Perspectives for Russian Arctic Conservation in a Circumpolar Context

With Special Attention to Potential Advantages of Linking Science and Conservation

International Biological Station Lena- Nordenskiöld, Russia
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Sponsored by WWF-Sweden

Workshop Summary

Prepared by

WWF Arctic Programme
Oslo, Norway

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Recommendations

of the
International Workshop

**"Perspectives for Russian Arctic Conservation
in a Circumpolar Context"**

28 July 2000
Lena Delta, Tiksi, Sakha Republic (Yakutia), Russian Federation

The Ministry of Nature Protection of the Sakha Republic (Yakutia) and the WWF International Arctic Programme hosted an international workshop "Perspectives for Russian Arctic Conservation in a Circumpolar Context" on the occasion of the fifth anniversary of the founding of the International Biological Station Lena Nordenskiöld. The workshop was attended by 36 participants from Russia, Sweden, Germany, Iceland, The Netherlands, Norway, the US and international organizations.

The primary aim of the meeting was to evaluate the experiences and achievements of the work of the Lena Nordenskiöld Station. Specific goals were:

- to specify and evaluate trends in ecosystem and habitat protection in the Russian Arctic during the past decade
- to discuss and assess future research opportunities and cooperation possibilities
- to review the activities of the research station, which, in our view, contribute significantly to the support of conservation efforts in the Arctic
- to recommend additional actions to be undertaken in the years to come.

Workshop participants were impressed by the results of the 1994 environmental conference “On Nature Protection,” hosted by the Sakha Republic, and a subsequent decision in 1995 by Sakha’s first president, Mikhail E Nikolaev, to initiate an environmental protection plan in the republic. In addition to establishing the International Biological Station Lena Nordenskiöld, these activities led to the protection of 765,000 km^2 in Sakha.

Sakha’s generous first “Gift to the Earth” (in recognition of the WWF Living Planet Campaign), a protected areas network covering 20% of the territory in 1996, has stimulated the creation of other “Gifts” in the Russian Federation and throughout the world. The workshop viewed these and other similar examples of nature conservation in Arctic Russia over the past decade as encouraging steps towards the protection of the entire arctic region.

The Russian Federation has actively participated in the work of the Arctic Council’s programme for the Conservation of Arctic Flora and Fauna (CAFF) and has led the Circumpolar Protected Areas Network (CPAN) project, which has identified a need for further environmental protection initiatives in the Arctic.

The near doubling of the size of the protected areas network in the Russian Federation over the past ten years greatly impressed the workshop. This is an outstanding achievement, especially because financial resources for conservation have not increased during this time. The workshop valued the unique standards set by the Russian zapovednik system of strictly protected nature reserves.

Scientific research has proven to be a key tool for nature protection in the Arctic. For instance, the results of migratory bird research led to the establishment of the African Eurasian Waterbird Agreement under the Bonn Convention.

Considering the aforementioned, participants of the International Workshop "Perspectives for Russian Arctic Conservation in a Circumpolar Context" recommend:

1. The comprehensive development of the International Biological Station Lena Nordenskiöld, so that it can continue to support Russian and international research while promoting conservation throughout the Sakha Republic, the Russian Federation and the Arctic;

2. Increased attention to public awareness and education, for example, by recognizing the potential of ecotourism in national parks;

3. Further development of international protected areas, particularly in Beringia and in the Barents region;

4. Nomination of the Lena Delta as a World Heritage Site;

5. That the University of the Arctic assists in linking science and conservation through the development of nature conservation curricula and international exchange programmes that include the use of arctic research stations;

6. The integration of disciplines, such as the social, economic, earth and biological sciences to further nature conservation;

7. That the US National Science Foundation take into consideration the International Biological Station Lena-Nordenskiöld, and/or stations in the Laptev, East Siberian and Chukchi Seas when developing future programmes;

8. The integration of the knowledge, ways and values of indigenous and other local peoples in the planning and implementation of protected areas, and appreciation of the conservation value of sacred sites and sanctuaries as promoted by the Russian Association of Indigenous Peoples of the North (RAIPON);

9. As a part of the current Russian Federation governmental reforms, the creation of a joint federal-regional commission to address issues related to the establishment of protected areas, which should include representatives of indigenous and other local peoples and appropriate new federal okrugs;

10. Increased interaction among research stations in the Russian Arctic, including the Lena-Nordenskiöld station, the International Biological Willem Barents station and a proposed biological station in the Pechora Delta;

11. The development of cooperative links among operations on the deltas of the Lena, Yukon-Kuskokwim and Mackenzie Rivers;

12. That the Arctic Council, United Nations Environment Programme (UNEP), Northern Forum, WWF and other organizations cooperatively develop the means to support arctic environmental initiatives such as those included herein, by sharing the circumpolar experience of the Northern Forum at the sub-national level;

13. The development of research projects which help to illustrate the socio-economic value of nature conservation by considering issues such as ecotourism potential, services from nature regimes (including carbon trading), debt-for-nature swaps and other forms of preservation of natural resources for future generations;

14. Broader recognition of the fact that conditions in the Arctic have an impact on global issues such as the survival of shared species, climate change, the long-range transport of pollution and the depletion of the ozone layer; and that non-arctic states take concrete steps to share the responsibility of safeguarding the arctic environment;

15. That congratulations be extended to the Russian Federation, CAFF and UNEP for progress on the Global Environmental Facility (GEF) project "Integrated Ecosystem Approach to Conservation of Biodiversity and Minimization of Habitat Fragmentation in the Russian Arctic;" and to challenge project proponents to take advantage of the good practices existing in the Russian Arctic;

16. The integration of WWF's circumpolar project on the "Twenty-Five Largest Unfragmented Areas in the Circumpolar Arctic" into the aforementioned Russian Arctic GEF project; and

17. That WWF takes the lead in producing a report on the "Common Future of the Arctic," which should be coordinated with the publication of UNEP's upcoming Global Environmental Outlook report. Appropriate organizations will contribute to the report.

Finally, the workshop acknowledges the overall environmental achievements of the government of the Russian Federation during the past decade, and expects that this trend will continue within present and future governmental structures.

Рекомендации

международной рабочей встречи

«Перспективы охраны природы в Российской Арктике
в циркумполярном контексте»

28 июля 2000 г.
Дельта Лены, Тикси, Республика Саха (Якутия), Российская Федерация

36 участников из России, Швеции, Германии, Исландии, Нидерландов, Норвегии и США, а также представителей международных организаций собрались на Международную рабочую встречу «Перспективы охраны природы в Российской Арктике в циркумполярном контексте», посвященную пятилетию со дня создания Международной биологической станции «Лена-Норденшельд», расположенной в резервате Дельта Лены.

Участники международного семинара, организованного Министерством охраны природы Республики Саха (Якутия) и Всемирным фондом дикой природы (WWF), сконцентрировали свое внимание на опыте работы станции «Лена-Норденшельд», предварительных итогах и достижениях ее деятельности, чтобы:

1) выявить и оценить тенденции в области охраны экосистем и среды обитания в Российской Арктике за последнее десятилетие;
2) обсудить и оценить перспективы исследований и сотрудничества;
3) обсудить деятельность исследовательской станции, которую мы рассматриваем как существенное дополнение в поддержке усилий по охране природы в Арктике; и
4) рекомендовать дополнительные мероприятия по охране природы в Арктике на ближайшие годы.

Участники встречи были впечатлены результатами республиканской природоохранной конференции «Об охране природы» 1994 г. и последующим решением первого Президента Республики Саха (Якутия) Михаила Николаева инициировать разработку программы охраны окружающей среды Республики Саха, начиная с 1995 г. Кроме создания Международной биологической станции, акция Республики Саха привела к взятию под особую охрану 765 000 кв. км территории республики.

Этот первый щедрый Подарок Земле Республики Саха (Якутия), осуществленный в рамках кампании WWF «Живая Планета» в сентябре 1996 г. послужил примером для создания новых охраняемых территорий в Российской Федерации и во всем мире. Участники встречи рассматривают эти и подобные примеры охраны природы в Российской Арктике в течение последних десяти лет как обнадеживающий шаг по пути охраны Арктики.

Российская Федерация активно участвует в работе программы Арктического совета по сохранению флоры и фауны Арктики (CAFF) и возглавила инициативу по созданию Сети Циркумполярных Охраняемых Территорий (CPAN), которая показала необходимость дальнейшей активизации природоохранных мероприятий в Арктике.

Участники семинара также были глубоко впечатлены тем, что Российская Федерация более чем в два раза увеличила площадь охраняемых территорий в Арктике за последние десять лет, что особенно важно, принимая во внимание финансовые трудности в стране.

Участники семинара высоко оценили уникальный опыт функционирования российских заповедников, и отметили, что российская наука может стать ключевым инструментом в области охраны природы Арктики. Например, результаты исследования мигрирующих птиц привели к появлению Соглашения об Афро-Евразийских Водоплавающих Птицах в рамках Боннской Конвенции.

Учитывая вышесказанное, участники Международной встречи «Перспективы охраны природы в Российской Арктике в циркумполярном контексте» рекомендуют:

1) всестороннее развитие Международной Биологической Станции «Лена-Норденшельд», чтобы данный факт мог послужить поддержкой Российских и международных исследований, в тоже время, способствовать охране природы в Республике Саха, Российской Федерации и в Арктике;
2) повышение внимания к общественному сознанию и просвещению, например через экотуризм, признавая в этом отношении большую роль национальных парков;
3) дальнейшее развитие международных охраняемых территорий, в частности, в Берингии и Баренцевом регионе;
4) придание дельте Лены статуса территории Всемирного наследия;
5) оказание Университетом Арктики содействия в усилении связей науки с охраной природы путем разработки обучающих курсов по охране природы, международных программ по обмену, которые должны включать использование арктических исследовательских станций;
6) обеспечение интеграции биологических наук с такими дисциплинами, как социология, экономика и науки о Земле в целях улучшения природоохранных мероприятий;

7) рекомендовать Национальному научному фонду США учитывать МБС «Лена-Норденшельд» и/или станции моря Лаптевых, Восточно-Сибирского и Чукотского морей в будущих программах;

8) активнее использовать знания, обычаи и ценности коренных и других местных народов при планировании и создании охраняемых территорий, также признавать природоохранную ценность сакральных мест и святилищ согласно предложениям Российской Ассоциации Коренных Народов Севера (RAIPON);

9) принимая во внимание современные реформы в Правительстве Российской Федерации, рекомендовать создание российской федерально-региональной комиссии по вопросам создания охраняемых природных территорий, в состав которой должны входить представители коренных и других местных народов, а также новых федеральных округов;

10) поддержать взаимодействие арктических исследовательских станций, включая станцию «Лена-Норденшельд», Международную Биологическую Станцию имени Виллема Баренца и планируемую биологическую станцию в дельте Печоры;

11) развивать сотрудничество охраняемых территорий в дельтах рек Лена, Юкон-Кускоквим и Маккензи;

12) чтобы Арктический Совет, Программа ООН по окружающей среде (UNEP), Северный Форум, WWF и другие организации совместно разрабатывали мероприятия по поддержке Арктических инициатив по окружающей среде, такие как включенные в данные рекомендации, учитывая циркумполярный опыт Северного Форума на суб-национальном уровне;

13) развивать исследовательские проекты, которые помогут продемонстрировать социально-экономическую значимость охраны природы, рассматривающие такие вопросы как экотуризм, выплата долгов путем осуществления природоохранных работ, коммерческое сохранение природных ресурсов и другие формы сохранения природных ресурсов для будущих поколений;

14) признавая факт влияния Арктики на глобальные экологические процессы, такие как выживание отдельных видов, изменение климата, трансграничное загрязнение и разрушение озонового слоя; призвать неарктические страны к большей ответственности за состояние природной среды Арктики;

15) выразить признательность Российской Федерации, CAFF и UNEP за прогресс в проекте GEF «Комплексный экосистемный подход к сохранению биоразнообразия и снижению разрушения среды обитания в Российской Арктике» и привлечь их внимание к использованию практического опыта, существующего в Российской Арктике;

16) интегрировать циркумполярный проект WWF «25 крупнейших неразрушенных территорий в циркумполярной Арктике» в вышеупомянутый российский арктический проект GEF; и

17) что WWF должен играть ведущую роль в разработке отчета «Общее будущее Арктики», с привлечением соответствующих организаций, и который должен быть скоординирован с публикацией предстоящего отчета UNEP по глобальному обзору окружающей среды;

и в заключение участники рабочей встречи признают общие достижения Правительства Российской Федерации в области охраны окружающей среды за последнее десятилетие и выражают надежду на сохранение этой тенденции существующими и будущими государственными структурами.

Session One

The establishment of new nature reserves in the Russian Arctic over the past decade – lessons learned and plans for the future

During the first session, the discussion continued in small working groups that evaluated the effectiveness of Russia's protected areas network over the past decade as a biodiversity conservation tool. The workshop recognized that evaluations of protected area networks could be approached from different perspectives.

1) Has the establishment of a protected areas network in the Russian Arctic been effective from a conservation perspective?

General remarks:

- Russia's rapid progress in establishing new protected areas in the Arctic in recent years is noteworthy. It is possible that Russia's efforts are influencing the development of protected areas strategies and programmes in other parts of the circumpolar region
- Although insufficient funding may be limiting the effectiveness of the protected areas network as a conservation tool, the future benefits of having established this system are expected to be high.

Effectiveness from a conservation perspective:

- The conservation value of protected areas is undeniable in view of dramatically increasing pressures on remaining wilderness. Many of Russia's protected areas have been afforded a level of protection by virtue of their remote location
- Protected areas can help to limit the extent of industrial resource development, currently the largest threat to the Russian Arctic
- In many cases, the strength of protected area designations has not been tested. Shell Oil's proposal to construct an oil pipeline in the Great Arctic Reserve may provide an opportunity to test Russia's commitment to protected areas
- Limiting the effectiveness of the protected areas network at present are inadequate financial support and representation of territories and ecosystems.

Effectiveness from public relations, educational and awareness raising perspectives:

- Protected areas can play an important role in increasing public and political awareness and interest in nature conservation. For instance, educational materials can be used to broaden appreciation and understanding of such areas
- The creation of protected areas has increased public understanding of the environmental problems motivating nature protection
- Public interest in and appreciation of protected areas is declining, and respect for the staff working in resource management and conservation fields is diminishing. Public awareness, support and pride in protected areas have been higher in the past.

Effectiveness from a scientific perspective:

- Many high quality research and monitoring programmes have been carried out in protected areas throughout Russia. The present level of research activity is much lower than what it has been, and resources for scientific work have dwindled
- As anthropogenic impacts on natural areas continue to rise, the value of protected areas as scientific reference points will also increase. Chronicles of Nature, a long-term data series initiated before western involvement in Russian Arctic research, has great potential as a resource for evaluating the effectiveness of protected areas programmes. The following points were made by the workshop about the value of the data from zapovedniks (strictly protected reserves):
- Much of the nature reserve data in Chronicles of Nature is in Russian digital format. Some Russian research institutions make digital data available until reports are translated into other languages from Russian
  - Historical data are available
  - Data from zapovedniks may not include long-term climate data.

Another example is the Arctic Monitoring and Assessment Programme (AMAP), a working group of the Arctic Council, which has launched a broad-based programme for assessing the impact of climate change on natural systems and human communities.

2. How could the process for planning and establishing protected areas in the Russian Arctic be improved?

The workshop recognized the value of the zapovednik system as a method of preserving reference areas in an untouched condition, and recommended that the system be maintained. Recommendations were also put forward about improving the effectiveness of the process for planning and establishing protected areas.

