin where more than four of five reservoirs are eutrophic. In the Songhua River basin, more than 50 percent of groundwater resources are already affected by pollution, meeting water quality Class 4 or worse (ADB 2005).

From Lake Khanka downstream in the Ussuri-Wusuli River

One of the origins of the Ussuri-Wusuli River is the transboundary Lake Khanka-Xingkaihu, from which its Song'acha River outlet flows into the Ussuri River. The overall water quality of the rivers that flow into Lake Khanka meets fishery requirements, except COD values for some rivers. UNEP-GEF (2005) reported total Khanka Lake 1995-1996 water use of 739 million m^3/year, of which approximately 693 million m^3/year were used for irrigation.

The major sources of pollutants in the Lake Xingkai/Khanka basin are agriculture, soil erosion, untreated residential and industrial sewage, and tourism. Pesticide pollution in the lake is caused by pesticide overuse on extensive croplands around the lake. On the Russia side, inflow rivers still carry DDT and HCCH groups of pesticides in sediments that settle on the lake bed. Over the last decade of the 20th Century, 12,300 tons of pesticides (approximately 33 kg/ha) have been applied to crops on the Russian side of the lake basin. Soil erosion due mainly to unregulated land use amounts to approximately 2.35 million m^3 in Mishan City in China. Untreated sewage from Mishan City flows into the Muling River, from which flood waters are discharged to Khanka-Xingkai Lake as needed via a sluice gate. Industries including coal mining, non-ferrous metallurgy,

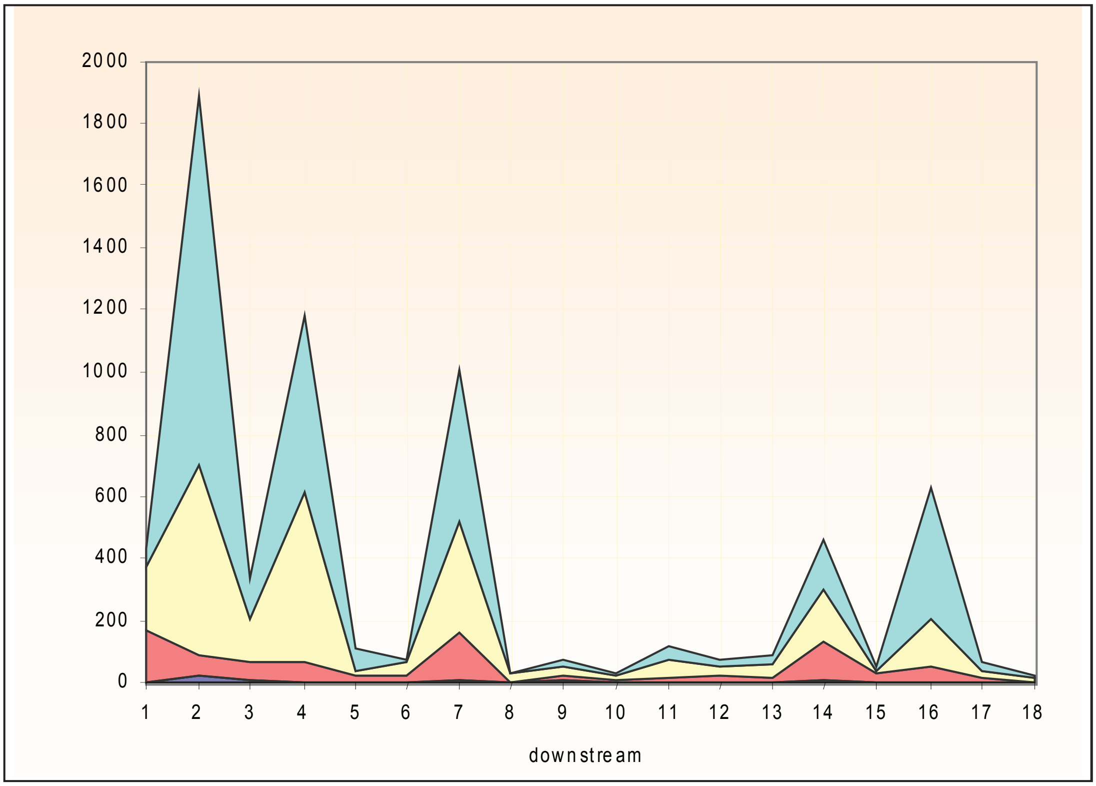


Figure 3.5
Amur River water pollution in 1997 as determined by microbiological analyses (Kondratieva 2004)

metal working, and cement and building material production discharge untreated wastewater into the basin. The lakes attract around 160,000 tourists annually who generate an estimated 60,000 tons of sewage containing 6 tons of BOD_5 and 18 tons of COD (UNEP-GEF 2003). Oil and phenol concentrations in lake waters approach the maximum allowable standard for fisheries. Concentrations of iron, copper and zinc exceed the fisheries standards (ABWMA 2003).

The Russia side of the lake basin has potential for economic re-development that could be accompanied by environmental threats if protective measures are not incorporated into the economic development plans.

Arsenievka River is a tributary of the Ussuri River in Russia. It flows through densely populated districts of Primorsky Province where its waters often exceed standards for BOD, iron, and oil. The rural reaches of the river are characterized as "somewhat polluted" to "clean" with only iron, copper, and phenols exceeding fisheries standards in 2003 (ABWMA 2003).

Downstream from Lake Khanka-Xingkai, Ussuri-Wusuli River water quality is fairly stable, meeting Class three or four standards in China (ADB 1999) and similar levels in Russia.

Lower Amur — Russian headache

After its confluence with the Ussuri-Wusuli the Amur-Heilong leaves China and flows 950 kilometers through Khabarovsk Province to its mouth at the Sea of Okhotsk. Russian scientists concluded that recent declines in pollutant discharges by Russian industry had not led to improvement in the Amur-Heilong River ecosystem. The main factors causing continued degradation of water and ecosystem quality were transboundary pollution (mainly from the Songhua River), industries (mainly power stations and transportation), and forest fires. Recent studies indicated a steady increase in concentrations of aromatic hydrocarbons moving downstream.

A 1998 study of transboundary pollution using microbial indicators revealed that the summer 1998 floods in the Songhua River caused increased pollution levels in the Amur–Heilong River near Khabarovsk. Concentrations of hydrocarbons exceeded acceptable levels in Russia by a factor of 40. Two years later 41 percent of water samples taken from the Lower Amur exceeded applicable standards (Khabarovsky Provincial Centre of State Sanitary and Epidemiological Supervision, unpubl. report). Viruses including interoviruses, rotaviruses, and hepatitis also occurred more frequently in recent years (UNEP 2003).

Figure 3.5 is adopted from Kondratieva (2004) to show the uneven distribution of pollutants in the lower Amur according to microbiological indicators.

Point 1 is upstream from the mouth of the Songhua River; Point 2 with highest pollution is immediately downstream from the Songhua/Amur-Heilong confluence; Point 16 is at Nikolaevsk near the mouth of the Amur River.

The sampling point showing the highest level of contaminants is below the confluence of the Songhua and Amur-Heilong Rivers. This reflects the contaminant load carried into the Amur-Heilong by the Songhua. Other points showing high levels of contaminants are near cities on the lower Amur.

Generally, all waters of the Lower Amur are characterized as "polluted" or "highly polluted". The main concerns for the water supply at Khabarovsk are phosphates, dichloro-ethane, lead, copper, zinc, nickel, cadmium, and aluminum. Suspended sediments also add to water pollution. This is caused by soil erosion in the Songhua and Ussuri-Wusuli basins and subsequent sediment transport by floods to the Lower Amur River. During the floods of 1991-1995 and 1998 concentrations of suspended particles reached 574 mg/l (3.5 times higher than normal) near Khabarovsk.

Lake Petropavlovskoe in the suburbs of Khabarovsk is the most polluted Lower Amur wetland due to inputs of untreated city sewage and large pig farms in suburban agricultural areas. The small streams Chernaya and Sita that discharge into Lake Petropavlovskoe are the most polluted small water bodies known in the Russian part of the Amur basin. In 2003 allowable standards for vanadium were exceeded here 51 times and standards for iron were exceeded 38 times. The lake is becoming a virtually unmanageable wastewater pond that threatens the Amur ecosystem because it discharges into the Amur during floods (ABWMA 2003).

All of the Lower Amur suffers water pollution. Recent research shows that most contaminants in the Lower Amur arise upstream of Khabarovsk (Kondratieva 2005, Ivanova 2004, ABWMA 2003). However, contaminants are also added by Khabarovsk Province, which produces the greatest pollutant volume among the six Russian provinces in the Amur Basin. Of 132 treatment facilities tested in 2003 only six had satisfactory performance (ABWMA 2003). Concentrations of heavy metals in sediments are especially high for zinc, nickel, copper, lead and hydrocarbons. These are complicated by secondary pollution, anthropogenic changes in water temperature on the vast floodplains of the Lower Amur. Applied research to formulate plans for pollution risk management is very complex but urgently needed (see Kondratieva et al. 2005 for detailed discussion).

Wastewater

In this section we describe wastewater discharge, treatment, and related issues for Russia, Mongolia, and China.

Russia's wastewater

In 2003, the total volume of wastewater discharged from four Russian provinces in the Amur-Heilong basin was estimated at 1,057 million m^3. Preliminary research on non-point sources has been carried out only for three cities in the Middle and Lower Amur and is yet to yield any reliable pollution load estimates.

In 2003, the eastern part of the basin had 435 wastewater treatment facilities with total annual capacity of 586 million m^3. Only 315 million m^3 were treated in 2003 (54 percent of capacity). Of these, only 65 million m^3 were treated properly (21 percent of treated wastewater). Only a small percentage of wastewater is treated to "clean norm" standards.

Wastewater treatment plants have such poor performance because they are required to process more wastewater than they were designed for and operating standards often do not meet specifications. Outdated technologies are used, and funds are not adequate for repairs. Scarce funds are devoted to construction of new treatment plants rather than to upgrading and repair of older plants.

The system of pollution quotas does not work between regions and industries partly because the existing "Basin agreement" managed by AWBMA does not include the China side of the Argun, Ussuri, Songhua and other sub-basins, and therefore no meaningful total pollution quotas are agreed. This applies to the Amur-Heilong as a whole and to specific sub-basins such as the Argun, Ussuri, and Lake Khanka. ABWMA believes this problem cannot be resolved until an international Amur-Heilong basin agreement includes equitable and

Table 3.16 Industrial and domestic pollution in the Songhua River basin in 2003 (ADB 2005)

	Total wastewater discharge/ Cubic meters per day	Total wastewater discharge/ Million cubic meters per annum	COD kg/day	COD thousand ton per year	NH3-N kg/day
Industrial	3,334,323	1,217	563,771	206	41,803
Domestic	6,083,740	2,221	2,387,613	872	197,510
Total	9,418,063	3,438	2,951,384	1078	239,313

ecologically sound protocols to allocate pollution quotas (ABWMA 2003).

According to estimates by the Far East Institute for Water Management (Dalvniilkh), human-induced pollution loads in transboundary waters of the Amur ecosystem in China are 10 times greater than in Russia in terms of ammoniacal nitrogen and lead, and four times greater for hydrocarbons. China's share of total pollution is 75 percent in the Upper and Middle Amur to the confluence with the Songhua River. From the Songhua mouth to the Ussuri mouth China's contribution equals 98 percent, and in the Ussuri River China accounts for 97 percent (ABWMA 2003).

Mongolia's wastewater

Discharge of untreated wastewater in Mongolia is probably many orders of magnitude less than in Russia or China. However, overgrazing, placer mining and other activities contribute unknown volumes of non-point source pollution. Data showing high mineralization of the lower reaches of the Kherlen and Khalkh Rivers support this hypothesis. According to UNEP in Choibalsan City, Kherlen receives approximately 1.83 million metric ton/year of untreated wastewater.

China's wastewater

There is a paucity of data for the western part of the basin (Inner Mongolia in the China basin), but one can safely assume that the bulk of pollution in the basin comes from the more developed and populated provinces of Heilongjiang and Jilin.

Estimated pollution levels for the Songhua River basin in effluent volumes and COD load and selected anions, are listed in **Table 3.16**. Industrial pollution estimates for 2003 are based on the loads from more than 700 major enterprises over the Songhua River basin, representing most of the discharged load. Industrial wastewater discharge was estimated at 3.3 million cubic meters per day in 2003. Due to the rapid increase of urban population over the last 10 years, and the slow development of wastewater treatment plants (there was not even one plant prior to the mid-1990s, Ma Jun 2004), domestic sewage represents the major source of organic pollution in the Songhua River basin. In 2003, the total industrial wastewater discharge in the 49 major cities of the basin was estimated at approximately six million m^3 per day for a daily pollutant load of about 2,400 tons of COD and 197 tons of NH. The basin is presently poorly equipped with domestic wastewater treatment plants, with only 11 operating facilities in 2003 and a treatment capacity of 1,550,000 t/day. By the end of 2006, seven additional plants under construction were designed to add treatment capacity of 855,000 t/day.

Data on wastewater volume seem to be somewhat disjunct from data on water use. If we apply appropriate water consumption rates to volumes used for domestic and industrial purposes (10.4 km^3/year, see **Table 3.12**), we arrive at roughly five to seven km^3 of wastewater annually. This compares to the 3.4 km^3 listed in **Table 3.16**. Reasons for the discrepancy are unclear but probably include cooling of industrial facilities and some other industrial uses not accounted for in the ADB (2005) study due to their low levels of pollution discharge.

The composition of the pollution load has changed

Table 3.17 Point-source pollution (PSP) vs non-point source pollution (NPSP) loads in the Songhua River basin in 2000 (ADB 2002)

Pollution in COD in tons/day	Nen	2nd Songhua	Songhua	Songhua basin Total
PSP load	44	188	161	393
NPSP load	241	79	203	524

over time: domestic COD was estimated to be only 30 percent of the total pollution load in the early 1990s. It is currently over 50 percent (over 70 percent for Changchun), probably resulting from both improvement of industrial effluent control measures and a rapid rise of urban population without appropriate sewage treatment facilities. In 1999, less than 20 percent of the domestic wastewater was subject to treatment before being discharged into rivers (ADB 2000).

When non-point and point-source pollution estimates for the same year are compared (**Table 3.17**), it is clear that non-point source pollution is the dominant COD source in the Songhua River basin (57 percent), the Nen watershed (85 percent) and in the main Songhua catchment (56 percent). In contrast, PSP is the dominant COD source in the Second Songhua. However, PSP is the dominant source in winter, which is generally regarded as the critical period for water quality in the Songhua River basin (ADB 2005).

According to UNEP (UNEP PDF-B 2003), the total amount of wastewater discharged into the Argun River basin is nearly 20 million tons/year and the amount of pollutants is 14,527 tons/ year, of which 11,701 tons are COD_{cr}, accounting for over 80 percent of the total pollutant load; 1,760 tons of suspended matter, accounting for 12 percent of the total amount of pollutants; and 996 tons are $BOD_{5,}$ accounting for seven percent of the total amount (UNEP 2003).

To understand the dynamics of wastewater treatment we used market research reports on wastewater treatment demand for the year 1999-2000 (Yu Hongmei 2002). In 2000, 4,590 industrial enterprises located in the northeast generated wastewater. Of these, 344 were located in Jilin and 1780 in Heilongjiang. Although some of the enterprises installed pollution control equipment to comply with minimal national discharge standards, the treatment effects were not completely satisfactory. In addition the national and provincial pollution discharge standards were still very low and only regulated COD. The many unregulated pollutants cause substantial water quality degradation and should be subject to treatment. But most industrial manufacturers in the province use equipment that is technologically outdated by 20 years or more, and the majority of industrial enterprises use unsophisticated, low cost, approaches to treat industrial wastewater.

Of all industrial wastewater discharged in the northeast region in 2000, 77 percent reached the national discharge standard, leaving 431 million tons of substandard wastewater discharged into rivers and the sea. In 2000, Heilongjiang treated 1.1 billion tons and Jilin treated 390 million tons. Among the three provinces in the northeast region, Heilongjiang appears to best manage its industrial wastewater. Heilongjiang treats over 94 percent of industrial wastewater as compared to 78 percent in Jilin.

In 2000, 39 percent of 1,981 environmental projects under construction in the northeast region were for industrial wastewater treatment. In 2000, Jilin invested \$25.5 million in 160 industrial wastewater treatment projects and Heilongjiang invested \$87.5 million in 259 projects.

If all municipal sewage treatment facilities were in full operation, they would be capable of treating 29 percent of sewage discharged in Jilin and 44 percent in Heilongjiang. However, many facilities fail to operate at full capacity. Therefore, the actual municipal sewage treatment rate currently reaches only 15 percent in Jilin and 35 percent in Heilongjiang according to the provincial Environmental Protection Bureaus.

During the 10th Five-Year Plan (2001-2005) provincial governments in the northeast region planned to construct 89 municipal sewage treatment facilities and 76 industrial wastewater treatment projects. It is a useful comparison that in the United States, every 10,000 people are served by a sewage treatment plant whereas in China's urban and suburban areas, each plant serves 1.5 million people. From 2001 to 2005, China planned to invest \$84 billion on environmental protection projects nationally: water pollution control (\$36 billion), air pollution control (\$30 billion), solid waste disposal (\$11 billion), ecological protection (\$6 billion), and infrastructure (\$1 billion) (Yu Hongmei 2002).

The World Bank concluded that pollution and environmental losses cost China an annual 8-12 percent of its \$1.4 trillion GDP in direct damages. Losses are caused by the impact on crops of acid rain, medical bills, lost work from illness, money spent on disaster relief following floods, and the implied costs of resource depletion (Economist 2004). SEPA notes that China plans to invest over ¥1,300 billion (\$156.6 billion) in environmental protection from 2006-2010, more than 1.5 percent of GDP over this period. SEPA secured ¥50 billion (\$6 billion) in loans from China Development Bank for three projects that top the environmental protection agenda: urban sewage treatment, solid waste treatment, and hazardous waste treatment. Bank authorities promise to double the loans once there are additional well-planned projects in the pipeline (Liu Yingling 2005).

Projects in the 1990s were financed primarily by loans from the World Bank, Asian Development Bank, or concessionary financing arrangements with foreign governments. These funds were then transmitted to provincial governments as partial funding for construction of facilities. Most local governments are expected to generate capital to match the contribution derived through the central government.

Planned anti-pollution programs in recent years often stalled due to a lack of funds or professional personnel. By mid-2004, for example, a five-year cleanup plan launched by SEPA in 2001 had received only one-third of the $7.25 billion in planned investments. China has also invested $2.4 billion since 1994 to clean up the Huai River, the primary water source for a sixth of the population. However, SEPA recently deemed the project a failure after a 2004 inspection showed that over 31 percent of industrial polluters exceeded the maximum permitted discharge and 57 percent of water treatment plants were out of service. Moving forward with clean-up remains difficult because huge sums are also needed to relocate or shut down polluting plants.

Pollution treatment infrastructure, another key to preventing and alleviating serious contamination, has lagged in China as well. Due to lack of funds some 85 water treatment plants along the Huai River, slated for operation by the end of 2005, had not yet been built by late 2006. Across China the government is keen to attract foreign technology to build and operate new water supply and sewage projects. Official statistics show that the potential commercial opportunity from these efforts could top $37 billion (Li Zijun 2006).

Basin Total Wastewater

While wastewater discharge from Russia probably totals around one cubic kilometer per year and China's total can be conservatively estimated at four to five km^3 per year, this does not account for farmland runoff, a serious threat in itself. More importantly, these estimates are unrelated to volumes of individual contaminants, and are therefore almost useless for prediction of responses of river ecosystems, biota and human populations. Pollution prevention must be based on much more specific analyses of the most dangerous pollutants and their distribution in the river basin (see Kondratieva essay in Part Four).

Influence of pollution on ecosystems, species and people

About 70 percent of the people in Khabarovsky Krai use Amur River water for drinking and home use even though the water usually contains dangerous concentrations and types of bacteria and viruses. During the last five years cholera has been regularly detected near Khabarovsk (Sanitary and Epidemiologic Service, Gossanepidnadzor). Around 23 percent of water samples from the Khabarovsk water supply system contain bacteria that cause digestive system diseases. About 10 percent of water samples contain antigens of viral hepatitis A. The level of dysentery and hepatitis A in Khabarovsky Krai is double the national average.

Health risks from eating fish are as high as from drinking water. Contaminants are metabolized in the ecosystem by microorganisms and algae, and then accumulated by fish that feed on algae and benthic organisms. Fish-eating birds, mammals, and people are impacted by exposure to high concentrations of heavy metals and organic contaminants accumulated in fish tissues.

Since 1996 people have observed a decline in the quality of Amur-Heilong fish during winter. People report a distinctive "drug-store" or "chemical" odor to the fish tissues. During previous periods of low water levels in the Amur-Heilong River (1940s, 1960s, and 1970s) such odors were not detected. Russian researchers conclude that a new factor appeared in the mid-1990s that caused fish caught during winter in the main channel of the Amur-Heilong River to carry this chemical odor. The odor is caused by increased concentrations of organic pollutants that are insufficiently mineralized due to low oxygen concentrations and low water temperatures. These contaminants are more concentrated in winter because water levels are lower and there is less dilution. Increasing water pollution is also a contributing factor.

Recent research focused on the mechanism of change in organoleptic indicators in fresh fish caught in the Amur during winter. Researchers found that polytoxicosis develops in fish due to a combination of extreme water conditions (low oxygen and temperature) and chronic water pollution by toxic elements and organic substances. When defense mechanisms are disturbed heterotrophic microorganisms are introduced. These processes combine with bio-extraction of volatile substances to produce the acrid odor.

Microbial analysis of fish showed that all fish in the main trunk of the Amur-Heilong River, especially those downstream from the Songhua-Amur confluence, are highly contaminated with bacteria and do not meet existing epidemiological standards for human consumption. Most fish contained 100 times more bacteria on their gills than did fish from the Amur-Heilong tributaries.

Volatile organic compounds identified from Amur-Heilong waters by gas chromatography include: ethanol, methanol, acetone, acetaldehyde, ethylacetate, isopropanol, and butyric acid esters. Similar compounds of microbiological origin were found in experimental fermentative fission of protein in fish muscle tissue. Increased content of nitrogen-volatile compounds (up to 410 mg/kg) was common among big fatty fish caught in the Amur mainstream: Normal concentrations do not exceed 150-170 mg/kg. High concentrations of trimethylamine from 2.4 to 6.2 mg/kg characterize fish (*Parasilurus asotus, Lenciscus waleckii, Lota lota*) caught in the Amur-Heilong mainstream. Trimethylamine concentrations were 10 times higher in winter than in summer. Many amines not only produce unpleasant chemical odors, but also precede carcinogenic nitrosamines. In winter increased concentrations of mercury (up to 0.72 mg/kg) were registered in different fish species, irrespective of their feeding ecology. Increased mercury concentrations in fish are assumed to be associated with chronic pollution of water and bottom sediments in the Amur-Heilong River. Pesticides in Amur-Heilong fish were not found to exceed the current food industry requirements. Maximum concentrations of DDT and its derivatives were registered in winter in *Chanodichthys mongolicus* (0.0623 mg/kg) and in *Parasilurus asotus* (0.0751 mg/kg); concentrations of lindane isomer did not exceed 0.03 mg/kg. Taking into consideration lindane volatility and the possibility of chlorophenol formation during DDT metabolism, the discovered ingredients could significantly impact organoleptic qualities of fish caught in the Amur-Heilong River (Kondratjeva et al. 2005).

The Medical University of Khabarovsk conducted a three-year monitoring project (2000-2003) to identify the most significant pollutants, assess their risks and toxicities, quantify bioaccumulation and transformation in the ecosystem, and define the relationships between xenobiotics and diseases of people that live near the river and consume fish as a main food. The most significant pollutant of Amur-Heilong water, bottom sediments, and biota proved to be oil (various hydrocarbons) and its various fractions and complexes. The chemical composition of this group of pollutants is mostly soluble toxic cyclic hydrocarbons. Chlorine-organic pollutants (mostly chlorine-alkanes and chlorine phenols) and products of transformation of diesel fuel were found in water, bottom sediments, fish, and humans.

Health research on local residents revealed that pathologies of digestive organs, especially the liver, are widespread. They rank second after blood-vessel pathologies in adults and first among children. This is probably due to regular consumption of Amur-Heilong fish (**Table 3.18**). This is quite likely, since according to the same researchers, lab rats fed such fish for 21 days showed symptoms of hepatitis. This shows that most people in the lower Amur, especially indigenous peoples, are suffering direct health impacts from water pollution.

Table 3.18 Percent of Amur-Heilong basin residents that eat Amur River fish every day (adopted from Ryabkova 2003)

	Indigenous peoples	Indigenous and newcomers
men	93.3	89.2
women	100	95.0
children	57.5	26.9

The main point of disagreement between authorities and researches on the subject is related to concentration of pollutants in food chains and their transformation in river water. Government authorities are inclined to use somewhat simplistic approaches to analyzing primary pollutants and their sources. In contrast, research projects seek more detailed information. Researchers argue that there is clear evidence that bio-accumulation of secondary substances in fish and other components of ecosystems and bio-transformation of contaminants into more toxic forms present even greater threats to ecosystems and populations.

Contemporary research data on health risks in the China part of the basin are scarce and all come from the ADB (2005) project. However, relationships between water pollution and public health have been demonstrated over many decades. The Second Songhua has, since the early sixties, been polluted by industrial discharges containing several kinds of contaminants including mercury and methyl-mercury in significant concentrations (estimated respectively at about 150 tons and 5 tons in the early seventies). Since 1982, mercury and methyl-mercury discharges by Jilin factories have ceased. Health investigations carried out in 1999-2000 among residents along the Second Songhua showed that concentrations of mercury in human hair declined since 1975 but remained higher in the resident population located in the previously polluted area than in the control sample group. However, observed concentrations remain below the national standard of 10μg/g. An epidemiological study on the carcinoma mortality of the exposed population along the lower reaches of the Second Songhua River was carried out from 1980 to 1984 by the Jilin Provincial Sanitation and Anti-Epidemic Station. It showed higher incidence of liver and gastric cancer among the population located in these key locations along the river as compared to average rates among the remainder of the population.

Songhua River water quality was cooperatively monitored from 1997-2000 by the Heilongjiang Provincial Environmental Protection Research Institute, Harbin City and National Environmental Monitoring and Testing Stations, Songliao Water Resource Protection Bureau, Harbin University of Medicine, Harbin University of Industries, and Sawa University, France. The group reported 191 organic chemicals (detected or suspected) in the Songhua River over its 1,200 kilometer length, of which 46 chemicals are known to cause serious health problems. An associated epidemiological study identified heightened levels of health risk in the use of Songhua River water for drinking. Groundwater near Zhaoyuan was contaminated by 133 identified micro-pollutants (ADB 2002, 2005). In a parallel study, 45 types of organic pollutants were found in the body of fish from Songhua River. The Ames experiment on fish flesh from the Songhua River was positive for carcinogenicity of some compounds (ADB 2005).

Industrial wastewater pollution mainly affects crops and fisheries. The effects of industrial pollution on agricultural products have seldom been verified scientifically in the Amur-Heilong basin and direct effects have mostly been neglected. Industrial pollution discharge, agricultural chemical pollution and agricultural ecosystem deterioration are severe threats to grain production and to supply of grains to the Songhua River basin.

Industrial pollution is now showing visible damage to fisheries. This accounts for the high proportion of damage claims by fishermen as a result of water pollution accidents. Fish catches in the Jiamusi reach of the Songhua River are around 10 percent by weight of those in the early 1980's (ADB 2002, 2005), suggesting that increasing pollution might be affecting fish production. Water quality in the lower reaches of the Songhua might be worse than in the Amur-Heilong River because of the intensive pollution in the lower Songhua and the dilution effect of the Amur-Heilong. Chinese professional fishermen who migrated from Jiamusi City on the lower Songhua River to Jiayin County on the Amur-Heilong mainstream claimed the primary reason for leaving home was the deteriorating quality of Songhua River fish that was detected as a strong chemical flavor (pers. comm. with Simonov 2004). However, they admitted that this does not stop people in Jiamusi from catching and eating fish. The latest data obtained after the November 2005 chemical spill by Russian experts showed detectable concentrations of different pollutants in Amur-Heilong River fish. Mercury concentrations, for example, were dozens of times higher than normal.

CASE STUDY: 2005 Songhua spill Accident and its consequences

The Spill

On 13 November 2005, an explosion occurred at a petrochemical plant of the Jilin Petrochemical Corporation in Jilin Province, China. The explosion led to a spill of an estimated 100 tons of toxic substances made up of a mixture of benzene, aniline, and nitrobenzene. Surface water concentrations of these compounds immediately exceeded the levels permissible in China. The contaminants subsequently entered the Songhua River and ultimately the Amur-Heilong River at the border with the Russian Federation. SEPA coordinated an emergency monitoring program that showed benzene, nitrobenzene, and aniline exceeding permissible level in surface water in the Second Songhua River. The pollution plume flowed downriver at a rate of 1-1.5 kilometers per hour. The front of the plume reached Jiamusi

City on 10 December 2005. The stretch of the plume was 80 km as it passed Harbin and it extended to 150 km long at Jiamusi. On December 12 an agreement on joint monitoring of the pollution was reached between China and Russia. From December 22-27 the pollution plume passed Khabarovsk City in Russia, the first large settlement downstream from Harbin that derives its drinking water from the river (UNEP 2005).

Coordination of response

At the central government level, the State Council (consisting of all Ministers) established a task force to handle what became known as the "Songhua River Water Pollution Incident". The task force continues to coordinate a number of working groups. SEPA heads the working group on monitoring and prevention with the newly appointed environmental minister as the leader. This working group includes the Ministry of Water Resources, Ministry of Construction, and Ministry of Agriculture, China Academy of Sciences, Heilongjiang Provincial government and Jilin Provincial government. At the provincial level, a similar organization was set up to coordinate the response to the emergencies caused by the chemical spill. The Environmental Protection Department is to monitor water quality, reporting to the relevant authorities to take actions, providing advice on responses by local authorities, as well as carrying out impact assessments and research for medium and long term actions (UNEP 2005).

In each prefecture along the Songhua River similar task forces were organized to coordinate emergency response and assist anti-pollution efforts. Hundreds of officials from SEPA and other agencies were sent from Beijing to the field and stationed along the river to provide leadership and guidance to local personnel. The division of responsibilities at all levels of management was very rigid and precise. Each participating agency has a clearly and narrowly defined scope of activities. Summary data covering the overall situation were available only at the highest levels of the State task force.

Monitoring

On 18 November, 5 days after the accident, SEPA issued emergency monitoring instructions to its provincial counterpart, Heilongjiang Environmental Protection Department. The instructions provided by SEPA focused on three important issues:

- the location and rate of travel of the pollution plume;
- the concentrations of benzene and nitrobenzene in the river water; and
- the length of the pollutant plume.

These three factors enabled authorities at different levels to design and undertake mitigation measures. After receiving the instruction, the provincial EPD immediately activated the emergency monitoring plan to quantify benzene and nitrobenzene concentrations at Zhaoyuan monitoring section, 163 km upstream from Harbin City. SEPA issued a special guideline for the monitoring of the two substances. In addition, SEPA deployed over 50 experts and 18 pieces of equipment from all over the country to strengthen monitoring capacity. The tests for benzene and nitrobenzene are conducted using gas chromatography (GC), and/or gas chromatography/mass spectrometry (GC/MS). Sampling of river water proved to be challenging especially right after the accident. In November when the river was in the process of icing, no proper means and methodologies were available for taking samples. Monitoring experts had to develop ad hoc sampling methods. The concentrations of benzene and nitrobenzene were monitored at 30 cross sections of the Songhua River from the site of the accident to the Russia border. The key monitoring points along the Songhua River and peak nitrobenzene levels monitored are shown in **Figure 3.6**.

The data show a general decline in pollution concentration as the plume moved downstream. The declining concentrations were probably due mainly to dilution and elongation of the plume (UNEP 2005).

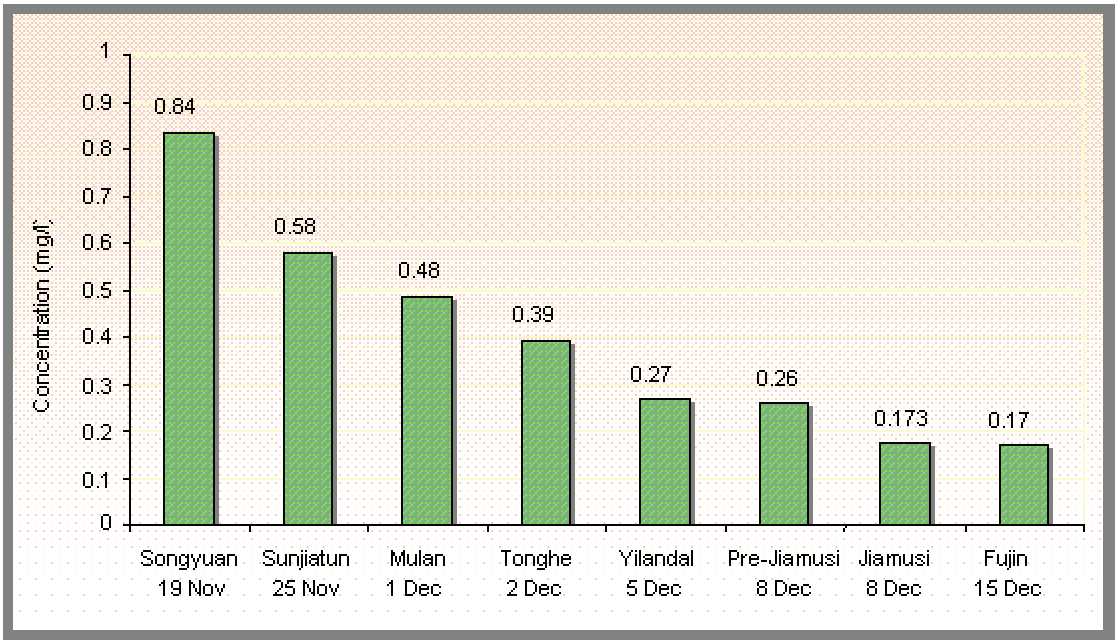
All available equipment was used to monitor benzene and nitrobenzene in addition to various routinely monitored basic parameters such as pH and BOD. No special analyses were conducted for trace heavy metals and other substances that might have resulted from the Jilin explosion. This was because these substances were not found in the pollution plume as it passed the Jilin-Heilongjiang province boundary. Therefore they were considered unlikely to be a problem further downstream.

Pollution control and mitigation measures

China adopted a series of mitigation measures during the early days after the incident including:

- shut down all waste-discharging pipelines within the chemical plant area;
- build sandbag barriers to prevent drainage of

Figure 3.6 Peak nitrobenzene concentrations measured in the Songhua River in 2005



wastewater from fire fighting and/or chemical production into the drainage system;

• divert some wastewater into the wastewater treatment plant;

• use special vehicles to collect the remaining wastewater at the site of the accident.

In addition to these measures water was released from the Fengman hydroelectric power station reservoir located upstream from the Jilin accident site to dilute the pollution. No information was provided on the quantity of water released. Some SEPA sources said that the new Ni'erji reservoir was also releasing extra water to aid dilution of the contaminants.

Water supply to the city of Harbin (population four million) is taken from the Songhua River and was shut down from 23-27 November 2005. As a preventive measure the Heilongjiang authorities advised all municipalities along the Songhua River to shut down operation of ground water supply within one km from the Songhua River as the pollution plume approached. Authorities also asked residents along the river to stop taking water from shallow drinking water wells within two km from the river and to stop catching and eating river fish.

SEPA began planning for an environmental impact assessment of the accident and remediation of the damage. The Chinese Academy of Environmental Sciences led the assessment. The Ministry of Science and Technology, Ministry of Water Resources, Ministry of Agriculture, Ministry of Construction, Chinese Academy of Sciences, and Heilongjiang and Jilin Provincial governments participated in the efforts. The main work is a systematic investigation of the ecological situation of the Songhua River, especially the pre-incident conditions in tributaries. Samples of aquatic organisms, such as fish, sediment and ice were taken for testing. Drinking water sources and ground water safety are also assessed in this project. The 11th five-year plan of Heilongjiang Province was revised to account for the incident and the impact assessment. The SEPA-led monitoring project should provide a basis for determination if and/or when Songhua River water can be used for crop irrigation (UNEP 2005).

According to the new general director of SEPA (appointed just after the incident), from November 2005 to January 2006 five mitigation measures were implemented to ensure the safety of drinking water and food for local communities (Speech Delivered by Minister Zhou Shengxian of SEPA at the Press Conference on Songhua River Pollution, 24 January 2006):

• reducing pollution in the Songhua River;

• increasing the water flow to dilute the pollutants;

• strengthening and improving emergency response measures;

- decreasing water intake and controlling groundwater pollution; and
- banning fishing.

A research project entitled “Ecological Impact Assessment of the Major Water Pollution Accident in the Songhua River and its Countermeasures” was approved on 13 December 2005. The project aims to assess the ecological and environmental impacts of the accident, identify long-term aquatic ecology pollution risks, and develop countermeasures. The project includes 15 sub-projects such as assessment of health risks, assessment of impacts on the safety of aquatic food, and assessment of impacts on the quality of farm and sideline products. The project was carried out in two phases, one for emergency response and the other for mid-term action. Emergency response was completed in March 2006. The mid-term component was completed in October 2006. In a speech at a press conference for Songhua River pollution on 24 January 2006, Minister Zhou Shengxian of SEPA announced to the public and to Russian counterparts that:

- secondary pollution from nitrobenzene in the ice or sediments of the River is minimal. The current findings indicate that only small amounts of nitrobenzene (approx 60 kg) were frozen in the ice (mainly in Jilin Province);
- nitrobenzene concentrations in the fish of the Songhua River or fish ponds along the River meet the permissible standard and fish are safe to eat;
- groundwater is guaranteed safe to drink;
- use of Songhua River water for irrigation in spring 2007 would not affect the growth of crops;
- active carbon powder proved effective in removing nitrobenzene from the water; and
- in future cases where pollutants such as nitrobenzene in drinking water source areas exceed the standard by marginal amounts, the active carbon powder technique may be applied to ensure safe water supplies to cities.

Information policies and constraints

Secrecy surrounded the pollution incident during the first five days after the spill. People initially learned about the impending danger from rumors and unverified media reports. This lack of proper communication from government authorities caused some panic. Unfortunately, the monitoring effort of SEPA was not sufficiently communicated to the public, causing the level of public uncertainty and fear to rise.

During later stages government communication improved noticeably. Monitoring results were broadcast via TV shortly after they were released by the monitoring centre of Heilongjiang Province. The concentration of the pollutants was broadcast every two hours as it passed through Harbin. Press conferences were organized by the relevant local governments to inform the media and information was posted on the SEPA website.

Several constraints were faced by international teams who attempted to assist pollution-control efforts. The UNEP mission experienced the following:

“Information on the overall coordination and composition of the State Task Force for handling the Songhua River Water Pollution Incident was not made available to the mission team. UNEP regrets that it was not in a position to share expert opinions on public health measures since the request to include a public health expert in the mission was not accepted by SEPA. Therefore, the public health aspect has been omitted from the original terms of reference. In addition, the terms of reference excluded response measures taken by local, provincial and national agencies, including civil defense, health, army, police, fire brigade, etc. At the time of the UNEP mission the task force appointed by the State Committee dealing with the Songhua River Spill was conducting investigations at the site of the explosion in Jilin. Therefore, the UNEP team was not able to visit the accident site. A site visit could help clarify the causes of the accident, immediate response measures as well as an indication of the contingency plans and measures in place at the site” (UNEP 2005).

Cooperation between China and Russia in monitoring and response

Cooperation between China and Russia was intensified on 24 November, 11 days after the spill. SEPA officials met Russian Embassy personnel and informed them of the pollution incident and later provided relevant information on a daily basis. When speaking with Russian officials Chairman Hu Jintao said “We will take all necessary and effective measures and do our utmost to minimize the pollution and reduce the damage to the Russian side".

The Russian government provided a list of chemicals to China and requested that they be monitored. On 28 November, a Russian delegation of seven people from the Ministry of Natural Resources and other agencies of Khabarovsk Province arrived in Harbin.

China and Russia agreed on a joint monitoring protocol whereby Russian experts and officials traveled to China to sample water and test concentrations of benzene and nitrobenzene. On 1 December the first samples were taken with participation of the Russian experts at the Mulan cross-section between Harbin and Jiamusi. The samples were divided into three portions: One was tested in China under observation by Russian experts; one was taken to Russia for testing; and one was kept in storage for future use.

Joint monitoring in December continued at the Tongjiang cross-section and was carried out at the rest of the monitoring points within China and in Russia. Both countries were to strengthen joint monitoring based on the Joint Emergency Response Monitoring Plan for Water Quality of the Songhua River signed on 12 December between Heilongjiang and Khabarovsk Provinces.

At the request of Russia, Heilongjiang Province began construction of a diversion dam on the Fuyuan waterway on 16 December 2005. The dam was to prevent polluted water from flowing into the drinking water intakes for Khabarovsk City. The pollution plume was not predicted to flow through the lower reaches of Xiaohezi of Fuyuan County, therefore Chinese residents living in this area were not to be affected (UNEP 2005).

The Songhua spill showed again that information exchange between Russia and China needs improvement. Agreements of the past have not been strictly observed. Data collected from 2003-5 in accordance with the joint monitoring program of Khabarovsk and Heilongjiang were not exchanged until a Khabarovsk delegation visited Harbin in late November 2005. By April 2006 Russian specialists had not received detailed information on the composition of pollutants in the original spill. Russian authorities were initially preparing to deal only with benzene and nitrobenzene pollution because these chemicals were reported by China. Only when the plume approached Khabarovsk were other compounds detected, including chloroform, chlorophenol, chlorbenzene, xylene, toluene, and organochlorine pesticides. The first sample taken by Chinese and Russian specialists on the Songhua River near Mulan on 1 December 2005 contained chloroform (Greenpeace and WWF Russia joint press-release, 26 December 2005).

Russia and China ultimately agreed to sample jointly and then discuss results prior to making joint announcements. However, this protocol has yet to be applied to the results of 1 December 2005 sampling. Multiple requests by Russia to compare and discuss results went unanswered. Khabarovsk Provincial government announced in early April 2006 that analyses of 150 samples of water and bottom sediments from the Songhua River near Jiamusi and Tongjiang, China, revealed a wide array of dangerous pollutants including polyaromatic hydrocarbons, polycyclic chlorine-carbons, benzoperene, fenantrene, and others. Some of these were found at concentrations 50 times greater than allowable levels.

On the whole, Russian communication with China on the issue has not been well coordinated among agencies and had several abrupt changes over the four months following the spill. Despite the absence of a binding agreement on transboundary pollution, Russian officials (Viktor Shudegov, head of the committee for environment, education and science of the Russian Federation Council, V. Chaika, State Prosecutor) in November 2005 revealed plans to seek compensation from China in international courts (RIA-Novosti, 25 November 2005). Viktor Ishayev, governor of Khabarovsk region, hinted at compensation claims by saying on 16 December that the region would spend 200 million rubles (about $7 million) to deal with the benzene slick. He was promptly corrected by Kamil Iskhakov, President Putin's special envoy in the Russian Far East, who said that on 16 December that the actual damage should be assessed first before claiming compensation from China. Yet after the spill reached the Russian border, Russian officials temporarily stopped arguing that Russia was entitled to compensation from China (Blagov 2006). The incident revealed that Russian agencies did not have reliable monitoring data to evaluate levels of contaminants before the spill, and thus were powerless to prove that damage had indeed occurred.

On 21 February 2006 China and Russia signed a formal agreement entitled "On approaches to joint monitoring of cross-border rivers". This agreement has been in preparation for 13 years and was ready to be signed when the chemical plant exploded. The water bodies under joint surveillance include the Amur-Heilong, Ussuri-Wusuli, Argun-Erguna and Razdolnaya-Suifen Rivers and Khanka-Xingkai Lake. The agreement is unlikely to cover inland waters of the same river systems in the two countries. In signing the agreement the new SEPA Director Zhou and Yuri Trutnev, Russian minister of natural resources, also tentatively agreed to work out plans for emergencies. By the end of May 2006 a detailed plan for joint monitoring operations on main transboundary water-bodies was finalized in Beijing to be implemented beginning in 2007, but actual first round of joint sampling did not start smoothly in spring 2007 due to harsh weather conditions and poor coordination between agencies.

On 10 March 2006 Kamil Iskhakov, President Putin's special envoy in the Russian Far East, officially voiced his concern about China's proposed measures to prevent future pollution accidents. One week later in a press-conference preceding Putin's visit to Beijing, an aide announced that environmental and pollution issues are properly handed at the agency level. However, during that visit to Beijing, discussions included plans for oil pipelines across the Amur-Heilong basin, projects that would greatly increase potential for future pollution and emergencies.

Several subsequent accidents in the Songhua basin reported by the Chinese media during 2006 evoked very negative reactions from Russian regional authorities and environmental agencies. This was mainly due to great uncertainty and considerable mistrust of official information from China. Khabarovsk Province Administration in August 2006 at a special press-conference raised concerns regarding the validity of the current federal approach to a "strategic partnership" with China that does not ensure ecological security (Governor Ishaev press-conference 31.08.2006).

At the national level Russia and China appear keen to prevent the benzene slick from becoming an issue in bilateral relations. The Chinese authorities came up with damage-control measures, including a formal apology to Russia for the spill. In response, Russian officials silenced talk of compensation and deleted the issue from high-level negotiations (Blagov 2006). To date lessons from the Songhua spill have not radically improved governmental capacities to tackle transboundary issues. It can only be hoped that the lessons learned domestically will enhance the capacity to prevent similar catastrophes and to efficiently manage environmental emergencies when accidents happen.

Environmental conclusion: How will the Songhua spill affect the ecosystem?

The Songhua spill exposes a multitude of environmental and other risks that must be considered in the context of chronic water pollution of the Amur-Heilong River. Briefly, these risks are:

- Political: Solving the pollution problem depends on the ability of Russia and China to use this incident to enhance transboundary environmental safety. If Russia does not exploit the spill to radically improve its cooperation with China on environmental issues, there is a risk that environmental safety could be removed from agendas for international negotiation and cooperation.

- Medical: Health of people and wildlife consuming water and fish might be affected months after the spill. Documented problems include abnormally high levels of pathologies of the liver, circulatory system, and nervous system, plus increased levels of deformities, all of which have chemical origins related to eating contaminated fish from the Amur-Heilong River.

- Social: Communities in affected areas might be further repelled from the river and deprived of opportunities to use its resources sustainably. This would lead to increasing social tension and declining support for long-term protection and sustainable use of ecosystems.

- Economic: Fish resources might continue to decline while costs of drinking water increase as do costs for treatment of domestic and industrial sewage. These outcomes are already apparent in the expenses for emergency response and the ban on fishing and decrease in demand for Amur-Heilong basin fish.

- Ecological: Fish populations might continue to decline due to declining capacity for natural water purification; polluted sediments continue to accumulate and secondary water pollution increases. One of the worst scenarios is pollution of ox-bows and floodplain wetlands by hazardous chemicals. This could lead to high concentrations of pollutants and mass death of aquatic fauna (after Kondratieva 2005, Greenpeace and WWF Russia 2005).

Aftermath in Russia

Russia has long blamed China for pollution yet has never established an effective environmental protection system for itself. The Russian reaction to the 2005 accident showed that many years of "reform" of environmental agencies has yielded no positive outcome. During administrative reforms in 2000-2005 the efficient laboratories of the State Environmental Committee were eliminated as the Committee itself was dismantled. The expensive equipment was dismantled or sent to peripheral organizations. Most importantly, skilled specialists were lost, leaving Russia no option but to ask China to send experts to help to monitor nitrobenzene pollution. Today there is no responsible Russian agency capable of solving complex environmental problems within Russia, let alone dealing with transboundary emergencies.

As a fishery, the Amur-Heilong is of highest importance and should adhere to the strictest possible standards. Two different standards for concentration of water pollutants apply in Russia — one for fisheries and another for domestic supply. The observed concentrations of nitrobenzene were always below the maximum permissible level for domestic water supply. In contrast, nitrobenzene concentrations exceeded the maximum permissible level for fisheries. On the night of 21 December the concentration of nitrobenzene in the water 130 km upstream from Khabarovsk was more than 13 times greater than the maximum permissible concentration for fisheries. Official Russian sources consistently reported concentrations in terms of the less stringent standards for drinking water, thereby avoiding any mention of the fact that pollution far exceeded levels allowable for fisheries.

The Khabarovsk Regional Government did everything it could to safeguard its citizens. Beginning in 1995 it made many proposals to national agencies to set up an international monitoring system on the Amur-Heilong River and solve transboundary pollution problems. Moreover, Khabarovsk Region on its own proposed cooperative monitoring plans to Chinese authorities from 2000-2005, and devoted funds and other resources to work on these issues. However, recent reforms of the government of the Russian Federation transferred authority for environmental issues from regional governments to national authorities. But there currently is no federal body in Russia capable of solving environmental problems, either in emergencies or normal operations. There are no agencies in Russia capable of formulating and implementing international environmental policies, even when they involve close neighbors (Greenpeace & WWF Russia 2005).

National authorities frequented Khabarovsk from late November onward with little coordination or purpose. The Minister for Emergencies, chief of Sanitary Service, vice-chief of the Enforcement Service under MNR, and others visited the region, initiated independent monitoring efforts, called press-conferences and made political statements. Meanwhile the public received contradictory reports, one day rushing to buy bottled water, the next canceling classes at universities. To date, responsibility for coordination has not been assigned to any one national-level agency or task-force.

From China, Khabarovsk received a contribution of several pieces of monitoring equipment, a supply of activated carbon power, and an agreement for dam building to safeguard the water supply to Khabarovsk. The latter was of questionable utility because the actual source of drinking waters in the complex maze of floodplain channels near Khabarovsk has never been thoroughly studied: Some believe the source is the Amur-Heilong, while others claim it is the Ussuri-Wusuli.

An environmental monitoring plan for the Russian side of the Amur-Heilong was completed in March 2006. China had already proposed a draft plan in November 2005 and expected interim results in March 2006. Little or no coordination has been achieved between the two plans. The Khabarovsk provincial government has not convinced national authorities to devote sufficient resources to implement the plan or even to share costs of the emergency measures.

One of the most obvious economic losses stemmed from the fishing ban imposed on the main channel of the Amur-Heilong by provincial governments. Many people along the Lower Amur derive their living from fishing, including the majority of indigenous people. Their incomes declined because of fear and uncertainty about the extent of the pollution. For example, some anadromous fish such as lamprey swim upstream during winter to spawn. These species carried little or no contaminants but market demand declined because of consumer fear.

The measures listed below were proposed by Greenpeace and WWF Russia experts, who monitored the spill on its way from Harbin to Khabarovsk.

• Impacts must be evaluated and restoration measures must be implemented. A plan must be developed and implemented by the federal authority through coordination with other agencies and organizations. In Russian the agency authority is the Ministry of Natural Resources and the mandated participants in the environmental impact evaluation and monitoring are Goskomhydromet (State Commission on Hydrology and Meteorology) and the Russian Academy of Sciences.

• It is necessary to provide agencies and the general public information on the procedure and results of the environmental impact assessment led by SEPA, or to organize a cooperative environmental impact assessment. For this and future cooperation it is necessary to establish a Russia-China Environmental Monitoring and Research Center to study ecological problems of the Amur-Heilong using the extended network of monitoring stations along the main river channel.

• The implementation plan and transboundary cooperative plan must be supported by sufficient federal funding.

• The number of Goskomhydromet hydrochemical monitoring stations on the main channel of the Amur-Heilong River must be increased from three to a number sufficient to monitor transboundary pollution. The list of monitored compounds must include all typical pollutants found in China tributaries of the Amur-Heilong.

• An effective transboundary communication system for problems and emergencies must be specified by Russian-Chinese agreement as soon as possible. The meeting of Ecological Ministers of the member countries of the Shanghai Cooperation Organization (SCO) in 2006 should provide a platform for discussing such an agreement (Greenpeace and WWF Russia 2006).

By August 2006 there had been no decisive progress in Russian national policy toward addressing any of these recommendations. The Songhua spill become a symbol of long-term negligence of key environmental safety issues in the Russian Far East and lack of national government capacity and motivation to solve transboundary pollution problems.

Aftermath in China

Chinese environmental agencies took full advantage of the Songhua spill to advance many interrelated anti-pollution policies. Some of these were prepared long ago but had not received sufficient attention and funding from State Council. Some policies are country-wide and some relate specifically to northeast China, but all owe their genesis to the Songhua spill.

On Friday, 13 January 2006, Premier Wen Jiabao said "water and land resource management and environment protection are the major strategic issues for revitalizing the industrial belts". He also stressed that water quality deterioration, especially on the Songhua and Liao Rivers, must be curbed.

A "comment-soliciting meeting on the 11th Five-Year Plan for the Prevention and Control of Water Pollution in the Songhua River Basin" was held in Harbin from January 6-7, 2006. The Plan presented the following four measures:

• First, prevention and control of water pollution of the Songhua River is integrated into the priority list of the national water pollution control program for river basins;

• Second, public access to clean drinking water is a top priority;

• Third, consider the environmental monitoring system and capacity building for law enforcement as part of the highest political agenda; and

• Fourth, clarify agency responsibilities and implement an accountability system, under which provincial authorities will be accountable for the plans, tasks, objectives and financial resources.

The Plan will increase resources and strengthen environmental emergency response over the coming three years. The Plan will address aspects including organization and institutions, professional team building for environmental emergency response, equipment and facilities, legal development, technologies and standards, advance of science and technology, the establishment of information platforms, and comprehensive command and coordination systems for emergency response.

A total of 16 water quality monitoring stations will be established from the site of the chemical spill to the downstream Fuyuan Section on the Amur-Heilong River. Monitoring of central drinking water sources and groundwater sources for the cities and towns along the river will be strengthened. Monitoring of river substrates, ice, and aquatic fauna will continue. Close attention will be paid to the impacts of water quality on fish in the river, and monitoring of the safety of aquatic products will be strengthened. The China-Russia Joint Monitoring Program on Boundary Rivers will be further developed (speech delivered by Minister Zhou Shengxian of SEPA at the Press Conference on Songhua River Pollution, 24 January 2006).

On 29 March 2006 the plan was approved by China's State Council and funding was allocated at ¥10 billion (around $1.2 billion) over the coming five years. The plan includes more than 200 projects, of which 100 or more will address industrial pollution. One objective is to reduce chemical oxygen demand (COD) by 70,000 tons annually. Seventy projects will work on improving facilities for sewage processing to a capacity of three million tons of sewage per day. The remaining 20 projects will focus on localities that were seriously polluted. Priorities will be treatment and protection of sources of drinking water in large and medium-sized cities to ensure safety of drinking water and water quality of the China-Russia border rivers. Priorities will also be populous cities including Harbin, Changchun, Jilin, Qiqihar, Daqing, Jiamusi, and Mudanjiang.

The plan sets targets for pollution prevention and control by 2010, including:

• Sources of drinking water in large and medium-sized cities should be treated and protected.

• Urban sewage in major cities and main sources of industrial pollution should be treated.

• Major pollution hazards should be controlled and monitored.

• Total discharge of major pollutants should be reduced.

• Water quality of seriously polluted water bodies in large and medium-sized cities should be improved.

• Monitoring of water quality and early detection and emergency response mechanisms should be improved (Xinhuanet, 29-30 March 2006).

SEPA issued a notice in February 2006 ordering that environmental accidents must be reported directly to the Agency or to the State Council within one hour after being discovered. After receiving notification, authorities must immediately investigate incidents. The disclosure system aims to provide the public with the latest and most accurate reporting, in an effort to avoid misinformation and widespread panic. Officials not adhering to these rules will be prosecuted (China Daily 7 Feb 2006).

SEPA has rigidly adhered to these requirements and now issues bi-monthly notices on the number of incidents registered.. The Songhua spill began the count. According to these reports 45 incidents caused significant water pollution by 1 February 2006 and 73 incidents were registered by 29 March 2006 (Xinhuanet, 8 Feb and 29 March 2006). This reporting and response system has already influenced the behavior of industrial managers and local authorities, who now report even minor incidents on a weekly basis. When managers fail to report (as in the 6 April 2006 Harbin chemical plant explosion), they sometimes flee for fear of prosecution (Harbin Shenhuo Ribao, 7 February 2006).

SEPA began to carry out environmental risk assessment on chemical plants near rivers, densely populated areas, and nature reserves in February 2006. Initial inquiries were made at 127 petrochemical plants, with some ¥450 billion ($55.7 billion) in investment. Already 21 plants have been cited for violating environmental regulations and these face punishment and further monitoring for compliance (SEPA, Xinhuanet, 9 February 2006).

Foreign Ministry spokesman Liu Jianchao stressed on 16 February 2006 that China will properly solve cross-border river issues with neighboring countries through dialogue and will continue to adopt responsible policies without infringing upon interests of neighboring countries. The Songhua spill and Irtysh River water use issues were quoted as areas were this approach is employed.

On 17 February 2006 China unveiled a plan to combat environmental degradation in the country for the next 15 years. Pollution control was high on the agenda. The State Council made a decision "On implementing the scientific concept of development and stepping up environmental protection". The goal states that by 2010 the environmental quality of heavily-polluted regions and cities in the country will be improved and the trend of environmental degradation checked. By 2020 environmental and ecological conditions in the country will be improved remarkably. To realize this goal, the Chinese government has outlined seven major tasks for environmental protection. Five tasks focus on pollution control in water, air, and soil. The plan addresses major problems including the worsening of acid rain, the increasing area of polluted soil, the emerging harm of persistent organic pollutants, the potential risks at nuclear facilities, and the decline of biodiversity.

The plan urged establishment of a long-term mechanism for environmental protection, including drafting laws on soil and chemical pollution as well as on compensation for environmental damage. It also demands strict enforcement of environment-related laws and severe punishments for polluters (including governmental officials). The plan calls on governmental departments and localities to formulate economic policies beneficial to environmental protection in the sectors of price, tax collection, credit, trade, land and government purchase.

"The most urgent task for us is to reduce water pollution to ensure the safety of drinking water", said Zhou Shengxian, director of the State Environmental Protection Administration (SEPA). He continued: "The worst environmental pollution in the country is coming, highlighted by frequent occurrence of major pollution incidents, and the issue of pollution has become a 'lit fuse' of social instability" (Xinhuanet).

Financial support for policies and projects is obtained in part from international aid agencies. For example, in the last five years Songhua River water management has become a long-term focus of ADB assistance. ADB supported the Songhua River Flood, Wetland and Biodiversity Management project, and the subsequent Sanjiang Plain Wetland Protection project. ADB also supported the Harbin Water Supply Project with a loan of $100 million and the Jilin Water Supply and Sewerage Development Project with a loan of $100 million. The latter two projects directly address pollution control in the Songhua River basin. Since the preparation of the Harbin Water Supply Project the importance of the Songhua River Basin water pollution issues has become part of a continuing policy dialogue between the ADB and the PRC Government. To overcome the uncertainty about the extent of the Songhua River Basin pollution and its clean-up, the ADB financed the $1 million Songhua River Study. It has been completed and its findings will be incorporated into the 11th Five Year Plan in the context of the Northeast Revitalization Strategy. Key recommendations from the study include:

21. Development of a long term vision for the Songhua River basin. This consists of a strategic plan encompassing the identification of water quality objectives and targets, reforms and strengthening of the existing river basin and pollution control management practices;

• Strengthening and developing the capacity of key organizations responsible for pollution control and management at both the river basin and regional level;

• Identification of knowledge gaps relating particularly to non-point sources of pollution, water quality assessment and water quality inventories; and

• Development of a long-term strategic investment plan for the Songhua River basin, which includes almost ¥29 billion to be invested over the next 15 years. An Immediate Action Plan, or Songhua River Basin Environmental Revitalization Program has been defined suitable for implementation during the 11th Five Year Planning period. The total investment amounts to $2.0 billion, including proposed external lending support of about $1 billion. In 2006 the ADB Board prepared to approve a loan amount from $500 million to $1.5 billion to be disbursed in two to five tranches to support implementation of the plan (ADB web site.)

Despite the tremendous challenges of pollution prevention in the Songhua basin there has been progress. During the few months after the Songhua spill, Chinese authorities managed not only to strengthen environmental policies in the basin, but also managed to exploit the incident to support nation-wide policy reform and increases in pollution-prevention investments. On some level, the Songhua spill symbolizes a starting point for a new greener and cleaner mode of development.

Chapter 21

Transport Infrastructure

Impacts of Transport Infrastructure

Transport infrastructure impacts are difficult to quantify because many different impacts stem from roads, pipelines, railroads, and complex regional development schemes. Almost all human-induced environmental impacts are caused and/or exacerbated by infrastructure projects. National governments and international institutions have been planning the development of international transportation corridors and related industrial facilities throughout the Amur-Heilong basin for the past 15 years. By 2005 some large projects were implemented and these raised new, formidable challenges to environmental security in the region. Simultaneous with these regional developments each of the basin countries accelerated development of domestic transport networks and this has provided access for exploitation of unspoiled areas. The Amur-Heilong basin has suffered from a lack of regional strategic planning for and assessment of transport developments. In this chapter we emphasize the magnitude of the problem and focus on those developments that are or could be driving forces for regional cooperation. Infrastructure related to electric power generation is not covered here because it was covered earlier in the "water use and water infrastructure" section. Readers may revisit the map of Globio assessment to find how human impacts in the region are closely linked to transportation networks (**Map 3.1**)

Roads and related infrastructure

Russia

Commodities in Russia are transported mainly by train or boat. Road transport is limited. The most severe historic impacts on ecosystems of the RFE resulted from the construction of the Trans-Siberian Railway (completed in 1916) and the Baikal-Amur Railway (1970s-1990s, never fully completed). Both were planned to facilitate trade, resource-extraction, and settlement of remote areas of the Amur-Heilong Basin. Both more or less achieved these goals, but their environmental impacts have been difficult to define. The Trans-Siberian Railway shaped development patterns, and thus its environmental costs can be viewed as inevitable. In contrast, the Baikal-Amur Railway exacted tremendous economic, social, and environmental costs during construction but has not as of yet facilitated sustainable development. It is hardly justifiable today, even from an economic perspective. Both railways severely fragmented Amur-Heilong ecosystems and profoundly affected the distribution and migration routes of many species. The railways facilitated many severe impacts including human-induced forest fires, creating a burned belt for 50-100 km along the railroads.

New railways are now planned as access routes to natural resources in remote areas. One example is the Elga Railway that will lead to high quality coal deposits in southeast Yakutia. It might also threaten fragile ecosystems in upper Zeya watershed by improving access for poachers, loggers, and gold-miners.

Even with a shrinking population in the Russian Far East, the network of settlements and roads continues to grow. The number of paved roads is still relatively low — an average of 4.1 km of paved roads per 1,000 square kilometer in the RFE, compared to 23.7 km for all of Russia. Transportation routes and roads can have severe direct and indirect impacts on biodiversity. Roads fragment otherwise intact habitats and cause disturbances. An extensive network of logging roads crosses boreal forests, allowing access of poachers to remote areas. Many of the vehicles in forested areas are equipped with four-wheel drive, making isolated areas even more accessible. Major roads and networks of settlements are considered the main constraints on tiger and leopard migration from Ussuri forests and southern Manchurian forests in Primorsky Province. Investigations in the Sikhote-Alin Zapovednik and its vicinity show that most tigers with radio-collars could not penetrate road barriers or were killed in their vicinity (Goodrich & Miquelle 2005, Miquelle et al. 1999, 2005). The main negative effects of roads in the RFE stem from improved access to resources in previously inaccessible locations. The worst examples of this include the new Cross-Sikhote-Alin road (Lidoga to Vanino) in Khabarovsky Province and plans to open access from Khabarovsk Sukpai River to Primorsky Samarga or Edinka River. In 2001-2005 modernization of the Moscow-Vladivostok highway sparked little environmental debate because it followed the alignment of the Trans-Siberian Railway. However, construction undoubtedly degraded nearby wetlands and streams. In contrast, the smaller Khabarovsk-Nahodka highway is seen as a source of major environmental impact because it crosses natural areas never before violated by roadways.

The network of unpaved roads might be more threatening to nature than the paved roads. Road development in forested areas provoked a serious environmental debate in 2005, when Primorsky Province proposed to build roads in Verkhnebikinsky Wildlife Refuge, thus opening it for logging.

Mongolia. Mongolia's human population density is one of the lowest in the world. The road network in Mongolia is sparse. Roads occupy about 0.2 percent of the Mongolian portion of the basin but still cause considerable environmental impacts. Controversial plans to develop a "Millenium Road" through Numrog Nature Reserve on the border of Dornod Province and Xinganmeng Prefecture of Inner Mongolia evoked criticism from Mongolian and international environmentalists when in August 2003 the Ministry of Nature and Environment (MNE) organized its first ever public hearing on an environmental impact assessment (EIA). An international agreement between Mongolia and China was used by the vice-governor of Dornod Province to justify the project even though the roadway lacked environmental or economic support. To a large extent the project would duplicate a recently renovated border crossing located closer to the town of Sumber but in a neighboring province.

Paradoxically absence of roads in steppe and desert areas also causes grassland degradation and increases erosion of fragile soils. The interprovincial Ondorhaan-Choibalsan road has multiple tracks and could reach up to one kilometer in width in areas with easily degradable soils. Off-road "multi-tracking" caused degradation of 300,000 hectares of steppe in Mongolia, and the first areas to be damaged were the most productive lands near the settlements (ADB CEA Mongolia 2005).

Construction of Ulaanbaatar-Zamyn Uud railway blocked the main route of Mongolian gazelle migrating to the western provinces. The herds located west of the railway stopped reproducing and distribution was severely limited. Population numbers dropped sharply (Lhagvasuren et al. 1985, Lhagvasuren 2000, Tsagaan 1980). With the onset of oil exploration in the vast steppe area of eastern Mongolia and plans for a railway, it is critical to address potential threats to Mongolian Gazelle from disturbance, habitat loss, blockage of migration routes, and fragmentation of habitats.

China. Road densities in China are several times greater than in Russia or Mongolia and related problems are more acute. In districts neighboring Russia the road density varies from 27-200 km/1000 km^2 (Ganzey 2004). Rapid development of cities, industries and agriculture in northeast China in recent years necessitated highway construction and this caused dramatic losses of wetlands. China's decision in 1994 that automobiles would be one of four growth industries dictated that more vehicles would need more roads and this would cause conversion of wildlands and farmlands to pavement (Brown 1995).

The construction of National Highway 301 in Heilongjiang's Zhalong National Nature Reserve fragmented wetlands of the Nen River into four sections, causing serious impacts to material and water exchange regimes and biodiversity. It also resulted in wetland degradation and loss of wetland functions. Most nature reserve managers view road improvements as enhancements to tourism revenue. Managers often pay little or no attention to long-term ecological impacts of roads on the protected area itself.

Transboundary issues

Large-scale industrial and agricultural development in Amur-Heilong River basin started with the agreement between Qing Dynasty China and the Russian Empire on construction of the East-China Railroad in 1896. The railway crossed the entire basin from west to east. This is arguably the basin's most significant infrastructure project in terms of cumulative impacts on the environment. Many patterns of development and directions of environmental impact were determined by this railway that opened resources of the basin for large scale international trade and accelerated exploitation. All further large development projects were influenced by this railway.

The Inner Mongolia Highway and Trade Corridor Project (IMH) is designed to promote cross-border trade between China, Russia, and Mongolia by improving transport infrastructure along the East-China Railway. The World Bank has supported expansion of highway capacity by upgrading or constructing about 177 km as part of the IMH. Component Two, Border Roads for Trade, upgraded and rehabilitated about 413 km of the highway network mainly at small border crossings with Russia and Mongolia that are key international trade sites. Other sites were simply missing links in the highway network. The project was designed to facilitate China's trade with Russia and Mongolia, but also for trans-shipment through Chinese seaports to other countries. Although the full extent of environmental impacts is unknown, it is certain the expressway dissected main core zone of Erka Nature Reserve near Zhalainuo'er town. This is an important floodplain wetland connecting Dalai Lake and Argun River Floodplain, and a known stop-over foraging site for Siberian crane and other endangered birds. The EIA was carried out using World Bank procedures, but does not recognize this important impact and lacks suggestions for impact avoidance and mitigation (see http://www-wds.worldbank.org/servlet/WDS. Project: Inner Mongolia Transport. Appraisal Date: September 26, 2004). Mongolian transport links to China are also developed with participation of international development agencies, and also have potential to degrade fragile steppe and semi-desert ecosystems.

The China-Russia-Korea border area is another biodiversity hotspot affected by railway, power-line, sea-ports, and highway development projects. An international project was designed to create a new system of transport routes in the Tumen River region (or "Tumangan", "Tumannaya"). The project site was named the Tumangan River Economic Development Area or TREDA and would have been developed by five regional countries. The design called for a new port at the mouth of the Tumen River, and free economic zones in northeastern North Korea, the Yanbian Prefecture of China, and Khasansky District in southwestern Primorsky Province. To date international banks have not supported the proposal. However, North Korea implemented part of the project independently, creating a free economic zone and modernizing its port. China invested billions of dollars in the development of the Yanbian Prefecture, building a modern highway from Beijing to the border with Russia. Only in Russia did the project fail to materialize. A diagnostic environmental analysis of the project was carried out with funding from GEF-UNDP (Baklanov *et al*. 2002) but additional assessment would be needed to make decisions on future economic development of the Tumen River Basin.

Bridges are often proposed to connect China with Russia across the Amur-Heilong River. At least four bridges are in design, with the Blagoveshensk-Heihe Bridge likely to be the first built and to have the most profound impact on trade in the region. An EIA of the bridge and associated highways identified serious threats to nesting habitats of red-crowned crane and other rare birds on the adjacent Amur-Heilong floodplain. Another Pokrovka-Loguhe Bridge is planned near the confluence of the Argun and Shilka Rivers at the source of the Amur-Heilong River proper. This route would facilitate roundwood exports to China. According to field research, this project also threatens nearby floodplain habitats of many rare and endangered plants (O. Korsun, 2005, report to WWF RFE on field research in Pokrovka).

Tarabarov (Heixiazi) Islands near Khabarovsk were recently divided between Russia and China, and will inevitably become the site of a major transboundary infrastructure development soon after demarcation of the new border in 2007. Plans have been semi-officially announced in China where the project would boost development of Fuyuan County at the remote north-eastern tip of the Sanjiang Plain. The natural resource issue at stake is that most of the lands in China territory are natural wetland habitats for many endangered species and critical stop-over sites on the waterfowl migration route along the Amur-Heilong and Ussuri Rivers. Although proposals were put forward to create an international nature reserve or peace park (ESD-USAID 1996), this has not been an issue in recent negotiations (see Essay 2, Part Four on international cooperation in basin management).

Oil case-study: Major oil pipeline projects in Amur-Heilong River basin

Perhaps the most vivid example of the potential impacts of infrastructure projects on the environment and socio-economics in the Amur-Heilong Basin is oil and gas pipeline development. Oil and gas infrastructure has become an arena for intensive public debate. This subchapter explores the development history of several high-profile projects.

The Daqing oil field on the Song-Nen Plain in western Heilongjiang Province is the largest exploitable oil-field in China. Although awareness of impacts of oil production on ecosystems is high in northeast China, few quantitative data are available. Production is in decline in the old fields of Daqing and new areas are explored in Jilin, Inner Mongolia, and Eastern Mongolia. Some exploration sites are in wetlands and nature reserves where development and operation of oil fields would cause disturbance to wildlife and water pollution (ICF-GEF Siberian Crane Wetland Project; www.scwp.info). The petrochemical industry development in northeast China is supported by "The Plan for Revitalization of Northeast China Old Industrial Bases". The objective is to obtain added-value through processing as oil production volume declines. Another option is to import oil from Russia. Russian policy to diversify its oil exports and Daqing's need for oil match perfectly, making the Song-Nen Plain the most likely destination for Russian oil exports.

To date oil has been delivered by rail. A recent threat to the environment of the basin is construction of oil pipelines. The scale of proposed projects matches that of the longest pipelines in the world. One route was proposed from Angarsk (Russia) to Daqing (China) and a second route was proposed from Angarsk to Nakhodka (both in Russia). Construction and operation of the pipelines would impact forests, freshwater resources, fish, and wildlife of Eastern Siberia and the southern part of the Russian Far East, affecting two globally important watersheds: Lake Baikal and the Amur-Heilong basin.

The experience of Russian pipeline operations in Siberia presents a cautionary tale for the new Russian Far East pipeline proposals. Spill-prevention technology dating from the 1940s and 1950s has been poorly maintained, wells and valves have failed, and many lines lack remotely operated controls. The result has been system failures and spills on a scale dwarfing the worst experiences of tanker or pipeline spills in the United States. The technical and management standards for Russian pipeline operations vary enormously. Some decaying facilities dating from early Soviet pipelines and drilling operations are accidents waiting to happen. Other projects built in recent years, with international expertise and sufficient investment capital, are at world-class technical standards but lack public and regulatory oversight measures typical of North American and European operations. The spill prevention measures for the two pipeline proposals discussed here are vastly improved over traditional Russian standards. However, they do not always achieve the standards of the 30-year old Trans-Alaskan Pipeline System design, nor do they achieve current international standards for Best Available Technology.

This case-study illustrates current issues in environmental safety, public participation, EIA, and handling of environmental issues in major strategic development projects pursued by the government of the Russian Federation. **See Map 2.4** on all major planned and existing oil & gas pipeline routes in Amur river Basin referred in text.

Original Russia-China Pipeline Proposal

The first proposal called for a pipeline from Angarsk, on the southwest tip of Lake Baikal in Irkutskaya Region, connecting with the Chinese pipeline system at Daqing in Heilongjiang Province (**Map 2.4**). This route to Daqing is 2,213 km long and mostly in Russia (1,452 km) crossing Irkutskaya Region and Buryatia (including the unique Lake Baikal watershed) and Chitinskaya Region (Amur River watershed). Part of the route would be in China (795 km) crossing Inner Mongolia and Heilongjiang Provinces (Amur-Heilong River watershed). At capacity the pipeline would transport over 20 million metric tons (146 million barrels) of oil per year to China. Project cost was estimated at US$2.5 billion.