Integrate protected area planning into overall land-use planning efforts:

- Include all relevant parties and stakeholders in discussions when establishing protected areas. Consider the needs and interests of indigenous peoples and other local residents
- Consider areas of traditional use, sacred sites, potential for tourism and public education, and ecological and economic evaluations
- Implement new forms of protected areas such as “ethnic ecological areas” or “international protected areas”. Develop a reserve system to set aside lands not immediately scheduled for protection to meet future conservation needs
- Evaluate potential economic contributions accruing from sustainable uses of an area (e.g. ecotourism)
- When choosing areas for protection, focus on areas threatened by potential development such as forested areas and areas containing oil and gas reserves.

Integrate public outreach into protected areas programmes to ensure recognition of the values of protected areas by the public and decision-makers:

- Develop the educational potential of protected areas by establishing nature centres, interpretive trails and education and outreach programmes and other initiatives
- Increase efforts to attract and train young professionals to serve in the fields of conservation and protected areas management.

Ensure adequate funding to complete necessary tasks:

- Carry out economic evaluations of all protected areas
- Develop innovative methods of raising funds to support conservation
- Making protected areas self-financing was a point of concern. Would this lead to the end of protected areas as we now conceive of them? Will economic pressures or expectations result in the sale of natural treasures? Governments should finance protected areas and assure this support through legislation
- Russia should use its vast mineral wealth to influence corporations to contribute to the financing of protected areas.

Identify and protect under-represented habitats:

- Inadequate representation of certain ecosystems in the Russian Arctic is an important problem that should be addressed
- A gap analysis undertaken by CAFF (the Arctic Council working group on conservation of arctic flora and fauna) shows that the most productive ecosystems are found in the lower Arctic in Russia (forest tundra, mountain taiga, etc.) and in marine, near-shore and coastal areas. Another finding was that the existing protected areas network does not adequately protect these types. However, these conclusions may be related to inconsistencies in the interpretation of ecosystem types during the analysis
- The gap analysis also indicated that the most biologically rich terrestrial areas and the most productive marine areas often have the lowest level of protection
- The establishment of many protected areas in the Russian high Arctic has been driven by an interest in conserving habitat for migratory birds. There is a need to consider other groups of species as well, such as endemic plants, stationary birds and insects.

Streamline categories of protected areas to make them comparable with categories applied in the rest of the circumpolar Arctic:

- A standard method of classifying natural areas should be developed to make protected areas designations more transparent to the public and to international groups. Imposing a broad-scale standardized approach, however, may reduce local progress in establishing protected areas, and for this reason, local systems of designating protected areas should be preserved. National standards could possibly be worded to permit a wider interpretation that will allow for flexibility in applying classifications at a regional level. Experiences of other nations and the international community should be taken into consideration when planning new protected areas.

Consider a federal overview of the development of protected areas designations:

A federal agency could be established that would serve as a registry for protected areas. The registry would be a repository for information about all levels of protected areas throughout Russia.

- There is a need for regional reporting to a federal agency to encourage consistency in information gathering on a regional level
- Increase the level of agreement between regional and federal ecological legislation.

3. What are realistic expectations for the future of protected areas in the Russian Arctic?

General findings:

The working groups recognized that the present governmental administration could severely undermine progress made over the last decade in protecting natural areas. Nonetheless, a strong desire to move forward in a spirit of optimism was expressed.

Perspectives:

- Public support for protected areas will be essential in the future
- In undertaking protected areas management, it may be necessary to develop alternative strategies to accomplish some goals. For example, in the face of budgetary reductions, increase use of volunteers, integrate scientific agencies into planning work, involve universities in research, etc.
- Develop new forms of protected areas including areas that are specifically designated for ecological education and ecotourism values, while also considering the limitations and the benefits of ecotourism. There is a tendency to overvalue the benefits of ecotourism
- Focus on establishing protected areas of international significance
- Prioritize new protected areas to include marine, mixed marine-terrestrial, and wetland habitats in the protected areas network.

4. Which aspects of the protected areas system in the Russian Arctic should be adopted in other parts of the Arctic, and what can Russia learn from other arctic nations?

How to learn from each other:

- Evaluate the positive and negative experiences of other nations when developing protected areas systems. Undertake an evaluation and comparison of different management schemes (e.g. Nordic scheme and the Alaska-Russia model)
- Recognize that unique cultural and national values may preclude an effective transfer of methodologies from one country to another (e.g. as experienced by CPAN (Circumpolar Protected Areas Network)
- Investigate the potential for applying more specific techniques for managing protected areas. An example could be the development of a protected areas management forum that meets regularly to discuss ideas and develop pragmatic solutions to tangible problems.

Notable Russian achievements:

- Chronicles of Nature, a compilation of long-term research and monitoring data collected in Russian zapovedniks, is an enormous resource for the international scientific community
- When designating protected areas, it is necessary to ensure effective public participation in all steps of the process (e.g. via community meetings), and to consider the interests of indigenous peoples. The Great Arctic Reserve in Sakha (Yakutia) was established within such a framework
- Native groups such as RAIPON (Russian Association of Indigenous Peoples of the North) and conservation groups are working to integrate cultural heritage and nature protection concepts into strategies for planning and managing protected areas. Native people played an important role in the establishment of the Kytalyk Resource Reserve in Sakha (Yakutia). This approach was taken to the development of a protected areas system in Sakha over the past few years
- The Russian concept of zapovedniks provides a symbol of the intrinsic right of nature to exist in an undisturbed state. By adopting this concept, Russians have set an appropriate standard for other nations
- The Russian system can act with remarkable speed to establish a new protected area after it has been proposed – in the absence of public involvement
- The development of multi-layered atlases for use in identifying potential areas for protection in the region of Murmansk.

Notable achievements by other arctic nations:

- Multi-use approaches to the management of protected areas that aim to resolve or minimize conflicts between nature conservationists and users (eg. Canada and Alaska)
- The development of ecological tourism, cottage industries and other economic activities to raise funds and increase support for protected areas (e.g. Alaska and Norway) – while acknowledging the positive and negative impacts of these activities. The potential of ecological education, public outreach and recreational uses of protected areas should be further developed in Russia
- Publicizing information about protected areas and educating policy makers is an important and on-going process in other countries. This approach has been very effective in protecting natural areas via land use legislation in Alaska
- The provision and enforcement of clear regulations for public use of protected areas and permitted management activities. This will ensure that public experience of protected areas is in accordance with expectations
- Integrated approaches to protected areas management such as establishing heritage areas that consider both cultural and natural values
- Russia should develop a joint regional-federal commission on land-use planning that is based on the Alaskan model, and which will identify and make recommendations about future protected areas to the federal government
- Apply similar methods to those used in the early stages of protected areas planning in Alaska and Canada (e.g. gap analyses by WWF-Canada's Endangered Spaces Campaign)

to identify and evaluate conservation needs. A second example is the use of early research and indigenous knowledge in defining the boundaries of Nunavut, a recently established Canadian territory

- The use of existing institutions such as the Northern Forum, the Arctic Council and established governmental agencies to create a greater flow of information, with the aim of increasing the number of protected areas and elevating their conservation status
- Specific scientific achievements such as developing methods of identifying and evaluating permafrost conditions.

Session Two

Linking science and conservation - increasing common ground and capacity-building for conservation

During Session II, the working groups focused on improving linkages between scientific research and conservation in the Russian Arctic.

5. Where do connections exist between science and nature conservation in the Russian Arctic today?

Russian Arctic:

- Connections between science and nature conservation can mostly be found in zapovedniks (strictly protected reserves) that have research departments, but are also found in research institutes, etc.
- In Sakha (Yakutia), the Ministry of Nature Protection coordinates research with a nature conservation theme. The ministry also coordinates projects carried out by international non-governmental environmental organizations such as WWF, IUCN (World Conservation Union), Northern Forum and others
- Scientists are involved in all stages of the designation and management of protected areas. To provide an example, scientists assist in defining conservation categories when protected areas are established. This results in a high level of scientific integrity that positively distinguishes protected areas in Russia
- The Russian Heritage Institute combined historical and cultural studies with ecological investigations during the development of a comprehensive national park proposal for Novaya Zemlya. The protection of important areas was based on scientific research and inventories
- Scientific data collected within protected areas (e.g. Chronicles of Nature) is provided to:
  - existing research institutions for future work and explorations
  - appropriate administrative bodies and decision-makers
  - environmental and other NGOs.
- Currently, conservation science is often oriented towards a single discipline, usually biology
- There is a need to establish better links between science and protected areas management.

Arctic in general:

- Because scientists are frequently initiators of conservation movements and campaigns, connections between science and conservation are strong in the circumpolar region
- At several sites in Scandinavia, and here in the Lena Delta, research stations are associated with or located in protected areas (e.g. long-term historical station in Abisko, Saami-run research station in Laponia)

- The use and dissemination of scientific knowledge by UNEP (United Nations Environmental Programme) serves as an example of how science can be effectively linked with conservation
- In CAFF (the Arctic Council working group Conservation of Arctic Flora and Fauna), leadership roles are filled by scientific institutions and individual scientists
- The discovery by scientists that protection measures are required for Alaskan eider species is an example of science directing conservation management by addressing specific conservation-related questions. Scientific findings have led to concrete management actions in Alaska, particularly in cases where scientists took an active role in communicating their findings to different audiences
- Wildlife viewing activities (e.g. walrus monitoring in Alaska) provide opportunities for community-based monitoring
- An understanding of ecosystem dynamics, including both natural and anthropogenic processes, is a prerequisite for selecting natural areas for protection, engaging in responsible planning and predicting outcomes of various management and natural regimes. Specific examples of this type of research are studies of geese in the western Palearctic and research on human-related mechanical impacts on tundra habitats.

6. How can the realms of science and nature conservation cooperate more effectively?

General remarks:

- Arctic research should be more targeted towards answering conservation-related questions, and scientific task forces should be established for this purpose. Some suggestions are:
  - Ask the International Arctic Science Committee (IASC) to provide an overview of international scientific projects that are applying results to nature preservation, or which have this potential
  - Request the University of the Arctic to integrate activities that link science and conservation into study programmes (e.g. produce a list of nature conservation topics for potential masters and doctoral theses, use biological stations to foster international exchange programmes for students and/or to conduct research in the field of nature conservation)
  - Use "hot spots" in the Arctic as geographic loci for evaluations of global climate change.
- Continue efforts to make biological, oceanographic, climatological and other data collected by military institutions available to the conservation community, and where possible, take advantage of the military for logistical support to expeditions
- Because scientists play an important role in conservation work in Russia, it is important to find ways to fund Russian science and Russian scientists. The current economic climate in Russia may lead to a "brain drain"(e.g. the emigration of scientists to other countries)
- Scientific activities should be coordinated more effectively
- There is a need for an increased focus on "quality" rather than "quantity" in Russian science

- In addition to stating findings, researchers should also make recommendations based on their results.

Interdisciplinary approach:

- In order to expand the reach of science in nature conservation, it will be necessary to involve scientists of all appropriate specializations - not only those with expertise in the biological sciences. An integrated approach to nature conservation includes, among others, disciplines such as social sciences (history, economics, etc.), physical sciences and law
- Specific suggestions included:
  - Economic institutions could become involved in economic evaluations of nature conservation by exploring topics such as the impacts of subsidies on prospects for nature conservation
  - Improve environmental legislation at the local, regional and national levels, and improve the implementation of this legislation
  - Widen and institutionalize the use of traditional environmental knowledge and other forms of indigenous expertise in all aspects of science-based natural resource programmes and in the designation and management of protected areas
  - Communities are potential participants in multidisciplinary management teams. Co-management boards in Alaska and Canada are examples of this type of cooperation (e.g. Eskimo Whaling Commission, Walrus Commission).
- Promote exchanges of information and specialists between nature conservation organizations and scientific institutions working in similar areas
- Consider the utility of the antarctic model of linking scientific research and nature conservation via ecotourism.

Public outreach:

- The results of scientific studies should be provided to Russian administrators, decision-makers and the public as part of a broader effort in environmental education.
- The science world in Russia is too isolated; connections between the conservation community and educational institutions should be improved
- In order to build up tighter links between communities and scientists, greater efforts should be devoted to training local people for local conservation work. This might include “site specific training” and scientific capacity building
- Efforts should be made to make protected areas centres of ecological education. This would help to establish bilateral connections to local populations.

International cooperation:

- Enhance exchanges of conservation experience, specialists (international expeditions) and information between arctic regions and nations. Make wider use of international experience and technical and financial assistance (e.g. the US Arctic Research Commission and National Science Foundation). The US National Science Foundation is planning four new northern research stations, including one in Russia. The International Biological Station Lena-Nordenskiöld and the Willem Barents Station, among others, offer good opportunities for developing research capacity

- Promote and expand international networks of protected area managers
- Make use of the “sister cities” concept to promote relationships among protected areas having similar characteristics. Consider a triangulation or triplication of the Yukon-Kuskokwim, Lena and MacKenzie river deltas stations or protected areas
- The International Arctic Science Committee (IASC) could increase its contribution to specific fields relevant to arctic nature protection.

Protected areas:

- Increase the availability of literature, technical and methodological support for assessing data collected in protected areas
- Make use of all categories of protected areas, according to the recommendations of Russian and foreign scientists
- Maintain the scientific tradition of identifying “hot spots” in need of protection, and encourage scientists to provide tools for ongoing monitoring of the status of protected areas (e.g. remote sensing)
- Links should be established between governmental environmental bodies and research branches of zapovedniks.

7. How can the CAFF/GEF project in the Russian Arctic be effectively linked to other projects/activities?

Potential partners:

- In theory, it would be possible to link the CAFF/GEF (Global Environment Facility) project with almost any Russian bilateral programme (e.g. with programmes in Norway, Sweden, Finland, Barents, and the European Union)
- Include representatives of the Northern Forum and indigenous groups (e.g. Russian Association of Indigenous Peoples of the North (RAIPON) and the Saami Association) in the planning and implementation of the project
- The project could be linked to the WWF/GRID project on the "Twenty-Five Largest Unfragmented Areas in the Circumpolar Arctic" because data collected for these projects can be directly incorporated into the CAFF/GEF project
- Look for and build on similar efforts such as those underway in some zapovedniks
- Take the easiest possible approach to implementing projects. Develop local projects and search for local motivation
- It may be possible to increase cooperation between regions now that the State Committee on Ecology (Goskomekologiya) of the Russian Federation has been dissolved. Sakha and Taimyr could be potential sites for implementing the CAFF/GEF project as these regions have a comparatively long history of protecting natural areas.

Other proposals to facilitate project implementation:

- Advertise the CAFF/GEF project in the Russian mass media, hold seminars and conferences and produce joint publications
- Greater attention should be paid to the sustainable development of traditional nature use areas during the implementation of CAFF projects. Multi-use protected areas should be planned and created in selected regions
- Ensure that science-based conservation activities are economically reasonable and profitable
- Involve scientists from all over the world in the following fields and activities, among others:
  - Biodiversity conservation
  - Habitat fragmentation
  - Coastal and marine areas
  - Management strategy development and protected areas management
  - Inventories of cultural and natural heritage in the CAFF/GEF pilot regions.

8. How can practical challenges to implementing field projects in the Russian Arctic be dealt with?

Permissions:

- Request Russian federal, regional and local governmental officials to clarify and simplify issues concerning necessary permissions (e.g. customs, visas, medical documentation, etc.) related to travel in Russia and to the implementation of projects This information should be compiled and made readily available to prospective project organizers. The Ecological Travel Center (ETC) should be involved in presenting the information on the Internet
- Encourage ETC to facilitate research travel, access, permits, etc.

Cooperation:

- Improve networking opportunities to increase exchanges between researchers about successes and difficulties in planning, launching and implementing expeditions (e.g. an interactive website accessible to both expedition leaders/participants and research station directors/reserve managers)
- Research stations could provide brief (e.g. 20-page) summaries of natural and cultural resources in reserves, and of sites that might interest researchers. Research stations could also supply important information to local residents, managers, and scientists
- Since some arctic expedition/project databases already exist, merging those in existence and encouraging additional contributions may be more effective than creating a new database. For instance, CAFF generates circumpolar maps and descriptions for the Circumpolar Protected Areas Network (CPAN) vis-à-vis site-specific summaries and descriptions.
- When planning field projects, consider regional research interests in nature conservation

- Scientific projects should coordinate and share logistics with conservation projects
- Increase the percentage of Russian scientists in international field projects in Russia
- For Russians, funding presents a practical challenge to undertaking field projects.

Behaviour:

- Establish and implement an international Code of Behaviour for Scientific Expeditions and projects in the north. WWF's guidelines for arctic tourism and the "Rovaniemi Code of Conduct for Northern Businesses" could serve as models
- Implement environmental management plans according to current international standards for research stations and associated expeditions
- Visiting researchers should be prepared to donate resources (e.g. research equipment, library materials) to the research stations hosting them
- Involve locals in expedition activities as much as possible, and provide them with information about objectives, methods and results to improve operations.

Conclusion:

- The groups identified several challenges faced by western scientists working in Arctic Russia and came to the following general conclusion:
- All western researchers should realize that Russia is Russia.

Session Three

The international biological station Lena-Nordenskiöld: Capacity-building and future roles in biodiversity monitoring

During session three, the working groups evaluated the accomplishments of the International Biological Station Lena-Nordenskiöld and identified strategies for expanding its capacity. Recommendations were also made concerning the development of a management plan for the station.

Accomplishments of the Lena Delta Biological Station over the last five years:

General:

- The Sakha Republic (Yakutia) has created huge protected areas over the last few years. The establishment of the Lena Delta biological station led to an enlargement of the Lena Delta Reserve and reconfirmed the republic's goal of protecting over 20% of its territory. This first "Gift to the Earth" (a WWF campaign) has stimulated the creation of additional "Gifts" in Russia and around the world
- The station has supported many projects that have already published results. This work is improving global understanding of this region and is contributing to advancements in science
- The station is providing research opportunities for local specialists, and has activated and invigorated local research
- Research conducted out of the station has led to the discovery of new species and expansions of species' distributions.
- The station is still operating, as this successful hosting of a workshop serves to demonstrate. Station workers are still employed, but are minimally paid and have very low operating budgets

Developing staff skills:

- Language training (English)
- Training in information dissemination, marketing (promotion of the station) and workshop facilitation
- Training in project management, budgeting and reporting using standard western business practices to facilitate work with western donors and funding agencies
- Coordination of staff training activities of the Lena, Taimyr and Pechora stations
- Staff exchange programmes
- Training in simple monitoring activities such as bird ringing (banding)
- First aid training – ideally at the first responder or emergency medical technician level.

Assessment of Station Needs:

- A reliable connection between the station and the outside world via satellite phone and fax and e-mail/Internet access (from Tiksi) is necessary. Reliable contact between the station and field researchers is needed for safety; VHF radios or other appropriate equipment should be available to researchers working out of the station
- Reliable, predictable transportation between Tiksi and the station is required. Safe and reliable local transportation is needed as well (e.g. by skiffs and motorboats, snow machines and all-terrain vehicles). A boat should be rented from a contractor in Tiksi, instead of purchasing one. Packhorses could also serve as a means of transportation
- Basic equipment needed includes computer equipment, a map table and a library with general and scientific literature. Other equipment should be brought by researchers and left when research is finished
- A reference library should be available. The development of a reference collection of representative plants and animals should be considered
- A wet lab is needed. It should include basic lab equipment (e.g. microscopes), biological sampling and storage equipment (including a freezer for samples), and a waste management system
- Permanent field equipment (radios, camping gear, vehicles for researchers)
- A meteorological station
- First aid and emergency equipment
- Energy, water and sewage improvements
- A brochure and web page about the station and the zapovednik should be produced

Cooperation potential:

- Develop a promotional strategy and educational materials for the station. This could include publications, a website and multi-level information packets for schools, researchers, the public, tourists and funding organizations

  Outreach materials should contain information about the station and surrounding areas (including research opportunities), logistical considerations, transportation options, contact names and addresses, restrictions and research guidelines, permit needs, lists of available equipment/facilities, information about what visitors need to bring and budget information (costs of traveling to the station and using its facilities)
- During the discussion, it was pointed out that a website could be developed in cooperation with the Sakha (Yakutia) Ministry of Nature Protection and a Swedish research station. The potential Swedish partner could not only provide assistance in developing the website and outreach materials, but also could help in developing environmental standards for the station.

Networking:

- Organize and coordinate research activities at the regional, national and international levels. Make better use of international connections

- Develop a circumpolar arctic research station registry and website. This could list research opportunities, contacts, facilities, links to universities, research staff, etc. This network would facilitate information exchange, systematize monitoring, research methodologies, and advertise visitor and exchange programmes
- Establish student exchange programmes to build up a network of contacts. This could include bilateral student supervision
- Develop a summer school for local students that is organized and taught by station staff. Develop links between the school and international educational projects (Northern Forum, Sister Schools Shorebird Program, etc.)
- Clear links are needed between the station and the zapovednik. An integration of these two entities will facilitate international work in the Lena Delta.

Financial support:

- Sakhan authorities must take an active role in identifying the needs of the station and should appoint one responsible person that sponsors can rely on as an information source
- Develop a funding strategy, operating budgets and budget forecasts. International sponsors require a transparent overview of the costs associated with running the station. Identify funding sources and pursue funding
- There is a danger in overestimating the capacity and role of WWF with respect to the provision of long-term support to the station
- An international council could be convened to help guide the direction of research, or at least suggest research projects. Such a steering committee would serve solely in an advisory capacity and make recommendations about possible research projects.

Capacity-building and possible activities

- Identify research priorities or at the least, recommend research projects. An international council could be convened to help guide the direction of research, and/or to suggest research projects
- Establish the International Biological Station Lena-Nordenskiöld as a CAFF/AMAP monitoring site for the purpose of filling information gaps related to climate change, biodiversity and contaminants monitoring in the Russian Arctic
- Initiate a climate change programme (e.g. establish a climate station, take permafrost temperature measurements, etc.)
- The station should take care of practical arrangements for visiting scientists and expeditions. Station staff must be able to assist visitors in this regard
- Encourage the use of the station for workshops/meetings (e.g. for the Northern Forum)
- Because the station is inconveniently located for some researchers, the construction of smaller huts/houses in the delta proper should be considered. In Ny Ålesund, Svalbard, helicopter transport of mobile units/hut to field sites has solved this problem
- Environmental standards need to be considered
- Necessary work includes:

- Basic vegetation mapping
- Studies of the ethnography of modern and historic indigenous residents. This project is time sensitive, and considered a priority, because few elders remain and valuable information will soon be lost forever
- Establishment of permanent monitoring plots.

Visitor management

- The original purpose of the station, and its close tie to the zapovednik, should not be lost sight of. While there is room to develop tourism on some, probably small level, research support should be the primary function of the station
- Ecological tourism is seen as a potentially valuable revenue generator. However, the station is encouraged to begin on a small scale (e.g. 10 people at one time, to minimize initial investments and possible losses of limited resources). The remoteness of the station and its location in a unique delta habitat may be attractive to tourists. WWF and the Ecological Travel Center could coordinate initial tourism ventures
- Money generated through tourism should be used to support the station and the zapovednik
- Tourists should have some access to the nearby countryside. Consideration should be given to developing a trail system and offering guided hikes and hunting/fishing/bird watching in the surrounding barrier zone
- Academic activities such as workshops, training sessions, seminars, etc. should be promoted. The station could also organize academically oriented excursions from the station. Researchers from nearby institutions and others could be invited to these events.

Recommendations for an ornithological monitoring programme in the Lena Delta

Klaus-Michael Exo
Institut für Vogelforschung 'Vogelwarte Helgoland',
An der Vogelwarte 21, 26386
Wilhelmshaven, Germany,
Email: michael.exo@ifv.terramare.de

Diana Solovieva
Lena-Delta Reserve,
Fiodorova St., 28, Tiksi, 678400,
Yakutia, Russia,
Email: diana@DS3902.spb.edu

Abstract
The Lena Delta is the largest delta in the Arctic and is richer in wildlife than many other arctic areas. Among the largest protected areas on earth; the delta including the New-Siberian Islands covers 61,320 km^2. Because of its' overall international importance for numerous endangered plant, bird, mammal and fish species, a strict nature reserve, the Ust-Lensky "zapovednik", was established in the delta in 1985 and expanded in 1996. Creating protected areas, however, is not sufficient to ensure the maintenance of wildlife populations and ecological quality – monitoring the state of the environment and the effectiveness of mitigation measures is also necessary. Despite the delta's high international importance and the establishment of a nature reserve, relatively little attention has been paid to these activities to date. Achieving an up-to-date understanding of the ecological status of the area will require the development of an integrated environmental monitoring programme. This is even more urgent in view of global climate change, since many climate models predict a temperature increase in arctic regions over the next few decades, and indicate that the Arctic will experience the earliest and most pronounced effects of this warming.

In this paper, we present a general outline for an integrated ornithological monitoring programme for the Lena Delta. Birds are known to be generally sensitive to changes in environmental conditions caused by different factors, and for this reason are effective indicators of such changes. When assessing the status of bird populations and population trends in time and space, both for the purposes of overall monitoring and to detect "early warning signals" of environmental change, population size, breeding success and levels of contamination should be determined. Climatological data, arthropod density, and the numbers of lemmings and predators should be recorded in parallel. We also recommend that a bird ringing (banding) programme be developed to analyse migration routes, immigration, emigration and survival rates.

Keywords: Monitoring, birds, Lena Delta, Arctic

Introduction

Covering an area of about 32,000 km^2, the Lena Delta is the largest delta in the Arctic (for a detailed description of the area see PROKOSCH 1997, PROKOSCH & SOLOMONOV 1998, BELCHUSOVA et al. 2000). Owing to its' geographical location, wide range of habitats and favourable weather conditions during summer, the Lena Delta is richer in wildlife than tundra in the adjoining territory of Yakutia and many other arctic areas. Besides arctic and subarctic elements, northern-boreal faunal elements of Siberian, Asian and North American origin can be found there. By 1997, a total of 122 bird species were recorded in the delta, and of this total, 67 bred there at least once (LABOUTIN et al. 1985, POZDNYAKOV & SOLOVIEVA 1998, GILG et al. 2000). In addition to a high diversity of birds, the delta also supports high densities of some species. In 1997, GILG et al. (2000) registered mean densities ranging between 250 and 640 birds/km^2, mainly comprised of Lapland buntings (*Calcarius lapponicus*), grey phalaropes (*Phalaropus fulicarius*) and several *Calidris* sandpipers (see BLOKHIN 1990, 1998, BELCHUSOVA et al. 2000). The transcontinental migration routes of birds breeding in the Lena Delta are widely dispersed and complex. Overwintering sites of these species are located in Australia, south and southeast Asia, America, Africa, and Europe.

Despite the Lena Delta's overall international importance for many (including endangered) bird species, and the establishment of the Ust-Lensky "zapovednik" (strict nature reserve) in the delta in December 1985 (e.g. VOLKOV & KORTE 1994, PROKOSCH 1995, 1997, PROKOSCH & SOLOMONOV 1998), relatively little attention has been paid so far to the assessment and monitoring of environmental conditions, including the status of breeding bird populations. This is a serious concern, since access to reliable population data is crucial to the effective conservation and management of the area, and would improve the current understanding of factors regulating populations. A targeted monitoring programme is even more vital when considered in light of global climate change, as climate models predict a temperature increase over the next several decades, with arctic regions experiencing the earliest and most pronounced effects of this warming (NEILSON & DRAPEK 1998, ZÖCKLER & LYSENKO 2000). In spite of this, long-term monitoring of biotic and abiotic parameters to document environmental changes has only been carried out at very few arctic sites, such as Zackenberg, Greenland (MELTOFTE & BERG 2000). Recently, a breeding bird monitoring programme was initiated in northwestern Taimyr (TULP et al. 2000, KLAASSEN & KHOMENKO 2001).

Why monitor?

The establishment of protected areas alone is not sufficient to ensure the maintenance of wildlife; the status of ecosystems and the effectiveness of policy and mitigation measures must be closely followed. A sound environmental monitoring programme is therefore essential. Since the term "monitoring" is often applied in a very broad sense, it will be more narrowly defined for the purpose of this discussion. According to FURNESS et al. (1993), elements of a proper monitoring programme include surveillance (repeated surveys using standardised methods) plus: (1) assessment of any changes against some standard or target, (2) the data must be collected in such a way that reasons for departure from the standard are readily apparent, and (3) provide a clear understanding of the objectives of the programme. An integrated monitoring programme that fulfils these targets would function as an "early warning system" for detecting environmental change, because detrimental factors affecting the ecosystem would be evident at an early stage. It would also provide the information necessary to guide policy makers in effective decisions about conservation measures and management.

Though an integrated monitoring programme will aim to elucidate reasons for population changes, causal factors will not necessarily be obvious from monitoring data alone. In order to overcome this shortcoming, an indispensable tool, concomitant research, should supplement the monitoring programme. Research should also accompany monitoring of the effects of measures introduced to counter environmental deterioration.

Why monitor birds?
There are many possibilities for monitoring environmental change. The selection of monitoring elements strongly depends on the objectives of a study, or the "issues of concern" being investigated. Issues of concern in arctic ecosystems can be the effects of climate change, impacts of fisheries, inputs of pollutants and impacts of tourism on the environment. As a starting point in assessing environmental change in the Arctic, we recommend the monitoring of bird populations for several reasons (for details e.g. FURNESS & GREENWOOD 1993, BIBBY 1999, GREENWOOD 2000). Birds are long-lived organisms occupying a high trophic level. Furthermore, they are extremely mobile and use a variety of different resources. Thus they integrate over many different factors, time and spatial scales (e.g. climate change, contamination, eutrophication, fisheries and tourism). Some of these influences would be hard to detect individually, such as the effects of environmental stressors occurring at lower levels.

The value of birds as indicators can be viewed from different perspectives. As mentioned previously, they can signal the early stages of environmental deterioration. Moreover, birds themselves are the subjects of conservation efforts. Their importance in arctic ecosystems is illustrated by the fact that 95% of all *Calidrid* sandpipers and more than two thirds of all geese breed in the Arctic (ZÖCKLER 1998). Other reasons are more pragmatic: Birds are especially well-studied organisms and are easy to identify, and for these reasons data about them are easy to collect. Further, there is a considerable public interest in birds.

The main aim of this short contribution is to present a framework for an integrated ornithological monitoring programme in the Lena Delta Nature Reserve (LDNR) and to provide impetus for its development. We are not suggesting the establishment of a completely new programme. A lot of work is being carried out at present, but investigations are often poorly coordinated, and methodologies often vary between projects. For this reason, much of the data collected thus far are not readily available or are not comparable to data from other sources. What we are proposing is a greater harmonisation and coordination of existing programmes, with the introduction of standard and possibly more effective methods. This will increase the benefits of existing projects and improve the management of the LDNR.

Population size, breeding success and levels of contaminants in selected species are parameters that should be measured when assessing present and future trends in breeding bird populations and when using birds as indicators. We also recommend the establishment of a long-term ringing programme to analyse migration routes, immigration and emigration and mortality rates. In combination with parallel assessments of climatological data, the availability of arthropods, numbers of lemmings and predators, etc., it should be possible to detect short-term fluctuations as well as long-term changes in environmental conditions.