The project was conceived by the Russian oil company *Yukos* at a time when it enjoyed the political support of the Russian federal government. The environmental impact assessment for the project has not yet been endorsed by government because of multiple violations of environmental standards and Mistakes in the first environmental impact statement that heightened public attention to the issue. At present the project is being redrawn to comply with Russian environmental standards. However, local communities and NGOs were concerned that the amount of political and economic interest in the proposal could lead to implementation regardless of violations of environmental legislation. Violations included routing of the pipeline through environmentally sensitive areas, lack of precautionary measures against catastrophic leaks and spills, and insufficient mitigation measures for environmental impacts.

The Yukos environmental impact statement (EIS-Rus. OVOS) acknowledged that "the environmental challenges of the planned alignment, which "goes through difficult and rugged geographic and climatic areas where there are high mountains, permafrost, swamps, landslides, cliffs and a large number of rivers…Going around Lake Baikal, a large number of nature reserves, protected territories and the Tunkinskii National Park will be difficult" (Yukos 2003). The region is subject to landslides, mudslides, earthquakes, and a host of other obstacles, and provides habitat for numerous endangered species (snow leopard, tiger, eagles, caribou, storks, geese, and a host of fish, plants, and other species).

Steiner (2003) reviewed the Russia-China Pipeline EIA and found that spill prevention and leak detection measures were inadequate or poorly defined. The proposed leak detection system recommended only deviation alarms for pressure and flow rates, and line volume balance (LVB) detection. The leak-loss sensitivity on these systems is only 1 percent under operational conditions, which means that a leak of less than 30 tons/hour (225 barrels) could not be detected. The implementation of transient volume balance (TVB) leak detection can improve this figure to 0.4 percent, or 105 barrels/hour. The Yukos EIA also presents insufficient information on other leak detection and security measures, including aerial and ground surveys. Critical operating procedures for shutting down and restarting the Russia-China Pipeline were not disclosed. Given the importance of opening/closing sequences, pressure surges, and operator training, these omissions are troubling. Overpressure events triggered during restart and shutdown sequences can cause pipeline movement, damage and even ruptures.

The sharpest criticism of the EIA concerned spill response measures. The document includes no contingency plans for a spill, and the maximum estimated volume of a spill is far too low (4,800 m^3 or some 33,750 barrels). There were no detailed discussions of on-site equipment, personnel, response times, training, and command and control mechanisms to respond to a spill. Before oil can begin flowing, all these mechanisms must be established and protocols must be in place to respond to an accident or rupture (Steiner 2003).

The Russian oil industry has a distinctively bad environmental record in extracting and transporting oil in permafrost regions. The worst pollution from spills, leakages, and erosion occurs in northeastern European Russia and in northwestern Siberia, in the Tyumen Region. In Tyumen, a single 1993 spill at a pumping station released at least 420,000 tons of oil near the Sosvinsky Nature Reserve (Russian Ecological Politics Center 1996). Another, more widely-known oil spill at a Komineft operation at Usa in 1994 spilled a vast amount of oil into the Pechora and Kolva Rivers, endangering Atlantic salmon habitat. The estimated amount of this spill was between 100,000 and 200,000 tons (Greenpeace 2001). For reference, the grounding of the *Exxon Valdez* spilled approximately 37,000 tons into Prince William Sound, Alaska.

Another very important issue is river crossings, which usually require trenching for Russian pipelines. Little information is available from the EIAs of the Russia-China or the Siberia-Pacific pipeline about the standards for trenching in these projects. Given the risks of ice-scour and stream meanders in most Siberian and Russian Far East river systems, it is important to know that any pipelines are deeply buried and securely anchored.

Russian standards for public involvement in environmental impact assessments are weak. Russian law mandates citizen involvement only in the review of an EIA. The basis for citizen involvement in environmental impact assessments is Russian Federation Executive Order #372 of May 18, 2000, which states that a public hearing process will be designed with the assistance of the local government. Executive Order #372 describes public consultation as: *"A complex of measures aimed at supplying the public with information about the planned economic and other activities and about their probable impact on the environment, with the purpose of learning the preferences of the public and to take them into account in the overall EIA process."*. Public organizations (NGOs) are also entitled under the EIA Law (1995, amended 2004) to carry out "public EIAs" and publish results in the "official state EIA" process.

The degree to which these requirements are met varies among projects. The Yukos-led Russia-China Pipeline project has a poor record of public participation. Local NGOs along the pipeline route complain that public hearings have been infrequent, difficult to attend, and poorly advertised. The 4,700-page environmental impact assessment "appears more meant to overwhelm and obfuscate" than to enable educated public comment and critique. Important elements such as independent ecological monitoring of the pipeline construction and training of civilians in spill response are not reflected in the planning documents. Yukos did not publicly considered the role of independent monitoring and oversight of pipeline construction and operation.

By 2005 Yukos was almost fully dismantled as an independent company, its owner jailed, its obligations to export oil by rail to China questioned. However, the president of the Russian Federation in 2005 reiterated his support for construction of a pipeline delivering oil to China (Xinhua: V. Putin press conference 05 September 2005) as an offshoot of the Siberia-Pacific pipeline project described in the following section.

Siberia-Pacific Oil Pipeline (SPOP) Proposal

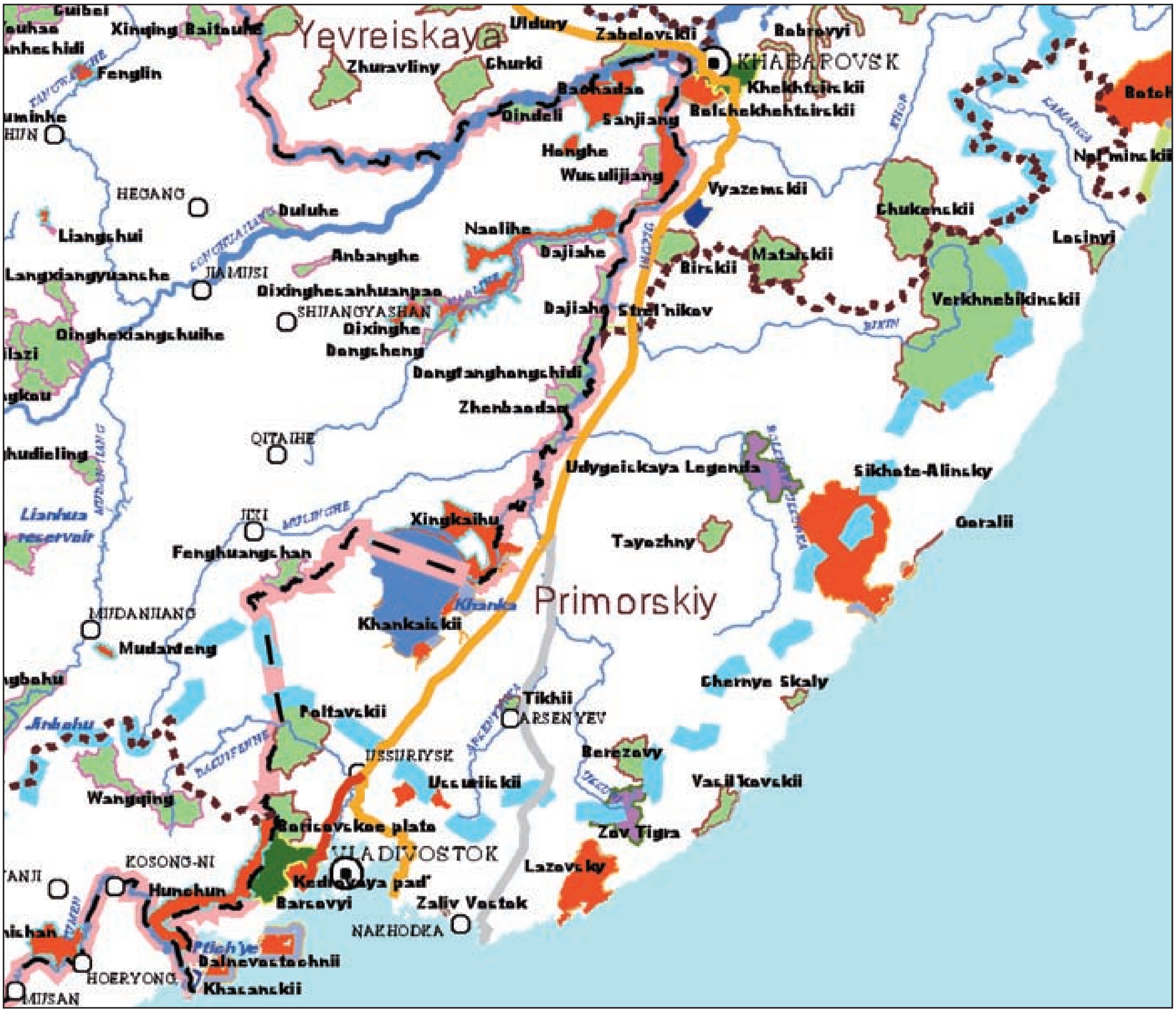
A second proposal called for construction of a pipeline from Angarsk to southern Primorsky Krai. This project is proposed by the Russian oil giant *Transneft*, the world's largest oil distributor. The route of this pipeline lies completely within the Russian Federation and most of it is within the Amur-Heilong River Basin. The route was conceived to open Japan and South Korea to Russian oil exports, feeding a large and wealthy market, and could serve China as well. The pipeline also makes it possible to make tanker exports to the United States or elsewhere across the Pacific.

From an environmental perspective, this project has enormous challenges. Already, Transneft has proposed altering the boundaries of the Baikal World Heritage Site to allow the construction of its pipeline first from Angarsk, and then from Tashet, threatening Baikal from both south and north respectively. The route would cross large mountain ranges and seismically active regions. The pipeline would carry hot oil from deep within the Earth across vast stretches of permafrost which are susceptible to melting or erosion. Rare and endangered species and vulnerable forests and tundra might be at risk. The pipeline would threaten Siberian rivers that support populations of taimen, lenok, grayling, and pike; Amur-Heilong basin rivers with their populations of salmonids and pike; and the enormous offshore fisheries in the Sea of Japan, where the line will terminate. In the Amur-Heilong basin alone the proposed route crosses the Amur-Heilong and all major tributaries of the Amur-Heilong and Ussuri Rivers. As it crosses Khabarovsky Krai, the pipeline turns south, traversing almost the entire 1,000 km length of the Sikhote-Alin mountain range that lies between the Sea of Japan and the Amur-Heilong and Ussuri Rivers (**Map 3.7**). This final leg, from Khabarovsk to Nakhodka, is the greatest threat to salmon populations. East of the Sikhote-Alin range, the rivers of Primorsky Province drain to the Sea of Japan. These watersheds contain habitat and spawning grounds for the endangered cherry (masu) salmon (*Onchorynchus masou*), pink salmon (*O. gorbuscha*), chum salmon (*O. keta*), and related salmonids including lenok, grayling and taimen. These fisheries hold immense economic, cultural, and ecological value not only to the Russian Far East, but to the larger Pacific Rim and its ecosystems.

The Sikhote-Alin region, containing these river systems, is the historic homeland of indigenous peoples including the Udeghe and Tazy. While their populations are relatively small, the presence of indigenous communities is another matter complicating future decisions on rights-of-way and future revenue-sharing.

The Siberia-Pacific pipeline would cross more permafrost areas than any other ongoing Russian Far East pipeline project. The proposed route would run north of Lake Baikal, through cold permafrost regions. It is possible that this proposal would actually be more feasible from an engineering perspective, because the permafrost is several degrees colder and less at risk of thawing. However, the pipeline would also require elaborate permafrost protections. The size of the project and the difficulty of the terrain, in conjunction with Transneft's history of pipeline operations in permafrost conditions, could pose serious threats to the regional environment. Transneft submitted two routes for the Siberia-Pacific Oil Pipeline passing north of Lake Baikal for evaluation in the government's Environmental Impact Review (EIR). One of these routes, passing the shores of the lake at a distance of 12 km, was rejected by the government in 2003 due to the threat it posed to Lake Baikal. Authorities selected a second route some 80 km from the lake shore and outside the lake catchment.

In April 2002 Primorsky governor Darkin and Transneft signed an agreement to build the pipeline



Map 3.7 Transneft pipeline and nature reserves in Primorsky and Khabarovsky Provinces (enlargement from Map 2.4 showing detail on nature reserves)

terminal at Perevoznaya on Amur Bay opposite Vladivostok. This agreement was signed before the official Environmental Impact Review (EIR) of the project was completed. From that moment conservationists strongly opposed a terminal located on Perevoznaya-Amur Bay because the risk of accidents resulting in oil spills is 17 times higher and a spill in Amur Bay would do much more damage than at other sites. The pipeline would threaten the Far Eastern State Marine *Zapovednik*, a 63,000 ha protected area off the coast of Primorsky Province, which is known for its extensive marine shelf ecosystems and breeding bird colonies.

Fifteen percent of Russia's endangered species can be found exclusively in the area of the proposed terminal site in Southwest Primorsky Krai. One of the endangered animals found only here is the Amur leopard. With a global population of about 35, the Amur leopard is probably the world's rarest big cat (**Map 1.30**). The pipeline would run directly through a wildlife refuge and the proposed terminal site is adjacent to Kedrovaya Pad, a UNESCO Biosphere Reserve and important leopard habitat (**Map 3.7**).

In March 2005 Greenpeace Russia, WWF Russia, Phoenix Fund, IFAW Russia, and WCS urged the

Russian Government not to build the terminal on Amur Bay.

In mid 2005 local authorities and NGOs exposed illegal clear cutting by Transneft contractors along a route passing less than one kilometer from Lake Baikal. This route parallels existing railways and would be much cheaper to build and operate than the routes more distant from Lake Baikal. Rosprirodnadzor then filed lawsuits against the subcontractors that work on the pipeline at Lake Baikal. Meanwhile, Transneft also stated that natural conditions make it impossible to build the pipeline along the northernmost route and that it is impossible to bring construction workers to the sites, let alone heavy equipment.

On 1 July 2005, a court in Khabarovsk, Russia, ruled the official Environmental Impact Review (EIR) of the project invalid as a result of serious irregularities and violations of Russian law. Irregularities included: withholding of essential project information, failure to investigate alternative terminal sites, providing of incorrect information to the public, use of inaccurate information in the project assessment (including inaccurate data on the suitability of the proposed terminal site), and obstruction of independent NGO participation in the EIR process.

President Putin subsequently criticized Russian environmentalists for obstructing Russia's economic development. He accused NGOs of accepting finance from "competitors," citing the Siberia-Pacific Pipeline Project as his main example. He was apparently not informed that NGOs argued for a more environmentally sound route but not for cancellation of the project.

In total, 17 public hearings were organized in August 2005 along the pipeline route. At a conference in Vladivostok on 18 September 2005 three Russian ministers spoke out against the plan to build the terminal at Perevoznaya. However, Transneft declared its intent to build at Perevoznaya, claiming the statements by the ministers did not reflect an official government decision.

In February 2006 an expert commission for the Siberia-Pacific Oil Pipeline (SPOP) EIA led by Rostechnadzor, a new agency handling the issue (see socio-economic section for history on reform in Russian government) firmly refused to approve the Perevoznaya section. But the commission was forced to accept the pipeline section near Lake Baikal This indicated continuing very high pressure on the commission from upper levels of government. Moreover, the newly adopted Water Code, containing a definition of the Lake Baikal protected catchment area was returned to the State Duma to exclude this clause, thus making way for the SPOP.

This series of incidents provoked waves of domestic and international protest and criticism. Even the Russian president was pressured to intervene in late April 2006 "advising" Transneft to relocate pipeline route "as far as feasible from the lake".

The solution as it abruptly surfaced in early summer 2006 was to completely realign the Siberian route, to pass though fewer seismic zones of Sakha-Yakutia near the oil fields exploited by Rosneft company. Kozmino Bay near Nakhodka was agreed as a terminal at the Pacific Coast.

Since its inception many aspects of the pipeline design and route have changed, thus shifting the urgency and magnitude of different potential impacts. The project now is under unified management of Transneft, and is split into three sections. Only one of them, from Taishet to Skovorodino, has a construction schedule which is likely to be changed (to be completed in 2008) and, presumably, funding has been allocated. In May 2007 EIA for Yakutia section of the pipeline was successfully challenged in courts by local NGOs on the basis of lack of public participation and insufficient data on environmental safety measures.

The section from Skovorodino to the Pacific (to be completed in 2010) will require additional funding from private sources and/or Pacific Rim countries. Japan, a likely beneficiary of the project, has hesitated to offer funding. This section might be cancelled due to lack of funds, uncertainty on oil supplies and changes in international policy. Some components of this section, such as the crossing of the Amur-Heilong River near Khabarovsk, would pose severe environmental risks.

The Skovorodino-Daqing pipeline is likely to be completed much earlier than its original deadline of 2020. China is able and willing to participate in financing this project. Russia is willing to attract Pacific Rim investors but has been slow in finalizing the deal with China. At year-end 2006, China, tired of Russian policy shifts, insisted that a branch pipeline from Skovorodino should cross the Amur-Heilong main channel and reach Chinese territory at the nearest location. This would be Dzhalinda village, where a joint dam was proposed under the "Joint Scheme for Amur and Argun" (see section on water infrastructure). The Amur-Heilong river crossing and the continuing route through the rugged, undeveloped terrain of the Great Hinggan Mountains pose considerable environmental risks that are yet to be assessed. Potential environmental impacts multiply when considering oil processing facilities planned by China and Russia along the pipeline route (see section on water pollution).

Despite numerous agreed amendments, all three stages still pose enormous threats to the environment. The Russian Federal Ministry of Natural Resources, Rostechnadzor, and other agencies face formidable challenges to encourage oil producers to accept safer routes and invest in the best available technologies to provide maximum environmental safety of pipeline construction and operation. At the same time, most risks could be reduced by careful spatial planning, e.g. avoiding multiple crossings of major watercourses, seismic zones, and major wetlands. Despite a record history of public debate and litigation, on-going project operations still do not comply with minimal standards of transparency, public participation and community outreach.

Chapter 22

Conversion of Wildlands to Farmlands

Generic impacts

The key ecological concern in the catchment is loss of biodiversity due to habitat loss and degradation due to sustained, extensive land use change from natural wetland and river valley forests to farmland. Agricultural development has been responsible for most habitat losses in the Amur-Heilong basin, particularly in the wetlands. The relatively small percentage of land occupied by farmland in the basin is somewhat misleading. The conversion of wetland to farmland happened first in the floodplain habitats along the rivers, thus claiming the most biologically productive areas with greatest species richness and importance. The influence of agriculture and animal husbandry in shaping landscapes is especially impressive when viewed in the long-term historical perspective. One thousand years ago, enormous pastures fed 100,000 horses of Zhurzhen (Nuzhen) before this ancient state was overpowered by successors of Chinggis Khan (Genghis Khan).

Our ability to trace human-induced changes in Amur-Heilong ecosystems is limited to the period of starting from the 18th Century. In summary, modern agricultural development in the Amur-Heilong basin had several environmental consequences:

- destruction of natural ecosystems and land conversion into monocultures;
- alteration of hydrologic regimes of wetlands and water bodies, and withdrawal of water from surrounding natural habitats;
- fragmentation of natural habitat and disruption of migration routes;
- water pollution, soil erosion and change in sedimentation patterns
- sustained and frequent wildfires that damage wildlife, alter water regimes, and prevent the reestablishment of forests

The China portion of the Amur-Heilong basin has endured much more agricultural development than in Russia or Mongolia, particularly in the Songhua River basin. However in most developed agricultural areas in Russia, such as the Zeya-Bureya Plains and Khanka Lowlands, environmental consequences are already very similar to those in China, despite the much lower population density.

Russia

In the Upper-Zeya, Zeya-Bureya, Middle-Amur plains, and Khanka Lake lowlands of Russia, 2.4 million ha of wetlands have been converted into arable land, hay fields, and pastures. The degradation of wetlands and human disturbance has caused declines in waterbird nest productivity on the remaining small patches of wetlands around lakes and bogs. Additionally, at least three million ha of forest, mostly on the plains and along rivers, have been converted to farms.

Amurskaya Province includes one of the largest lowlands of the Amur-Heilong basin. The Zeya-Bureya Plains are more than three million ha in area and include more than half of the most productive agricultural lands of the Russian Far East. From a biodiversity perspective, this is the most diverse reach of the middle-Amur and has the greatest variety of species in the Northeast Asian-Australasian flyway, including vast numbers of migratory birds (cranes, storks, geese, and ducks). The southeastern part of this area includes the Arkhara lowland (300,000 ha), which retains most of its original landscape character and is one of the best-preserved wetland complexes in the RFE. In the 19th and 20th Centuries most of the Zeya-Bureya Plains saw 90 percent of the forests cut, half of the wetlands drained, ever more damaging annual grass-fires, soil erosion, alteration of hydrology, and desertification. During the late Soviet era farmers used destructive heavy tractors, requiring vast rectangular fields, often one square kilometer each. Increasing soil erosion and loss of soil organic matter were hidden for a while behind ever-growing state subsidies. Eventually the farmlands needed more pesticides, herbicides, and fertilizers to produce crops. The Lake Khanka-Xingkai wetlands were converted to wet farmlands for rice production. Here, agricultural chemicals directly entered the aquatic ecosystems.

The collapse of subsidized agriculture in Russia partly relieved the development pressure on wildlands, but the complete recovery of natural ecosystems from abandoned farmlands is unlikely. Many of the abandoned farmlands are lowlands and would naturally revert to forested wetlands if protected. More than half of the agricultural lands are still used for some mechanized crop or hay production. These are vast fields with minimal yield per unit area. Natural revegetation of fallow fields is precluded by recurring grass-fires set by villagers.

Abandonment of farmlands is seen as an open door for the land-hungry farmers in China. Chinese farmers have traditionally employed labor intensive modes of production. This style of farming can readily be supported by small but growing Chinese investments in the agriculture sector. However, there are ethnic and social conflicts with economically less active and nationalistic Russian villagers. This further complicates the environmental problems of the abandoned, eroding and frequently burning farmlands.

In regions such as Evreiskaya Autonomous Province the influx of Chinese farm workers is substantial. By 2006 Chinese immigrants cultivated 50-70 percent of previously abandoned farmlands along the border. The main crop is soya-bean. Fearing environmental consequences Russian authorities banned the use of imported pesticides and fertilizers. But there is no system in place to monitor the need for or effectiveness of such restrictions. Local populations of protected species such as soft-shelled turtle are subjected to intensified pressure due to demand from Chinese who consider it a delicacy. Newly reclaimed areas and seasonal workers are supervised by only a few environmental enforcement officers, typically 1-2 officers per large rural district. These are incapable of controlling even the most obvious violations, and there are no programs to raise the environmental and legal awareness of immigrants (Simonov 2004-2005, field research). Given the rapid influx of immigrants and near absence of regulatory controls it is probable that environmental degradation on Russia's abandoned farmlands will parallel that south of the border in China. This scenario could, however, be avoided by implementation of systematic measures to regulate and educate the new farmers.

China

Agricultural land cover in Russia is less than 5 percent as compared to 15-25 percent in China (excluding natural pastures). Conversion of forests and wetlands to arable land is officially banned in basin provinces and is therefore no longer considered a major concern in China. However, it still occurs in many areas. Since 1958, the forest cover in Heilongjiang Province declined from 200,000 to 160,000 km^2.

The vegetation cover is still reasonably dense in the mountains but is sparse on the gentlest slopes of the hilly zone where farming and grazing are common. These areas are the most exposed to erosion. Industrial forestry operations have declined in recent years because timber harvest has been limited in natural forests. This put many forest workers out of work with the result that they must turn to alternate means of earning income. Many grow crops in small fields around and inside the forest. Meadows and wetlands without trees along forest road network are widely used for these purposes, sometimes even within nature reserves. Animal husbandry is also encouraged by forest management authorities. The same peasants collect edible plants, cultivate medicinal plants and mushrooms, and undoubtedly use some animals for subsistence. As a result many forest areas are penetrated by networks of multi-purpose plantations, which occupy smaller land areas, but have disproportionate impacts on the surrounding forest ecosystem. A recent study of land-use change indicates that most lands converted into crop production in the 1990s are found in mountain areas (Liu et al. 2005).

On the plains, formerly productive and biodiverse wetlands, grasslands, and forests have been replaced over most of the catchment by expanses of single-species cropland that are occasionally interrupted by rows of single-species shelterbelt trees. In the agricultural landscape there is little wildlife habitat and almost no wildlife.

The wetlands in the Song-Nen and Sanjiang Plains are endowed with highly fertile soils and other abundant natural resources such as extensive tracts of forest, grassland, and reed beds. They are naturally suited to agriculture, animal husbandry, forestry, and fisheries. In their pristine state, the Song-Nen and Sanjiang plains were mostly wetlands. They had an essential role in absorbing floods and sustaining low flows. Development in general and farming in particular reduced these wetlands considerably and, through fragmentation, reduced their capacity to absorb floods and to sustain low flows.

A significant difference between the Song-Nen and Sanjiang Plains is the predominance of mineral-rich soils in the Song-Nen. Historic removal of forest cover, followed by drainage and reclamation of lands for agriculture resulted in the movement of mineral salts to the surface. Thus, many of the Song-Nen wetlands are affected by high salinity and alkalinity.

According to China's MWR report on the Song-Nen plain "In the early years after foundation of the State, large wetlands covered areas at Da'an, Zhaozhou, Daqing and Tailai. They extend around 50-60 km from east to west and 170-180 km from north to south". About 20,000 km^{2}of ponds and marshes also covered the basins of the Wuyu'er River, the Nemo'er River, the lower reaches of the Yalu River, the Huolin River and the Tao'er River. At present, the remaining wetlands cover an area of 6,500 km^2, a decline of about 70 percent. In Qiqihar Prefecture alone the grassland area declined from 20,000 km^2 in 1963 to 14,000 km^2 in 1982.

Now the wetlands in Song-Nen Plain face chronic water shortage, because they are often disconnected from the mainstream by flood-control embankments that prevent recharge during floods. To preserve such sites as wetlands, water must be diverted to them from the rivers through man-made canals. Under such conditions wetlands not only cannot store water to sustain stream flows during the dry season, but actually must withdraw low flows from the mainstream during droughts. In the drought year of 1999, 70 million m^3 of water were diverted from Tao'er River to Xianghai Reservoir to raise the low water level. Lianhuan Lake becomes dry in some prolonged drought years and wild fires significantly affect many species of birds. Channels have been built to divert water during low flows from the Nen River to Dongsheng Reservoir and to Lianhuan Lake. Thus the remaining wetlands in the Songhua basin are somewhat artificial since their maintenance now relies on the construction of reservoirs and canal water diversion from the main streams. Due to lack of water, many wetlands or former wetlands in the Song-Nen Plain have become saline. Furthermore, the water diverted to the wetlands is often the drainage water from crop irrigation. It may therefore be heavily laden with salts and agriculture chemicals. In Zhalong National Nature Reserve in autumn 2004 many kilometers of wide channels were dug in the core zone to provide water for fish ponds in dry years. The drought was exacerbated by refusal of local authorities to provide water from upstream because it was needed by farmers. The wetland was so dry, that reed bed fires started earlier than ever and covered half of the most valuable crane habitat.

The Sanjiang is a vast plain (63,600 km^2 of non-mountain area), originally nearly all wetlands and floodplain forest. Soils are mainly waterlogged black clays. Before the 1950s, the floodwaters of three big rivers (Heilongjiang, Songhua, and Wusuli) readily entered the wetlands, were absorbed, and sustained wetland ecosystem processes. In 1949 the wetland area in Sanjiang Plain was 5.345 million hectares, or about 50 percent of the entire territory of the plain and only three percent of the plain was farmland. Since then, the area of wetlands has declined due to conversion to cropland and drainage projects. Cropland area has increased steadily as shown in **Table 3.19**.

After 1949, the Sanjiang Plain wetland area decreased from 5.34 million ha to 1.48 million ha, and the cultivated area increased from 0.786 million ha to 4.57 million ha (Liu et al. 2004).

Wetlands have frequently been drained for cultivation or converted to fish or shrimp ponds. More than 40 percent of the farmland is low and easily flooded; nearly

Table 3.19 Wetland and Cropland Areas in the Sanjiang Plain ('000 hectares)

	1949	1975	1985	1990	1995	2000
Wetlands	5,350	3,240	2,720	2,110	1,980	1,480
Croplands	780	2,050	3,490	3,600	3,740	4,570

Source: HEPB and Heilongjiang Research Institute of Environmental Protection. Environmental Impact Assessment of Integrated Agricultural Development and Environmental Protection Planning of Sanjiang plain. Harbin. 1996. 2000 figures from Liu et al. 2004.

80 percent is poorly drained. Drainage channels have caused dehydration of wetlands, changed hydrologic conditions, and some wetlands have disappeared. For example channels and ditches were constructed adjacent to Honghe National Nature Reserve for agricultural drainage and irrigation supply. The channels encircle the reserve and change the course of the only surface water source for Honghe, the Nong River. The only remaining source of water is rainfall, which is not adequate to keep these internationally recognized wetlands wet.

After over 40 years of agricultural development, the Sanjiang plain still accounted for 43 percent of the total area of the unconverted floodplain wetlands in the lowlands of Heilongjiang Province (the uplands still hold around half of Heilongjiang's wetlands and their area is typically underestimated by surveys). Political agendas such as the 2003-4 grain security policy pose serious threats to the remaining natural wetlands.

Conversion of wetlands to agriculture was officially banned in 1999 in Heilongjiang and Jilin Provinces, and in Inner Mongolia. Although small-scale wetland drainage and reclamation still occur, it is believed that large-scale wetland conversion to agriculture is no longer a threat. This is due in part to the "32-Character Policy" of former Premier Zhu Rongji, which includes provision for returning farmlands to wetlands. Further small-scale losses of wetlands in the Sanjiang Plain due to reclamation for agriculture could well result from opportunistic conversion of pristine wetlands. This type of loss occurs at the boundaries between wetlands and farmlands, and is difficult to detect because it proceeds slowly at any given location (see for comparison results of remote-sensing analysis of land-use change in Chapter 24). It is, however, a significant threat, particularly in dry years such as 2000 when normally flooded lands were dry. Another widespread phenomenon is declining groundwater levels due to intensive pumping for agriculture, which is believed to contribute to dehydration of the remaining wetlands on the plain.

Because of sharp rises in grain prices in 2004-5 and renewed tax-exemptions and subsidies to grain producers, conversion of wetlands and other non-agricultural lands into croplands has recently become much more profitable than during the preceding five years. In 2002-2003 the attention of nature conservation authorities of Heilongjiang Province was focused on identifying farmlands that had been previously converted from wildlands and could be restored to wetlands and forests. From 2004 in many areas like Sanjiang National Nature Reserve the main concern was preventing further illegal conversion to cropland in small patches on margins of nature reserves. Increased incentives for crop and livestock production will also exacerbate water deficits in natural wetlands. Up to 250,000 hectares of new grain fields were reclaimed (or earlier reclamations "legalized") in Heilongjiang province in 2004 (out of 2.2 million ha reclaimed nationwide in that year). Much of the new farmland was converted from floodplain wetlands.

At least two million hectares of new cropland were added in the Amur-Heilong basin over the 1990s (calculation based on Liu et al. 2005). Northeast China forest cover decreased by 1.26 million ha, and grasslands shrank by two million ha due to conversion to agriculture. Another 0.6 million ha of conversion resulted from "water" and "unused land" categories, consisting mostly of wetlands (Liu et al. 2005).

Land degradation and desertification

In China human activities have caused not only conversion of wetlands and deforestation of plains but also signs of extreme environmental deterioration. These include human-induced drought, desertification, wind erosion, and alkalinization of soil, all of which have affected the region over increasing land areas. Despite its short history of development more than 60 percent of the cultivable land on the Sanjiang plain is now affected by wind erosion. This problem is most serious in the central part of the plain where reclamation began earlier than elsewhere.

In addition to deforestation and overgrazing, over intensive agriculture also causes extensive land degradation. Of the land opened up in the past 10 years, one half has already been abandoned. From 1986-1996 the National Agricultural Administration Office conducted a satellite remote-sensing survey covering 53 counties or county-level cities in Heilongjiang, Inner Mongolia, Gansu, and Xinjiang. The survey showed severe grassland and forest destruction in those provinces. Over the decade about 1.74 million ha were converted to farmland, but only 884,000 ha remained cultivated, accounting for 51 percent of the total. The three great waves of cultivation since the 1950s destroyed large stretches of natural vegetation, which later deteriorated into bare, sandy, and erosive land. With neither conditions for cultivation nor protective measures, many areas became desert (Ci Longjun 2001).

Salinization and alkalization of soils is a serious problem on the Song-Nen plain. The rate of desertification in the Song-Nen plain was predicted to reach 100 km²/year in the (SWRC 1999). The process is initiated when land is inappropriately drained for agricultural development. Water logging occurs, and with high evaporation rates in spring and summer, salts start to accumulate at the soil surface. In the first stage, hydroxide anions accumulate, creating alkali soils that have high pH levels and a white color. Cations progressively migrate to the surface, and a top layer of calcium, magnesium, or sodium is formed. With increasing concentrations of magnesium at the surface, the soil changes from alkaline to saline and becomes red. This mineralization process is a geological phenomenon that occurred naturally before the intervention of man. But the process was strongly mitigated by the seasonal floods over the plain, which flushed the soils of their excessive salts. Construction of dykes, drainage of wetlands, and irrigation have modified this fragile balance, resulting in an accelerated build-up of salts in the top soil layer and making it unsuitable for agriculture. Farmers acknowledge that after a flood inundates their fields, harvests are better during the next two to three years at least, confirming the role of flooding in maintenance of soil fertility by flushing salts. Using alkaline- or saline-prone areas as temporary water detention ponds may be highly profitable. This would reduce peak flood discharge while improving soil conditions by washing salts from the surface. The improved soil fertility would favor natural restoration of grasslands that have declined sharply in area to the financial detriment of thousands of households that raise livestock.

In the 1960s annual desert expansion averaged about 1,560 km² in China. In the 1970s and 1980s, an average of 2100 km² of grassland gave way to deserts. The increased number of sandstorms parallels the desert expansion in China. According to China's official meteorological record, an average of five strong dust storms and sandstorms per year occurred in China in the 1950s. That number increased to 23 in the 1990s, with a corresponding rise in economic losses. Official records show that in 2001, 14 sandstorms came from Mongolia, accounting for 44 percent of China's total sandstorms that year (Hu Yean & Zhu Xiaochao 2004).

Huge areas of grasslands and croplands are lost to moving sands, mostly as the combined result of drought, cultivation, and overgrazing in Jilin, Heilongjiang, and Inner Mongolia (**Table 3.20**). At least two-thirds (or 62,431 km²) of the huge Ke'erqin Grassland area in the Song-Nen Plain has been converted into nearly barren land with sparse vegetation and low productivity. According to CAE two other largest desertification zones include Song-Nen plain (7,850 km²) and Hulunbei'er grassland (7,435 km²) (CAE 2007).

Based on data collection beginning in 1947, the population of Inner Mongolia has soared from 5.61 million to 32 million. The population increase has resulted in higher demand for domestic animals. Inner Mongolia presently has only 51.7 million hectares of pasture grassland, a reduction of 16.3 million hectares from 68 million hectares in 1990. The pastures in Inner Mongolia have the capacity to feed approximately 700,000 people and 30 million animals. Yet in reality there were 62 million domestic animals in the year 2000, a 70 percent increase from the 1983 count of 39 million.

Grassland loss and desert expansion are the direct result of excessive grazing. At the core of the problem is the disintegrated grassland ownership policy that gives everyone the right to use the grassland, especially those with the financial resources to invest in animal husbandry. Because of the high market prices for livestock, locals enlarge their herds and occupy more grassland, which inevitably destroys the land (Hu Yifan & Zhu Xiaochao 2004). Hulunbei'er Prefecture of Inner Mongolia had some of the best pastureland in China. Farming was limited on the grassland before 1958. In 1958-1962,

Table 3.20 Land degradation in Heilongjiang and Jilin ('000 km²) (adopted from Karakin & Sheingauz 2004)

Province	Degraded land (total)	Including				
		Saline	Water erosion	Washed out	Alkaline	Desertified
Heilongjiang	183.8	6.8	7.7	1.3	8.6	3.9
Jilin	42.9	0	14.2	0.4	17.1	7.5
Total	226.7	6.8	21.9	1.7	25.7	11.4

Box 3.1 Economic Losses Resulting from the Impact of Deforestation on Desertification (Wang Hongchang, Deforestation and Desiccation in China. A Preliminary Study. 1993)

In addition to genuine deserts, China had 176,000 km^2 of desertified land and 158,000 km^2 of lands that are vulnerable to desertification in 1989. From the 1950s through the 1970s desertification in China increased at an annual rate of 1,560 km^2. We argue that with increasing afforestation will come increasing precipitation which will enable afforestation of desertified regions.

In China, nearly four percent of all desertified lands are located in semi-humid regions with annual precipitation of 500-600 mm. These areas include the lower reaches of the Nen River and the Second Songhua River, located in the eastern section of Baicheng Prefecture, in Jilin province, as well as the northern section of the middle reaches of the East Liao River, and the southeastern section of the Ke'erqin Sandy Lands of Inner-Mongolia. Desertification in these regions is a result of human activities and could be reversed through agroforestry.

Some 65 percent of desertified lands are located in semi-arid zones, such as the eastern and central sections of Inner Mongolia, as well as northern Hubei, northwestern Shanxi, northern Shaanxi, and southeastern Ningxia provinces. Annual precipitation in these regions is 250-500 mm. If all forest-able lands in China were afforested, precipitation levels might increase to such an extent that these semi-arid zones could be rehabilitated through agroforestry and sustainable grazing.

We can calculate the additional evapotranspiration that would occur if all potentially forested lands were actually forested. We assume that one half of all additional moisture accrued as a result of afforestation efforts will remain within the borders of each province, with the remainder exported to downwind provinces. Though we can safely assert that afforestation increases the production of atmospheric moisture, and that this moisture will travel northward on the summer monsoon, in fact, we know very little about atmospheric moisture. It appears that precipitation levels in Inner Mongolia will rise by 14 percent with an increase of forest cover. Inner Mongolia has 400 mm isohyets more than 1000 km long. The distance between the 400 mm and 300 mm isohyet is more than 400 km at the east end of the province, 200 km in the middle and 100 km in the west. The possibility of a 14 percent increase in precipitation might extend the forest lands by about 100,000 km^2. Similar projections could be made for the provinces of Qinghai, Gansu and Ningxia.

198,000 hectares of grassland were converted to cropland. Today, after less than 50 years, the best grasslands have become desert. Land degradation in Hulunbei'er is widespread, affecting 40 percent of 8.3 million hectares of pastures, with 0.75 million hectares of desert expansion in the last 30 years. China recently had to invest US$1.9 billion to prevent further degradation (Hulunbuir Grassland in China to turn green in Five years; China Daily, Sept. 2001, N3). Fortunately, the Hulunbei'er government recently decided not to accelerate production on its own territory, but rather to exploit its strategic location relative to China-Russia trade. Hulunbei'er now trans-ships produce from other regions of China to Russian markets (Secretary General of Hulunbei'er Government, personal communication 2006).

Despite the low population densities in Mongolia, land degradation is an especially severe problem. The total area of degraded land is 121.7 million hectares, of which 97 million ha suffer wind and water erosion, one million ha are lost for any agricultural activity, 8.6 million ha are degraded by overgrazing and 7.9 million ha are covered by human-induced moving sands (Badarch and Doljinsuren 2002). In Eastern Mongolia more than 40 percent of pastures are degraded. Underlying reasons are similar to those in Inner Mongolia. Collective nomadic traditions and corresponding systems of pasture management, which were retained even in Socialist times, can no longer be sustained in the new capitalist era. Growing numbers of livestock and shrinking availability of pasture to each livestock-owner make sustainable pastoralism associated with long migrations from winter to summer pastures no longer economically fea-

BOX 3.2 Forests and Water Resources, Heilongjiang Province: A Case Study, (Wang Hongchang. Deforestation and Desiccation in China. A Preliminary Study)

Between 1896 and 1940 forest cover in Heilongjiang shrank from 70 to 55 percent, declining from 331,000 to 258,180 km^2. Concurrently, growing stock declined by 890 million m^3, from over four billion m^3 to just over three billion m^3. Forest cover and growing stock continued to decline and by 1948 shrank to 167,070 km^2 and two billion m^3 respectively. In 1948 average growing stock per ha was 111 m^3, and forests covered 36 percent of the province. By late 1986, forested area in the province shrank to 157,710 km^2, and growing stock declined to 1.5 billion m^3, equivalent to 83 m^3/ha. In sum, between 1896 and 1986 forested area in Heilongjiang declined by 173,290 km^2, a decline from 70 percent forest cover to only 35 percent, while growing stock shrank by 2.6 billion m^3.

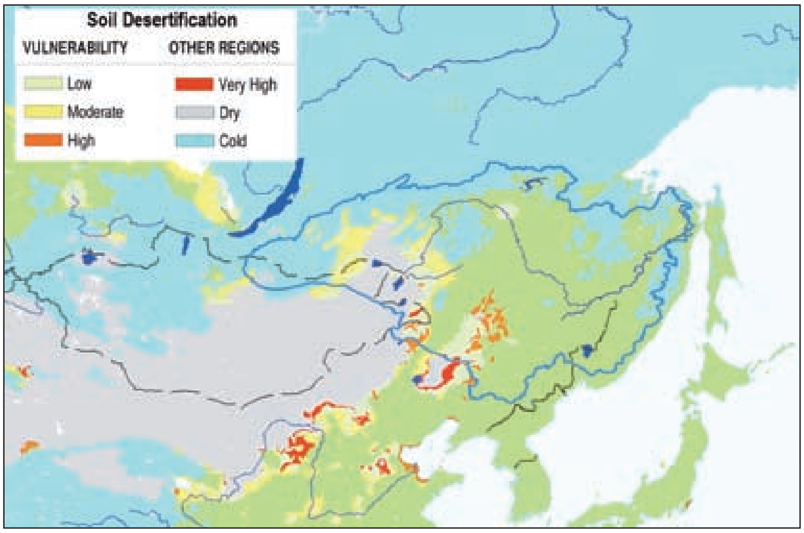
A key cause of deforestation in Heilongjiang province has been commercial lumber production. Heilongjiang is China's largest supplier of lumber for commercial use, producing 465 million m^3 between 1949 and 1986. To produce this quantity of lumber the province required 734 million m^3 of growing stock. However, lumber production for commercial use is not the sole contributor to deforestation in Heilongjiang. Of the 7,950 km^2 deforested since 1976, only 2,970 km^2 were actually used for the production of commercial lumber. Slash and burn farming accounted for an additional 620 km^2, and unauthorized felling of trees accounted for 1,990 km^2. 6,000 ha of Mongolian oak were destroyed for the culture of silkworms and edible fungi, and 1,250 km^2 were cleared for construction of railroads, highways, and high voltage lines. Finally, 4.7 km^2 were lost to forest fires.

Gao Yonglu et al., estimated that in 1984 forests in Heilongjiang retained 6.6 billion m^3 of water, equivalent to nine times the total water storage capacity of all the reservoirs in the province. If we assume that the water-retention capacity of a forest is proportional to its growing stock, then we can infer that forests in Heilongjiang had the capacity to retain 8.4 billion m3 of water in 1948, and over 12.2 billion m3 in 1896. Gao et al.(need date) also estimated that as a result of more extensive and more mature forests, Heilongjiang attracted an additional 25 mm of precipitation to the province in 1984. Given the greater extent of forest cover in earlier periods, we can infer that as a result of greater forests, Heilongjiang attracted an additional 32 mm of precipitation in 1948 and an additional 69 mm in 1896.

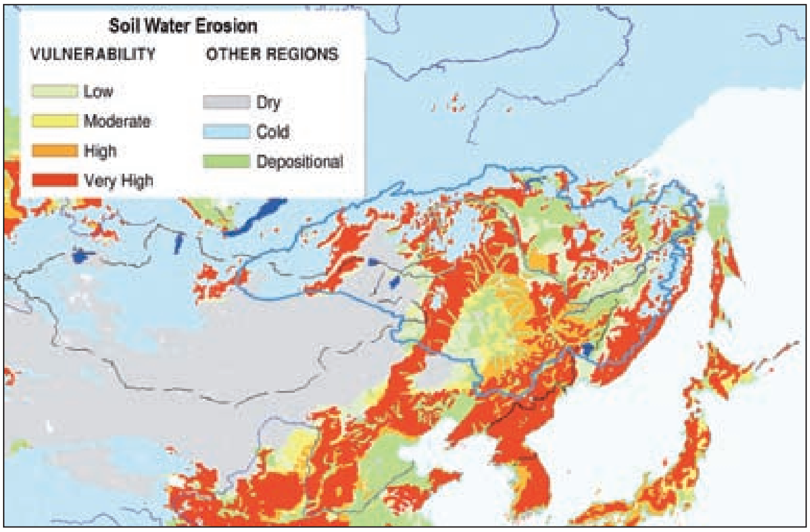
China's northeast includes the provinces of Heilongjiang, Jilin, and Liaoning, as well as the northeastern corner of Inner Mongolia. Deforestation of this region impacts on regions to its west, including the adjacent province of Inner Mongolia (at an elevation of 1,000-1,300 m above sea level) and the Qinghai-Tibet plateau to the west of Inner Mongolia (at an elevation of 4,000-5,000 m above sea level). During spring and summer the northeast monsoon originating in the Sea of Okhotsk, and the southeast monsoon originating in the Pacific Ocean, reach the northeastern region. These monsoons push the air from above the northeastern region in a westward direction. The more humid the air above the northeastern region, the more moisture will reach Inner Mongolia, and eventually, the Qinghai-Tibet plateau. Based on our argument that deforestation causes a decrease in precipitation levels, we infer that deforestation in Heilongjiang results in decreasing moisture levels in Inner Mongolia, and eventually, on the Tibet-Qinghai plateau. As a result of decreased moisture levels both Inner Mongolia and the Tibet-Qinghai plateau suffer from rising desiccation rates.

sible or socially acceptable. However no viable alternative of sustainable land management has been suggested (Mandych 2004). Increased crop production is also a problem, since it claims the most productive lands near water sources, and almost inevitably converts them into sands. The Mongolian Ministry of Nature and Environment inventory of the previously reclaimed 1.3 million ha of plowed lands showed that 585,000 ha are abandoned due to desertification (MMNE 2005).

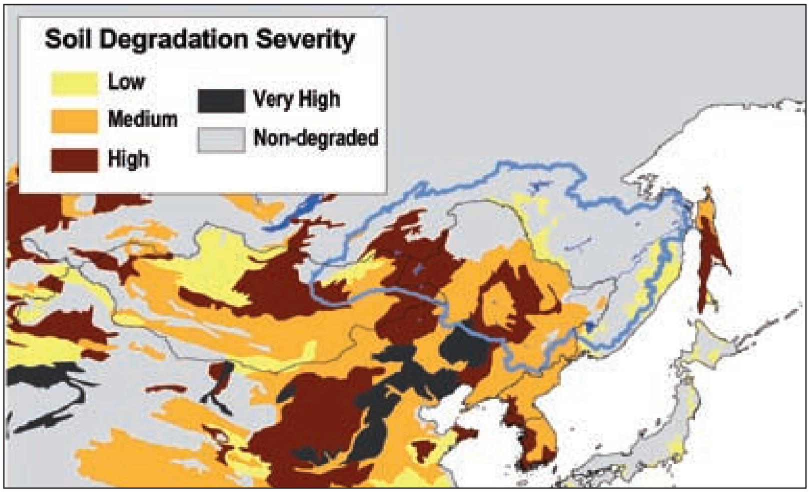
While land erosion is widespread in agricultural areas of Russia, agriculture-driven land degradation is



Map 3.8 Soil vulnerability to desertification



Map 3.9 Vulnerability to water erosion



Map 3.10 Soil degradation in Amur Heilong River basin

not recognized as a major threat as it is in China and Mongolia. However, in many steppe areas of Chitinskaya Province and ABAO plant density declined from 80-90 percent to 30 percent, while productivity of pastures was reduced to 100-200 kg/ha and only 25 percent of original pasture is preserved in good condition (Kochneva and Strizhova 2006). Factors causing degradation are essentially the same, the main factors being drought cycles, overgrazing and grass-fires. To date overgrazing is less severe than in China and many places in Mongolia due to lower livestock numbers. This gives little reason for optimism, since similar ecosystems might be degraded in a similar way very quickly, and growing economic cooperation in the region, if not balanced by sound environmental policies, might quickly bring about this change.

Land degradation is the beginning of a vicious cycle because it does not happen in isolation. It brings increased pressure to bear on remaining land and water resources, thereby eventually degrading them as well. Desertification and land degradation process unfolding in the southwest Amur-Heilong basin **(see boxes 3.1 and 3.2)** have potential to expand further and might eventually become a problem for all three countries and an additional cause for competition for water and land resources. Judging by natural conditions, and prevailing economic trends, Russia's Chita Province might be vulnerable in the near future, especially if demand grows for locally-grown meat or other animal husbandry products.

Institutional denial of land degradation is problematic. Reports and statistics are often simply not designed to trace subtle yet alarming changes in regional ecosystems. Three indicative maps of soil erosion depicting vulnerability to desertification (**Map 3.8**) , vulnerability to water erosion (**Map 3.9**) and degree of existing soil degradation (**Map 3.10**) are derived from world-wide databases to demonstrate general trends in the region.

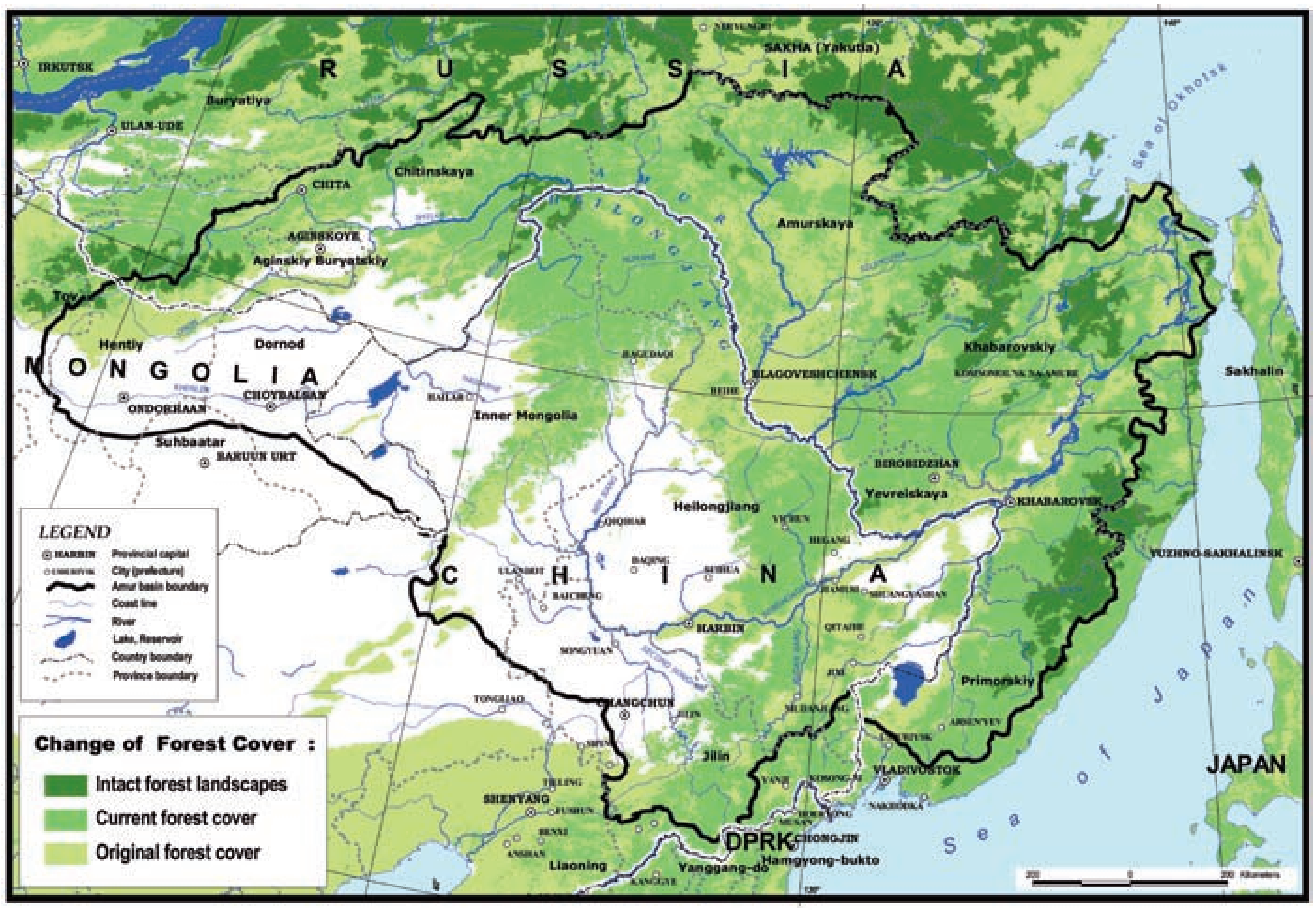
The threat factors we describe do not work in isolation. Current debates on ecological degradation and restoration of landscapes, at least in China, encompass agriculture, forestry, water management and climate change. We therefore conclude this agricultural section by presenting two related case studies by the same author, one emphasizing the role of forests and reforestation policies in landscape dynamics in agricultural regions of Amur-Heilong basin. The logic of the author reflects basic considerations underlying landscape preservation and restoration policies in modern China.

Chapter 23

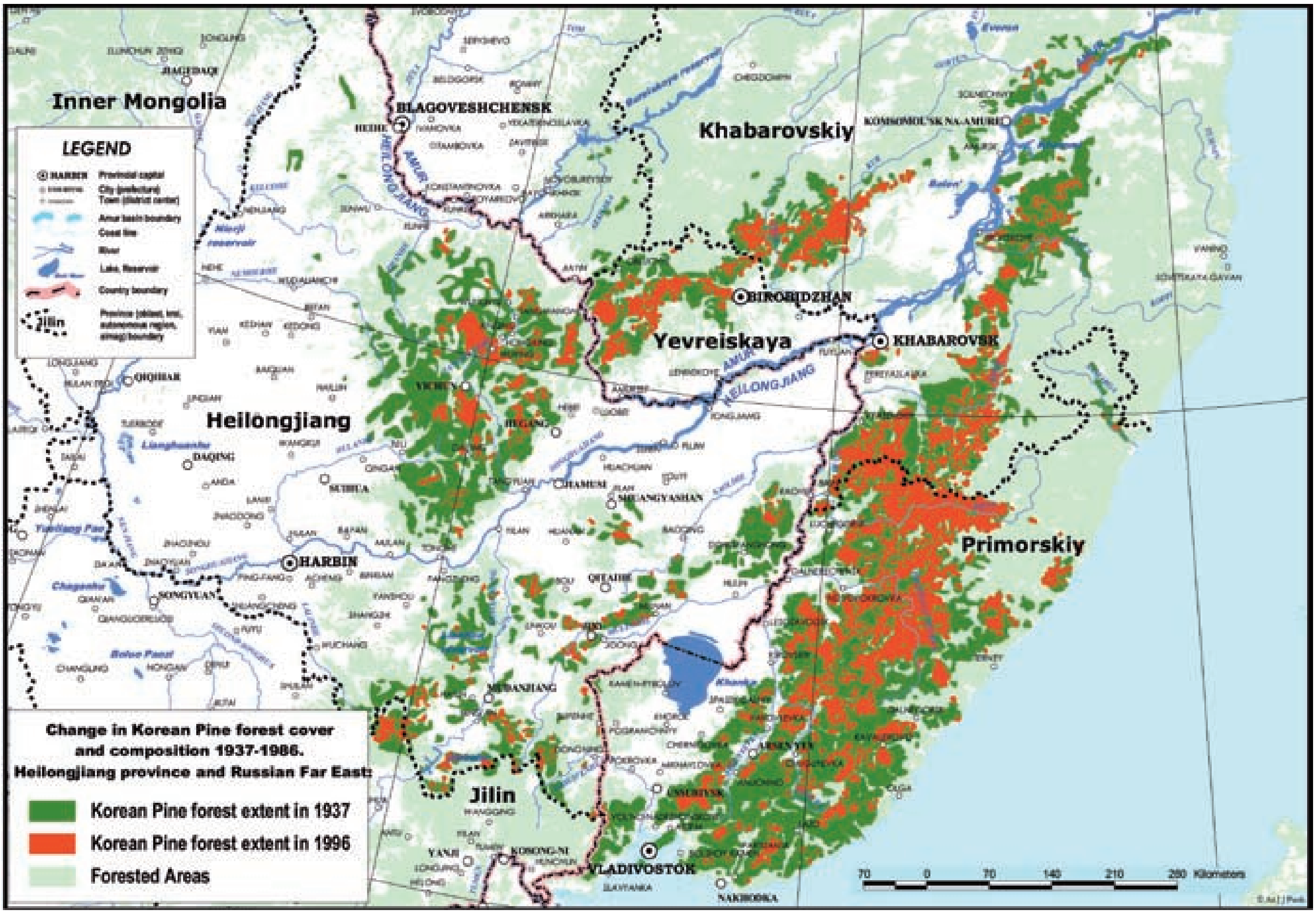
Logging and Fires

Timber harvest in the Russian Far East

Due to difficulties in integration of data from three countries we focus this subchapter on South RFE, where pressure is growing at the fastest rate in the basin. However, understanding of basin-wide situation might be facilitated by observing two maps supplied in this chapter. The first map presents general trends in change of forest cover (**Map 3.11**). It shows that loss of forest cover has so far occurred mostly on the plains and thus is mostly result of land-conversion to agriculture and other uses, with timber harvest likely having only facilitating role in the process. However the share of remaining "intact forests" with a high percentage of old growth is small and confined to remote areas, and this indicates the leading role of logging in degradation of most valuable forest ecosystems. The second map (**Map 3.12**) illustrates this trend using the most valuable Korean pine-broadleaf mixed forests as example. Available data do not cover the southern extent of this forest formation in Jilin province, where the history of logging is longer than in northern areas. However, in the north of Korean pine forests range in just 60 years logging resulted in more than a 50 percent reduction in the area occupied by this



Map 3.11 Change in Forest Cover in Amur Heilong River Basin



Map 3.12 Change in Korean Pine Forest Cover and Composition

most productive ecosystem on which the Amur tiger and other charismatic wildlife depends.

Threats associated with logging

The main threats to biodiversity from current forestry practices are fragmentation of intact forests, unsustainable logging (legal and illegal), and forest fires. Illegal logging has become an acute problem in the post-Soviet period as a result of privatization of the forest industry, liberalization of forest trade, and the fact that the government no longer has a monopoly on forest exports. According to estimates in a WWF study, 1.5 million cubic meters of timber are cut illegally in Primorsky Province alone. There has been considerable disagreement among experts on the definition of "illegal logging" and its extent in RFE in recent years (see RFE Forestry Sector Review in Sheingauz 2006). Forest management in general is inefficient as it mostly implies exploitation of mature forests while management of already logged areas is often neglected. Harvesting techniques rarely support natural regeneration. Planting and artificial regeneration measures are carried out on less than 0.3 percent of the logged lands and have no effect whatsoever on quality and quantity of RFE forests (Sheingauz ed. 2006). Even "selective" cutting damages forest ecosystems when roads are built and heavy machinery is used. Due to the energy crisis and a socio-economic depression, much of the rural population of the RFE depends on firewood for heating fuel and, less frequently, for cooking.

Unsanctioned logging and illegal export of valuable tree species threaten the integrity of forest ecosystems. With intensive logging, the biodiversity of forest ecosystems is decreasing. Tiger, leopard, bear, wild boar, roe deer, and Siberian spruce grouse are a just a few of the animals that depend on healthy forest ecosystems. Impacts of forestry on biodiversity and ecosystem health include:

Box 3.3 Salmon rivers vs Forestry

In the Amur-Heilong Basin well-being of most salmon runs depends on conditions in forest streams in mountainous areas, where it spawns. In this respect condition of salmon runs of particular streams serves as useful indicator of integrity of entire watershed ecosystem.

In RFE Federal District most extensive research on the subject was completed by cooperation between foresters hydrologists and ichthyologists, mostly on rivers of Sakhalin Island in the 1960s-1980s, and then it's results were for decades shelved as contradicting logging policies of Russia. Summary of research results were collected and published by NGOs "Sakhalin Watch," "Wild Nature of Sakhalin" only in 2005. (Soloviev, Mezhennaya editors. Forest and Salmon. Yuzhno-Sakhalinsk.2005)

Logging in watersheds has very complex influence on surface flow, erosion patterns, temperature, and thaw patterns in rivers of the Far East. Substantial change in forest cover leads to degradation of soil cover and negative changes in local microclimate. (Klintsov A. Water protection role of Sakhalin forests. Yuzhno-Sakhalinsk 1973). According to comparative research natural forest cover in a watershed of spawning river cannot be reduced below 50 percent without detrimental consequences for spawning salmon. Low technological discipline in real-life logging operations leads to inevitable damage to salmon runs despite well-meaning protective measures prescribed in logging plans. Increasing water turbidity, use of streambeds for transportation and storage, spills of petrochemicals were observed at all researched sites. If adhering to better standards is impossible in practice, the most cost-effective solution is to abstain from logging in watersheds of spawning rivers, thus preserving economically valuable fish stocks. (Rukhlov F. and Spivak E., in Soloviev, Mezhennaya editors. Forest and Salmon. Yuzhno-Sakhalinsk.2005). Reproduction rate (efficacy) of pink salmon in similar unaffected rivers was compared to Nerpichia River where logging lasted for 10 years and Peskovskaya River with three years of logging operations. Reproduction on Nerpichia River was 13.6 percent, and on Peskovskaya river 36.4 percent of that on rivers with unaffected watershed. Accelerated sedimentation during post-spawning period in the fall was considered the most obvious factor limiting reproductive success of salmon. Shershnev A., and Rudnev V. (1979 report), in Soloviev, Mezhennaya editors. Forest and Salmon. Yuzhno-Sakhalinsk.2005).

Following this research stricter control measures were declared by national and provincial authorities and one-kilometer wide "spawning river protection forests" put into a special management category exempt from logging. However inspections conducted in 2002 disclosed that on the majority of spawning rivers these regulations were never observed by logging companies. In 2001 salmon fisheries contributed 60 percent of local budget, while forestry accounted only for 1.6 percent, therefore logging in salmon watersheds was incurring huge losses to local economy at large. (Zatuliakin, A., 2002, in Soloviev, Mezhennaya editors. Forest and Salmon. Yuzhno-Sakhalinsk.2005)

Such evidence spurred thinking in other RFE regions and a set of recommendations for watershed forest protection was developed for rivers of Sikhote-Alin Mountain ridge in Primorsky Province. (Opritova R.A. Influence of logging on river hydrology in Primorsky Province. Vladivostok. Institute of Biological and Soil Sciences FEBRAS.1988). These recommendations allow for logging in 25 percent of the elementary watershed area, but put forward very detailed instructions regarding distribution of logging areas, limits of annual cut, size of logging patches and many other technical detail. Watersheds smaller than 300 sq. km should be excluded from logging. This science-based guidelines were never incorporated into any legally-binding regional logging regulations.

• transformation of old-growth and secondary forests from all types of logging practices (including selective), decreasing overall biodiversity and increasing the frequency of forest fires;

• increased erosion and degradation of forest soils;

• disruption of hydrologic and microclimatic regimes through logging and construction of logging roads and related construction;

• increased turbidity of waterways and changes in water temperatures, especially in small streams, which often leads to devastation of fish populations; and

• high levels of chemical and organic pollution of waterways from outlets of wood-processing and cellulose plants.

Massive destruction of forest landscapes continues in southern Russian Far East, eliminating habitats not only for wildlife but also humans. Once destroyed, evergreen and broad-leaved forest ecosystems dating from the Tertiary Period cannot regenerate naturally under present day climatic conditions. Forage resources for ungulates is being destroyed as well due to the loss of productive oak and cedar-pine forests, and patches of horsetail from felling ash trees and elms in valley forests. Declines in numbers of ungulates reduces the carnivore prey base.

Forests are known to be regulators and accumulators of moisture. The destruction of forests causes swift changes in the hydrological regime of soils and water bodies. These changes lead to floods, erosion of soils from slopes, water-logging of low-lying areas, and prolonged droughts. Accelerated sedimentation of river beds during spawning periods will lead to further substantial declines in the RFE populations of salmon (**see Box 3.3**). The totality of these adverse processes is bound to yield disastrous economic and social consequences for rural communities.

Material and financial resources have been exported from the region for many years. This outflow has compounded the difficulty of improving social conditions in this harsh region. It has given rise to mass unemployment that has impoverished the populace.

Problem definition is difficult

Illegal logging is a broad term used to describe crimes relating to timber harvesting and related trade. The term includes economic crimes such as tax evasion and corruption (**Box 3.4**). Illegal logging has become a significant problem in Russia within the last 10-15 years. Illegal logging in Russia has many faces and it is very difficult to give precise estimates of its impact and magnitude. Illegal logging occurs throughout Russia but it is most commonly seen in wood-exporting regions where potential financial gain is greater from international trade.

Illegal logging happens in all forested countries, developed and developing. The critical issue is the scale of the crime. Illegal logging in the RFE is encouraged by opportunities to quickly and easily sell illegally harvested timber for cash to nearby exporters. Timber export procedures are the tools used to legalize trade in (or "launder") illegally harvested and traded wood in

Box 3.4 Illegal logging definitions

Illegal Logging and Forest Crime — WWF Definition:

"Illegal logging occurs when timber is harvested, transported, processed, bought or sold in violation or circumvention of national or sub-national laws." *(WWF Position Paper on Illegal logging and forest crime, April 2002)*

Illegal Logging — Decision of the Supreme Court of the Russian Federation:

"Illegal logging is harvesting of trees, shrubs, and lianas without a felling license, order or logging with a felling license, order issued with violation of the standing felling rules as well as logging in other (than allowed) areas or outside their boundaries, over allowed volume, logging of other (than allowed) species or trees, shrubs, and lianas prohibited for harvesting…" (*Ruling of the Plenum of the Supreme Court of the Russian Federation "On Court Application Practice of Laws Concerning Liability for Environmental Offences," No. 14 of 5.11.98).*

Russia. Illegal logging exerts direct negative impacts on biodiversity and forests in protected areas. At the same time it indirectly damages society by legalizing tax evasion and customs fraud. This reduces the market competitiveness of legally harvested and traded timber. It also reduces the amount of tax revenues available for forest management and improvement of social and economic conditions in forest districts.

Consequences of illegal logging include the following:

No royalties, taxes, or other charges are paid by logging companies for illegally harvested wood. As a result, state forest management units cannot obtain government funding to implement needed forest management measures. The Count Chamber noted in a report entitled "Efficiency of Forest Resources Use of the Russian Federation" that the lack of funding of such works was 1.5 billion roubles (about $50 million) in 2000 and the control of forest revenues was ineffective. As of January 1, 2001, forest users had not paid forest charges in the amount of 1.3 billion roubles. In Russia nearly 20 million of 80 million hectares of exploitable forests are not properly reforested. As a result, the species structure of forests degrades, the area of high-quality timber stands decreases, the share of low-quality stands increases, and most of the commercially valuable trees are high graded.

Illegal logging first degrades the ecologically most valuable stands. In Eastern Siberia and RFE these most valuable forests are pristine and are essential for the maintenance of ecosystem functions including conservation of rare species, and protection of biodiversity.

Illegal loggers take only commercial timber while leaving much waste wood that promotes forest fires and pest outbreaks.

In northern boreal forests, the main perpetrators of illegal logging are established logging companies that log in excess of limits allowed by their felling licenses, log outside established felling areas (including in protected areas), and fell protected species.

The differences between harvested and reported timber volumes can be seen in the discrepancies in government statistics. The timber harvest reported by the Ministry of Natural Resources of the Russian Federation, based on the data of forest management units, is about 63 million m^3. The report of the State Statistics Committee of the Russian Federation is based on data provided by logging companies and forest management units, and shows a harvest of 30.6 million m^3. Such large discrepancies may be caused by logging companies reporting less timber than they harvested (it is not illegally harvested but undeclared) or by inaccurate statistics. Regardless, analysis of the existing "inaccurate" official statistics clearly shows that the level of illegal logging in the RFE is high.

In many respects, illegal logging demonstrates the weakness of state control over forestry. However, much of the responsibility lies with logging companies and trading agents that practice illegal logging and involve illegally harvested timber in commercial circulation. In private discussions, top managers of Russia's wood exporting companies often comment on the high percentage of timber that is sold on spot contracts in cash, particularly in seaports. Middlemen control this business, reselling such timber to official exporters.

Illegally harvested wood is laundered through subsequent transportation and trade, which often entails additional illegal practices, such as:

- Misclassification of wood to avoid profit taxes (e.g. declaring pulpwood instead of sawn wood);
- Signing double invoices or contracts to avoid taxes: One invoice for the customer indicating the correct price, and another invoice for the fiscal bodies indicating a much lower price;
- Payment in cash without registering the trade;
- Undervaluing export prices and volumes in the "official" contracts to hide profits. Additional money may then be paid by the customer in cash or remitted to a secret bank account;
- Documenting export through short-lived companies or export by faked documents;
- Under-declaring wood volume by bribing customs officers.

Customs legislation infringements in Russia-China trade

The RFE Regional Customs House annually analyzes export transactions and customs infringements. Their results show that increasing export volumes of raw logs and lumber to China are accompanied by increasingly frequent customs rules violations in quantity[1]. By 1 December 2002 raw log exports through customs gateways of RFE Regional Customs House were 10,560,000 m^3, and exports of lumber were 399,000 m^3. In 2001, for the similar period 9,341,000 m^3 of raw logs and 332,000 m^3 of lumber were exported. At the same time the RFE customs officers revealed 471 violations of customs rules for the 2002 year, compared to only 394 violations in 2001. Twenty criminal cases were prosecuted in 2002. The total value of seized timber illegally transferred across the Russia-China border was over 143 million rubles.

In view of the steady prices for Russian timber in China markets in 2001-2002, the rapid growth in exported timber volume is another negative tendency revealed in the analysis of export transactions in 2002. It means that exporters illegally underestimated the customs value of exported timber.

During internal investigations in 2001, the RFE State Customs Committee concluded that suspect definitions of "round wood" had allowed exporters to understate the exported volumes by up to 20 percent. This equaled approximately 1.8 million m^3 of unaccounted round wood of $36 million in value, and $1.8 million of uncollected export duties.[2]

Thus, the main infringements of customs rules made by forest products exporters to China in 2002 were:

• failure to observe export customs regulations requiring remittance of currency revenues to the accounts of authorized banks;

• breaking terms of repatriation of sales revenues;

• submitting false documents or documents obtained illegally (licenses of RF Ministry of Economic Development and Trade);

• non-declaration, or invalid declaration (understating, under-grading, misclassification of species); and

• non-securing entry of goods of equivalent value (breaking terms of barter contracts).

[1] Press-conference on Joint Session of RFE and Siberian Customs Houses about organization of effective customs control for timber products export. Vladivostok, 15/05/2003.

[2] Analytical note on maintenance of RF state interests in round wood exports. In Bulletin of RF Auditing Chamber # 5(41) 2001.

A new Russian Federation Customs Code took effect on 1 January 2004. It required the exporter to submit only an export license and a confirmed trade contract to export timber products. There is no requirement to identify the origin of exported timber. To export logs the exporter needs only a sales contract, but not a logging license.

There are multiple explanations for illegal logging in Russia and they can be categorized into five main groups:

1. Imperfect legislation and forest policy;

2. Inadequate control of forest operations;

3. Limited capacity for wood processing in Russia;

4. Behaviour of large timber traders; and

5. Low standard of living and high unemployment in wood-producing areas.

1. Imperfect legislation and forest policy

There are several inconsistencies and gaps in the current legislation and policy regarding forests and forestry in Russia. The Russian government and the World Bank are currently discussing the need for a major forest policy reform to ensure more coherent and efficient forest management in the country. Gaps and inconsistencies make it difficult to judge whether a particular forestry operation is legal or illegal. A few examples of imperfect legislation and policy are:

• Conflict of interest. State forest management units are simultaneously responsible for control of commercial forestry and forestry management. The units often conduct thinning of forests in a way that is more similar to commercial logging. Since it is the units themselves that control the thinning, the exaggerated thinning is not stopped.

• Issuing of short-term forest concessions. Despite the fact that it is legal for forest authorities to lease forest areas to logging companies for up to 50-year periods, short-term leases (three to five years) prevail due to gaps in the law. Short-term concessions result in very intensive logging activity to "mine" all forest resources within the short leasing period. Longer leases would promote more sustainable forest exploitation.

• Tax free wood for local needs. The current law allows for tax free use of forest resources by local people for local needs. However, timber traders often buy such wood for commercial purposes thereby avoiding paying taxes.

2. Inadequate control with forest operations

Illegal logging can be explained mainly by the weaknesses in state control of forestry operations. In principle, any forest operation is controlled by a state forest management unit. This applies even in areas that are leased to companies for commercial logging. Logging is permitted only by issuance of licenses by state forest management units. Logging must be performed only according to the terms specified in the licenses. The state forest management units are responsible for control of all steps of harvesting, from the assignment of cutting areas to their subsequent reforestation. However, the state forest management units often do not fulfill these functions properly, mainly because they lack sufficient funding. In accordance with the Forest Code of the Russian Federation, forestry control operations are funded by government revenues from royalties and other forest charges. This means that evasion of forest charges reduces government revenues, provides less funding for management units, and ultimately results in less effective control and more illegal logging.