Breeding bird census
Despite the international importance of the Lena Delta for birds, including endangered species, and the establishment of a "zapovednik" in the delta more than 15 years ago, realistic estimates of most breeding bird populations are still lacking. The first bird counts were carried out in the 1960s (EGOROV 1965). Some aerial surveys were conducted in the 1980s in preparation for the establishment of the LDNR (LABOUTIN et al. 1985). The last aerial survey was carried out in 1994 (HODGES & ELGRIDGE 1995). These counts have provided some evidence of pronounced fluctuations in bird populations. For example, survey data show that numbers of *Anser* geese breeding in the LDNR have declined dramatically

since the 1960s, to about one-tenth of the numbers documented during this decade. Bewick's swans (*Cygnus columbianus bewickii*) declined in the 1970s and 1980s, but increased in the 1990s. Aerial surveys are only appropriate, however, when counting colonial breeding species and larger, conspicuous birds such as ducks, geese and swans. In order to evaluate the importance of the LDNR for breeding bird populations and to assess protection measures, total population sizes of all common and/or endangered species should be recorded regularly. Information about breeding bird densities and distribution provides a baseline for effective conservation action.

The specific objectives of monitoring breeding bird numbers in the Lena Delta are:

- To monitor changes in the size of the total breeding bird population;
- To monitor changes in spatial distributions of populations and in habitat use;
- To provide the data necessary to estimate total flyway populations;
- To estimate the percentages of different flyway populations breeding in the Lena Delta;
- To monitor the effects of nature conservation measures, global climate change, sea level rise, contamination, etc.; and
- To establish an "early warning system" for detecting environmental change.

When attempting to assess trends in numbers of widespread species over time and space in the Lena Delta, two important considerations must be made: (a) As it is not possible to survey all typical breeding bird species in the entire delta, a sample set of representative census areas (reference areas) must be established where annual counts can be carried out, and (b) standardised and repeatable counting techniques must be implemented.

To approach adequate species representation, the following criteria must be fulfilled:

- All principle types of habitat used by breeding birds in the LDNR must be represented (e.g. polygonal tundra, maritime tundra and southern grassy tundra). A stratified sampling technique considering different habitat sizes and breeding bird densities appears to be appropriate;
- Reference areas should be distributed to include the entire terrestrial area of the delta;
- Each reference area should cover only one distinct habitat type;
- If possible, areas investigated in the past should be selected; and
- Only those sites where long-term monitoring appears feasible should be selected.

All species should be counted in reference areas, and standardised methods must be implemented. Two standard techniques are likely appropriate: (a) line transects, involving counts of all individuals, with the exception of flocks, and (b) mapping of territorial pairs in census areas. In addition to annual surveys of all species in reference areas, the census programme should include complete surveys of selected "target" species (e.g. colonial breeding species) once every five years. Colonial breeding species should be counted by means of aerial surveys. Additionally, the distribution and population sizes of large mammals e.g. reindeer *(Rangifer tarandus*) and muskox *(Ovibos moschatus*) should be mapped. Annual surveys should be carried out in June/July.

Methodological details such as the number and distribution of representative key sites (reference areas), census methods and timing must be worked out by a group of monitoring experts connected to the International Biological Station Lena Nordenskiöld (IBS) and the LDNR. Satellite-based remote sensing may be used to inventory habitats (e.g. MORRISON 1997). We propose to carry out the first complex aerial survey under the supervision of the US Fish and Wildlife Service in 2002. Detailed habitat mapping should also be carried out during this survey. This will help in preparing for investigations of most other monitoring elements.

Breeding success

On a long-term scale, environmental changes are reflected in changes in population numbers. However, many long-lived species, such as waders (shorebirds) and waterfowl breeding in the Arctic are “K strategists” (i.e. annual survival rates of adults are high, annual reproductive output is low and sexual maturation is slow). The effects of environmental changes on populations of these species will not become evident for some time, and may be delayed for a number of years (e.g. PULLIAM 1988, NISBET 1989, WALSH et al. 1991, BECKER 1992, EXO et al. 1996, THYEN et al. 1998). Negative environmental trends are much more quickly detected by estimating breeding success than by estimating population numbers. For example, in so-called “sink” habitats, populations may persist for years, even though within-habitat reproduction is insufficient to balance mortality. In these habitats, breeding bird populations can be maintained by immigration from “source” areas nearby (PULLIAM 1988).

Furthermore, monitoring breeding success in different habitats can shed light on reasons for population changes (e.g. by recording causes of nest losses), and is crucial to the successful use of birds as environmental indicators and to the quick implementation of counter-measures. For most arctic species, data on breeding success is limited to percentage estimates of juveniles in wintering populations obtained from counts at traditional wintering sites (e.g. SUMMERS & UNDERHILL 1987). These data may indicate overall annual breeding conditions in the Arctic and total numbers in flyway populations, but are not reflective of local conditions.

The most important indicator of breeding success is the number of fledged young per pair. As a first step however, we recommend the collection of data on clutch size and hatching success, including causes of nest losses. Recommending standardised recording methods should be fairly easy, particularly for these two parameters. The locations of nests can be marked by recording GPS coordinates and/or with a stick or stone placed about 10 m from the nest. By floating eggs in water, the incubation stage can be determined (e.g. VAN PAASSEN et al. 1984, TULP et al. 2000). To avoid guiding predators to a nest, nests should not be visited again until the estimated hatching date. Fledging success of (most) species can be estimated by counting adults and juveniles in defined areas at the end of the breeding season. However, species-specific recording methods need to be developed and implemented.

In addition to fledging success, we recommend the measurement of body mass development of individual chicks of selected species. Body mass is a good indicator of prey availability and the feeding situation in different areas and in different years (EXO et al. 1996, THYEN et al. 1998).

When studying breeding success, species should be selected according to the following criteria:

- The LDNR must be a typical breeding area for the species in the circumpolar Arctic;
- The species must be common in the LDNR and a regular breeder, so that investigations can be carried out on a reliable number of clutches;
- Species breeding in a range of representative habitats in the LDNR should be selected, such as polygonal and maritime tundra;
- Consideration should be given to different feeding strategies (e.g. fish-eating birds, species preying mainly on arthropods, grazers etc.);

- The availability of standardised methods of monitoring breeding success in different areas by different observers; and
- Preferably, species investigated in the past should be selected.

In the LDNR, the breeding success of Bewick's swan (*Cygnus columbianus bewickii*), brent geese (*Branta bernicla/nigricans*), king eider (*Somateria spectabilis*) and Steller's eider (*Polysticta stelleri*) has been studied for several years. Information about the breeding success of the following species is also needed: Black-throated diver (*Gavia arctica*), grey plover (*Pluvialis squatarola*), little stint (*Calidris minuta*), grey phalarope (*Phalaropus fulicarius*), Ross's gull (*Rhodostethia rosea*) and snow bunting (*Plectrophenax nivalis*). Studies should be carried out in at least two "reference areas" per habitat type. At least 20 clutches per species and reference area should be investigated.

Evaluations of breeding success are a very useful tool for assessing the state of arctic ecosystems and, hence, for conserving them. However, monitoring of individual parameters, such as breeding success, often only reveals disturbances to the ecosystem, even if additional data on causes of nest losses are available. For this reason, monitoring of hatching and fledging success should be directly linked to monitoring of chemical pollution and food availability.

Arthropod density and seasonal abundance

Arthropods are the main food source for most waders and some sea ducks breeding in the Arctic. Besides annual weather conditions and the abundance of predators, such as Arctic foxes (*Alopex lagopus)*, skuas (*Stercorarius pomarinus*, *S. parasiticus*, *S. longicaudus*) and gulls (e.g. *Larus argentatus, L. hyperboreus*), the availability of arthropods is one of the main factors determining breeding density, annual timing of breeding and reproductive output. Therefore, it is strongly recommended that arthropod availability be monitored in parallel to studies of breeding bird density and breeding success. Moreover, a survey of arthropod densities in different habitats of the LDNR should be considered, since a pilot study in 1997 found that densities of arthropods (except *Coleoptera*) were lower in the southeastern part of the Lena Delta than in other areas, such as Taimyr (EXO & STEPANOVA 2000).

Sites for sampling terrestrial arthropods should be selected in such a way that a range of different habitats in the reserve is covered, similar to study plots for recording breeding density and breeding success in birds. Besides large-scale differences, variability in microenvironmental conditions should be considered when selecting study plots. The availability (or activity) of surface-living arthropods should be monitored using standard pitfall traps. Window traps can be used for flying insects (for details see SOUTHWOOD 1992). Ten traps per habitat type are likely to be sufficient for recording the occurrence of arthropods in different habitats. The trapping season should last from the beginning of snowmelt until the end of August/early September. Although neither of these methods measures arthropod abundance in a strict sense, the use of pitfall traps is recommended because it is a very effective method of estimating the activity of surface-living arthropods, and thus, the availability of prey. Furthermore, it is a standard technique, which means that data from different habitats and regions are easy to compare. Another advantage is that trapping is not as time consuming and destructive as other methods, such as soil sampling.

For most gulls and ducks, and especially their young, chironomid larvae are the most important prey item. For this reason, the abundance of chironomid larvae should also be recorded (e.g. by means of standardised core samples or by using water and emergence traps, SOUTHWOOD 1992).

Contamination of eggs

Organisms occupying high trophic levels such as birds are particularly sensitive to environmental conditions and are generally considered to be effective bioindicators of toxic and persistent environmental chemicals. In several countries, bird populations are being used to monitor the current condition of the environment as well as to identify long-term trends (e.g. BECKER et al. 1992, 1993, 1998, FURNESS 1993). In particular, collecting and analysing bird eggs has many advantages: eggs reflect geographical and annual contaminant levels in breeding sites, even in species which migrate over large distances, and they are easy to collect and analyse (e.g. GILBERTSON et al. 1987, BECKER 1989, DIETRICH et al. 1997, BECKER et al. 1998). Egg collecting does not involve the killing of animals, and breeding success is only marginally reduced by this practice. Furthermore, relationships between contaminant levels, eggshell quality, and hatching and fledging success can be studied.

Though most arctic regions are only sparsely populated and are remote from industrial activities, high levels of various toxic chemicals and heavy metals still accumulate in arctic environments, mainly by long-range airborne transport from industrialised regions (see compilation in AMAP 1998). Despite the fact that increasing pollution in different areas of the Arctic has been documented repeatedly and that arctic ecosystems are known to be especially vulnerable to pollution, there have been few studies of chemical contamination of arctic biota. However, a recent study of contaminants in grey plover (*Pluvialis squatarola*) eggs from the Lena Delta revealed that HCH (organochlorine) contamination was about 10 times higher than in wader eggs from northwestern Europe (EXO et al. 2000). This may indicate the direct input of HCH from industrial sources to the Lena Delta.

When using animals as indicators of early stages of environmental change, species occupying different trophic levels and employing different feeding strategies should be selected. In the Lena Delta, we recommend analyses of contaminants in the eggs of species that meet these criteria, such as Bewick's swan (*Cygnus columbianus bewickii*), king eider (*Somateria spectabilis*), ptarmigan (*Lagopus mutus*), little stint (*Calidris minuta*) / dunlin (*Calidris alpina*), herring gull (*Larus argentatus*) and arctic tern (*Sterna paradisaea).* These species are common breeders in the Lena Delta, and in much of the Arctic. This means that it is possible to compare geographical differences between populations.

Besides industrial chemicals such as polychlorinated biphenyls (PCBs), HCB (hexachlorobenzene) and mercury, organochlorine pesticides such as HCH and DDT should be analysed. In parallel, parameters such as egg weight, length and width, and the weight and thickness of eggshells should be measured. We recommend that 10 fresh eggs be collected annually from each species for this purpose. This modest sample size is an appropriate compromise between the interests of species conservation, the high costs of chemical analyses and statistical requirements (e.g. BECKER et al. 1998). To ensure reliable and comparable results, the collection of eggs and chemical analyses should be carried out according to international standards (e.g. the "Joint Assessment and Monitoring Programme" (JAMP) of the "Oslo and Paris Conventions" ; OSPAR 1996, SOMMER et al. 1997, BECKER et al. 1998).

Migration routes of birds breeding in the Lena Delta

Many of the Lena Delta's breeding birds have complex and widely dispersed migration routes. Breeding birds arrive from overwintering sites all around the globe: Australia, south and southeast Asia, India, America, Africa and Europe. The delta is located at the interception of several different flyways: the East Atlantic, the West Asian/African, the Central Asian/Indian and the East Asian/Australasian flyways. A marine route, the arctic flyway, passes over polynyas in the Laptev Sea and along the coast of the Arctic Ocean westward (SOLOVIEVA 1998). It appears that for many wader species, the Pacific route is the most important one (POZDNYAKOV & SOLOVIEVA 1998).

Much less is known, however, about migration routes and wintering areas. Ring recoveries show that Steller's eiders (*Polysticta stelleri*) fly to moulting lagoons in southwest Alaska after raising young in the delta, and that brent geese (*Branta bernicla nigricans*) winter in the Gulf of Mexico. So far, rings have been recovered from only three wader species: the little stint (*Calidris minuta*), from Hungary (SOLOVIEVA 1996), the sanderling (*Calidris alba*), from Great Britain (LEBEDEVA 1985) and the curlew sandpiper (*Calidris ferruginea*), from Australia (OSTAPENKO 1980). There are some indications that curlew sandpipers winter in both Australia and South Africa (POZDNYAKOV in press).

Many long-distance migrants, including species breeding in the LDNR are declining as a result of large-scale constructions and the degradation of natural habitats along migratory routes and in wintering quarters. For this reason, the identification and protection of important stopover sites and overwintering grounds are top conservation priorities. The conservation of long-distance migrants will require the establishment of global networks of protected areas (e.g. MATTHEWS 1993, DAVIDSON & STROUD 1996, DAVIDSON et al. 1999, ASIA-PACIFIC MIGRATORY WATERBIRD CONSERVATION COMMITTEE 2001). It is also recommended that a regular banding programme be initiated to gain a clearer understanding of the migration routes used by species which breed in the Lena Delta. The interception of different continental flyways in a relatively small area makes the delta a unique location for the study of migration. The annual phenology of migration can be recorded by regular transects or point counts of migrating birds in selected areas. Recent analyses of long-term data sets indicate the some (bird) species respond to global warming by advancing phenological events (e.g. migration, egg laying) and that effects of warming can be detected by monitoring phenological events (e.g. CRICK & SPARKS 1999, HUGHES 2000).

Bird ringing is not only a vital tool for studying migration routes, it also offers excellent possibilities for understanding mechanisms underlying population trends and life history strategies (e.g. by recording survival rates of adult and juvenile birds as well as immigration and emigration rates; BAIRLEIN et al. 1994, BAILLIE et al. 1999, DAVIDSON et al. 1999, PEACH et al. 1999, SPINA et al. 1999). As a tool, bird ringing is essential to an integrated monitoring programme. When ringing adults, biometric measurements should be recorded using standard techniques (e.g. EVANS 1964, 1986, SVENSSON 1992, BAIRLEIN 1994a, ENGELMOER & ROSELAAR 1998).

Organisational structure

The aim of this contribution is to present some initial ideas for an ornithological monitoring programme and to stimulate the development of an integrated ecological monitoring programme in the LDNR (see BAIRLEIN 1991, 1994b, 1996, BAILLIE et al. 1993, 1999, FURNESS & GREENWOOD 1993, BIBBY 1999, GREENWOOD 2000). A more detailed concept specifying the selection of study sites and (field) methods should be developed by an expert group linked to the IBS Lena Nordenskiöld and the LDNR. As far as possible, the programme should be built on existing programmes, but methodologies must be harmonised and missing elements added. It is also recommended that international monitoring programmes and action plans, such as the Arctic Monitoring and Assessment Programme (AMAP), the Conservation of Arctic Flora and Fauna (CAFF), the Convention on Biological Diversity, the Asian-Pacific Migratory Waterbird Conservation Committee and the Convention on Wetlands of International Importance (Ramsar Convention) be consulted to guarantee an integrated and harmonised circumpolar network. In particular, monitoring of long-distance migrants requires a high level of international cooperation. The government, local communities and non-governmental organisations should be involved in the development of the programme. The BioBasis Manual for the Zackenberg Ecological Research Operations (MELTOFTE & BERG 2000) and the monitoring programme started by Foundation WIWO (Stichting Werkgroup Internationaal Wad-en Watervogel Onderzoek, Zeist, The Netherlands; TULP et al. 2000, KLAASSEN & KHOMENKO 2001) could serve as models of elaborate and successfully integrated programmes. Once finalised, an outline of the monitoring programme, including methodological details, should be published as a manual. Before establishing the final programme, the applicability of the techniques as well as the value of the study elements chosen as indicators of environmental change should be assessed. We therefore recommend a pilot phase lasting two years. The results of the pilot studies will form the basis for a final monitoring programme. After 5–10 years, when baseline data are available, thresholds for taking actions, or "ecotargets", should be established.

An appropriate institutional framework and sufficient governmental support are essential to the successful implementation of an environmental monitoring programme. The IBS, which was built to encourage cooperative biological studies, provides excellent possibilities for establishing a monitoring programme. A full-time senior researcher employed by the IBS should supervise and manage the programme. This person should be responsible for the development and publication of the manual, the organisations of data collection, updating sampling procedures, data evaluation and analyses and the presentation of annual reports. Fieldwork should be carried out by staff from the LDNR/IBS and part-time assistants (e.g. students).

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Integrated ecosystem management approach to conserving biodiversity and minimizing habitat fragmentation in the Russian arctic: (ECORA)*

A joint project of Russia, the United Nations Environment Programme (UNEP) and Conservation of Arctic Flora and Fauna (CAFF), supported by the Global Environment Facility (GEF)

Snorri Baldursson
Executive Secretary, CAFF Secretariat
PO Box 375, 600 Akureyri, Iceland
Email: snorri@ni.is

Lars Kullerud
Polar Programme Manager at UNEP/GRID Arendal
Service Box 706, 4808 Arendal, Norway
Email: kullerud@grida.no

History

In the summer of 1999, the Chair of the Arctic Council programme for the Conservation of Arctic Flora and Fauna (CAFF), the Russian Federation and the Global Resources Information Data Base–Arendal, Norway (UNEP/GRID-Arendal) initiated a project to conserve biodiversity and minimize habitat fragmentation in the Russian Arctic (ECORA). An early concept paper was prepared which resulted in a project development grant (PDF-A) from the Global Environment Facility (GEF) and financial support from Norway and other countries. The main activity during the PDF-A phase of the project was a stakeholder workshop held in Moscow, February 2000, to secure the commitment of regional and federal Russian authorities. A second project development grant (PDF-B) was approved by GEF in late July 2000. This paper briefly describes the activities undertaken in the PDF-B phase and the proposed full project.

Summary: Project Objectives and Description

The overall objective for the full project is the conservation and sustainable use of biodiversity in the Russian Arctic. This will be achieved through the adoption and implementation of integrated ecosystem management strategies and action plans in three carefully selected landscape/ecosystem units or Model Areas. The project will concentrate its efforts on improving ecosystem management in ecologically and culturally important locations of the Russian Arctic where economic development pressures and threats to biodiversity are intense and existing protection measures are weak. The project will encourage and establish mechanisms for full consultation and participation of indigenous peoples, local communities, affected economic sectors, relevant non-government organizations, regional authorities, federal authorities and other stakeholders.

The full project will serve as a standard for the development of multi-sectoral and integrated ecosystem management strategies to conserve biodiversity in other regions of the Russian Arctic and beyond. It will draw upon best practices and experiences from other arctic

* Content of original manuscript has been updated.

countries and contribute new knowledge that will be shared throughout the circumpolar region.

PDF-B phase activities, Fall 2000 through 2001:

To support the development of a full project brief and application, the following activities were conducted during the PDF-B phase:

Activity 1: Project management and administrative support

Development of a project management structure comprised of:

- A **steering committee** represented by the Russian Federation Ministry of Natural Resources (RF MNR), the United Nations Environment Programme (UNEP) and CAFF. The role of the committee was to oversee the entire project.
- An **Expert Task Team (ETT)** composed of representatives from all major national and international project stakeholders including relevant Russian federal ministries, expert agencies and the Russian Association of Indigenous Peoples (RAIPON). Its role has been to provide overall coordination and stakeholder input, as well as technical support and advice.

Activity 2: Project meetings

Necessary project meetings were organized and held when required.

Activity 3: Stakeholder consultations

Consultative and fact-finding missions to five regions (okrugs) of arctic Russia were carried out during the summer and autumn of 2001. Consulting with the six arctic regions was necessary as the information base collected during the PDF-A phase was not sufficient to select the planned model areas.

Activity 4: Selection of model areas

During the PDF-B phase of the project, three model areas were selected from an initial list of 23 proposed sites. The areas selected for inclusion in the main phase of ECORA are: Kolguev Island (Nenets Autonomous Okrug), Kolyma River Basin (Yakutia/Sahka Republic), and Beringovsky (Chukotka Autonomous Okrug).

Activity 5: Overview of protected areas in arctic Russia: federal and regional levels

The Circumpolar Protected Areas Network (CPAN) project has maintained a registry of existing and proposed circumpolar protected areas larger than 10 km^2 in size that meet the criteria for World Conservation Union (IUCN) categories I–V. For the Russian Arctic, however, only federal protected areas (plus a few major regional ones) have been registered. To obtain a more detailed picture of conservation efforts in the model areas, a report describing and illustrating all relevant aspects of protected areas issues in those areas was prepared.

Activity 6: Overview of ongoing international projects and identification of scientific support for biodiversity conservation in the Russian Arctic

A multitude of local and international conservation projects (bilateral, multilateral, non-government, etc.) are currently operating in the Russian Arctic. All of these projects are addressing important conservation issues. However, it is doubtful that they collectively address the fundamental conservation needs or priorities of this region. The objective of this activity was to make a compilation of ongoing international projects and an analysis of their potential relationships to the ECORA project.

Activity 7: Base map of biological and cultural diversity, undisturbed ecosystems and main threats to biodiversity in the Russian Arctic

An analysis was made of the availability and quality of maps of biological and cultural diversity, biodiversity, intact ecosystems, and major threats to biodiversity in the model areas. Information was gathered from Russian institutions, as well as CAFF and other international projects. This information will be used as a baseline for preparing thematic maps for the model areas in the main phase.

Activity 8: Circumpolar review of best practices of integrated land-use and ecosystem management

The objective of this activity was to compile an overview of, and evaluate experiences in, developing and implementing integrated ecosystem management strategies in the circumpolar Arctic, and to assess them for transferability to Russia. The practices and processes identified will be used as a basis for creating integrated ecosystem management plans in the main phase of ECORA.

Activity 9: Review of legislation, socio-economic infrastructure and administrative arrangements relevant to the project

The critical legal, administrative and socio-economic frameworks that regulate activities of relevant sectors, institutions, enterprises and private companies on the regional and local level were reviewed. This activity identified the legal and policy reforms needed for improving management and conservation practices and may contribute to the modification of regional laws, regulations and practices.

Activity 10: Feasibility reports from regions

The five arctic regions involved in the PDF-B phase prepared feasibility reports. These reports focused specifically on information availability and needs, regional expertise, main sectoral/industrial interests, training and capacity-building needs and proposed implementation mechanisms for the main phase of ECORA.

Activity 11: Preparation of draft training programmes

Based on the feasibility reports prepared in Activity 10, initial requirements for training and capacity-building programmes in the selected regions/model areas were identified to enable rapid implementation during the full project phase.

Activity 12: Prepare a draft project evaluation plan

Each step of the main project was subject to an outside evaluation that was carried out at set intervals and stages of implementation of the project.

Activity 13: Prepare the GEF project brief

A project brief was (i.e. application for a full project) prepared based on the findings of the above activities and submitted to the GEF for funding of the main phase of ECORA.

PDF-B Phase Activities 2002:

Project activities for 2002 are outlined on the ECORA website: http://www.grida.no/ecora/

Status of a concept for the development of protected natural areas in the Russian Arctic

Stanislav Belikov
All-Russian Institute for Nature Protection
113628 Russia, Moscow, Znamenshoe Sadki
Email: arctos@glasnet.ru

Presently, the network of natural protected areas (NPAs) in the Russian Arctic consists of 11 zapovedniks (strictly protected areas), two national natural parks, one regional natural park, approximately 300 zakazniks (reserves) and natural monuments. Most NPAs are concentrated in the Republic of Sakha (Yakutia). In total, NPAs comprise about 11% of the Russian Arctic. In comparison, 56% of the total terrestrial area of the Svalbard archipelago and 72% of its surrounding waters are protected. The state of Alaska has protected 57% of its area in some form.

Although notable progress is being achieved in optimizing the protected areas network in the Russian Arctic, a number of problems remain unsolved. National and natural parks and territorial reserves and refuges needed to support traditional subsistence uses of nature in coastal zones are poorly represented. Representative natural sites, or zapovedniks, are not yet established in all landscapes of high conservation priority, and a special strict protection regime has not been applied to sacred sites and Ramsar sites.

Additionally, a concept for the further development of the NPA system in the Russian Arctic is lacking. However, a draft general concept has been prepared with the assistance of WWF-Russia. Basic principles of the general concept may be applied to the Russian Arctic, however; this region has distinct natural, social and economic characteristics that must be considered. Features which set the Arctic apart from other regions include: ecosystems which are highly vulnerable and sensitive to human-related impacts (two-thirds of the region is ice-covered year-round), a complex of national and international legislative regulations concerning the protection and use of biological resources in an exclusive economic zone, and the existence of 30 small aboriginal groups whose subsistence economies almost completely depend on traditional uses of natural resources (e.g. fishing, hunting, reindeer grazing, sealing and whaling). In addition to the general concept, it will be necessary to develop regional concepts that reflect environmental and socio-economic conditions in different territories.

Within the present vision, which is being designed specifically for the current transitional period of the Russian economy, NPAs are the main instrument for securing ecological safety, balanced resource use, the protection of biological and landscape diversity, and favourable environments for local and indigenous peoples. The development of an NPA system must exceed the pace of economic development in the Arctic while taking into account national and global experience, the traditions of local and indigenous peoples and specific environmental and socio-economic conditions in particular ecoregions (i.e. the Barents and Bering Sea basins). The system must be linked to NPA systems in non-Arctic Russia and to the Circumpolar Protected Areas Network (CPAN).

Reserving areas for future NPAs is a pro-active measure that will protect lands at the territorial level. However, establishing NPAs in areas where local and indigenous communities use natural resources is only acceptable if communities agree with proposed regulations.

Conservation of biological diversity is one of the major reasons for developing an NPA system in the Russian Arctic. The All-Russian Institute for Nature Federation has proposed an NPA system for the Russian Arctic comprised of several regional sub-systems with clearly defined boundaries. This would require an appropriate partitioning of terrestrial and aquatic areas. Important challenges to the conservation of biodiversity in the Russian Arctic are overharvesting of resources, mostly of fish stocks, and anthropogenic contamination of coastal and marine areas. Certainly, global climate change and the depletion of the ozone layer are also serious problems.

The arctic region is very important to the future economic development of Russia. Huge hydrocarbon deposits have been discovered on the coastal shelf, and the production and transport of oil and gas are perhaps now the most important threats to the Arctic's biodiversity. It is imperative that an NPA system be established to protect critical habitats while there are still opportunities to do so.

The most polluted areas in arctic seas in Russia are bays, inlets and water bodies near the mouths of major rivers. Unfortunately, important migration routes and feeding and reproductive grounds of marine animals are usually located in these areas. Because most contaminants are transported from southern territories, establishing NPAs in coastal and marine areas alone will not be adequate to solve pollution problems. It will also be necessary to include the basins of great arctic rivers when developing NPA networks.

A major gap in existing networks of NPAs lies in the marine/coastal realm. Although a number of reserves and natural monuments extend to the coastline and even have offshore components, few offshore zones are currently protected. The situation is somewhat better for zapovedniks: 7 of 11 zapovedniks have protected offshore zones, and between 25 and 50km of the marine zone is protected by the Wrangel Island zapovednik.

As a rule, the most biologically productive and diverse areas in arctic seas are located along coastlines, off archipelagos, over oceanographic fronts, in the marginal sea ice zone, and in persistent polynyas. Although they function as ecological bridges and corridors, NPAs with fixed boundaries cannot be established in such areas, because they undergo dramatic seasonal and inter-annual changes. A possible solution is to include them (upon nomination by regional authorities) in a list of areas of special concern. This will require some restriction of economic activities, primarily shipping, and oil and gas exploration and development.

From a practical point of view, an inventory of territories and special thematic maps, such as undertaken for the Murmanskaya Oblast, should precede the development of the NPA network. The "Ecological Atlas of the Murmanskaya Oblast" issued in 1999 shows natural and ecological conditions, anthropogenic impacts, the status of ecological complexes and the medical situation in the region. Maps should be accompanied by a cadastre (official document containing a set of data) of plants and animals and a cadastre of NPAs. Allowances should be made for precise evaluations of economic losses caused by human activity.

Scientific research and monitoring are the responsibilities of state nature reserves. Monitoring is presently carried out in only 6 of 11 reserves. These reserves are Wrangel Island, Ust-Lensky, Kandalakshsky, Pasvik, Taimyrsky and Putoransky.

It is widely known that the catastrophic state of affairs concerning research in natural reserves in Russia is primarily a result of a very low level of government funding. Scientific research in NPAs should be adequately supported through the state budget. The present situation necessitates that research efforts focus on one or two key themes in all or a majority of zapovedniks. This type of research, which could be key to an understanding of arctic ecosystem processes, should be conducted both in NPAs and in contiguous territories where human activities are important.

The exchange of rangers as a tool in nature conservation in the North*

Mats-Rune Bergström
Principal Administrative Officer, County Administration of Västerbotten
Storgatan 71 B, 90186 Umeå, Sweden
Email: mats-rune.bergstrom@ac.lst.se

The County Administrative Board of Västerbotten, Sweden, cooperates with other regions in northern Scandinavia in matters concerning nature conservation and wildlife management. Since 1994, the cooperation has included other parts of the circumpolar region. The county is currently directing a project involving six administrations in Norway, Sweden and Finland. The aim of the project is to assess the conservation status of large carnivores and golden eagles and to evaluate methods of inventorying these fauna.

The Northern Forum is an international organization established in Anchorage, Alaska that addresses political, environmental and economic issues shared by northern peoples. The County Administrative Board of Västerbotten chairs a working group within the forum, which represents 23 regional bodies. The working group has developed guidelines for wildlife management in northern regions in close cooperation with the prefecture of Hokkaido, Japan. Hokkaido led the development of the guidelines, and Västerbotten is directing the second phase of the project, concerning implementation. The last meeting of the group took place in Edmonton, Canada in October 2001, when the project committee presented a report on brown bear management guidelines to the general assembly. Another workshop is being planned for August 2002, when participants from the Russian Far East, Hokkaido, Alaska and Canada will discuss a variety of issues including hunting and poaching, involving the public in decision-making, developing management guidelines for bear viewing and management, and the potential for ecotourism.