3. Limited wood processing capacity

Russia's capacity to process timber is lower today than during the soviet era. This is mainly because the Russia wood processing industry has been starved for raw material supply due to the increasing demand for roundwood in European markets mainly from Sweden and Finland. This has increased the roundwood prices beyond the range affordable in Russia. In Asian Russia, with its lack of processing capacity, large quantities of roundwood are bought by Chinese companies. This means that the share of roundwood in total wood exports has increased at the expense of processed wood products. It is well known that export of processed wood products is more profitable for national economies than export of roundwood. An increase in domestic wood processing would raise export revenues and create jobs — both would help raise standards of living in Russia. Also, because the roundwood export trade in Russia is notoriously the most criminal sector of the forest industry, decreasing this sector would contribute to combating illegal logging.

4. Behavior of large timber traders

Foreign timber traders buying Russian wood products can contribute to illegal logging if they do not ensure that the timber they buy is legal. If timber is bought from suppliers which cannot credibly document its legality, then the timber should be assumed to be illegal. Some traders operating in Russia purchase timber in cash (which makes it easier for the seller to avoid paying taxes) and do not ask for certificates of origin (which increases the risk of purchasing illegally harvested timber). These practices are especially common in the RFE, where middlemen often sell their timber.

5. Low standard of living and high unemployment in wood-producing areas

The low standard of living in many timber-producing areas in Russia may lead to increased illegal logging, at least for the smaller scale operations. Solutions to the low standard of living are mainly to be found outside the forestry sector. However, expansion of the wood processing industry would create jobs and thus foster socioeconomic development.

To convince government agencies in Russia and Europe, responsible timber buyers, and international environmental organizations of the legality of timber and wood products, harvesters must meet national regulations. Wood processing and exporting companies should introduce procedures to trace the origin of timber and make their businesses more transparent. There are already cases of adoption of responsible timber trade practice in Russia and this trend is encouraging.

Fire

One of the most influential ecological disturbances is fire, especially when fire frequency is increased greatly by human actions. In terms of the land area affected each year it is the most widespread impact factor for forests, wetlands and grasslands of the Amur-Heilong River basin. Poor logging practices leaving behind networks of access roads and huge loads of dry fuel are leading factors exacerbating the problems of human-caused fires in the basin. Abandoned fields with dry grasses provide massive fuel loads that can be converted by an accidental ignition into a disaster. Unorganized collection of non-forest timber products, careless recreation, and burning of hayfields also lead to forest and grassland fires. In southwest Primorsky Province dry grass has been burned for centuries. This uncontrolled method of managing hayfields and fern beds each year turns the entire lower mountainous region of the Khasansky District (southern tip of Primorsky Province) into an enormous wall of fire, enveloping up to 40 percent of the entire territory. This region provides some of the last remaining habitat for the endangered Far Eastern leopard. As a result of the high frequency of anthropogenic fire mixed forests are turning into scrub and sparse oak woods. These species-poor forests in turn give way to fields of grass and shrubs. The area of forest degradation is increasing, posing serious threats to the Far Eastern leopard and other species. Statistics on forest fire causes show that human activities are responsible for 94 percent of fires in the most valuable mixed broadleaf-coniferous forest zone of the Russian Far East (**Table 3.21**). The fire problem seems to be most acute in Russia, widespread in Mongolian grasslands, and common but not so detrimental in the much more fragmented ecosystems of China.

Table 3.21 Main sources of forest fires in forestry units of Amur-Sikhote Alin region and their relation to settlements and infrastructure

Source of ignition	Percent of all cases	Percent of fires within 5 km from human settlements and roads
Activities of local population (improper and careless handling of fire)	60	37
Lightning	6	0
Railroads	4	4
Forest logging operations	4	0
Field survey teams	2	0
Activities of other organizations	4	0
Unknown sources	14	1
Agricultural burning and prescribed burning outside of forests	6	3
Total	100	45 percent

Adopted from "Fire management in high biodiversity value forests of the Amur-Sikhote Alin ecoregion". Scientific-technical Basis of the GEF Project. A.S. Sheingauz editor. Khabarovsk, Russia, 2005).

Forest fires

Fire plays an important role in succession of some types boreal forest stands. Yet during extremely dry years or when fires are suppressed for long periods, large-scale fires with catastrophic impacts can result. In 1998, a catastrophic forest fire burned more than three million hectares of forests in Khabarovsky Province. To ensure that boreal forests are resilient to fires and maintain a natural balance during long-term natural succession, large blocks of natural forests need to be protected.

Catastrophic forest fires typically recur every 30

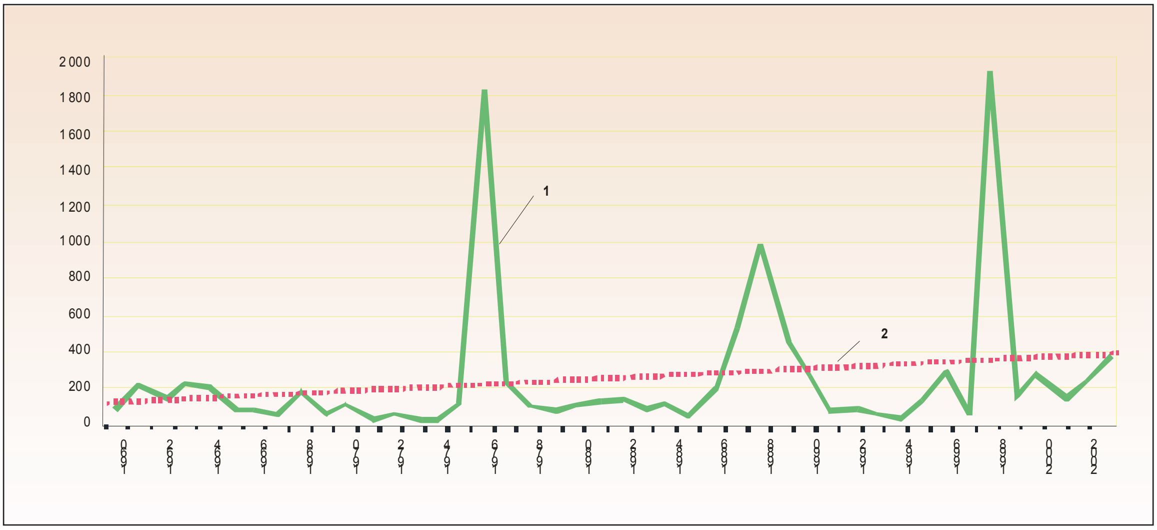


Figure 3.7 Fire Area ('000 ha) in southeastern RFE (Primorsky and Khabarovsky Krais, Amurskaya and Sakhalinskaya Regions, Evreiskaya Autonomous Region), 1960-2003, (1 –data, 2 –trend)

Source: RAS FEB ERI database, 2005 (Sheingauz 2006) years in the RFE, but during the past 50 years the frequency has increased to once in ten years (**Figure 3.7**). The largest and most disastrous forest fires occurred in 1972, 1979, 1988, and 1998. More than 1 million hectares were burned in each of these fires. As a result, non-forested habitats are increasing in area. Catastrophic fires have become a critical problem for the forests of the RFE, altering species composition and compromising forest integrity. In Khabarovsk province, which has the highest fire frequency in the RFE, research in 2003 by Medical University of RFE showed that frequent massive forest fires are positively correlated with the spread of certain diseases and mortality among human populations of the most affected districts.

In 1987 a huge forest fire in the Great Hinggan Mountains in China caused losses of billions of yuan and attracted worldwide attention. This forest area of 23 million hectares has 13 million ha of closed-canopy stands, mainly larch, Scotch pine, and birch. During 1966-1986, 100 fires that averaged 130,000 hectares were reported. In 1987 a catastrophic fire lasting for a month wiped out more than 870,000 ha of forest, with 40 million m^3 of wood and commercial timber value of more than $1 billion just in salvage timber. Two hundred people were burned alive and 56,000 left homeless. In 1988-1995 the largest salvage operation in world history, partly financed by a $56.6 million World Bank loan, salvaged 12 million m^3 of timber. Parallel efforts in reframing the fire prevention policy of China resulted in tremendous improvement in forest fire prevention in northeast China (Kreiner et al. 1990). But soil erosion and other factors degrade ecological conditions and prevent forests of the Great Hinggan Mountains from rapid recovery. Biodiversity and biological productivity of huge areas are still far from recovery. Local communities have lost many species of forest organisms that were important to the subsistence of villagers who collect non-timber forest products.

One solution pursued in the Amur-Heilong Basin is to develop and implement effective government-sponsored fire management policies. This has been done in China over the last 30 years with remarkable results: satellite imagery analysis suggests that in most border areas major forest fires have not occurred for more than 10 years (Ganzei 2004).

Consequences of fires for forest ecosystems and species

Different forest communities have different successional dynamics after fires. Succession also depends on local relief, humidity, soils and many other factors. Larch and Scotch pine forests are among the best adapted to frequent fires, while spruce and spruce-fir forests are often replaced by meadows, larch and birch stands. Among mixed forests with Korean pine, those growing in drier conditions on mountain slopes experience greater damage than those confined to stream valleys. In most species-rich mixed forests, fires reduce the number of tree species. Primeval Korean pine/mixed forests are less susceptible than other forests to fires, but after selective logging the frequency and severity of fires may rise dramatically.

In many areas recurring fires result in development of secondary wetlands, grasslands, or deep degradation of soil with exposure of barren rocks. Restoration of forest cover in such areas requires three to four times longer than average, if it happens at all.

The Amur tiger (*Panthera tigris altaica*) is a good indicator species to trace influence of fires on local fauna. In 1995-2000, forest fires burned approximately 220,000 hectares in and around remaining tiger habitats. Large, burned, open areas disrupted migration routes for tiger and its prey in winter due to extremely thick snow cover. For at least 70 years, these habitats cannot sustain wild-boar, which is the main tiger prey. After an initial 20-year period of recovery, tall shrub thickets become useless as foraging habitat for other ungulates for decades. Korean pine forests are replaced by much less productive types sustaining one tenth the densities of deer. In five years fires can completely eliminate the resource base needed to sustain one reproducing female tiger. In years of catastrophic fires damage is much greater. Such fires in 1976 affected 0.5 million hectares and resulted in replacement of Korean pine mixed forests by less productive forests and grasslands. These areas have not been recolonized by tiger.

Most species are affected by forest fires, but each in its own way and to its own degree. **Table 3.22** summarizes the importance of this factor for selected species. A map of fires in South Primorsky Province (**Map 3.13**) shows that recurring fires are explicitly linked to the network of settlements and clearly limit the expanse of habitats used by tigers and leopards.

Table 3.22 Negative consequences of forest fires on wildlife (expert evaluation from 1 to 10 based on decrease in populations and time required for recovery; 10 represents greatest impact)

Species	Crown fire	Mixed fire	Ground fire Spring	Ground fire autumn	Average
Musk deer	10	10	8	7	8.8
Reindeer	10	10	7	7	8.5
Red deer	10	9	1	3	5.8
Sika deer	10	8	1	4	5.8
Moose	7	5	1	2	3.5
Roe deer	10	6	1	5	5.5
Wild boar	10	10	5	8	8.2
Black bear	10	9	3	6	7.0
Brown bear	10	4	2	6	5.5
Tiger	10	9	4	4	5.8
Leopard	10	9	5	5	7.2
Otter	7	6	2	1	4.0
Yellow-throated marten	10	8	4	4	6.5
Manchurian hare	3	7	8	5	5.8
Fox	3	3	5	3	3.5
Grouse	6	6	9	7	7.0
Pheasant	0	0	9	7	4.0
Waterfowl	5	5	8	1	4.8

Adopted from "Fire management in high biodiversity value forests of the Amur-Sikhote Alin ecoregion". Scientific-technical Basis of the GEF Project. A. S. Sheingauz, editor. Khabarovsk, Russia, 2005

Grassland and wetland fires

Grass fires are widespread in the Amur-Heilong River system valleys and have been affecting ecosystems for at least 2,000 years as part of cultural traditions of ancient tribes and modern rural citizens. Traditional burning practices of local people were focused on suppressing rich forest and bush communities in an attempt to sustain otherwise non-viable agricultural ecosystems on which those people, mostly new settlers, relied for survival. The cultural aspect of the problem results from limited adaptation of human populations to rich local conditions very different from those in areas where they emigrated from a few generations ago (Gaponov 2006, Sukhomlinov 2005).

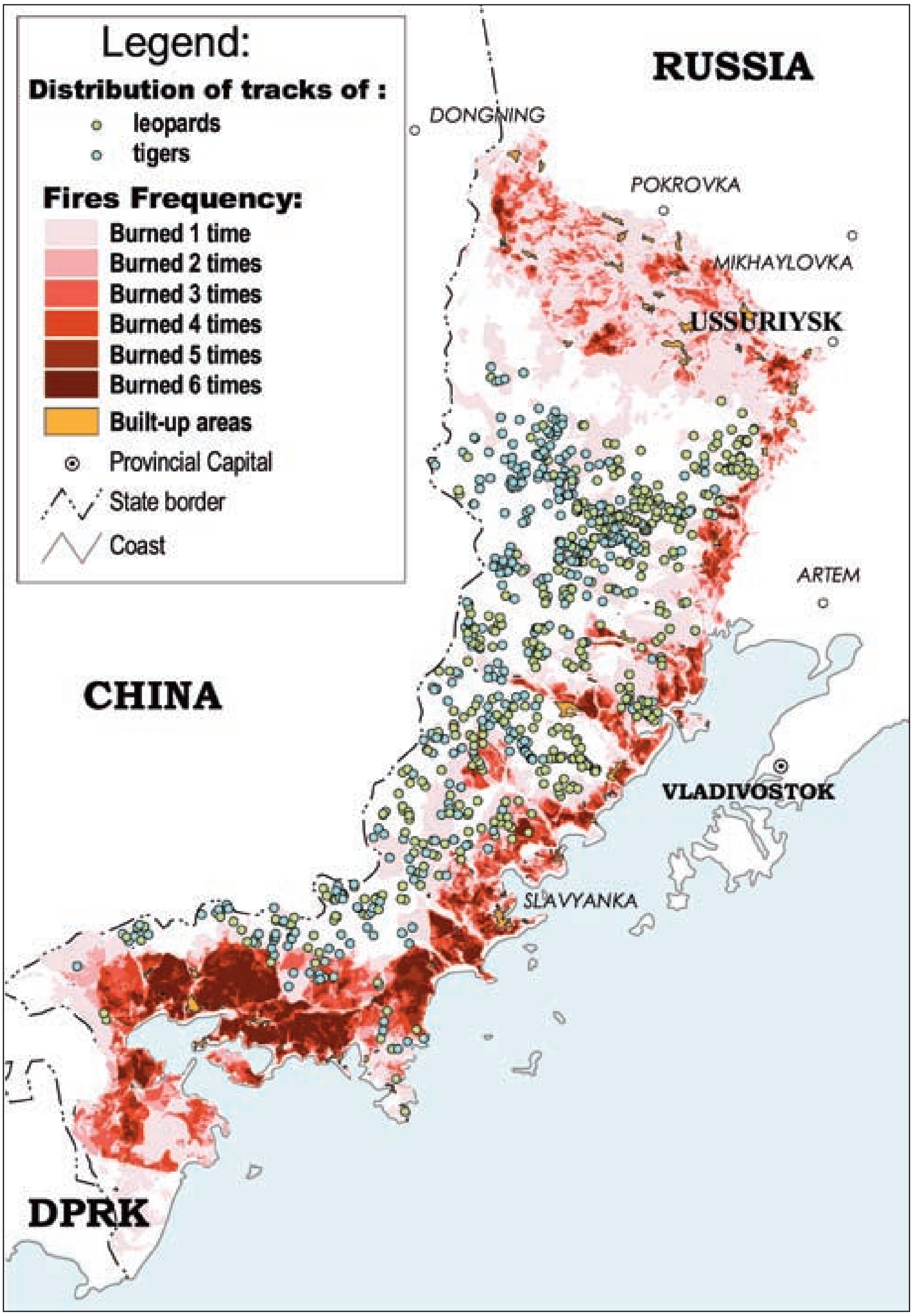
These fires maintain forest-steppe vegetation and the border between forest, meadow, and marsh habitats. The frequency and scale of grass fires depend on draught conditions and human activities. Fires should be regulated with special measures like prescribed burns or creation of mineral belts. This is easy to prescribe but nearly impossible to implement in the RFE country side, where uninterrupted fields of tall dry weeds are dominant feature of landscapes for at least half of the year.

In China's Sanjiang plain, grass fires are set to facilitate conversion of wetlands into plowed land and are routinely used by peasants to maintain and reclaim land for farming. In some areas in the Sanjiang plain burning was banned in spring and autumn. Villagers began burning during summer (Dahmer 2001). This is particularly hazardous to flightless young birds that are unable to escape fires. Burning also results in loss of escape cover, leaving surviving birds to face greater threats of predation.

Burning of grassland and wetland vegetation is a threat to wildlife, increases atmospheric and water pollution, destroys biomass, and contributes to climate change. However, it is a common practice throughout the catchment and in Russia presently happens at a larger scale than in China. Grass-fires are the single most serious impediment to natural regrowth of forests and to reforestation efforts in Zeya-Bureya plains and many areas in the upper parts of the basin.

In the countries of the Amur-Heilong basin, unlike in North America, all forest fires are still considered disasters. However, research on fires in various grassland-wetland and forest-grassland ecosystems has yielded controversial results. On one hand, many of these plant communities depend for their existence

Map 3.14 Frequency of fires in Southeast Primorski Province, summed over 6 years for which satellite imagery was available between 1996 and 2003 (Miquelle D., M. Murzin, M. Hoette. 2004. Fire impacts on the population of Far East Leopard in Sotheast Primorski Kai. http://www.tigis.dvo.ru)



on periodic fire. For example, the Zeya-Bureya plains vegetation cover has been shaped by natural and human induced fires for at least the last 1,500 years. Many plant and animal species of the region that survived up until now are adapted to periodic fires, given that these fires do not occur too frequently, do not occur in breeding season, cover only a certain percent of the area leaving sufficient refugia, and do not inadvertently change basic ecological conditions of the biotopes. If flammable litter is accumulated at a given spot in excess quantities for unusually long periods of time, it will some day catch fire, and environmental impacts will be more severe. The problem is that nowadays prevailing fire frequency in grasslands is too high and fire affects too large a percentage of the total area. Fires often occur during spring breeding season when they severely reduce productivity of nesting birds. When complicated by other land management factors (e.g. eased land conversion, more frequent droughts) excessive fire frequency leads to irreversible changes of habitats. Consequently, large expanses of land along the Amur-Heilong and its tributaries are covered by plant communities poor in species and productivity. Fire-induced changes are most acute in drier western part of the basin where fire can lead to irreversible aridization of certain habitats. With effects of climate change fire-related problems in many areas are destined to increase many fold.

Unfortunately, long-term applied research on this problem has been carried out in only a few places in the Amur-Heilong basin. In Khingansky Zapovednik, and in many nature reserves and land management units in China, current practice includes prescribed burning of dry grass in 20 to 40 percent of the area in complex forest-wetland-grassland landscapes during a particular "safe" season. While such practices undoubtedly reduce the probability of catastrophic fires, research should be conducted to evaluate whether this is effective to sustain biodiversity, productivity and other natural values of local ecosystems.

Is fire Problem #1 for terrestrial ecosystems?

According to some environmentalists, most resource economists and the majority of responsible officials of RFE, wildfire is the most threatening cause of terrestrial ecosystem degradation in the Russian part of the Amur-Heilong basin. There are many reasons for this opinion:

- Fires affect much larger areas than other threatening impacts. As for many grasslands and wetlands — fires are dominant factors shaping these landscapes in RFE);

- Fires are common companions of other human impacts (logging, agriculture, recreation), and multiply negative effects of these activities;

- Fires have a positive feed back cycle and can occur repeatedly in certain plant communities preventing their natural recovery;

- Especially in the drier, western parts of the basin, fires could lead to radical transformation of landscapes, with elimination of certain species, plant communities and even lead to desertification of certain areas.

- As droughts become more frequent fires occur more frequently and sweep across larger areas; and

- Fires, unlike illegal logging, are not perceived as results of corruption or sheer mismanagement, and responsible agency authorities in Russia cannot be blamed for "improper fire dynamics."

Fire may be the number one threat to the terrestrial regions of the Russian Amur-Heilong, but not in China. In China arson is punished as a major crime, officials are held responsible for fires, and local people do not dare smoke outside during fire-fighting season. The region is thus a large-scale socio-ecological experiment. In the near future, besides the obvious benefits of mutual learning about fire-control, it gives us an opportunity to assess the role of fires in ecosystem degradation process in the Amur-Heilong basin.

Chapter 24

Global Climate Change

Many man-made local environmental problems are exacerbated by global climate change. Droughts are endemic to the region and in its western parts are playing a major role in ecosystem dynamics. Increasing economic development consumes an ever larger share of total water resources while climate change makes droughts more frequent and severe. Together these agents are bringing some species and even ecosystem types to the brink of extinction.

Projected change

Existing scientific forecasts of future climate change in particular regions are not very reliable. According to the Hadley Center, by 2070-2100, mean annual temperature in the Amur-Heilong River basin is predicted to rise by three to five degrees C. Seasonal increases will vary, but the greatest increase of summer temperatures is predicted to be five to 10 degrees C.

Precipitation in the western Amur-Heilong basin and throughout grassland and forest-grassland zones could possibly decline by 30 mm per month (100 mm per warm season), accounting for up to 36 percent of total precipitation in the warm season. A decline of 10-30 percent in warm-season precipitation is likely to have a serious impact on wetland ecosystems. Declines in soil moisture during summer and fall are likely to have the greatest negative consequences for flora and fauna.

In the Lower Amur, precipitation might increase, but even a slight change in mean temperature leads to rapid change in depth of soil freezing and extent of permafrost areas with profound consequences for vegetation cover and hydrological regimes. Permafrost is already retreating to the north throughout the northern parts of the basin.

Ecosystem response

In the western part of the basin forest tundra, forest and forest steppe communities occur in narrow strips sandwiched between dry cold tundra in the north (or at higher elevations) and dry semi-deserts in the south (or at lower elevations). These belts of forest habitats support the major share of the region's species diversity. Any abrupt change of climate would probably lead to extirpation of these communities. Restoration of these communities seems unlikely in present climatic conditions. The existing mosaic of forest-steppe on mountain slopes in Mongolia is the most likely first candidate for extirpation induced by climate change. The complex mosaic of habitats in most ecoregions of the Amur-Heilong basin is largely dependent on current climate patterns and climate cycles, and high variation in precipitation between years and seasons. Smoothing of this variation in the course of climate change will lead to decreasing diversity of microclimates in adjacent locations and subsequent losses of habitat diversity. Therefore climate change will inevitably affect regional landscapes. However, reliable data on current trends are scarce and most originate from long-term research and monitoring in zapovedniki (strict scientific nature reserves).

In the Sikhote-Alinsky Zapovednik, climate change might push the ranges of many species of temperate mixed forests (tiger, wild boar, deer) northward and increase the densities of local populations. In the Zeisky Zapovednik, long-term changes in musk deer populations are clearly correlated with cycles in precipitation. Climate fluctuations affect forage availability for musk deer by making habitat conditions better for lichen growth after wetter years and enabling better access to tree lichens in winters with high snow cover. Therefore it is possible that as the regional climate becomes dryer, musk deer populations will suffer due to decreasing forage availability.

In the Khingansky Zapovednik of the middle Amur-Heilong, climate change and cycles have been studied in detail. The prolonged drought has been shown to negatively affect reproductive success of oriental white stork, and population numbers of white-naped cranes, red-crowned cranes, and other waterbirds. Their repro-

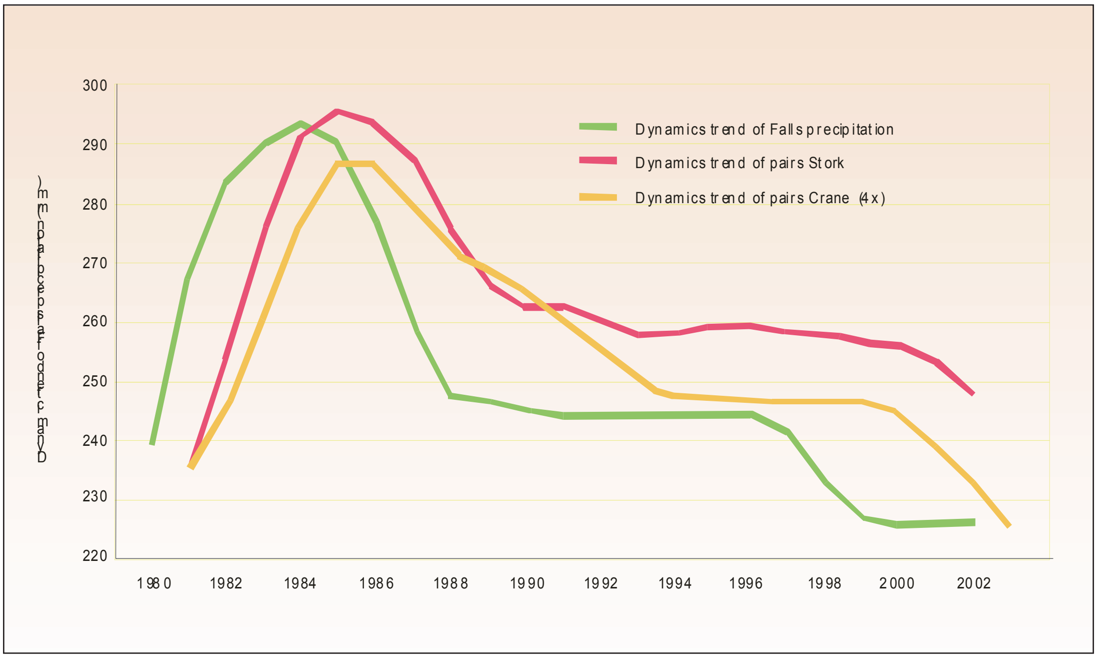


Figure 3.8 Precipitation correlated with numbers of breeding pairs of storks and cranes

ductive success in the wild depends on water supply to the breeding areas during nesting and brood-rearing because cranes and storks feed mostly on aquatic organisms. Declining numbers of frogs and loaches (small fish) are results of low water levels in rivers and streams. The breeding success of cranes and storks in spring and summer is determined by water retained in streams and soils from the previous autumn (wet season). There has been a trend of decreasing annual and autumn precipitation during last 10-15 years. Since 1936, there have been three droughts of six to seven years each and one continuing drought for the past seven years (**Figure 3.8**). This will ultimately threaten the populations of cranes and storks as climate change progresses. (Kastrikin V.A. 2005,Parilov et.al 2006 in Kokorin ed. 2006)

Warmer temperatures are also indicated by northward shifts of the northern borders of the natural ranges of several bird species: Great Grebe (*Podiceps cristatus*) extended its northern range limit to the Khingansky Zapovednik during the last twenty years; the first records of Swinhoe's Yellow Rail (*Coturnicops exquisita*) in the Middle Amur-Heilong River basin were made in the 1990s; Manchurian Reed-warbler (*Acrocephalus tangorum)* was recorded near Bolon' Lake (Khabarovsk region) in 2000. The drought caused some mammal and insect species of arid areas to expand their geographic distributions (Kokorin ed., WWF 2006), for example, *Cricetulus barabensis* settled in the grasslands of the Khingansky Reserve during the last four years. The portion of steppe *Tabanidae, Diptera* increased from 45 to 60 per cent during 2002-2006. *Tabanus signatipennis* which previously occupied China, Japan, and Korea was recorded in the Khingansky Reserve for the first time.

Ornithological research throughout the region also suggests that ranges of many southern species have extended northwards during the past 20 years.

Socio-economic response to climate change

Land use changes result from a complex interplay of many factors, but climate change is definitely one of them. This can be seen from a case study on change of main grain crops in Heilongjiang Province from the 1980s. The following case study reflects trends occurring over a short period of time and may not be indicative of longer-term trends. However, these findings might accurately reflect current trends, suggesting that the influence of climate change on regional land-use is being felt much faster than some expected.

This case study investigated the relationships between changing acreages of grain crops and global warming in Heilongjiang Province. Analyses were based on agricultural statistics and ground-based climate data during 1980 to 2001. The analyses showed:

- All the thermal indexes indicated that air temperatures in Heilongjiang Province have increased remarkably over the last two decades. 1984, 1987, 1994 and 1997 are 4 important turning points in the warming

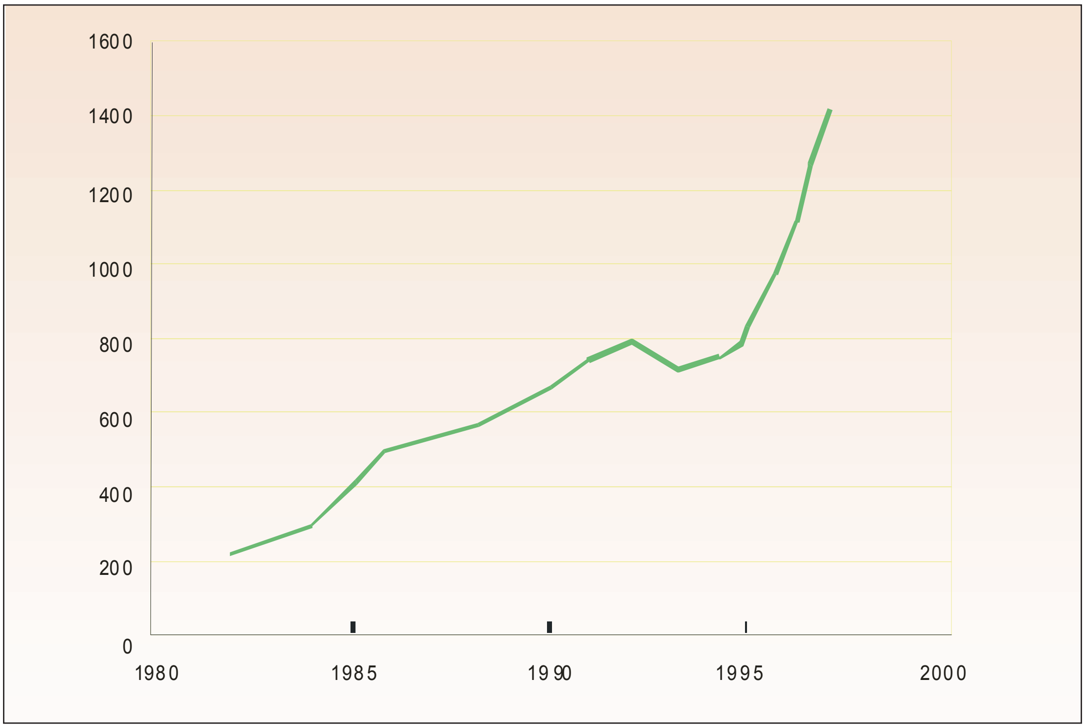


Figure 3.9 Expansion of rice fields in Heilongjiang 1980-2000 (left scale-'000 hectares)

Source: Heilongjiang Today: Information office of the people's government of Heilongjiang Province. Harbin, 2003.

trend. The magnitude of the warming trend increases from the north to the south and from the east to the west. Song-Nen Plain was most affected.

- Wheat, corn, and rice are three main crops planted here. With increasing air temperatures, the rice acreage has increased from 2×10^5 ha to 16×10^5 ha, wheat acreage has declined from 20×10^5 ha to 6×10^5 ha, and the acreage of corn has increased (**Figure 3.9**). Thus the planted acreage has shifted from dominance of wheat and corn to dominance of corn and rice over the last 20 years.

- The relationship between the acreage of these main crops and global warming is evident. The northern planting boundary of rice in Heilongjiang Province has extended to 52º N, and has also expanded to the east. The borderline of corn also advanced northward. Meanwhile, the wheat areas have retreated northward. The changes in planted area lag 1-2 years behind the temperature change.

This example also shows interplay between climate variations, agricultural policies of the government, and advance in farming technologies. But any real-life example will present us with interplay of natural and human-induced factors, which finally is or should beat the heart of our analysis.

Because the conversion of wetlands to agriculture most easily happens at the fringes of wetlands in dry years, a dryer climate results in greater acreage of converted wetlands. The same holds for dessication of natural wetlands due to overexploitation of aquifers and surface waters driven by irrigation demand. There is a pressing need across the region to analyze data on climate change and drought cycles and their interplay with fire and different land use pressures.

We can predict that persistence of current wasteful water management policies coupled with projected climate change will contribute to:

- further aridization of natural landscapes;
- decreasing surface water flows in river courses;
- further declines in water resources available for use; and
- increased levels of pollution in watercourses

Given current modes of development, these factors will spur massive use of the Songhua, Ussuri, and Amur-Heilong River waters, with construction of large reservoirs on the main channels of major rivers being the most effective means of water diversion.

Chapter 25

Exploitation and Trade in Biological Resources

Hunting and collecting exerts severe pressure on flora and fauna populations and species numbers. The pressure intensifies with growth in human population density, development of trade, and advances in technology. In the Amur-Heilong basin, hunting and collecting is clearly unsustainable and is largely conducted illegally in all three basin countries. The harvest has led to declines in many populations..

Plants and animals in the Amur-Heilong River basin are being overexploited due to:

- its rich and unique biodiversity;
- its close proximity to Asian markets with diverse and strong demand for such products;
- increasing demand in those markets supported by growing wealth;
- impoverishment of rural communities, unemployment, deterioration of welfare systems of the socialist era;
- deterioration of regulation of the trapping industry, which no longer allows a trapper to sustain himself through legal taking of fur-bearing animals, and thus converts him into a poacher; and
- inefficient legal systems and inadequate management capacity both in customs and wildlife enforcement in the face of growing liberalization of international trade.

Although the above list of factors was compiled by Lyapustin et al. (2005) specifically for the RFE, at least the first four factors are important in all three basin countries.

Hunting in the RFE

Some of the far-reaching impacts of hunting in the RFE are:

- impacts on populations, distribution, and age structure of wild animals;
- overhunting of many species in certain areas;
- widespread poaching of rare and endangered species;
- disturbance of other flora and fauna by hunters;
- control of wolf populations to keep game numbers high; and
- protection of certain areas and baiting of ungulates, which changes distribution patterns and movements

Hunting in the RFE is traditional, and it is often the only livelihood for indigenous peoples. Hunting is permitted on 95 percent of the territory of the RFE. More than 300 hunting estates function in the region, and there are approximately 87,500 registered hunters, of which more than 1,000 are commercial hunters. Game resources in hunting estates are still abundant, but the populations of most game species are decreasing throughout the region. Remote areas have relatively abundant game animals, while in areas close to human settlements, animal populations are depleted.

There are over 200,000 sable in the RFE, of which more than 32,000 were taken in 1997-98. Brown bears number about 11,000, of which 638 were legally killed that year. Around 350,000 ungulates inhabit the region, 8,000 of which were hunted officially in 1997-98. When considering poaching (without permit or over established quota), the actual number was approximately five times greater. For a recent review of management of fur-bearing animals see the 2005 TRAFFIC publication “Trapping A Living”.

Unfortunately, the existing state system of game estates has crumbled, and most entrepreneurs who now lease them privately do not adhere to high standards. The game industry is no longer profitable and management is unable to keep qualified people to serve as rangers or to invest in restoration of game populations. In general, hunting and fishing inspectors, charged with enforcing restrictions, have suffered declining morale and lost much of their mobility and enforcement capabilities. Poaching is widespread due to high levels of unemployment in remote forest villages.

Rural people are not involved in management and distribution of wildlife resources, experience considerable hardships in obtaining various licenses and permits, and consequently return to illegal means of hunting. According to Gaponov (2006), measures to protect species of high commercial value prove ineffective because they fail to consider the public good. It is extremely important to redistribute legal authority for control and allocation of natural resources in a way that advantages local communities through local self-government.

The harvest of biological resources in China

Due to greater population density in China and much more intensive use of wild biological resources, populations of wildlife in northeast China are under much greater harvest pressure than in Russia. The range of species collected for food or medicine in China is very wide. Examples are striking for a westerner accustomed to a much less diverse diet.

Far East forest frog (*Rana* dybowskii) is used in pharmaceutical and perfume manufacturing, and is also a food delicacy. Its case history exemplifies the potential for unregulated harvest to decimate wildlife populations. The same species is a perfect example of how wise management can reverse negative trends. When populations were being decimated in Heilongjiang Province, the Provincial Forestry Department adopted a policy of allowing individuals to lease stream valleys for frog rearing. This consists of several practical methods of ensuring better conditions for wild frogs to survive the winter in deep ponds, salvaging roe from drying seasonal pools, and feeding larvae to increase survival in the most critical first year. The lease holder is entitled to exclusive use of his stream valley and is permitted to harvest mature (3-4 year-old) frogs each autumn. At least in the valleys of the Small Hinggan Mountains, this policy worked both for frogs and lease-holders (typically local forestry officers). Long-term consequences of this approach to frog conservation are yet to be studied, but are unlikely to be detrimental (Maslova 2005).

Small passerine birds are caught in large numbers and used both as daily food and for sale. Birds are caught in nets set in backyards of village homes. An estimate for one small Lindian District north of Daqing is 10,000 birds per day during four months of spring and autumn migration each year (Guo Yu Min pers. comm. 2004). Since many households practice this routinely it cannot be combated only by law enforcement.

Hunting with rifles by local residents was banned in China in the 1990s when firearms were surrendered by the public. Small-scale sport hunting at designated hunting reserves is now the only legal form of hunting and is unlikely to affect wildlife populations or species numbers. The ban on firearms has had a positive effect on numbers of many game species and decreased their fear of humans, so that one can easily observe waterfowl and grouse at much closer distance than that typical in Russia. For example, a 10 year hunting ban in Jilin Province and associated conservation measures have led to twofold increases in roe deer and wild boar and less pronounced but steady increase in other ungulate populations (WWF-China 2006).

However, in remote areas poaching is widespread, the range of hunting tools is diverse (traps, snares, nets, explosives, poison), and enforcement systems are far from perfect. Resent limitations on logging has led to massive migration of former loggers from mountain forests into towns, thus somewhat relieving this pressure. Nevertheless, if sufficient market demand arises for particular wildlife species, natural populations can be reduced dramatically in only a few years if not months. Hunting is illegal: Villagers who take part of their subsistence from the forest are, by strict interpretation of the law, engaged in poaching.

Authorities are trying to encourage licensed “wildlife farming”, but this may lead to further depletion of wild populations, because specimens for “farming” are caught alive in the wild. Farming is encouraged for such species as wild boar, red deer, Sika deer and roe deer, wild ducks and some others. Bear farms have been an especially controversial issue. Bears are illegally caught to supplement existing farm populations. Little is known about the status of China’s bears in the wild. It is extremely unlikely that the black bear is any-where near as plentiful as official statistics claim. The proliferation of farms stocked with wild-caught bears is directly affecting China's wild populations of Asiatic black bear and brown bear. Bears are also being taken, in violation of CITES, from neighboring countries to supply the farm trade in China. Although the government claims to discourage the capture of wild bears (no permits to capture bears have been issued since 1989), few farms are stocked with anything except bears from the wild. Of the farms visited or researched by international experts, only one has even contemplated breeding its bears because buying so many wild bears seemed too expensive (Highley and Highley 1994). Despite these concerns and lack of clear scientific evidence on the effects of farming, China authorities insist that farming contributes to bear conservation, and at least in the Small Hinggan Mountains the frequency of encounters with black bear increased substantially over the recent decade (Simonov interviews of forest managers, villagers, naturalists). Russian game managers also claim that gall-bladder from farmed bears has overtaken the market in China, such that now a Russian hunter must kill three bears to earn the same money that he could make just from one bear several years ago (Ermolin A., Krechet Hunting Society, pers. comm. with Simonov).

Since the early 1990s the no-access policies at the Russia-China border were weakened and by 2005 ecosystems near the border experienced double pressure from both Russian and Chinese populations. In 2002-2004 in Primorsky Province several incidents of intentional poisoning of small rivers by Chinese subjects present a vivid example. Small groups of Chinese villagers, probably from poverty areas, went across the border into a poorly guarded border strip of Russia and used outdated pesticides to catch frogs and small fish for sale in local markets. Poaching in a wide border strip located between posts of border guards, and rarely visited by guards from either side, became a widespread problem.

Conservation efforts undertaken on one side of a border do not necessarily help to protect transboundary ecosystems. At the end of 2001, the Wildlife Conservation Society (WCS) China Program established the first Amur Tiger and Far Eastern Leopard Office in Hunchun Nature Reserve located on the border with Southern Primorsky Province of Russia and DPRK. In 2002, six monitoring stations with a total of 36 staff were set up at the reserve. Staff of the Nature Reserve management bureau work jointly with the forest police bureau to take wide-ranging and large-scale actions to fight poaching. This effort uncovered nine criminal cases, confiscated five guns, 200 rounds of ammunition, 24 detonators, five sticks of dynamite, five grenades and over 3,000 poaching tools, such as steel wire traps, clinchers and stylets. The posts also found one leopard skin, 3.7 kg of leopard bones, one deer tail, two deer penises, 21 roe deer, one boar, one musk gland, one bear gallbladder, wild geese, widgeons, vultures, and hawks.. WCS sponsored the Hunchun Nature Reserve management bureau to launch the "Mountain Cleaning" Project from January 2002 to March 2004. It was undertaken twice, each time for two months, to remove snares, poaching traps, and clamps. Over 4,000 of them were removed from the mountains along the border (Wild Amur Tiger Conservation in China. Li Zhang. Institute of Ecology, Beijing Normal University).

On November 2004, Russian border guards and a "Tiger" special anti-poaching brigade investigated a site 1.5 kilometers from Jilin Province, beyond the barbed-wire fence, where a body of a female tiger was found. The tiger was trapped by a 5-millimeter thick steel-rope snare set on a deer trail. Remains of two red deer, nine similar snares and seven bottles for chemical substances with Chinese characters where found in the vicinity. This was most likely a snare set by Chinese poachers coming from vicinity of neighboring Hunchun National Nature Reserve, where antipoaching measures were undertaken earlier in 2002-2004. This is a typical illustration of the lack of cooperation on nature conservation in the border zone, where it is increasingly difficult to control poaching. In these circumstances efforts to combat poaching on the Chinese side of the border ultimately result in increased poaching in poorly protected parts of the same ecosystem in Russia.

Trade in flora and fauna in RFE

Unfortunately at least 80-95 percent of trade in flora and fauna products is conducted through illegal channels and evades control and accurate statistics in most countries of the world. This is especially evident along the Russia-China border.

For several centuries perspective poaching and uncontrolled trade in wild animals and plants has been a major problem in the Russian Far East. In the late 19th and early 20th centuries, the Russian government was unable to control hunting and trade in wild products conducted both by Russian and foreign subjects. While marine mammals and fish were largely the domain of American and Japanese poachers, terrestrial flora and fauna have been most extensively exploited by Chinese subjects. From 1899 to 1910 the number of Chinese hunters in the Ussuri taiga was estimated at 50,000, while ginseng collectors reportedly reached 30,000. Well established networks of Chinese traders covered the whole region and involved in this trade the majority of aboriginal peoples and Russian settlers. Sable and marten fir, musk, deer antlers, tiger and goral, river pearls, ginseng were especially sought after due to great demand in China. In what is now Primorsky Province, the annual harvest of sable was 150,000; for musk deer, 30,000 animals; and for tiger, 150 animals. Annual exports of ginseng only from the city of Vladivostok were estimated at 380 kilograms, an amount approaching the contemporary harvest in forests of China. A customs-free zone along the border existed until 1913 and this greatly eased smuggling of animal and plant products. After the Russian Revolution of 1917 the situation did not improve and similar devastation of wildlife resources continued through the 1920-30s, but decreased afterwards due to strict border controls and after most foreign residents were expelled from the RFE. Many authors claim that rampant poaching and trade during the late 19th to early 20th Centuries was the main cause of rapid declines in many biological resources including sturgeon, salmon, ginseng, and tiger (Lyapustin 2006). However some authors also claim that not allowing Russian subjects to manage biological resources at the local level is an equally important factor in the deterioration of RFE wildlife populations (Gaponov 2006).

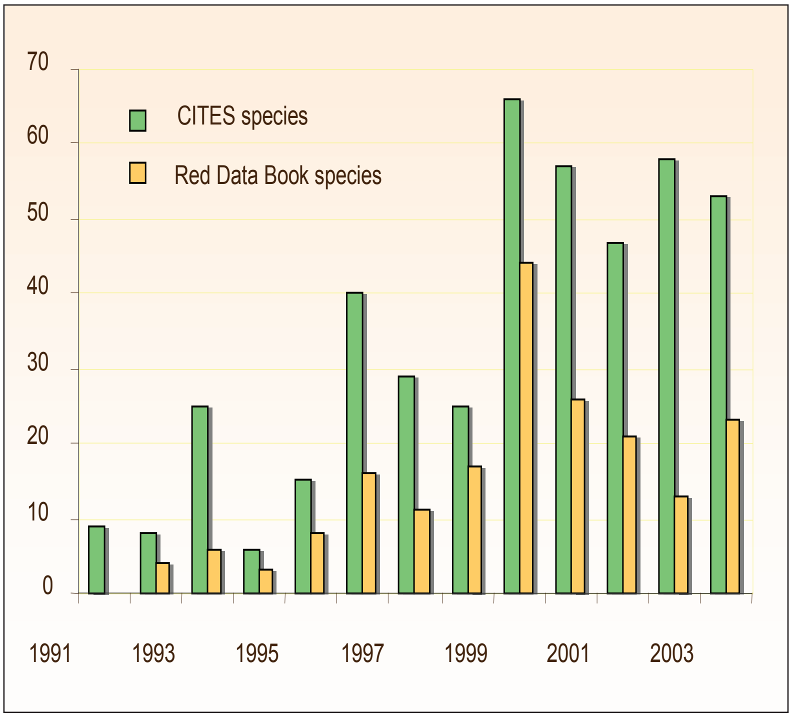


Figure 3.10 Illegal Transportation of CITES and Red Data Book Species through the Russian Boundary

Liberalization of the border regime and trade incentives for poaching has enabled a many-fold increase in demand from Asian countries and networks of Chinese traders seeking a wide assortment of animal products. According to Chinese respondents questioned in Russia, prices for animal products (deer penis, musk, bear bladders, soft-shelled turtle) in local markets in Birobidzhan (Evreiskaya Autonomy) is at least 20-50 percent less than in neighboring Heilongjiang Province.

Most data presented below are derived from assessment of trade in fauna and flora in the RFE from 1999-2003 based on customs data (Lyapustin 2005). In terms of legal protection, products might be divided into the following categories:

- CITES-listed species (ginseng, sturgeon, bears, musk deer, otter, tiger, leopard, other felines, falcons, and wolf) (**Figure 3.10**);
- Russian and provincial Red Data Book species; and
- Other economically valuable species taken and traded by illegal means.

In 1999-2003 more than 600 violations (255 of those relate to CITES-regulated species) were disclosed by customs officials. This number constitutes a small fraction of the total number of illegal transactions. The list includes well over 60 species of animals and plants used for traditional medicine, food, fur, and as pets. Most products originated from the RFE, but traffic of products from Siberia and other regions was also high through eastern borders. Most of this traffic goes to China, the Koreas, Japan, and less frequently to USA and Europe. Among individuals charged for customs violations from 1999 to 2003 there were 363 Chinese citizens, 133 Russian citizens, 51 South Korean citizens, and less than a

Table 3.23 Selected investigated customs violations and volume of trade in comparison with results of "Tiger" anti-poaching enforcement squad, Ministry of Natural Resources (Statistics for 1999-2003 in RFE)

Item	Customs: # of incidents	Customs: Volume (in pieces or specified)	"Tiger": Volume (in pieces or specified)
Black bear cubs	2	21 live cubs	28
Bear paws	34	448	168
Tiger bones	15	14 sets	5 sets
Tiger skins	2	2	20
Musk	42	208	71
Red deer antlers (panty)	44	139 kg	
Squirrel pelts	6	3433	18006
Sable pelts	5	968	65
River Otter pelts	7	457	16
Racoon dog pelts	6	4286	
Ginseng root	31	41306 gram	67543 gram
Pine nuts	4	98 ton	
Orchids	1	240	
Amur sturgeon and kaluga meat	37	27 ton	
Sturgeon caviar salted	17	8 ton	
Sturgeon caviar live	2	14 kg	2 kg
Frogs dried	5	158 kg	
Soft shelled turtle	48	200	

dozen individuals from other countries.

Criminal networks supporting this business are well organized, equipped with modern means of communication and weapons, often supported by corrupt officials of enforcement agencies, and helpful in moving traders through well designed channels for border crossing. With this support, the traders rarely get caught. Products are typically harvested by local rural residents, bought by Chinese traders or Russian intermediaries, accumulated in special secret storage facilities, transported by large, well -armed parties for secure but illegal border crossing. A good example of the magnitude of this trade comes from one March 2004 seizure, when the following items were taken:

- 1,600 sable furs
- 142 antlers of red deer (108.5 kg)
- 30 red deer testicles
- 3 red ptarmigan
- 13 kilograms of deer musk glands
- 388 kilograms of sea cucumber
- 2,180 black squirrel pelts
- 155 river otter pelts
- 33 pelts of raccoon dog
- 30 red fox pelts
- 778 bear paws
- 24 bear gall bladders
- 1,550 furs of red marten
- 3 deer hearts
- 32 fresh penises of deer
- 47 dried penises of deer
- 17 frozen penises of deer
- 133 deer tails
- 49 kilograms of dried frogs

Of course there are also individual smugglers and firms specializing in certain products, but the mode of operation described above accounts for most of the traffic.

Efficiency of customs controls is believed to be higher than that of anti-poaching enforcement operations, but still very low. Selected statistics of violation controls from 1999-2004 in the RFE are listed in **Table 3.23**.

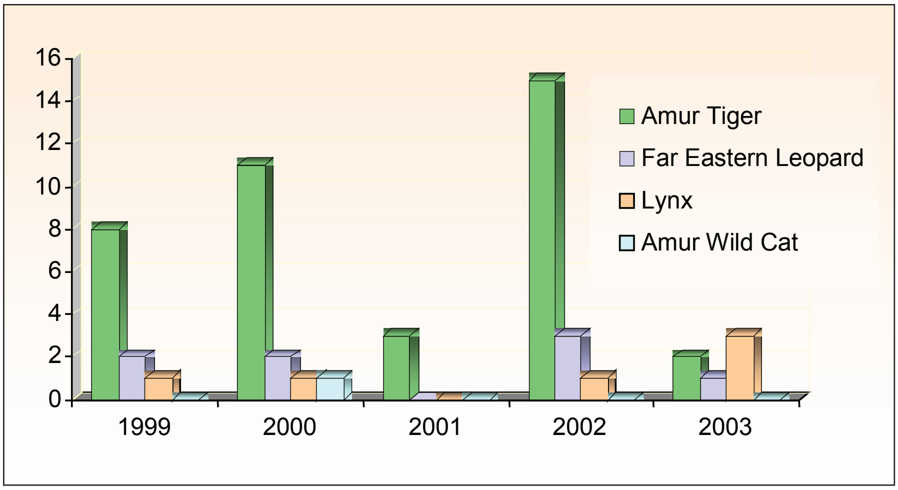


Figure 3.11 Number of Registered Attempts to Smuggle Feline Derivates

The degree of threat from trade varies widely for different species depending on population numbers, demand, degree of protection, and many other factors. Thus trade in tiger and leopard products, protected in all countries of the region and by CITES, is believed to attract the greatest attention of enforcement agencies. Therefore, disclosed violations probably account for more than 10 percent of all poaching and smuggling incidents. Poaching and smuggling of tiger and leopard is very risky, but steady demand from China, the Koreas, and Vietnam contributes to its persistence (**Figure 3.11**).

Bears, considered game species in Russia but subject to trade regulation by CITES, are the victims of a much greater number of violations. In adjacent China, both brown and black bears are protected by law due to extirpation of native populations. Many bear products are in high demand in Asia markets and this contributes to steady pressure on populations in adjacent provinces of Russia. Legal traffic is minimal, since it is difficult to obtain CITES permits even for a bear hunted in full accordance with Russia laws. A similar situation prevails for musk deer and other deer species, although trade in most of them is not regulated by CITES. For a detailed review of musk-deer trade in Russia and Mongolia see "No license to kill" by Traffic-Europe (2004).

Trade in animal pelts seems to account for the most significant share of legally traded goods, with legal exports slightly exceeding or equal in volume to the estimated illegal trade. China is the main destination of legal and illegal trade in unprocessed pelts, with finished products often exported back to Russia. Skillful Chinese traders successfully compete for local supplies with Russian firms traditionally exporting pelts to European Russia and European countries.

Trade in wild birds is much smaller by volume, but has a wider array of destinations. Among these are Arabian countries, European, and American collectors and zoos.

Chinese soft-shelled turtle, frogs, and snakes are caught and illegally exported to China. This problem is not a new one. Before the 1930s frogs from the Suifenhe (Razdolnaya) River valley and other areas were highly valued in Chinese markets. This harvest was restarted in the 1990s by Chinese migrant workers, and nowadays Russian collectors capture and sell frogs and turtles to Chinese traders.

Trade in wild plants and mushrooms is also widespread but is often overlooked, with pine nut being most common legally traded item and ginseng being the most famous object of illegal trade. WWF-RFE conducted several studies on ginseng trade and concluded that after the opening of international markets in 1991 and due to the growth of smuggling activity, the demand for wild ginseng has skyrocketed. Black market prices have increasingly exceeded the official state purchase prices. Impoverished rural Russians have begun to harvest ginseng on a large scale for sale entirely to Chinese traders. All remote forest areas have become subject to uncontrollable ginseng harvest. The official and the factual sides of this business have practically nothing in common. The examples of 1992 and 1995 are especially enlightening: The official harvest was reported as 70.5 and 27.0 kg, respectively, while extrapolation-based studies show that at least 1,200 kg of wild ginseng root was exported in those two years. In 1997 the governor of Primorsky Province issued Decree # 251 "On measures to improve protection of wild ginseng and regulate harvest of ginseng roots", which set a harvest quota at 50 kg per year. In 1998, the harvest of wild ginseng root was banned completely. Despite these measures annual harvest of raw ginseng roots only in the central part of Primorsky Province totals up to 500 kg, according to the data submitted by some competent authorities. Results of a residents' poll conducted in over 40 towns and villages show that up to 1,000 kg of wild ginseng roots have been dug out and smuggled to China. Extrapolation of these data across the entire ginseng habitat in the Russian Far East suggests that we should speak of 1,200-1,500 kg of illegally harvested and smuggled wild ginseng roots annually. (Fomenko and Gaponov 2003, Gaponov 2006).

Although there is little evidence that any species in the RFE has been brought to extinction by poaching (except for Steller's sea cow in the 18th Century), neighboring China has a rich record of poaching-caused extinctions. Many species still routinely hunted in Russia, are listed under CITES Appendix I and II and assigned protection categories 1 and 2 in China, with vigorous demand for products derived from them. This means that further liberalization of border trade and associated involvement in Asian markets presents a very difficult challenge for protection of fauna in RFE.

Fishing

Over-harvest of fish resources is an acute issue throughout the Amur-Heilong basin. Decline in fish resources was observed in the late 19th Century and attributed to uncontrolled international fishing in the Lower Amur and along the sea coast, leading to declines in numbers of sturgeon, salmon and other species.

In the late 1940s, the rapid decrease of freshwater fish harvest in the Amur-Heilong was caused by increased fishing during WWII. These circumstances led the Soviet government to send an ichthyological expedition to Amur. The leader of the expedition was Georgii Vasilievich Nikolsky, professor of the Moscow State University. This expedition remains the most consistent and comprehensive analysis of fish and fisheries in the basin. The main recommendations for fish stock restoration such as banning most barbaric harvest methods used by fishing collectives, designing less destructive fishing gear, artificial propagation of some valuable species, etc. were only partly implemented by authorities. **Figure 2.5 in Part Two** shows the steady decline in fish harvest, leading to collapse of most state-owned fishing enterprises.

Presently only the Lower Amur and the Middle Amur-Heilong below Hinggan Gorge retain commercial fisheries on the Russian bank. Due to very different traditions of fishing and regulation, China retains a system of commercial fisheries with fishing plots leased by professional fishermen further upstream in the Amur-Heilong. Subsistence fishing by the local Chinese population includes a variety of devices, some nets using fine mesh capturing three to five centimeter fish fry, as well as occasional use of explosives and poisons. Subsistence fishing among the Russian population has been constrained since the 1960s by a strict border protection regime. This unequal access to river resources is seen as a major injustice by locals and leads to assigning blame for overfishing entirely to the China side, in spite of the fact that the real mechanisms of fish depletion are much more complex. Indeed, the root cause of the currently depressed fish resources is the lack of an adequate international fishing regime throughout the transboundary basin. Existing international fishing rules are partly out of date and are poorly enforced by both sides. They do not relate to the Lower Amur which includes important fish reproduction habitats and migration routes for salmon and sturgeon. While China presumably is responsible for overfishing in the Middle Amur-Heilong, Russia has an extremely poor enforcement system in the Lower Amur, characterized by severe overfishing of salmon and sturgeon. This combination of ineffective management precludes restoration of fish stocks throughout the basin.

One of the most noticeable changes in recent years due to poor fisheries management is the decrease in the spawning range of salmon, which, only 30 years ago, extended upstream to the Upper Amur-Heilong but now only reaches the middle of Hinggan Gorge.

Several species of fish are listed in Russia's Red Data Book (endangered species) with unclear justification and poorly defined protection measures. For example, Chinese perch or "auha" is listed as a species at the northernmost reach of its geographic range. However, it is a staple food throughout China and a species of choice for fish farming. Natural population numbers fluctuate widely year to year, and in abundant years this fish may account for up to one quarter of daily catch in the Middle Amur-Heilong.

For a comprehensive review of fishing see the recent publication by WWF-RFE, "Amur Fish — Wealth and Crisis" that reflects current views of Russian experts on the subject. Data for China and Mongolia fisheries are confined to case-studies in the Socio-Economic Development chapter of this report.

Chapter 26

Conclusion

Lack of comparable data from adjacent countries and unified databases for the region are two of the key obstacles to a more detailed analysis of threats to biodiversity in the Amur-Heilong basin. Many questions remain unanswered, and methods for a prognostically useful synthesis are yet to be designed.

Human-induced pressures, including climate change, cyclical droughts, and fires, all interact and threaten regional biodiversity.

The impacts on biological systems vary from region to region. The resilience of different ecosystems and species populations to human activities varies from ecoregion to ecoregion, and from country to country. For example, paving roads in the Mongolian steppe could well aid in reducing soil erosion caused by multi-tracking off-road vehicles and simultaneously cause little or no damage to hydrologic regimes. In contrast, in northern RFE new roads can severely degrade hydrologic regimes and soils but these impacts are negligible in comparison with other road related impacts such as opening remote areas to human disturbance and exploitation of resources and increasing fire frequency. On the Song-Nen and Sanjiang plains of northeast China, roads often dissect wetlands, block flows of surface water, displace farmlands, reduce infiltration of rainfall and increase soil erosion. Conversion of farmlands and urbanized sites to roads is typically compensated by sacrificing another parcel of the great northern wilderness.

These three cases demonstrate the wide variation in the nature of impact caused by a single type of human intervention, road construction. This leads us to conclude that assessment of threats, impacts and their causes should be undertaken within ecoregions or even smaller biogeographic units.

Comparison of ecoregional profiles will provide a clear picture which ecosystems and species of the basin are most threatened and why. Comparative analysis of national components of transboundary ecoregions will help identify and explain the causal mechanisms underlying threats and their relationships with socio-economic systems and cultures.

This is an important step in a needed analysis of conservation priorities, but only takes us part of the way toward answering the question "What is to be done?" While problems may be usefully considered at the scale of natural systems, solutions and adjustments should be planned in socio-economic dimensions.

Socio-economic systems today do not function within the bounds of ecoregions. Many major human-induced pressures and threats span ecoregions, the entire river basin, or even extend beyond the basin boundary. Responsible analysts should work at scales commensurate with the extent of threats and the scope of proposed land-use planning adjustments.

Readers of this chapter may already be convinced that using national boundaries to constrict impact analyses is a mistake because resource-extraction often has transboundary dimensions. Nevertheless solutions are obvious and rather simple. The long-term development policy for Revitalization of Old industrial Bases is already at work in China's northeast and a detailed analysis of the environmental limitations of this region has been drafted by the Chinese Academy of Engineering (CAE 2007). Concurrent policies in RFE and Mongolia are reactive rather than proactive, attempting to adapt to their more energetic neighbor while trying to counterbalance its influence.

Because of its transboundary, regional, and global implications, China's northeast development strategy and the countermeasures or adaptations of Russia and Mongolia are valid subjects for a focused transboundary strategic environmental assessment (SEA). This might respond to a range of issues including:

- the cumulative and interrelated impacts of policies, plans and programs;

- the identification and priority ranking of locations and types of projects for funding;
- the identification of sensitive sites where development plans require detailed evaluation before modification, rejection or approval;
- the selection of different short- and long-term development options;
- a definition of the key policy elements for sustainable natural resource management in the Amur-Heilong basin.

This list of issues will help:

- strengthen the process of EIA for individual projects, particularly the extent to which they integrate the often complex web of interrelated sectors and stakeholders;
- advance the sustainability agenda for the region and national territories within it; and
- address the cumulative and large-scale impacts, including those that cross national boundaries.

Most if not all of the above issues need to be addressed within the context of SEA and methodically applied to the North East Old Industrial Bases Revitalization policy and its less completely articulated equivalents in adjacent countries. This is not a new conclusion, nor does it differ greatly from recommendations made as early as 2001 by Asian Development Bank with reference to the Songhua River Flood, Wetland and Biodiversity project (ADB 2001). But the passage of five years has not diminished the utility of this recommendation and recent emphasis on the North East Old Industrial Bases Revitalization policy in China makes the call for a basin-wide SEA even timelier.

Given the favorable attitude of most international institutions to strategic, large-scale assessments it would appear a simple task to arrange funding and expertise to complete the task. But one important obstacle continues to block the path to integrated transboundary strategic assessment and planning: the persistent lack of coordination in protection and resource management among basin countries. To date we are unaware of any joint program or agreement between China, Russia, and Mongolia, that could serve as a useful launching ground for such SEA (see Part Four for more specific discussion).

Rapidly deteriorating environmental conditions in the Amur-Heilong basin require national and international programs on environmental management. Joint assessments must precede such programs.

Part Four

Options for the Future

Four Essays and Two Case Studies

Roe Deer crossing a Wusuli-Ussuri River tributary © WWF-Russia / V. Solkin

Conservation education—Saving Cranes © WWF-Russia / Y. Darman

Chapter 27

Essay Number One:

Future economic development and nature conservation in the transboundary ecoregion

By Eugene Simonov

Cooperation for consumption

In Davos in 2005, China's leaders predicted that national per capita incomes would triple by 2020. Russian leaders plan a 120 percent increase by 2015. These predictions are based in part on recent economic growth in both countries. China experienced 9.5 percent GDP growth in 2004 and 9.9 percent in 2005, above the expectations of economists and politicians. Russia's economy is growing somewhat slower (about 7 percent), but in 2002 its leadership set an ambitious goal of doubling GDP in the next several years.

While Russia seems to gradually lose global economic and political influence, China steadily makes its way toward the position of the most influential superpower. It manages simultaneously to play dual roles as a leading developing country and emerging superpower. China has developed ties with the European Union and countries of the former USSR, has actively shaped the WTO process, has supported the revitalization of the UN, and has developed long-term ties with a multitude of regional alliances from ASEAN to countries of Africa. China has learned to participate in the globalization process by maximizing gains and minimizing losses. China has little choice but to increase its dependence on the rest of the world on which it relies heavily as a market for manufactured goods and as a source of raw materials and new technologies. The mode of economic development in China contradicts the geography, demography, and resource-base of the country. China faces a hidden crisis of energy and resources behind the speedy economic growth and produces enormous pollution, having 15 of the 20 most polluted cities of the world. In 2003, China consumed some 30 percent of the world's iron and steel, 40 percent of cement, and 31 percent of coal, but somehow China's GDP accounted for only four percent of the world total (Xinhua, SEPA 2004).

The government of China undertakes serious and systematic efforts to alter this mode of development and many policies have been designed to make it more "sustainable." These include China's "Agenda 21" prepared in response to the Rio Summit in 1992 and a recent move to develop a "circulating economy." This new buzzword popular in 2004 is a name for a policy that seeks to turn the linear growth of the traditional economy (resources - products - pollution discharges) into a circulating and feedback type of economic growth (resources - products - recovered resources), with highly efficient and circulating use of resources as its core. The objective is to make low consumption, minimal discharge, and high efficiency basic features of economic growth. According to official sources (Xinhua, SEPA 2004) this policy is now seriously considered as an option for resolving the resource/environment crisis and putting the country on a path toward sustainable development. Implementing this plan includes intensive economic and technological research, development of training programs and performance standards, and numerous "circular economy model zones." One such zone was established in Liaoning Province specifically to promote this policy for "Revitalization of China's Old Industrial Bases." Encouraging though they are, such policies will not soon change the trend of growing resource consumption.

Russia has been in continuous economic crisis since the collapse of the Soviet Union. In the early years of crisis there was an advanced system of environmental controls that later proved largely unworkable because implementation was managed by ineffective institutions. Economic crisis led to steep declines in production but only small declines in industrial pollution. However, the crisis caused drastic declines in domestic agricultural production. An unintended environmental gain of those reforms was that most environmental hazards associated with farming declined as well. The crisis further strengthened Russia's traditional dependence on the export of unprocessed natural resources such as oil, gas, minerals, timber, and fish. While domestic industry was in ruin, foreign firms were invited to develop the remaining natural resource base. During the few most recent years there has been a limited and uneven revival of some industries and agribusinesses that are slowly adjusting to new conditions. In the Russian Far East (RFE), the crisis of the early 1990s was most painful due to the region's traditional dependence on dwindling governmental subsidies in this remote region, and partly due to the close proximity of the highly competitive Chinese economy, which inhibited and continues to inhibit development of Russian businesses along the border.

The WWF Ecoregional Conservation Action Plan (Darman et al., 2003), based on 2000-2001 socio-economic analyses, suggested three possible scenarios for socio-economic development for RFE:

1. The "business-as-usual" scenario in which trends of natural resource exploitation remain as they were in 2000. This scenario would result in: intense exploitation of natural resources; loss of industrial potential of extraction enterprises; closure of many settlements in remote regions; massive emigration from the RFE; changes in age composition of the population; aggravation of the financial situations of military, border, and customs agencies resulting in increased poaching and illegal trafficking; worsening of Russia's geopolitical position in the Asia Pacific Region; and a regional economy where the RFE would continue to supply raw materials to other countries in the region.

2. The second scenario assumes that the Russian government would increase its level of support to the RFE, investing in the region as the largest natural resource base in Russia. Investments would be made to modernize the energy sector and transport system, as well as to provide Russia with needed raw materials, increase the export potential from specialized branches of industry; and organize machine-building production to meet the needs of local extraction industries.

3. The third scenario assumes that the RFE will continue to be economically isolated from the rest of Russia and will seek out foreign markets and investment sources in neighboring countries of the Asia Pacific Region. Development in the RFE would be supported by raw material exploitation, financed by foreign capital investments, and equipped with modern industrial technologies. The service sector (tourism and other services) would begin to grow. Raw material development would remain the most profitable sector, since it is the only sector of the economy that can compete on domes-

tic and foreign markets. A marked increase in production would be required to support such a scenario, which would also help improve living conditions for the local population.

Recognizing that each of these scenarios has some validity, whatever outcome emerges will be strongly influenced by China. Thus in the three scenarios above, the words "international" or "foreign" could well be read as "mostly Chinese." When viewing the basin as a whole, economic processes in neighboring countries must be considered fundamental to basin management.

Mongolia will continue to experience the growing influence of China along with a substantial remnant influence from Russia. These two countries account for the lion's share of Mongolian foreign trade, foreign participation in resource extraction, and bilateral attempts to sort out transboundary environmental problems. The economic and political rise of China will possibly have even greater influence on Mongolia than it has had on the Russian Far East. Consequences will follow prevailing trends, with probably greater adverse impacts on the environment due to Mongolia's more vulnerable ecosystems and weaker regulatory capacity in government. Whether closer and broader economic cooperation with the less resource-hungry Russia might reduce development pressures on the Mongolian environment remains an open but valid question. Vladimir Putin's Russia is trying to re-establish its influence in neighboring former socialist countries, but whether these new policies will have positive environmental consequences remains unclear. To date, Russian agencies enthusiastically view the prospects of Russian engineering firms helping Mongolia to plan and build hydropower dams on vulnerable rivers, such as the Selenga River tributaries that flow into Russian territory. Yet the potential win-win alternative solution of simply increasing electricity exports from the existing large hydropower facility downstream on Russia's Angara River is not even considered. Due to the shortage of data on China-Mongolia economic relations, the following discussion of regional development will mainly focus on Russia-China relations.

Russia-China — A Perfect Match?

Sharp contrasts between China and Russia are particularly vivid along the Amur-Heilong River that separates these two large countries. These contrasts can now be viewed as useful preconditions to growing economic cooperation. The Russian Far East is rich in natural resources that are comparatively sparse in China. China's large and growing processing industry can obtain relatively inexpensive raw materials and fuel, which Russia is increasingly eager to sell. Issues disputed in the past have become solid foundations for present and future cooperation that will last as long as Russia still has resources for sale.

The rapidly increasing population of China has for decades been viewed as a threat to the depopulated Russian Far East. However, the numbers of Chinese migrating across the border to the north have never been substantial by Chinese standards. Growing depopulation of the Russian Far East coupled with the resolution of territorial disputes and growing economic interdependence is encouraging an influx of Chinese workers for infrastructure development, agriculture, forestry, and mining, as well as trade and services. However, because the region's unfriendly conditions (from the harsh climate to well-developed nationalism) do not encourage long-term residence of Chinese settlers, a probable scenario is an increasing influx of seasonal workers or short-term residence of Chinese business people. While resource exploitation could be high in such a scenario, sustaining desirable environmental standards and developing agreeable levels of environmental awareness among employers and workers would require tremendous investments of effort and cooperation, both of which are unlikely to materialize in the near future. This "colonialist" mode of resource exploitation is not new to China or Russia. During the past two centuries this has been the prevailing business model in Russia's Amur-Heilong basin: Workers were brought to the region temporarily and later returned to their permanent residences in China when resources were exhausted or when enough money was earned to return and start permanent economic activities. Whether remaining ecosystems of the basin can withstand a new wave of this type of "slash and burn" development remains uncertain. Whether the alternative scenario of Chinese long-term immigration or permanent residence could have less destructive socio-economic and environmental consequences is an important question to answer.

The Russian government and society at large believe that "loss of territorial integrity" is a major "China threat," and there seems little capacity to objectively assess the potential long-term outcomes of different scenarios. However, if we wish to protect ecosystems of the Amur-Heilong basin, we have to consider all likely scenarios of future integration and their consequences for society, the economy, and the state of nature. A scenario where the sharp demographic gradient along the Amur-Heilong River remains unchanged despite clear economic advantages of workforce migration, seems to be least likely. The key questions are more likely to be about how the process of transboundary integration develops and, as it does, what policies, institutions and agreements are needed to ensure sustainable economic development and biodiversity conservation in the basin.

The Amur-Heilong basin is China's gateway to Russia. Following the collapse of the USSR in early 1990, the first wave of Chinese businessmen began trading with Russia along the border. By 2006 the Chinese traders were somewhat disillusioned by low returns, an unstable legal and policy environment, corruption, and discrimination against foreign businessmen. However, China's relationships with Russia are framed as a "strategic partnership" and trade is growing 25-35 percent annually, surpassing the volume of Chinese trade with all countries of Africa. There is strong political will to increase this volume threefold in the coming 5-10 years. Regardless of its volume or content, transboundary commerce will inevitably affect the Amur-Heilong basin because most of the common border lies within the catchment. Although China is not specifically interested in the basin, it lies on the route to all other locations in Russia and has the potential to provide raw materials to China's growing economy. China firmly supports Russia's entry to the WTO, and seeks to be the first country to complete the talks on bilateral market accession with Russia. China supports Russia's entry because this will benefit both countries and their strategic partnership, and because it secures China's access to natural resources it lacks.

According to China official sources (Interview with Wen Jiabao by Xinhua News Agency 2004), priority areas for transboundary cooperation are energy, science, high-technology, equipment manufacturing, and infrastructure. Russia and China have independently scored many achievements in aviation, new materials, and biological technology. Russia also has a good foundation in equipment manufacturing, especially nuclear energy utilization, electricity generation, and heavy machine manufacturing. China has achieved rapid development in communications, electronics, and textile and shipbuilding industries. This suggests the two countries could best cooperate in machinery and equipment manufacturing. China is specifically interested in enhancing cooperation in energy, oil, and natural gas. Nuclear plant construction might become another important field in Sino-Russian energy cooperation. China's vision for cooperation goes far beyond trade in resources and staple goods, to expanded cooperation not only in commodities trade, but also in service trade, investment, tourism, finance, and high-technology.

However, despite these starry predictions, the latest bilateral trade statistics from RIA Novosti show the share of raw materials (oil, timber, fish, metals) in Russia's exports to China in 2005 nearly reached 90 percent of Russia's overall exports to China. In contrast, China has been exporting more and more equipment to Russia. The structure of trade whereby one side sells raw materials to the other in exchange for machinery was described in the past century as a colonial pattern in which the raw material exporter invariably stood to lose. But China cannot export raw materials because it has none to spare and Russia hardly wants to buy them at prevailing market prices. Both Moscow and Beijing are trying to find a way around this obstacle to long-term, mutually beneficial trade. One example is located in Eastern Siberia where Chinese investments will build plants to process timber into products required by China, such as cellulose for paper. This will help the RFE economy capture the benefits of processing in addition to the gains from sale of the raw materials.

Moscow wants to focus on "science-intensive" and technologically advanced projects in cooperation with China, even in the sphere of raw materials (RIA Novosti — Opinion & Analysis — Sino-Russian trade: record scale and obsolete structure 09:5026/04/2006). The economic viability and environmental soundness of this plan should be questioned. The latest Putin-Hu Summit in Beijing in March 2006 clearly indicated that both sides are most interested in increasing flows of raw materials and energy: specifically, oil, gas, and electricity. Russia appears to accept this as long as the label of "science-intensive raw materials" obscures the unsustainable characteristics of this relationship.

China authorities officially declared that Russian businesses are welcome to invest in northeast China, where the two countries share traditional economic ties. Russian businesses are encouraged to bring in their advanced technologies, expert personnel, and high-quality services to help revitalize northeast China. Russian enterprises have also been invited to join in local industrial reforms through various means and are especially welcome to construct infrastructure such as communications, roads, and power grids. China views Russia not only as a source of raw materials, but also as a cooperator to revitalize the economy of the northeast, which today produces about one-third of China's cash crops, two-fifths of its petroleum, half of its timber, and more than a quarter of its machinery. China's open door to Russia might eventually inspire the sought after development because the business environment in China's northeast, despite its many pitfalls, is better than in the Russian Far East.

In terms of historic environmental change, the "development assistance" provided to northeast China by the Russian Empire and then the Soviet Union probably caused the greatest alteration of natural ecosystems of the Amur-Heilong basin in the last century (of course Japanese "development assistance" to this region during the occupation also resulted in substantial environmental damage). Therefore, to the extent possible, we should avoid framing the coming wave of development exclusively as "China's threat to Russian nature." Interaction of the two countries will probably take on a much more complex form as they develop closer economic and political ties. Unless precautionary measures are taken, tremendous environmental damage will occur throughout the basin and the responsibility will not be attributable solely to either side. It is worth remembering that the Songhua spill of November 2005 resulted from an explosion of a petrochemical factory that belongs to a group reliant on Russia's oil exports.

Doomsday Scenario

Below we describe the most probable hypothetical "business-as-usual" scenario of international economic cooperation and integration in the Amur-Heilong basin. Such a scenario is based on the premise that an effective common environmental policy will not be developed or rigorously implemented. Should this assumption prove false, a brighter future could well be realized.

Several factors taken together could drive massive increases in environmental impacts through pollution, urbanization, and extraction of natural resources in the Amur-Heilong. These factors include strategic partnerships between China and Russia focused on natural resource extraction, pledges to triple the volume of transboundary trade, and China's economic policy for the modernization of its "Old Industrial Bases" of the northeast. As the two countries strive to spur economic growth through cooperation, the Amur-Heilong River that defines their common border is destined to be the grist between these two mill-stones of economic progress.

Experiences with cooperative economic ventures in the region have produced few examples of beneficial environmental policies. None of the existing international agreements has been adequate to reverse the depletion of natural resources or deterioration of natural ecosystems. Shared knowledge and understanding that are rapidly developing in commerce have no parallel in natural resource management and nature conservation. The two nations are not prepared to face environmental pressures resulting from their economic development, and are much less prepared to take into account environmental impacts when planning future activities. If this continues unchecked, economic growth will accelerate environmental degradation. The outcomes are unimaginable given that even today some wild rivers are undrinkable and some wild fish inedible. Short-term economic changes that would obviously cause adverse environmental impacts might include:

- Increased trade in raw materials (timber, NTFP, mining products);
- Greater logging pressure on primary forests in RFE and Siberia without further reductions in logging throughout northeast China;
- An influx of migrant workers, which at least in the RFE, will use outdated technology;
- The expansion of arable land at the expense of wetlands and grasslands, which in the RFE is likely to be given to migrants on short-term lease and without any incentive for land conservation;
- Multifold increases in pressure on well-preserved ecosystems along the border because of liberalization of border control regimes, lack of environmental enforcement, and easy access to resources;
- Development of numerous "free trade zones" dotting the border region that will increase traffic of commodities and render enforcement of CITES and other regulations virtually impossible;
- Joint efforts in dam construction on the main-

stream of the Amur-Heilong River and tributaries, and similar efforts in the great Siberian river basins to the north;

• Development of transport infrastructure aimed at capturing trade opportunities in northeast Asia, criss-crossing the region from the Tumen River area to a "Millennium" road through Mongolia;

• Speedy construction of multiple pipelines and supplementary means of oil and gas transport across the region;

• Increased harvest of valuable biological species like Kaluga sturgeon, and the devastation of many wild populations for the sake of commercial farming development;

• The construction of large industrial facilities for processing natural resources in a "scientifically advanced manner" (pulp mills in Chita, Amurskaya and Khabarovsky Provinces), associated with significant environmental pollution and quick depletion of the resource base;

• Water transfer schemes to north-central China and inner regions of northeast China, that might eventually lead to a water crisis in this superficially water-abundant region.

Each example above is supported by a plan, an agreement, or the clearly articulated intent of the two countries. But this list is only preliminary, and could be expanded to include many more equally possible examples.

The environmental impacts of the above scenario would be enormous. The immediate economic disadvantages for Russia are obvious: Russia would be unable to ensure more balanced development in the RFE and would likely become a debtor of China. Over the long term both countries lose economically, environmentally, and socially. However if the two governments do not develop adequate safeguards or jointly plan more sensible and sustainable development strategies, this scenario will be realized. The reason for this conclusion is simple: This scenario is the most likely if existing "market forces" and prevailing economic policies are maintained. It does not require much additional effort or investment from government. Any sensible alternative would require great human and financial resources together with a lot of good will. And even good will would not necessarily lead to sustainability, especially if it targeted only parts of shared ecosystems. China's attempts to attach environmental safeguards to regional development strategies provide a good example of the types of controls needed to guide development.

Northeast resources and environmental assessment: China policy recommendations in a basin-wide context

Because many aspects of the resource crisis have already hit hard in China's section of the Amur-Heilong, the Chinese Academy of Engineering (CAE) undertook a strategic assessment of the resource base and has developed recommendations to ensure sustainability when "Revitalizing the Old Industrial Bases of the Northeast" (see Chapter 12 for assessment results). The recommendations were discussed and agreed upon by governmental agencies and represent the ideal strategic guidelines for development in northeast China through 2030. The coming 24 years is a long period of time, keeping in mind that it took just one century of development (with substantial international involvement) to convert nearly pristine northeast China into an area on the brink of ecological crisis. Northeast China is now an area where 45 percent of the forest cover is dominated by immature tree stands too young to cut, large rivers too polluted to be used as drinking water supplies, and mismanaged plains with drying wetlands devastated by increasing floods. Despite all these disasters, the final CAE report states that the region is still far richer in natural resources than other parts of China, and the current "crisis" is due more to gross mismanagement than to natural resource limitations. CAE therefore recommends improved management. For the purposes of our study the major shortcoming of these recommendations (simultaneously also the main prognostic advantage) is that CAE had no intention or mandate to deal with basin-wide issues, therefore ignored environmental impacts in Russia and Mongolia. In this short essay we cannot achieve the level of detail represented by two years of work of the entire CAE. We therefore pose several questions for further consideration of possible environmental consequences should the development scenario recommended by CAE be implemented as planned. Questions follow selected recommendations of the CAE.

• "Land use: Arable land area should not be increased; forest, grassland, and wetland areas should not decline any further."

Question: How will limitations imposed in China affect neighboring Russia and Mongolia, where arable land is also located in wetland areas (mostly floodplains)?

Question: Most remaining wetlands are transboundary, how can they be protected if economic pressure in one country increases due to limits imposed on farmland area in its neighbor?

• "Agriculture: Given its obvious advantages, the area should become the biggest grain producing base in the country, with the proportion of irrigated land increasing where conditions allow."

Question: How would an increase in irrigated land influence Amur-Heilong hydrology?

Question: How would increasing the area of rice paddies, mostly expected to occur in the Sanjiang plain, influence transboundary pollution by pesticides and other pollutants?

• "Forestry: It is necessary to continue along the already selected course of reforms and protections to ensure sustainability of forest use."

Question: How will the continuation and strengthening of limitations on logging in China, when coupled with growing demand for timber in China, increase pressure on forests in adjacent Russian provinces?

Question: A major cause of the 1998 Songhua floods was mismanagement of watershed forests and floodplain wetlands. What are projections for flood patterns in the Amur-Heilong main channel if similar pressures increase over next 25 years?

• "Mineral resource base: Increase efforts in geological surveys to ensure greater availability of mineral resources; increase mining operations in neighboring countries."

Question: How to manage the current trend in transfer of obsolete and environmentally damaging mining technologies?

Question: How to manage the "side effects" of ecological devastation around remote mining settlements?

• "Water Environment: Preserve water quality and aquatic environments; prevent pollution as a major task of "Revitalizing the Old Industrial Bases of the Northeast".

Question: How to bring the restoration of natural fish stocks into this equation, which are both an important aquatic resource and indicator of healthy river condition?

Question: How to balance this goal with objectives set for expanding irrigated agriculture in a transboundary context?

• "Ecosystem carrying capacity is already exceeded by the levels of industrial and agricultural development in some areas. On the basis of comprehensive water-saving measures, we should carefully proceed with water transfer projects in priority areas."

Question: Will proposed water transfers decrease incentives for introducing costly water-saving measures?

Question: What is the actual demand for water transfers in the next 30 years if we take into account not only the adjacent Liao River, but the thirsty 3H (Hai, Huai, and Huanghe) basins?

Question: If water infrastructure is installed, what tools do we have at hand to assure that overall withdrawal does not exceed the agreed limits, and what international body could set and monitor such limits?

The questions listed above represent examples of problems that will soon arise. The CAE study has no mandate to answer them. But the questions must be answered if we are to consider the long-term well-being of the ecosystems of the Amur-Heilong basin. We hope the questions will draw the attention of Russian authorities to the emerging discrepancy in the environmental dimension of Russia-China relationships.

Proposals to safeguard basic environmental safety in China appear then to actually reinforce the "doomsday scenario" for the Amur-Heilong basin as a whole rather than confronting it in a constructive manner. To reverse alarming environmental trends we must address many difficult questions such as:

1) Despite shared geophysical conditions, the abundance of resources and approach to nature conservation in Russia's portion of the basin differ greatly from that in northeast China. Cultural differences in perception of "wild nature" are even greater. In this environment of stark contrasts is it possible to agree on which natural qualities should be preserved in different parts of the shared basin? Should we seek to establish

any such standards on a basin-wide scale and would this help solve conservation problems?

2) Despite some sharp differences within the basin, we tend to treat the Amur-Heilong basin as an interconnected natural system. To what extent does the resilience of the transboundary ecosystem and the biodiversity resource it supports depend on those less developed (better preserved) tracts of land predominantly located on the Russian side of the basin? Contemporary environmental policies in northeast China lead to increased exploitation of adjacent areas in Russia. By now this is no longer a stochastic process, but a reflection of conscious policy decisions. This is most obvious in the field of forest preservation. Is there any long-term environmental gain for China in lessening pressures on already affected forests by encroaching on preserved ones? How can the basin as whole benefit from China environmental policies that get stronger day by day?

3) Given globalization and prevailing economic trends it is reasonable to assume that Russia is destined to remain China's major natural resource supplier until Russia's resources run out. Are there policy mechanisms similar to those put forward in the CAE assessment that would encourage China to consider sustainability of resource use in Russia? Given all the differences between the two countries, would such considerations really be useful for biodiversity conservation?

4) The main policies in the region are formulated and implemented at national and regional levels. To date, joint planning in the Amur-Heilong basin has led to some of the most environmentally devastating plans and projects such as the "Joint Scheme for Argun and Amur water resources development." Is it advisable to insist on establishing an international basin management body, while it is known that the two most powerful countries of the basin favor highly unsustainable, environmentally unsafe development options? What type of international process and interaction, if any, may best help countries of the basin to coordinate and harmonize national environmental policies to safeguard the environmental well-being of the Amur-Heilong?

China's stated policies are quite satisfactory when compared with those of its northern neighbor. There is a clear multifaceted strategy for domestic economic development through "The Revitalizing of Old Industrial Bases in the Northeast." This policy has a complex but clear international dimension mostly to secure access to resources of neighboring countries. It includes environmental safeguards developed by academia to clarify environmental safety and resource availability issues. It would be overoptimistic to expect government to go beyond that and on its own consider transboundary environmental issues arising from this development strategy.

Will Russia mind Russia's business?

The greatest problem at the moment seems to be with Russia, which has no development policy for the Russian Far East comparable to China's policy for "Revitalization of the Northeast." The current "Socio-economic development program for Far East and Transbaikalia" has a long history of misfortunes, and several fundamental pitfalls:

- It is a collection of various projects and good wishes rather than a coherent strategy;
- It requires no environmental assessment that might help avoid or mitigate environmental impacts;
- It receives less than 10 percent of approved government funding, which renders it incapable to shape real-life development patterns;
- It is largely constrained by Russian borders thus does not match "Revitalization of the Northeast" and misses conflicts and synergies between Russia and China that shape real economic and political development in the region.

We may speculate that it is not this paper-program, but rather China's economic expansion policies that are influencing development of the Far East and East Siberian Russia.

Recent discourse on the Siberia-Pacific pipeline (likely to terminate in China and thus clearly in line with the "Revitalization of the Northeast" strategy) demonstrates that the Russian government behaves as if it is unaware how much resource it still has for sale abroad. This ignores the question of more detailed thinking on sustainability or how wise use of resources might benefit local economies. Russian leadership at all levels seems to believe that exported natural resources are too plentiful in Russia to be put under thrifty economic management. There is too little concern for how the amounts of extracted resources might influence environmental safety of the region.

Meanwhile China's economic and environmental policy-making shows an alarming trend to rely on cooperation with Russia to help rid China of dirty technologies, ensure increased inflow of resources (such as fish to restore depleted domestic stocks), and provide other "ecological services" free to China but at uncalculated environmental cost to Russia. Russia behaves as if it welcomes this approach, providing leases for use of outdated gold-mining techniques, encouraging logging practices no longer permitted in China, calling for increases in resource exports, and volunteering to install new electricity generation capacity to supply its energy-hungry neighbor. Of course the effects of these practices are felt not only in the Amur-Heilong basin but they tend to concentrate in areas such as border zones that are more accessible and economically attractive for such "slash and burn" cooperation.

If in the near future Russia does not base its "science-intensive cooperation in the natural resource field" on equally science-intensive consideration of environmental safety issues focused on border regions, Russia will soon face resource crises and environmental problems on the scale that China today faces. The preceding chapters show that in many cases the environmental crisis is already unfolding. As a "nation in transition" Russia is somewhat spoiled by lenient environmental policies and has grown accustomed to "international environmental cooperation," mostly in the form of large grants that enable Russia to mimic the advanced technologies of other countries and to clean up its own mess once these technologies fail. Transboundary environmental issues become virtually irresolvable due to the absence of Russia's own environmental (and development) agenda, a general lack of skill in safeguarding its own national interests, and the lack of an agency responsible for and capable to deal with these problems. Meanwhile it is clear what, why, and how things should be done unilaterally to confront the challenge, even before China agrees to cooperate on Amur-Heilong issues.

Learn from China: set limits

Resource extraction trends are mostly influenced by Chinese demand and regulated by policies for "The Revitalization of the Northeast." Demand, patterns of intervention, and other parameters are more or less predictable, and should enable the development of useful strategies for the RFE. A fundamental question is: What volume of natural resources could Russia provide at mutually acceptable economic costs without compromising environmental conditions and ensuring sustainable long-term cooperation? The "more is better" principle used to date has led to the sale of valuable commodities at below-market prices with maximum environmental damage. China's national logging ban is an example worthy of study on the process of imposing limitations on resource extraction. Although there is no point for Russia in imposing a country-wide logging ban similar to China's, it would be worthwhile to consider a similar measure to cover the 200-400 kilometer strip along the border that suffers the highest rates of illegal logging and environmental damage. It is also important to consider such a ban for small-scale mineral deposits in the midst of wilderness areas, where damage caused by migrant miners is far greater than economic gains from mining leases.

Stop relying blindly on giant infrastructure projects and begin to apply the highest EIA standards

The most alarming trend of the Putin era is the reemergence of the "big-is-beautiful" mentality with reference to infrastructure projects. This leads to giant industrial facilities (pipelines, cellulose plants, hydropower dams) designed and built with disregard for the sustainable well-being of local communities and the environmental impacts. Here again it is best to learn from China's mistakes and from China's practice of scrutinizing proposals for small-scale economic development using the same standards and the same intensity of large-scale projects. This approach has produced the world's largest dam on one of its largest rivers (Three Gorges Dam) but also a wide network of small hydropower stations on tributaries. While China has large scale oil refineries there are also affordable technologies to burn straw and stalks from the fields.

Due to a recent resurgence of interest in massive hydropower projects in Russia there is a special need for rapid and energetic action to protect Russia's river basins. It is time to learn from the recommendations of the World Commission on Dams (WCD 2000). This would support an informed policy debate between NGOs, regional authorities, and energy agencies on standards for environmental performance of hydroelectric dams in the Amur-Heilong basin. This will necessitate assessments of the cumulative hydrological, environmental, and socio-economic impacts of the Zeya and Bureya hydroelectric projects on the Amur-Heilong basin. The next logical step is to assess the discrete and cumulative environmental impacts of all currently proposed dams.

The most likely by-product of this exercise would be constructive cooperation with energy authorities on nation-wide environmental performance standards for “green” hydro-power.

It is necessary to revise the infamous China-Russia Joint Comprehensive Scheme for Argun and Amur Water Development. There is a need for a comparative assessment of development alternatives by authorities and the Russian United Energy Company. This would support selection of development alternatives best adapted to natural features of the Amur-Heilong basin ecosystems and socio-economic conditions.

The long-term question to be answered is whether interaction between Russia and China can result in better regional standards and schemes for energy/fuel generation, transport, and consumption. For example, one of the main attractions of the proposed dam in the Hinggan straights of the Amur-Heilong mainstream is China’s investment in the joint venture. Given that the bulk of generated hydropower would be consumed in China, would it be possible to attract China’s investment funds for implementation of alternative energy schemes located not on the main trunk of the Amur-Heilong, but on tributaries or streams elsewhere in Russia that have already been affected by hydropower development such as the Lower Bureya? Or would it be possible to explore interests of Chinese investors in developing alternative energy sources like the Tugur Tidal Hydropower Plant on the Sea of Okhotsk?

Select appropriate partners and projects for economic cooperation

While China knows what it wants from cooperation with Russia, the same cannot be said for Russia. Cooperative ventures nowadays are typically initiated by China firms and the appropriate government partner coming to the RFE and suggesting certain agendas to local authorities and businesses. Such proposals are often pre-selected to meet certain criteria to receive financial support and/or policy backing from Chinese government agencies. Naturally, when bound for Russia, environmental issues are not high priorities on these agendas.

Meanwhile, adjacent northeast China has a lot to offer in terms of “environmental business” and “green production.” But the policies of Russian counterparts (not always present) are poorly suited to capture those advantages, and cooperative ventures rarely focus on activities such as processing of non-timber forest products (NTFPs), production of ecological produce for exports, nature tourism, waste processing facilities, resource-saving technologies, or other beneficial types of commerce. Examples of environmentally-friendly cooperation, if they do exist, are unknown to the public and authorities and are never singled out as positive examples worth replicating.

The assessment of environmental sustainability of cooperative projects should be undertaken in Russia and explicit policies must be developed to promote and encourage broadening such cooperation. We hope, for example, that the somewhat awkward efforts to cooperate on wood processing in East Siberia proposed in March 2006 by President Putin will quickly evolve into a more comprehensive screening of opportunities and policy tools to support favorable options.

When Chinese businesses enter Russia they must be fully informed of the environmental requirements of Russian law and be assisted in meeting them. Based on the RFE experience, even the best undertakings left unchecked or unassisted can cause substantial environmental damage. Russia’s business environment is far from welcoming, with a logging firm having to obtain permits and submit reports to up to 16 different governmental agencies. To cope with the complex regulatory environment and bureaucracy, it is necessary to expand some extension services to safeguard environmental performance of the ever growing number of Chinese businesses in Russia.

If such a system for project selection and support is enacted, there is a much better opportunity to apply strict EIA procedures and enhance capabilities of enforcement agencies to make all firms adhere to environmental standards and expel those who fail to do so continuously.

In the present gloomy state of affairs even most enforcement and supervising institutions cannot accurately identify which cooperative project is better than another. Environmental assessments are undertaken in a very formal, academic manner. Communication with China firms is severely impeded by lack of trust and the absence of a common language. The most direct way for a firm to obtain its desired result lies through corruption. The result convinces observers that Russia is intentionally lowering environmental standards to compete for Chinese investment. However, in reality most agencies are simply not competent to determine what standard should be set in which way and how to encourage adherence to it.

Develop international environmental policy and an institutional framework to implement such a policy

Despite obvious transboundary environmental threats on the border, Russia has no clear international environmental policy. At best, decision-makers know what the transboundary problems are, but have no plan to solve them. Moreover, there is no responsible agency and no resources dedicated to solving these problems. Thus it is no surprise that despite the existence of more than a dozen bilateral treaties related to the environment and natural resources, little fruitful cooperation is seen. And when it is seen it is normally because there is a responsible institution, such as a nature reserve, that needs this cooperation, is willing to endure the ineffective bureaucracy to overcome lack of funds and authority, and finally achieve some result despite the non-functioning government machine. Unfortunately results achieved this way are often unsustainable. The situation is even worse when several governmental entities lose patience and try without coordination to use their incomplete and conflicting mandates to solve acute transboundary problems. We recently witnessed an example of this in case of the Songhua River spill of 2005, where wonderful opportunities to start meaningful dialog were almost lost, due in part to lack of leadership and unclear division of responsibility among agencies.

Therefore, to resolve Amur-Heilong basin environmental issues with its Asian neighbors, Russia desperately needs a clear international environmental policy, an authoritative and resourceful agency responsible for its implementation, and a coordination mechanism that harmonizes and translates the interests of dozens of domestic actors into clear proposals for Russia's international partners. Currently there are 10 agencies involved in the "implementation" of international agreements related to the Amur-Heilong. There is one lay-level clerk in the Ministry of Natural Resources responsible for relationships with at least a dozen Asian countries, and almost no financial support for this work. Even though Russia and China have succeeded in establishing a high-level Environmental Subcommittee under the mechanism of meetings of the heads of State, Russia is not likely to use this mechanism properly unless it completes its basic homework first.

Nature along the border in need of strengthened protection measures

The last but not the least of urgent tasks is retaining the "green buffer" of natural ecosystems, that has been preserved as an artifact of the strict border protection policies of the USSR. While sorting out institutional discrepancies and engaging in policy development might require long time spans, this task is straightforward and rather simple. Millions of hectares of relatively pristine forest, wetland and grassland habitats are preserved along the border due to the former no-access policies of the Russia government. Nowadays this protection regime is deteriorating, thus exposing the area to rapid resource exploitation due to its close proximity to resource-hungry neighbors. Keeping in mind the environmental value of such a buffer, protection policies should be reinforced and modernized. Border guards, who now spend most of their efforts preventing illegal exploitation of natural resources by foreign subjects, should be explicitly tasked and retrained to add an environmental component to their agenda. An alternative scenario, currently unfolding all along the Russia-China border, will result in unsustainable development with few benefits to the country, and greater corruption, legal violations, and environmental damage.

All measures stated above could and should be implemented by Russia unilaterally as a precondition for more fruitful international dialogue on the transboundary environment.

International ideals of integrated river basin management

Despite what may seem like an impending doom for the region, there is still substantial hope for the future of the Amur-Heilong and its people. Unlike many other basins in the temperate zones of the world, the Amur-Heilong still has a chance to retain most of its natural qualities, tremendous biodiversity, and bioproductivity. However, whether this hope is realized depends to a large extent on how questions presented in previous sections of this essay are answered.

It is obvious that as a consequence of uncoordinated management of natural resources the environment is deteriorating in all three nations of the shared basin. Results of excessive catch of fish, dumping of untreated wastewater, excessive water withdrawals, unilateral dyke-building on transboundary river channels, and rampant logging are dotting the basin and have caused declines in ecosystem resilience and the availability of natural resources. The three countries sharing the Amur-Heilong basin naturally share basic ecological concerns such as sustaining water quality and bio-productivity and wetland and forest conservation. It is quite clear to decision makers that no single country acting alone can solve these problems. Therefore there is solid ground for pursuing a mutually beneficial, coordinated management plan for common resources. The development of a regional framework for integrated river basin management should lead to the establishment of an international cooperation mechanism, which would require developing an agreement for protecting the Amur-Heilong River ecosystem. This could only be successfully developed over a long time frame, and will require several preparatory stages (regional framework, common vision, common action plan, and implementation mechanisms).

This issue is much broader than Russia-China relationships on the border, and its consequences affect many other countries, for example Japan, whose fisheries and catches of other aquatic products are strongly influenced by Amur-Heilong outflow into the Pacific Ocean. Mongolia, despite its somewhat marginal position in the basin, might happen to be the most useful and influential partner in future international planning and policy setting. Because Mongolia is landlocked between Russia and China, it would benefit most from a mechanism to resolve transboundary environmental issues with both neighbors. Its water resources are scarce and vulnerable, and this recently led Mongolia to adopt IRBM as its guiding water management principle. Despite all the harsh judgments expressed above, it should be emphasized that both China and Russia already have tremendous capital to be used in designing an integrated river management regime in the form of advanced conservation policies, mature environmental research institutions, developed nature reserve networks, and experience in cooperation on transboundary environmental issues along other stretches of their long borders. The current haphazard international environmental management regime in the Amur-Heilong basin does not meet standards to which both countries adhere to on other sections of their own territories. In the long term, establishing an International Integrated River Basin Management Agreement and an International Council overseeing its implementation seems a viable solution. Programs and agreements developed to support IRBM over the long-term could be multilateral, trilateral, and/or bilateral, and should include special agreements on the conservation of areas of high biological diversity (see Chapter 30 on Green Belt of Amur-Heilong), an integrated regional strategy for development planning and environmental impact assessment, and programs to improve systems of transboundary trade and economic cooperation.

In the short term one of the most urgent tasks is gaining a common understanding of the basin's issues and better knowledge of the practices and policies in neighbor countries. Tremendous educational effort is needed to draw decision makers' attention to transboundary dimensions of the most common environmental problems and explain why and how they can be solved by international efforts. To date, common knowledge of environmental issues is surprisingly limited in the basin. Along the 4,000 kilometer Sino-Russian border there is not one joint applied research centre studying transboundary environmental issues. There are few academic research programs, mostly funded by third countries and agencies. Even projects initiated by international organizations (GEF, ADB, WB, UNDP) and targeting conservation of transboundary ecoregions are usually confined to one country's territory. Only WWF as an international NGO having offices in all three basin countries has been trying to attract attention to the basin problems and to create the platform for IRBM and regional conservation. Local Chinese populations are slightly better informed about natural resources and environmental conditions in RFE, than Russians about Chinese environmental policies. However, the operational focus of this knowledge is normally on tapping rich resources rather than protecting shared environments. Unless common environmental goals are known among all sectors of society, there is no hope for making new agreements and signing new protocols. Since a healthy environment and abundant nature still occupy important places in the value system of Russian society, and these issues are shifting to a higher position in the rapidly changing modern Chinese society, they could and should be transformed into a common vision for nature conservation and sustainable development in the Amur-Heilong basin.

Chapter 28

Essay Number Two: International Nature Conservation and River Basin Management

By Eugene Simonov and Tom Dahmer

International cooperation and generic impediments

Need for a Cooperation Framework

The Amur-Heilong basin exemplifies transboundary regions in need of shared environmental responsibility, particularly for wetlands: Almost 3,500 kilometers of the border between two countries is formed by shared river courses and adjacent wetlands, many of which are of global conservation concern.

Countries and provinces of the basin place conflicting claims on dwindling resources, and lack effective mechanisms for coordinating the management of diverse natural resources. International trade with China and other Asian neighbors drives resource extraction in the Russian Far East (RFE) and Mongolia. Areas near the border have potential for the most rapid unregulated development. The depletion of biological resources, agricultural development, and pollution already create basin-wide problems and should generate strong incentives for basin-wide river management regimes. This calls for development of comprehensive environmental standards within a shared nature resource management framework. By the beginning of the 21st century the international and national policy environments were ready for profound changes:

- Declines in fish catches led to the promulgation of Amur-Wusuli international fishing regulations.
- The Dauria and Lake Khanka International Nature Reserves were established to protect globally important transboundary ecosystems and Ramsar wetlands.
- Floods in 1996-1998 led to the adoption of more environmentally sound river management and wetland conservation policy for Chinese rivers.
- Effective efforts to ban/limit logging in the headwaters of northern rivers in China immediately caused a corresponding increase in Chinese demand for Russian timber from similar habitats where the ban was not imposed.
- Cooperative China-Russia efforts were launched to control water pollution and agreements on water monitoring were signed at provincial and national levels.

However these policy initiatives were haphazard: related problems were addressed independently by different institutions while participating parties failed to formulate a coherent framework for basin-wide action.

Difficulties in international environmental cooperation.

Many political and economic developments, like China's Policy to Revitalize Old Industrial Bases of the Northeast, will accelerate cross-border cooperation and economic integration. In trade and resource extraction, transboundary demands are severe and influential, and often lead to direct and effective links across the border. In other aspects of transboundary relationships, particularly in nature conservation, opportunities to share benefits are frustrated by ambiguous objectives that have not yet led to effective joint conservation:

- Local governments, researchers, and NGOs share limited transboundary communication, and have little knowledge of biodiversity conservation problems, policies, and achievements in neighboring countries.
- Existing international conventions, agreements and treaties for the environment have weak implementation mechanisms, and they are administered by separate agencies with poor coordination between them.
- Good conservation practices, policies, and programs developed and implemented domestically are yet to be supplemented by an international basin-wide mechanism for mutual learning and reinforcement;
- International projects undertaken with support of various agencies and NGOs (UNDP,GEF, UNEP, ADB) lack coordination, often duplicate efforts, and usually, similar to national policies, confine their efforts only to that part of a transboundary ecosystem in a single country;
- While environmental concerns are acute in each basin country, environmental cooperation is limited, is overshadowed by resource extraction and infrastructure development, and is seldom represented by institutions capable of coordinating cooperative efforts.

All of the factors listed above impede progress on transboundary conservation. Yet international cooperation on nature conservation and management cannot be developed quickly. Political, cultural, and sectoral barriers must be overcome, and this requires development of long-term conservation policies with strong international dimensions. Conservation issues have not yet found the place they deserve in the overall framework of international cooperation and this leads to foregone opportunities to improve environmental management of transboundary ecosystems and use of shared natural resources. In **Boxes 4.1 and 4.2** we describe some examples of such unresolved issues.

This following sections describe the current agreements and arrangements that guide environmental cooperation in the basin and discuss ways to improve them.

China-Russia cooperation on environment and natural resources

Russia-China Treaty

The fundamental agreement guiding the more specific interactions between Russia and China is the "Treaty on good neighbor relations, friendship and cooperation" signed by Heads of State on 16 July 2001 and ratified in February 2002. The Agreement stresses

Box 4.1 Incomplete Research Example: Assessment of wetlands on the Amur-Heilong floodplain

In 2003-2004 Russia's Institute of Water and Ecology in Khabarovsk was asked by WWF Russia to undertake a preliminary assessment of the status, degree of threat, and conservation value of Amur-Heilong River floodplain habitats. Maps and reports were produced covering the Lower Amur-Heilong as well as Russia's side of the Middle Amur-Heilong and Lower Ussuri-Wusuli. The assessment of the Lower Amur-Heilong was credible as a foundation for planning conservation measures, probably because this reach of the river lies entirely within Russia. In contrast, assessment of the Middle Amur-Heilong and Ussuri-Wusuli was literary one-sided due to the lack of data for the China side of the river. Important characteristics such as wetland status, degree and types of human impacts, and numbers and distributions of endangered species cannot be accurately described without these data. Reviewers of the report concluded that an assessment of wetlands on only one river bank was not a satisfactory result and not adequate for long-term planning of nature conservation. This outcome was not surprising because it is true of any attempt to assess basin conditions using data from one side of a river. A valid assessment of this type can only be undertaken with cooperation between border countries, and taking into account floodplain wetland ecosystems in their natural boundaries.

This example presents a clear warning that most conservation information presently collected in the region is unsuitable for global biodiversity assessment and ecosystem-wide or species range-wide conservation planning (which are common goals for most international projects).

Box 4.2 Basin-level example: Fish and Pollution

The relationships between fisheries and pollution presents a good argument for designing a regional cooperation framework. Since the 1980s the fish stocks of the Middle Amur-Heilong have been overexploited due to the lack of unified policies and agreed quotas. The establishment of a joint China-Russia Commission on fisheries and a transboundary agreement on fishing regulations in 1994 did not stop declines in fish stocks, partly because there was no enforceable agreement on quotas or permissible mesh sizes for fishing nets. Russia attributed the continued overexploitation to growing numbers of Chinese fishermen. This perception, coupled with generally declining enforcement and corruption in Russia, gave Russian fishermen incentives to overexploit migratory fish stocks in the lower Amur-Heilong before they reached the upstream transboundary waters.

The effects of over fishing were compounded by physical and chemical changes in the river basin. Water diversion for agriculture and dam construction on tributaries drastically reduced volumes and altered the timing of river flows. Rapid economic development without environmental safeguards, mainly in China, caused rivers to carry life-threatening levels of pollution. As a result, at least for half of each year, especially during the winter season, fish caught downstream were contaminated by pollutants and could not be eaten without risk to the health of humans and wildlife. In 2002 China (in the framework of the Agreement on Fisheries and the UN Law of the Sea) proposed joint monitoring and anti-poaching patrols downstream in Russian territory. At the same time, but in a separate forum (dedicated to water pollution control and water management), Russian provincial governments encouraged its China counterparts to undertake joint measures to reduce pollution of the Songhua River in China and revise water diversion schemes.

Taken separately these interventions could be perceived as intrusions in each other's internal affairs, but together they provide a good opportunity to combine efforts for good integrated management of a common river basin. Both sides now suffer losses caused by actions on the opposite side of the river and need to find solutions to these problems in an integrated and cooperative manner. While Chinese participation in fisheries enforcement in the lower river may help more fish to return to upstream transboundary waters, Russian involvement in pollution control in China may protect this resource from poisoning. Continued application of the existing uncoordinated and non-integrated management models for fisheries and water pollution is a barrier to resolving these issues simultaneously.

This example shows that coordinating approaches to these related problems within shared river ecosystems will be possible only within a commonly agreed decision-making framework that is both trans-boundary and trans-sectoral.

that cooperation must be focused on joint development efforts in the transborder region.

Article 19 of the Agreement is dedicated to "protection and improvement of the natural environment" and "just and equitable management of transboundary rivers". Cooperation is prescribed in the following fields:

- prevention of transboundary pollution;
- management of biological resources of transboundary river basins and the North Pacific;
- protection of rare species of plants and animals;
- protection of natural ecosystems of adjacent (bordering) regions;
- prevention of natural disasters and human induced catastrophes.

The Agreement lists key environmental issues and provides a good basis for elaborating them in more specific cooperative mechanisms. However, the role of environmental issues in overall official relations between the two countries is still unclear.

The "Concept for transboundary cooperation" issued by the Russian government clearly sets objectives for curbing transboundary pollution and developing transboundary protected areas as priorities in Sino-Russian relations. In October 2004 Vladimir Putin and Hu Jintao signed an "Action plan for implementation of the Treaty on good neighbor relations, friendship, and cooperation for 2005-2008." The plan aims to achieve progress on the following environmental issues: improve joint water quality monitoring, develop an agreement on transboundary waters, transboundary cooperation on protected areas, and expanding nature reserve networks in border regions, drafting agreements on the management of hydrological process near Khabarovsk, cooperation in the framework of international organizations and agreements on protection and utilization of aquatic biological resources. It also prescribed cooperation to halt illegal logging. There was no clear implementation mechanism for this action plan.

The November 2005 Songhua chemical spill brought China-Russia environmental issues to the center of public attention worldwide. Simultaneously this made it impossible to discuss other bilateral issues due to the priority placed on the spill. Consequently, environmental issues were deliberately removed from the agenda of talks between Putin and Hu Jintao in March 2006 in Beijing, when breakthrough agreements on nature resource exports and joint development were signed (ITAR-TASS 21 March 2006).

Environmental agreements

The agreement "On Cooperation in Protection of the Natural Environment" was signed on 27 May 1994 at the ministry level. The Russian Ministry of Natural Resources (MNR) and China's State Environmental Protection Agency (SEPA) are responsible for implementing the agreement. The agreement is general but specifically lists biodiversity conservation, the establishment and management of transboundary protected areas, cooperation on environmental impact assessments, joint efforts in environmental education, and coordinated development of environmentally-sound laws and policies guiding economic development as priorities. The agreement envisions exchanges of information, joint workshops and seminars, exchanges of specialists, and the development and implementation of cooperative projects. A China-Russia Joint Task Force for Environmental Protection was formed to oversee implementation of the agreement by meeting annually. Implementation has been impeded by several problems:

- Domestic interagency barriers did not allow for effective involvement of all relevant agencies. For example, China's State Forestry Administration oversees most nature reserves but has had little interaction with Russia's MNR on these issues.

- For central agencies in Beijing and Moscow transboundary environmental issues are low priorities. However, there is no effective mechanism to delegate authority to the provincial representatives who are often better informed and more interested in resolving problems.

- Too few resources have been devoted to implementation of agreements and no clear strategy has been developed.

- Transboundary relationships have been plagued by poor communication and little mutual understanding. These are difficult to overcome by simply conducting annual meetings.

Following the revival of cooperation in 2003, the only visible output has been related to the monitoring of pollution in transboundary waters. No progress has been made on biodiversity or wetland conservation.

In 1997 a "Memorandum on Tiger Protection" was signed to prevent poaching, smuggling, and trade in tigers and tiger parts but no work program was implemented. The joint work resulted only in three workshops (Harbin, 2000; Hunchun, 2003; and Yanji, 2006), all initiated by Wildlife Conservation Society (WCS) and other international NGOs.

Transboundary nature reserves were established by national-level agreements and supervised by MNR in Russia and SEPA and SFA in China. In 1994, a trilateral agreement was signed by China, Mongolia, and Russia to establish Dauria International Protected Area (DIPA) to protect globally important grasslands in the headwaters of the Amur-Heilong basin (DIPA 2005). A trilateral meeting in Chita, Russia in March 2006 endorsed the plan and many proposals for joint projects and actions. In 1996 a China-Russia agreement was signed for the "Khanka/Xingkai Lake International Nature Reserve." The agreement envisioned a broad range of cooperative activities and established a "Mixed Chinese-Russian

Commission on Lake Khanka/Xingkai International Nature Reserve" (see Chapter 30, Amur-Heilong Green Belt, for detailed discussion of transboundary protected areas).

In early 2006 a special protocol on "common approaches to monitoring of transboundary waters" was signed between SEPA and MNR. It calls for the establishment of two working groups for planning and coordinating water quality monitoring in transboundary rivers: Amur-Heilong, Ussuri-Wusuli, Argun and Razdolnaya (Suifen). It is not clear whether monitoring is to include aspects other than chemical pollution or if it would consider pollution sources located in inland areas of the two countries. Talks on technical aspects of the proposed joint monitoring were difficult and uneven, and success can only be judged after the first monitoring cycle is completed during 2007. Consultations held in October 2004 in Beijing by representatives of Russia, SEPA, and SFA have demonstrated that different Chinese agencies would prefer to have independent agreements with Russian counterpart agencies. To this end SEPA (China's authority on biodiversity) demonstrated little interest in cooperation on biodiversity conservation and protected area management, both of which are shifting to the jurisdiction of SFA (China's authority on wildlife conservation and exploitation, wetland protection, and manager of 80 percent of protected areas). Despite an agreement in 2003, a working group of experts on biodiversity and protected areas was formed only in 2007.

Environment Sub-commission

Acknowledging the obvious pitfalls of the proposed 2006 protocol for joint monitoring, Russia proposed to upgrade the agreement to the level of Sub-commission under the Commission on Regular Meetings of Heads of State, thereby giving it a well defined, cross-sectoral and intergovernmental foundation. Experienced diplomats from the Ministry of Foreign Relations negotiated this issue for several months and finally China agreed that the new approach has advantages over its predecessor.

Relevant agencies were assigned to proceed and Russia's MNR was designated in 2005 to coordinate the formation of an "Environment Sub-commission" (Interagency Working Group on Environment and Natural Resources) to function through regular meetings of Heads of State. Coordinated in China by SEPA, such an agency would facilitate interagency cooperation on environmental issues and include all relevant agencies.

A founding meeting of this commission was convened in September 2006 in Moscow and virtually all related agencies attended from both China and Russia. Governments of bordering provinces were also invited to send representatives.

Discussions at the meeting revealed the tremendous difficulties that lie ahead. First, neither Russia's MNR nor China's SEPA was comfortable accepting responsibility for engaging other government agencies in substantive interagency coordination because both lack administrative authority to do so. Many other agencies also had mixed feelings regarding the potential for dominance of the process by MNR and SEPA. On the Russia side, leadership of MNR was challenged or questioned by a range of agencies from Ministry of Foreign Affairs to Federal Water Service. On the China side all other agencies besides SEPA showed little initiative and contributed little to discussions at the meeting. SEPA openly acknowledged that it did not envision discussion of the whole spectrum of environmental agreements and mutually important issues, and was inclined to focus on pollution monitoring.

Secondly, the mandate of the Subcomission is intentionally vague. With great difficulty the two sides agreed that that the mandate is somehow related to the "Action Plan for Implementation of the Treaty on Good Neighbor Relations, Friendship, and Cooperation for 2005-2008." However, the original Environmental Agreement did not specify other agreements to be coordinated by the Subcomission. Therefore, at least in a legal sense, this is not an overarching mechanism for guiding all existing and newly established cooperation on environmental issues. Both sides ultimately agreed that Subcomission mechanisms supersede and replace all provisions included under the original Environmental Agreement. Unfortunately, the new mechanisms are inadequate in that they do not guarantee the formation of a clear implementation mechanism, even for the existing agreements which are vague and in need of revision. The new Subcomission replicates and refines the model that failed earlier under Environmental Agreement. The Subcommission meets annually, has a secretariat with ill-defined responsibilities, is authorized to establish task forces with wide and yet unspecified mandates, and has no clear procedure to develop plans and monitor their implementation. An alternative that was considered but rejected was to appoint temporary task forces with specific measurable objectives and entitle the Subcomission to establish, manage, fund, and dissolve those task forces.

To date the two sides agreed to establish three task forces on:

• "green issues" — biodiversity, protected areas, ecosystem conservation, etc.;

• "pollution prevention and cooperation in case of environmental emergencies;"

• "protection of transboundary waters and monitoring of water quality"

Mandates and work plans for these task forces will be defined after the Subcommission is approved by Heads of State at their meeting in November 2006.

In terms of practicable solutions to transboundary environmental problems the situation in 2006 is very close to the status quo in 2004 with a new Subcomission serving as an expanded inter-agency replica of the former China-Russia Joint Task Force for Environmental Protection. In spite of the many risks and pitfalls, the Subcommission is a positive half-step forward in raising environmental issues in bilateral relations. Much depends on how each side achieves interagency cooperation and formulates clear and constructive positions as bases for future dialog.

Fisheries agreement

A Russia-China agreement on "Cooperation in Fisheries" was signed in 1988. The State Veterinary Inspection Committee (which recently included the former Fisheries Committee) in Russia and the Ministry of Agriculture in China are responsible for overseeing its implementation. The agreement calls for cooperation on research, protection, and management of fish stocks, development of aquaculture, and improvement of technology. A "Joint China-Russia Commission on Fisheries" was established to oversee this work. After signing the agreement, both parties began to develop a more specific supplemental agreement entitled "Cooperation in the field of protection, regulation, and reproduction of aquatic biological resources in transboundary waters of the Amur-Heilong and Wusuli Rivers," which was signed in 1994. The supplemental agreement includes a key component on "Amur-Wusuli Fishing Regulations," These agreements cover 25 species of fish, two crustaceans, one turtle, one mollusk, and three aquatic plants. The regulations specify minimum harvestable sizes for fish, net mesh sizes and lengths, seasonal fishing-ban periods, locations of waters closed for fishing, and permitted fishing gear. There are also provisions to mitigate impacts of agriculture, municipal and industrial pollution, water control infrastructure, and mining. A Special Task Force and Consultative Expert Group were established to implement this Agreement.

Although these actions have not yet stopped the decline of fish stocks, they provided a regular forum for exchange of important information, the resolution of disputes, and planning of joint measures. Jointly agreed fishing bans were implemented as were joint anti-poaching operations. Regulations have been periodically discussed and strengthened since 1994.

The 16th meeting of the Joint China-Russia Commission on Fisheries in May 2006 in Moscow was attended by representatives of several agency authorities from both sides and clarified a wide range of issues including quotas for sturgeon catch and exports, and joint positions for negotiation of quotas with the CITES Secretariat.

Forestry, water, energy agreements

In 1995 China and Russia signed the "Agreement on joint measures to combat forest fires.". Because the two countries are largely divided by major rivers that serve as fire-breaks, the need to apply this agreement has not arisen. The agreement does however contain useful provisions for joint training in best practices and could be used to study control of grassland fires in wetlands.

In 2000 China and Russia signed the "Agreement on Joint Use and Regeneration of Forest Resources," which was intended to regulate Chinese investment in Russia's forestry industry. The task force created under this agreement should have overseen cooperation on a variety of issues, such as joint logging ventures, investment in Russia's forestry sector, processing of wood products, forest regeneration, fire control, and pest control. In 2003-2005 many forest resource processing and export agreements were developed under the broad framework of the 2000 agreement, mostly involving provinces of Siberia, rather than Russian Federal Authorities. During the 2005 visit by the Russian Minister of Natural Resources to China, joint efforts were proposed to control illegal logging and timber trade (ENA-FLEGT process). Timber trade, joint processing, fire and pest control are also listed as priorities for cooperation in an "Action plan for implementation of the Treaty on good neighbor relations, friendship and cooperation for 2005-2008." The existing agreement was drafted in 2000 and does not address nature conservation. It included only the Russian Forest Service, which was merged with the MNR two months after the agreement was signed. Institutional barriers do not permit broadening the scope of the Forestry agreement to incorporate not only cooperation on logging and arrangements for China firms entering Russia to extract timber, but also a wider range of issues including biodiversity conservation, wildlife management, nature reserve development, forest management standards, wetland management, and CITES implementation. In China these issues are managed by SFA. However, in Russia partnership would require the collaboration of three interrelated agencies recently formed to replace the former Ministry of Natural Resources (Ministry of Natural Resources, Natural Resources Enforcement Service and Forest Agency).

In 1986 Russia and China agreed to establish a special task force to develop a "Comprehensive water development scheme for transboundary waters of the Argun and Amur Rivers." This task force has been active for more than 10 years during which time it produced a water resources development strategy. From environmental and economic points of view, the outputs of the task force are questionable. However, at least from the management perspective, the task force has probably been the best organized of all transboundary joint planning exercises (see Chapter 19 for detail). In 2004 representatives of Russia's Water Service and China's Ministry of Water Resources reached an agreement to re-establish an expert group for consultation on a range of water issues. Chinese counterparts emphasized that any water diversion and infrastructure projects undertaken within the territory of China, such as those on the Irtysh River (in western China, Kazakhstan, and Russia) the and Songhua River, are unlikely to be discussed or amended. In 2005 however, there was a clear signal from China's Foreign Ministry that Irtysh and other issues could be discussed with neighboring countries in due course.

Other China-Russia agreements, although not directly related to biodiversity conservation, do profoundly influence the Amur-Heilong Ecoregion. For example, the "Agreement on Cooperation in the Energy sector" plans the development of oil and gas exports from Russia to China. Many of the proposed pipeline alignments cross the Amur-Heilong basin and some would parallel the Amur-Heilong River valley. Such projects would have significant impacts on the environment, particularly on wetland habitats and migration routes. The agreement on delineation of international borders, amended in 2004, is also closely related to the dynamics of natural rivers (see Chapter 19 for detail).

Proposed new national level documents

Several bilateral agreements and supplements to existing agreements, some of them already under preparation, could, if implemented, improve environmental conditions in the basin. Below we present several examples discussed in various Russian agencies.

Since the early 1990s Russia encouraged China to sign an "***Agreement on use and protection of transboundary waters.***" Although Russia's agencies drafted a version of the agreement that met government approval (Decree 555, 7 May 1997), this process has not yet come to fruition in spite of steadily evolving contents and goals over the last 10 years. Different agencies in Russia would be affected to varying degrees by the outcome of the agreement and much would depend on which agency is assigned to assume the leading role in implementation. Originally it was a general framework agreement opening communication channels between water management agencies of two countries and was slightly biased toward hydrologic regimes, water use, and water infrastructure. The Water Service (already a part of MNR) was an obvious champion for such an agreement, but lacked its own capacity to negotiate with Chinese counterparts. The Russian MNR has been trying to draw SEPA's attention to the value of this agreement for years. As water pollution became a high-profile political issue, the leadership in bilateral negotiations shifted to the Ministry of Foreign Affairs where the focus was on water quality, mutual responsibility for water pollution, and compensation for damages. To date, all proposed versions omitted the larger issues of sustaining ecosystem processes, conserving biodiversity and habitats, wetland management, and environmental assessments. Lacking these components, the agreement could accomplish little toward achieving integrated river basin management. The formation of the Environmental

Subcommission and a working group on transboundary waters gives hope that further formulation of Russia's position will be guided by consensus achieved through interagency consultation.

In the past, China was slow to react to Russian draft agreements, but, after the Songhua spill in November 2005, China could no longer delay formulating its own safety and water quality initiative. However, signing international agreements focused on "compensation" is contrary to China's international policy, so the agreement remains unsigned. There is hope that China will take a proactive approach and counter the narrowly biased Russian proposals with a broader agreement that covers many river basin management issues.

The existing set of agreements might also be supplemented by:

- *The Protocol on Protection of Wildlife and Natural Habitats* (drafted in Russia under the Russia-China Environmental Agreement) which covers poaching, trade, and the establishment of protected areas, as well as the general exchange of information and specialists. Based on previous experience with environmental agreements, cooperation is more likely if the agreement is focused on issues managed by a single agency or department and its counterpart agency across the border (in this case SFA in China and MNR in Russia).

- *Protection of Migratory Birds*. Similar agreements on protection of migratory birds already exist between China and Japan, China and Australia, Russia and Japan, Russia and both the Koreas, and China and the USA. In 2006, China suggested that an agreement with Australia might serve as a model for a similar future agreement with Russia. Two questions should be analyzed when considering this proposal. How do migratory bird issues (avian influenza included) on vast shared expanses of Eurasia differ from those on the East Asian-Australasian flyway connecting Australia and China? How can we avoid the obvious current ineffectiveness of Russian participation in such agreements, which is exemplified by the existing agreements with Japan and South Korea?

- *Implementation of CITES, enforcement of anti-poaching regulations and wildlife trade issues*. These have always been difficult topics for bilateral discussions. However, given the agreed bilateral position on sturgeon management, and the clearly stated intention to form a partnership for participation in international treaties and associated processes, there is a clear necessity to jointly address this issue;

- *Lake Khanka/Xingkai Fishing Rules or Agreement on Protection and Management of Fisheries (Aquatic Biological Resources) of Khanka/Xingkai Lake*. In 2002-2003 both countries unilaterally attempted to implement measures to protect the lake's rapidly dwindling fish stocks. But unilateral efforts are destined to be ineffective because the international border splits the Lake into China and Russia portions. A transboundary agreement regulating fishing, the impacts on fisheries, aquaculture, and trade in fish could be a useful tool for rehabilitating the fish resource. Such an agreement might be achieved simply by extending the agreed Amur-Ussuri Fishing rules to include Khanka/Xingkai Lake. However, development of a new and more specific document for the Lake and the Ussuri/Wusuli basin would add value to the overall Fishing Agreement. The new document should address the shortfalls of the fishing rules now in effect, and consider larger ecosystem processes. A new document for Khanka/Xingkai Lake is also appropriate now because the current Fisheries Agreement will need review and revision in the near future if the two governments are serious about restoring and conserving the dwindling fish stocks throughout the Amur-Heilong Basin.

- *Task forces*. An important challenge to any agreement is the formation of effective task forces (working groups) and expert committees to implement cooperative projects. To date in the field of biodiversity (habitat conservation, ecological networks of transboundary protected areas, species conservation) there are no such groups and this impedes progress. Insufficient resources are allocated and there is no mechanism for delegating authority from the national to the local level where it can be used for fruitful cooperation.

China-Mongolia cooperation on environment and natural resources

China has only a few environmental protection agreements with Mongolia, but in many cases they are more comprehensive than those between Russia and China.

Mongolia-China Agreement on protection and utilization of transboundary waters

The agreement was signed on 29 April 1994 in Ulaanbaatar within the framework of the Treaty on the Sino-Mongolian Boundary System.

The agreement addresses the scarce and vulnerable water resources shared by the two countries, namely the Bulgan River (outside the Amur-Heilong basin) and the Kherlen and Khalkh Rivers and Buir-nur Lake (within the Amur-Heilong Basin). This agreement brings together all aspects of aquatic ecosystem management, including hydrology, river-bed processes, aquatic wildlife and plant life, pollution, and other issues. Ideally, the agreement would serve as the basis for integrated river basin management in the sub-basin comprised of Dalai and Buir Lakes, and their main tributaries, the Kherlun and Khalkh Rivers.

The agreement prescribes joint monitoring and research, coordinated development of water use and water infrastructure, protocols for agreeing volumes of water withdrawal, and exchange of related information. The agreement also stresses the issue of excessive fishing on Buir Lake. It gives priority to cooperative protection and utilization, but sets aside fishing quotas for special consideration in separate consultations.

The Water Agency of Mongolia (part of MONE) and MWR of China are required to conduct bi-annual meetings of the Joint Committee for implementation of the agreement. While the Mongolian Water Agency is authorized to deal with the full spectrum of issues addressed by the agreement, MWR lacks authority for aquatic bioresources and shares responsibility for water quality with SEPA.

While the Agreement helps to sustain dialogue and information exchange, it has not yet led to resolution of existing controversies.

China does not negotiate annually with Mongolia on water withdrawals from the upper Khalkh River, nor is Mongolia keen to negotiate with China on planned water transfer from the Kherlen River to the Gobi Desert. Management of biological resources (mainly fish) is often raised by Mongolia, but discussion is deferred by China because MWR is not authorized to discuss biological resource management.

Similar to the Russia-China examples cited earlier, this Mongolia-China agreement demonstrates the lack of forethought needed to avoid discrepancies between the contents of an agreement and the mandates of agencies.

According to the Mongolian Water Agency, the exchange of information has improved in recent years and joint expeditions are planned for the near future.

Sino-Mongolian Agreement on Cooperative Conservation of Nature (1990)

The objectives of the agreement are:

- bilateral cooperation to prevent soil erosion; anti-desertification; grassland protection; establishment of transboundary nature reserves and hunting bans along the borders;
- the joint study and development of techniques to control sand-storms and soil erosion;
- the joint study and conservation measures for protection, breeding, and utilization of Mongolian gazelle and other wildlife and wild plants along the common border; and
- cooperation with the UN on development of conservation organizations (including NGOs).

A Memorandum on cooperation between China's SEPA and Mongolia's MONE (1990) addressed the establishment of protected areas for wildlife conservation along the border; the need to conduct surveys and research to control pollution on border rivers and lakes, especially Khalkh River and Kherlen River; and the regular exchanges on nature conservation and management.

Terms of Reference were signed in Hohhot in December 2000 for The Third Committee on Trade and Economic Cooperation (CTEC). The committee coordinates development of bilateral relationships between China's Autonomous Region of Inner Mongolia and the Mongolia Ministry of Industry and Trade. Planned activities include cooperation on environmental issues. This is yet another example of an agreement signed by province-level units of the government of China (Autonomous Region) with a national-level unit of government in a counterpart country (National Ministry in Mongolia).

Mongolia-Russia cooperation

Cooperation in natural resource management between Mongolia and Russia has a long history. Many development projects in Mongolia in the 1950s-1980s were undertaken with technical and financial assistance from the Soviet Union. Agricultural products and raw materials were extensively traded between Mongolia and the Soviet Union, while machinery and other goods were exported from Russia to Mongolia. During that period most Mongolian students of natural sciences and natural resources management attended Russian universities. Therefore, today's elder generation of experts and top-managers in these fields is fluent in the Russian language. Based on a shared language and a long history of transboundary interaction, the two countries have undertaken a wide range of cooperative research projects on natural resources in Mongolia. A good example is the "Joint Complex Russian-Mongolian Expedition" established in 1970 by the Academies of Science that yielded knowledge on ecosystems, flora, and fauna of the region. In 2005 it published the Atlas of Ecosystems of Mongolia (Vostokova and Gunin 2005).

The new capitalist Russia did not inherit the Soviet Union's special attitude toward Mongolia, and Mongolia lacked resources to continue Soviet-era cooperation at its own expense. Fortunately, international donors were creating incentives for both sides to develop new links with institutions in western countries and their development aid agencies. But the present level of Mongolia-Russia cooperation on environmental issues does not achieve its potential given the solid foundation laid in the past and the new sources of international funding.

Cooperation with Mongolia on nature conservation is unanimously characterized by Russian participants as more friendly and fruitful, less bureaucratic, and less costly, than with any other neighboring country. Mongolian agencies operate with low levels of funding so bureaucracy is limited.

All transboundary agreements stem from and refer to the Mongolia-Russia Agreement "On Friendly Relationships" (1993). Examples of agreements that followed on the heels of this agreement include:

- "Cooperation in Environmental Protection" (15 February 1994): Similar in scope to the Russia -China agreement, but also includes a clause on common standards for environmental impact assessment;
- "Cooperation in Forestry" (5 April 1995): Addresses management, technology, fire and pest management, and the consideration of environmental and social impacts.
- "Geological Survey and Use of Mineral Deposits" (2 November 1996);
- "Protection and Use of Transboundary Waters" (11 February 1995).

The "Agreement on Protection and Use of Transboundary Waters" replaced agreements on "Water Management" (9 December 1988), and on "Rational Use and Protection of Selenge River basin waters" (3 July 1974), and was broad in scope. It addressed:

- environmentally sound use of water resources, prevention of pollution and depletion of waters;
- research on hydrochemistry, hydrobiology, and river bed processes;
- exchange of research information and flood forecasts;
- joint research, assessment and planning in flood management;
- joint water quality monitoring and pollution prevention;
- preserving conditions for natural migration of fish and other aquatic fauna;
- developing common concepts for river basin water management;
- developing joint pollution and hydrological monitoring standards and procedures;
- sharing of water resources;
- joint research on protection of water resources;
- information exchange on planned water management measures;
- jointly financed transboundary work and pursuit of international funding to support it;
- international standards of water quality; and
- prevention or reduction of negative impacts on transboundary water basins in national territories.

Such an agreement is necessary because many rivers cross common borders, including the Baldj, Onon, Uldz and Imalka in the Amur-Heilong basin area. In 2006 at the meeting of the Joint Working Group (chaired by water resource agencies of the two countries), joint planning of river basin management was discussed in detail. Mongolia recently adopted progressive new laws on river basin management and seeks Russia's assistance to develop strategies for management of shared river basins, with the Selenga River proposed as the first pilot project. This initiative is clearly a step toward enhanced conservation, but it raises concerns since Russian technical assistance will be based on outdated technologies for water engineering and "ZAO Sovintervod" approaches, which are infamous for similar schemes on the Amur-Heilong. Mongolian engineers informed their Russian partners that they plan to build a hydropower plant on the Egiin River, a tributary of the Selenga, and seek Russian assistance in "solving environmental and hydrological problems arising in the course of the project." New water quality monitoring procedures were adopted and the number of jointly monitored substances was expanded. Proposals were not discussed to divert water from the Onon, Selenge, and other rivers to the Gobi Desert that are likely to evoke consequences under this agreement. Mongolia asserts that these proposals have not yet been approved, but the pilot phase will affect only the Kherlen River, which is shared with China and not Russia. In general both sides have keen interest in expanding cooperation. Russia's Water Service claimed that it already has six transboundary water basin management agreements with adjacent countries and can apply this experience to the Selenga, Onon and other rivers.

Provincial transboundary cooperation and its environmental implications

Cooperation across the river

Cooperation between provinces of Russia and China is regulated by an "Agreement on a general framework for cooperation between provinces of Russia and China" (1997). It permits provinces to develop any international agreements that do not encroach on exclusive responsibilities of central governments, and to establish cooperative mechanisms to implement these agreements. Whereas both national authorities in Moscow and Beijing are remote from the Amur-Heilong River basin and its environmental problems, provincial authorities are close to the issues and often more aware of local conditions that affect prospective solutions. Thus inter-provincial initiatives are often more accurately focused on the most important transboundary issues. Khabarovsk Province has been the most active among Russian provinces in implementing transborder initiatives. In 1998 Khabarovsk Province signed the "Agreement on development of economic, cultural and scientific cooperation" with China's Heilongjiang Province and began cooperating on environmental issues. In 2000 parties developed a "Plan for joint nature conservation for 2000-2005," which included a broad range of activities from sharing and unifying detailed environmental data to development of joint projects in biodiversity conservation, nature reserve management, pollution control, environmental education, and others. In February 2002 parties endorsed a joint program on water pollution monitoring in the Amur-Heilong and Ussuri/Wusuli Rivers. The program also involved Evreiskaya Autonomous Province and called for joint sampling expeditions, the exchange of information, calibration of data, and unification of pollution measurement methods.

In 2003 Evreiskaya Autonomous Province negotiated its own agreement for cooperation in natural resources and environmental protection with Heilongjiang Province. While the resource use component of this agreement has been implemented, the environmental protection component has not.

Under the framework of a 2003 "Agreement on development of economic, cultural and scientific cooperation" with Inner Mongolia, Chitinskaya Province of Russia signed a memorandum to establish a Task Force on Water Quality in the Argun River with Inner Mongolia Autonomous Region. Meetings and cooperative monitoring have been undertaken since 2003, and by 2005 these activities had evolved into the "Memorandum for Protection of the Environment in the Argun/Erguna River Basin." The Memorandum covered pollution, biodiversity conservation, and protected area planning. An Additional Task Force on Biodiversity and Landscape Conservation was established and the vice-director for science of Daursky Zapovednik (Strict Scientific Nature Reserve) was invited to coordinate it from the Russian side.

A similar process has unfolded between Chitinskaya and several Mongolian provinces (aimags). In 2002 an additional agreement was signed between Dornod and Khentii Aimags of Mongolia and Chitinskaya Province of Russia on "joint action in preservation of transboundary ecosystems." The "Plan for Nature Conservation in the Upper Amur-Heilong River basin" was adopted in 2004 by Chitinskaya Province and ABAR, and lists a wide range of international activities to be implemented through existing and new agreements with Mongolia.

There are many examples of Russian provinces signing agreements with administrations at lower levels in the government hierarchy in China (counties, districts, and prefectures) (e.g. Amurskaya Province with Heihe Prefecture of Heilongjiang Province). This inequality is dictated by practical considerations such as comparable scales of economies and is therefore the trend likely to persist in future.

Cooperation along the river

Existing levels of cooperation between provinces and countries have been insufficient to reverse deterioration of their shared environment. The first important step toward developing a basin-wide agreement was made in Russia by the government of Khabarovsky Province, an area that suffers from environmental mismanagement upstream. In 2003, by the initiative of Khabarovsky Province and WWF, the Amur-Heilong River Basin Coordination Committee on Sustainable Development (ARBCC) was formed in Khabarovsk by governments of the six Russian Provinces in the river basin. The committee includes the Association for Interregional Economic Cooperation in the Far East and Zabaikalie and four federal (national) agencies: Amur Basin Water Management Authority, Amur Basin Fisheries Management Authority, Pollution Monitoring Agency and Amur Basin Navigation Authority. Later it co-opted two additional members — one represents the scientific community and the other the Amur NGO alliance.

The Committee was formed to develop a common vision with policies and programs for preservation of the Amur-Heilong River ecosystem, supervise implementation of interregional programs, and help participants allocate resources to support this work. One of most important tasks of the Committee is to advise the Russian Government, as well as member-provinces, on a coherent Russian position on basin environmental issues to enhance Russia's dialogue with China and Mongolia, and to facilitate involvement of Chinese and Mongolian partners in solving common environmental problems.

Four priorities emerged at the first meeting of the Committee: 1) the prevention of trans-boundary pollution; 2) biodiversity conservation; 3) sustainable land-use; and 4) the improvement of the welfare of local communities dependent on natural resources. To address these priorities the Committee organized interregional working groups on biodiversity and protected areas with representatives of all six provinces.

Progress of the ARBCC through early 2006 has been slow because of continuing rearrangements in all participating agencies due to administrative reform and slow decision making among the six provinces. Several issues must be resolved to make the ARBCC more effective:

- An equitable decision-making mechanism between the six basin provinces (perhaps "one province, one vote");
- National government agencies more involved and the presence of a lead agency, possibly the Water Agency, which already manages the "Basin Agreement;"
- A shift from short-term opportunistic exploitation of resources to more strategic planning encompassing integration of all IRBM issues;
- the ability to grant NGOs and research institutions access to the decision-making process and information;
- Regular consultations with counterparts in Mongolia and China.

After several unsuccessful attempts to invite official representatives of neighboring provinces of China to ARBCC events, by year-end 2006 the Working Group of ARBCC was preparing for hearings in the Russian Federal Duma (Parliament) scheduled for 2007. The Scientific-Civic Committee under ARBCC represents the academic research and NGO communities and plans to participate in public debates on the UNEP-GEF Amur Basin Management Project launched in mid-2006.

Opportunities and problems for future provincial cooperation

The most promising locations for establishing international agreements and cooperation mechanisms are within neighboring provinces. Their ability to focus on local issues can lead most directly to implementing practical work to solve problems. However, there are important drawbacks:

- Responsibility for resolving key environmental problems rests, at least in Russia, with ministries of the Central Government. There must be effective mechanisms for direct involvement of the ministries in this process;

- From a basin-wide perspective many of these agreements are not geographically or institutionally integrated and/or some might be redundant. For example, Heilongjiang Province may have similar agreements with four neighboring provinces of Russia (Amurskaya, Evreiskaya Autonomous, Khabarovsky, and Primorsky). This can waste time and resources, and even lead to unproductive competition among Russian provincial administrations.

- Joint implementation mechanisms have not yet been established for the most promising agreements (such as the 1998 Memorandum of Understanding on Wusuli-Ussuri Basin Land Use between Heilongjiang, Khabarovsk and Primorsky Provinces);

- Agreements on use and conservation of natural resources were originally designed to cover both economic and environmental issues. But these are used by agencies solely to spur economic development while environmental issues are ignored (the Heilongjiang-Evreiskaya Autonomous Province agreement exemplifies this trend).

Interregional coordination mechanisms involving representatives of central government would help to shorten learning curves and harmonize these relationships. In 2003, conditions for establishing such mechanisms were developed in Russia by the formation of the Amur Basin Coordination Committee. It includes representatives of regional and national agencies, but is driven by interests of provincial governments. In 2006 provincial representatives were also invited by national government to sit in on the "Russia-China Environment Sub-commission" (Interagency Working Group on Environment and Natural Resources).

The emerging inter-provincial relations on basin-wide environmental issues lack mechanisms for transboundary coordination. This could be corrected by programming regular consultations between provinces of China and Mongolia, and the ARBCC on issues including biodiversity, wetland management, and transboundary ecosystem conservation. A potential alternative is that cooperation will develop through better representation of provinces in task forces of the Environment Sub-commission at national level.

If both the ARBCC (basin level) and the Environmental Sub-commission (national level) address the same basin issues, this can help sustain a balance in the complex and uneven relationships between provinces and the federal government in Russia. Provincial authorities frequently claim they suffer from a federal policy that spurs economic cooperation with China without considering social and environmental consequences in border regions. To this end, the ARBCC may help to formulate and raise concerns of border provinces, while the Environmental Sub-commission provides opportunities to participate in formulation of national positions in Sino-Russian environmental cooperation. It is too early to evaluate whether the two mechanisms are effective in achieving environmental goals.

The most likely champion of basin-wide environmental cooperation with Russia would be Heilongjiang Province. It already cooperates through the "Revitalization of Old industrial Bases," borders five out of six Russian provinces in the basin, and has signed environmental agreements with at least three of them. Heilongjiang Province emphasized the previously established mechanism for regular consultations on transboundary issues as one of its claims to take the lead in economic cooperation. To date this mechanism does not fully and properly incorporate environmental policy issues.

Inner Mongolia has achieved greater cooperative progress with Russia than with other provinces within China. The few environmental agreements it has with Russia's Chita Province cover a wide spectrum of key environmental issues and in recent years have made quicker progress on conservation efforts in the Argun River Basin. The only Russia-China "ecological" district-to-district agreement to date is also from the Argun River and limits the size of fishing nets and specifying other standards for use of common resources. Many factors contribute to enhancing cooperation between Inner Mongolia and Russia, including low political tension along the common border with Russia (largely unchanged since the 17th century); greater willingness of authorities from Inner Mongolia and Hulunbuir Prefecture to take responsibility for international cooperation; less reluctance on the part of central government to delegate responsibility to lower levels (probably related to special status of Inner Mongolia as an autonomous region); clearly perceived scarcity of common natural resources and vulnerability of transboundary ecosystems; a border with only one Russian province, which decreases competition between Russian provinces and promotes common standards; and the ability to draw on similar experience with Mongolia. Although development of a basin-wide environmental cooperation at the province level should be linked to the policy for "Revitalization of Old Industrial Bases of the Northeast" and thus centered on Heilongjiang Province, the best testing ground for early formation of constructive river-basin management cooperation models seems to be in the Argun River basin shared by Inner Mongolia and Chita Province (and Mongolia if the Dalai-Buir Lakes basin is considered). Given that both sides have for many years cooperated with Mongolia and the three parties have established a trilateral protected area, this is also a most beneficial place to start any trilateral cooperation on integrated river basin management.

Local environmental cooperation: generic difficulties

In earlier centuries, border relations were less constrained by national authorities and more defined by the behavior of local communities or stakeholders. Of course national policies still had great influence, but, in many cases, local communities were the only force capable of implementing them. At least in the western part of the basin there are records of Russian and Chinese subjects (including those of what is now Mongolia) coming to regular meetings to reaffirm specific rules of good-neighbor relationships and agree on the use of various natural resources: game, pastures, timber, and arable land. A recent attempt of Priargunsky District (in Russia) to agree with Erguna District (in China) on fishing net mesh-size is reminiscent of those days when such issues were not the exclusive domain of governmental enforcement agencies but were managed in traditional ways using local regulations based on common sense honed by practical experience. We have no evidence that these informal trans-jurisdictional agreements and regulations were effective, but they must have made useful additions to national policies and agreements by giving local people entry points into decision-making, providing education and communication tools, and helping to harmonize national policies with local conditions. The central government, at least in Russia, often felt uncomfortable with these local interactions and tried to curb them when it had adequate enforcement capability. From the central government perspective, local trade is equivalent to trafficking, use of traditional tribal hunting grounds is poaching or a violation of the border regime, and nomadic herders represent annoying and unnecessary flows of immigrants. Due to tensions with China, improved enforcement capabilities of national agencies, and declines of local traditional cultures, by the last quarter of the 20th Century most local transboundary interactions were either considered illegal or fully subordinate to regulation by the state. That is precisely when both China and Russia realized the urgent necessity to renew close relationships between adjacent districts. Incentives were created for local districts to develop trade and businesses ties, but environmental and natural resource regulations and planning largely rested with national agencies and provincial administrations. Today we would argue that the creation of any sustainable land-use regime in a transboundary area (adjacent districts, nearby forestry management units) would require recovery of the cultural tradition of local transboundary cooperation followed by provision of local access to transboundary decision making.

All agreements and processes discussed above could work more effectively if they were implemented with local inputs along the border regions. Unfortunately, most local stakeholders do not have well-defined roles in intergovernmental and inter-provincial processes. While many share concerns with higher administrative levels, there is little opportunity for a district government and/or individual firm to participate in solving regional or transboundary problems. The situation varies from stakeholder to stakeholder and from location to location, and focused policy research at multiple locations is needed to explore specific impediments and recommend solutions. This type of research has yet to be attempted, but some possible points of departure are discussed below.

Local divisions of federal regulatory/ enforcement agencies

Border guards of China and Russia have achieved close and constructive cooperation in transboundary areas. Although they deal with violations of border crossing and trafficking, many of these violations are related to the use of natural resources. In most locations border guards need to investigate causes of common violations, educate potential violators, and carry out joint Russia-China patrols to prevent violations and develop better site-specific regulations. Two issues prevent enforcement agencies from solving natural resource problems they face. First, nature conservation is not explicitly written into their mandate and they lack knowledge and authority to address this issue. Second, at least in Russia, border guards are part of the Federal Security Bureau, a closed institution characterized by controversial relationships with local communities and minimal oversight from society. Unfortunately, in addition to their official role as keepers of a secure border, enforcement agents often hunt illegally and participate in other types of natural resource exploitation. Beginning in 2005 the border area officially controlled by border guards in Russia was increased and the Federal Security Bureau now plays an even larger role in natural resource use regimes and related transboundary cooperation.

Close relationships between Forest management agencies across international borders are focused on logging and exports of timber, and rarely extend beyond ensuring enforcement of acceptable performance of Chinese firms in Russian forestry bureaus. However even this enforcement is largely the responsibility of the Federal Natural Resource Enforcement Agency, which has a small number of employees in each province and almost no ties with the many prospective counterparts in China (SEPA, SFA, other agencies). The only example of cooperation other than enforcement was a joint training program in 2005 led by the Forest Management Agency and the Federal Natural Resource Enforcement Agency in Evreiskaya Province. The program trained Chinese foresters in compliance with Russian laws and engaged the foresters in a comparative analysis of forestry practices and regulations in the transboundary Small Hinggan mountain forests. Despite the success of this first transboundary training program (supported by WWF), additional programs were not scheduled due to the lack of support from forestry agencies in China and Russia.