Since 1994, the County Administrative Board has cooperated with regions in northwest Russia within the framework of the Contact Forum, an informal network of agencies in Norway, Finland, Sweden and Russia focussing on biodiversity issues in the Barents region. This has mainly involved raising funds for the formation of national parks and holding seminars on the management of natural areas. The cooperation began in Vodlozerski National Park in Karelia, Western Russia and was later expanded to include the regions of Murmansk, Archangelsk and Nenets.

Most recently, the County Administrative Board has been involved in efforts to support the establishment of a national park in an area east of the White Sea on the Bellamore-Kuloisky plateau. This future national park will cover an area of approximately 10,000-15,000 km2.

Early on in our cooperative work in Russia we observed certain differences between Russia and Sweden with respect to the establishment and management of large protected areas. In terms of setting aside areas for protection, the process is more or less similar for both regions, a difference being that Russia has managed to protect larger intact natural areas than Sweden. On a regional basis, the proportion of protected areas in the landscape is higher in Russia than in Sweden, and Russia provides greater resources for the management of these areas.

* Content of original manuscript has been updated.

A comparison between Västerbotten and Karelia, Russia clearly illustrates these points. Västerbotten presently has 150 nature reserves and one national park. The total area represented by nature reserves is approximately 8,000 km2, or 12 % of the area of the county. Eight rangers are responsible for the management of these areas. Vodlozerski National Park in Karelia alone is 4,500 km2 in size and staffed by 130 people, including a park director and researchers connected to the park. This example shows that Sweden sets aside minimal resources for the management of protected areas when compared to Russia.

This striking difference led to discussions in the early stages of work in Vodlozerski National Park about the possibility of developing a long-term ranger exchange programme to improve the management of protected areas in Karelia and Västerbotten. Rangers have been working in the national park since 1996 to gain first-hand knowledge that will improve park management practices in Sweden.

The first phase of the programme involved both familiarizing rangers with natural areas and their biological features, and networking. Later on, the exchange developed to include routine activities and specific management issues in protected areas. This has involved training in everything from faunal inventory methods to supplying firewood for tourist cottages and sustainable methods of wood cutting in protected forests.

The aim of protected areas management in both Sweden and Russia is to preserve biological diversity and secure the conservation values that were the basis for setting natural areas aside. The ranger exchange programme has demonstrated effectiveness in dealing with a problem commonly faced by management agencies: how to survey biological diversity with limited resources, what methods to use and how to interpret results. The knowledge gained will be applied in a future joint project that will evaluate methods for surveying fauna. In recent years, the programme has expanded to include protected areas in the Archangelsk region, where rangers have primarily participated in brown bear surveys and bird inventories in the Pinega zapovednik.

The ranger exchange programme is one component of an international cooperative effort between Västerbotten and northwestern Russia that has contributed significantly to the management of large protected areas in northern regions. The programme has also led to a better understanding of the problems shared by park managers in different countries, and has helped to identify new solutions to management problems that can be applied "at home".

Ours is an increasingly globalised society, where tourism is an important business, and where high expectations are placed on nature tourism as both a source of income and a source of support for the management of large protected areas. Therefore ranger exchanges are an important means of communicating the experiences of eco-tourism, and the best management practices for sustainable eco-tourism development.

Dark-bellied goose research on Taimyr: practical experiences and links to conservation

Barwolt S Ebbinge
Alterra Green, IBN-DLO, Alterra, PO Box 23, 6700 AA Wageningen,
The Netherlands
Email: ebbdall@xs4all.nl

Abstract

This paper describes the findings of a six-year investigation of the role of predators in limiting breeding success in dark-bellied brent geese populations in western Taimyr. The project, a joint effort of Alterra in Wageningen, The Netherlands and the Russian Academy of Sciences in Moscow, Russia, provides an example of what can be achieved in the Russian Arctic through international cooperation. The role of predators in limiting the distribution of prey species is often greatly underestimated, since actual predation is rarely observed in the field. Prey species are also limited by predator avoidance behaviours that develop in response to the continuous selection pressures exerted by predation. The responses of dark-bellied brent geese to predators under differing situations illustrate how finely tuned these behaviours can be. For instance, in years when lemmings are abundant, brent geese are able to safely nest near snowy owls, which vigorously defend their nests and young from herring gulls, a species that also preys on geese. In years when lemmings are scarce, geese avoid snowy owls, and switch to a diet of waterfowl and other birds.

A strategy that is more frequently adopted by brent geese is nesting in herring gull colonies on small islands. Herring gulls are not a threat to adult geese, although they sometimes prey on their eggs and can take a high toll on newly hatched goslings. Nesting in herring gull colonies also provides protection against snowy owls and other species of gulls. Another possibility is that the presence of herring gulls serves to indicate fox-free islands after ice break up in spring.

Predator activity and abundance in the Arctic is largely dependent on the abundance of lemmings. This study analysed the impact of predators on populations of dark-bellied brent geese by evaluating population trends in western Taimyr between 1990 and 1995, when two complete lemming cycles occurred. Predator impacts will likely be more visible in the future because brent geese are increasing in numbers and habitats affording safety from predators are becoming fully occupied. Density-dependent effects may also become more evident as safe nesting sites become overcrowded and greater numbers of geese are forced to nest in places that are accessible to predators.

The results of this baseline research have attracted considerable interest from the Dutch government and NGOs focusing on Russian tundra ecosystems, and have led to substantial funding from the NGO Netherlands for Nature Conservation in the Russian Arctic. Moreover, public awareness of remote and pristine areas in the Arctic has grown considerably following the airing of a television documentary about the project in The Netherlands and Germany.

Introduction

Migratory birds are key elements connecting arctic ecosystems with temperate and tropical systems, especially wetlands. Consequently, ornithological research has played an important role in mobilizing interest in and support for nature conservation activities in the Arctic. For instance, more than one-third of WWF-Russia's annual budget is supported by The Netherlands, a non-arctic nation. Some of the most important wintering areas for arctic-nesting geese in Western Europe are located in this country, which has been a leader in research on population dynamics of geese since the late 1950s.

Moreover, the Goose Specialist Group of Wetlands International is chaired by BS Ebbinge, from Alterra in Wageningen, The Netherlands. This expert group, which has about 400 members, focuses on research and monitoring of populations of migratory geese in the northern hemisphere. Most annual meetings are held within the Eurasian flyway, but in 1998 a special annual meeting was held in Japan that focused on geese in eastern Asia. Since 1990, The Netherlands has been actively involved in research in the Russian Arctic and has cooperated on research projects with the Russian Academy of Sciences in Moscow.

One outcome of this combined effort is the development of a six-year programme that aimed to understand the role of predators in limiting the breeding success of dark-bellied brent geese. The programme was implemented by Alterra in the Pyasina Delta in western Taimyr.

The breeding success of dark-bellied brent geese and many species of waders (shorebirds) nesting on the Taimyr Peninsula is strongly correlated with lemming cycles (Roselaar 1979, Summers 1986, Summers & Underhill 1987, Greenwood 1987, Krebs 1993). The lemming cycle in the Taimyr Peninsula shows a marked periodicity of three years (Rykhilkova & Popov 2000). Brent geese breed very well in peak lemming years, but invariably fail to produce a significant number of offspring in the year following a lemming peak. In the third year of a lemming cycle, the breeding success of brent geese is difficult to predict with certainty.

Though many other factors have an impact on the breeding success of high arctic migratory bird species (Ebbinge 1989, Ebbinge & Spaans 1995, Ebbinge et al. 1999), none of these factors can explain the marked fluctuations in breeding success that have been observed in brent geese. Summers & Underhill (1987) have proposed a prey-switching hypothesis, which holds that the assumed main predator of brent geese, the arctic fox, preys primarily on lemmings in peak lemming years, thus enabling waders and brent geese to nest safely during lemming peaks. When lemming populations crash, arctic foxes turn to alternative prey items such as nesting birds, particularly eggs, which leads to nesting failure in brent geese. This theory is supported by surveys conducted in the wintering grounds of brent geese that have shown a complete lack of birds in first-winter plumage.

When offered the opportunity to work in the Siberian breeding grounds of the dark-bellied brent goose by Dr E E Syroechkovskiy, Alterra did not hesitate to initiate a six-year programme to study the factors determining nesting success and failure in this species. The study was restricted to one locality over a period spanning two complete lemming cycles, and focused on Lidia Bay (74.07 N; 86.50 E) in the Pyasina Delta.

Researchers have visited many other brent goose nesting sites on the Taimyr under the auspices of the Great International Arctic Expedition. The results of their studies have also contributed to our ideas about key factors influencing the breeding success of brent geese in this region.

One of the first important discoveries made by these teams was that during peak lemming years, snowy owls were suddenly able to successfully nest in certain areas where nesting success had been very poor in past years (1991 and 1995) (Underhill et al. 1993; Summers et al. 1994). Another interesting finding was that snowy owls drove foxes out of their territories, thus creating "safe havens" for nesting brent geese. It was immediately evident that the simple prey-switching hypothesis could not be valid, because snowy owls are known to nest only when lemming abundance is high, and the prey-switching hypothesis predicts that foxes are not interested in other prey items when lemmings are abundant. So, the question remains, why do brent geese nest near snowy owls in peak lemming peak years?

Study area and methodology

Between 1990 and 1995, the breeding success of brent geese on the Bird Islands and adjacent mainland tundra area along Lidia Bay, in the western Taimyr Peninsula was studied by an international research team made up of Dutch, Russian, English, German and Polish biologists (see Fig. 1, and Spaans et al. 1993). Blinds and specially designed field huts were used to observe nesting brent geese. The distributions of brent geese, lemmings (mainly *Lemmus sibiricus*, and *Dicrostonyx torquatus*, in much lower densities), snowy owls and arctic foxes were studied on the mainland tundra and the large island of Farwaterniy. The main field camp was located near Mys Wostochniy (Figure 1).

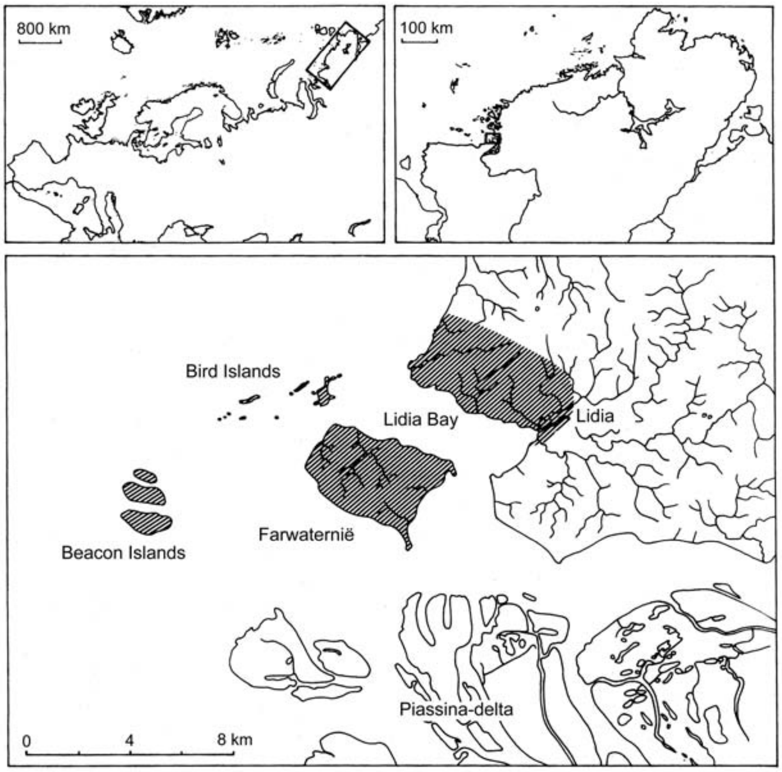

Fig. 1 Study area (hatched)– Lidia Bay and the Bird and Beacon islands in western Taimyr. The two uppermost maps indicate the location of the study area on regional maps.

Over six consecutive years, lemming abundance was studied using standard trapping methods (Rykhlikova & Popov 2000). Abundance was expressed as an index based on the number of lemmings trapped every 100 days, given that one trap open for a period of 24 hours represented a single trapping day. The abundance of arctic foxes, snowy owls and herring gulls, the main predators of brent geese, was estimated by counting the number of used fox dens and the number of owl and gull nests in the study area.

In each year of the programme, the research team was present before the arrival of the first brent geese in early June. In 1990 and 1992 the team left the study area in July, but in 1991, 1993, 1994 and 1995 the team remained until mid-August to ring (band) brent geese and to study the distribution of moulting birds.

Results

Dark-bellied brent geese

Brent geese nested in small numbers on the mainland tundra, but mainly nested on the Bird Islands, where 3,000 pairs of herring gulls also nested (see Table 1). No brent geese nests were found on the mainland in 1992 and 1995, years that followed peak lemming years. High lemming densities were reflected in the numbers of non-nesting snowy owls (10–30 individuals) in the study area.

In 1992 a great number of arctic foxes were observed, even on the Bird Islands (see fox index in Table 1). A fox index was developed that shows the number of foxes that visited the Big Bird Islands during the first 10 days of nest initiation (10–20 June). Much to our surprise, fox numbers were extremely low in 1995, despite a lemming peak in 1994. A local trapper told us that he had caught many foxes the previous autumn, and that few foxes had survived the winter.

Brent goose nests were most common on the mainland in years when both predator numbers and lemming numbers were low; the so-called "in-between-years" when lemming numbers begin to build up. During the two peak lemming years (1991 and 1994), brent geese also nested on the mainland, but the nests were still predated by arctic foxes, which were abundant (see Table 1). Thus, even in peak lemming years, brent goose nests on the mainland were not safe from fox predation.

Many more brent goose nests were found on the Bird Islands in each of the six years comprising the study. The only exception was 1992, when foxes were abundant and regularly visited these islands during the period of nest initiation. Most brent geese left the islands within two weeks of nest initiation, after failing to lay eggs. Regular visits by foxes to the islands disturbed the geese, which no longer defended their nesting territories from other geese. Only 15 pairs of brent geese managed to lay eggs in 1992, whereas in other years more than 250 nests were found.

The year 1995 was very remarkable in terms of nesting. A total of 381 nests were established on the islands, compared to 243–291 in other successful years. Possibly, nesting was high on the islands in 1995 because few safe nesting sites were available elsewhere. Many snowy owls roamed the study area, but did not nest because of food shortages related to the lemming peak the year before. Their presence may have forced greater numbers of geese to nest on the islands in 1995 than in preceding years.

Table 1: Nest predation of dark-bellied brent geese around the Lidia Bay area and on the Bird Islands.
(n.a. = not applicable)

		Mainland		Bird Islands		
Year	Lemming index	Goose nests	Predation	Goose nests	Predation	Fox index
1990	0.3	12	0 %	252	0 %	0
1991	10.4	9	100 %	291	0 %	1
1992	1.2	0	n.a.	15	7 %	39
1993	1.7	15	20 %	251	0 %	0
1994	10.0	6	67 %	243	0 %	0
1995	0.4	0	n.a.	381	0 %	0

Annual mean values for clutch sizes of brent geese are given in Table 2. Clutch sizes were measured in the first week of July, when all geese were incubating. Clutch size does not reflect the total number of eggs laid, but rather, the number of eggs laid minus the eggs lost to predators. It noteworthy that clutches averaged almost one extra egg during the peak lemming years of 1991 and 1994. The most important predator of goose eggs on the islands, the herring gull, nested earlier in these years and fed almost exclusively on lemmings in the early part of the season. Early nesting likely contributed to a marked reduction in egg predation by gulls in 1995. In other seasons, clutch sizes were most likely reduced by partial predation.