District governments (known as “rayon” in Russia and county, ”xian” or “qu” in China) could be important players in environmental cooperation, especially in developing sustainable local models of natural resource use. Township or village levels of government known as “selskii okrug” in Russia and “xiang” in China are also potentially important players in border areas.

One result of the “administrative reform” of 2003-2006 in Russia was the splitting of local self-governments into two levels, “district” and “settlement,” driving an increase in the size of local government bureaucracy. Simultaneously, the provincial and federal responsibilities for social welfare were delegated to the two new local levels of government, thus greatly increasing costs. Almost all natural resources are managed by provincial and federal agencies with little input from local government. Thus there are few income generating opportunities for local government. Taxes on farmland are a major source of revenue for local governments. However, large tracts of farmland have been abandoned during the last two decades, reducing tax revenues. The reformed local governments are left with increasing expenses for social welfare and declining tax revenues. Although the reform is recent and it is too early to evaluate its consequences, the most probable outcome is predictable. In transboundary areas, pre-reform local self-government was heavily reliant on the small share of fee-income it received from the activities of Chinese businesses engaged in logging, mining, trade, and agriculture. Reform will probably increase local government dependence on this type of fee-income and on bribery to cover increasing costs and declining tax revenues.

Districts rich in forests, minerals, or other resources are likely to see increased opposition to any additional conservation measures (protected areas, no-hunting zones, water-protection zones). This is because local governments will try to preserve opportunities to earn money from resource leases to outsiders. Where nature reserves are established, such opportunities are lost. In the case of agricultural lands, on which local government can assess taxes, the leasing of abandoned lands to anyone capable of paying taxes is likely to accelerate. Long-term, integrated land-use planning which considers the sustainability of resource use is not likely to be high on local agendas given the pressing survival needs in the reformed local administrations. Although local governments have nominal “environmental protection services,” each with up to three personnel, these offices have limited authority and lack capacity to consistently implement plans in the fluid political and economic environment of the RFE today (see case study in Chapter 31).

The situation in China differs from that in Russia in one important aspect: China has vertically integrated environment and resource-management agencies into practically all levels of government. In general, vertical integration in China’s bureaucracy ensures that the same environmental policies are systematically incorporated in agendas of government at all levels.

A large share of government funding is allocated on a competitive basis from national programs supporting policy implementation (such as the Nature reserve development program, Natural Forest Protection Program, and Grain for Green Program). No matter how alien to the agendas of local governments, implementation of these programs enjoys local support because they deliver financial gains from national coffers to local communities. In the course of implementation, local governments often take on the core environmental concepts of such programs and make them part of the local agenda. Although results are mixed, in general this approach ensures that successful models of problem solving are replicated in many communities.

Especially interesting are environmental planning exercises initiated by SEPA for "green districts" and "green villages" in an attempt to arrive at new and sustainable modes of development for administrative units. For example such "green strategies" are pursued by Jiayin and Luobei districts in the Small Hinggan Mountains (Xiaoxing'an Ling) of Heilongjiang Province on the border with Evreiskaya Autonomy, and by Erguna Municipality that includes 600 kilometers of international border with five districts of Chita Province in Russia. In the Erguna case the enlightened leader of the local administration recently invited Russian neighbors to develop a joint "ecological zone" along the Argun River. We are yet to see whether willing and capable counterparts emerge on the Argun River bank in Russia.

The contrast between Russia and China in terms of human population densities and levels of economic development tends to discourage transboundary environmental cooperation. Northeast China's dense population and large and rapidly growing economy depletes natural resources and generates many environmental impacts most of which are severe. In contrast, the RFE is sparsely populated and economic growth is slow. Natural resources are largely intact and environmental impacts of development are isolated and small in scale. China's proximity to the resource-rich RFE is often viewed by China as a stop-gap opportunity to import low-cost raw materials to substitute for and thereby enable recuperation of China's domestic resource base. This is strongly reinforced by national policies that create incentives to "go abroad" to ensure supply of resources. The best example of this is China's purchase of Russian timber. Notions of "common environment" and the need to ensure sustainable use of natural resources are non-operational in local and national policies alike. No matter how quickly local environmental policies improve in China, they will not automatically translate into transboundary environmental cooperation when short-term resource needs are pressing in China and low-cost raw materials are available in the RFE. (For example, see the case study on the Small Hingan in Chapter 31).

Local governments will be unable on their own to resolve environmental problems in transboundary regions unless clear incentives are created by national governments. Such resolutions also require agreement between China and Russia. Further cooperation also requires the selection of ecologically important areas on the border where new models of transboundary interaction can be developed. Sites where China already pursues "green development" would probably be most suitable.

Cooperation based on protected areas is discussed in detail in Chapter 30 on the Amur-Heilong Green Belt.

Role of international treaties, fora, and development assistance projects

Numerous treaties have been signed by basin countries for the protection of the international environment. The Convention on Biological Diversity, CITES, and Ramsar Conventions are among those most relevant to Amur-Heilong basin management. There are also many international nature conservation fora and institutions where basin countries participate. A common drawback of these treaties is the traditional UN designation of global regions: the Amur-Heilong basin lies between European and Asian regions, with Russia considered European while China is considered Asian, and Mongolia may belong to either group in different international fora. Since many implementation mechanisms and financial aid programs are developed specifically for particular regions, activities designed to address the Amur-Heilong basin as a whole are difficult or impossible to implement under the jurisdiction of a single regional bureau. Even large NGOs such as WWF or IUCN share this bureaucratic problem. Some conventions, agreements and organizations are confined to particular regions of the world with many European institutions excluding China, and most Asia-Pacific fora marginalizing Russia. Except for the Ministerial Conference on Environment and Development in Asia and the Pacific that held its 5th meeting in Seoul in 2005, there are no high-level intergovernmental fora dedicated specifically

Box 6.3 International Environmental Conventions and Multilateral Agreements Relevant to the Amur-Heilong River Basin

*countries that have acceded or have observer status are listed

- Convention on Wetlands of International Importance Especially as Waterfowl Habitat: (Ramsar), 1971 (Russia, China, Mongolia)
- Convention for the Protection of the World Cultural and Natural Heritage, 1972 (Russia, China, Mongolia)
- Convention on International Trade in Endangered Species of Wild Fauna and Flora — CITES, Bonn Amendment, 1979 (Russia, China, South Korea, Mongolia)
- Convention on Long-Range Transboundary Air Pollution, 1979 (Russia)
- Convention for Protection of the Ozone Layer, 1985 (Russia, China, Mongolia)
- Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, 1989 (Russia, China, Mongolia)
- UN Convention on Environmental Impact Assessment in a Transboundary Context 1991 (Russia,)
- UN Framework Convention on Climate Change, 1992 (Russia, China, Mongolia)
- Convention on Biological Diversity, 1992 (Russia, China, Mongolia, North and South Korea)
- Convention on the Protection and Use of Transboundary Watercourses and International Lakes, 1992 (Russia,)
- UN Convention on Transboundary Effects of Industrial Accidents, 1992 (Russia)
- UN convention on fighting desertification. 1996 (Mongolia, China)
- Bonn convention on protection of migratory species. 1999(Mongolia)
- Rotterdam convention on preliminary informing of international trade of chemically hazardous substances and pesticides. 2000 (Mongolia)

to environmental issues in north-East Asia. For this reason, international environmental agencies normally split the Amur-Heilong Basin to fit into the regional designations they individually recognize. The most relevant multilateral conventions, agreements and programs are presented in **Box 6.3**.

International funding for conservation projects in the Amur-Heilong basin has a mixed record. Although northeast Asia cannot by global standards be considered a poverty region, countries of the Amur-Heilong basin have difficulty financing environmental protection and benefit greatly from international assistance. While China and Russia can devote resources to solve domestic environmental problems, they have not yet developed financial mechanisms to support transboundary environmental cooperation. This makes such cooperation dependent on funding from international sources. Historically, many worthy transboundary initiatives became feasible only when international agencies mediated. However, most bilateral and multilateral funding supports conservation in a single country. Bilateral donors with prolonged interest in the region include Japan, Australia, and Canada (focused on China), the USA (focused on Russian Far East and lately Mongolia,), and EU countries with shifting interests. Environmental projects are often small parts of their development assistance packages. Japan and the USA have financed nature conservation initiatives linking two or more countries of the region, but these projects are a small fraction of total funding. Often such funding is linked to migratory birds or other natural features and processes spanning many countries. The objectives of bilateral agencies prevent them from direct funding of transboundary projects other than those mediated by an NGO, research institute, or regional international committee overseeing implementation of regional environmental projects.

Multilateral assistance agencies have greater freedom in funding projects in transboundary areas, but their environmental assistance to the individual countries of the Amur-Heilong basin has historically been greater than their support for transboundary issues. The main reasons for this are the lower implementation costs (and required efforts) for single-country projects, more active lobbying for such projects, and the absence of influential regional institutions that can guarantee smooth implementation of multinational projects. Another fundamental obstacle is that multilateral agencies (similarly to the UN) divide Northeast Asia into Europe and Asia, with only the World Bank having a mandate to work in all three basin countries, while the EBRD excludes China and the ADB excludes Russia. The GEF has been a primary source of most focused environmental funding in this transboundary region.

International NGOs act as starters for many environmental initiatives in the basin, but their capacity to address transboundary issues is also limited. Greenpeace, WWF, WSC, Wetlands International, and others have representative offices in China, Russia, and some even in Mongolia. However work programs of these offices are mostly shaped by national agendas rather than by international priorities of the head offices. However, NGOs have demonstrated that they are more effective at building cross-border relationships than intergovernmental agencies.

Below we provide several examples to explain the roles and problems of international conventions and international assistance in addressing environmental issues in the Amur-Heilong River basin.

The Ramsar Convention

The Ramsar Convention is an important policy tool in the Amur-Heilong basin. The basin is considered by the Ramsar Convention Bureau to be a part of Asia and is supervised from the Asian Ramsar Bureau office. More than 12 Ramsar sites have already been listed and inventories have been completed for wetlands that qualify as Ramsar sites throughout most of the basin.

The basin includes many important wetlands that are linked by hydrology, bird breeding, and wildlife migration. These wetlands are ideally suited to coordinated management using the Ramsar Convention's regional, river basin approach. Integrated river basin management (IRBM) in the Amur-Heilong can only be accomplished through international cooperation, a worthy objective of which would be an agreement and plan for protecting the entire Amur-Heilong River ecosystem. Drafting of the plan is a long-term commitment that would require several preparatory stages: design of a regional conservation framework, development of a common transboundary vision, drafting of a basin-wide action plan, and specification of implementation mechanisms. The Ramsar Convention's regional approach provides a suitable framework for managing this process.

During recent years IRBM became one of most important themes of Ramsar because of its long tradition of helping to form regional initiatives and alliances. The Mediterranean Regional Ramsar Initiative, uniting 11 countries in project activities and 25 countries in policy consultations, is the most advanced model developed under the Ramsar Convention heretofore. The founding of the Mediterranean Initiative led to the establishment of a funded coordination body supported by the Ramsar Convention Secretariat. This body is able to discuss and coordinate wetland policy issues beyond bilateral agreements, and can establish joint transboundary projects and raise funding. In 2005, more than 10 such regional initiatives existed globally. Some of these had received approval from the Ramsar Convention Secretariat and have started operations.

Since all countries of the Amur-Heilong basin are long-time signatories to the convention, this mechanism could provide a very useful umbrella for transboundary efforts in integrated river basin management. Many existing bilateral and trilateral agreements may be used to support this umbrella and to address aspects of IRBM (wetland management, international protected areas, protection of transboundary ecosystems and biodiversity, pollution monitoring, fisheries regulation). The Ramsar Initiative was discussed in May 2005 at the Ramsar Regional Asian Meeting and was supported by participants, including official representatives of the three basin countries. A plan to establish regional coordination facilitated by the Ramsar Convention was also approved at a Trilateral Meeting of DIPA in March 2006 (see Chapter 31 for discussion on wetland conservation).

A Land Use Program in the Ussuri/Wusuli Basin

From 1995-6 Ecologically Sustainable Development, Inc. (of the USA) assisted scientists and state planning agencies of Primorsky and Khabarovsky Provinces of Russia and Heilongjiang Province in China to design a Sustainable Land Use and Allocation Program for the Ussuri-Wusuli River Watershed. The project was coordinated by the NGO Ecologically Sustainable Development and supported by the US National Committee on US-China Relations. Funding was provided in part by USAID, and in part by US private foundations that ensured support for Chinese involvement that could not be funded from USAID directly. The planning exercise was participatory, with frequent workshops, consultations, site visits, and public hearings. To date it remains the case of closest cooperation in nature conservation between bordering provinces.

The resulting land-use program was broad and general, and dealt with every major aspect of land-use, opportunities to achieve sustainable development, environmental monitoring, and nature conservation.

Government stakeholders in Russia and China have agreed on selected joint actions through various international fora and agreements. These include the Memorandum of Understanding (signed on 25 May 1998) on the Wusuli-Ussuri Basin among Primorsky, Khabarovsky and Heilongjiang Provinces. The MOU prescribed the joint planning of protected territories, the joint development of tourism and recreation facilities, initiation of applied science exchanges in hydrology, and watershed management, for enhancing and maintaining water quality and fish resources in the Wusuli-Ussuri River and adjacent waterways. Through the MOU, it was proposed to national governments that an International Wusuli-Ussuri River Commission (IUC) be established. Unfortunately, IUC has not been established and nothing has replaced it to oversee continuation of cooperation. The result is that much of this project's potential has been neglected. However, the project accumulated many important nature conservation and land-use concepts, and many have been implemented by countries unilaterally despite the obvious advantages of cooperation. Most of the Program's proposals have been revised and implemented in the China part of the basin (such as the protected area corridor along the left bank of the Ussuri-Wusuli River), while in Russia this has occurred to a lesser extent.

The research completed by the USAID project and the resulting inter-provincial agreement could be used in future to further conservation and sustainable development in the Ussuri-Wusuli watershed.

The Global Environmental Facility

The Amur-Heilong River basin frequently draws the attention of the Global Environment Facility or GEF and other international environmental agencies. In the GEF realm alone several basin projects have already been implemented or are undergoing project development:

- UNDP-GEF Protected areas in Eastern Mongolia (final report due in 2006))

- UNDP-GEF TumenNet (1997-2002) — which covers the Tumen River Basin and the Daurian Global Ecoregion with Russia, China, Mongolia, and both Koreas participating.

- WB-GEF Midsize Amur tiger protected areas in Khabarovsky province, Russia (2002-2005)

- WB-GEF Fire prevention in HCVF of Amur-Ussuri region in Russia — PDF-B (2004-2005), full project to be started someday.

- UNDP-GEF Sustainable Use of Wetlands in China Project (restarted after midterm review in 2005)- with national, provincial and Sanjiang site components all relevant to the Amur-Heilong basin;

- UNEP-GEF Conservation of the Globally Significant Wetlands and Migration Corridors required by Siberian cranes and Other Globally Significant Migratory Water birds in Asia (2003-2007)) — involves nature reserves and institutions from Russia and China;

- ADB-GEF Songhua River Flood, Wetland & Biodiversity Management Project , China (PDF B 1999-2001) addressed integrated river basin management issues relating flood prevention to wetland conservation;

- ADB-GEF Sanjiang Plains Wetlands Protection Project (full project started in 2006) — addresses wetland conservation and upland restoration in Khanka-

Xingkai lowlands and Middle Amur-Heilong plain in the China part of the basin;

• GEF-UNDP-WWF Dauria Wetland-Steppe Midsize Project (planned to start in 2006):addresses conservation of wetland-grassland ecosystem in the Russian part of the Amur-Heilong headwaters;

• UNEP-GEF Transboundary Diagnostic Analysis for Khanka/Xingkai Lake (2002-2004):served as PDF-A phase for Integrated Management of the Amur-Heilong River Basin Project

• UNEP-GEF Integrated Management of the Amur-Heilong River Basin Project: PDF-B started 2006 development of a basin-wide regional framework for integrated management of the Amur-Heilong basin and associated continental and Sakhalin Island coastal areas in China Russia and Mongolia.

• Several GEF projects that address environmental conditions in North East Asia coastal waters influenced by river runoff.

While these GEF projects are most closely related to the Amur-Heilong River basin, there are still at least seven more projects being implemented or planned in the basin, all relating to broader environmental issues. Many internationally funded non-GEF projects have also been completed or continue in the basin under the administration of WWF, ADB, or WCS. Preparation for most of these projects has not been fully coordinated and each at best mentions a few others where there is potential for sharing activities or resources. As such there is significant overlap, duplication, and missed opportunities for more powerful and lasting basin-wide benefits. Various assessments by international experts, data collection, policy analysis, capacity building, and planning consume most of the funding for each project. However, when a new project starts it normally fails to make use of the knowledge base developed in earlier projects. Therefore the initial exploratory cycle is completed again and again while little capacity is devoted to promoting and supporting nature conservation. Because technical reports produced by each project undergo limited peer review, are seldom translated into national languages, and are almost never published or disseminated among experts and managers in the region, most are essentially lost for future use. Unless the development phase of each project specifies the need to review and the existing knowledge base, this wasteful cycle will continue.

The task ahead is to promote better coordination among the GEF and non-GEF projects underway in the basin and capture the synergy from the many existing initiatives. Each project should promote the same set of international treaties and agreements, and the same regional conservation objectives. These diffuse and often overlapping efforts could benefit from coordination to achieve some or all of the following:

• periodic communication to develop common objectives and complementary action plans;

• common data management and dissemination standards, integration of data in accessible databases; measures to prevent duplication of existing information;

• common policy toward assisting various GEF partners and stakeholders to achieve better coordination and develop common priorities and enhance cooperation;

• joint public outreach activities promoting global conservation (supported by the GEF) to various audiences in the basin and at national and international fora;

• joint assistance to the GEF and national agencies to identify future interventions and develop long-term conservation plans (funded by the GEF and other sources).

The most efficient way to achieve this in the Amur-Heilong basin is to set up an environmental information clearinghouse, which could take the form of an international NGO/research center. The center would operate under a long-term agreement between major stakeholders and would establish a permanent secretariat. Ideally the center would become the headquarters of a future Amur-Heilong River Basin Management Council. The center would be staffed by a professional information manager and capable technical experts who might serve as advisors to any of large international project.

Communication and information sharing

Insufficient communication mechanisms

The fragmentation of information and authority for decision-making and implementation is a widespread flaw in environmental protection, and it is most vividly manifested in the case of transboundary wetlands and IRBM. Efforts of governments, NGOs and international agencies to safeguard a single river ecosystem typically lack common themes and agreed priorities. Many key issues such as transboundary ecosystem conservation, endangered species protection, integrated development planning, and strategic assessment of development and conservation options are not resolvable within existing frameworks. Most stakeholders are uninformed of the scale of environmental problems therefore not interested in solving them. International agencies and NGOs have a more global perspective but still attempt to solve problems within the boundaries of a single country or jurisdiction of a single agency. Specialists rarely have the chance to meet and produce coherent descriptions of environmental problems at appropriate scales.

Information Sharing

One fundamental issue is the need for information sharing. Lack of information about a neighbor's environmental situation, policies and plans has impeded environmental cooperation between countries of the region. Thus the most logical first step is to develop a clearinghouse to promote information sharing and develop a common vision. This is not an entirely new issue.

The Amur-Heilong basin has strong research centers at Harbin, Khabarovsk, Changchun, Chita, and Vladivostok. These institutes have accumulated enormous archives of information that are seldom used because they are almost never shared. The Chinese Academy of Sciences issued a public statement in 2004 criticizing the institutionalized reluctance to share scientific information as a key barrier to accelerated national development. Unfortunately, most research centers are slow to respond to such criticism.

The following examples of routine activities would greatly facilitate effective information sharing:

- invite neighbor countries to participate in field research;

- shift away from incompatible "country-reports" to more sophisticated and more useful transboundary data collection, analyses and reporting;

- develop, update, and publish annotated bibliographies on basin-wide environmental issues;

- institutionalize information exchange procedures between national research institutes and resource management agencies on shared natural resources and environmental problems;

- develop simple information collection standards and basic multi-lingual datasets and tools that can be used by a wide range of researchers and institutions; for example, a single, user-friendly, basin-wide GIS would be an excellent starting point.

- improve coordination and cooperation between agencies and international projects in the Amur-Heilong River Basin, (with emphasis on synergy of several GEF projects).

- establish at least one joint international environmental research center dealing specifically with transboundary environmental issues of Amur-Heilong River Basin.

New transboundary mechanisms for information sharing between technical research institutions will be ineffective unless communication is established between other key groups of stakeholders who need information for decision-making and action.

Status of Environmental Data for Decision Making

Basic water and environmental data used for decision making are biased, fragmented, and unreliable. They are ill suited to solving transboundary problems.

The largest body of data ever collected jointly by neighboring countries is contained in two project documents entitled "Joint Water Management Schemes for the Argun and Amur Rivers" (1961, 1993). These represent extensive research on many essential aspects of river system functions. While the basic data are invaluable, conclusions derived from them are often biased because the data were compiled for a narrowly defined purpose — building reservoirs in the main channel. 1993 data were further complicated first by the debate between environmentalists and hydro-engineers that occurred during data analysis, and second by avoiding politically sensitive issues in the bi-lateral dialogue, including bank erosion, flood protection, pollution, and border issues. We could not trace Russian volumes of the Schemes that had been translated to the Chinese or vice-versa. This might mean that neither side had a chance to study the information held by the other side, bringing into question the legitimacy of the joint conclusions. These enormous datasets were shelved in the late 1990s and never used for water resource management

Another prominent body of data on biology, ecology, and management of Amur-Heilong fish was collected and analyzed in the “Works of Amur Ichthyologic Expedition” (Nikolsky, G., editor, “Works of Amur Ichthyologic Expedition.” Moscow State University 1950-1956). The expedition set out to develop recommendations for restoring depleted fish stocks and, in the process, developed a compendium of basic and applied knowledge on freshwater biota which remains the most complete knowledge base on the subject.

In recent years academic research on the Amur-Heilong River has been carried out by several principal institutes in the region. In Russia studies were poorly coordinated and rarely progressed beyond primary research on narrow subjects. Most of these focused on issues of secondary importance to the main questions of ecosystem function and basin-wide water management. In 2003-2005 a decision was made by the Far East Branch of the Russian Academy of Science to increase funding for Amur-Heilong studies, but no coherent research program has been established. The number of field expeditions and projects has, however, increased. Unfortunately, many of the results are high quality but irrelevant to decision-making.

In China, academic research has advanced in the fields of wetland science. Several monographs have been published on the wetland ecosystems of the Sanjiang and Song-Nen plains and their human-induced impacts (for example: Liu Xingtu and Ma Xuehui. Natural Environmental Changes and Ecological Protection in the Sanjiang Plain. Forestry Science Publishers. Beijing 2002. 355 pp). Wetland ecosystems of the northeast receive growing attention from various national institutions and journals (see Wetland Science Journal). The most influential of these, the Chinese Academy of Engineering Sciences, conducted the multi-year Northeast Water and Soil Conservation Research Programme (2006). Existing bilateral China-Russia programs supporting joint research have started only a few small research projects relevant to Amur-Heilong basin environmental management.

International assistance projects supported by the GEF, the Asian Development Bank (ADB), the United States Agency for International Development (USAID), the Japan Association for International Cooperation and Assistance (JAICA) and international research institutes since the 1990s have been promoting wider approaches and have served as vehicles for formulating basin-wide priorities and synthesizing data across large parts of the basin. Some of the best available English-language sources on the Amur-Heilong environment originate from those projects. Many of them are repeatedly quoted in this Reader. However, the nature of some of these projects prevented them from producing quality information and assisting decision making. Such projects were heavily laden with policy agendas of funding agencies, participating national agencies, and consulting institutions. The short time-frames of these projects allow little time for data acquisition and often preclude peer review. In many instances this leads to low report quality and repeated sale of the same datasets to different projects rather than production of new reports from high quality data. Unfortunately, despite the presence six GEF projects in the region, little coordination has been achieved between them. The legacy of the development phase of the “Songhua River Flood, Wetland, and Biodiversity Management” Project undertaken in 1998-2001 by ADB-GEF is an especially valuable asset for advancement of future studies. Although it was later implemented as a flood management infrastructure project without much of the original focus on wetlands and biodiversity, it produced a large body of information on the relation between wetlands and flood-control and other critical issues.

In recent years domestic funding has increased for applied research supported by resource management agencies in both China and Russia. Periodic reports produced by these agencies are valuable sources of data. In Russia, advances in studies on pollution and river dynamics have been achieved by agencies that assign such research to local research institutes. In contrast to these successful research projects, the third cycle of the “Amur Basin Comprehensive Water Management Scheme” was ordered by ABWMA in a similar process. The general problem of such studies is the lack of capacity among management agencies to set objectives and control implementation of the research project by the contractor. In the case of the “Scheme,” no such control existed for nearly two years.

Planning done by resource-management and environmental agencies is also an important primary resource both for background information and for data on current policy. Agencies prepare extensive plans covering wide varieties of topics and containing and analyzing volumes of environmental data. Preparation of large plans requires contributions from an array of professional disciplines. Many applied science institutions specializing in environmental and other scientific fields exist both in China and Russia. Some more innovative plans require subcontracting researchers from academia. In Russia such planning efforts in the environmental field have recently undergone a sharp decline due to the dismantling of environmental agencies, while in China they seem to be on the rise. A large proportion of agency resources are devoted to these planning exercises. However, as a rule, the scope of planning is limited to responsibilities of a given agency and follows strict planning guidelines, many of which were written 10-20 years ago. Such plans are strong on specific sectoral detail but weak on cross-sectoral issues that often are most important when considering environmental problems.

In China there is a tendency for more integrated planning that blends traditions of socialist state-planning with a new understanding of market mechanisms and complex environmental issues using advanced scientific analyses. One policy calls for Jilin and Heilongjiang to become two early models of "Green Provinces." Within these provinces each prefecture was asked to prepare a plan for environmentally-friendly development. While this seems a useful and appropriate new direction for northeast China, closer analysis reveals flaws. For example, the "green development" plan for Hegang Prefecture was written in 2003-2004 ("Hegang Shi Shengtai Shi Jianshe Guihua. 2004"). An important component of the planning background for this prefecture was omitted from the green development plan. This was a proposed dam project at Taipinggou in Hinggan Gorge on the main channel of the Amur-Heilong River. Rather than discuss this large dam project that would undoubtedly have the most profound impact on the local and regional environment, repairs on nine small rural reservoirs were prescribed in detail.

Important monitoring data include the "Nature Chronicles" kept by Russian Zapovedniki (strict scientific nature reserves each having a research department). Although focused on monitoring biota, this research includes basic meteorological and hydrological monitoring in the reserve vicinity and is often relevant to broader studies of ecosystem function. Several reserves in China also have research departments and carry out observations on fauna numbers and movements, and other natural features, depending on key issues in their locations. Such long-term monitoring results are invaluable for study of impacts of large-scale projects on natural ecosystems and for tracing influences of climate change. A collection of articles by Zapovedniki researchers on ecosystem responses to climate change in the Amur-Heilong Basin published in 2006 with WWF support is a fine example of proper use of this monitoring system (Kokorin 2006).

Basic monitoring of meteorology, hydrology, and pollution is carried out by the Russian Hydrometeorological Agency (RosKom Gidromet), with a sparse network of monitoring stations spread throughout the immense expanses of the RFE. This network provides useful but insufficient data to determine the diversity and spatial-temporal distribution of pollutants in the Amur-Heilong River main channel. Since 2000, more or less regular monitoring of pollution was jointly carried out by Roskom Gidromet and Chinese counterparts from SEPA. This program was strengthened following the 2005 Songhua spill.

Environmental monitoring of the local effects of dam construction on the Bureya River was originally planned largely as a public relations measure. Initiated and funded by RAO-UES Russia, this monitoring scheme neither envisioned the investigation of the Bureya Dam's impacts on the Amur-Heilong River, nor fully took into account the cumulative impacts of two dams in the Amur-Heilong watershed. However, it proved to be a revolutionary achievement and sat in stark contrast to the previous absence of any systematic effort to assess effects of dams on basin rivers. Several institutes of academia, three zapovednik research departments, and numerous contractors monitor both the site and downstream. Continuous pressure from environmental NGOs helps ensure objectivity. WWF-facilitates this process by publicizing early results of research in popular brochures (such as Podolsky S. –editor. Bureya Dam — Zone of High Tension. WWF Russia, 2005, 80 pages). However, the main body of data collected to date is poorly analyzed, partly for fear that funding will cease when first conclusions are drawn. There is also no clear procedure for using monitoring results to specify funding of mitigation measures.

Finally in terms of data, there are the environmental impact assessments (EIAs) that are mandatory in China, Russia, and Mongolia. Environmental impact statements (EIS) prepared by the firm undertaking a project are reviewed by a committee of experts assigned or licensed by environmental authorities. In Russia, and more recently in China, special provisions are made to allow public access, hearings, and comment during an EIA. Therefore EISs are prepared for use in a competitive and highly political process. This leads to limitations on the types of data and the level of detail included in an EIS. Nevertheless, for public and outside experts, it is usually the only opportunity to get acquainted with details of a proposed development. To emphasize the shortcomings of most EISs we quote from some conclusions regarding several dozen EISs of water-management projects from the 1999 ADB Songhua River project Midterm report (ADB 2001)

"Review of EIA documents led to the following remarks:

- The documents are often limited in size and content, frequently attached as a part of the feasibility report.

- Information provided is generally detailed when based on field investigation (water quality, flora, fauna, soils) but very broad or even non-existent when it concerns indirect issues. For Ni'erji dam, the EIA did not provide figures on the alteration of downstream flow after implementation of the dam. For example, only one water sample was collected in the context of sediment transport.

- Impact analysis is generally factual, most of the time limited to qualitative identification of direct effects, but without actual quantification assessment and cumulative impact evaluation. It is also mainly limited to on-site impacts; off-site impacts (such as downstream implications for a dam) are partly to totally neglected.

- Mitigation measures are generally limited to compensation (mainly for social issues) or to monitoring activities.

- Alternatives to projects are generally not discussed in EISs, and if they are, the engineering analysis dominates the discussion.

- Environmental management plans are generally very preliminary, paying too little attention to the institutional requirements and training needs required to ensure their effective implementation.

- The way the environmental monitoring and management plans are formulated makes them difficult to implement because measures are not clearly detailed in terms of objectives, budget allocation, responsibility and indicators of achievement."

Although the above comments were written in relation to specific experience in China in 1999, they summarize EIS deficiencies common in Russia. Some of the shortcomings might be overcome by including detailed regulations and requirements in the terms of reference for the EIS contractor. However, proper consideration of the range of feasible land-use alternatives presents a more difficult problem. Since most EIAs are part of commercial projects, firms developing them are typically not interested in objective consideration of all feasible alternatives, particularly the "no-go" option, which is often the preferred alternative from a conservation perspective.

Conclusion

The fragmentation of conservation efforts in the Amur-Heilong region has led to short-term and unsustainable management decisions. Lack of transboundary communication and data sharing has fostered the development of national, and therefore incomplete, conservation knowledge. Few of the natural or socio-economic processes that influence environmental conditions within the Amur-Heilong are confined within national boundaries. Globalization of national economies will challenge conservation and sustainable development as the three countries of the region become increasingly interdependent in future. It is imperative to face this challenge using an integrated river basin approach, thereby avoiding repetition of past mistakes caused by approaches that focused on one country, one habitat, one species or one issue at a time.

In the field of wetland habitat conservation the Amur-Heilong basin has only one example of international coordination formulated at a scale appropriate to address critical environmental issues on a landscape scale. This is the International Nature Reserve at Khanka-Xingkai Lake basin. And even this initiative has yet to begin working effectively.

Much more intense cooperation at the Dauria International Protected Area (DIPA) has yet to expand the focus of managers from several nature reserves to the larger and more appropriate scale of the entire Daurian ecoregion (or watersheds of the Argun and Onon Rivers) (see Chapter 32).

Methods of communicating on basin-wide or ecoregion-wide levels are yet to be developed. As a result, each country, each agency, and each international project expends resources to design partial and unsustainable solutions to transboundary ecosystem conservation problems.

Policies in which environmental cooperation is defined are also too narrow and cannot provide useful frameworks for decision-making. The success or failure of transboundary environmental policies depends on how they address socio-economic issues. To date, these issues have been segregated. This leads to unchecked, unsustainable resource extraction, and progressively marginalized environmental issues. None of the existing transboundary efforts addresses ecologically sustainable development of border regions or evaluates environmental outcomes of various on-going economic processes.

The ultimate goal of conservation in the Amur-Heilong must be the protection of natural ecosystems while ensuring welfare of human populations. To date, no international environmental cooperation process is mature enough to evaluate its progress against this goal. International cooperation in the Amur-Heilong basin using an IRBM approach would provide a tool for integrating environmental and economic issues, and achieving the objectives of nature conservation and well-being of local communities.

Chapter 29

Essay Number Three:

Amur-Heilong River Pollution: A Downstream Perspective for Understanding and Managing Environmental Risks

By Lubov M. Kondratieva

From the editors:

This essay by Dr. Kondratieva of IWEP (Institute of Water and Environmental Problems, Khabarovsk, Russia) reflects experience and insights gained in the Russian "Priamurie" — areas along the Lower and Middle Amur-Heilong in Russia — the reach of the Amur-Heilong that receives the full pollution load from the entire basin. Thus this is the most appropriate location to model strategies for pollution control throughout the basin. We hope that the voice of Dr. Kondratieva will be heard when basin countries begin to design stringent international safeguards for the health of Amur-Heilong and its inhabitants.

Framing the ecological risk approach

The key ecological problem of the Priamurie, the valley of the Middle and Lower Amur-Heilong in the Russian Far East, is pollution by organic compounds of diverse origins.

As Amur-Heilong pollution becomes one of the leading environmental risk factors in the RFE, it is of paramount importance for Priamurie society and government to choose criteria to evaluate and monitor the severity of risks. Two obvious indicators are apparent — the presence of highly toxic substances in river water and the presence and distribution of fish. Pollution problems have many dimensions:

- They affect ecosystem process and services, as well as population dynamics and biodiversity;
- They require the development of appropriate technology and management processes to measure pollution and safeguard human life-support systems;
- They require the calculation of economic costs of different risk scenarios in order to balance the costs of offsetting risks with the costs of preventing accidents or compensating for consequences;
- They expand questions of the environment into the realm of society.

The ability to manage ecological risk and prevent negative impacts depends not only on accurate measurements of pollution, but also on the proper formulation of a complex scope of inquiry that considers all the aspects listed above. Worldwide experience shows that effective risk management and accurate risk assessment requires the use of high standards and modern methods of research, sophisticated, precise equipment, detailed environmental knowledge and environmental awareness, flexible management systems, and appropriate economic mechanisms. The selection of appropriate methodologies for evaluating risk should be based on:

- scientifically valid risk assessment methods;
- thorough consideration of all parts of polluted ecosystems (in our case this at least includes water, ice, sediments, suspended substances, aquatic organisms, and animals and humans consuming water and organisms);

• consideration of different rates of change and responses to change in various components of the system that vary from immediate reaction to decade-long processes, with many components having their own seasonal and multi-year dynamics;

• use of reliable methods to assess economic costs and predict and avoid economic losses.

Management-oriented risk assessment requires substantial financial resources. For example, in 1993 the United States Department of Environmental Protection appropriated 750 million dollars for such studies. Investigation costs can be high even on risks associated with a single substance. Appropriate testing for carcinogens in just one chemical substance might require $500,000 and use as many as 800 experimental animals. However, losses from unmanaged or improperly managed pollution risks are much more costly than the expenditures necessary to predict and prevent them.

Modern science is unfortunately not omniscient, so, when comparing risks, managers often have to make hard choices based on value judgments. A textbook example from the Amur-Heilong basin is the attempt to offset the risk of hunger by use of pesticides that accumulate in higher organisms and thus threaten future generations. In this case the resulting ecological risk only revealed itself years or decades after the initial decision to use such pesticides was made. As such, it is extremely difficult to predict the magnitude and multiple effects of such a decision. But even in this case we have clear criteria for "biodegradable" substances, which are already more or less universally accepted: If a given substance does not decompose and re-enter natural nutrient cycles, but rather accumulates in living organisms, it should be considered higher risk. Therefore, if we understand the whole system in which risk works, we are likely to make better decisions, even when we cannot precisely quantify and accurately predict long-term effects and associated costs.

Pitfalls in current monitoring practices

Control mechanisms for pollution control in the Amur-Heilong lack an appropriate methodology and modern equipment. For this reason, the State monitoring programs in Priamurie are not capable of embracing all the compounds that pollute the Amur-Heilong River and impact human health in the basin. Only 32 pollutants, nine of which are of organic origin (easily oxidizing and sulphur-containing organic compounds, fats, methanol, phenols, oil products, furfural and turpentine) are controlled in wastewater of different enterprises of Priamurie. Most xenobiotics in surface and river runoff are not controlled. The intermediate byproducts of their breakdown accumulate and migrate in trophic chains for years.

Water quality is estimated using annual averages even though it is known that seasonal changes have fundamental impacts on the appearance of biological side effects. Traditional criteria of water pollution are often inappropriately lumped together for comparison as are entire classes of compounds in spite of their radically different characteristics. For example, as an index of water pollution in Priamurie the following combinations of pollutants are assessed: BOD (biological consumption of oxygen during decomposition of easily accessible substances), oil products, suspended matter, dry residue, phenols, synthetic surfactants, and fats. Evaluating these pollutants as a group complicates the process for determining the possible consequences of individual pollutants on biological systems.

Pitfalls common for contemporary pollution monitoring in Russia are further complicated by the growing risk of transboundary pollution. The explosion at a Jilin petrochemical facility in late 2005 is significant not because it added to already critical pollution loads, but because it highlighted the importance of joint efforts to control pollution and the inadequacy of such efforts in the past.

Russia-China water pollution monitoring has generally been ineffective for managing pollution problems. First, such monitoring uses grouped indicators like BOD and COD to measure pollution by organic compounds. Measuring "oil pollution," it characterized concentrations of a wide variety of hydrocarbons of mixed origin, and methods used for "phenols" were even less precise. In general, transboundary monitoring has used outdated standards and methods from the 1980s that allowed the characterization of some "wholesale" pollution figures, and have been incapable of measuring individual toxic substances for which "allowable concentrations" are established by law. Moreover, pollution was characterized as a mean value of all measurements from May to October, thus neglecting seasonal differences. They also depend on the mean value for any given transect across the river, thus ignoring important spatial differences. The critical but unmeasured parameter for the Amur-Heilong is the difference between concentrations on the right versus left bank. Despite clear agreement about what, where, and when things should be measured, this was partially ignored, and the resulting data contained many important gaps, especially for the China side of the river. Thus no definite conclusions could be drawn regarding organic compounds and certain toxic substances. Water quality data have not been subject to meaningful transboundary discussions or analyses, in spite of the obvious potential for interaction to resolve discrepancies and contradictions, and help to estimate the relative accuracy of monitoring results. In the early stages of this monitoring program the Russian agencies were informed that identification and measurement of many important contaminants would be impossible without new chromatographers and other sophisticated equipment. However, the requisitioned equipment arrived only after the 2005 spill. Without this equipment nothing could be done to trace some toxic substances that bioaccumulate. Finally, information exchange between Russia and China was often delayed for months or years after analyzing samples, some data from China were never sent to Russia, thus there could be no improvements in procedures or management as time passed and experience was gained in China.

The results from joint monitoring in the early years of the 21st Century were discouraging. No new information was produced to quantify the proportional responsibility for Songhua River pollution or to understand many of the toxic substances in greater detail. It was, however, emphasized that the Songhua River transports substantial amounts of organic substances, suspended particles, and ions of heavy metals to the Amur-Heilong. Unfortunately, these results did not enable quantification of the proportional responsibility for pollution according to various human activities, or tracing of individual toxic substances that pose threats to human and ecosystem health (chlorphenols, polyaromatic hydrocarbons, nitro-amines, and pesticides).

Often overlooked issues

Failure to identify priority toxic substances

From the perspective of Khabarovsk Province, overall pollution is dominated by transboundary sources from adjacent territories of China, wastes from power plants, mines, oil products from various sources, river transport services, and forest fires. These were the most important factors contributing to Amur-Heilong pollution loads. Such a statement, however, provides a weak basis for taking actions to confront the problem.

In order to control safety of Amur-Heilong waters in terms of ecosystem health and human safety we should choose correct and comprehensive indicators for monitoring. To date environmental risk management has been simplified as a mere response to large-scale accidents, catastrophes, animal death, and damage to human health caused by failures of technological processes — chemical spills, traffic accidents, etc. The recent "phenol problem" in the Amur-Heilong is a vivid example. A subjective criterion was used to estimate ecological risk after surface water pollution incidents: the odor of water and fish during the period of river freeze-up. This was arbitrarily connected with pollution by a technogenic monophenol, and the maximum permissible concentration of only one component (phenol) was used as a criterion. All other factors were disregarded for a long period of time.

Waters of the Amur-Heilong receive a great variety of toxic substances, most of them having nothing to do with industrial spills or other accidents, but resulting from everyday land-use practices. Bioindication methods reveal seasonal fluctuations in Amur-Heilong pollution by heavy metals and pesticides, which are known to be transported with suspended matter to the sea and accumulated in sediments. Then, owing to biogeochemical processes, these toxins migrate through trophic chains, thus damaging biological resources and endangering human health.

For example, during the past five years highly toxic and non-degradable chloro-pesticides and polyaromatic hydrocarbons are frequently registered in Amur-Heilong waters; however there is no consistent monitoring system. These substances migrate between different ecosystem strata (water, sediments, ice, aquatic organisms), accumulate in fish and sediments, easily transform into soluble forms and migrate to the sea.

To choose priority indices of ecological safety, in 2002 with support from "Landesverband der Inneren Mission E.V." a charitable organization (Munich, Germany) we undertook seasonal surveys of the Amur-Heilong water and fish quality using a combination of methods. Bioindication was combined with the more conventional physical and chemical methods (IR-, and UV-spectroscopy, gas and liquid chromatography, atomic-absorptive spectrometry). Fish and microorganisms were used as indicators. Twelve indices were applied for ecological and toxicological assessment of fish quality. Amur-Heilong River pollution by persistent organic compounds was analyzed.

The maximum diversity of toxic components is usually registered in fish caught in the Amur-Heilong mainstream. Changes in organoleptic properties of fish occur in the freeze-up period under complex contamination of water by chlorine-containing pesticides and ions of heavy metals. Our data show that concentration of hexachlorocyclohexane and DDT pesticides in fish caught in winter is comparable with data from fish in British rivers before industrial activities were restricted there in 1972. Pesticides can accumulate and transport throughout the trophic chain, and thus appear in fish. Changes in fish organoleptic characteristics during winter can be attributed to substance exchange disturbance, as well as to pesticide decomposition products. We assume that agricultural complexes in China along the right bank of the Amur-Heilong River supply most of the pesticides.

Volatile organic substances of different groups found in fish cause the peculiar chemical odor during the freeze-up period. Concentrations of 3-methyl-amine, detected in fish as a "chemical" smell, were much higher in winter than in summer. All fish caught in the Amur-Heilong mainstream in the Nanai District contained high 3-methyl-amine concentrations ranging from 2.4 up to 6.2 mg/kg. 3-methyl-amine not only causes a "chemical" smell, but also is considered to precede carcinogenic nitrosamines, especially when nitrates are abundant in water. Permissible nitrosamine level in fish products should not exceed 0.003 mg/kg, or around 0.01 percent of measured levels.

In winter, mercury concentrations in fish caught in the main stream were two times greater than in tributaries. The total natural and technogenic impact on the quality of the aquatic environment causes fish polytoxicosis in winter.

None of the substances mentioned above could be traced by the standard monitoring methods used in the existing environmental monitoring program.

Overemphasizing industry and neglecting non-point and secondary pollution

When authorities assess anthropogenic impacts on aquatic ecosystems, the extent of ecological risk is, first of all, estimated according to initial pollution by toxic compounds from industry. However, the greater input of chemical compounds to river water is caused by spring and autumn floods where surface and ground runoff contains pesticides, oil products, and mineral and organic fertilizers. These are subjected to microbiological breakdown and transformation, and then accumulate in living organisms. When affected fish and other wildlife die these accumulated contaminants are released, causing secondary pollution. Metabolic products of blue-green algae and macrophytes during summer, diluted and suspended organic compounds in surface runoff, and various substances accumulated in sediments may become the sources of secondary pollution.

Some difficulties in environmental monitoring are caused by the "multi-channel" sources of toxic compounds as a result of various chemical, physical, and biochemical processes. Many ecotoxicants and their precursors (natural and anthropogenic, organic and mineral substances) arise from outside water bodies. Decomposition by microorganisms can contribute to the toxification of surface waters in amounts nearly equal to those caused by initial pollution. This is why, when assessing ecological risk based on initial pollution, one should consider the general trophic level of water ecosystems in addition to the often synergistic effects between pollutants and potential sources of secondary contamination.

Suspended particles are important indicators of water pollution, influence water turbidity and sediment loads, and carry a variety of toxic substances including heavy metals. Placer mining for gold and extraction of sand and gravel from river beds are major sources of human-induced suspended matter reaching the Amur-Heilong from Russia. However, it is not widely recognized that this influence should be controlled and managed. A greater influence on water quality and basic hydrology throughout the region is the presence and operation of hydropower dams on the Songhua, Zeya, and Bureya Rivers. Impounded waters with decomposing timber on the beds of the reservoirs suffer altered water chemistry and microbiological characteristics. Seasonal redistribution of river flows leads to increased erosion and channel deformation with profound consequences for water quality. Massive flushing of water may lead to the redistribution of bottom deposits containing heavy metals and other contamination. This was evident during the analysis of ice samples that bore clear marks of the “flushing” of the Songhua River by Fengman Reservoir waters shortly after the 2005 spill in Jilin. New hydropower stations planned in the main channel could have even more profound consequences on river hydrology and water quality.

Ever growing economic activity in the Songhua River basin has resulted in a massive influx of suspended matter transporting a wide array of chemical compounds, many of them yet to be identified. This is consequence of accelerated erosion resulting from dam and dyke building, agriculture, construction, mineral extraction, and other activities. Suspended particles are three to 20 times higher in the Amur-Heilong immediately downstream of the Songhua River.

Forest and wetland degradation and wildfires are overlooked

Aquatic ecosystem processes are greatly influenced by deforestation and the destruction of wetlands and wildfires, but this is rarely considered in pollution management programs.

Erosion and concomitant pollution by suspended matter directly results from excessive logging and land conversion to agriculture. To prevent land slides and excessive erosion, logging should not exceed 50 percent of the total area of each affected primary watershed. A second and more persistent problem is eradication of bottomland forests, which is especially obvious in the China part of the basin but common in Russia as well. All sizable rivers should be protected by wide strips of natural vegetation, preventing massive erosion during floods, as well as serving as natural filters for many toxic substances. To develop more specific recommendations these issues should be monitored and studied in different parts of the basin to account for climatic variation and local land-use patterns.

Fires have similar consequences in terms of increased erosion, but also significantly add to other aspects of water pollution. Analysis of seasonal contamination of the Amur-Heilong River by persistent polyaromatic hydrocarbons showed that some reaches of the Amur-Heilong River below Khabarovsk had summer concentrations 10 times those in winter. In summer, forest fires play an important role in Amur-Heilong pollution by polyaromatic hydrocarbons. Toward the Amur-Heilong estuary, polyaromatic hydrocarbon concentrations increase in all water samples along all river profiles.

Little attention to the river — sea contact zone

The research, use, and conservation of world biological resources are increasingly focused on pollution problems in coastal waters. These are frequently sites characterized by high productivity. Ecological conditions in coastal areas of the Okhotsk Sea and the Sea of Japan are potentially degraded by two main factors: pollutants and their transformation products (metabolites), both transported by the Amur-Heilong to its estuary, and by oil/gas developments on the Sakhalin Island shelf.

Estuaries are considered to function as special biological filters in the river-sea system. Large-scale processes including water mass transport, migration and sedimentation of suspended matter, flocculation, coagulation of colloidal particles, assimilation and bioaccumulation of organic and toxic compounds characterize the zone of sea, and fresh water mixing. The Amur-Heilong estuary is characterized by patterns of suspended matter influx and subsequent distribution to the north and south. The Amur-Heilong estuary is a transitional and accumulative system that absorbs 95 percent of discharged solids with a high concentration of organic matter. The river transports 23 million tons of solid matter to the estuary annually. Ocean currents then distribute these between the Okhotsk Sea and the Sea of Japan. When the river is not frozen the main discharge of solids is in the Okhotsk Sea (5.6 million tons), and 71 percent of suspended matter is accumulated in the estuary itself. When the river is frozen, 2.28 million tons of suspended matter moves toward the Sea of Japan — 0.48 million tons of which are carried seaward beyond the estuary boundaries. Significant differences in water quality were found between discharges in the Okhotsk Sea versus the Sea of Japan. Organic matter, typically difficult to mineralize, was discharged more into the Okhotsk Sea than to the Sea of Japan. In summer, river discharge volume is high and causes organic matter production and destruction in the shallow estuary. The main portion of persistent components is carried out into the Okhotsk Sea.. A much lower self-purifying parameter is also registered here. According to surveys by V.A. Chudaeva in 1982 and 1989 heavy metals discharge from far eastern rivers into the Sea of Japan can be listed in descending order of concentration as: Fe, Mn, Cr, Cu, Ni, and Zn.

Iron, manganese, zinc, and lead are carried into the Okhotsk Sea with suspended particles, whereas chromium, nickel, and cadmium are dissolved. The Amur-Heilong River annually discharges an estimated 32,300 tons of dissolved forms of nine main elements and 840,000 tons of their suspended forms. These figures show that 25 times more of these elements are transported downstream with the suspended particles than in their dissolved form. The study of organic mineral complexes in suspended matter and sediments is, therefore, extremely important for understanding the toxicology of the river. The amount of iron discharge into the Pacific seas is rather high, particularly the component adsorbed onto suspended particles. The mechanisms of iron ion migration and their behavior in the river-sea system depends largely on the relationships between the production and breakdown processes and several physical and chemical factors (e.g., oxygen, temperature, pH, salinity gradient). The amount of iron carried into the coastal waters might significantly influence primary production dynamics and organic matter decomposition. When oxygen is limited, organic matter decomposition rates depend on SO_4^{2-} and Fe^{2+} ions as acceptors of electrons. Such zones are characterized by active sulfate reduction and iron oxidation, which might account for high concentrations of dissolved organic matter in deep waters and might increase toxic heavy metal concentrations. On the other hand, when water is enriched with oxygen (e.g., by the growth of phototrophic organisms (phytoplankton), iron-manganese bacteria may be active as well and may transform iron oxides into hydroxides $Fe(OH)_3$. Natural prerequisites for the important role of humic acids are linked with landscape specific features of the Middle-Amur-Heilong Lowland, the Amur-Heilong River drainage system (waterlogged flood plains) and high humification level of some streams like the Tunguska River and Lower Amur-Heilong flood plain lakes.

To evaluate the amount of toxic matter discharged by the Amur-Heilong River into the sea, the role of suspended humic substance forms, bound with toxic elements needs further study.

Recommended approaches to deal with ecological risk

Current approaches to surface water quality estimation are based on the prediction of the biotic complex and by studying its reactions to changes in environmental factors. For estimating the consequences of water pollution and preventing ecological risk and damage to human health, it is necessary to consider various scales (basin, ecosystem, organism) while taking into account inner reservoir processes and the specificity of mechanisms determining water quality (**Table 4.1**).

Table 4.1 Hierarchical levels of risk estimates of aquatic ecosystem pollution

Estimate scale	Accounting factors, processes and mechanisms
Basin	• Natural-climatic conditions • Landscape peculiarities • Types of economic activity on watersheds • Chemical composition of wastes • Diffusion sources of pollution • Transmarginal pollution • River, ground and surface runoff • Aerogenic emissions • Soil erosion in water-protection zones
Ecosystem	• Water quality • Structure of communities • Biological productivity • Self-purifying potential • Secondary pollution • Formation of toxicants in contact zones (water-atmosphere, water-suspension, water-bottom, water-ice) • Bioaccumulation in trophic chains • Precursors of toxic substances • Products of destruction and transformation
Organism (cellular)	• Stability and adaptation of hydrobionts • Combined effects (synergism, additiveness and others) • Impact of superecotoxicants and limiting factors • Bioaccumulation (inhibitors and stimulators) • Ecologically permissible concentrations for pollution • Maximum non-active toxicants' concentrations • Thresholds (organism, cell, gene) • Organs-targets • Mechanisms of toxicity (physiological functions, biochemical reactions, heredity and others)

The basin approach includes the registration of all forms of economic activity which degrade terrestrial and water ecosystems throughout watersheds, not only the discharge of sewage. Monitoring transboundary pollution takes a special place. The ecosystem approach analyzes an aquatic system by accounting for changes in trophic pyramids (biomonitoring) including primary producers (phytocenoses), consumers (zoocenoses including fish), and reducers (microbial communities). Analyzing pollutants in all ecosystems components (suspended substances and sediments), not only water, is also an important aspect of the ecosystem approach.

For undegraded natural aquatic ecosystems that maintain a dynamic balance of natural cycles and biological diversity, development of new methodologies to quantify water pollution is especially important. It is necessary to shift from evaluating water quality according to single hydro-chemical indices toward accounting for ecosystem processes and biodiagnostics.

Based on international experience and Priamurie pollution data, the following pollution parameters are recommended for priority study:

- Water — polyaromatic hydrocarbons, polychlorinated biphenyls persistent organic pollutants), nitrosamines;

- Fish — chlororganic pesticides –persistent organic pollutants including variety range of chloro pesticides, methylated amines, ions of heavy metals (cadmium, mercury, lead)

These priority parameters should be considered when developing social and economic programs and ecological and health risk assessments. Pollution research in the Amur-Heilong River should help address the following topics:

- Transformation mechanisms of organic matter of natural and anthropogenic origin;

- Analysis of biological dynamics of persistent pollutants;

- The accumulation and migration mechanisms of toxic substances;

- The development of regionally acceptable standards of pollution;

- The Amur-Heilong River discharge impact on coastal marine bioresources;

- An ecological feasibility study for new effective and safe water treatment methods; and

- Revealing ecological and social factors that influence Priamurie population health.

The above research and monitoring programs must be directed at a broad range of socio-ecological objectives:

- ensuring safe water supplies;

- the preservation of fish resources, feeding areas, food supplies, and spawning areas;

- reducing the risk of food poisoning; and

- formulating appropriate international environmental safety standards.

Success in these areas will depend on the right choice of monitoring criteria and a very focused framework for research and monitoring.

Research on biotic and abiotic ecosystem components is needed to determine Allowable Impact Standards that will guide environmental management in future. Objective, internationally recognized standards will enable the development of a firm regulatory base for environmental management and for addressing transboundary pollution. Standards will provide guidance for the development of programs that support a wide range of benefits, including even those not typically associated with pollution control (e.g., revitalizing traditional land-uses, preserving native culture). Standards are also needed to regulate environmental aspects of fisheries in the Amur-Heilong estuary and surrounding seas. Finally they are essential in programs for the prevention of water pollution (drinking water safety, reducing health risks, restoration of aquatic environments, and improvement of water purification systems).

Of course the success of any pollution prevention program also depends on the level of mutual understanding between Russia and China, support from both the Russia and China Academies of Sciences, increased financial commitments from government agencies, and support from the international community.

Reducing levels of pollutants requires more than research, it requires the formation and implementation of policy. The following policy mechanisms must be established if pollutant levels in the Amur-Heilong are to be held in check:

- Strict international control over the discharge of pollutants into surface waters;

- Forest and wetland restoration in river valleys in China and Russia;
- An improved system for the prevention of wildfires;
- Development of an agreed-upon set of international water quality standards;
- Joint Russian-Chinese monitoring in the Amur-Heilong and Songhua Rivers, expanded to focus on previously overlooked aspects; and
- The systematic exchange of information of all aspects of pollution by toxic substances (in water, air, soils).

Chapter 30

Essay Number Four:

An Ecological Network Approach to Biodiversity Conservation

By Yury Darman, Eugene Simonov, Tom Dahmer and Darron Collins

Introduction

An ecological network is a concept that integrates land management tools, planning schemes, and protected areas (PAs) into a framework for transboundary biodiversity conservation and the sustainable use of natural resources.

Ecological networks are a response from the world conservation community to the challenges of globalization and a response to the inadequacies of protected areas. An ecological network reflects the necessity to protect connectivity and interdependence of key biodiversity features that deteriorate rapidly under the pressure of socio-economic development.

The Amur-Heilong River basin contains 15 ecoregions, many global biodiversity hotspots, and many long-ranging species. The basin combines pristine wilderness with human densities and rates of economic development that rival those of European nations. Further integration between Russia and China is to be expected in the Amur-Heilong basin. Without careful ecosystem management, wilderness will ultimately give way to urbanization and massive, unsustainable resource exploitation. As such, an ecological network could provide an alternative, more sustainable future in the region.

This essay introduces the idea of an ecological network as a tool for conservation in the Amur-Heilong. We briefly review natural values, threats, and policies and then analyze the existing systems of PAs and their problems in the three basin countries. Finally, we propose a set of activities that are critical for establishing a transboundary ecological network in the Amur-Heilong.

Natural values and threats revisited

With northern boreal, temperate, and subtropical biomes, the Amur-Heilong basin supports a tremendous diversity of habitats and species. The Amur-Heilong basin provides habitat for 130 freshwater fish species, including seven species of migratory salmon and Kaluga — the largest sturgeon in the world. The floodplains of the Amur-Heilong and its tributaries serve as important stopover and nesting sites for millions of migratory birds in three major transcontinental flyways. As much as 95 percent of the world's nesting population of Oriental white stork is found in the Amur-Heilong floodplain, along with 65 percent of the red-crowned crane, and 90 percent of the white-naped crane populations. The Amur-Heilong basin contains some of the best preserved temperate forest ecosystems and still has a significant population of Amur (Siberian) tiger, wild ginseng, and other rare animals and plants. The area includes three WWF Global 200 priority ecoregions, including the Amur-Heilong freshwater ecoregion and the Russian Far Eastern temperate forests ecoregion shared by Russia and China. The Daurian wetland-steppe ecoregion is shared by all three basin countries. The Siberian boreal forest ecoregion forms part of the Amur-Heilong basin as well. And the Amur-Heilong River discharge greatly impacts another Global 200 marine ecoregion — the Sea of Okhotsk.

The magnificent Small Hinggan Range forms the

Hinggan Straights, where the Amur-Heilong rushes through a spectacular narrow gorge and provides a migration corridor between forests in Manchuria and the northern boreal forests in Russia. The western segment of the basin includes tremendous expanses of boreal forests on the Greater Xing'an and Amur-Zeya plateaus and unique wetland-steppe landscapes of Dauria.

The Ussuri-Wusuli River valley, another important sub-basin within the Amur-Heilong, is also known for outstanding diversity of flora and fauna. The ADB-GEF (2003) reported 75 species of mammals, 339 birds, 14 reptiles, 11 amphibians, and 89 fishes on the Sanjiang Plain, with the best preserved ecosystems in the Ussuri-Wusuli basin. Among this rich faunal diversity, 28 species are listed by IUCN as globally threatened and 12 are near-threatened. CITES prohibits international trade in 11 species and restricts trade in 43 others. Researchers in Russia have documented nesting sites for many threatened species including Blakiston's fish owl, Oriental white stork, and scaly-sided merganser (ADB-GEF 2004).

Despite the regional and international conservation importance of the basin, a systematic assessment of biodiversity and conservation needs has never been undertaken on a basin-wide scale or in any of the 11 ecoregions that overlap national boundaries. Region-wide conservation measures are limited to identified "hot-spots" (e.g., Sanjiang wetlands) or charismatic megafauna (e.g., tiger, cranes).

Only two recent planning initiatives addressed conservation issues on scales larger than individual PAs. The Ecoregional Conservation Action Plan for Southern RFE (Gorovoy & Martynenko 2003) addressed conservation needs in four provinces in Russia. The Ussuri-Wusuli Plan (ESD-USAID 1996) addressed conservation planning issues in the vicinity of the Ussuri-Wusuli River basin, but lacked any systematic biodiversity assessment (see Chapter 6, Essay 2).

Threats to biodiversity have been assessed by many projects in each basin country, but have rarely been compared across international borders. Agriculture and infrastructure are destroying wetlands, unsustainable and illegal logging ate eliminating forests, domestic livestock is threatening the integrity of grasslands, overfishing is depleting fish stocks, and untreated wastes are polluting air, water, and soil. Some of these threats arise and affect ecosystems mainly within a single country but have consequences over much larger areas.

The transboundary implications of these threats include downstream water and soil pollution by siltation and discharge of untreated wastes, impacts on water flow by dams, overfishing, and construction of water management and transport infrastructure. These threats clearly affect the transboundary waters and associated habitats on which all three basin countries depend.

A general lack of integration between conservation and development is a systemic threat in its own right. Irrigation and drainage, flood control, agriculture, and wetland protection are managed by three agencies with little incentive to coordinate. In China, the provincial Forestry Department is the authority for wildlife and wetland protection while the Environmental Protection Department manages biodiversity conservation and water quality. The Water Resources Department is the flood management and water allocation authority, while the Agriculture Department is the authority for farming, grazing, and freshwater fish. These authorities and other provincial agencies allocate water resources and make grassland, forest, and wildlife management decisions largely independent of one another.

Protected Areas: Problems and Possibilities

The most conventional approach to protecting habitat and species — both in the Amur-Heilong and globally — has been to create individual or a set of geographical boundaries where national governments restrict access to and use of resources within those boundaries (**Map 4.1**). More recently, attempts have been made to stand back, survey the distribution of biodiversity across a region, and lay out a network of PAs to protect a representative sample of that biodiversity. Also more recently, attempts have been made to implement multiple-use management policies within particular geographies which theoretically balance the needs of biodiversity and human economies. In the Amur-Heilong these PAs will form the "center of gravity" for an ecological network. (The term "protected area" is used here for lands singled out for nature conservation, typically with specific regulations applied for nature protection.)

Map 4.1 Protected areas coverage of Northeast Asia

History and Legal Framework of PAs in the Three Amur-Heilong Basin Countries

China

Setting aside areas to preserve natural resources and cultural heritage has been practiced in China for centuries. A large portion of northeast China was closed for immigration and extractive land-uses through the middle of the 19th Century as hereditary lands and hunting estates of the Qing Dynasty Emperors. This was an effective type of protected area for several centuries.

Modern China has been active in the establishment of PAs since the first nature reserve (NR) was established in Dinghushan in Guangdong Province in 1956. Since then, new PAs were added slowly until 1979 and then rapidly after the Cultural Revolution.

There are several laws regulating PAs: the Nature Reserve Regulations, the Temporary Regulations for Scenic Landscape and Historical Site (SLHS), and a Management Measures for Forest Parks. All NRs are established under the 1994 Regulations of the People's Republic of China on NRs which allow for only one management category. Even so, Chinese NRs are established for a variety of purposes and at different levels of government (national, provincial, prefectural, county or district).

Russia

Some NRs securing strategically important natural resources (forest, fish, and game animals) were known in the Russian Empire as early as the early 18th Century. Since the beginning of the 20th Century, the establishment of PAs has been a widely recognized and highly effective tool in nature conservation. The Barguzinsky (Buryatiya province) and Kedrovaya Pad (Primorsky Province) zapovedniks (strict PAs) were established in 1916, the same year that national parks were formally legislated in the United States.

According to the Federal Law "On Specially Protected Nature Areas" (1995) there are several principal types of protected nature areas with different legal status, protection regimes, and functions. These are: zapovedniks (strict scientific national NRs), National Parks, Nature Parks, Zakazniks (wildlife refuges, NRs), nature monuments, as well as botanical gardens, arboretums, and natural resorts (areas where nature possesses outstanding healing qualities). Approximate correspondence of protection regimes and IUCN categories are listed in **Figure 4.1**.

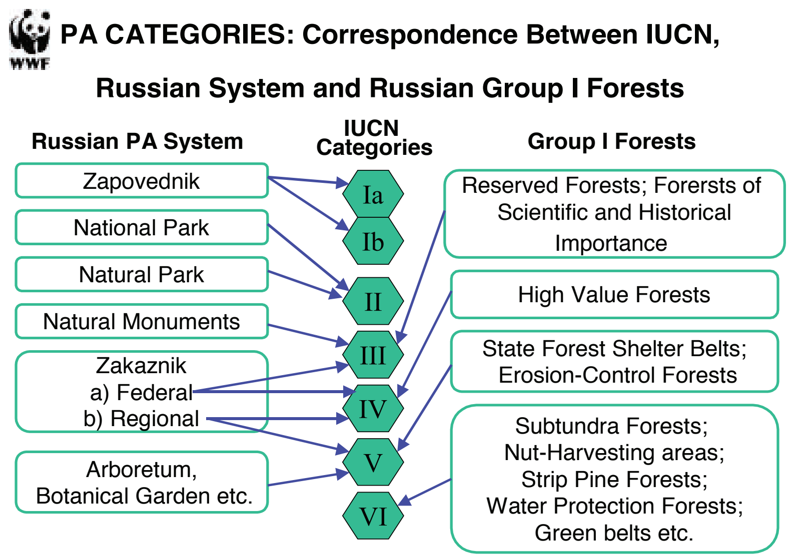


Figure 4.1 Protected area categories

The Federal Law "On Specially Protected Nature Areas" also allowed regional authorities to design and establish new types of PAs. In Russia's Amur Basin, Khabarovskii, Primorskii and Amurskaya Provinces have already introduced new legal forms of PAs: ecological corridors and protected wetlands of regional importance. Territories of traditional land-use by indigenous peoples are subject to a different set of Federal Laws, but are also considered by many authors as a type of protected area.

In addition to the PAs considered under the Federal Law, there are other categories of lands with legal land-use restrictions designed to conserve particular resources and qualities of the environment: water protection zones, recreational zones, and Korean pine-nut-harvesting zones. Most of these areas are controlled by nature-resource management agencies.

Since modern Russia is in constant administrative reform, the federal and regional laws and regulations for PAs and other protected lands are constantly changing. During the 2004-05 general administrative reform, amendments were introduced into the federal "Protected Area Law." The amendments prevented regional authorities from managing and planning PAs (including federal national parks), and upgraded botanical gardens to federal level. The amendments also removed the requirement for fair compensation to land owners and users when their land use rights are affected by gazettal of a protected area. Since this revision was unsustainable, it was essentially overruled in 2006 by a revision that granted greater authority to provincial governments to manage provincial-level PAs (zakazniks, monuments of nature, nature parks).

Mongolia

Environmental protection has a long history in Mongolia. Marco Polo wrote about closed seasons for hunting, and in 1709 Khalkh Juram set aside 16 mountains that were to be protected from hunting, cultivation, and timber felling. In 1778 Bogdkhan Mountain was formally set aside as a protected area and became the first such formally protected landscape in the world. Another ten areas were protected by 1977, for a cumulative area of 5.6 million hectares (3.5 percent of the country). The PAs Law of 1997 is now the basis for the establishment and management of PAs. According to Mongolian law, the taxonomy of PAs include the Strictly Protected Area (SPA), National Park (NP), Nature Reserve (NR) and Natural Monument (NM), and the law clearly defines protection regimes and zoning regulations. All of these PAs are the responsibility of the national Ministry

Table 4.2 Management of China NRs by management agency in 2003 and 2005

Agency	Abbreviation	China 2003	China 2005	China's Amur Basin 2005
State Forestry Administration	SFA	1,360	1,648	161
State Environmental Protection Administration	SEPA	251	272	47
Ministry of Land Resources	MLR	82	66	4
Ministry of Water Resources	MWR	61	60	11
Ministry of Agriculture	MOA	60	75	13
State Oceanic Administration	SOA	44	88	-
Ministry of Construction	MOC	27	16	2
Other agency		114	124	10
Total		1,999	2,349	268

of Nature and Environment (MONE), and all other land-management issues are delegated to local governments. Amendments to the Law were discussed in Mongolia's Parliament in 2005 to provide for the preparation of management plans and for better financing the system as a whole. According to WWF, the numbers of PAs established and managed by local authorities has increased, but there is no apparent legislative push toward this trend (Batsukh and Belokurov 2005).

PA extent and PA management responsibility

China

By 2005, China had established 2,349 NRs covering an area of 1.5 million square kilometers (15 percent of the China's land area). Of these, 243 are national NRs, accounting for 9.0 percent of the country's land area. In addition to NRs China had established over 2,000 PAs of other types by year-end 2002. These include 1,476 forest parks and 690 scenic landscapes and historical sites that account for a further two percent of the national territory (Xie Yan et al. 2004). More than 50,000 additional small conservation areas were established to protect natural landscapes and preserve water and soil.

Forest parks are created and managed solely by the State Forest Administration (SFA) for tourism and recreation. They often overlap with established and planned NRs. Scenic Landscapes and Historic Sites (SLHS) are designated mostly by the Ministry of Construction, which is also responsible for national obligations under the World Heritage Convention. Similar to Forest Parks, SLHSs often overlap with existing or planned NRs but have less defined management structures. Nation-wide, the SLHS remains a type of designation rather than a consistent mode of protected area management.

Table 4.2 covers just one type of protected area in China: "NRs" (ziran baohuqu in Chinese). Activities in and management of NRs are governed by a body of law promulgated by China's State Council. Other protected area types such as scenic landscapes and forest or wetland parks are not governed by State Council regulations (**Table 4.4**) (Yan Xie et al. 2004).

Over ten different ministries or administrations now manage NRs in mainland China. However, two agencies have primary responsibility on PAs issues: State Environmental Protection Administration (SEPA) is the national authority for environmental protection and biodiversity, and SFA is the national authority for forest, wetland and wildlife conservation. Distribution of NRs among principal management authorities in 2003 and 2005 shows that the SFA managed 70 percent of all reserves (**Table 4.2**).

As of 2005, NRs established and governed by the forestry sector totaled 1,648, accounting for 12 percent of the national land area, and including 1,717 national NRs. In all three provinces of the Amur-Heilong River basin, the management of NRs under SFA is further divided between the Forest Industry Bureau (subordinated more or less directly to Beijing) and provincial forest bureaus that report to the provincial government. These agencies often compete with one another, communicate poorly with each other, and have divergent approaches

Table 4.3: Types of NRs by protection objective in China

Protection objective	Number by year-end 2001	Area by year-end 2001 ('000 ha)	Number by year-end 2005	Area by year-end 2005 ('000 ha)	Number by year-end 2005 in Amur Basin
Natural Ecosystems					
Forest ecosystem	769	22,451	1205	32,336	80
Prairie and meadow ecosystem	33	3,510	46	3,238	14
Desert ecosystem	20	36,240	29	39,969	-
Inland wetland and watershed ecosystem	137	21,610	245	25,597	86
Ocean and coast ecosystem	40	1010	66	980	-
Wildlife					
Wild animals	325	41,500	483	43,566	45
Wild plants	111	2,100	144	2,488	17
Natural Monuments					
Geological Formations	90	1,100	103	1,202	10
Paleontological	26	360	28	574	2
Total	1551	129,910	2349	149,949	268

Department of Natural and Ecological Conservation, SEPA 2002, 2005; Xie Yan et al. 2004, and year end 2005. Reference for 2005: Department of Natural and Ecological Conservation, SEPA China NRs. National List. Environmental Science Publishers. Beijing 2006.

to planning and management. In Heilongjiang Province, 65 percent of forests are managed by two Forest Industry Bureaus subordinated directly to Beijing. Most of the NRs are planned and managed by the Heilongjiang Provincial Forestry Bureau which is responsible for the remaining 35 percent of forest lands of poorer quality. Because there are few remaining large tracts of pristine habitat in China, NRs are typically located in partially fragmented landscapes and often include villages, farmlands, and water control infrastructure.

NRs (**Tables 4.3 and 4.4**) are assigned to one of three major types — wildlife protection, ecosystem protection, or natural monument protection, although most reserves include elements of more than one type. NRs have three management zones, the core area with no use, habitation or interference permitted, apart from limited scientific research; the buffer zone where some collection, measurements, management and scientific research is permitted; and the experimental zone where scientific investigation, public education, tourism, and raising of rare and endangered wild species are permitted. There may also be an outer protection zone where the normal range of human activity is allowed with restrictions if those activities have damaging effects inside the NR.

A few very large NRs in sparsely-populated areas of Tibet, Xinjiang, and Qinghai account for about 30 percent of the national nature reserve coverage, so the coverage is neither ecologically nor geographically representative. More problematic, in China, PAs are often superimposed on complex mosaics of other land uses with little or no institutional jurisdiction or influence over the holders of land-use rights. Under the China Constitution all land and sea belongs to the state, but different individuals, organizations, or communities may enjoy powers or rights to decide how land or resources will be used. Many such tenure rights overlap or predate the boundaries of PAs and thus cause frequent conflicts between PAs and local communities. In some areas with many ethnic minorities, community rights are strong and traditional land-uses may have been established although never certified, long before the founding of the PRC. Many farmers have extended the lands that they cultivate beyond their certified limits, but have enjoyed such tenure unhindered for many years. Unfortunately, nature reserve managers lack the authority to solve many emerging problems such as these because regulations are poorly written or, in some cases, not written at all.

Table 4.4: PAs of China and in the China portion of the Amur-Heilong River basin

Protected area category and level	China total number 2005	China total area thousand ha	China percent territory	China's Amur Basin total number 2005	China's Amur Basin total area thousand ha	China's Amur Basin percent territory
National NR	243	88,989		27	3,771.4	4.2
Provincial NR	773	44,870		85	6,665.8	7.4
Prefecture NR	421	5,015		44	446.2	0.5
District NR	912	11,075		112	2,621.1	2.9
Total NR	2,349	149,949	15	268	13,504.6	15
National Scenic Landscapes and Historic sites (2005)	177			21	No data	
Forest Parks (national and local), (2003)	1,658	13,900		52	No data	
Total PAs	4,184			341		

(Adapted from SEPA 2006, Ye Hechang 2005, www.chinafpark.net. 2004, authors' calculations)

A rapid assessment of Amur-Heilong Basin NR management conducted by WWF-China provides an overview of reserve management from the point of view of NR managers (WWF-China 2004). Thirty three reserves were selected for evaluation and the reserve managers were invited to the Rapid Assessment Project Protected Area Management (RAPPAM) workshop in Harbin City, Heilongjiang Province in 2003.

Management effectiveness was scored as "high" in only five of the 33 PAs in the assessment (15 percent). Seventeen PAs (about 52 percent) scored in the "medium effectiveness" range of 10-15, and 11 PAs scored less than 10.

Among the key indicators of management effectiveness, planning was ranked as quite strong with a system-wide average score of 3.8. In contrast, inputs, practices, and outputs were considered weak, averaging scores of 2.1, 2.7, and 2.5, respectively. Site design received the highest score of the ten aspects, while facilities and personnel were among the lowest scores. Most reserve managers felt that management outputs in their PAs are weak, primarily because they lack sufficient financial support and skilled workers to conduct critical management activities.

Russia

In Russia different PA types operate with different management systems and are managed by various federal and provincial agencies. The oldest, best known, and most prominent PA type is the zapovednik, a strict scientific nature reserve where all economic activity is prohibited. Any zapovednik holds title to its land and falls into IUCN category Ia or Ib in terms of management objectives prescribed by law. Law also requires the formation of a buffer zone around zapovedniks with restrictions imposed on land-use. Twelve zapovedniks in the Amur-Heilong Basin form the core of a PA network of the region.

All other types of PAs are characterized by a mix of nature protection and compatible economic activities. The Russian National Park system started in the 1970s as a part of the Forest Service and combined conservation and recreational objectives with limited forestry. Only one national park – Alkhanay NP – has been established in the Amur–Heilong Basin by 2006.

Zapovedniks and National Parks are managed directly from Moscow by the Directorate of PA Management of the MNR Service for Control in the Field of Natural Resources (SCFNR). This arrangement combines enforcement and land management under one federal agency. Each zapovednik and national park has a management institution in the field (PA administration) that answers directly to the national agency in Moscow. Typically each unit has administrative, enforcement, research, and environmental education departments staffed with professionally trained people. Some of the better managed zapovedniks have brought nearby lower-level PAs under their jurisdiction or simply conduct law enforcement in those areas. Provincial authorities, however, are often hesitant to give away control of large and valuable tracts of land for establishing a national conservation authority such as a zapovednik, which typically enjoys administrative independence from the province.

Over the last two decades all other types of PAs have been in constant management flux with management and funding responsibility shifting between agencies and levels of government. Among national PAs this is still the case with federal wildlife refuges, national nature monuments, and national nature resorts. Since liquidation of the State Game Management Departments in 2005, many federal wildlife refuges (federal zakaznik) have no clear reporting lines, staff, or budget. Among seven such federal refuges in the Amur-Heilong Basin, at least three are supervised by nearby zapovedniks, and that improves their chances to withstand pressures and threats.

One major obstacle slowing the establishment of efficient national–level PAs in Russia has been the lack of cross-sectoral co-ordination at the federal level. In some instances, up to six different agencies supervise federally-managed PAs. This has changed over the past decade due to reform within the Ministry of Natural Resources. At the start of the 21st century, at least 80 percent of federal PAs have been gathered under the jurisdiction of one agency, providing opportunity to establish more consistent policies and management standards at the national level. The first of the written policies was issued in 2001 on zapovednik management. With support from the GEF Russia Biodiversity Project and leading NGOs, senior staff from zapovedniks and national parks received regular training and instruction during 1994-2002. This helped to upgrade and standardize PA management across the country.

The most numerous types of PAs are zakazniks (refuges/NRs to protect zoological, botanical, or landscape features, or in some cases a combination of these features) and nature monuments. These are the most flexible and diverse forms of PAs, and are established either by the federal government or by provincial authorities. These PAs are established to protect natural features and prevent ecosystem fragmentation, restore rare species, and preserve attractive scenery, etc.

Land titles are usually not withdrawn from landowners, tenants, or users (forestry enterprises or farms) in zakazniks, but conservation restrictions are imposed on land-use activities. Most provincial zakazniks and nature monuments which have no management staff in the field and are controlled by periodic inspections of supervising conservation agencies. In the Amur-Heilong Basin, 66 provincial level zakazniks with a total area of 46,930 km^2 are protected to some extent and are considered important PAs both by authorities and conservation NGOs. In contrast, most nature monuments and "local PAs" are small (less than 1,000 ha). Thus the 355 nature monuments of the Amur-Heilong Basin occupy only 102,500 hectares, for an average of 289 ha per nature monument. Most of these small PAs are neglected and forgotten soon after establishment and have no management oversight whatsoever.

Nature parks were an early attempt by provincial authorities to establish efficient protected area management institutions solely under their own jurisdictions. Usually, besides biodiversity value, nature parks have some scenic value for tourism. Examples are several parks in the volcanic regions of Kamchatka Peninsula. Khansansky NP, the only nature park in the Amur-Heilong basin vicinity, was founded at the southern tip of Primorsky province to protect wetlands at the mouth of the Tumen River. The park has never had effective management and for the last five years has been on the brink of liquidation due to conflicting interests between hunting and recreation.

As of 2003, federally listed PAs covered 74.6 million ha or nearly 10 percent of the country's territory, of which approximately 50 million ha are actually owned by conservation agencies with on-site management personnel.

Encouraged by federal law, legislative bodies of different regions endorsed regional statutes for PAs to allow for the development of dozens of different new types of protected natural areas (e.g., traditional land-use zones, ethnological parks, critical species habitat,

Table 4.5 Protected areas in Russia and the Russian portion of the Amur-Heilong Basin 2003-5

Protected area category	Russia total number of PAs in 2003	Russia total area of PAs ('000 ha)	Area as percent of Russian territory	Number of Russia's Amur Basin PAs in 2006	Russia's Amur Basin PA area ('000 ha)	Percent of Russia's Amur Basin territory
Zapovednik (Strict Scientific National Nature Reserve)	100	33,700	1.6	12	1,494.6	1.5
Zapovednik buffer zones	No data			10	410.8	0.4
National Park	35	7,000	0.41	1	148.0	0.13
Zakaznik -Federal Wildlife Refuge	69	12,500	0.73	7	809.2	0.8
Zakaznik -Provincial refuges	4,000	101,400	5.9	66	4,693.0	4.5
National Nature Monument	28	40	0.001	0	0	
Provincial Nature Monument	10,000	4,100	0.17	244	69.0	0.06
Local Nature Monument				111	33.5	
Nature Park	60	15,500	0.77	0	0	
Botanical park/ garden/ Arboretum				2	0.2	
Nature Resort (healing landscape)				12	80.2	0.08
Total under PA law categories	14,300	174,240	9.7			
Other special provincial PA categories	2,300	52,000	3	4	346.9	0.34
TOTAL	16,600	226,240	12.7	460	8,085.4	8,1

(after Kuleshovay, Andronov, Kochneva, Darman)

ecological corridors, resource reserves, and protected landscapes). Due to varying definitions in provincial laws, the total area covered by these new PAs is unclear. The estimated total area exceeds 50 million ha or approximately an additional three to four percent of Russia's territory, but as the 2005 RFE inventory shows, the real total might be two times greater (**Table 4.5**). It is difficult to determine what degree of protection, if any, is afforded by each of these new PAs. In Amur-Heilong basin provinces, innovation is somewhat limited and only four PAs of three new types have been established to date. On the other hand, some PAs like the regional wetland reserve in Amurskaya Province and tiger migration corridor in Khabarovsky Province are in priority locations.

In addition to the state-managed PAs, a small number of PAs has been established by private individuals and NGOs. The best known and oldest of these experiments is Muravievka Park, which was established in the early 1990s by the Socio-Ecological Union for crane protection, research, and education. Most other private PAs were established for game management research and wildlife restoration by organizations and individuals leasing hunting estates. Of course these quasi-PAs are protected not by conservation laws, but by good will and the efforts and investments of their founders.

The Russian Federation is blessed by great expanses of unaltered natural ecosystems covering a significant part (up to 60 percent) of its territory. Essential life-supporting functions of natural ecosystems characterized by high levels of biodiversity are still perceived throughout Russia as "common property." At the same time there is an ever growing drive for privatization and quick exploitation of this property. Large-scale resource extraction projects transforming terrain are not always subject to sufficient environmental assessment to determine their costs in terms of biodiversity, climate change, or altered hydrological cycles. On the other hand even the 100 established zapovedniks secure only a very small portion of the country's biological diversity, and do not protect representative samples of all ecosystem types.

For the foreseeable future, the Russian economy will be recovering from 10-years of crisis and will focus on the extraction of natural resources in both readily accessible and as of yet undisturbed areas. And, in such an environment, it is unlikely that any set of traditional PAs will by themselves help reach a more tenable balance between conservation and development (**Map 4.2**).

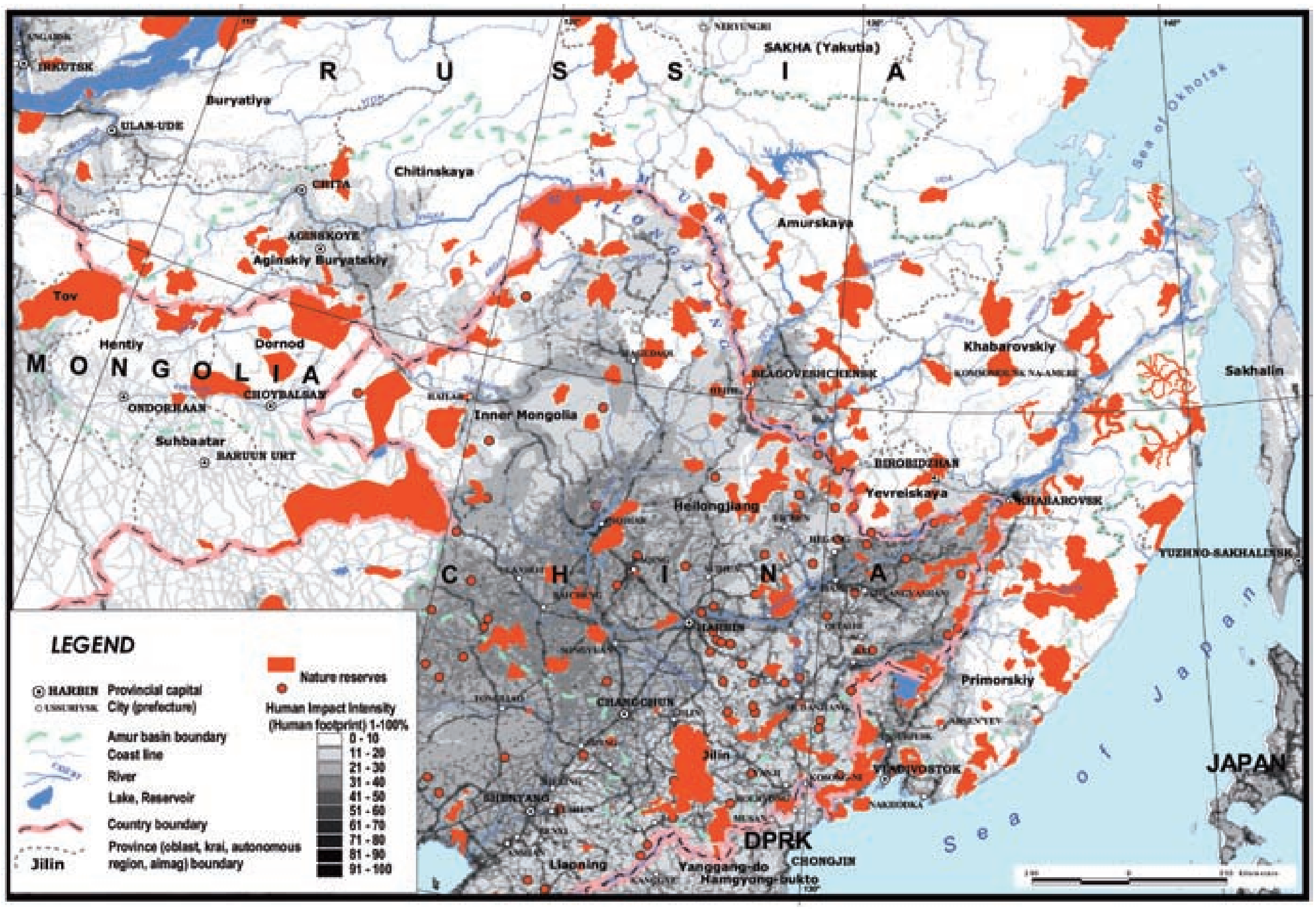
Mongolia

By 2005, Mongolia had listed 55 national-level PAs occupying over 13 per cent of the total land area (20.95 million ha). Strict PAs covered 10.5 million ha, 19 national parks covered 8.5 million ha, 18 NRs covered 1.9 million ha, and six national monuments covered 80,000 ha (**Tables 4.6 and 4.7**). Among those PAs, there were two UNESCO-World Heritage Sites, three Man and Biosphere Reserves, and 11 Ramsar wetlands of international importance. In addition, 552 areas with a total area of three million ha were protected by regional and local authorities (Batsukh and Belokurov 2005).

Three SPAs, one national park, and four NRs are located in the Amur-Heilong River basin in Mongolia, covering 1,964,843 ha (**Tables 4.7 and 4.8**). Also important are PAs adjacent to the basin including one SPA, one national park, one Nature Reserve and one Nature Monument, which cover another 1,874,776 ha, are ecologically linked to the river basin, and are managed by the same local PA Directorates. Local PA directorates (administrations), each typically managing several PAs, are financed from the state budget, and operate under direct management of the Ministry for Nature and the

Table 4.6: Protected area types in Mongolia

Mongolian Protected Area Types	PA Examples in Amur Basin proper (and in adjacent Eastern Mongolia))
1. Strictly Protected Area (SPA) Wilderness areas with high scientific value. PAs divided into: pristine zone (nothing but research allowed), protected zone (conservation-related activities also allowed,), Limited use zone(tourism, religious ceremonies, plant collection allowed). Hunting, logging and construction prohibited.	Khan-Hentyi; Mongol-Daguur, Numrog; (Eastern Steppe/ Mongol-Dornod)
2.National Park (NP) Areas with natural, cultural, educational values. NPs divided into core areas (conservation and research allowed), ecotourism zone (tourism and related activities allowed), limited use zone (also allow grazing, and construction with NP's permission)	Onon-Balj; (Gorkhi Tereldj)
C. Nature Reserve (NR) Could fall into ecosystem, biological, paleontological and geological categories. NRs allow for economic activities that do not harm values under protection.	Ugtam Mountain; Toson-Khulstai; Khar Yamaat; Yahi Lake; (Lkhachivandad)
D. Natural Monument NM protect unique landscapes, cultural sites, sight-seeing attractions. Allow for many activities non-conflicting with protection objectives.	(Ganga Lake)



Map 4.2 Intensity of human impact and protected areas in Amur-Heilong River basin

Environment. Two PA administration offices and three groups were in charge of protection and management of national PAs in Mongolia's Amur-Heilong Basin in 2004. These PA administrations employ 60 people, of which at least 30 are rangers.

A rapid assessment of PA Management in Mongolia conducted by WWF-Mongolia summarizes the views of conservation professionals on the current situation in

Table 4.7: PAs of Mongolia and PAs within the Mongolian part of the Amur-Heilong River basin

Protected area category	Mongolia total number 2003	Mongolia total area thousand ha	Mongolia percent territory	PA in Mongolia's Amur Basin total number 2003	PA in Mongolia's Amur Basin total area thousand ha	Percent of Mongolia's Amur Basin territory
Strictly Protected Area	12	10,500		3	721,021	3.2
National Park	19	8,500		1	425,752	1.9
Nature Reserve	18	1,900		4	828,070	3.7
Natural Monument	6	80		0	0	
Total PA under national law	55	20,950	13.5	8	1,975	8.8
Local PAs	552	3,000				
Total PA	607	23,950				

(Batsukh & Belokurov 2005, WWF Mongolia 2006)

Mongolia's PA system. The rapid assessment was conducted nation-wide for SPAs and NRs with six PAs of the Eastern Mongolia subject to analysis (Batsukh and Belokurov 2005). Management effectiveness was scored as "high" only in Khan-Khentii SPA and Gorkhi Tereldj NP. For Numrog, Mongol Daguur, and Eastern Steppe SPA it was "medium," while Onon Balj NP had the lowest score from all national parks in Mongolia.

For all Mongolian PAs, of all the key indicators of management effectiveness, planning was ranked highest but had multiple problems such as an absence of long-term management plans, poor planning for community outreach, and land-use conflicts imbedded in reserve design. Inputs into the system received the lowest score with funding shortages, lack of consistent technical information, and low development of PA infrastructure being especially evident shortcomings. Management processes and their outputs scored higher with environmental education and threat prevention considered the most tangible outputs system-wide. One perplexing conclusion that might be derived from the study is that no tangible progress can be achieved unless efforts at the lay-level receive comprehensive support from MONE in the form of funding, technical support, and improved planning and reserve design.

By 2005 the three basin countries had established approximately 700 PAs covering 205,572 km^2 or just over 11 percent of the Amur-Heilong River basin (**Table 4.8, Map 4.3**). That figure is actually lower than the

Map 4.3 High level PAs in Amur-Heilong River basin


SAKHA (Yakutia)
S S I A
Amurskaya
Khabarovskiy
Sea of Okhotsk
Sakhalin
BLAGOVESHCHENSK
BIROBIDZHAN
Yevreiskaya
KHABAROVSK
Heilongjiang
H I N A
HARBIN
CHANGCHUN
Jilin
Primorskiy
VLADIVOSTOK
YUZHNO-SAKHALINSK
JAPAN
Sea of Japan
DPRK
CHONGJIN
Hamgyong-bukto
Yanggang-do
Chagang-do
Liaoning
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WWF
200 0 200 Kilometers

Table 4.8: PAs in each of the three Amur-Heilong River basin countries by end 2005.

Country	Total PAs number	Total PAs area (km²)	Total PAs percent basin area	National PA number	National PA area (km²)	National PAs percent basin area	Provincial/ Local PA number	Provincial/ Local PA area (km²)	Provincial/ Local PAs percent basin area
China (only NR)	268	135,046	15	27	37,714	4.2	241	97,332	10.8
Mongolia	8	19,748	8.8	4	11,677	4.8	4	8,281	3.7
Russia	460	80,850	8.1	20	28,620	2.9	440	52,220	5.2
Amur-Heilong basin total	736	235,644	11.1	50	78,013	3.6	641	130,559	7.5

average coverage in Russia and Mongolia and barely reaches the average in China.

Why should PA coverage of the Amur-Heilong basin be less than the national averages for each basin country when we know the basin is of such high conservation importance? A variety of factors contributes to this paradox, including (i) the remoteness of provinces and less capacity in the region's PA administration; (ii) lack of research on biodiversity values in earlier pre-disturbance years when the need for protection would have been more obvious; (iii) reluctance to establish PAs because of the perceived conflict between conservation and resource extraction; and (iv) lack of concern for still relatively abundant biological resources on the part of national policy-makers. An ecological network uniting the goals and strategies of the protected area systems in the three countries would be a critical step toward establishing a more widespread and ecologically effective protected area system in the Amur-Heilong as a whole.

Current problems in PA management throughout the Amur-Heilong

Personnel

China

Statistics for 2005 appear to show a strong commitment to conservation. These note that that the 170 NRs of Heilongjiang Province employ 2,285 people, including 886 that have a technical education beyond high school. The 33 NRs of Jilin Province employed 1,589 personnel of which 527 were professionals with technical training. In the Inner Mongolia Autonomous Region, 189 NRs employed 1,886 personnel of which 720 had received technical training (SEPA 2006). Numbers of personnel at each NR remain low, with an average of less than 20 workers per unit of which only seven are professionally trained.

The national commitment to enlarge the protected area network will mean a growing demand for NR managers. The national goal of educating more natural resource professionals will help meet the need for trained entrants to the workforce. However, PAs normally present harsh working environments, are far from major population centers, and offer relatively low salaries and few additional income opportunities. Young graduates will not accept such positions until the financial compensation is proportional to the hardship and sacrifice.

Despite a PA task force created to address the issue of NR staffing (Xie Yan et al. 2004), there is little "prestige value" to being a reserve manager or staff — especially in the remote northeast. The diverse functions of PAs are poorly understood by the general public, including those who make decisions affecting their viability. Nature reserve directors are often drawn from professions such as civil service: there is neither a formal career structure that would lead to well-trained reserve staff.

Russia

In 2006, the RFE Department of Nature Resource Enforcement emphasized staffing and training problems as the most challenging issues for NRs in the Amur-Heilong Basin (Andronov, V.A., unpublished report at Khankaisky Zapovednik 15-year conference). PA working conditions in China are similar to those in the RFE although the management tradition in Russia is 40 years more mature. The proportion of trained professionals is slightly higher because of the long history of research stations and management history at national PAs. However, work at national reserves is not a very attractive career path for contemporary university graduates and most universities do not provide adequate training for aspiring conservationists. During the last 10 years of reforms the PA system lost many capable people. The emergence of provincial PA directorates may result in a multifold increase in demand for such professionals and severe competition between agencies for hiring staff. In addition, the slight economic revival of some RFE areas has already resulted in staff leaving for newly opened industrial enterprises and other work opportunities. The monthly salary of a ranger is much less than that of a qualified worker or junior manager. Massive migration of qualified professionals to European Russia is another alarming tendency.

Mongolia

The protected area staffing situation in Mongolia is most challenging, because the overall PA network of the basin employs 60 personnel responsible for more than 3,000,000 hectares. International projects (mainly GEF) aimed at alleviating this problem have not built up a critical mass of PA staff. By 2006, when projects providing additional benefits were largely finished, many of the better-educated and more entrepreneurial PA personnel left PA administrations for other career paths in academia, business, and government. Current salaries and benefits cannot attract or retain capable university graduates or those with skills to become rangers. When conducting wildlife enforcement training in Numrog SPPA in 2006, the Wildlife Conservation Society's Mongolia program was more successful in its cooperation with border guards and Law Enforcement Agency officers than with protected area administrators.

The WWF PAs assessment suggests the following measures to improve staffing and capacity building:

- The Ministry of Nature and Environment should develop a system-wide policy on PA staffing and set in place financial mechanisms for its implementation.
- Develop national training and capacity building programs for PA staff and specifically rangers.
- PA personnel should have regular evaluations of their qualifications and knowledge.
- Improve the ability of managers at the protected area level to prioritize their activities with limited staff and funds available (Batsukh and Belokurov 2005).

Funding

China

Although PAs are intimately linked with economic development in China, the central government does not provide stable or adequate budget allocations PAs. The central government has neither established a separate account in its budgeting system to support the PA system. In recent years, government funding to PAs has been significantly increased, but most of the increase comes from one-time allocations, or for short-term projects.

PAs are funded by a variety of mechanisms. National NRs may receive funding from ministries for infrastructure construction, while salaries are paid by provincial budgets and, in many cases, by county budgets (Xie Yan et al. 2004). Most funds flow to State Forest Administration NNRs, which receive capital investment and project implementation funds from the national government. The national government annually allocates more than 30 million RMB to national NRs just in the realm of Nature Reserve Development Program, however, these funds are mostly used for infrastructure development. In a given year only about 30 of the 243 national nature reserves are eligible to receive such funds.

Provincial Reserves receive almost no funding from the central government except for infrequent allocations for specific projects. Salaries and operations of NRs are usually funded by provincial, prefecture, or county level governments. Some provinces are much weaker in their capacity to finance PAs than others. It is often the economically poor provinces and counties that contain the best natural areas for biodiversity — the same counties least likely to dedicate funds for nature conservation.

Although funds are provided by central and provincial governments for PA establishment and management — and the amounts provided annually are increasing — this public funding remains far from adequate, particularly for operational costs. PAs across China have noted major funding shortages for staff salaries and benefits, maintenance, and running costs of equipment and infrastructure, travel, compensation for animal damage to surrounding farmlands, legal prosecutions, communications, public outreach, and meetings with local stake-holders. Reserves ranked below national level receive irregular and small installments of funding from governments at their respective levels. As a result, the trend has been for PA managers to promote as many reserves as possible to the national level, thereby ensuring some degree of financial stability.

This funding scheme has several obvious drawbacks. First, it provides strong incentives to develop infrastructure (offices, museums, visit centers) and participate in major projects (i.e. tree planting) with little thought given to whether these are needed to achieve conservation objectives.

Second, PAs receive major funding only for their initial establishment. Following that, civil service employees continue to be paid their government salaries, but there is typically no funding for management needs. It is relatively easy for PA directors to get funds for physical construction, but much harder to obtain funding for maintenance and basic operations.

Third, there is little ability to withstand local economic pressures, since salaries come from local government budgets and can be adjusted if disagreements arise over PA management. The current level of public financing is not sufficient to run the PA system and leads to a variety of economic ventures that are in conflict with PA objectives. PA managers are thus encouraged, or forced against their better judgment, to set up their own sources of funding through various economic ventures. Policies that require NR managers to raise revenue for operational costs have led to activities that are clearly deleterious to the values that the NRs were designed to protect. In Chinese NRs such revenue raising activities include tourism that relies on construction of damaging infrastructure, hotels, zoos and specimen collections, cultivation of food crops, forest, reed and bamboo plantations and fish farming and other types of aquaculture, even though these activities are forbidden within NRs (Xie Yan et al. 2004). Clearly, if individual PA units are to contribute to the long-standing ecological health of the region, China must develop new and innovative public funding mechanisms for PAs.

Russia

Despite the long history of zapovedniks, funding for Russian PAs is scarce and unstable. At the beginning of political and economic reforms in Russia in 1990-97 financial support for PAs from budgets at all levels declined sharply. Reliable funding from federal sources was available for salaries of personnel, but not for capital investment, development of infrastructure, or research. PA managers were forced to learn how to design and execute individual projects in cooperation with international donors and NGOs. Later, reserve managers developed income generation schemes ranging from tourism to filmmaking. However, in 1998–2001 the funding situation seemed to stabilize. Some regional authorities legally earmarked fixed shares of all regionally collected natural resource-use fees for PA design and management (e.g., three percent in Amurskaya Province), while others developed specific ambitious PA programs.

The 2005 budget for all 100 zapovedniks was 250 million rubles ($9.4 million at 26.5:1). In the Russian Far East, the central government provides 75-95 percent of the budget, with annual allocations ranging from two to 12 million rubles per reserve (from $65,000 to $400,000). Other funds were derived from nature tourism, fines from violations, local sponsors, and grants from foundations (Andronov 2006). Despite some success where alternative funding is concerned, the overall capacity of Amur-Heilong basin zapovedniks to raise money outside national allocations has been fairly low. And, as Moscow puts more pressure on zapovedniks to raise more money themselves, this could become even more problematic over time.

Provincial funding for lower level PAs increased over the past three years due to establishment of PA Directorates. The proportion of these funds spent by provinces on conservation activities remains undocumented and probably differs from region to region, but since 2004, provincial reserves are ineligible for allocation of any federal funds. The situation differs between provinces in accordance with the level of wealth and attitudes of authorities, but in general the provincial zakaznik (refuges) now receive basic funding. In 2005, the total budget for such refuges was about $1 million (or about $10,000 per PA). Allocation of funds for management of nature monuments and other types of small local level PAs is minimal and irregular and there is little room for improvement since no responsible staff oversees most of those PAs in the field.

Mongolia

In Mongolia, government funding for PAs is very scarce. The greatest conservation gains have generally been made by international projects (e.g. GEF) which distribute modest amounts of funding over long periods for specific development activities in NRs. The WWF RAPPAM analysis concluded that low salary levels lead to low and inadequately qualified staff in PAs. The analysis of inputs in terms of staffing, communication, infrastructure, facilities, and financing revealed a system that is chronically lacking resources at practically all levels of management.

Enforcement

China

In China, it is lack of funding and, concomitantly, lack of personnel that makes it especially hard to implement PA legislation. PAs generally are frequently surrounded by villages and towns and such development leads to conflict. Many NR managers have no control over development activities within the reserve boundaries, even if these activities are forbidden under the 1994 Nature Reserve Regulations. The boundaries defined for many reserves have created conditions in which laws and regulations are unenforceable. Mines, towns, and cities are sometimes included within NRs even though such activities are theoretically illegal.

Problems are exacerbated when agencies with overlapping jurisdictions pursue objectives that conflict with the PAs objectives. For example, there is the policy to construct a road to connect every Administrative Village and such a policy has frequently over-ridden the mission in many PAs throughout the country. Similarly, the policy of reforestation — which on the surface may seem to promote the values within a PA — oftentimes involves planting exotic species and monocultures inside PAs. Not surprisingly, major development projects often have significant impacts on PAs and powerful government agencies are able to ride roughshod over the legislation, inflicting damage on PAs and the environment in general. In one of the most extreme cases, for example, Momoge NNR had to be redesigned to give way to an oilfield.

Absence of proper boundary markers hinders management effectiveness in many PAs, especially lower level NRs. However, most NRs do not even hold title to the land within their boundaries. This is recognized as a major problem in present day nature reserve planning and management, and many reserves cannot upgrade to national level unless the managing agency acquires such title.

Above all, population pressure remains the most serious factor influencing enforcement capability. Strict protection laws cannot be enforced when the PAs are required to provide resources to feed thousands of people. In the Amur-Heilong basin, despite low population densities compared to other regions of China, population remains the most serious impediment to proper enforcement.

Russia

Enforcement personnel in federal PAs at one time had rights similar or even surpassing those of armed police. PA personnel were allowed to investigate violations — most importantly for poaching and arson — not only within reserves, but in surrounding areas, thus covering threatened animal population ranges and ecosystem boundaries not fully confined to NR borders. However, the frequency and nature of violations has changed significantly over the last 15 years. Exploitation of natural resources by private entities and individuals are increasing in number and diversity, while enforcement staff capabilities remain the same or decline. Effective patrolling of large and complex areas requires increased government investments in personnel and equipment. In Russia (and Mongolia) population pressure is less extreme, but areas in need of patrolling are enormous.

Enforcement techniques and policies were fairly well developed in Russian zapovedniks during the reform period and were retained afterwards. By 2004 the number of enforcement/protection personnel per zapovednik in the RFE ranged from five to 50 and averaged 17.5. In many old zapovedniks a balance has been achieved in situations where violations do not significantly threaten protected ecosystems or species. The most detrimental influence on some remote strict NRs was caused by staff accommodations and activities of their own management units. Most Zakazniks and Nature Monuments are protected against encroachment only by their remoteness or absence of roads rather than by patrolling ranger teams. In many PAs, NGOs such as "Bars," the Student Team for Nature Protection in Amurskaya Province, play significant roles in assisting the monitoring of violations and enforcement in PAs.

Considering the unfavorable economic and legal situation in Russia, it is surprising that practically all types of PAs manage to maintain a certain degree of protection against large-scale organized encroachment by logging and mining companies, road and pipeline builders, and developers. The PAs accomplish this only because prohibition of these activities is specified in their PA legal documents.

The case study on oil pipelines (see Chapter 21) shows that the presence of PAs can be an important obstacle to development even in the case of strategic infrastructure. But this is true mostly for high profile reserves: During planning for a pipeline in Amursksya Province, the borders of Imangra Wildlife Refuge were simply moved to clear a path for builders. One alarming trend has been that encroachment attempts are on the rise and the projects are becoming more severe while the number and influence of entities capable of confronting them has been declining.

Federal NRs, especially federal refuges, have little oversight over their activities so the temptation to use resources for the personal gain of managers or local authorities increases year to year. Acknowledgement of this trend at the national level has already led to numerous attempts of Moscow agencies to delegate management of national PAs to lower-level authorities (provincial governments, or branches of federal agencies). Until 2003 such delegation of authority was the dominant management mode for national parks and this led to numerous violations of law and programmed degradation of natural amenities. It now serves a strong precaution to such reforms in the future.

Mongolia

Enforcement activities in eastern Mongolian reserves are hindered by lack of personnel, vehicles, and fuel. Most enforcement authority rests not with PA administrations but rather with the Law Enforcement Agency, which has at least one representative in each soum (district). Military border guards are also required to prevent poaching and can do so effectively because they are stationed in the field (WCS-Mongolia 2006).

More sophisticated encroachment associated with businesses like mineral exploration, development of tourism facilities, or road construction is subject to enforcement through different agencies and procedures, and PA administrations do not generally play a major role in combating such projects. For instance, the building of the Millennium Road across the China border in Numrog SPA evoked considerable concern of NGOs and some national agencies, and was then subjected to EIA and public hearings. However, the resulting compromise decision permitted the building of the road several kilometers from the SPA. This is expected to create the same range of threats as did the original design (influx of visitors, poaching, unchecked tourism development and trafficking).

As is the case in China, Mongolian PA boundaries have not been well demarcated. This increases the uncertainty about boundaries of pasture, and logging, mining and hunting areas, and leads to land use conflicts while greatly increasing the vulnerability of PAs (Batsukh & Belokurov 2005).

According to a rapid PA assessment, PAs in eastern Mongolia face less intense pressure than in other regions. This is likely due to the smaller population pressures and greater availability of similar resources outside PAs. Nevertheless, the eastern steppe Dornod Mongol, Mongol Daguur and Numrog SPAs were characterized as highly threatened areas with high socio-economic pressures. Although there is little systematic data on the current state of enforcement, it is clear from all reports on hunting, land degradation, and species surveys that enforcement capacity in Mongolia is inadequate. Widespread poaching of gazelle and other wildlife in and outside NRs is a growing concern. Degrading of bogs, wetlands, and riparian vegetation by livestock is another grave concern, exacerbated in times of draught.

Monitoring & Research

China

Systematic monitoring or research has been carried out in just a handful of Chinese PAs. Changbaishan NNR is famous for its research station and long-term affiliation with research institutions. Zhalong NNR has a well developed research department that in 1999-2000 published a monograph entitled "Research and management of natural resources of Zhalong NNR" (Wu Zhangsen 2000). Sanjiang and Honghe NNRs have their own research departments and cooperate with a field station of Changchun's Northeast Institute for Agricultural Ecology and Geography, which is located at Honghe Farm. Cooperation with universities and provincial research and survey institutes remains the main research mode for most NRs that have research programs. In most reserves it is limited to preparation of "Scientific reports on feasibility of reserve establishment" and subsequent formal documents necessary to plan management, upgrade reserves to higher levels, and capture funding from national projects. Although documents are often unsophisticated and data on species distribution are often fragmented and derived from literature, these are often the best sources for basic information on NRs and changes occurring over time.

International Dalaihu NNR and Xingkaihu NNR both have capable research departments and carry out many joint projects with universities, research institutes, and with their Russian and Mongolian government counterparts. Joint international training is regularly organized in research and monitoring in Dalaihu NR, and in 2004 began in Xingkaihu NNR as well. Research and monitoring progress in China PAs is rather modest but nonetheless significant for planning and management. Yet, despite these best-case examples, the vast majority of Chinese PAs lack adequate monitoring and research and the long term viability of such PAs is therefore jeopardized.

Russia

Quite the opposite from the situation in China, Russian zapovedniks have an 80-year tradition of quality research, and each zapovednik in the Amur-Heilong basin has a research department of three to eight staff. The presence of educated and qualified biologists among reserve personnel has a positive impact for morale and leads to quality management in many zapovedniks. Scientific councils of each zapovednik consist of managers and researchers from each reserve. Affiliated institutions normally are asked to evaluate or formulate all major plans and proposed management actions. Monitoring records in the form of "Chronicles of Nature" contain long-term records of a wide variety of natural phenomena, and are used to track long-term trends in species dynamics and ecosystem process.

However, due to the decline in respect for science in Russian society, and to fairly outdated methods of research used by personnel of isolated reserves, the product of this monitoring and research has declined.

Given recent social trends, the quantity of PA research has also declined. Federal Law on PAs requires that access be granted to PAs for training of conservation professionals by universities and government agencies. However in 2004, only 233 students attended field programs in all NRs in the 10 provinces of RFE Federal District (Andronov 2006).

Russian law also requires the participation of zapovednik staff in EIAs of projects in the immediate vicinity of PAs, or of projects involving issues of concern for protected area management. Personnel of various zapovedniks annually take part in 12-15 EIAs or similar assessments undertaken by provincial agencies.

All provincial PAs in the Amur-Heilong basin lack research personnel unless they have links with research institutions. Provincial inventories (cadastres) of PAs are compiled with WWF support in most regions, and most basic information for each PA is reflected in those databases. Emergence of PA Directorates will most likely lead to increased management-oriented research, since it is needed by new agencies, and since agencies tend to employ experienced researchers. Management-oriented research is also undertaken in the course of activities of international projects and international organizations. WWF is the long-term champion in this process.

Mongolia

Despite historical linkages with Russia that extended to scientific inquiry, insufficient study of flora and fauna is common for practically all levels of management in Mongolian PAs. The WWF PA rapid assessment recommended hiring a science director and forming a scientific council for each reserve, and suggested the establishment of a Research Center for PAs to implement research and inventory programs on PAs (Batsukh & Belokurov 2005).

In the late 1990s, eastern Mongolia PAs were headed by highly qualified professional ornithologists who collected and analyzed biological data and launched several international projects. The Biodiversity Assessment of 2002, the Eastern-Steppe GEF project of the late 1990s, and TumenNet GEF project are the primary sources of most information on monitoring and research in Mongolian PAs. During the last five years most research has been carried out jointly by Mongolian-Russian and Chinese-Mongolian teams under the auspices of Dauria International Protected Area, or adjacent reserves of two countries. Presently joint research is a foundation for a partnership between Russian Sokhondinsky Zapovednik and Mongolian Onon-Balj NNR.

Community relations

China

While China, as a party to the CBD, has embraced the concept of community involvement and fair sharing of benefits from the utilization of biodiversity, local people are largely excluded in practice and even regarded as a problem rather than an opportunity for collaboration.

Given that bias, community relations with PAs in China is often calibrated with compensation. Compensation for relocation and land use restrictions is prescribed by a variety of modern Chinese laws. Compensation is viewed as a better tool than cooperative management despite the fact that large sums of money are needed to relocate people from NRs. At the same time, various cooperative management arrangements with local people are explored by the SFA in the realm of forest management and protection activities. As these tools and policies mature they will undoubtedly spread into the realm of PA management.

Dalaihu NNR, Zhalong NNR, and some other reserves are atypical. They have not only built long term relationships with international and domestic NGOs, but have also sought to broaden their support base by establishing specific quasi-NGOs "Friends of XX NNR", typically including scientists, journalists, opinion-leaders, and decision-makers both from the reserve vicinity and remote cities.

Russia

In the RFE several more progressive PAs have well-developed and effective education and communication departments, but the network of reserves as a whole is in need of this type of assistance. In 2004-2006 WWF-RFE and WWF-CPO assisted NRs in the basin to build capacity for community outreach, host awareness-raising events, and publicize environmental problems. The key concept of these activities is running region-wide awareness campaigns ("Amur Wave", "Protect Oriental White Stork", "Amur-Heilong Ambassadors") with events taking place in each PA and in major population centers.

Many NRs have long-term relationships with national and international NGOs and depend on their advocacy and fundraising efforts, some initiate establishment of NGO support for a particular reserve (such as the "Hinggang Keepers" NGO established to support Khingansky Zapovednik). All zapovednik managers of the RFE are loosely united in the "Council of Zapovedniki managers of RFE," which coordinates information exchanges across reserves. However, this Council is rather weak and is heavily dependent on support from WWF and other donors.

Although the community outreach system in Russian PAs has made tremendous progress from its start in the early 1990s to a regularly scheduled country-wide "March for Parks" and region-wide campaigns, sober assessment reveals that it fails to secure sufficient support from society at large, and often does not target important audiences. Andronov (2006) observed that the support base for NRs is limited to the scientific community and children, while little attention is paid to raising awareness among adults and decision-makers in governments.

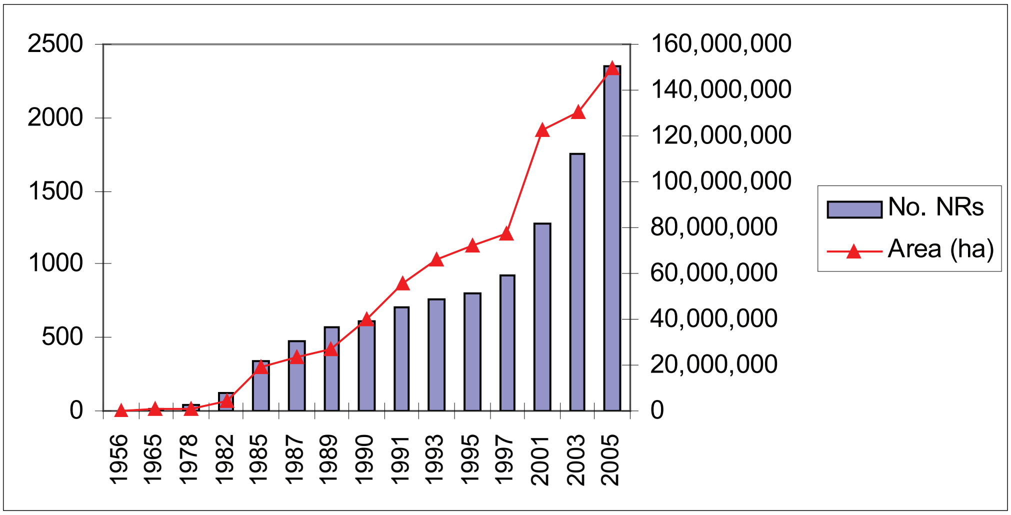
Mongolia

It would seem that traditional respect for nature might make local populations comfortable counterparts for PAs in Mongolia. In reality the relationship is more complicated because there is little institutionalized communication between nature reserve managers and nomadic grazers using the same territory. Community outreach programs were seen as a potentially effective tool to address this problem. Ecotourism is also often seen as an essential tool for linking nature reserve values with development of rural economies. Mongol Daguur SPA recently built a visitor center to undertake public outreach and ecotourism activities. Given the small size of the local population, PA employment that might be offered to the most capable of the locals as PA rangers could become an important factor in community relations.

Protected area planning

Most countries have made a first and critical leap — oftentimes without even knowing it — toward understanding and promoting the concept of an ecological network: countries generally consider their suite of protected areas within a context of a country-wide protected areas system. In fact, in the Amur-Heilong, each province in all three basin countries has developed

Figure 4.2 Numbers (left scale) and areas (right scale) of NRs in China from 1956 through 2005



a long term plan (extending to 2010-2015) for gazetting new PAs and upgrading existing PAs. Such plans are critical when considering the efficacy of PAs as a whole and when considering the need to join plans in any kind of ecological network.

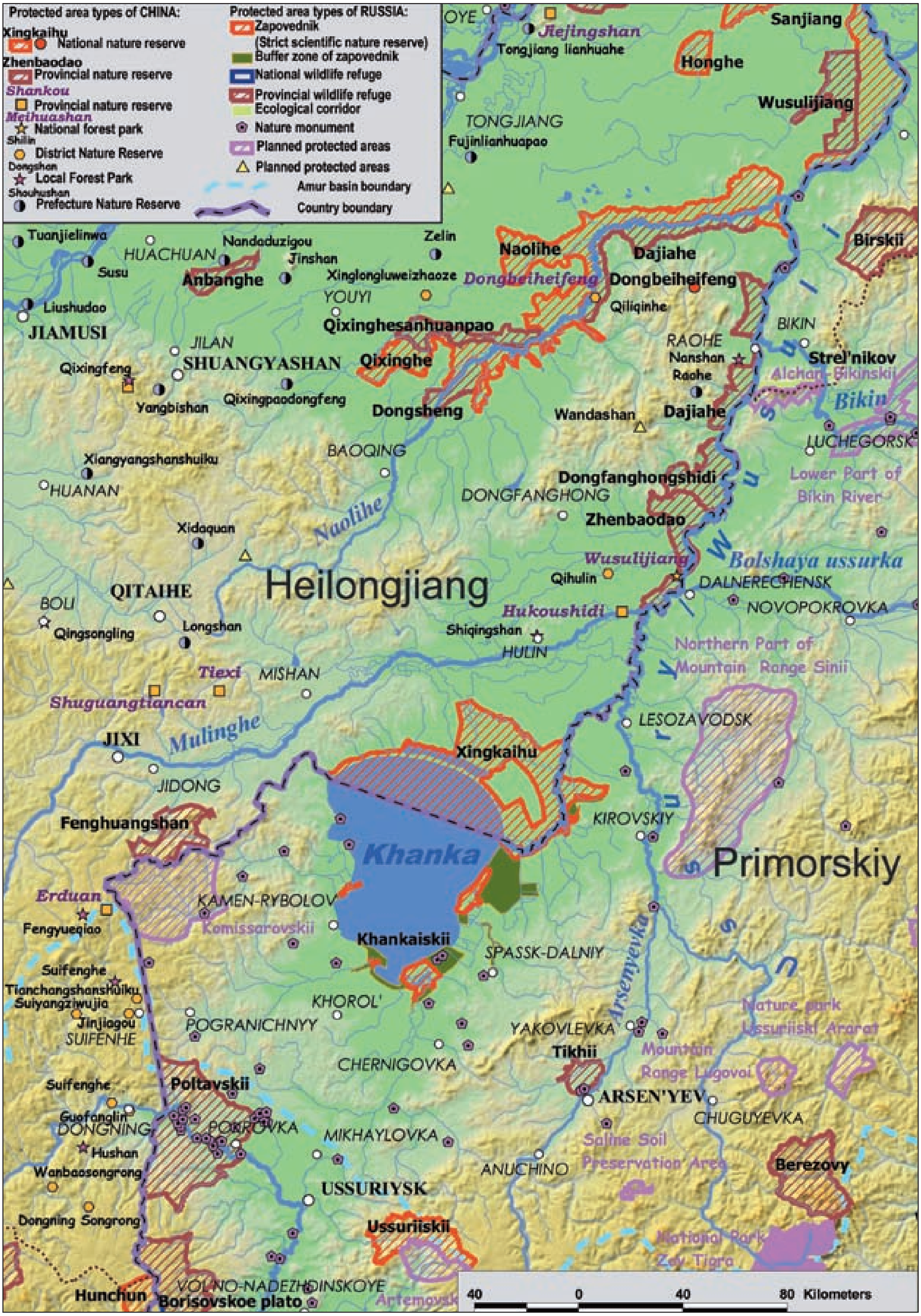
China

Due to the rapid "greening" of national policies and the realization by the national government of the growing natural resource crisis, the number of new NRs skyrocketed from 1995 to 2000 (**Figure 4.2**). However, for many local authorities, the establishment of a nature reserve serves as insurance of some government investment into areas where resource extraction has been abruptly limited by other policies or by direct resource depletion. This is supported by the drive to promote reserves to the national level, and make them eligible for funding from a variety of national programs or projects. Therefore national policies and funding programs are leading factors in planning and establishing NRs in most provinces. Acknowledging this reality, the national government applies more selective and stringent criteria to provincial proposals for new NRs. This has resulted in smaller numbers and acreages of presumably better habitats being gazetted as NRs after 2000.

PAs within the Amur-Heilong basin of China follow the general national trend, with Jilin Province having a small but most comprehensive system of PAs (WWF-China 2004), and Heilongjiang Province having the most ambitious and innovative policies combined with the most difficult obstacles. From 2001 to 2005 47 PAs were gazetted in northeast China and eastern Inner Mongolia with a total area of 3,649,238 hectares. According to 2005 plans, 29 PAs would be established in northeast China and Inner Mongolia with a total area of about 1,550,000 hectares (WWF-China 2004). These successes were acknowledged by WWF's Gift to the Earth campaign when the Government and Forest Department of Heilongjiang Province were recognized as Earth Keepers on 8 June 2005.

During the past five years wetland PA creation was emphasized while the ability to establish forest NRs was limited because logging was still permitted in most areas of high biodiversity value. Most of the forest lands belong to three Forest Industry Bureaus who, being state enterprises, have comparatively weak conservation policies and limited access to national project funding. Therefore the future of forest ecosystem conservation in China's Amur-Heilong basin depends largely on reform of the Forest Industry Bureaus. The future of wetland, grassland, and river basin conservation in China will ultimately depend on cooperation with neighboring Russia and Mongolia.

An important trend in China's Heilongjiang Province is the development of protected corridors of wetlands along major rivers. Protection of the remaining natural wetlands in China should involve formation of similar corridors of PAs. An example is the Naoli-Qixing River catchment, where several established NRs (some of them merged and promoted to national status) now include most of the Naoli and Qixing River floodplains. This is an outstanding example of the type of interven-



Map 4.4 Protected areas of upper Ussury/Wusuli River and Khanka/Xingkai Lake basins

tion needed to preserve and restore wetland habitats and biodiversity on the Sanjiang Plain (**Map 4.4**).

Despite advances in the number of individual PAs in China, a task force was created — the PAs Task Force (PATF) — to assess the gaps in ecosystem coverage. PATF found some biogeographical units had no PA coverage or only minimal coverage, some biogeographical units important for biodiversity conservation are underprotected, and many threatened species are not covered, or not covered well, by the NR system. Considering all species of mammals (560), reptiles (391) and amphibians (287), 48 species are left entirely unprotected within the current system of PAs. Many more plant species are left unprotected. PATF also concluded that the current national PA system does not fully represent China's biodiversity nor does it protect ecosystem functions. Finally, the report concluded that individual PAs are not connected well by habitat corridors.

Partially because of these findings, a new approach to PAs is being put into practice by SEPA, one based on Ecological Function Conservation Areas (EFCAs). These are large areas that, by design, include settlements and a wide range of human activities, and often overlie existing NRs. The aim is to provide coherent guidance to land use across critical ecological zones with important biodiversity and ecological processes (Xie Yan et al. 2003.). In many respects, these EFCAs are national level ecological networks and represent very tangible progress toward a watershed level ecological network for the Amur-Heilong in its entirety. In Heilongjiang province there are at least three EFCAs: in Greater Hinggan Mountains (Headwaters of Nen River), Small Hinggan Mountains (Headwaters of Tangwang River), and Sanjiang Plan.

Russia

Despite claims that a profound scientific basis underlies the design of its national PA network, Russia has a mixed record in terms of PA growth. However, in all periods of history the scientific community and NGOs have played key roles in PA planning, and this has ensured the formation of a representative but uneven PA system. Despite its early start in 1916, the formation of the PA network always lagged behind in the remote Amur-Heilong basin.

Privatization of land and natural resources, along with removing governmental controls from business activities, is rapidly shaping a completely new context for biodiversity conservation, to which conservation agencies, the scientific community, and environmental NGOs are yet to adapt. For decades, land for future PAs could have been set aside in a relatively simple and inexpensive way since the state still held most property rights. However, unlike industry, which will take a long time to revive, property rights are subject to change in the near future, seriously complicating the establishment of new PAs. For example, Presidential Decree #1155 (October 2 1992) "On PAs in the Russian Federation" decreed the expansion of the area of zapovedniks and national parks to cover up to three percent of Russia's territory. In 1994, the government in 1994 declared a plan to establish 114 zapovedniks and national parks to fulfill that directive by 2005. However, due to a lack of cooperation and ownership of the project on the side of regional and local authorities, mainly caused by disagreements on land-use rights, only 28 PAs from that list were established by 2001. By 1998 the creation of zapovedniks ceased completely. Various agencies and entities claimed the lands proposed for protection and instead used them for resource extraction and development, and general support for environmental causes from the national government declined dramatically. Against this backdrop a new modest national plan was adopted for the period of 2001-2010 listing only nine zapovedniks and 12 national parks. By 2006 not a single new zapovednik was established in Russia. Four new national parks had already received all the necessary approvals from provincial authorities in the RFE, but only two (Zov Tigra, Udegeiskaya Legenda) were formally gazetted due to the constant change in legal requirements and management responsibilities of federal agencies.

Policy shifts in some provinces of the Amur-Heilong basin are also lagging several years behind Moscow. In 1995-2002 substantial increases in provincial PAs were achieved in all provinces of the Amur-Heilong basin, partly with the help of international support from WWF and other organizations. Provinces have issued pledges for a significant expansion of PAs. Khabarovsk Province, for example, proposed additions to its network of PAs covering more than 800,000 ha to be established by 2005. Special regulations on ecological corridors for ecological networks were also adopted. In Amur Province the government pledged to create an interconnected system of PAs covering up to 10 percent of the region by 2005. Primorsky promised to expand PAs up to 17.8

percent of the total region area. All of these programs were accepted as WWF Gifts to the Earth. The governor of Amursky Province fulfilled his obligations and others made substantial progress. Over a period of 10 years new PAs in the Amur-Heilong basin were established on 3.7 million hectares with support of international funding and work of NGOs including WWF, Khabarovsk Wildlife Foundation, and Amur Socio-Ecological Union. By 2003 five out of six Russian provinces had already established Provincial Interagency Committees on biodiversity and PAs. And, across the Russian Amur-Heilong, provinces committed two million hectares of new PAs.

Unfortunately, these plans were blocked by a 2004 country-wide administrative reform that shifted authority from the provinces to the national government. When authority reverted back to the provinces a year later, management responsibility for provincial PAs also returned and became much more burdensome since federal agencies from now own abstain from managing them. From that time the major concern of the provinces was how to manage and adjust existing PAs rather than how to create new ones. This concern is likely to retard development of PAs at least for the next several years despite ambitious plans that have been developed for each province. Despite these problems with PA expansion in the Amur-Heilong, the scenario in Russia approximates that of its southern neighbor: Russia has moved from a piecemeal PA approach to a system wide approach, and, as such, has set the stage to consider larger, transnational conservation trends through an ecological network.

Mongolia

Government policy in Mongolia has been to increase the area of protection to 30 percent of the country. Part of this expansion would take place in the Amur-Heilong headwaters. The climate in Eastern Mongolia is extreme and the region is ecologically vulnerable. Therefore, biodiversity conservation, sustainable use, and restoration of natural resources are very important during this time when human population and livestock numbers are increasing, settlements are expanding, and industrial development and human interaction with nature is intensifying. About half of the projected PA expansion will consist of strict PAs. The balance will be NRs that allow for some to significant natural resource utilization. The expansions are planned for areas that have little human habitation in order to minimize the social and economic costs associated with reducing natural resource extraction and human use.

Resource extraction projects and the development of infrastructure for international trade have introduced real-life corrections to these well-meaning protected areas policies. For example, local administrative and citizens' representative meetings in the districts of Dornod Province proposed to protect "Kherlen-Menen," "Jarantogoo," and "Tashgain Tavan Nuur" biodiversity areas as Nature Reserves and Special Protected Areas. However, approval of this proposal was postponed due to road construction, oil exploration, and extraction in some portions of the area.

Conservation Schemes Outside of Protected Areas

Protected areas will form the core of any multi-national ecological network in the Amur-Heilong. However, it is also critical to understand the conservation mechanisms other than PAs that are shaping the region.

Land-use policies along the border

The Amur-Heilong River itself demarcates a several thousand kilometer border between China and Russia, and the sharp international contrasts in population density, land-use patterns, and cultures between those two countries. For centuries the lands along the border have been disputed. In both China and Russia the Amur-Heilong basin is located at the remote margin of a large centralized state, and subject to little attention from administrators in the capital cities. Remote locations, harsh climates, and often tense border relations are all factors that have contributed to preserving the basin's natural values.

Not unlike the demilitarized zone between North and South Korea, the Russia-China border area has been a de-facto protected area for the past 40 years. Borderlands were protected by Soviet frontier guards who restricted access to the wide "border zone" and fully closed areas immediately adjacent to the border line. In China the policies were historically more liberal and population pressure more acute. However, even in China, the border areas still contain much larger tracts of wilderness than other localities in the basin.

The Border areas of the Amur-Heilong are patrolled by armed officers, respected by locals, and encompass natural ecosystems covering several million hectares. In recent years, military protection has deteriorated due to declining funding and increasingly vague objectives. As relations improve and protection weakens, the border area has experienced pressure from both Russian and Chinese populations. The no-man's-land between countries is frequently used, primarily by Chinese villagers, for stream poisoning to capture frogs and small fish for sale in local markets, snaring wild deer and boar, collection of edible and medicinal plants. This type of encroachment was non-existent in earlier years when the military patrols were more obvious and threatening.

It is critical to ensure that policies provide for long-term conservation and sustainable use of these "green buffers" along the international borders. Given that the Russian Border Guard Service has already been assigned an important role in protecting aquatic biological resources (preventing illegal fishing, for example) and in China nature conservation is a relatively high concern for provincial authorities, establishment of such policies is practical when both sides agree on approaches to implementation. In China, the provincial agencies, including Heilongjiang Forestry Department, have already agreed that the management of some military areas will be delegated to the related NRs once the troops are reassigned (Li Lifeng, WWF China, pers. comm.).

If the situation along the border continues toward less control, the impressive band of NRs being established along the border in China could quickly become degraded. This is because these PAs are typically only parts of much larger contiguous habitats that are protected in the patrolled strip on the Russia side of the border. The China PAs are connected with the Russian border zone by species migrations and movements, hydrology, and other natural processes. Ironically, a driving force for degradation of biodiversity in the border zone would be trade liberalization between China and Russia.

Forest management and ecosystem conservation

Forest management and planning are undergoing rapid change in both Russia and China and effect an enormous percentage of terrain within the Amur-Heilong. Because the two countries are strongly linked by the timber trade, forest management and planning are transboundary by default. China is now developing more aggressive and ambitious forest conservation policies, while the contrasting trend in Russia has been to allow greater exploitation of previously protected forests in response to market demand. Although there is little hope for reversing this trend in Russia, improving communication on best practices for forest biodiversity conservation and basin-wide standards is necessary for the protection of high conservation-value habitats. Transboundary communication is now largely limited to issues that concern trade, which further complicates efforts to achieve a sustainable balance between conservation and exploitation.

All three basin countries are slowly evolving away from Soviet-style forest management that favored clear cutting. This is especially true in China. But such management in Russia has been tempered with very abundant and a widely distributed forest base where logging was limited or banned. Unfortunately, not all of the protected forests have been protected as planned, and some forests that were assigned to protection categories do not necessarily include areas of the highest biodiversity value or those supporting crucial ecosystem process. Various agencies and other stakeholders have recently carried out identification and mapping projects to delimit and thereby aid protection of high conservation value forests (HCVFs), some for the purposes of certifying well-managed forests, some in an attempt to protect tiger and leopard habitat and vulnerable ecosystem types.

Forest ecosystems frequently overlap international borders of the basin. For this reason, HCVF inventory methods used in the two countries should be harmonized and results of their application should be comparable. Protection of HCVFs could, in some cases, be achieved through agreements with logging companies, using forest certification to reward good management, consumer pressure, and other mechanisms to limit tree felling. With the recent changes to the forest code and the reallocation of almost 120 million hectares of forest concessions, clearly, forest management and protected forests within concessions must figure as key parts of an ecological network in the region.

Water protection forests

The three countries of the basin have provisions for delineation and protection of "water protection forests," which are typically species-rich, and vulnerable plant communities along rivers, which often border important wetlands. Delineation of these zones is based on old regulations that often disregard important ecological processes. However, these provisions are still important land-management tools that can be readily used to protect forests and wetlands on floodplains of major rivers. This is an urgent measure since bottomland biodiversity-rich forests tend to disappear quicker than any other forest types, and because riparian vegetation plays a crucial role in capturing pollution and reducing erosion. Joint efforts for improved policies and practices for delineation, expansion, and protection of such critical wetland and bottomland zones (e.g., along the Amur-Heilong, Wusuli, Song'acha, and Argun Rivers and Xingkai-Khanka Lake) must be undertaken to inspire transboundary conservation.

Watershed forest management

It is generally accepted that unsustainable forestry practices degrade hydrologic and hydrochemical regimes, increase flood damage, and reduce freshwater biodiversity. Ma Jun, in his 1999 book on China's water crisis[1], emphasized deforestation and change of forest composition in northeast China as a leading factor in river ecosystem degradation (Ma Jun 1999, 2004). This highlights the importance of catchment management as an issue where transboundary cooperation might be very productive. The ADB-GEF Sanjiang Plains Wetland Protection Project proposes forest restoration and management on 50,000 ha of uplands in Heilongjiang Province that drain to important wetlands. This five-year project began in 2007. Extension of this concept across the border rivers would be a key step toward integrating transboundary catchment management.

Reforestation

Reforestation is needed in many key natural zones of the basin such as the Zeya Bureya Plains, Xingkai-Khanka Lowlands, and the Sanjiang Plain. Many plains of the Amur-Heilong region that retain large wetlands no longer support large areas of riparian or floodplain forests. As a result, these wetlands no longer sustain natural ecosystem dynamics. Restoration of floodplain habitats implies not only wetland conservation, but also large-scale reforestation of adjacent slopes and previously forested bottomlands.

China's strong reforestation policies have led to an 18% increase in forest cover (data from State Forestry Administration). However, most of the recent gains were in commercial forest plantations that often consist mainly of exotic and commercial timber species. Plantations differ in structure and composition from forests that occur naturally in the basin. Government programs for conversion of farmland to forests and wetlands are often viewed by local authorities as means to obtain subsidies for the impoverished rural population rather than as ecosystem restoration schemes. Excellent histories of these China government programs were written by Xu and Katigris (Xu 2002).

Transboundary cooperation would speed the development of policy and technology, and help resolve contradictions between ecosystem restoration and rural development on the Amur-Heilong plains. This is especially relevant following the emergence of China's 2004 grain production policy, which will inevitably slow reforestation efforts in rural areas of China.

Wetland issues and policies

Since pressures on wetland ecosystems are greatest there, China has put forward the most comprehensive set of protection measures among the three basin countries. Wetland conservation policies currently implemented in China include:

- The National Wetland Conservation Action Plan
- Ban of massive wetland reclamation
- The 32-character policy; and
- The Heilongjiang Province wetland regulations of 2003.

These policies provide a complicated but solid matching framework for integration with Russia and Mongolia authorities. Policies and programs on wetlands in both countries are still in the early stages of development, so such an integrated framework would be useful. Use of China's wetland policies as a model for international standards may reinforce the government's decision to protect wetlands in northeast China while increasing funding for implementation.

[1] Ma Jun. 2004. China's Water Crisis. International Rivers Networks Books, EastBridge Books, Norwalk, CT, USA. Originally published in the Chinese in 1999 by China Environmental Science Publishing House, Beijing.

The results of China's wetland conservation policies are very impressive. Of the 220 NRs in the China segment of the Amur-Heilong basin, some 83 are wetland reserves (37 percent of natural reserves for the region and nearly 24 percent of all wetland reserves in China). Their combined area totals 6,083,410 ha, accounting for 52 percent of the total area of reserves in the basin and 38 percent of wetland reserves in China. (Li Xiaomin 2004) Six of the national NRs in Amur-Heilong basin are listed as Ramsar sites (Xingkai Lake NNR, Sanjiang NNR, Honghe NNR, Zhalong NNR, Dalai Lakes NNR, and Xianghai NNR). Many of the remaining wetlands in the region are designated as NRs at the national, provincial, or county level.

Beyond designation of NRs lies the difficult task of actually implementing nature conservation in the field. For example, despite all the emphasis of wetland conservation through PAs, conversion to farmland still occurs. This is largely due to the 2004 Grain Policy. Large wetlands-based NRs do not have effective management. Levels of funding allocated to NRs are typically insufficient and proposed management interventions are too costly. For example, the wetland restoration plan for the Xingkaihu NNR would require approximately US$ 10 million — much more than could be acquired for this purpose from any imaginable source.

There is also an increasingly institutionalized preference for restoration projects over the protection of pristine natural habitats. This arises in part because of government subsidies for "returning farmland to wetland." New NRs in unspoiled habitats require funding which is unlikely to materialize. In contrast, restoration of farmland to forest or wetland carries a high probability of funding from the state or province to the local level. This problem parallels closely the problems associated with systems of wetland mitigation banking in the United States.

Wetland conversion to farmland must be stopped by strict enforcement of existing laws and regulations banning wetland conversion. This should be supported by extending conservation-education and alternative economic opportunities to communities adjacent to wetlands. Education programs must address the links between wetland conservation, floodwater storage, aquifer recharge, and drought relief because these issues are fundamental to raising the living standards of the basin communities. This must be supported by government funding to encourage communities to find or develop alternatives to conventional farming that are more beneficial means of income generation while causing less harm to ecosystems. This is a subject to which the experience of WWF-China's Middle Yangtze project could be successfully applied.

Wetland destruction in the Russian segment of the basin proceeds at a slow pace due to recent declines in agriculture. However, on the major plains of the region this process will be accelerated in the near future by China-Russia cooperation in agricultural development. The Lake Khanka lowlands and Zeya-Bureya plains are the two most threatened areas in this respect.

In Russia, wetland conservation policies are fragmentary and often contradictory. No specific agency is responsible for wetland conservation. Provisions exist in forestry, water and environmental laws to protect wetlands, but the government does not have adequate means to inventory the extent and status of wetlands. Land inventories mostly register peatlands, which on the whole are less threatened than other types of wetland habitats. Wetlands important for water birds are typically protected in the PAs system. Many more are effectively protected by remoteness alone. There are six Ramsar sites, two Man and the Biosphere reserves, and other international nominations attributed to individual wetlands. Annual fires, which lead to dehydration of wetlands and xerophytization of vegetation, are the most common plague affecting protected and unprotected wetlands alike (see Chapter 23).

In Mongolia most wetlands are periodically dry, making those few that persist a precious asylum for wildlife. Virtually all such areas are listed as IBAs, and some as Ramsar sites. At the same time those river valleys and lakes are typically the only source of water for domestic livestock, a situation that leads to their degradation. Inclusion of such wetlands in PAs does not reduce such pressure, since no alternative water source is available during the drought. Water demand from a growing mining industry puts additional pressures on wetland habitats, and placer mining of gold directly destroys riparian wetlands and bogs in forested headwaters.

All major wetland systems in the Mongolia part are transboundary. New water laws in Mongolia, modeled after IRBM principles, include wetland conservation provisions, but effective implementation mechanisms have yet to be established.

In many portions of the basin wetlands have already been deprived of natural water supplies by drainage management for flood control and by agricultural practice and transport infrastructure. Agricultural development and flood control are the primary agents affecting wetland dehydration in China, while in Russia, dam construction and other infrastructure development are the most pernicious threat.

China's water pricing system encourages overuse and wastage of precious freshwater supplies (Ma Jun 2004). Reform of water pricing is often resisted by those who presume it would add to the financial woes of farmers. But if farmers saved money by reducing excessive applications of nutrients, they could accumulate more than enough to pay higher water fees.

In Russia, wetland conservation is approached through legally proscribed water protection zones. These zones are most often too narrow to match the natural flooding patterns and rarely protect significant portions of floodplain from construction or intensive agriculture. Russia also lacks enforceable provisions to ensure that floodplain wetlands downstream from a dam receive ecologically sufficient floods. This inadequacy in regulations has already led to degradation of large floodplain wetlands along the Zeya River.

Grassland Conservation and Preventing Land Degradation

Among the three countries of the basin, only China has special legislation on grassland conservation. This is dictated by the much higher degree of degradation of grasslands in China (see Chapter 22). Land degradation is especially acute in China's Song-Nen Plain and in western parts of the Amur-Heilong basin. China's Ministry of Agriculture has long promoted fencing to prevent grassland deterioration. Although fencing enables temporary recovery of grasses, it can disrupt migration of wildlife and the nomadic lifestyles of local herders.

Grassland protection began recently along the China-Mongolia border in the form of a cooperatively managed "green corridor." The project started in 2004 and covers an area of 4,000 km^2 on both sides of the border. Objectives include restoring grassland by planting grasses and preventing desertification by planting trees in shelter belts. China assists Mongolia by providing technical training, equipment, and planting materials.

Retaining and stimulating nomadic patterns of animal husbandry in Mongolia is a key task for ecological network planning in the Eastern Steppe. Deterioration of pastures near main roads and settlements has already led to the shrinkage of habitats for endangered wildlife and changes in migration patterns of some wild populations.

There is an urgent need to develop a cooperative strategy for grassland restoration and conservation, especially in relation to habitat conservation of migratory wildlife such as Mongolian gazelle. Reestablishment of this species in Russia would have been impossible without natural grassland corridors and absence of barbwire on the Russia Mongolia border within Dauria International Protected Area (see DIPA case-study in Chapter 32). At the same time important populations in the northeastern corner of Mongolia are presently under threat because protection of species is not coordinated between the three countries and barbed-wire fences on the borders with Russia and China block migration routes. If unfavorable winter weather conditions provoke massive migration of animals northwards and eastwards they will die of hunger and stress being unable to cross the border. Even if animals do cross they will be exterminated by poachers on unprotected territory. This is a classic task of ecological network planning to forecast and solve such problems.

Fisheries

Because aquatic species exist within a fluvial environment and are de facto highly mobile, special effort is required to provide appropriate regulatory and spatial planning measures to ensure conservation and restoration of aquatic species. Fish stocks — biological resources managed by a variety of agencies — provide vivid examples of this necessity.

The 90 percent decline in Amur-Heilong fish catches has been widely documented (WWF-RFE 2004). The basin supports valuable stocks of salmon and sturgeon that require effective international protection. To achieve this, Russia and China entered into three bilateral agreements: the Russia-China agreement on "Cooperation in Fisheries" (1988), the "Agreement for Cooperation in the field of protection, regulation and reproduction of aquatic biological resources in Transboundary waters of the Amur-Heilong and Ussuri-Wusuli Rivers" (1994), and the "Amur-Heilong-Ussuri-Wusuli Fishing Regulations." The regulations cover 25 species of fish, as well as two crustaceans, one turtle, one mollusk, and three aquatic plants. The regulations specify catch size limits for fish, net mesh sizes and lengths, seasonal fishing ban periods, closure of waters to fishing, and permitted fishing gear. They also contain provisions to mitigate harmful impacts of agriculture, municipal and industrial pollution, construction of water infrastructure, and mining. A Special Task Force and a Consultative Expert Group were established to implement this agreement.

This cooperative mechanism, although far from stopping declines in fish stocks, have at least provided a regular forum for exchange of important information, resolving disputes, and planning joint measures. Commonly agreed fishing bans were implemented as were joint anti-poaching operations. The regulations have been continually discussed and strengthened, most recently in 2003.

Article four of the fishing regulations imposes a total ban on fishing in transboundary waters of the Amur-Heilong and Ussuri/Wusuli from 11 June to 15 July and 1-20 October for all fish species.

Article five lists waters in which commercial fishing is banned year-round in Russia. These include reaches of the Ussuri/Wusuli and Amur-Heilong two km up and downstream from the mouths of major tributaries (Zeya, Bureya, Bira, and Bikin) as well as 500 m up and down all other tributaries on the full width of the Amur-Heilong and Ussuri/Wusuli. In China, a similar ban is imposed on the lower Songhua River and all left-bank tributaries from the mouth of the Niu'erguxiaohe to the mouth of the Songhua River, as well as in waters of the Amur-Heilong 2.5 km up and downstream measuring from the left and right banks of the Songhua confluence, as well as at the Naoli River confluence with the Wusuli-Ussuri, and a reach of the Amur-Heilong in Luobei County (Hegang Prefecture). All forms of fishing are prohibited in these zones, which are to be demarcated with special signs delimiting the no-fishing zones.

Other articles specify types and lengths of nets that are allowed, and legal placement of the nets in the river channels.

In addition to the measures prescribed by the transboundary agreement, countries also implement their own national policies. Several reserves to protect rare and valuable fish species have been established in China and Russia (Humahe NR, Dichun NR, and others). Russian legislation also prescribes protection of forests near spawning rivers and the delineation of areas with temporary and permanent fishing bans.

There is a well established set of agreements to guide protection and restoration of fish stocks. Agencies in the two countries, however, have no capacity to protect fish biodiversity because the majority of species is overlooked even by basic monitoring. Nor do they have capacity to harmonize domestic policies with international agreements. Therefore most "no fishing zones" prescribed by international agreements do not necessarily coincide with those enforced domestically. Thirdly, China has no say in the protection and management of migratory stocks in Russia's reach of the Lower Amur. This might be a strong disincentive to participate in any binding agreements on upstream areas. Lastly, due to the legal status of international waters it is not the Fisheries inspection teams, but rather the border guards who have the authority and greater capacity to deal with enforcement issues. But border guards are neither legitimate partners to the bilateral agreements, nor do they have sufficient expertise in fish resources or biodiversity issues.

Little is known about the overall transboundary status of aquatic biodiversity in the headwaters of the Amur-Heilong that are divided between three countries. One well-known species of fish is taimen (Hucho taimen), both an "aquatic charismatic megafauna" and the major reason for fishing-tourism in Mongolia. The migrations occur in transboundary rivers such as the Balj, Onon, and Khalkh Rivers, and must become subjects of international concern in any taimen conservation program. In the realm of Russia-Mongolia and China-Mongolia relations, protection of aquatic species is difficult to discuss because of mismatching responsibilities of agencies that represent countries in negotiations (see Chapter 28 for detail).

An ecological network in the border areas could add significant value to national-based attempts at fish conservation, especially in clarifying biodiversity conservation priorities and related transboundary issues, promoting the establishment of NRs and enforcement of their protection regimes, delineating protection forests along spawning rivers, and imposing seasonal fishing bans in vulnerable areas. The recent and acute problem of invasive aquatic species, mostly coming from fish farms, should also be considered in ecological network design.

An Ecological Network: The Amur-Heilong Green Belt Concept

In 1999, WWF-Russia initiated a series of discussions with scientists and conservation practitioners in order to develop a new concept for Russia's system of protected nature areas, one that reflected the country's new social and economic conditions. These discussions have given rise to the concept of ecological networks.

An ecological network is a network of natural and impacted areas that are connected functionally and spatially and are subject to special conservation regulations designed to fulfill the following key functions:

- long-term in-situ conservation of biological diversity;
- sustaining ecological balance and ecosystem processes in large areas;
- conservation and regeneration of a variety of useable biological resources (including genetic resources);
- provision of essential ecosystem services at different spatial scales;
- minimization of natural ecosystem fragmentation;
- promotion of sustainable use of biological resources/ecosystem services and just distribution and sharing of benefits coming from it;
- preservation and dissemination of indigenous knowledge, practices and culture; and
- ensuring compatibility and preventing conflicts between socio-economic development (plans and policies) and long-term biodiversity conservation and sustainable use of biological resources.