The proportion of goslings taken by gulls on and around the islands was high in all years. Losses usually occurred within one week of hatching. In 1995, gosling predation was extremely high, because geese did not disperse from the islands to moult and raise their young elsewhere. This was the only year we observed this phenomenon (Table 3). The presence of snowy owls on the mainland may have been an important reason why the geese did not disperse from the islands in 1995, as they did in years when we stayed long enough to observe this event (1991, 1993 and 1994). Consequently, concentrations of moulting birds were much higher on the islands in 1995 than in other years. Food shortages coupled with a high rate of predation by gulls were likely the principle reasons why almost all goslings perished in 1995.

Table 2: Clutch sizes of brent goose nests on the Bird Islands and gosling predation by gulls.

Year	Lemming index	Number of goose nests	Mean clutch size	Gosling predation by gulls
1990	0.3	252	3.0 (n = 72)	some
1991	10.4	291	3.8 (n = 130)	70 %
1992	1.2	15	?	n.a. (fox year)
1993	1.7	251	2.9 (n = 129)	90 %
1994	10.0	243	3.8 (n = 101)	80 %
1995	0.4	381	2.8 (n = 245)	99 %

Table 3: Distribution of moulting brent geese in Lidia Bay in relation to lemming cycles.

Peak years		Low years		Build up years	
1991	dispersed	1992	?	1990	?
1994	dispersed	1995	only on islands	1993	dispersed

Arctic Fox

In 1990, no foxes were observed in the study area. In the peak lemming years of 1991 and 1994, at least two dens where occupied by fox families. Despite low densities of lemmings, one den was occupied in 1993 and young foxes were successfully raised. In 1992, none of the fox dens in the study area were occupied, but many foxes were observed wandering about. At certain times, up to three different foxes visited the Bird Islands in a single day. The only year that foxes were not observed visiting these islands after the first arrival of geese was 1992 (Spaans et al. 1998).

In 1995 we expected to see many foxes wandering about because lemming populations peaked the preceding year. After the snow melted in the spring of 1995, it became evident that many foxes had succumbed to starvation during the winter of 1994–95. A few foxes were observed in late July and August; however, none of the dens in the study area were occupied.

Snowy Owl

In 1990, only one snowy owl was observed in the first week of June. Sightings of snowy owls in the study area were also very low in 1993. Snowy owls nested in the study area during the two peak lemming years (1991 and 1994). In 1991, one pair successfully raised chicks and in 1994 six pairs nested successfully. In years following peak lemming years (1992 and 1995), snowy owls were seen very regularly (up to 30 individuals in 1992 and 6 individuals in 1995), however, nesting did not occur. In 1995, several unsuccessful attacks by snowy owls on goose families were observed. We believe that owl attacks were the main reason why all adult geese eventually returned to the Bird Islands with their goslings. The high concentrations of geese on the island caused food shortages, which together with high predation pressure from gulls, resulted in almost 100% mortality of goslings.

Herring gull

Each year of the study, 3,000 pairs of herring gulls and about 10 pairs of glaucous gulls nested on the Bird Islands. In 1992, the only year that foxes regularly visited the islands, gulls were clearly incapable of defending their nests against the invaders. This suggests that gulls are only able to nest successfully when they are able to find nesting locations inaccessible to foxes. Ice break up appears to be an essential prerequisite for successful nesting by gulls on the islands. All gull colonies were located on islands that are inaccessible to foxes in most years. Thus, brent geese were also able to nest in fox-free areas by joining gull colonies. Only when foxes are very hungry and abundant, or when ice break up occurs very late in the season, do foxes venture to these islands from the mainland in search of food.

Brent geese can successfully nest within 1m of a gull nest. Because gulls aggressively defend nesting territories against invasions by other gulls, nesting in close proximity to gull nests effectively protects geese from egg predation by gulls. Egg predation appeared to occur most frequently at the edges of gull colonies, where many gulls can be found. However, very few gulls nesting at the edges of colonies will defend their territories against attacks from other gulls. As soon as goslings on the Bird Islands were old enough to walk, adult geese attempted to lead them to water. On particularly windy days when swimming was difficult, gulls were able to predate many goslings on their way to the mainland. On calm days, however, many families of geese could successfully swim to the mainland, a distance of about 5–10km.

Discussion

The reproductive capacity of long-lived birds is optimized when adults make the most advantageous trade-offs between their own survival and that of their eggs or offspring. Sacrificing some eggs or goslings, or even a complete brood by nesting within a gull colony may not significantly diminish lifetime reproductive success, because of the potential to successfully raise young in the future. By choosing to nest elsewhere, however, an adult goose may risk its own life.

Our observation that most geese nested in gull colonies on small islands can be explained in these terms. A low mortality risk for nesting adult birds may compensate for an often-high level of gosling mortality resulting from gull predation. The isolated Bird Islands are usually safe from foxes and snowy owls, the latter of which are also capable of taking adult geese on the nest. However, it is very difficult for owls to penetrate gull colonies because gulls heavily attack them. The presence of gulls poses no serious threat to adult geese, which, during incubation, benefit from the high quality forage that grows where guano is deposited.

However, gulls do prey on goose eggs, particularly when lemmings are not abundant. Since gulls usually handle eggs for some time before consuming them, preying on eggs exposes gulls to counter-attacks by geese, which fiercely defend their broods. Often, gulls only manage to partially consume eggs, and risk serious injury to do so. This probably explains why predation of goose eggs is relatively rare in gull colonies.

While airborne, however, gulls are able to snatch goslings and later swallow them whole without enduring serious counter-attacks by adult geese. Goslings are therefore much more profitable prey items for gulls. The first few days after hatching are hazardous for young geese, particularly when windy conditions prevail. Because a large proportion of young geese are lost to gull predation, most adult geese leave gull islands with their goslings within a week of hatching to raise them along riverbanks on the mainland.

A second nesting strategy is to nest within territories maintained by snowy owls. However, this strategy is only possible once every three years when lemming abundance is high enough to enable owls to nest. By adopting this strategy, it may be possible to avoid losing eggs to predation and to reduce the level of predation of newly hatched goslings to a minimal level, although there have been some reports of snowy owls preying on small goslings. There is some risk of predation to adult geese, but so far this has only been documented in non-lemming years, when snowy owls do not nest. In years when lemmings are abundant, it is likely more beneficial from an energetic standpoint for snowy owls to feed solely on lemmings and refrain from pursuing adult geese. Adult geese are of course faced with the problem of assessing the dietary preferences of snowy owls in any particular year. In years marked by high lemming densities in western Taimyr, snowy owls are already nesting by the time the geese arrive, from 10–15 June. It is possible that nesting owls are feared less by geese than non-nesting owls, because the former are more stationary.

Adult geese nesting in snowy owl territories also disperse from these areas to raise their goslings in safety elsewhere. In peak lemming years, this breeding strategy appears to be the most profitable one for brent geese. A possible drawback may be the amount of time invested in searching for suitable nesting localities within snowy owl nesting territories each year. Gull colonies are predictable sites that can be located year after year by applying knowledge acquired in previous seasons. Brent geese eggs hatch one to two weeks earlier in gull colonies than those laid in snowy owl territories.

A third strategy is nesting in more or less isolated locations along small rivers on the mainland tundra. This is a very profitable strategy in years when foxes are absent (1990 in our study area), but as soon as they are present, even in peak lemming years, offspring rarely survive beyond the egg stage.

In our study area, all three strategies were available to geese, but only the first strategy (nesting on islands with gull colonies) and the third strategy (nesting alone on the mainland tundra) were adopted. Even when six pairs of snowy owls nested in our study area in 1994, only one brent goose nested in the vicinity of a snowy owl.

The third strategy was utilized by 4% of the brent geese nesting in the study area in four of six seasons, and was only successful in 1990, when no foxes were present in the study area. In comparison, the first strategy was used by 96% of geese in five of the six seasons.

Only in one season (1992), when virtually no brent geese were able to initiate nesting, were none of these strategies used. Disturbances by foxes, which were abundant that season, forced the majority of the geese to abandon their nesting territories during the early stage of nest initiation (Spaans et al. 1998).

Future studies and analyses should assess the relative success of each of the three strategies, and the relative importance of each strategy to the brent goose population in the entire western Taimyr. Further, it is important to determine whether individual geese are faithful to one strategy, or whether they are capable of switching to the most profitable strategy in any particular year. To a large extent, the abundance of both lemmings and predators determines which strategy is adopted.

Increasing the present level of knowledge about predator-prey relationships in the virtually pristine ecosystems of the high Arctic will help scientists to better understand the ways by which populations are controlled by natural factors. This baseline knowledge is of great importance to the development of sound wildlife management practices, both in the Arctic and in areas of the world where humans play a much more significant role in influencing ecosystems.

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Lemming research in the Russian Arctic – practical experiences and links to conservation

Ludmila Emelyanova
Moscow State University, Biogeography Department
Moscow, Russia
Email: ludmila@biokom.msk.ru; nln@gol.ru

Lemmings are key species in the tundra ecosystem; no other biota are as characteristic of an ecological zone. The main consumers of tundra vegetation, lemmings can withdraw up to 70% of the aboveground phytomass (Tishkov, 1989) and attain a biomass of tens of kg/ha. Tundra species closely connected to lemmings in arctic food chains include the arctic fox, snowy owl, rough-legged hawk and ermine. A variety of other species are also associated with lemmings, including the pomarine skua, wolf (which feeds exclusively on lemmings in years when they are abundant) and bumblebees, which nest in lemming burrows. When lemming numbers are low, two important predators, the arctic fox and snowy owl, switch to other prey, mainly waders (shorebirds) and waterfowl, with heavy impacts on numbers. The study of various aspects of lemming ecology is fundamental to an understanding of the overall functioning of tundra ecosystems.

There are 5 lemming species in Eurasian tundra according to modern taxonomy . The Norwegian lemming (*Lemmus lemmus*) is well represented in the Kola Peninsula and in Scandinavian tundra (Norwegian lemmings are commonly called “pestrushki”, a Russian word that refers to their mottled or multi-coloured appearance; over time, this name has come to refer to all lemmings). This species is a common inhabitant of flat and mountain tundra and forms widespread populations in the forest regions of the Kola Peninsula during some years.

The Siberian lemming (*Lemmus sibiricus*) inhabits the continental Eurasian tundra from the Kanin Peninsula in the west to the Lena Delta in the east. The Bunge lemming *(Lemus bunge)* ranges from the Lena Delta to the mouth of the Kolyma River. Both species appear to inhabit the Lena Delta, and their spatial distributions in this area should be investigated. The brown or orange-bellied lemming (*Lemmus trimucronatus*) is represented in the east from the Kolyma River up to Chukotka (Fig.1). This species was earlier considered to be a subspecies of the Siberian lemming.

The collared (white) lemming (Dicrostonyx torquatus) and a relative species of lemming of Vinogradovv (Dicrostonyx vinogradovi) were mentioned from the Kanin Peninsula to Chukotka and Kamschatka and at Vrangel Island, respectively . It is the only lemming from genus Dicrostonyx which turns white in the winter.

Species of the genus *Lemmus* predominantly inhabit moister ecosystems, such as sedge-moss and cottongrass tundra, whereas the opposite tendency is characteristic of species of the genus *Dicrostonyx*, which are usually found in dry lichen-herb and willow tundra.

A feature of lemming populations that affects many other northern species is their cyclical population trends. These cycles occur over a 3–5 year period, with exceptionally high peaks every 11 years. These peaks can occur throughout the major part of the Palearctic, as occurred in 1991 (Emelyanova & Milyutina, 2000) (see Fig. 2). This periodicity means that the Arctic is a virtual desert during the "depression years" of the lemming cycle, but brims with life during peak years.

Studies of lemmings in Russia began in the 1930s and 40s. Currently, lemming research is primarily concerned with habitat preferences, ecology, diet, breeding and characteristics of population cycles. Since 1987, brief summaries of the state of lemming populations have been included in a report on waders published annually in Russia. This information enables researchers to estimate lemming population densities during a specific year (Tomkovich 1999).

Because lemmings play a major role in ecosystem dynamics, they have been the subject of long-term studies in different parts of Russia, and many questions have already been addressed. However, available data is not consistent or complete in all cases. Consequently, there are many knowledge gaps, and continued investigations into lemming cycles will be necessary. Annual and multi-year monitoring of lemming populations should be carried out at an established site in the Russian tundra. Among possible directions of future lemming studies we could envision the following:

1) Which is the optimal tundra sub-zone for lemmings and
2) Which territories are close in spatial-temporal parameters of lemming life cycles? Permanent inter- and multi- year monitoring of lemming populations in at least at one site on Russian tundra is a great necessity, as the lemming cycle is still not completely understood.

At present, annual population counts are not conducted anywhere in the Eurasian tundra. Because of its location and support facilities, the Lena Delta research station has the potential to be an ideal site for such a long-term monitoring study.

Although there is no direct threat to any lemming species such as hunting or persecution, the main threat now is loss and destruction of habitat related to human activity. This is not unique to the tundra ecosystem, but due to its remoteness, it is one which may escape widespread publicity, and one which affects all species on the tundra.

The more we learn about lemming populations, the better we will understand tundra ecosystems: their flora, fauna and abiotic components. Since opportunities for studying natural cycles and changes in lemming populations only exist in intact tundra ecosystems, Russian state nature reserves should be established as sites for monitoring lemming populations. Most existing data about lemming populations have been collected in nature reserves; namely Laplandski, Taymyrski and Wrangel Island reserves. No protected areas exist within the European tundra, and therefore, scientific information on lemming populations for this part of the Arctic is sparse and incomplete. Human activities are exerting a strong and widespread influence on the tundra zone in Europe, and many natural ecosystems are essentially transformed or already lost. Protected areas must be created to ensure the continued survival of lemmings in the Arctic.

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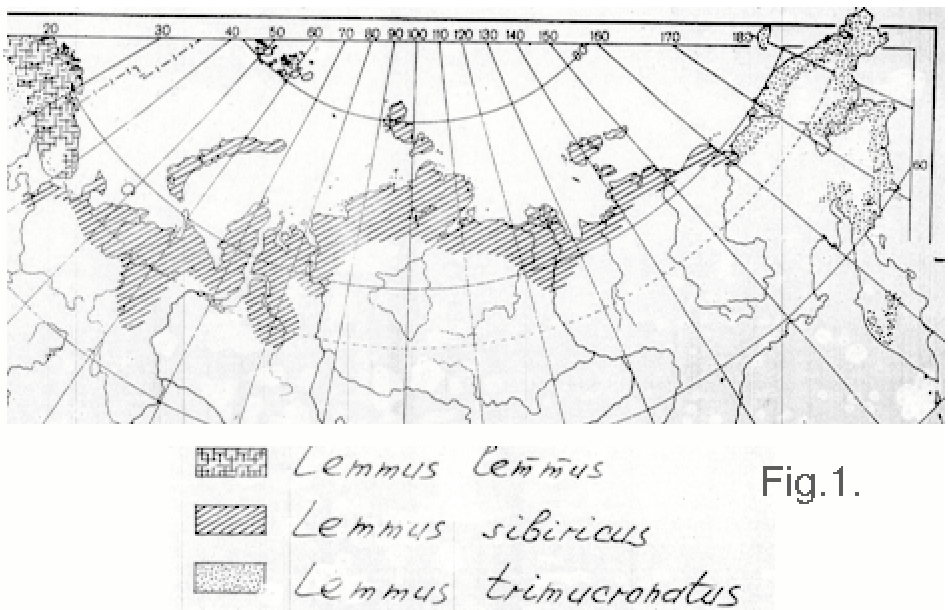

Fig.1. The distribution of Lemmus lemmus, L. sibiricus, L. trimucronatus

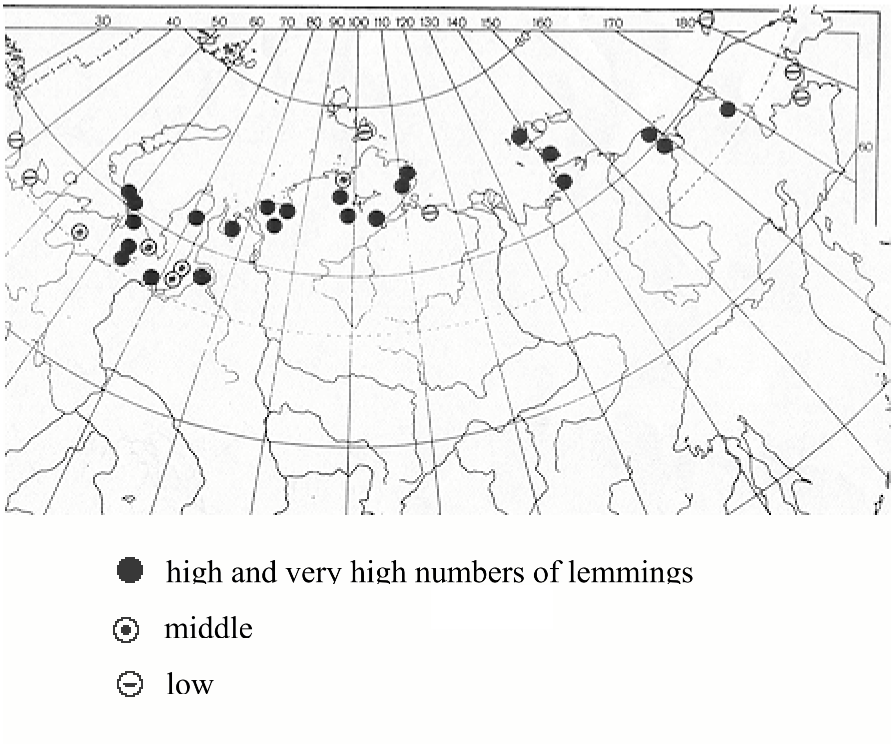

Fig.2 The high lemming peak of 1991.