An ecological network also:

- includes representative species, ecosystems, and natural processes;
- fulfills key ecological functions;
- considers spatial and functional interconnections that allow species populations and natural processes to persist;
- is designed to ensure long-term viability, taking into account climate change and other anticipated human and natural impacts;
- embraces management policies that are compatible with socio-economic infrastructure and land-use patterns of the region;
- includes various stakeholder groups during the design and implementation phase
- is designed with financial sustainability principles.

The idea of an ecological network for the Amur-Heilong exists — it is called the Amur-Heilong Green Belt — and it aims to protect priority wetlands, grasslands, and forest habitats throughout the basin but focuses on ecosystems along international borders.

In contrast to other issues affecting the transboundary environment, such as pollution or dam building, cooperation to develop a trans-boundary protected area network is promising and should be more fluid because it is largely unaffected by controversy. All basin countries recognize the value of biodiversity and have recently made significant contributions to its protection. At high political levels basin countries have signed key conventions and agreements to achieve nature conservation and restoration. These provide a solid foundation for sustainable management of the basin as a whole through transboundary protected area cooperation.

Despite much progress, the Amur-Heilong Green Belt is still a concept rather than a specific initiative. It is being promoted by NGOs in the Amur-Heilong Basin including WWF, the Amur Socio-ecological union, the Nature Conservation Center "Dauria," and the Amur Ecological Foundation.

To date, the Green Belt approach to transboundary cooperation on PAs networks has been implemented using three approaches:

- bilateral agreements for biodiversity conservation and nature protection: As noted in Chapter 6 Essay 1, these are often paper agreements that achieve little of the original intent;
- multi-lateral agreements for international PAs: These have been partly successful at the bi-lateral Xingkai-Khanka Lake on the Heilongjiang-Primorsky border (Russia and China) and the tri-lateral Dauria International Protected Area (DIPA) on the Mongolia-Chita-Inner Mongolia border (involving all three basin countries);
- international funding for the establishment or management of international PAs: Examples are WWF

and GEF's funding at Dauria and Xingkai-Khanka reserves, WCS and WWF funding at Hunchun and at China's Wandashan Range, and the Crane Site Network supported in part by Wetlands International and the Wild Bird Society of Japan.

Moving forward, the Amur-Heilong Green Belt must take this initial progress on transboundary protected area cooperation and begin to focus on:

- developing a consensus-driven transboundary ecological network of protected areas based on supporting legislation and policies at international, national, and provincial levels;
- developing the institutional capacity within individual protected areas and among system-wide staff to work cooperatively on ecological network establishment in river basin provinces;
- developing and gaining official recognition for a Amur-Heilong basin-wide and scientifically valid management plan for the ecological network;
- stimulating institutional support for the establishment of new PAs to fill gaps in habitat representation and species needs and creating essential links between existing PAs;
- developing and implementing management plans for model transboundary areas with a focus on strengthening institutional, technical, and management capacities across national boundaries and building public support and participation mechanisms;
- supporting policies integrating ecological networks into socio-economic development and designing mechanisms to achieve long-term social, financial, political sustainability of the protected areas;
- developing effective communication tools to promote ecological networks to target groups (local communities, municipal authorities, provincial agencies, national governments, international donors, among others) that demonstrate the ecological value and economic viability of these protected landscapes;
- developing a common understanding of regional biodiversity, land-use, and institutional capacity to use and improve this database in planning and management processes.

Seven steps need to be taken in order to change the Amur-Heilong Greenbelt Ecological Network from an idea into a reality.

1. Existing international agreements must be improved to allow for better transboundary cooperation

Improvement in the framework of bilateral and multilateral agreements would be the first step in securing a transboundary ecological network. Even limited additions to existing agreements and implementation mechanisms would make a world of difference. The following simple scenario describes a scenario for modifying such an existing agreement to allow for the unimpeded planning and establishment of an ecological network throughout the basin.

The Upper Amur-Heilong Basin already has the making for a full-scale transboundary Ecological network by amending the trilateral agreement on the Dauria International Protected Area (DIPA) to cover the entire Daurian Global 200 ecoregion. The agreement was already agreed in principle in March 2006 (see case study on DIPA in this Chapter), and represents a solid framework for developing a conservation plan for the entire area west of the main ridge of the Greater Hinggang Mountains. It implemented, the plan would simultaneously cover all ecological network development issues between China and Mongolia, and between Mongolia and Russia within the western part of the Amur-Heilong Basin and its immediate vicinity.

Russia-China relationships in transboundary conservation issues need to be strengthened by an additional bi-lateral agreement on transboundary ecosystem conservation that focuses on protected area planning and management, wildlife habitat management, and wetland conservation in the common border area of the Amur-Heilong basin. The SFA of China and the MNR of Russia are the most appropriate coordinating agencies for reaching such an agreement. Activities supported under such an agreement must include the establishment of joint research and monitoring programs, the coordinated planning of PAs, joint training and exchanges of PA staff and relevant agencies, and the development of joint databases and information centers. The agreement must also address issues such as enforcement of wildlife conservation laws in transboundary areas and harmonization of nature-resource use policies along the border.

The most important challenge to any such agreement would be the formation of effective working groups to implement the plans. To date such groups do not exist and this has impeded the implementation of cooperative plans. Sufficient resources have not been allocated and there is as of yet no mechanism for delegating authority from the national to the local level where it can be used for fruitful cooperation. Even without agreements, conservation in an ecological network would be spurred by the establishment of a joint work plan with a capable working group assigned to implement it. This would do more than dozens of agreements that are not supported by well-defined implementation protocols. For example, the Sino-Russian interagency Sub-Commission on Environmental Cooperation formed in 2006 (see Chapter 28) could establish such a working group (task force).

2. Data must be collected jointly and shared openly

High conservation value forests (HCVFs), natural grasslands, important wetland, and riparian areas must be mapped and prioritized for protection throughout the tri-national region. Such assessments (for HCVFs and other high-value habitats) must identify, map, and characterize key habitats for important species. For example, characterization and identification of critical spawning, rearing, and migration habitats for migratory fish need special attention. Population studies should be undertaken for all species of special concern. For instance, accurate estimates of important fish stocks and the impact of fisheries (including illegal catch) should help guide scientifically-based management decisions for quotas and other harvest limits.

Specific data exchanges on wide ranging mammal species like Mongolian gazelle and migratory bird species must receive specific attention from the three basin countries. And, between Russia and China, there needs to be more open exchanges where Amur tigers and Amur leopards are concerned. And, across all species assemblages, their needs to be standardized methodologies for data collection. Some important progress has been made on this front where transboundary tiger monitoring in Russia and China is concerned.

Even incompatible national listings of endangered species cause confusion due to incomplete transboundary information. For instance, Russia still lists as critically endangered a good number of aquatic species considered staple food items by people in neighboring China even though such species are caught in the same waters. The harmonization of data would also benefit the conservation of species by emphasizing trade restrictions on species common in Russia but already on the brink of disappearance from the opposite river bank in China.

3. The existing network of protected areas must be assessed

The establishment of PAs provides a legal basis for conservation actions that are not achievable by other means. However, the effectiveness of protection depends on many legal, social, and institutional factors, the most important of which have been discussed above. Although the extent of PA coverage of the basin as a whole is impressive, important questions remain:

- What types and areas of priority ecosystems and which globally threatened species are protected within the PAs?
- How much of the protected acreage has been or is now degraded by human influence and what does this mean for biodiversity conservation in future?
- What level of protection is legally afforded each type of PA in each country?
- How many of these PAs (especially regional and local PAs) have no funding, infrastructure, personnel, or management?
- Which parts of the total protected acreage are managed for biodiversity conservation by capable management units?
- What is the mode of PA management in each country and what are the consequences for biodiversity values?
- Are PAs actually protecting biological resources?

While for individual countries we can qualitatively answer most of these questions, we cannot yet draw the basin-wide picture showing how transboundary ecosystem conservation is served by the existing PAs. The planning alone involved in the creation of a tri-national ecological network would inspire much needed quantitative data.

4. Protected areas must be resilient in the face of a changing climate

Anticipated effects of climate change should be taken into consideration in any design of PAs or corridors. WWF-RFE has already encountered this problem in ecological network planning. A preliminary assessment carried out by the Environment Research Center of the University of Durham (May 1998) showed that under the most probable scenarios of global warming the effectiveness of the existing and planned PAs could decline substantially because of habitat fragmentation due to the northward progression of warmer winter temperatures. The following list of possible consequences of climate change should be incorporated into planning for ecological network design:

- Potential changes in species distribution and migration should be taken into account when planning borders of future PAs. In some cases additional temporary elements such as buffer zones should be established to accommodate uncertainties associated with different climate change scenarios and their effects on biota.

- Possible unavoidable deterioration of biodiversity values in some existing PAs should be taken into account and sufficient compensatory replacement for them envisioned in planning.

- PA management might be increasingly affected by wildfires as farming in China progressively expands northward into Russia.

- Carbon sequestration might become an important conservation option with respect to emission reduction units under the Kyoto protocol. Transfer or trade of carbon units may be an additional source of funding for PAs. This opportunity should be studied in detail to raise the profile of conservation while raising funding.

5. Better collaboration must take place in existing transboundary protected areas

By 2006 there were nearly 40 large Russian PAs of national and provincial status established along the Chinese and Mongolian borders. In China the number and acreage of comparable PAs is the same. In Mongolia, 12 PAs have been established in transboundary ecoregions. In many cases, political borders cross natural ecosystems or migrating wildlife cross political borders. Ecosystem processes such as periodic floods shape habitats on both banks of boundary rivers and their disruption on one side affects both banks. Often populations of endangered species occupy both sides of a border zone and threats and impacts are similar and often interdependent on both sides. For all these reasons the management of these PAs would greatly benefit from transboundary cooperation. This was acknowledged early in modern relationships of Amur-Heilong basin countries.

In 1994 a trilateral agreement was signed by China, Mongolia, and Russia to establish Dauria International Protected Area (DIPA) to protect globally important grasslands in the headwaters of the Amur-Heilong basin (DIPA 2005). Joint research and conservation efforts have focused on wetlands and migratory waterfowl, grasslands, and migratory gazelle. DIPA staff led the planning and negotiations for expansion of existing reserves and establishment of new reserves in the most important habitats. By 2005 a framework for cooperation led to useful analysis of conservation problems and needs throughout the Daurian Ecoregion and development of a cooperation plan for the 5-year period 2006-2010. A trilateral meeting in Chita in March 2006 endorsed the plan and many proposals for joint projects and actions.

In 1996 a China-Russia agreement was signed for the "Khanka-Xingkai Lake International Nature Reserve." The agreement envisioned a broad range of cooperative activities and established a "Mixed Chinese-Russian Commission on Lake Khanka-Xingkai International Nature Reserve." From 1996-2001 meetings were held and cooperative plans were developed, but no sustained cooperative initiative emerged. In 2000-2001 the UNEP-led project-preparation activities on "Lake Khanka-Xingkai Diagnostic Analysis" prepared a knowledge base on environmental issues of the lake basin for use in developing closer cooperation. In 2003-2005 a series of international meetings was held on the China side of the reserve. Discussions centered on a draft charter of a "Mixed China-Russia Commission on Lake Khanka-Xingkai International Nature Reserve" and plans for immediate cooperation. Those meetings encouraged species inventories, joint wetland research, joint training for monitoring of waterfowl migration, hosting an international camp of environmental student groups from Amur-Heilong basin "Amur Ambassadors", and multiple joint workshops and field trips. Cooperation enabled both sides to apply for biosphere reserve status and the Man and the Biosphere UNESCO program, and helped China to improve local wetland conservation legislation.

A bilateral agreement was signed in 2001 by Sanjiang NNR and Bolshekhekhtsirsky Zapovednik). One of its original goals was to protect seasonal migration route for ungulates across the Ussuri River. Lack of clarity in the agenda for cooperation combined with international bureaucratic difficulties led to little cooperation under this agreement. In 2006 the agreement was renewed with additional involvement of Honghe NNR in China and Bastak Zapovednik in Russia.

An agreement between Onon-Balj NR in Mongolia and Sokhondinsky Zapovednik in Russia was signed in 2005. By 2006 it had led to several joint expeditions to inventory biodiversity of the Onon headwaters in the Khentii Mountains and an ambitious plan for a new international protected area called the "Source of the Amur" that would unite two Mongolian and two Russian NRs in the Trans-Baikal Coniferous Forests Ecoregion.

Cooperation started in 2005-2006 on bird banding between the network of bird-banding stations of Heilongjiang Province (many of them in NRs) and ornithologists from several Russian zapovedniks. This immediately improved the exchange of essential data on band returns that was impeded for years and resulted in several useful training events and greatly eased the financial burden on the Russian side by easing access to inexpensive made-to-order birding nets.

Khingansky Zapovednik (Amurskaya Province) once had extensive contacts with colleagues in the NRs in China that protected migratory birds from Khingansky such as Zhalong, Zhanghe, Dongtinghu, and Poyanghu. Practical cooperation in recent years has been impeded by a lack of funding and inconsistent attention from supervising institutions. To overcome difficulties in transboundary nature conservation and to develop lasting communication and coordination mechanisms Khingansky Zapovednik, with support mainly from WWF and PERC, organized in autumn 2004 the first Amur Green Belt workshop. Representatives from scientific institutions, conservation agencies, NGOs and 15 NRs of Russia and China participated. Partnerships were strengthened, communication channels established, transboundary activities were planned, and agency authorities were given recommendations for improvement of international cooperation. The workshop format proved effective and now the Amur-Heilong Green Belt enjoys support of the Russian Ministry of Natural Resources and many provincial stakeholders. One recommendation of the Khingansky workshop was to convene regular workshops to discuss transboundary conservation in the Amur-Heilong River basin and effectively coordinate these efforts.

In addition to the cooperative activities already undertaken at the transboundary and international NRs mentioned above, **Table 4.9** lists selected NRs and outlines prospects for future transboundary cooperation. Activities required to make these initiatives more effective include:

- workshops to discuss common management issues;
- personnel exchanges to transfer and develop technologies;
- field training courses using best management practices or recent advances in research;
- joint research projects on species and ecosystems of common concern
- joint public communication and community outreach programs;
- environmentally benign economic activities at model sites, including tourism;
- joint projects on reserve management at sister-reserves (e.g. Xingkai/Khanka, Sanjiang/Bolshekhekzirsky/ Zabelovsky);
- transfer of good policies and standardizing policies and practices along borders;
- enhancement of conservation law enforcement in transboundary areas;
- cooperative regional land-use planning and local land use planning in model transboundary wetlands
- joint programs for expansion or establishment of new NRs and transboundary networks;
- transboundary conservation management planning at 2-3 model wetlands or forests; and
- transboundary assessment of threats and species or habitat recovery.

Discussions in 2004 at the first Amur Green Belt workshop underscored that China-Russia cooperation is also impeded by:

- Lack of cross-cultural understanding;
- Problems and comparative strengths of partners are poorly known, thus it is difficult to see advantages from cooperation;

Table 4.9: Selected PAs and proposed fields of cooperation

Ecoregions	Selected established NR (province[1], country[2])	Selected planned NR (province[1], country[2])	Proposed areas for cooperation
Daurian Steppe Global 200 (includes 3 ecoregions)	Mongol-Daguur NNR (Dornod, M) Dalainur NNR, Huihe NNR, Tumuji NNR, Erguna wetlands NR, (ARIM, C) Momoge NNR, Xianghai NNR (JL, C) Zhalong NNR (HL, C) Daursky NNR (Chita, R) Alkhanay NNR (ABAP, R) Aginskaya Steppe, (Aginskii -Buriatsky,R)	Argun river and Onon River floodplain wetland (Chita\ARIM,R/C) Buir Lake (Dornod,M) Duldurginski (Aginskii okrug,R)	Migratory birds conservation Wetland conservation Grassland conservation and fire management; Conservation of migrating Mongolian gazelle Ecotourism development Trilateral environmental education on Daurian steppe
Trans-Baikal conifer forests	Onon-Balj NNR, Khan KhentyNNR (Khenty,M) Sokhondinsky NNR, Mountain Steppe NR (Chita,R)	"Source of Amur" IPA	Planning a transboundary reserve network; Joint measures to prevent poaching of migratory species Forest conservation as waters supplier Prevention of wildfires Research on preservation of forest-grassland ecosystem
Da Xing-an-Dzhagdy Mountains conifer forests	Wuma,Erguna,Shiiwei NR (ARIM, C) Huzhong NNR, Nanwenhe NNR, Humahe, Beijikong (HL, C) Simonovsky, Tolbuzinsky, Urushinsky NR (Amurskaya, R)	Gazimur Relic Oaks (Chita, R) Verkheamurskii, Bussevskii (Amurskaya, R)	Boreal forest research; Conservation of forests logged for pulp and paper; Studies of upper Amur/Argun valley
Manchurian mixed forests Lesser Xing'an Mountains	Khingansky NNR, Khingano-Arkharinsky NR (Amurskaya, R) Bastak NNR, Dichun NR, Schuki-Pokhtoi NR (EAP, R) Wuyilin NNR, Dazhanhe NNR, Xinqin NR (HL, C) Taipinggou (HL, C),	Pompeevsky NNR (EAP, R)	Conservation of Lesser Xing'an forest and wetland ecosystem; Research and protection of large mammals; Ecological tourism development in Xing'an Gorge; Conserve and restore fish habitat (salmonid); Research on Korean pine forest use and protection.
Ussuri broadleaf and mixed forests	Dongfanghong NR, Zhenbaodao NR, Dajiahe NR. (HL,C) Strelnikov Corridor NR(Khabarovsky, R)	Wandashan tiger NR (HL, C), Bikinskii Tiger corridor, Alchan-Bikinsky NR (Primorsky, R)	Conserve Ussuri Watershed (Under 1996 MOU of HL, Khabarovsky and Primorsky); Tiger conservation; Research and protection of endemic species Expand, strengthen ecological network along Wusuli-Ussuri River
Link to Changbai Mountains mixed forests	Hunchun, Wanqing, Tianfozhishan (JL,C) Fenghuangshan, Erduan NR (HL. C); Kedrovaya Pad , Barsovyi NNR, Borisovskoe Plateau, Poltavsky NR (Primorsky, R)	Land of Leopard IPA Tiger and leopard corridors (Jilin, C)	Leopard and tiger conservation; Wildfire prevention; Reforestation and habitat restoration
Amur meadow steppe	Sanjiang NNR, Honghe NNR, Bachadao NNR, Naoilihe, Duluhe NR (HL, C), Bastak/Zabelovsky/ NNR, Zhuravliny (JAP, R) Bolshekhekhtsirsky NNR (Khabarovsky,R)	Jiayin wetland (Hl.C); Khor-Podkhorenok (Khab.R) Heixiazi/Tarabarovy Islands	Cooperative transboundary sus-dev projects (Fuyuan-Khabarovsk) Expand and strengthen protection in Wusuli-Ussuri Corridor Recover endangered bird populations (stork, cranes) Monitor pollution and water infrastructure impacts Conserve and restore sturgeon
Suifen-Khanka meadows and forest meadows	Xingkaihu NNR, Zhenbaodao, Hukou, Dongfanghong wetland NR (HL, C) Khankaisky NNR (Primorsky, R)	Song'acha expansion of Khankaisky NNR (Primorsky, R)	Joint monitoring of lake ecosystem and migratory birds; Expand, strengthen protection in Song'acha River wetlands and Ussuri River valley; Develop sustainable ecotourism Wildfire management Khanka Lake environmental education program; Fisheries management and protection

[1]ARIM = Autonomous Region of Inner Mongolia; EAP = Evreiskaya Autonomous Province; HL = Heilongjiang Province; JL = Jilin Province; [2]C = China; M = Mongolia; R = Russia, NNR=National -level protected area, NR=provincial or local protected area.

• Lack of matching expertise in a sister reserve and no means of accessing to entire reserve network. For example, information and experience or skills needed by one reserve are often readily available not from an assigned partner, but from another reserve in the neighboring country. Unfortunately, partnership agreements seldom include provisions for making such contacts;

• Lack of contacts due to impassable borders and excessive formalities. The most fundamental requirement for transboundary cooperation is permission to cross the border. Surprisingly, the issuance of long-term visas for crossing the border remains an obstacle leaving nature reserve personnel no option but to apply for expensive tourist visas. Russian nature reserve personnel must also receive permission from Moscow for each trip abroad. This outdated requirement is nothing more than a bureaucratic obstacle to transboundary travel;

• Lack of staff capable of direct communication. Russian reserves typically do not have personnel able to converse in Chinese;

• Lack of Russian funding specifically earmarked for cooperation. Since 2003 some reserves in China have allocated modest budgets for international cooperation, but Russian reserves have not done so; and

• Lack of guidance, interest, and involvement of management agencies.

To achieve sustainable progress these difficulties should be addressed and resolved by any international project or agreement-implementation process.

6. The Ramsar Convention must be used in a regional context

A sixth step toward the development of a regional system of PAs involves the more effective use of the Ramsar Convention Bureau's *Regional Initiative Program*. This is ideally suited to the Amur-Heilong basin because all three basin countries are signatories to the Ramsar Convention.

All 12 of the basin's Ramsar wetlands are connected hydrologically, or, alternatively, by the movement or migration of wildlife. Protection of these wetlands, therefore, could be enhanced by a coordinated effort under the Ramsar Convention. The current approach of Ramsar which lists wetlands on a site-by-site basis could well be supplemented and improved by a corridor approach that would list wetlands along rivers and borders such as the Wusuli-Ussuri floodplain or Argun-Erguna Midflow floodplain. Because of the immediate threats from economic development it is critical to hasten Ramsar listing of wetlands that are essential parts of the transboundary ecological network and coordinate planning and management on both sides in transboundary river valleys. **Table 4.10** lists examples of Ramsar Wetlands and wetlands meeting Ramsar criteria, emphasizing their current status and the need for transboundary conservation when appropriate.

From the ten regional wetland clusters presented in **Table 4.10**, only two would be effectively protected in the absence of strong transboundary cooperation. The existing 12 Ramsar sites cover just 15 percent of important wetland areas that meet the Ramsar Convention criteria. Except for Daurian Steppe and Khanka-Xingkai Lake, all other sites have no international management arrangements. This discrepancy obviously calls for more systematic, basin-wide wetland assessments and application of Ramsar conservation tools. The Ramsar Convention also provides a strong framework for developing an ecological network because it emphasizes integrated management of all types of habitats in important river basins.

An appropriate implementation model is the Ramsar Mediterranean Initiative in which 11 countries participate to conserve wetland habitats and biodiversity in the Mediterranean region. An advantage of the Ramsar regional initiative program is that the initiative establishes a secretariat, which serves as an implementation office and a clearinghouse for project funding and regional activities.

The spirit of Ramsar Convention guidelines for regional initiatives is relevant to filling gaps in the current conservation agenda for the Amur-Heilong basin:

"The overall aim of regional initiatives should be to promote the objectives of the Convention in general and to implement the Ramsar Strategic Plan in particular, through regional and subregional cooperation on wetland-related issues of common concern. Regional and subregional initiatives should be based on a bottom-up approach. As a matter of priority, the involvement of as many as possible Contracting Parties of the region or subregion(s) covered by the new initiative should be sought from the start, including all relevant stakeholders with an interest in and directly or indirectly responsible for wetland issues, including the ministries responsible for the environment and water issues, intergovernmen-

Table 4.10 Major wetland regions of the Amur-Heilong River basin (also see Part One Map1.3 of Amur-Heilong River Basin Wetlands with major PAs)

River valley (basin)	Area and its status in Russia	Area and its status in China	Ramsar listing	Needed conservation management action
1.Lake Khanka, Songhacha river (Ussuri/ Wussuli)	Khankaisky Zapovednik (NNR), MAB reserve	Xingkaihu NNR	Listed in both countries	Listing of International Ramsar site and joint management, extension along Sonhacha river
2.Ussuri/ Wussuli midflow	. No PAs	Hutou NR, Dongfanghong NR, Zhenbaodao NR, Dongfanghong Wetland NR,	Eligible but not listed	Protection of Russian river bank, coordinated management across agencies and borders
3.Ussuri/ Wussuli lower reaches	Ussuri right bank- complementary wetlands. No sizable wetland PAs. Only Bolshekhehtsirsky Zapovednik (NNR) includes small wetland area	Dajiahe NR, Naolihe NR, Wusulijiang NR, Eastern section of Sanjiang NNR	Only Sanjiang listed,	Expanded protection of Russian river bank, coordinated management across agencies and borders, developing international NR at Heixiazi/Tarabarovy Islands.
4a.Bikin river lower reaches, 4bKhor river lower reaches. (Ussuri River tributaries)	No PAs Alchan-Bikinskaya inter-fluvial wetland, Khor and -Podkhorenok interfluvial wetlands	No sizable wetland, but with obvious linkages to ecosystems and populations of the area #3 described above.	Eligible but not listed.	PAs designed already some time ago should be finally established.
5.Amur/Heilongjiang Main Channel (Sanjiang section)	Zabelovsky NR (managed by Bastak Zapovednik)	Western section of Sanjiang NNR, Honghe NNR, Qindeli NR, Bachadao NNR	Only Sanjiang and Honghe listed, rest likely eligible, especially in Russia.	Expanded protection of Russian river bank and islands, coordinated management across agencies and borders,
6.Middle Amur: Zeya-Bureya Plain on the left bank, Lesser Xingan Mountain wetlands on the right bank.	Khingansky Zapovednik (NNR) Muravievsky NR, Amurskii NR, Tom'-Tashina inter-fluvial protected wetland (several NR)	Da Zhanhe NR, Xinqing NR, Wuyilin NR This is the only transboundary case where ecological interdependence of two river banks is not immediately obvious.	Two Ramsar sites in Russia. Largest best preserved wetlands of the Amur basin but no Ramsar sites in China.	Strengthening protection of mountain wetlands in China's Lesser Xingan. The only case where reason for coordinated effort is not directly ecosystem integrity, but protecting endangered populations and technology transfer.
7.Lower Amur wetland plains and lakes (Amur main channel and Gorin, Amgun and other major tributaries)	Amur Liman (estuary), Udyl Lake, Orel/Chlya Lakes, Kizi Lakes, Amgun river mouth, Evoron-Chukchagirskaya Lowland; 5 wildlife refuges and one Bolonsky Zapovednik (NNR)	Confined to Russia, but most of migratory fish and waterbirds in China reserves depend on these habitats.	Highly eligible, Bolon Lake and Udyl lake are a Ramsar site. Very small degree of protection is provided by sparse network of, little percent of Amur main channel bank and floodplain protected by PAs	Establish coherent ecological network to safeguard this ecoregion, develop specific measures to protect and restore waterbirds and fish populations.
8.Argun/ Erguna River Midflow	No PAs	Erguna -Genhe Wetland NR, Erka NR, no protection on the ground so far.	Higly Eligible. no PAsso far, planning underway.	Establishment of continuous NR network along Argun river on both sides, developing international management scheme under auspices of existing DIPA (Duria International Protected Area).
9.Great Lakes of Dauria Steppe	Daursky Zapovednik (NNR) -Torey lakes , Nozhiy Lake NR -	Dalainur NNR: Hulun(Dalainur) and Beier (Buirnur) Lakes, Huihe NNR .	Dalaihu and Daursky -Ramsar sites, other also eligible. Two more sites listed in Mongolia.	Develop Sino-Russia-Mongolian international Ramsar site and MAB reserve. Link Daursky and Dalai NR with Argun Midflow (#8) thus securing critical habitat linkages. Upgrade protection of Huihe NR, and Mongolian wetlands in Khalkh, Kherlen and Onon river basins
10. Wetlands of Song-Nen Plain	Exclusively in China, linked to Russia by migration of cranes and other waterbirds.	Zhalong NNR, Xianghai NNR, Tumuji NNR, Momoge NNR, Ke'erchin NNR, Longfeng NR	Zhalong and Xianghai are Ramsar sites, while other areas are not.	Restore wetland hydrology severely affected by water withdrawals and agricultural encroachment.

tal bodies, NGOs, academia, and economic actors. A regional initiative should base its operation on the development of networks of collaboration established upon clearly defined terms of reference, thus creating an enabling environment for the involvement of all stakeholders at all levels." (Source: Guidance for the development of regional initiatives in the framework of the Convention on Wetlands (Annexe to Resolution VIII.30))

A Ramsar Amur-Heilong regional initiative would help catalyze a basin wide ecological network by helping:

- identify and fill information gaps;
- establish archives of Amur-Heilong River basin information;
- enhance institutional capacity to implement policy, legislation and regulations at all levels;
- establish new PAs to fill conservation gaps and link ecoregions;
- enhance institutional capacity to work cooperatively on nature conservation;
- develop and gain official recognition for a scientifically valid strategic conservation plan;
- develop and implement model transboundary interventions to strengthen institutional, technical and management capacities and build public support and participation;
- support policies integrating conservation into socio-economic development
- achieve ecological, social, financial, political sustainability; and
- develop communication tools to promote ecological networks.

The greatest value of the Ramsar Convention initiative with respect to the Green Belt concept is that the Convention covers important habitats and natural processes not only by means of establishing traditional PAs. Rather, all land-use policy issues described in the beginning of this essay would receive systematic attention within the realm of ecological network development. Spatial planning, land-use policies for forested watersheds, water utilization and water infrastructure policies, fisheries and game management are all subject to close analysis and evaluation when it comes to protection of freshwater ecosystem of a large river basin.

7. Financing

Unfortunately, all the planning and good will in the world will not result in a fully-function transboundary ecological network in the Amur-Heilong. Even with all the previous paths implemented, if more financing is not directed toward protection — or, better still, sustainable financing mechanisms are developed across the PA network — many if not all of the problems that apply to individual PAs will find their way into the regional system as well. Fortunately, many of the previous six needed improvements can be made without significant increases in funding and taking these steps will help cement a way forward for more consistent funding to bolster the core funding needed at the site level.

Conclusion

Our study shows that the situation in the Amur-Heilong requires the development of a transboundary ecological network if we are to achieve a more lasting balance between conservation and economic development. More importantly, it also demonstrates that such an ecological network can achieve regional conservation and development needs that individual protected areas — or even national systems — on their own could not. Seven next steps to achieving such a network are identified.

An ecological network is needed in the basin to establish the largest scale possible for protected areas but also to link biodiversity conservation with economic development and policy planning. Considering the role of such a transboundary network of protected areas in the context of regional development has several significant benefits:

- The values of the shared transboundary ecosystem would finally receive proper recognition and their conservation would be subject to cooperative, transboundary management;
- Large expanses of globally important habitats would receive consistent protection across borders;
- China would ensure greater influx of threatened wildlife species from similar ecosystems in Russia, without which long-term survival of many species

in more fragmented and pressured ecosystems of rural China is doubtful;

- Russia and Mongolia would add a strong conservation component to their border policies;

- Russia, Mongolia and China would establish a "green buffer" zone that would prevent most and mitigate other environmentally damaging activities, thereby reducing mutual recrimination over harmful land-use practices;

- Better control over poaching and other illegal activities would ensure greater abundance of wildlife in border areas;

- Protection of fish habitat would create preconditions for re-establishment of harvestable stocks of economically valuable fishes, and the basin would recover its former fame and economic importance as a "River of Caviar";

- Joint activities in organizing eco-tourism in world-class natural landscapes (Amur-Heilong and Ussuri-Wusuli valleys, Xingkaihu-Khanka lakeshores, Daurian Steppe) would bring multiple benefits to local communities;

- Additional control would be exercised over smuggling, including traffic of timber and other biological resources;

- Border protection authorities would receive greater attention of government and society, their budgets would increase and their agencies would become more accountable after being assigned additional responsibilities for nature conservation.

- The ecological network would encourage development of productive relationships between provincial governments, conservation agencies, research communities, and NGOs of neighboring countries, while building common awareness of a wide spectrum of environmental issues, thereby preparing grounds for even more beneficial cooperation in environmental protection.

- Capacity and professional performance of conservation and nature resource management agencies will improve in the course of international cooperation

To demonstrate how ecological networks are currently helping solve regional conservation problems in important segments of the basin, we conclude by providing two case studies in important transboundary ecoregions: the Manchurian forests and Daurian Steppe.

Chapter 31

Case Study Number One:

Hinggan Gorge: International Conservation Area — High Potential Yet to be Realized

By Eugene Simonov

The natural setting

The site where the Amur-Heilong River enters a narrow gorge as it flows through the Small Hinggan (Xiao Xing'anling) ridge is renowned as the most important corridor for fauna migration and most scenic stretch of the great river. This is a bottleneck connecting Mongol-daurian grasslands and the wetlands of the Upper Amur with the vast wetland plains and lowland forests of the middle reach. Here Daurian grasslands converge with riverine meadows, and Siberian boreal forests converge with Manchurian temperate broadleaf forests. Both in geologic times and recent history this has been an important corridor linking forest ecosystem biodiversity of the larger portion of the Xiao Xing'anling ridge in China with the vast forests on the Amur-Heilong's left bank. On the Russian bank the broadleaf-coniferous Manchurian forest ecoregion covers several low mountain ranges (Malyi Khingan, Sutarsky, Pompeevsky) to converge with boreal forests of the Bureinsky Ridge 100 kilometers to the north-east. The Amur-Heilong is itself an important divide where all characteristics of the upper river ecosystem undergo abrupt change. Animals and plants of Manchurian, east-Siberian and Okhotsko-Kamchatka zonal complexes coexist here on opposing banks of the river (**Map 4.5**).

The area is known for outstanding plant and animal diversity and still contains large tracks of pristine forests, including mixed Korean pine and broadleaf forests. The best preserved forest ecosystems on the Russia side are confined to basins of the Dichun and Pompeevka tributaries, while on the Chinese bank the best examples are found in the Jiayin River basin and adjacent watersheds. The area supports large numbers of endangered and relic species of vascular plants and birds and mammals (scaly-sided Merganser, Asiatic black bear, Mandarin duck, Blakinston's fish owl, osprey and others). The narrow floodplain in the gorge has unique characteristics and is very vulnerable to human encroachment due to its small size and accessibility. The area is a primary habitat for Asiatic Black Bear (probably the best in northeast China), and seasonal migration of bear, deer, wild pig and other wildlife across the Amur-Heilong River is a prominent feature of the ecosystem. Some large mammals recently disappeared from the area: leopard was last taken here in 1936, goral was last recorded in the 1970s, Siberian Tiger last bred here in the 1990s, and reintroduction of these species is still possible. Chum salmon still spawn in Pompeevka and other right bank tributaries which is probably, the Amur-Heilong's most remote salmon run from the Pacific Ocean.

The human population is sparse on both sides of the river and depends heavily on local biological resources (non-timber forest products, hunting, and fishing). Major potential economic value of the region lies with its outstanding scenery and preserved nature. Boat trips through Hinggan Gorges (also called Three Dragon Gorges in Chinese) with tours to both sides of the river could become a viable tourism feature with relatively light impact on the environment. No major development has occurred in the area to date, but if agreement is reached on the Hinggan Gorge Hydropower Dam (Khingansky-Taipinggou dam), the ecosystem would be severely threatened and its integrity destroyed. Studies in the 1990s showed that construction of this dam in the main channel of the Amur-Heilong would lead to a drastic ecological change throughout the whole basin and would affect sedimentation patterns, the hydrological regime, the area and distribution of wetlands, the migration of animals, and the abundance of fish (see Podolsky 2006, Gotvansky 2005).

Local history and economy

Beginning in the 18th Century Hinggan Gorge was an important gold mining area, and many local Chinese families are descendants of those who came to mine gold. In the 19th Century the gorge became an important travel route for steam-boats. During these times, firewood was cut along the river's banks but no large-scale forestry disturbed the region. Fisheries also became big busines during the 19th century. Sturgeon is still the symbol of the Luobei County seat, and some towns in Jiayin County were founded on the mouths of salmon rivers. Russian and Chinese settlements in the region date back at least 100 years. According to local lore, organized, large scale forestry in China riverbank was introduced by Japanese during the occupation prior to WWII, and immediately after that logging was widely practiced on the Russia side. By 1965 a system of forest management based on maximum output of timber at all costs (following the Soviet "Lespromkhoz" or forest industry bureaus model) was firmly established on both sides of the river. This corresponded with the abrupt decline and local extinction of the Siberian tiger. Then Russia-China relations were frozen, and for the next 25 years there were no major changes except for the slow and steady depletion of the natural resource base.

In the Russia section of the Small Hinggan Mountains, stretching from the easternmost corner of Amurskaya Oblast (Arkhara District) to the Western part of Evreiskaya Autonomous Province (Jewish Autonomy:Obluchensky and Oktyabrsky Districts) the human population is very sparse and local economies are linked closely to Chinese markets. A wide stretch of forests along the river has been closed for decades to visitors due to strict Soviet border policies. Access was allowed only in selected settlements. Amurzet (center of Oktyabrsky district opposite to Mingshan) and Pashkovo (opposite to Jiayin) are two border trade points with intensive traffic of roundwood and other goods, and very limited traffic of tourists. Other than a surprisingly successful livestock breeding enterprise in Radde village near Pashkovo, hardly anything economically important exists within this border area. The inland zone is open to logging and mining and presently at least 40 percent of these activities are undertaken by Chinese companies and their affiliates, based in small towns on the opposite river bank. Forests are managed by forest management units (leskhoz) and leased to Russian and Chinese logging companies. There are also a small number of Russian professional hunting associations. each leasing large hunting plots. In general, the intensity of land-use is fairly low, and any increase in economic activity is due mainly to Chinese companies from Heilongjiang Province in China.

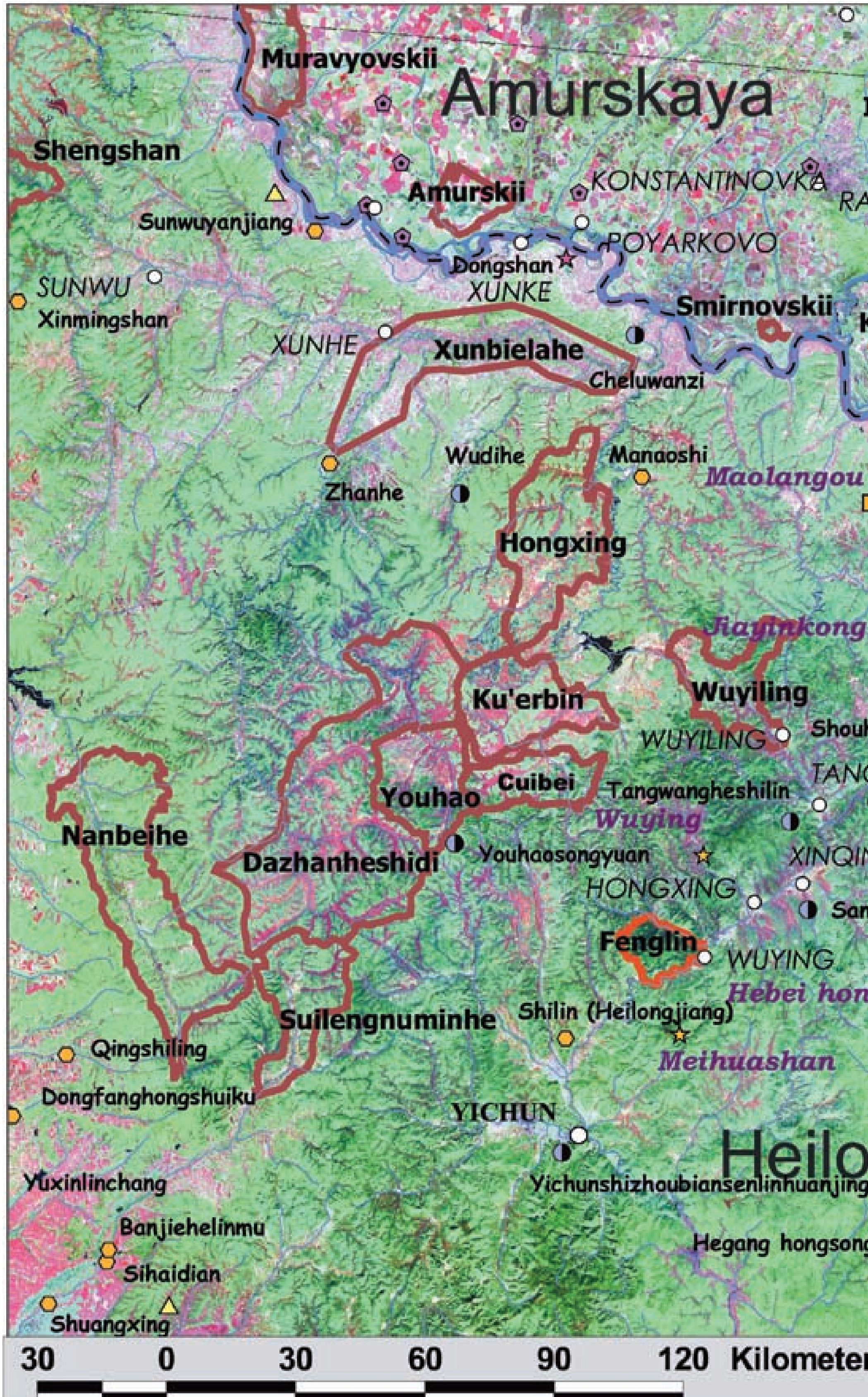
On the China bank, the management of forests is fragmented between Heilongjiang Forest Department(Bureau) (HFD) represented locally by the Luobei/Jiayin District Forestry Bureaus controlling the strip along the river bank, and Heilongjiang Forest Industry Department (HFID) represented by Hegang and Yichun District forest management bureaus controlling the larger forests further afield. Although clearcutting has been banned and the total volume of logging has declined, current logging practices still cause a steady decline in the most ecologically valuable stands, especially Korean pine. This results in loss of critical shelters for endangered wildlife. Examples are the thick tree trunks necessary for bear dens or merganser nesting hollows. Wildlife law enforcement has a lot of room for improvement, and populations of deer, wild pig and other game animals are under considerable pressure from trapping, snaring and poisoning by local poachers. Some populations of medicinal and edible plants are also largely depleted.

Locals find it increasingly difficult to find long-term employment, so they rely more on fishing, poaching, plant collection, and short-term employment opportunities. Land suitable for planting crops is sparse and unproductive, and the growing season is short. Human migration in and out of the area is more intensive than 10 years ago. Many businessmen moved out, and the economically active segment of the population seeks to sell houses and migrate to areas closer to the Luobei County seat. The population of the rural area along the river is about 2,000, with a population density less than one person/km^2. Income per capita in 2004 was less than 4,000 yuan ($500).

The population of the more distant mountains is governed by Forest Industry Groups and is concentrated in the logging bases near the Xiao Xing'an foothills. Hebei, a settlement of 10,000 people with much smaller villages in the mountains, is a good example, and seems to have similar population density and dynamics. Areas adjacent to the Hinggan Gorge in Jiayin County appear to be slightly more populated due to the greater availability of arable land in the wider river valleys.

The local economy and land management system is undergoing an abrupt transition from a heavy reliance on timber products and logging to a more diverse mix of forest products, secondary processing, the service industry, and government subsidies for natural forest conservation. Divisions of the forestry district are leading economic innovation in areas adjacent to the river by developing bee-keeping, frog farming, processing of wood and NTFPs, and marketing edible plants and mushrooms.

In the past, gold-mining was a major local industry that resulted in the destruction of local river valley ecosystems on all tributaries.. These impacts are widely recognized by local government and public opinion. Gold mining is banned in Luobei and all surrounding counties save for Jiayin County on the main channel of the Jiayin River. During the early 2000s the mining bureau which previously operated in Luobei obtained gold



Map4.5 Satellite view and protected areas in the Small Hinggan mountains


Protected area types of CHINA:
National nature reserve
Provincial nature reserve
Shankou
Provincial nature reserve
Meihuashan
National forest park
Shilin
District Nature Reserve
Dongshan
Local Forest Park
Shouhushan
Prefecture Nature Reserve
Protected area types of RUSSIA:
Zapovednik (Strict scientific nature reserve)
Buffer zone of zapovednik
National wildlife refuge
Provincial wildlife refuge
Nature monument
Planned protected areas
Planned protected areas
Planned Khinganski-Taipinggou Dam Site
Zhelundinskii
Irkun Tract
NOVOBUREYSKIY
RAYCHIKHINSK
Andreevskii
Khinganskii
ARKHARA
Khingano-Arkharinskii
Khabarovskiy
Ganukan
Khinganskii
OBLUCHYE
Bastak
konglonghuashi
JIAYIN
Jiayincishenglin
BIROBIDZHAN
Shouhushan
Shuki-Poktoi
TANGWANGHE
Tangwangheyuantou
Dichun
Xinqing Baitouhe
Yevreiskaya
Uldury
Sanyang
Taipinggou
Longjiangsanxia
Pompeevskii
hongsongmushulin
Zhuravliny
Churki
LENINSKOYE
Qindeli
ilongjiang
AMURZET
Jiejingshan
Tongjiang lianhuahe
Xilinheshuiku
Mingshandao
ngsongmushulin
Wanglaohaohe
LUOBEI
HEBEI
TONGJIANG
HEGANG
Shuilian
Fujinlianhuapao
neters
Laodengshan
Jiangjunshishidi
Duluhe
SUIBIN

mining rights on the Tulovchikha and Beresovaya Rivers in the Evreysky Autonomous Province. It operates there using the same mining technology that demolished stream ecosystems of the right bank. Mining companies enjoy strong support from the Hegang Prefecture Government, which uses special "sister" relations with the Jewish Autonomy to promote the expansion of mining operations in Russia. The community of Amurzet, backed by conservation agencies and NGOs, strongly opposes such devastating use of resources, but has little capacity to stop mining. Tensions are escalating over mining throughout the region. Despite their short history of work on the Russian bank, two gold-mining companies have been the targets of numerous field inspections by government agencies, during which many violations were cited, fines were levied, and mining operations were stopped and re-started several times. Rivers selected for placer mining still harbor small numbers of spawning salmon, and their basins are the most important breeding area for game pursued by local hunters. These local tributaries are also probable nesting habitat of scaly-sided merganser, which will inevitably disappear if riparian vegetation and old-growth timber are lost. Overall, ecological, economic, and social losses from gold mining far exceed the value of gold mined, and the small share of taxes that might trickle into local budgets. However, gold mining conforms to the current mode of development, where Russian border communities cover their social expenses from tax money received from Chinese companies that exploit natural resources. Despite negative experiences with its first two mining companies, in 2005 the Jewish Autonomy auctioned several new rivers for placer mining and in 2006 leased out a nearby deposit of manganese to Chinese developers.

Steady depletion of forest resources and increasingly strict logging regulations in China have led to the establishment of an active trade in timber and non-timber forest products (NTFPs) across Mingshan-Amurzet and Jiayin-Pashkov border crossings. Hebei forest industry bureau has formed special companies (Senhe, Longsen) to log in the Jewish Autonomous Province, and many small scale operators are trading medicinal and edible plants, frogs, and pine nuts across the border.

Tourism development pursued by Luobei and Jiayin Counties also emphasizes advantages of international travel from Harbin to Russia's Jewish Autonomy and Khabarovsky Province. However, the greatest opportunities lie with the development of nature tourism by boat through beautiful Hinggan Gorge from Mingshan to Jiayin and back, with the village of Taipinggou between them being a stop-over site with a rich history dating back 300 years.

Jiayin County, where depletion of natural resources is more evident, already officially positions itself as a "nature tourism area" and participates in relevant nation-wide eco-development programs. To catch up, the Luobei County Government tasked its Forest Bureau to develop multifaceted programs that target forestry and tourism opportunities. Mingshan Island, complete with relic groves of Manchurian nut and a Buddhist temple, became a tourist theme park and harbor for boats. An agreement was reached with the Jiayin government upstream on the joint development of tourist routes through the Gorge. Several tourist attractions were built in Taipinggou, including a Taoist Temple of Eight Saints, the Palace of QiXi Empress, and a Gold Mining Museum.

In January 2005 the old Taipinggou Forestry Unit office burned to ashes. This was immediately followed by an investment to build a new three story building accommodating a new office and a hotel, and additional investment is being made for the improvement of roads, building a pier, and other facilities. The estimated budget is about $800,000. Such investment could be interpreted as a choice made by the local government between a dam development scenario and a more sustainable development scenario, since most of the recent investment would be submerged if the dam were to be built. Altogether this new development project could soon develop fairly useful infrastructure for domestic Chinese tourists traveling to and across the border, for Russian tourists traveling to China, and for various international nature tourists.

However, two factors work against making Taipinggou an international eco-tourism destination. First, many other border towns are pursuing similar development strategies creating tremendous competition for customers. Second, and more important, Hinggan Gorge remains far from becoming a famous nature tourism brand name. Its tremendous natural and scenic values are poorly known in the world and even in China and Russia.

Table 4.11 Summary of protected areas in the Russian Federation near Hinggan Gorge*

Protected area	Year gazetted	area (ha)	Protected ecosystem/feature	Important species
Khingansky Zapovednik (Strict scientific national nature reserve, Ramsar site)	1963	97,231	Floodplain wetlands and grasslands, Broadleaf-coniferous forests.	Siberian and white-naped cranes, Oriental stork, red deer, black and brown bear, lynx
Khinggano-Arkharinsky Zakaznik (national wildlife refuge)	1958	48,800	Broadleaf-coniferous forests, Mountain larch forests.	Korean pine old growth; red deer, black and brown bear, lynx, moose
Dichun forest reserve (provincial)	1998	49,400	Broadleaf-coniferous forests, salmon river watershed	Korean pine old growth; red deer, black and brown bear, lynx
Zhuralviny provincial zakaznik (crane reserve)	1992	50,000	Floodplain wetlands and grasslands, Broadleaf-coniferous forests.	Japanese and white-naped cranes, oriental white stork, red deer, black and brown bear, lynx
Mandzhurka nature monument	2003	23	Floodplain lakes	Rare water plants and rare orchids, steppe vegetation
Bear Cliff nature provincial monument	2000	140	Rock ecosystem	Great owl, wild pigeon, rare plants
Fillipova Mountain – provincial nature monument	1999	160	Daurian steppe community	Feathergrass, orchids, other steppe species
2 protected caves – local nature monuments	1979	n/a	cave communities	bats
3 mineral springs – local nature monuments	1979	>5,000	n/a	n/a

* See Map 4.5.

Conservation efforts

In this part of the Amur-Heilong basin, the Manchurian coniferous-broadleaf mixed forest ecoregion is unevenly divided with the greater area in the Xiaoxing'an Mountains of China (approximately three million hectares of moderately fragmented forest), and the smaller area in the Malyi Khingan and adjacent mountains of Russia (up to 1.5 million hectares with much less fragmentation). Conservation of the Hinggan Gorge ecosystem can be achieved only by concerted effort of Russia and China because key habitats for viable populations of endangered wildlife are divided by the national border and because the exploitation of forest resources and local economic development is already transboundary.We might speculate that local extinctions of tiger, leopard and some other large mammals were in part due to limited habitat remaining on each side.

Protected areas in the Russian part of the Small Hinggan Mountains have a long history and all lie in the immediate vicinity of Hinggan Gorge (within 100 km). Data on Russian protected areas are summarized in **Table 4.11**.

All these protected areas are gazetted, but only some are regularly patrolled by rangers. Only two have field management units .

In addition to these areas, one should note that the left bank of the Amur-Heilong River is strictly protected by Russian frontier guards, and only limited access is allowed into a five to 20 kilometer-wide "border zone." As a result, a large belt of relatively intact habitat has survived on the Russian side of the river. However, this form of protection has been weakening over the last decades and now abundant natural resources of the area are under pressure from border guards and their "invited guests."

In 2003-2004 a "water protection zone" was planned along the Amur-Heilong left bank in the Jewish Autonomous Province, and results of this planning could be used for future ecosystem conservation efforts.

Since the early 1990s there have been numerous proposals for the establishment of a National Park on one or both sides of the river. These initiatives have not progressed because the valley as a whole has yet to be properly surveyed for its conservation values as a precursor to delineating prospective protected areas.

In 2003, WWF-RFE commissioned a study of the protected area system for the purposes of forming an ecological network in the Jewish Autonomous Province. Results were incorporated in the provincial planning documents. As a consequence of that study, in 2004, the Jewish Autonomous Province started planning a national nature reserve in the Pompeevka and Starikova River valleys adjacent to Dichun Nature Reserve. The objective was to establish more effective protection of a broadleaf-coniferous forest ecosystem and a salmon river. The current plan is to subordinate the new nature reserve or the entire left-bank nature reserve network to one of the existing zapovedniks (strict scientific national nature reserves). So far these efforts have not fully succeeded, since PA establishment would limit ability of local district authorities to make money from leasing out various local resources (forest, gold, hunting grounds, etc.) On the China bank, conservation efforts started in the more developed local forest industry bureaus of Yichun Forest Industry Group that occupies large areas in the Xing'an Mountains north and west of Jiayin River. Thus in 2002 the neighboring Xin Qing Forest Industry Bureau, that occupies the headwaters of Tangwang, Jiayin, and Wulaga Rivers supported gazettal of the provincial Xin Qing Moose Reserve on 68,000 ha in the Wulaga River watershed. In 2006, nesting of hooded crane (*Grus monacha*) was discovered by Dr. Guo Yumin of Capital Teacher's University. In 2006 the Xin Qing NR reserve was in the redesign process looking to incorporate crane conservation and pursue upgrading to national level. Further from the gorge and in the mountains, Wuying is the largest forest NNR, with total area over 100,000 ha of the best Korean Pine groves in China, and nearly every local forest industry bureau already has at least one provincial level nature reserve (**see Map 4.5**). By 2003 a National Forest Park "Three Gorges of Dragon River" was established along the riverbank in Luobei County to promote tourism development, but it did not have a major influence on current patterns of resource exploitation. Another National Forest Park of 11,000 hectares was established in 2005 in the Lianying forestry unit of the Hebei Forest Industry Group with a similar purpose. This park includes one of best preserved Korean pine stands in the region, since for many years it was protected from large-scale logging as a pine-nut production zone.

Under the Sino-Russian Agreement on Fisheries and Amur-Ussuri International Fishing Rules, a system of protected sections of the river was declared with permanent and/or seasonal restrictions on fishing. One of these sections lies in Luobei County and is primarily intended for protection of the northernmost large spawning area of Amur and Kaluga Sturgeons. Whether this regulation is presently enforced is unclear.

In 2004 the Heilongjiang Provincial government with support from WWF began planning Taipinggou Provincial Nature Reserve in Taipinggou and Jingmantun forestry units of Luobei Forestry Bureau. The target year for gazettal was 2006 with an area of 22,000 hectares, primarily in forests along the river that already have some degree of protection. This area was intensively logged 40-50 years ago and has many hectares of naturally recovering young broadleaf-coniferous forests. The site is known for its abundance of black bears and other charismatic megafauna. High density of animals observed in Taipinggou area is likely due to its role as a migration corridor between Dichun and Pompeevka on Amur left bank and rich forest ecosystem higher in the mountains that is managed by Hebei Forest Industry Bureau.

There is an explicit understanding between WWF and the Heilongjiang Forest Bureau that a future step toward more comprehensive conservation would include enlarging and upgrading the network of protected areas and developing an internationally recognized conservation area in Hinggan Gorge. A similar understanding is shared by WWF and national conservation agencies of the Russian Federation, although these steps are not yet written into national conservation plans or work plans under international agreements.

During the Heilongjiang Forest Industry Bureau reform in 2004, the Hebei Forest Industry Group was divided into the Forest Industry Group (enterprise) and the Department of Natural Resources DNR (quazi-government agency). The DNR includes a Wildlife Protection Division, a new institution that needs guidance and support for developing an appropriate framework and capacity for its wildlife conservation work.

According to the 2005-2010 plan for nature reserve development, the Heilongjiang government plans to establish only one more nature reserve in Jiayin District. This would be on the Amur-Heilong River bank across from Khingganskу Nature Reserve, reportedly to protect the floodplain wetlands. However, this plan does not take into consideration lands managed by the Heilongjiang Forest Industry Bureau, which make up more than 70 percent of the area in question (Hejiang and Yichun Forest Industry Sub-bureaus within 100 kilometer vicinity of the Hinggan Gorge). The Forest Industry Bureau manages much richer forests that are more threatened by current logging operations.

Tasks ahead

The objective for future work in this area is to safeguard this most threatened reach of the Amur-Heilong valley by promoting ecosystem conservation and sustainable development, and improving global recognition of resource and site values.

An international ecological network of protected areas, or an international conservation area in Hinggan Gorge, must be designed and established to ensure long-term conservation of the Small Hinggan Forest Ecosystem. First of all this means that just adding to the list of already existing PAs under fragmented management is unlikely to be the best way to proceed further. Larger-scale conservation planning for transboundary Small Hinggan ecosystem is needed, that explicitly takes into account role of various protection measures in ensuring connectivity and viability within larger remnant mixed-broadleaf forest ecosystem. Special attention should be paid to migration patterns of large mammal populations and long-term availability of breeding areas for endangered species. Critical link between forest tracks adjacent to riverbanks and those up in the mountains should be explored and addressed in this design. Future management, if not fully unified, should be still guided by commonly designed scheme for conservation of entire landscape, rather than on partial objectives related to particular small sites.

To improve protection of endangered flora and fauna (brown bear, scaly-sided merganser, Korean pine, salmon) technical and financial assistance should be provided to local governments and forest industry bureaus for upgrading management and enforcement capacities.

Effective conservation is impossible without introducing more sustainable approaches to natural resource utilization and cross-border commerce (including tourism). Placer-mining should be banned on the left bank of Amur, as it is already banned in China, and replaced by more sustainable land-uses. The local Russian population should be trained to use beneficial economic cooperation opportunities, and to rely less on rent from exploitation and export of nature resources by Chinese companies. Protected areas will not do the job and largely will remain on paper, unless right incentives are created to improve local resource-use policies and practices in Small Hingan transboundary area. Although there are many important specific aspects to be improved, the overarching objective is to put ecologically sustainable development sufficiently high on local agenda of transboundary cooperation. Replacing transboundary gold mining with international tourism is an example of change that should be achieved.

Hinggan Gorge is virtually unknown and it is important to promote values of the site nationally and internationally by means of mass-media, organizing high-profile events and campaigns, supporting world-class eco-tourism program, promoting site to international nominations, making Hinggan Gorge a world-renowned conservation site. The importance of these activities encompasses more than conservation and development in Hinggan Gorge. It serves the broader goal of promoting the shared conservation value of the Amur-Heilong River by using the most accessible and spectaclular reach as a symbol of conservation objectives that China and Russia can pursue together. Given the highest importance of the area both for conservation of freshwater ecosystems and broadleaf-coniferous forests, the site can be used as a representative for promotion of all important values to be protected in the Amur-Heilong basin.

Chapter 32

Case Study Number Two: Dauria International Protected Area (DIPA)

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The Russia-Mongolia-China Dauria International Protected Area (DIPA) was founded at the junction of the borders between Russia, Mongolia and China on 29 March 1994. Four specially protected nature areas of the three countries were combined to create DIPA:

- Daursky Zapovednik *(*state nature reserve) and Tsasucheisky Bor (forest nature reserve) under Zapovednik management in Chitinskaya oblast of Russia;
- Mongol Daguur strictly protected nature area in Dornod aimag of Mongolia, which borders on the Russian reserve;
- Dalai Nor National Nature Reserve in the Inner Mongolia Autonomous Region, China.

The creation of this trilateral protected area, consisting of functionally connected wetland and steppe habitats, was of special importance for biodiversity conservation in Dauria, particularly for the protection of migrant species of birds and mammals. Besides biodiversity and ecosystems conservation, the main target of the international protected area is monitoring of natural processes and phenomena in the Dauria steppe ecosystem.

Despite the differences in nature protection regimes and in the management and staff of the three areas, DIPA as a united international reserve has been a conservation success. Since the first years of DIPA's existence, the area was managed to promote cooperation, first in science and later in environmental education.

The first stage of the econet's development included a joint inventory of animals and plants within the reserves. During the twelve years since establishment, more than 300,000 km² of the region have been investigated by joint scientific expeditions. Surveys also covered the upper reaches of the Amur-Heilong basin from the Khentii to the Great Hingan Mountains. The total length of the expedition routes has exceeded 100,000 km. This enormous tri-national survey was a great opportunity to acquire data on biodiversity and distribution of rare species, define conditions of regional ecosystems, and also to select key areas for conservation of a number of species.

Dauria represents a narrowing of the transcontinental migratory flyways for birds. Thus, the region is globally important for conservation of a number of migratory and nesting birds. Among these are 30 species on the IUCN Red List (including globally rare or vulnerable), five species of cranes, swan goose, relict gull, and others (**Tables 4.12 and 4.13**). The most valuable and important data concerning conservation of individual species of birds were acquired for the white-naped, red-crowned, hooded, and demoiselle cranes, as well as swan goose.

The Ramsar Convention Bureau recognized the region's importance and listed the reserves comprising the DIPA as wetlands of international importance. All three reserves were listed. A current plan calls for the presentation of the international protected area as a united transboundary wetland. Other globally important areas have been identified, including the Argun (Erguna) and Huihe River floodplains, Lake Buirnuur, and Aginsky lake-steppe complex. All have special importance with respect to Ramsar Convention implementation (**see Part One Map 1.13 and Map 4.6**).

Another significant and model result of the joint work is research on the abundance, population structure, and geographic distribution in Dauria of the Mongolian gazelle. This enabled a set of recommendations for gazelle conservation in Mongolia and for their population recovery in Russia (Kiriluk, Goroshko, Kiriluk 2006).

Thorough analysis of the information obtained in joint scientific research revealed that ecosystem fluctuations and redistribution of animal populations are strongly correlated with periodic climate changes (see Box 1.1 in Part One and Chapter 24). During droughts the decrease in numbers of breeding great bustards on Mongolian steppes is accompanied by increases in forest steppes and forests of Transbaikalia. Increased numbers of nesting red-crowned cranes on the Argun River and their appearance on the Torey Lakes occurs together with decreases in numbers of nesting cranes in the Far East.

Table 4.12 Importance of Dauria ecoregion for conservation of some migrant birds species (after Goroshko 2006)

Species	Numbers of birds	Percent of birds migrating along East Asia-Australian Flyway
Grey plover (*Pluvialis squatarola*)	6,500	40
Lesser golden plover (*Pluvialis fulva*)	48,000	50
Wood sandpiper (*Tringa glareola*)	12,000	20
Red-necked stint (*Calidris ruficollis*)	150,000	32
Broad-billed sandpiper (*Limicola falcinellus*)	4,500	16

Table 4.13 Importance of Daurian ecoregion for conservation of some rare birds species (after Goroshko 2006)

Species	Number in the region	
	Number	Percent of world population
Swan goose (*Anser cygnoides*)	41,000	75
Great bustard (*Otis tarda dybowski*)	1,050	66
Demoiselle crane (*Anthropoides virgo*)	73,000	37
White-naped crane (*Grus vipio*)	1,400	29
Relict gull (*Larus relictus*)	2,430	20
Siberian crane (*Grus japonensis*)	275	13
Hooded crane (*Grus monacha*)	1,200	13
Asiatic dowitcher (*Limnodromus semipalmatus*)	300	2

Awareness of such climate-induced phenomena allows for a more objective estimate of the long term threats to the region's biodiversity. Such awareness also allows for more robust conservation planning. For example, with the beginning of the dry period, negative factors such as fragmentation of animal habitats and fires are of greater consequence. Disturbance of animals by people is also a greater concern due to increased competition for water. This situation is especially apparent in Mongolia where pastures are often situated near nesting areas of cranes and crucial parts of migratory routes of Mongolian gazelle are blocked by large numbers of yurts (portable homes used by nomadic herders).

Careful analyses of ecosystems and populations of rare species in relation to natural and anthropogenic factors enabled DIPA workers to propose a number of conservation measures. These included: (i) an interconnected multi-level regional network of protected areas; (ii) programs for conservation of critically threatened species, and (iii) integration of economic development planning with conservation planning to achieve sustainability.

In Russia, Mongolia, and China sites were identified for protection as strict nature reserves. When suggesting the category for the new reserves both biodiversity significance and socio-economic factors were taken into account. For example, increasing the area of buffer zones of the Daursky and Mongol Daguur reserves and of the transit zone of the Dalai Lake reserve was more practical and useful than enlarging the area of the core zone of the reserve. The main purpose of enlargement was to secure temporary migratory paths across a very large territory, which can be achieved through buffer zone management regulations just as easily with new core area. At the same time, with participation and assistance of DIPA personnel, new protected areas were founded. These are Aginskaya Steppe Zakaznik (Wildlife Refuge of regional importance in Russia) and Onon Balj National Park in Mongolia. Work to create a high-level protected area on Lake Buirnuur in Mongolia was under way in 2006, as was the planning for a Rus-


106°
51° 109°
112°
48°
45°
112°
45°
115°
R U S S I A
M O N G O L I A
CHITA
SUHBAATAR
BICHURA
KHILOK
KHILOK
YOROO
KRASNYY CHIKOY
CHIKOY
ULETY
KARYMSKOYE
Olengulskii
Argaleiskii
Alkhanai
Aginskiy Buryatskiy
Burkal'skii
INGODA
Akshinskii
DULDURGA
AKSHA
Aginskaya st
Sokhondinskii
Tov
Khan Khenti
KYRA
Gornaya step'
Mongol Daguur
TUUL
MONGONMORIT
BATSHIREET
Gorkhi-Terelj
Onon-Balj basin "A"
DADAL
BINDER
Onon-Balj basin "B"
ULDZ
ONON
CHULUUNHOROOT
Ugtam Uul
DASHBALBAR
BAYANDELGER
Hentiy
BAYANDUN
Dornod
BAYAN-ADRAGA
NOROVLIN
TSENHERMANDAL
OMNODELGER
GURVANZAGAL
Yakhi Nuur
BAYANJARGALAN
BERH
Toson hulslai
SERGELEN
Yahin Govi
TSAGAAN OVOO
MORON
ONDORHAAN
BAYAN-OVOO
DELGERHAAN
HOLONBUYR
KHERLEN
CHOYBALSAN(SOUM)
CHOYBALSAN
Khar yamaat
BAYANMONH
BAYANHUTAG
BULGAN
BAYANTUMEN
Kherlen Menem
DARHAN
TUMENTSOGT
Jaran Togoonr
BAYAN TSOGTO
GALSHAR
MONHHAAN
IHHET
SUHBAATAR
Dornod
Protected area types of CHINA:
Dalaihu
National nature reserve
Aershan
Provincial nature reserve
Weinahe
Provincial nature reserve
Moerdaoga
National forest park
Modamoji
District Nature Reserve
Halahahe
Planned protected areas
Protected area types of RUSSIA:
Zapovednik
(Strict scientific nature reserve)
Buffer zone of zapovednik
National Park
National wildlife refuge
Provincial wildlife refuge
Nature monument
Planned protected areas
Protected area types of MONGOLIA:
Strictly Protected Area
Buffer zone of strictly Protected Area
National Park
Nature Reserve
Kherlen Menem
Planned protected areas
Amur basin boundary
Country boundary
70 0 70 140 210 Kilometers

sia-China transboundary reserve on the Argun River floodplain. Goal-oriented action plans for the conservation of great bustard, swan goose, cranes, and Mongolian gazelle are currently being elaborated.

It is important to note that several new protected areas are being established in the border regions of the three basin countries. The gazettal of Onon Balj National Park and the Mountain Steppe Refuge on the Mongolia-Russia border are the first steps toward the establishment of a new transboundary protected area in the Onon basin named "Source of the Amur." The establishment of nature reserves on the Russia-China border (the Argun River floodplain) and the Mongolia-China border (Lake Buirnuur) — and their subsequent incorporation into DIPA -- will secure all three reserves of the international protected area with a single common boundary. This is of special importance for ensuring the conservation of a valuable natural ecosystesm and for establishing a single wetland, transboundary biosphere reserve based on protected areas in Russia, China, and Mongolia. Globally important biodiversity features along with a rich cultural history will make DIPA a viable applicant for trilateral World Heritage Site listing.

To construct a network of connected protected areas in Dauria it is especially important to consider the interaction between DIPA and other reserves of the region. This will enable the design

Map 4.6 Daurian steppe protected areas

of more intelligent research projects and more targeted environmental educational programs while promoting cooperation among the three countries. At present, joint activities in different fields bind the international protected area with Huihe National Nature Reserve and Sokhondinsky Zapovednik (Bioshere Reserve) in China and with Alkhanai National Park in Russia.

Cooperative environmental education in DIPA is one of the biggest advantages over a traditional piecemeal approach to protected areas. It is important not only for popularizing the protected area and raising the level of ecological awareness, but also for strengthening public relations between the neighboring regions of Russia, Mongolia, and China. Cooperative conservation education began with joint presentations in Mongolia and Russia to describe the reserves. International environmental art competitions were organized for children. These early steps laid a foundation for raising cooperation to a new level in the 21st Century. Examples of cooperative work now underway include the preparation and publication of jointly collected information in popular scientific editions, international environmental camps for children, seminars for protected area staff, the design of a joint web-site, and a base for the development of national and international ecological tourism.

Cooperative environmental education is closely tied to one task of DIPA as a biosphere reserve — facilitating sustainable regional development and reducing conflicts over natural resources. At present, only Daursky and Dalai Lake reserves are listed as UNESCO Man and the Biosphere reserves. The nomination of Mongol Daguur protected area to the network of UNESCO biosphere reserves is in process.

Socio-economic features of the border regions differ considerably in the type of settlements, economic structure, and living standards. Yet the three countries share many social and ecological problems that DIPA can help resolve by promoting ecological and educational tourism in the region. Today all three reserves have worked out excursions and tourist routes and have constructed visitor-centers. However, the standards of tourism infrastructure in the three countries and levels of state support for tourism enterprises vary widely. Several initiatives are intended to encourage sustainable development, including an international ornithological station, nurseries for rare animal species, and sustainable use programs within the biosphere reserve buffer zone. All are conceived as integrated components of DIPA.

Cooperation at DIPA is not the only story and we must touch also on transboundary tensions. The main problems are: (i) lack of state financing for international activities; (ii) communication problems (absence of translators from reserve payrolls); and (iii) difficulties in crossing the borders to work cooperatively in the border zones. This situation is due mostly to under-funding of international reserves as a special form of protected area by the national governments of the three basin countries.

Nevertheless, the 12-year history of DIPA convincingly demonstrates the benefits of and bright prospects for this form of international cooperation. As a complex nature-protection institution, DIPA can achieve numerous goals at regional, inter-governmental, and global levels.

This is true primarily for scientific research and monitoring carried out according to regional or global programs and protocols. Such programs are vital because of the reserve's position on the crossroads of migratory flyways of birds. The compilation of shared and comparable databases enables objective estimation of the conditions and trends of ecosystem change in relation to natural conditions as well as anthropogenic factors, all of which vary across the Dauria ecoregion. Using reliable transnational data obtained from these cooperative programs, qualified scientists can elaborate effective programs for regional restoration and conservation of biodiversity. This must lead to enhancement of the interconnected network of Dauria protected areas by including a range of stakeholders from education, commerce, and state and public agencies. One example of this is participation of DIPA personnel in regional, national and international working groups on biodiversity conservation such as the international working groups on swan goose and Mongolian gazelle, the Russia-China working group on the ecological condition of the Argun-Erguna River basin, the working group on conservation of landscape and biological diversity in the upper reaches of the Amur-Heilong River basin, and others.

Carrying out direct protection of natural complexes, DIPA works as a mechanism for implementation of international conventions and agreements adopted by the three basin countries, including the following conventions:

- Convention on Biological Diversity, or CBD;
- Ramsar Convention on wetlands of international importance especially as waterfowl habitat;
- UN Convention on the protection and use of transboundary watercourses and international lakes;
- Convention to combat desertification in countries experiencing serious droughts and/or desertification;
- Convention on the assessment of impacts on transboundary environments;
- Convention on the protection of the world cultural and natural heritage (the three counties supported the initiative for nomination of DIPA to the UNESCO List of World Nature Heritage),
- Seville strategy for biosphere reserves.

Having gained experience of international cooperation, DIPA occupies a central position in the organization of an effective system of interaction and collaboration of all nature reserves in the region.

Based on its role in scientific and environmental work, DIPA can be a powerful educational and cultural center, in particular, as an international scientific station and a base for field training of students.

At the same time, international protected area arrangement, however fruitful, cannot alone ensure full preservation of Dauria steppe and wetland ecoregion in its entirety. For example, water transfers from the Haila'er/Argun, Kherlen, Khalkh and Onon Rivers proposed since 2003 by China and Mongolia are likely to negatively affect wetland ecosystems throughout Dauria. DIPA staff can assist research on possible environmental impacts of water transfers on biodiversity, but transboundary water resource management lies far outside its realm of responsibilities. This example clearly demonstrates that securing of sufficient ecological linkages necessary for ecosystem conservation and resource management is an issue that should be resolved through ecological network planning. Management of transboundary river and lake basins is the responsibility of water management agencies rather than of protected area management units. To overcome this potential barrier to integrated basin management, present and future agreements on transboundary waters in the dry Dauria ecoregion should be fully coordinated with ecological network development. The rich and unique research data produced by DIPA should be fully considered when making management decisions that affect biological resources by altering hydrologic regimes.

Appendix One: Abbreviations

AAC Annual Allowable Cut

ABAR Aginsky Buriatski Autonomous Region

ABWMA Amur Basin Water Management Authority

ADB Asian Development Bank

AHEC Amur-Heilong Ecoregional Complex

AHGB Amur-Heilong Green Belt

ARBCC, ACC, ACCSD Amur River Basin Coordination Committee on Sustainable Development

ARIM (IMAR) Innner Mongolia Autonomous Region

BOD Biochemical oxygen demand

CAE Chinese Academy of Engineering

CAP Conservation Action Plan

CBD Convention on Biodiversity

CITES Convention on International Trade in Endangered Species

COD Chemical oxygen demand

CSP Country Strategy Program

CTEC Committee on Trade and Economic Cooperation

DIPA Dauria International Protected Area

EA Executing Agency

EAP Evreiskaya Autonomous Province

ECAPRFE Ecoregional Conservation Action Plan for the Russian Far East Ecoregional Complex

EIA Environmental impact assessment

EMP Environmental monitoring plan

EPB Environmental Protection Bureau

EPT Environmental Policy and Technology Project (funded by USAID)

ERBC Ecoregion-based conservation

FAO Food and Agricultural Organization of the United Nations

FDHP Forestry Department of Heilongjiang Province

FEBRAS Far Eastern Branch of the Russian Academy of Sciences

FLEP Federal Law of Environmental Protection (Russia)

FSC Forest Stewardship Council

GDP Gross Domestic Product

GEF Global Environment Facility

GEF-PDF Global Environment Facility-Project Development Fund

GFTN Global Forest and Trade Network

GIS Geographic information system

GOC Government of China

GPS Global positioning system

HCVF(s) High Conservation Value Forest(s)

HDRC Heilongjiang Development & Reform Commission

HEPB Heilongjiang Environmental Protection Bureau

HFB Heilongjiang Forestry Bureau, presently Forestry department of Heilongjiang Province

HFD Heilongjiang Financial Department

HLJ Heilongjiang Province of China

HPG Heilongjiang Provincial Government

IBA Important Bird Areas

ISAR Initiative for Social Action and Renewal in Eurasia

ISC Institute for Sustainable Communities

IRBM Integrated River Basin Management

IUCN International Union for Conservation of Nature and Natural Resources; now World Conservation Union

IWEP Institute of Water and Environmental Problems (Khabarovsk, Russia)

JAP Jewish Autonomous Province (equivalent to EAP)

masl meters above sea level

MoA (China's) Ministry of Agriculture

MONE Ministry of Nature and Environment (Mongolia)

MNR Ministry of Natural Resources (Russia, at federal level)

MNRU Ministry of Natural Resource Use (Russia, at province level)

MWR (China's) Ministry of Water Resources

NEC Northeast China (refers to Heilongjiang, Jilin, Liaoning provinces and Eastern part of Inner Mongolia.)

NGO(s) Non-Government Organization(s)

NR Nature Reserve

NNR National Nature Reserve

NRNNR Naoli River National Nature Reserve

NSO National Statistical Office of Mongolia

NTFP Non-timber forest products

NWCAP National Wetland Conservation Action Plan

OECF Overseas Economic Cooperation Fund (Japan)

PA(s) Protected Area(s)

PERC Pacific Resource and Environment Center

PRC People's Republic of China

RAS Russian Academy of Sciences

RF Russian Federation

RFE Russian Far East

RFE ECAP Ecoregion Conservation Action Plan for Russian Far East Ecoregional Complex (ECAP RFE-2003)

RMB Reminbi (Chinese currency also known as Yuan)

RWE round-wood equivalent

ROLL Replication of Lessons Learned (grants program funded by USAID)

SAPROF Special Assistance for Project Formation (Integrated Agriculture Development Project for State Farms in Heilongjiang Province)

SCFNR Service for Control in the Field of Natural Resources (Russia)

SDRC State Development and Reform Commission

SEPA State Environmental Protection Administration

SEU Socio-Ecological Union

SFA State Forestry Administration

SNTEC Service for Nuclear, Technological and Environmental Control

SOE(s) State-owned enterprise(s)

SPNA System of Protected Nature Areas

SWRC Song-Liao Water Resource Commission

TA Technical assistance

UNDP United Nations Development Programme

UNEP United Nations Enironment Programme

UNESCO United Nations Educational, Scientific and Cultural Organization

USAID United States Agency for International Development

USD Unites States Dollars

VOOP All Russian Society for Nature Conservation

WB World Bank

WCD World Commission on Dams

WCS Wildlife Conservation Society

WWF World Wide Fund for Nature

WWF-RFE World Wide Fund for Nature Russian Far East (from 2007 WWF Russia-Amur Branch)

ZT Zov Taigi

Appendix Two: References

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Appendix Three: Glossary

Usage in the text	English synonyms	Russian	Chinese	Mongolian	Definition/clarification/
Administrative terms					
autonomous region	autonomous okrug, autonomous province	Автономная область, автономный округ (avtonomnaya oblast, avtonomnyi okrug)	自治区/zizhi qu	Өөртөө засах орон Oortoo zasax oron	an autonomous province-level administrative unit in China and Russia established to provide autonomy to predominant ethnic minorities
city	prefecture	Город	市/shi	Хот Xot	China: administrative unit under a province that includes a large, prominent urban area and a surrounding sub-urban or rural area. Russia and Mongolia: large urban center
county	district,	Район (rajon)	县/xian	ДҮҮрэг Diireg	administrative unit under a province or city in China (same as "district"), called “banner” in Inner Mongolia.
district	county, banner (IMAR)	Район, уезд (rajon)	区/qu		administrative unit under a city in China, and under province in Mongolia and Russia
national		Государственный	国家级/guojiaji	Улсын Ulsiin	pertaining to national level of government
federal	national	федеральный	国家级/guojiaji		an entity at national (federal or state) level in Russian Federation
forest industry bureau		Леспромхоз (lespromkhoz)	森工总局/ sengongzongju		agency responsible for commercial forest management in China
local		Местный	地方/difang	Орон нутгийн/ бҮс нутгийн Oron nitgiin/bus nutgiin	any level lower than nation or state
leskhoz	forest farm	Лесхоз	林场/lingchang		
prefecture	city, league (IMAR)	Префектура, округ	市/盟/shi/meng		equivalent to a "city" in China, administratively below a province and above county/diistrict,called “league” in Inner Mongolia
province	region	Край, область, республика (krai,oblast, respublica)	省/sheng	Аймаг Aimag	An administrative division in basin countries immediately below national or federal level. In China and Russia other names are used for administrative divisions that are also ranked at province level. These include autonomous region, municipality, and special adminstrative region. In Russia the terms autonomous region and oblast also designate administrative divisions at province level.
province forestry bureau		Провинциальное управление лесного хозяйства	省林业局/sheng linyeju	Иргэдийн төлөөлөгчдийн хурал Irgediin toloologchdiin xural	province-level agency in China for administration of forests and conservation, and reporting to the government of the province and to the State Forest Administration in Beijing
provincial people’s congress		Законодательное собрание провинции	省人大/sheng renda		province-level congress subordinate to the National Peoples Congress or (Renmin Daibiao Dahui), the highest legislative body in China; the highest legislative body in each province
region		Область, Oblast	区域/州/zhou/ quyu		province-level administrative unit (as in “autonomous region”)
township		Город районного подчинения	镇/zhen		administrative unit under a county (district)
village		Сельский округ, село	乡/村/xiang, cun		administrative unit under a township

Usage in the text	English synonyms	Russian	Chinese	Mongolian	Definition/clarification/
Technical conservation terms					
biodiversity		биоразнообразие, биологическое разнообразие	生物多样性; shengwu duoyangxing	Биологийн төрөл зүйл Biologiin torol zuil	The variability among living organisms, including the variability within and between species and within and between ecosystems
biodiversity conservation		природоохранная биология, биология охраны природы	保护生物学	Биологийн төрөл зүйлийн хамгаалалт Biologiin torol zuiliin xamgaalalt	
biosphere		биосфера	生物圈	Шим мандал Shim mandal	
biological monitoring		биомониторинг, биологический мониторинг	生物监测	Биологийн төрөл зүйлийн байнгын ажиглалт Biologiin torol zuiliin baingiin ajiglalt	
coniferous forest		хвойный лес	针叶林	Шилмүүст ой Shilmuust oi	
deciduous broad leaf forest		широколиственный лес	温带落叶阔叶林	өргөн навчит ой Orgon navchit oi	
disturbance		фактор беспокойства	干 扰		
ecological flow		экологический попуск	生态流量\shentgai liuliang		minimum level or volume of river flow needed to sustain aquatic ecosystems
ecological carying capacity		экологическая емкость	生态容纳量	Экологийн даац Ekologiin daats	
ecological balance		экологический баланс, экологическое равновесие	生态平衡	Экологийн тэнцвэр Ekologiin tentsver	
ecological restoration		восстановление экосистем	生态恢复	Экологийн нөхөн сэргээлт Ekologiin noxon sergeelt	
ecoregion		экорегион	生态区域	Экобүс нутаг Eko bus nutag	A large area of land or water that contains a geographically distinct assemblage of natural communities that (a) share a large majority of their species and ecological dynamics; (b) share similar environmental conditions, and; (c) interact ecologically in ways that are critical for their long-term persistence.
environmental standard		экологические нормативы, экологические стандарты	环境标准	Байгаль орчны стандарт Baigali orchnii standart	
eutrophication		эвтрофикация	富营养化		
extinction		вымирание, исчезновение	绝 灭	Зүйл устаж үгүй болох Zuil ustaj ugui bolox	
flood period		Период паводка\ период затопления\ сезон паводка\сезон наводнения	汛期	Шар усны/үер усны улирал Shar usnii/uyer usnii uliral	

Usage in the text	English synonyms	Russian	Chinese	Mongolian	Definition/clarification/
geographic information system; GIS		ГИС- географическая информационная система	地理信息系统	Газар зүйн мэдээллийн систем Gazar zuin medeelliin sistem	
grassland		травянистая экосистема	草地	Бэлчээр нутаг Belcheer nutag	a landscape dominated by grasses
greenbelt		зеленый пояс	绿化带	Ногоон бүс Nogoon bus	a protective belt of natural or planted vegetation
habitat fragmentation		фрагментация ландшафта	生境破碎化	Ландшафтын тасарч хуваагдах үзэгдэл Landshaphtiin tasarch xuvaagdax uzegdel	
hydrobiont, aquatic organism		Гидробионты, водные организмы	水生生物	Усны амьд биет Usnii amid biyet	
habitat		местообитание	生　境	Амьдрах орчин Amidrax orchin	
local population		местная популяция	居　群	Орон нутгийн популяци Oron nugtiin populyatsi	
pollutant		загрязняющее вещество, поллютант	污染物	Байгалийн бохирдол Baigaliin boxirdol	
Ramsar Convention		Рамсарская Конвенция	国际湿地公约	Рамсарын бүс нутаг Ramsariin bus nutag	international convention for designation and protection of wetlands and associated wildlife and wetlaнынd functions
river mouth		устье реки, дельта реки	河口		
sediment		отложения, осадок	沉积物	Тунадас Tunadas	
species diversity		Видовое разнообразие	物种多样性	Зүйлийн olon зүйл Zuiliin olon zuil	
steppe		степь,травянистые сообщества умеренного пояса , грассланд(умеренного пояса)	草地高原	Тал Tal	plateau grassland
temperate grassland	steppe	степь,травянистые сообщества умеренного пояса , грассланд(умеренного пояса)	温带草原		
tundra		тундра	冻　原	Цармын бүс Tsarmiin bus	
wastewater treatment		очистка сточных вод	废水处理		
water pollution		загрязнение вод	水污染	Усны бохирдол Usnii boxirdol	
water quality analysis		анализ качества воды	水质分析	Усны чанарын шинжилгээ Usnii chanariin shinjilgee	
watershed	catchment, basin	бассейн, водосбор	流域	Голын сав газар Goliin sav gazar	drainage basin

Usage in the text	English synonyms	Russian	Chinese	Mongolian	Definition/clarification/
Protected area terminology					
nature reserve management bureau	zapovednik (national park) management bureau	Дирекция заповедника(нацпарка, заказника)	保护区管理局/ baohuqu guanliju	Тусгай хамгаалалттай нутгуудын удирдлагын газар Tusgai xamgaalalttai nutguudiin udirdlagiin gazar	agency responsible for management of a given nature reserve
protected area administration	PA directorate	Дирекция ООПТ	保护区处/ baohuquchu	Тусгай хамгаалалттай газруудын хамгаалалтын захиргаа Tusgai xamgaalalttai gazruudiin xamgaaltiin zaxirgaa	office established by a conservation authority responsible for administration of protected areas subordinate to this agency (all countries)
system of protected areas		Система ООПТ	自然保护区体系/	Тусгай хамгаалалттай газар нутгуудын сүлжээ Tusgai xamgaalalttai gazar nutguudiin suljee	protected areas unified administratively and sometimes by a conservation theme (e.g. wetland protected areas within a given river basin)
ecological network	econet	Экосеть, экологическая сеть, эконет	自然保护区网络		A group of important conservation sites that belong to same ecological zone, are linked administratively and managed to some extent as an integrated unit
water protection forests		Водоохранные леса	保护水林/ baohushuilin		forests protected under forest management regulations because of their role in water conservation
local protected area	local nature reserve	Местные ООПТ	县级保护区/xianji baohuqu	Орон нутгийн хамгаалалттай газар Oron nutgiin xamgaalalttai gazar	a county-level nature reserve
nature reserve	protected area	Природный резерват, ООПТ	自然保护区/ ziranbaohu qu	Байгалийн нөөц газар Baigaliin noots gazar	nature conservation area wholly or partially closed to the public
protected area-PA	nature reserve, wildlife refuge	ООПТ –особо охраняемая природная территория	自然保护区/ ziranbaohuqu	Дархан цаазат газар Darxan tsaazat gazar	an area of land or water or both designated for nature conservation
seed (production) forest		Семенной лес	母树林/mushulin		area of mature forest protected to provide seed material (e.g. Korean pine)
natural forests		Естественные леса	天然林/tianranlin		China: Forests of natural origin that are protected and subsidised by government because of important ecological functions they provide. Often fall into categories of ecological function forests in China.
ecological function forests			生态林/shengtai lin		China: Forests that are protected because they provide important functions such as protection of water supplies, protection of fisheries, or prevention of erosion in china
Group I Forests		Леса первой группы	一级保护林区		Russia: forests where logging is restricted due to high ecological, social, resource-protection or other significance

Usage in the text	English synonyms	Russian	Chinese	Mongolian	Definition/clarification/
Russia protected area types					
Zapovednik (Strict Scientific Nature Reserve)	strict scientific nature reserve, national nature reserve	заповедник	严格自然保护区	Дархан цаазат газар Darxan tsaazat gazar	State-level organization that holds title to its land and meets IUCN category Ia or Ib criteria for management objectives prescribed by law. Mostly consists of strict protection zone and zapovednik management bureau, that has patrolling, research and environmental education staff.
Zapovednik buffer zone		Охранная зона заповедника		Дархан цаазат газрын Орчны бүс нутаг Darxan tsaazat gazriin Orchnii bus nutag	In Russia PA law prescribes formation of a buffer zone around zapovdnik with restrictions imposed on land-use (regime similar to zakaznik described below but normally much better enforced due to presence of on-site staff)
national park		Национальный парк	国家公园guojia gongyuan	Байгалийн цогцолборт газар Baigaliin tsogtsolbort gazar	National park system started in the 1970s as a part of the Forest Service and combined conservation and recreational objectives with limited forestry. Each national park has on-site staff and complicated zoning regulations. NP management bureau normally holds title only to core zone and some other areas, but also controls lands owned by other landholders.
national wildlife refuge	zakaznik	Федеральный заказник	禁猎区(保护区)		Zakazniks (refuges/nature reserves to protect zoological, botanical, or landscape features, or in some cases a combination of these features). Evolved from temporary refuges established to replenish wildlife populations. The most flexible and diverse type of PA; established either by federal, or more frequently, by provincial government. Established to protect natural features and prevent ecosystem fragmentation, restore rare species populations and preserve attractive scenery. Land titles are usually not withdrawn from landowners, tenants or users (forestry enterprises or farms) in zakazniks, but conservation restrictions are imposed on land-use. Federal zakazniks normally staffed with 2-3 patrolling officers (game keepers), but not necessarily true for provincial zakazniks presently managed by some branch of province govenment.
provincial wildlife refuge	zakaznik	Заказник регионального значения	省级禁猎区		see above
nature monument (national, provincial, local)		Памятник природы (федерального, областного или районного) значения	自然保护小区	Байгалийн дурсгалт газар Baigaliin dursgalt gazar	PA established to protect geological,zoological, botanical, or landscape features of examplary nature on limited acreage, are established either by the federal government or by national,provincial or even district authorities
nature park		Природный парк	省级自然公园		PAs established by provincial administrations, that besides biodiversity value, have some scenic value for tourism.
botanical park/ garden/ arboretrum		Ботанический сад, дендропарк	植物园	Ботаникийн хүрээлэн Botanikiin xureelen	Also are protected areas according to Russian PA Law

Usage in the text	English synonyms	Russian	Chinese	Mongolian	Definition/clarification/
nature resort (healing landscape)		Лечебно-оздоровительная местность, курорт	疗养区		Nature resorts (typically beaches or mineral springs) have separate management system dictated by the needs of institutions and clients using them for medical and recreational purposes.
Liaoning Province		Провинция Ляонин	辽宁省/Liaoning Sheng		the only coastal province of northeast China; capital city is Dalian
pine-nut production groves	cedar-seed production zone	Орехопромысловая зона	母树林/mushulin		area protected from logging under Russian forestry regulations to ensure sustained yield of cedar nuts from Korean Pine or Siberian Cedar-Pine.
sanitary protection zone		Зона санитарной охраны	卫生保护地		a no-access or limited-use zone around reservoir supplying drinking water in Russia
water protection zone		Водоохранная зона	水源保护地		a zone with restricted land-use established along a river, lake or other water body according to water management laws and regulations.
ecological corridor		Экологический коридор	生态走廊	Экологийн шилжилтийн бүс нутаг Ekologiin shiljiltiin bus nutag	PA connecting important ecological areas to secure migration, exchange of genetic resources or other important movement of biological species/ In Russian Far East only Khabarovsk province explicitly defines such PA type in provincial legislation.
wetland of provincial importance		Водно-болотное угодье областного значения	省级保护湿地		new PA category established in Amurskaya oblast in Russia
territory of aboriginal land-use	traditional land-use territories	Территория традиционного природопользования			areas where land-use restrictions are imposed to provide for traditional lifestyles of aboriginal hunters, fishers, gatherers
China protected area types					
nature reserve	nature reserve, protected area	Национальный (государственный) природный резерват	自然保护区	Байгалийн нөөц газар Baigaliin noots gazar	The most common PA management category in China, established for a variety of purposes at national, provincial, prefectural, and county (district) levels. Has three management zones: (i) core area with no use but research and conservation; (ii) buffer zone where collection, measurements, management and research is permitted; and (iii) experimental zone where scientific investigation, public education, tourism and raising of rare and endangered wild species are permitted. Protection objectives include: (i) natural ecosystems (forest ecosystem, grassland ecosystem, desert ecosystem, inland wetland and watershed ecosystem, ocean and coast ecosystem); (ii) wild animal protection; (iii) wild plant protection; and (iv) natural monuments (geological formations and paleontological)
province level nature reserve		Природный резерват провиницального значения	省级自然保护区/ shengji baohuqu		see above
national (local) forest park		Национальный лесной парк	国家级森林公园		a PA type established for recreational purposes in China under Forestry Administration at national level
local forest park		Региональный лесной парк	森林公园		a PA type established for recreational purposes in China under Forestry Administration at provincial level

Usage in the text	English synonyms	Russian	Chinese	Mongolian	Definition/clarification/
Ecological Function Conservation Areas (EFCAs).		Резерват охраны экологический функций ландшафта	生态功能保护区/ shengtaigongneng baohuqu		These are large areas that, by design, include settlements and a wide range of human activities, and often overlie existing NRs. The aim is to provide coherent guidance to land use across critical ecological zones with important biodiversity and ecological processes
scenic landscape and historic site		Природные и исторические достопримечательности	风景名胜区	Байгалийн болон түүхийн дурсгалт газар Baigaliin bolon tuuxiin dursgalt gazar	a recreational or educational site designated for protection of landscape or historic resources but typically lacking management personnel or infrastructure, and not governed by national legislation or regulation
Mongolia protected area types					
strictly protected srea (SPA)		Резерват строгой охраны	严格自然保护区	Дархан цаазат газар Darxan tsaazat gazar	Wilderness areas with high scientific value. PAs divided into: pristine zone (nothing but research allowed), protected zone (conservation-related activities also allowed,), Limited use zone(tourism, religious ceremonies, plant collection allowed). Hunting, logging and construction prohibited
buffer zone of SPA		Охранная зона	缓冲区	Орчны бүс нутаг Orchnii bus nutag	Strictly protected areas of Mongolia often have outer buffer zone designated to protect larger landscapes and linkage between protected areas. Restrictions on land-use are minimal and normally not enforced.
national park		Национальный парк	国家公园	Байгалийн цогцолборт газар Baigaliin tsogtsolbort gazar	Areas with natural, cultural, educational values. NPs divided into core areas (conservation and research allowed), ecotourism zone (tourism and related activities allowed), limited use zone (also allow grazing, and construction with NP's permission)
natural reserve	nature reserve	Природный резерват	自然保护区	Байгалийн нөөц газар Baigaliin noots gazar	Could fall into ecosystem, biological, paleontological and geological categories. NRs allow for economic activities that do not harm values under protection.
natural monument		Памятник природы	风景名胜区	Байгалийн дурсгалт газар Baigaliin dursgalt gazar	NM protect unique landscapes, cultural sites, sight-seeing attractions. Allow for many activities non-conflicting with protection objectives
Place names, geographic names, cultural terms & names					
Aginsky-Buryatsky Autonomous Region		Агинский-Бурятский Автономный округ	阿加布里亚特自治区		Province on Russian Federation, populated by Buriat minority. After referendum in 2007 will be mered with Chitinskaya province to form Zabaikalsky Krai
Amgun River		Амгунь	阿姆贡河		river in Khabarovksy Province, Russia formed by the confluence of the Ayakit and Suduk Rivers; left bank tributary of the Amur-Heilong River
Amur Estuary		Amursky Liman	黑龙江和口/ Heilongjiang hekou		mouth of the Amur-Heilong River at the Sea of Okhotsk
Amur River		Амур	黑龙江/ Heilongjiang	Хара Мурен\ Амар морон	see Heilong River

Usage in the text	English synonyms	Russian	Chinese	Mongolian	Definition/clarification/
Argun River		Аргунь	额尔古纳河/ Eergunahe		a Russia-China border river on the Inner Mongolia-Russia border; the southern of two main tributaries whose confluence near the boundary between Inner Mongolia and Heilongjiang Provinces forms the Amur-Heilong River
Arsenievka River		Арсеньевка	Daubihe		Principal tributary to upper Ussuri-Wusuli River in Russia
Bikin River		Бикин	比金河/Bijinhe		right-bank tributary of the Wusuli-Ussuri River on the border of Khabarovsky and Primorsky Province in Russia
Bolon Lake		Болонь	博隆湖		large lake connected to Amur main channel in Khabarovsky Province
Bolshaya Ussurka River		Большая Уссурка	伊曼河/Yimanhe		right-bank tributary of the Wusuli-Ussuri River in Primorsky Province
Buir Lake		Буирнур	贝尔湖/Beierhu	Буйр нуур Buir nuur	large freshwater lake on Mongolian-Chinese border.Lake area of 615 km2; largest freshwater lake in eastern Mongolia Ramsar site no. 1377 in Dornod Province of Mongolia covering 104,000 ha; ;
Bureya River		Бурея	布列亚和		left-bank tributary of the Amur-Heilong River whose source is the Bureinsky Mountains of Khabarovsky Province
Chitinskaya Province	Chita Province	Читинская область	赤塔州		Russian province in South-East Siberia occupying Eastern Transbaikalia. Contains important headwaters/tributaries of Amur, Lana rivers and Lake Baikal. Chita city is the province seat.
Dalai Lake	Hulun Lake	Далайнор	呼伦湖, 达赉湖/ Hulunhu, Dalaihu,	Далай нуур Dalai nuur	large brackish lake in China portion of Daurian ecoregion. Site of a Man and the Biosphere Reserve in north-eastern Inner Mongolia; a Ramsar site
Dauria		Даурия	达乌尔区域	Дагуур Daguur	In Russia also called “Transbaikalia”, the region of 1 million km2 extending eastward 1000 km from Lake Baikal to the confluence of the Shilka and Argun Rivers and from the Patomskoye Plateau and North Baikal Plateau southward to the national border of the Russian Federation
Great Hinggan Mountains		Большой Хинган	大兴安岭/ Daxing'anling	Их Хянганы нуруу Ix Xyanganii nuruu	the dominant mountain range in eastern Inner Mongolia, extending for 900 km, aligned north to south, and forming the western boundary of the Nen River basin in western Heilongjiang Province
Guangdong Province		Гуандун	广东省/ Guangdong Sheng		A coastal south China province
Heilong River		Амур (Amur River)	黑龙江/ Heilongjiang	Хара Мурен\ Амар морон	The 4,444 km long river draining the world’s 11th largest river basin area which covers parts of Mongolia, Russia, China, and discharges to the Sea of Okhotsk
Heilongjiang Province		Провинция Хейлунцзян	黑龙江省/ Heilongjiang Sheng		China’s northeastern most province
Hulunbeier	Hulunbuir	Хулунбуир	呼伦贝尔市/呼伦贝尔盟		Prefecture (city) in northeast Inner Mongolia bordering Chitinskaya Province in the North and Mongolia in the west. Named after Hulunhu (Dalai lake) and Buir lake, which are two most prominent waterbodies of Daurian steppe. Hailar city is the prefecture seat.

Usage in the text	English synonyms	Russian	Chinese	Mongolian	Definition/clarification/
Huma River		Хума, Кумара	呼玛河/Humahe		Right -bank tributary of Amur-Heilong, originating in Great Hinggan Mountains in China
Inner Mongolia Autonomous Region		Автономный Округ Внутренняя Монголия	内蒙古自治区/Nei Menggu Zizhiqu	Өвөр монголын өөртөө засах орон Ovor mongoliin oortoo zasax oron	China's northernmost central province-level administrative division. Its four easternmost prefectures historically and geographically belong to Dongbei (Northeast China).
Jilin Province		Провинция Цзилин (Гирин)	吉林省/Jilin Sheng		One of 33 province-level administrative divisions in China, part of northeast China, includes sources of Songhua River
Khabarovsk		Хабаровск	哈巴罗夫斯克,伯力/Baili		capital city of Khabarovsky Province, Russia
Khanka Lake		Озеро Ханка	兴凯湖/Xingkai Hu		transborder lake, Ramsar site, and nature reserve in upper Wusuli/Ussuri River basin on the Russia-China national border between Primorsky and Heilongjiang Provinces
Khenty Mountains		Горы Хенти		Хэнтийн нуруу Xentiin nuruu	mountain range in north-west part of ARB
Kherlen River		Керулен	克鲁伦河/Kelulunhe	Хэрлэн гол Xerlen gol	originates in Mongolia and flows to Dalai Lake in Inner Mongolia;
Khor River		Хор	霍尔河	Бага Хянганы нуруу Baga Xyanganii nuruu	right-bank tributary of the Wusuli-Ussuri
Small Hinggan Mountains	Lesser Hinggan Mountains	Малый Хинган	小兴安岭/Xiaoxing'anling		north-south mountain range extending from Evreiskaya Autonomous Province southward to central Heilongjiang Province
Liaoning Province		Провинция Ляонин	辽宁省/A28Liaoning Sheng		the only coastal province of northeast China; capital city is Dalian
Luobei County, Hegang Prefecture		Уезд Луобей, Префектура Хэган	罗北县,鹤岗市/Luobei, Hegang Shi		one of two counties and six districts that constitute Hegang Prefecture, whose northeast border is shared with Russia along the Heilong River
Malyi Khingan, Sutarsky, Pompeevsky ridges	Lesser Hinggan Mountains	Малый Хинган, Сутарский, Помпеевский хребты.	小兴安岭/Xiaoxing'anling		Continuation of Lesser Hinggan Mountains in Evreiskaya Autonomous Province of Russia
Manchuria	North-east china	Манжурия	东北/Dongbei	Манжуур Manjuur	historic western name of the northeast region of China, normally considered to include northeast Inner Mongolia, Heilongjiang, Jilin, and Liaoning Provinces
Mudan River		Река Муданцзян	牡丹江/Mudanjiang		a southeast Heilongjiang Province river and right-bank tributary of the Songhua River, flowing from Jingpo Lake northward; also one of 12 prefecture-level cities in Heilongjiang Province (Mudanjiang Shi)
Mulin River		Река Мулинхэ	穆棱河/Mulinghe		a left-bank tributary of the Wusuli-Ussuri River in Heilongjiang Province
Mutnaya River		Река Мутная			river historically connecting Lake Dalai and Argun river in Inner Mongolia, destroyed by Zhalainuoer coal mine and replaced by Xinkaihe canal in the 1960s.
Naoli River		Река Наолихэ	达兰鄂罗木河/Dalaneluomuhe		a left-bank tributary of the Wusuli-Ussuri River in eastern Heilongjiang Province

Usage in the text	English synonyms	Russian	Chinese	Mongolian	Definition/clarification/
Nen River		Нонни	嫩江/Nenjiang		the northern of two tributaries whose confluence upstream from Harbin in Heilongjiang Province forms the Songhua River (the southern tributary being the Second Songhua River, whose source lies in Jilin Province)
Niu'erguxiao River		Река Нюергусяо	Niu'erguxiaohe		a river near the northeast tip of the Sanjiang plain
Onon River		Онон	鄂嫩河/Enenhe	Онон гол Onon gol	right-bank tributary of the Shilka River; originates on eastern slope of Khentii Mountain; flowing from Mongolia into Russia
Orshun River		Оршун	乌尔逊河	Оршуун гол Orshuun gol	a tributary of Dalai Lake
Sanjiang plain	Three Rivers plain	Равнина Санцзян, Трехречье	三江平原/Sanjiang pingyuan		floodplain area at the confluence of the Amur-Heilong, Songhua, and Wusuli-Ussuri Rivers located at the northeastern most tip of China
Second Songhua River		Вторая Сунгари	第二松花江/Di'er Songhuajiang		the southern of two tributaries whose confluence upstream from Harbin in Heilongjiang Province forms the Songhua River; its source lies in Jilin Province
Shilka River		Шилка	石勒喀河/		the northern of two tributaries whose confluence with Argun River on the Russia-China border near the boundary between Inner Mongolia and Heilongjiang Provinces forms the Amur-Heilong River,
Siberia		Сибирь	西伯利亚	Сибирь Sibiri	vague geographic term for Asian part of Russia east of Ural Mountains. In Russia normally distinguished from Russian Far East lying east of it, with Chitinskaya Province and Republic of Buriatia being easternmost provinces in Siberia. Administratively is covered by Siberian Federal District.
Songacha River		Сунгача	松阿察河/ Song'achahe		a left-bank tributary of the Wusuli-Ussuri River originating at Lake Khanka-Xingkai
Songhua River		Сунгари	松花江/ Songhuajiang		the largest right-bank tributary of the Amur-Heilong River, Inner Mongolia, Jilin, and Heilongjiang Provinces
Northeast China Plain		Северо-восточная Китайская Равнина	东北平原/Dongbei Pingyuan		the Song-Nen (Songhua and Nen Rivers) plain combined with adjacent plains in Liao river basin.
Song-Nen plain		Равнина Сун-Нонни	松嫩平原/Song-Nen pingyuan		lowlands in Inner Mongolia, Heilongjiang, and Jilin Provinces on the floodplain of the Nen and Songhua Rivers; bounded on the northwest by the Greater Hinggan range, on the northeast by the Lesser Hinggan range, on the east by the Zhangguangcai range, and on the south by the Changbai range
Stanovoy Range		Становой Хребет	外兴安岭/Wai Xing'anling		a mountain range in Russian Far East, aligned east-west near the Sea of Okhotsk; delimits the watersheds of the Lena and Amur Rivers
Tangwang River		Река Танванхэ	汤旺河		a tributary of the Songhua River originating in the Lesser Hinggan range
Tianchi Lake		Тяньчи	天池/Tianchi		a caldera lake at the summit of Changbai Mountain (2,745 m) on the China-Korea border; a Man and the Biosphere reserve

Usage in the text	English synonyms	Russian	Chinese	Mongolian	Definition/clarification/
Torey Lakes		Торейские озера	托列伊湖	Тарь нуур Tari nuur	Brackish lakes (Barun Torey and Zun-Torey) in Chitinskaya province. Place of Daursky Zapovednik and a Ramsar site
Transbaikalia	Zabaikalie	Забайкалье	外贝加尔区域,后贝加尔		"Area beyond Baikal Lake", includes Buriatia and Chitinskaya Province.
Udyl Lake		Озеро Удыль	乌德利湖		a large freshwater lake in Khabarovsky Province connected to Amur main channel
Uldz River		Река Ульдза		Улз гол Ulz gol	originates on east slope of Khentii Mountain, flows between Onon and Kherlen Rivers and joins Torey Lake in Russia
Ussuri River		Уссури	乌苏里江/ Wusulijiang	Уссур мөрөн Ussur moron	see Wusuli River
Wanda Range	Wanda mountains	Хребет Вандашань	万大山/Wandashan		A range of low mountains in eastern Heilongjiang Province, extending northeastward across the Wusuli-Ussuri River to join the Sikhote-Alin Mountains in Khabarovsky and Primorsky Provinces in Russia
Wudaliangchi Lakes		Удалянчи	五大凉池/ Wudaliangchi		A volcanic plateau in the Lesser Hinggan Mountains of Heilongjiang Province literally translated as “Five Great Cool Ponds”
Wusuli River		Река Уссури	乌苏里江/ Wusulijiang		A right-bank tributary of the Amur-Heilong River that originates in Primorsky Province and demarcates the China-Russia border between Primorsky and Heilongjiang Provinces basin area 193,000 km2
Xinjiang Uygur Autonomous Region		Синцзян-Уйгурский Автономный округ (Восточный Туркестан)	新疆维吾尔自治区/ Xinjiangweiwuer Zizhiqu		An autonomous region in northwest China where the Uygur ethnic minority is the dominant sector of the population. One of 33 province-level administrative divisions in China, including 22 provinces, 5 autonomous regions, 4 municipalities and 2 special administrative regions
Xinkai River		Канал Синкайхэ	新开河/Xinkaihe		A canal built to drain surplus water from Lake Dalai to Argun/Eerguna River in Inner Mongolia
Zeya River		Зея	结雅河		the largest left-bank tributary of the Amur-Heilong River; originates in the Tokisky-Stanovoy mountain ridge; flows through Zeya Reservoir and joins the Amur River near Blagoveschensk
Buriat ethnic minority		Буряты	布里亚特族	Буриад Buriad	a Mongolian ethnic minority residing in Russia, Mongolia and China
Ghengis Khan		Чингисхан		Чингис хаан Chingis haan	The 12-13 century Mongol conqueror who united the Mongol tribes and forged an empire stretching from China to the Danube River and into Persia
Hezhe ethnic minority		Нанайцы, Nanai	赫赭族/Hezhezu		a minority in northeast China and southern RFE dependent on fishing

Appendix Four: References to Data Sources for Mapping

(Complied by A.Purekhovsky, E.Egidarev, E.Simonov)

Since we could not readily find maps to illustrate the Amur-Heilong River Basin Reader, WWF Russian Far East upgraded its Amur GIS database and developed more than 60 thematic maps to accompany the book. Most map layers are also available at WWF in GIS format. These references list the materials used for map making (e.g. GIS layers, paper-maps, publications, and unpublished data). The maps presented in the Reader include many updates and corrections made by WWF-RFE and therefore may differ from the original data sources.

Part 1

Map 1.1 **Location of the Amur-Heilong River basin**
Source: ESRI Data

Map 1.2 **Political boundaries in the Amur-Heilong River basin**
Source: Administrative units (provinces, counties): Russia: DCW updated by DATA+; China&Mongolia - http://www.grid.unep.ch/appendix.html);
Railroads: Data Vmap0: http://geoengine.nga.mil NGA (National Geospatial-Intelligence Agency), 1997;

Map 1.3 **Topography of the Amur-Heilong River basin**
Source: Grid based on SRTM data: ftp://e0srp01u.ecs.nasa.gov/srtm/version2/; ftp://e0srp01u.ecs.nasa.gov/srtm/version1/;
Basemap Data Vmap0 http://geoengine.nga.mil NGA (National Geospatial-Intelligence Agency), 1997

Map 1.4 **Annual precipitation in the Amur-Heilong River basin**
Source: Lassere. 2003. Frédéric Lasserre. The Amur River border. Once a symbol of conflict, could it turn into a water resource stake? Le fleuve Amour : symbole de conflict passe, futur enjeu de ressource hydraulique ? Cybergeo: European Journal of Geography, N°242, 31/07/2003. 37 p

Map 1.5 **Floristic zones in the Amur-Heilong River basin**
Source: GEF TumenNET project archive. http://www.TumenNET; www.tumen.com.cn; www.TumenNET.mn; www.neaspec.go.kr/tumen)

Map 1.6 **Natural vegetation 18,000 years ago**
Source: GLOBAL ATLAS OF PALAEOVEGETATION SINCE THE LAST GLACIAL MAXIMUM./ Compiled by Jonathan Adams, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA
http://www.esd.ornl.gov/projects/qen/adams4.html; http://www.esd.ornl.gov/projects/qen/nercEURASIA.html

Map 1.7 **Natural vegetation 14,000 years ago**
Source: GLOBAL ATLAS OF PALAEOVEGETATION SINCE THE LAST GLACIAL MAXIMUM./ Compiled by Jonathan Adams, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA
http://www.esd.ornl.gov/projects/qen/adams4.html; http://www.esd.ornl.gov/projects/qen/nercEURASIA.html

Map 1.8 **Natural vegetation 12,000 years ago**
Source: GLOBAL ATLAS OF PALAEOVEGETATION SINCE THE LAST GLACIAL MAXIMUM./ Compiled by Jonathan Adams, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA
http://www.esd.ornl.gov/projects/qen/adams4.html; http://www.esd.ornl.gov/projects/qen/nercEURASIA.html

Map 1.9 **Natural vegetation 10,000 years ago**
Source: GLOBAL ATLAS OF PALAEOVEGETATION SINCE THE LAST GLACIAL MAXIMUM./ Compiled by Jonathan Adams, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA
http://www.esd.ornl.gov/projects/qen/adams4.html; http://www.esd.ornl.gov/projects/qen/nercEURASIA.html

Map 1.10 **Natural vegetation 8,000 years ago**
Source: GLOBAL ATLAS OF PALAEOVEGETATION SINCE THE LAST GLACIAL MAXIMUM./ Compiled by Jonathan Adams, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA
http://www.esd.ornl.gov/projects/qen/adams4.html; http://www.esd.ornl.gov/projects/qen/nercEURASIA.html

Map 1.11 **Natural vegetation 4,000 years ago**
Source: GLOBAL ATLAS OF PALAEOVEGETATION SINCE THE LAST GLACIAL MAXIMUM./ Compiled by Jonathan Adams, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA
http://www.esd.ornl.gov/projects/qen/adams4.html; http://www.esd.ornl.gov/projects/qen/nercEURASIA.html

Map 1.12 **Rivers of the Amur-Heilong River basin**
Source: Vmap0 http://geoengine.nga.mil. NGA (National Geospatial-Intelligence Agency), 1997

Map 1.13 **Ramsar sites, other wetlands and land use**
Source: Vmap0 http://geoengine.nga.mil. NGA (National Geospatial-Intelligence Agency), 1997; WWF data; Biodiversity conservation center, Socio-Ecological Union data; GLWD-Global lakes and wetlands database; Bogs:
Russian military maps 1:500000; Russian wetlands TIGIS 2002; Permafrost: FAO data;
2005 World Database on Protected Areas © 2005 IUCN, UNEP;

Map 1.14 **Northeast China showing the Songhua River basin and its major floodplain**
Source: ADB-GEF Songhua River Flood, Wetland and Biodiversity Management Project, Midterm Report 2000.

Map 1.15 **Classification of soils in the Amur-Heilong River basin**
Source: Soil and Terrain Database for North and Central Eurasia. / FAO & IIASA, 1999. http://www.iiasa.ac.at/Research/LUC/GIS/soil_types.htm
Dominant SOIL TYPES in the FSU, Mongolia and China.(FAO, IIASA-LUC CREATED map on a scale of 1:5 million uses the legend of the FAO-UNESCO Revised Legend of the Soil Map of the World (FAO,1990).)

Map 1.16 **Species diversity index in RFE**
Source: Karakin V. & Darman Yu., editors. Basic regulations for "Conservation Action Plan (CAP) of Biodiversity Conservation in the RFE Ecoregion on the Basic of Transfer to Sustainable Development. Report, WWF RFE, Vladivostok, 2001.
Gorovoy, P. and A. Martynenko (ed.) - 2004). The Biodiversity of Far East Ecoregional Complex. World Wide Fund for Nature Russian Far East, APELSIN publishers.Vladivostok.2004.

Map 1.17 **Vegetation cover**
Source Global Agro-Ecological Zones Assessment: Methodology and Results./ Günther Fischer., Harrij van Velthuizen., Freddy O. Nachtergaele. IR-00-064/ IIASA. November, 2000. Vegetation of the FSU, Mongolia and China in BIOME classification
http://www.iiasa.ac.at/Research/LUC/gaez.html
Corrected in RFE by WWF ECAP 2003 data on cropland

Map 1.18 **Global Land Use/Land Cover according to 2000 satellite imagery**
Source Global Land Use/Land Cover 2000 SPOT Vegetation
http://www.gvm.jrc.it/glc2000/
The Global Land Cover Map for the Year 2000, 2003. GLC2000 database, European Commission Joint Research Centre.
http://www.gvm.jrc.it/glc2000

Map 1.19 **Vegetation cover density**
Source: DeFries, R., M. Hansen, J.R.G. Townshend, A.C. Janetos, and T.R. Loveland (2000) A new global 1km data set of percent tree cover derived from remote sensing. Global Change Biology. 6. http://glcf.umiacs.umd.edu/data/treecover/07
Global 500m Tree Cover Product from MODIS
http://gis.esri.com/library/userconf/proc98/PROCEED/TO850/PAP844/P844.HTM#KJL

Map 1.20 **Species richness of terrestrial mammals**
Source: **Global mammal distributions, biodiversity hotspots, and conservation .Gerardo Ceballos, and Paul R. Ehrlich. December 12, 2006.** http://www.iucn.org/bookstore/HTML-books/Red%20List%202004/completed/cover.html

Map 1.21 **Species richness of vascular plants**
Source: A Global Species Assessment. Jonathan E.M. Baillie, Craig Hilton-Taylor and Simon N. Stuart IUCN.CH.2005.3.en ISBN: 2-8317-0826-5. http://www.iucn.org/bookstore/HTML-books/Red%20List%202004/completed/cover.html

Map 1.22 **Species richness of breeding birds**
Source: Species Richness of Land Birds in East Asia. Tzung-Su Ding. Feburary 2001. http://asianbird.zo.ntu.edu.tw/

Map.1.23 **Species richness of diurnal butterflies**
Source: Martynenko A.B. Ecology and geographic distribution of Butterflies PK. Vladivostok, IDU, 2004-IN RUSSIAN

Map 1.24 **Terrestrial ecoregions of the Amur-Heilong basin**
Source: Olson DM, Dinerstein E. 2001. Terrestrial Ecoregions of the World: A New Map of Life on Earth. BioScience 3., Vol.51 No. 10.
http://www.nationalgeographic.com/wildworld/terrestrial.html; Adjusted by compilers according to WWF RFE ECAP 2004

Map 1.25 **Global 200 Ecoregions in the Amur-Heilong basin**
Source: Olson DM, Dinerstein E. 2001. Terrestrial Ecoregions of the World: A New Map of Life on Earth. BioScience 3., Vol.51 No. 10.
http://www.nationalgeographic.com/wildworld/terrestrial.html; Adjusted by compilers according to WWF RFE ECAP 2004.

Map 1.26 **Distribution of Siberian Spruce Grouse**
Source: Gao, W., Gao, Z., Lu, C. & Li, X. 1997: Distribution and status of grouse in China. - Wildl. Biol. 3: 294
STORCH, I. 2000. Status Survey and Conservation Action Plan 2000-2004: Grouse. - WPA/BirdLife/SSC Grouse Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK and World Pheasant Association, Reading, UK.
http://asianbird.zo.ntu.edu.tw/bird_range.htm

Map 1.27 **Kaluga and Amur sturgeon habitat in the Amur-Heilong River basin**
Source: Novomodny, Zolotukhin, Sharov. Amur Fish: Wealth and Crisis. Khab TINRO and WWF RFE. Vladivostok Apelsin publishers 2004. http://www.wwf.ru/resources/publ/book/105/

Map 1.28 **Distribution of fauna types**
Source: GEF TumenNet project archive. www.tumen.com.cn
www.Tumen NET.mn www.neaspec.go.kr/tumen)

Map 1.29 **Range of Amur tiger**
Source: multiple sources 1907-2007:
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www.TumenNET.mn www.neaspec.go.kr/tumen)
Miquelle et al, WCS 2000-2003
WCS and WWF winter tracking data 1995-2003,
WWF CPO and RFE data 2004-2006

Map 1.30 **Distribution of the Far Eastern Leopard**
Source: Nowell, K., Jackson P. 1996. Wild cats. – IUCN, Gland, Switzerland.
RAS/98/G31 – UNDP/GEF – Tumen River Strategic Action Program.
(www.tigis.dvo.ru/tumenproject/start.htm www.tumen.com.cn
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WCS and WWF winter tracking data 1995-2003

Map 1.31 **Distribution of Ginseng**
Source: Shrivel, Yu, et al. Ginseng in Primorie. Vladivostok 2003. ECAP RFE 2003,
unpublished field records of WWF staff. http://www.wwf.ru/resources/publ/book/90

Map 1.32 **Distribution of White-naped Crane**
Source: BirdLife International. 2001.Threatened Birds of Asia: the BirdLife International Red Data. N. J. Collar.. Cambridge, UK
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WWFRFE unpublished filed data 2007
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Map 1.33 **Distribution of Mongolian Gazelle and location of calving grounds**
Source: RAS/98/G31 – UNDP/GEF – Tumen River Strategic Action Program.
(www.tigis.dvo.ru/tumenproject/start.htm www.tumen.com.cn
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Map 1.34 **Comparative diversity of fish by river basin**
Source: Moyle, P.B. and R.A. Leidy. 1992. "Loss of biodiversity in aquatic ecosystems: evidence from fish faunas." Pages 127–169 in P.L. Fiedler and S.K. Jain, eds. Conservation biology: the theory and practice of nature conservation, preservation, and management. New York, NY: Chapman and Hall.
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Map 1.35 **Distribution of anadromous salmon species (Oncorhynchus spp.)**
Source: Dr. Xanthippe Augerot. Atlas of Pacific Salmon. State of the Salmon Consortium. Berkley: UCP, 2005. http://www.stateofthesalmon.org/page.php?pgID=19

Map 1.36 **Bird migration routes**
Source: RAS/98/G31 – UNDP/GEF – Tumen River Strategic Action Program. (www.tigis.dvo.ru/tumenproject/start.htm www.tumen.com.cn www.Tumen NET.mn www.neaspec.go.kr/tumen)
Maps by Russian scientists: Haritonov, 1975; 1980; Velizhanin, 1977;1978; Glushenko, 1984; Roslyakov, 1996; Isakov, 1998; Shuntov, 1998;1996; Glushenko, Mrikot, 2001; Litvinenko, Shibaev,1987, 1991; Goroshko 2002, Karyakin 2000-2006, Potapov 2005.

Map 1.37 **Distribution of Red-crowned Crane**
Source: BirdLife International. 2001.Threatened Birds of Asia: the BirdLife International Red Data. N. J. Collar.. Cambridge, UK
RAS/98/G31 – UNDP/GEF – Tumen River Strategic Action Program. (www.tigis.dvo.ru/tumenproject/start.htm www.tumen.com.cn www.Tumen NET.mn www.neaspec.go.kr/tumen)
http://asianbird.zo.ntu.edu.tw/bird_range.htm
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Map 1.38 **Distribution of Oriental White Stork breeding areas**
Source: BirdLife International. 2001.Threatened Birds of Asia: the BirdLife International Red Data. N. J. Collar.. Cambridge, UK
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http://asianbird.zo.ntu.edu.tw/bird_range.htm
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Part 2

Map 2.1 **Abandoned croplands of the Zeya-Bureya plain in early 21st century**
Source: E.Egidarev. WWF RFE. 2004

Map 2.2 **Amur-Heilong River basin human population in the 1990s**
Source: Asia Population Database. Dr. Uwe Deichmann. National Center for Geographic Information and Analysis./ University of California, Santa Barbara, UNEP/DEIA/GRID-Geneva: 3 May 1996. http://www.ncgia.ucsb.edu/
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Map 2.3 **Oil and Gas resources and infrastructure**
Source: Philippe Rekacewicz and Rafael Kandiyoti (May 2005). Asia: in The pipeline
http://mondediplo.com/maps/pipelines200505. Original map updated by A. Purekhovsky

Map 2.4 **Existing and planned oil and gas pipelines in the Amur-Heilong River basin**

Source: Data derived from multiple oil/gas company reports, justification of investment, feasibility studies and impact assessments of oil/gas sector infrastructure from 2001-2007.(referenced in GIS database) Compiled by E. Cybikova (Transparent World Partnership, Moscow) and WWF RFE (Purekhovsky, Egidarev, Simonov).

Part Three

Map 3.1 **Distribution patterns of major human activities across the Amur-Heilong River basin**

Source: Nelleman, L. Kullered, I. Vistnes, B.C. Forbes, T. Foresman, E. Husby, et al., GLOBIO. Global methodology for mapping human impacts on the biosphere. UNEP/DEWA/TR.01-3: 2001. http://www.globio.info;

Human impact - Asian continent http://maps.grida.no/go/graphic/human_impact_asian_continent ; http://www.globio.info/region/asia/

Map 3.2 **Remaining areas in Amur-Heilong basin ecoregions with low human impact and classified as wilderness**

Source: Sanderson, E.W., M. Jaiteh, M.A. Levy, K.H. Redford, A.V. Wannebo, and G. Wolmer. 2002. "The Human Footprint and the Last of the Wild," BioScience, Vol. 52, No. 10 http://www.ciesin.columbia.edu/wild_areas/; http://wcs.org/sw-high_tech_tools/landscapeecology/humanfootprint

Ecoregional coverage from:

Olson DM, Dinerstein E. 2001. Terrestrial Ecoregions of the World: A New Map of Life on Earth. BioScience 3., Vol.51 No. 10.(http://www.nationalgeographic.com/wildworld/terrestrial.html)

Map 3.3 **Intensity of threats to biodiversity in the southern Russian Far East**

Source: Karakin V. & Darman Yu., editors. Basic regulations for "Conservation Action Plan (CAP) of Biodiversity Conservation in the RFE Ecoregion on the Basic of Transfer to Sustainable Development. Report, WWF RFE, Vladivostok, 2001.

Map 3.4 **Ecoregion Conservation Action Plan for Russian Far East Ecoregional Complex of 2003**

Source: Darman et al CAP RFE 2003;

Gorovoy, P. and A. Martynenko (ed.) 2004. The Biodiversity of Far East Ecoregional Complex. World Wide Fund for Nature Russian Far East, APELSIN publishers.Vladivostok.2004.

Map 3.5 **Irrigation in northeast China (from Lasserre 2003)**

Source: Lassere. 2003. Frédéric Lasserre. The Amur River border. Once a symbol of conflict, could it turn into a water resource stake ? Le fleuve Amour : symbole de conflit passe, futur enjeu de ressource hydraulique ? Cybergeo : European journal of Geography, N°242, 31/07/2003. 37 p

Map 3.6 **Existing and planned dams and water diversions on major steams in the Amur-Heilong River basin**

Source: Mostly WWF own data;.UNEP/DEWA/GRID-Geneva-geo@grid.unep.ch; Andrea De Bono; http://geoengine.nga.mil NGA (National Geospatial-Intelligence Agency), 1997;

Map 3.7 **Transneft pipeline and nature reserves in Primorsky and Khabarovsky Provinces (enlargement from Map 2.4 showing detail on nature reserves)**

Source: Data derived from multiple oil/gas company reports, justification of investment, feasibility studies and impact assessments of oil/gas sector infrastructure from 2001-2007.(referenced in GIS database) Compiled by E. Cybikova (Transparent World Partnership, Moscow) and WWF RFE (Purekhovsky, Egidarev, Simonov).

Map 3.8 **Soil vulnerability to desertification**

Source: Soil Interpretation in the Soil Survey – Past and Present. Berman D. Hudson, National Leader, Soil Survey Interpretations./ National State Soil Scientist's Meeting-Agenda "DELIVERING TECHNICAL SOIL SERVICES". March 19-22, 2001. Lawrence, KS
World Soil Resources Map Index_http://soils.usda.gov/use/worldsoils/mapindex/index.html

Map 3.9 **Vulnerability to water erosion**

Source: Source: Soil Interpretation in the Soil Survey – Past and Present. Berman D. Hudson, National Leader, Soil Survey Interpretations./ National State Soil Scientist's Meeting-Agenda "DELIVERING TECHNICAL SOIL SERVICES". March 19-22, 2001. Lawrence, KS
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Map 3.10 **Soil degradation in Amur Heilong River basin**

Source: Oldeman, L.R., Hakkeling, R.T.A., Sombroek, W.G., 1990: World Map of the Status of Human-Induced Soil Degradation: An Explanatory Note.
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Map 3.11 **Change in forest cover in Amur Heilong River basin**

Source: D. BRYANT, D. NIELSEN, L. TANGLEY. / The Last Frontier Forests: Ecosystems and Economies on the Edge. 1997. World Resources Institute. Washington, DC. http://www.globalforestwatch.org
The World's Last Intact Forest Landscapes (poster). 2006. Greenpeace. http://www.intactforests.org

Map 3.12 **Change in Korean pine forest cover and composition**

Source: Vegetation map of Amur river Basin. Sochava ed. Moscow 1969.
B.P. Kolesnikov editor. "Geobotanical map of Primorsky Krai". M., 1956.
Heilongjiang Senlin. Harbin: Deunbeilin'e Dasyue,. Chuiban'she, 1993.
Russian State Forestry inventory database 1989-2005

Map 3.13 **Frequency of fires in southeast Primorski Province, summed over 6 years for which satellite imagery was available between 1996 and 2003**

Source: Miquelle D., M. Murzin, M. Hoette. 2004. Fire impacts on the population of Far East Leopard in southeast Primorski Kai. http://www.tigis.dvo.ru)

Part Four

Map 4.1 **Protected area coverage of northeast Asia**
Source: 2005 World Database on Protected Areas © 2005 IUCN, UNEP; WWF data.

Map 4.2 **Intensity of human impact and protected areas in Amur-Heilong River basin**
Source: Sanderson, E.W., M. Jaiteh, M.A. Levy, K.H. Redford, A.V. Wannebo, and G. Wolmer. 2002. "The Human Footprint and the Last of the Wild," BioScience, Vol. 52, No. 10 http://www.ciesin.columbia.edu/wild_areas/; http://wcs.org/sw-high_tech_tools/landscapeecology/humanfootprint

Map 4.3 **High-level protected areas in Amur-Heilong River basin**
Source: 2005 World Database on Protected Areas © 2005 IUCN, UNEP;
Biodiversity Conservation Center; Amur Social-Ecological Union;
WWF; Institute of Zoology CAS. China biodiversity database: http://www.baohu.org/index.php
http://www.chinabiodiversity.com/index.php;
http://www.nationalgeographic.com/wildworld/terrestrial.html
2005 World Database on Protected Areas © 2005 IUCN, UNEP; WWF data.

Map 4.4 **Protected areas of upper Ussuri-Wusuli River and Khanka-Xingkai Lake basins**
Source: 2005 World Database on Protected Areas © 2005 IUCN, UNEP;
Biodiversity Conservation Center; Amur Social-Ecological Union; WWF;
Institute of Zoology CAS. China biodiversity database: http://www.baohu.org/index.php http://www.chinabiodiversity.com/index.php

Map 4.5 **Satellite view and protected areas in the Small Hinggan Mountains**
Source: 2005 World Database on Protected Areas © 2005 IUCN, UNEP;
Biodiversity Conservation Center; Amur Social-Ecological Union; WWF;
Institute of Zoology CAS.China biodiversity database: http://www.baohu.org/index.php http://www.chinabiodiversity.com/index.php;

Map 4.6 **Daurian steppe protected areas**
Source: 2005 World Database on Protected Areas © 2005 IUCN, UNEP;
Biodiversity Conservation Center; Amur Social-Ecological Union; WWF;
Institute of Zoology CAS.China biodiversity database: http://www.baohu.org/index.php http://www.chinabiodiversity.com/index.php;

Appendix Five: Jurisdictions

Counties and prefectures in the Amur-Heilong River basin and immediate vicinity

[Refer to corresponding numbers on Map 1.2, *Political boundaries in the Amur-Heilong River basin* (Part One, Chapter 1, pages 8-9)]

CHINA

Note: Only in China is there an intermediate administrative level of "prefecture" between county (district) and province (autonomous region) levels.

Heilongjiang Province	Map Number	County (xian,shi)	Prefecture (shi)
	1	Mohe Xian	Daxinganling Diqu
	2	Tahe Xian	Daxinganling Diqu
	3	Huma Xian	Daxinganling Diqu
	4	Heihe Shi	Heihe Shi
	5	Nenjiang Xian	Heihe Shi
	6	Sunwu Xian	Heihe Shi
	7	Xunke Xian	Heihe Shi
	8	Wudalianchi Resort	Heihe Shi
	9	Wudalianchi	Heihe Shi
	10	Bei`an Shi	Heihe Shi
	11	Nehe Xian	Qiqiha`er Shi
	12	Keshan Xian	Qiqiha`er Shi
	13	Kedong Xian	Qiqiha`er Shi
	14	Gannan Xian	Qiqiha`er Shi
	15	Longjiang Xian	Qiqiha`er Shi
	16	Qiqiha`er Shi Shixiaqu	Qiqiha`er Shi
	17	Fuyu Xian	Qiqiha`er Shi
	18	Yi`an Xian	Qiqiha`er Shi
	19	Baiquan Xian	Qiqiha`er Shi
	20	Tailai Xian	Qiqiha`er Shi
	21	Lindian Xian	Daqing Shi
	22	Du`erbaite Mongol Autonomous	Daqing Shi
	23	Daqing Shi Shixiaqu	Daqing Shi
	24	Zhaoyuan Xian	Daqing Shi
	25	Zhaozhou Xian	Daqing Shi
	26	Mingshui Xian	Suihua Shi
	27	Hailun Shi	Suihua Shi
	28	Suileng Xian	Suihua Shi
	29	Anda Shi	Suihua Shi
	30	Qinggang Xian	Suihua Shi
	31	Wangkui Xian	Suihua Shi
	32	Qing`an Xian	Suihua Shi
	33	Zhaodong Shi	Suihua Shi
	34	Lanxi Xian	Suihua Shi

35	Suihua Shi	Suihua Shi
36	Jiayin Xian	Yichun Shi
37	Yichun Shi Shixiaqu	Yichun Shi
38	Tieli Shi	Yichun Shi
39	Hegang Shi Shixiaqu	Hegang Shi
40	Luobei Xian	Hegang Shi
41	Suibin Xian	Hegang Shi
42	Tongjiang Shi	Jiamusi Shi
43	Fuyuan Xian	Jiamusi Shi
44	Tangyuan Xian	Jiamusi Shi
45	Huachuan Xian	Jiamusi Shi
46	Fujin Shi	Jiamusi Shi
47	Jiamusi Shi Shixiaqu	Jiamusi Shi
48	Huanan Xian	Jiamusi Shi
49	Jixian Xian	Shuangyashan Shi
50	Youyi Xian	Shuangyashan Shi
51	Shuangyashan Shi Shixiaqu	Shuangyashan Shi
52	Baoqing Xian	Shuangyashan Shi
53	Raohe Xian	Shuangyashan Shi
54	Boli Xian	Qitaihe Shi
55	Qitaihe Shi Shixiaqu	Qitaihe Shi
56	Hulin Xian	Jixi Shi
57	Mishan Shi	Jixi Shi
58	Jidong Xian	Jixi Shi
59	Jixi Shi Shixiaqu	Jixi Shi
60	Shuangcheng Shi	Ha`erbin Shi
61	Ha`erbin Shi Shixiaqu	Ha`erbin Shi
62	Hulan Xian	Ha`erbin Shi
63	Bayan Xian	Ha`erbin Shi
64	Mulan Xian	Ha`erbin Shi
65	Tonghe Xian	Ha`erbin Shi
66	Yilan Xian	Ha`erbin Shi
67	Fangzheng Xian	Ha`erbin Shi
68	Bin Xian	Ha`erbin Shi
69	Acheng Shi	Ha`erbin Shi
70	Yanshou Xian	Ha`erbin Shi
71	Wuchang Xian	Ha`erbin Shi
72	Shangzhi Shi	Ha`erbin Shi
73	Hailin Xian	Mudanjiang Shi
74	Linkou Xian	Mudanjiang Shi
75	Mudanjiang Shi Shixiaqu	Mudanjiang Shi
76	Ningan Xian	Mudanjiang Shi
77	Muling Xian	Mudanjiang Shi
78	Dongning Xian	Mudanjiang Shi
79	Suifenghe Shi	Mudanjiang Shi

Jilin Province	Map Number	County (xian, shi)	Prefecture (shi)
	1	Taonan Shi	Baicheng Shi
	2	Baicheng Shi	Baicheng Shi
	3	Zhenlai Xian	Baicheng Shi
	4	Tongyu Xian	Baicheng Shi
	5	Da`an Shi	Baicheng Shi
	6	Changling Xian	Songyuan Shi
	7	Qian`an Xian	Songyuan Shi
	8	Qianguo`erluosi Mongol Autonomous	Songyuan Shi
	9	Fuyu Shi	Songyuan Shi
	10	Shuangliao Xian	Siping Shi
	11	Gongzhuling Shi	Siping Shi
	12	Lishu Xian	Siping Shi
	13	Siping Shi Shixiaqu	Siping Shi
	14	Yitong Manzhurian Autonomous	Siping Shi
	15	Nongan Xian	Changchun Shi
	16	Dehui Xian	Changchun Shi
	17	Yushu Shi	Changchun Shi
	18	Changchun Shi Shixiaqu	Changchun Shi
	19	Jiutai Shi	Changchun Shi
	20	Shuangyang Xian	Changchun Shi
	21	Dongliao Xian	Liaoyuan Shi
	22	Liaoyuan Shi Shixiaqu	Liaoyuan Shi
	23	Dongfeng Xian	Liaoyuan Shi
	24	Panshi Xian	Jilin Shi
	25	Yongji Xian	Jilin Shi
	26	Jilin Shi Shixiaqu	Jilin Shi
	27	Shulan Xian	Jilin Shi
	28	Jiaohe Shi	Jilin Shi
	29	Huadian Shi	Jilin Shi
	30	Meihekou Shi	Tonghua Shi
	31	Huinan Xian	Tonghua Shi
	32	Liuhe Xian	Tonghua Shi
	33	Tonghua Xian	Tonghua Shi
	34	Tonghua Shi Shixiaqu	Tonghua Shi
	35	Ji`an Shi	Tonghua Shi
	36	Tonghua Xian	Tonghua Shi
	37	Hunjiang Shi Shixiaqu	Baishan Shi
	38	Jingyu Xian	Baishan Shi
	39	Fusong Xian	Baishan Shi
	40	Changbai Korean Autonomous	Baishan Shi
	41	Antu Xian	Yanbian Korean Autonomous
	42	Dunhua Shi	Yanbian Korean Autonomous
	43	Longjing Shi	Yanbian Korean Autonomous
	44	Wangqing Xian	Yanbian Korean Autonomous
	45	Hunchun Shi	Yanbian Korean Autonomous

46	Yanji Shi	Yanbian Korean Autonomous
47	Tumen Shi	Yanbian Korean Autonomous
48	Helong Xian	Yanbian Korean Autonomous

Inner Mongolia Autonomous Region

Map Number	County (xian,shi,qi)	Prefecture (shi,meng)
1	Eerguna Shi	Hulunbeier
2	Genhe Shi	Hulunbeier
3	Elunchun Zizhiqi	Hulunbeier
4	Yakeshi Shi	Hulunbeier
5	Molidawa Daurian Autonomous	Hulunbeier
6	Chenba`erhu Qi	Hulunbeier
7	Xinba`erhu-Zuo Qi	Hulunbeier
8	Xinba`erhu-You Qi	Hulunbeier
9	Arong Qi	Hulunbeier
10	Manzhouli Shi	Hulunbeier
11	Haila'er Shi	Hulunbeier
12	Ewenkezu Zizhiqi	Hulunbeier
13	Zhalantun Shi	Hulunbeier
14	Ke`erqin-Youyiqian Qi	Xing'an Meng
15	Zhalaite Qi	Xing'an Meng
19	Dongwuzhumuqin Qi	Tongliao Shi
16	Wulanhaote Shi	Xing'an Meng
17	Tuquan Xian	Xing'an Meng
18	Ke`erqin-Youyizhong Qi	Xing'an Meng
22	Zhalute Qi	Tongliao Shi
21	Huolinguole Shi	Tongliao Shi
20	Xiwuzhumuqin Qi	Tongliao Shi
34	Aluke`erqin Qi	Chifeng Shi
23	Ke`erqin-Zuoyizhong Qi	Tongliao Shi
33	Balin-Zuo Qi	Chifeng Shi
29	Xilinhaote Qi	Xilinguole Meng
32	Balin-You Qi	Chifeng Shi
24	Kailu Xian	Tongliao Shi
31	Linxi Xian	Chifeng Shi
26	Tongliao Shi	Tongliao Shi
30	Keshiketeng Qi	Chifeng Shi
28	Ke`erqin-Zuoyihou Qi	Tongliao Shi
25	Naiman Qi	Tongliao Shi
35	Wengniute Qi	Chifeng Shi
27	Kulun Qi	Tongliao Shi
37	Aohan Qi	Chifeng Shi
36	Chifeng Shi Shixiaqu	Chifeng Shi
38	Kalaqin Qi	Chifeng Shi
39	Ningcheng Xian	Chifeng Shi

Liaoning Province	Map Number	County (xian,shi)	Prefecture (shi)
	1	Changtu Xian	Tieling Shi
	2	Xifeng Xian	Tieling Shi
	3	Kangping Xian	Tieling Shi
	4	Kaiyuan Shi	Tieling Shi
	5	Zhangwu Xian	Shenyang Shi
	6	Faku Xian	Tieling Shi
	7	Qingyuan Manzu Zizhixian	Fushun Shi
	8	Tieling Xian	Tieling Shi
	9	Tiefa Shi	Tieling Shi
	10	Tieling Shi Shixiaqu	Tieling Shi
	11	Xinmin Xian	Fuxin Shi
	12	Shenyang Shi Shixiaqu	Shenyang Shi
	13	Xinbin Manzu Zizhixian	Fushun Shi
	14	Fushun Xian	Fushun Shi
	15	Fushun Shi Shixiaqu	Fushun Shi
	16	Huanren Manzu Zizhixian	Dandong Shi
	17	Liaozhong Xian	Shenyang Shi
	18	Benxi Manzu Zizhixian	Benxi Shi
	19	Benxi Shi Shixiaqu	Benxi Shi
	20	Dengta Xian	Shenyang Shi
	21	Kuandian Manzu Zizhixian	Dandong Shi
	22	Liaoyang Xian	Shenyang Shi
	23	Fengcheng Manzu Zizhixian	Dandong Shi
	24	Xiuyan Manzu Zizhixian	Dandong Shi
	25	Dandong Shi Shixiaqu	Dandong Shi
	26	Donggou Xian	Dandong Shi

MONGOLIA

Dornod Province (Aimag)	Map Number	County (somon)
	1	Dashbalbar
	2	Chuluunhoroot
	3	Bayandun
	4	Gurvanzagal
	5	Choybalsan
	6	Bayan-Uul
	7	Sergelen
	8	Tsagaan-Ovoo
	9	Bayantumen
	10	Holonbuyr
	11	Bulgan
	12	Matad
	13	Halhgol
	14	Choybalsan

Henti Province (Aimag)	Map Number	County (somon)
	1	Dadal
	2	Batshireet
	3	Omnodelger
	4	Binder
	5	Burenhaan
	6	Norovlin
	7	Bayanadraga
	8	Batnorov
	9	Gurvanbayn
	10	Tsenhermandal
	11	Bayaan-Ovoo
	12	Herlen
	13	Jargalthaan
	14	Herlenbayanulaan
	15	Olziit
	16	Bajnhutag
	17	Moron
	18	Delgerhaan
	19	Bayankhutag
	20	Bayanmonh
	21	Darhan
	22	Galshar

Suhbaatar Province (Aimag)	Map Number	County (somon)
	1	Tumentsogt
	2	Monhhaan
	3	Suhbaatar
	4	Byrentsogt
	5	Uulbayan
	6	Tuvshinshiree
	7	Halzan
	8	Erdenetsagaan
	9	Asgat
	10	Bayandelger
	11	Ongon
	12	Dariganga
	13	Naran

Tov Province (Aimag)	Map Number	County (somon)
	1	Erdene
	2	Mongonmorit
	3	Bayandelger
	4	Arhust
	5	Bayanjargalan
	6	Bayan

RUSSIA

Aginskii Buryatskii Autonomous Province (Okrug)	Map Number	County (rayon)
	1	Dul'durginskii
	2	Aginskii
	3	Mogoituiskii

Chitinskaya Province (oblast)	Map Number	County (rayon)
	1	Kalarskii
	2	Tungiro-Olekminskii
	3	Tungokochenskii
	4	Mogochinskii
	5	Chernyshevskii
	6	Sretenskii
	7	Gazimuro-Zavodskii
	8	Chitinskii
	9	Nerchinskii
	10	Karymskii
	11	Nerchinsko-Zavodskii
	12	Shilkinskii
	13	Khilokskii
	14	Shelopuginskii
	15	Baleiskii
	16	Uletovskii
	17	Petrovsk-Zabaikal'skii
	18	Aleksandrovo-Zavodskii
	19	Olovyanninskii
	20	Kalganskii
	21	Borzinskii
	22	Priargunskii
	23	Krasnochikoiskii
	24	Ononskii
	25	Akshinskii
	26	Krasnokamenskii
	27	Kyrinskii
	28	Zabaikal'skii

Amurskaya Province (oblast)	Map Number	County (rayon)
	1	Tyndinskii
	2	Zeiskii
	3	Skovorodinskii
	4	Magdagachinskii
	5	Selemdzhinskii
	6	Mazanovskii
	7	Shimanovskii
	8	Svobodnenskii
	9	Seryshevskii
	10	Romnenskii
	11	Blagoveschensk
	12	Belogorskii
	13	Ivanovskii
	14	Bureiskii
	15	Zavitinskii
	16	OktyAbr'skii
	17	Tambovskii
	18	Arkharinskii
	19	Mihailovskii
	20	Konstantinovskii
	21	Raichihinsk

Evreiskaya Autonomous province (Jewish autonomous oblast)	Map Number	County (rayon)
	1	Obluchenskii
	2	Birobidzhanskii
	3	Smidovichskii
	4	Oktyabr'skii
	5	Leninskii

Khabarovskii Province (Krai)	Map Number	County (rayon)
	1	Ayano-Maiskii
	2	Tuguro-Chumikanskii
	3	Nikolaevskii
	4	Ul'chskii
	5	Imeni Poliny Osipenko
	6	Verhnebureinskii
	7	Solnechnyi
	8	Komsomol'skii
	9	Vaninskii
	10	Khabarovskii

	11	Amurskii
	12	Nanaiskii
	13	Sovetsko-Gavanskii
	14	Khabarovsk
	15	Imeni Lazo
	16	Vyazemskii
	17	Bikinskii

Primorskii Province (Krai)	**Map Number**	**County (rayon)**
	1	Terneiskii
	2	Pozharskii
	3	Krasnoarmeiskii
	4	Dal'nerechenskii
	5	Lesozavodskii
	6	Khankaiskii
	7	Kirovskii
	8	Dal'negorskii
	9	Spasskii
	10	Chuguevskii
	11	Pogranichnyi
	12	Yakovlevskii
	13	Kavalerovskii
	14	Khorinskii
	15	Chernigovskii
	16	Anuchinskii
	17	Oktyabr'skii
	18	Mihailovskii
	19	Ol'ginskii
	20	Arsen'ev
	21	Khankaiskii
	22	Partizanskii
	23	Shkotovskii
	24	Nadezhdinskii
	25	Lazovskii
	26	Artem
	27	Partizansk
	28	Vladivostok

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ISBN: 978-988-17227-1-3

9 789881 722713

The Amur-Heilong River is the eleventh largest river basin in the world and the longest free-flowing river in the Eastern Hemisphere. This work describes the basin in four parts. Part One describes the natural setting, home to wild ginseng, Siberian tiger, far eastern leopard, Mongolian gazelle, snow sheep, Siberian spruce grouse, red-crowned crane, kaluga and Amur sturgeon, and hucho taimen.

Part Two compares and contrasts socio-economic conditions and natural resource management in the three main basin countries, Russia, China, Mongolia.

Part Three describes the reason for the recent increase in awareness of the Amur-Heilong, the environmental threats brought by rapidly growing economies and human populations.

One thread unites many basin-wide issues in the Reader, the concept of transboundary responsibility. Previous attempts at transboundary management of the Amur-Heilong's natural resources have failed to yield lasting results. In Part Four we discuss new approaches to address transboundary threats and to overcome past failures.

The Reader argues for prompt and effective action backed by technology and funding to restore the natural wealth of this globally important but largely unknown river basin. We hope administrators, managers, researchers, politicians, planners, conservationists, and business interests will use the Reader to define their role in this process. We hope the Reader will accelerate the spread of global awareness of this magnificent region and contribute to its restoration and long-term protection.

Cover photo:
Argun-Erguna Transboundary River Floodplain / Oleg Goroshko

Book design & layout by Kathy Harestad,
Selah, Washington, USA, www.kathyart.com

Published by Ecosystems Limited, Hong Kong,
www.ecosystems-ltd.com