Natural heritage of the Russian Arctic: perspectives and tools for preservation

Yuri L Mazourov
Russian Heritage Institute for Cultural and Natural Heritage
125299 Russia, Moscow, 2 Ul. Kosmonavtov
Email: heritage@mtu-net.ru

Introduction

A key factor predisposing a country in favour of designating protected areas in a region is the number of heritage sites it contains. A large number of heritage and/or natural features are the main prerequisites for proposing national parks.

In this paper, the term "heritage" refers to factors that are: integral to the formation and development of ethnoses (ethnic associations, groups or nations), materialized in natural and cultural objects and phenomena, and manifested in geodiversity. Certain characteristics distinguish heritage sites from other natural, cultural and historical features: 1) they have a greater heritage value (their loss is irreparable), 2) there is a real threat to their existence, and 3) they contain a heritage feature.

Features of natural heritage sites

The natural heritage of the Russian Arctic consists of natural features and species shared with the rest of the Arctic and features and species restricted to this region. The latter are responsible for its unique natural characteristics and should be the focus of heritage conservation efforts. However, regional features and species can only be understood when considered as components of broader-scale natural heritage.

This definition of natural heritage does not include all natural resources essential for human survival. It implies only those natural features that are at serious risk (either real or potential) of extinction or disintegration, with unpredictable consequences for the environment and for society. Distinguishing natural heritage from related entities (nature, natural property, natural values, natural conditions, natural resources, etc.) allows for its definition as a collection of environmental features and phenomena of particular reproductive, recreational, and aesthetic value that also have valuable characteristics unrelated to natural resource potential.

Natural heritage mainly functions to maintain environmental resilience in the face of noxious external factors related to human activity. Human pressures often lead to a loss of ecosystem capacity for self-regulation and reparation during the transformation of nature as a self-reproducing substance (nature proper) to a more or less amorphous "medium" (environment). When viewed from a historical perspective, the transformation of "nature" to "medium" appears to be inevitable. Important questions are 1) How rapidly is this change occurring, and, 2) What is the spatial relationship between "nature" and "medium" at any given time?

Ideally, human-induced transformation of natural ecosystems should not affect the eco-natural frame of the biosphere, that is, lands and waters, expressed in linear (non-aggregated) forms having the highest biological and landscape diversity indices. The eco-natural frame consists of spatial units performing the most important ecological functions and having the highest natural heritage potential. The less damage inflicted on the frame, the better natural heritage will be preserved, and the more stable the environment will be in a given region and in ecologically-related lands and waters.

The conservation of natural heritage through targeted and effective protection of the eco-natural frame is thus a key prerequisite for maintaining a stable environment. Indeed, the Masstricht Conference (1993) declared that a protected areas network (EECONET) is of highest importance to an effective natural heritage strategy for Europe. Novaya Zemlya, and particularly its northern part, will constitute an important link in a protected areas network under the strategy.

Characteristic natural heritage features and values of arctic regions include:

- Vast areas of intact or virtually undisturbed natural ecosystems
- Unique biota and landscapes
- High vulnerability of natural and cultural heritage due to the relatively low resistance of arctic ecosystems to external impacts
- Extensive ecosystemic links with nearby and remote territories, including the southern hemisphere. These connections were initially established by animals, especially birds
- Absence of a resident human population with a vested interest in the on-site protection of natural and cultural values
- Due to its remoteness from major environmental risk sources (i.e. industrial zones and large centres of human activity), the natural heritage of Novaya Zemlya has been well-preserved
- High scenic value of natural land and seascapes in Novaya Zemlya, which account for its attraction to tourists. The natural heritage of the island has significant recreational potential.

Specific problems related to heritage conservation in the Arctic

Traditionally, the Arctic has been viewed as a region in an early stage of economic development where natural and cultural heritage irretrievably lost elsewhere on the planet still remains in a natural state. In reality, the Arctic is losing its natural and cultural heritage at a more rapid rate than economically developed areas. This decline corresponds to a growing human interference in the Arctic that is at odds with public interests. Until recently, development has proceeded in a spontaneous fashion with undesirable and sometimes unpredictable consequences. This trend must be counterbalanced with a rational purpose-oriented management policy designed to promote the conservation of valuable natural and cultural heritage.

The need for science-based heritage conservation policy in regions in an early pioneering stage of development ensues from the following:

- Virtually undisturbed natural heritage in the form of biological and landscape diversity in newly developing areas, owing to the distance of these regions from major environmental risk sources (e.g. industrial zones and large centres of human activity)
- Well-preserved cultural heritage in the form of historical and cultural monuments, other evidence of past human activity, and diverse indigenous cultures that continue to survive

in developing areas because of their relatively intact traditional lifestyles and methods of land management

- High vulnerability of natural and cultural heritage in developing areas owing to the low resistance of natural ecosystems and indigenous minorities to industrial development and the effects of modern mass culture
- The enormous size of territories subject to pioneering economic developments in Russia (65–70% of its total area), which, in combination, greatly exceed the extent of areas at a similar stage of development in other countries
- During the current transitional period, modified traditional practices and new environmental and social risks are threatening natural and cultural heritage in developing areas.

At present, most of the land surface of the Earth is exploited for the benefit of humans; few untouched areas remain. The intensity of exploitation, however, varies locally depending on the degree of economic development in different areas. Thus, it is appropriate to follow the tradition of classifying lands into developed and developing regions (or regions in a pioneering stage of development).

Throughout the world, attention has traditionally focused on the pursuit and planning of economic, environmental, and cultural activities in developed regions. As a rule, developed parts of the world have the highest population densities, and therefore are subject to a variety of economic, ecological, and cultural problems. Consequently, they are the first regions to suffer the adverse social and environmental impacts that accompany the complete or partial loss of natural and cultural heritage.

The socio-cultural and ecological heritage potentials of areas in the early stages of economic development remain high because such areas have long history of low anthropogenic disturbance. Another reason is that they have not been considered of special value to humans until recently.

Developing regions with harsh natural conditions are usually remote from main transportation routes, both natural and artificial. Often, they are located in high latitudes, or in "unproductive" environments such as highlands, deserts or wetlands. Historically, humans attached little or no importance to these areas because they were considered of no practical value to state or public interests. Mostly, they were viewed in a negative light, because maintaining them would impose a burden on the national budget without the slightest hope of reimbursement.

This situation began to change dramatically at the close of the last century, because of growing ecological, social, and other problems, particularly in developed regions. As a result, areas formerly unaffected by human activity were quickly transformed into vitally important reserves for the future development of humankind. Evidently, the value of these territories is directly related to their size and to the extent to which they have been modified by human interference.

A scientifically sound and socially acceptable policy aimed at securing the natural and cultural heritage of peripheral areas of the civilized world is vitally needed. Achieving this will require the establishment of protected heritage territories to effectively safeguard the most valuable natural and cultural features and historical monuments.

An analysis of the problems related to heritage conservation in the Russian Arctic leads to the following conclusions and recommendations:

1. Most of the existing sites of natural, cultural and historic value have a protected status in developed regions. This status is not always compatible with the objectives of heritage conservation in newly developing regions. An important problem is that traditional uses by indigenous peoples are not permitted in the majority of nature reserves in the Russian Arctic. On the other hand, the experiences of many countries indicate that artificially preserving relicts of indigenous minorities in national parks has nothing to do with their living culture, being nothing more than window-dressing;
2. Enthusiasts of heritage conservation in developing regions must consider the increasing evidence of "neo-traditionalism" in populated areas and the global responsibility imperative in protecting areas having no resident human population;
3. All conceivable types of protected areas in newly developing regions should be classified into "traditional" (i.e. established and functioning in conformity with present Russian legislation and international law (e.g. nature reserves, sanctuaries, national parks, etc.) , and "non-traditional" units (e.g. ethno-ecological territories), in accordance with human settlement patterns. We propose that territories included in the latter category be defined as "heritage reserves"; and
4. When establishing protected areas in developing regions special emphasis should be placed on the specific features of individual heritage reserves, as opposed to the popular trend towards unification.

This practical approach to heritage conservation in the western Russian Arctic is illustrated by the establishment of heritage reserves in territories occupied by indigenous peoples (e.g. on Vaygach Island) and by the creation of a national park on Novaya Zemlya, an uninhabited archipelago in the Arctic Ocean.

Natural heritage policy

Traditionally, there have been two main approaches to the development of guiding policies for natural heritage management: 1) utilitarian (with a primary aim to derive, in different ways, material utility from natural objects and/or complexes) and 2) conservation-based (from imposing minor restrictions and enacting existing environmental regulations to ranking natural features in terms of the degree of protection required, and placing strict prohibitions on permitted uses). It is well known that the former approach to managing natural heritage, long practised worldwide, has resulted in either the loss or deterioration of many heritage sites.

Fortunately, the latter policy, which has a prominent ecological slant, has become more widely accepted in recent years because of increasing public understanding of the negative consequences of the loss of natural heritage. This global process has led to the development of a network of specially protected areas and its gradual transformation to an integrated heritage system. This tendency has become very apparent in certain regions over the past few decades, including the Arctic.

Because the international community has long recognized the importance of protecting the most valuable natural features and areas in high latitudes, arctic states have had a powerful incentive to establish national and nature parks, reservations of different types, game refuges, and other protected territories. As of the mid-1990s, there were 280 specially protected territories in the Arctic, if only the largest (over 1,000 ha) and the most significant of these are considered. The total area occupied by these territories exceeds 2,000,000 km2 (14% of the entire arctic region), a relatively high figure.

In recent years, the Russian Arctic has experienced a particularly rapid rise in the number and size of protected territories. In the early 1990s alone, five new state nature reserves were designated. As a result, the total area of nature reserves in Russia increased by 25%, and more than doubled in the northern quarters. In addition to nature reserves, other types of protected areas were also established, such as the largest nature sanctuary, Zemlya Frantsa Iosifa (Frantz Josef Land), on the archipelago bearing the same name. The sanctuary covers a total area of 4,200,000 ha (including off-shore waters) and includes Severozemel'sky Sanctuary on Severnaya Zemlya (total area 421,700 ha). The two sanctuaries have been designated as protected territories of national importance.

Most territories in the Russian Arctic have designated specially protected areas in a variety of categories, primarily nature reserves, sanctuaries and national monuments. Novaya Zemlya appears to be the sole exception in not designating a single protected natural, cultural or historical area within its boundaries despite having numerous heritage sites of great value. Obviously, this situation is counter to the current prevailing tendency in the circumpolar region and is incompatible with the regional and national interests of Russia. Although most formerly populated areas in Novaya Zemlya have been abandoned, Russia has not developed a comprehensive policy for the management of the natural heritage of the archipelago. Measures to conserve the natural values of the islands are practically non-existent. Meanwhile, continuing exploitation is leading to further deterioration of Novaya Zemlya's unique heritage.

It is evident from the preceding discussion that the Russian Arctic contains highly valuable natural heritage of regional, national and international importance. There is an urgent need to develop and implement effective government policy aimed at safeguarding the region's natural heritage and promoting its rational use. Natural heritage policies must consider the following:

1. Comprehensive evaluations of natural heritage based on the results of long-term field studies and scientific surveys;
2. Identification and inventories of natural heritage sites;
3. Classification of known natural heritage sites with regard for the provisions of international laws, federal and regional legislation, and the traditions and vital interests of local populations;
4. State registry of natural heritage sites recognized as being of special value, adequate protective status and further development of the heritage system by making all those concerned with the preservation of the heritage sites live up to their responsibilities;
5. Development and/or improvement of legislative machinery for the conservation and rational use of natural heritage;
6. Integration of natural heritage management into regional plans for land use and territorial development; if necessary, conducting site surveys.
7. Monitoring of environmental and natural heritage after ecological integrity is restored to degraded sites. Up-to-date technology, including telecommunication facilities will be required;
8. Ecologically compatible development of tourism and related infrastructure;

9. Integration of measures for the optimal management of natural heritage into regional programmes for socio-economic development; if needed, the development and implementation of special regional programmes for the conservation and rational use of natural heritage;
10. Harmonization of natural and cultural heritage conservation, and coordination of natural and cultural heritage conservation efforts between adjoining territories and different administrative levels;
11. Dissemination of knowledge about the natural heritage of a given region through all available channels; and
12. Support of public organizations concerned with the exploitation, conservation, rational use, and popularisation of natural heritage.

Heritage in general, and natural heritage in particular, are believed to be crucial to the stability of sustainable development. The current trend towards decentralization of governmental authority in Russia is placing most of the responsibility for managing natural heritage upon local administrations. On the contrary, state regulation of heritage strategy development should be requisite to the development of regional heritage policies.

Development of national parks and other protected areas in Alaska, 1958–1981

Walter B Parker, US Arctic Research Commission
Parker Associates, US, 3724 Campell Airstrip Road, 99504 Anchorage, USA
Email: wbparker@alaska.net

Susan Kruse, US Fish and Wildlife Service
1011 E. Tudor Rd., Anchorage AK 99503, USA
Email: susan_lapkass@fws.gov

The first steps toward the creation of the great system of national parks, wildlife refuges, national forests, wild and scenic rivers and state parks and refuges, one of Alaska's distinguishing features, occurred in 1879 when John Muir made the first of his several trips to this state. Upon his return, Muir made the glories of Glacier Bay known to a young and growing conservation movement in the United States. The Harriman expedition of 1898 made a more comprehensive view of the possibilities in Alaska visible to a wider range of conservationists and scientists.

The early period of the conservation movement peaked during the administrations of Theodore Roosevelt (1901–1908). In 1907, the US Congress created the Chugach and Tongass National Forests, which had been designated as forest reserves by Roosevelt in 1905.

Largely due to the efforts of Charles Sheldon, the first national park, Mount McKinley, was created in 1917. Katmai National Monument followed in 1918, and 12 years after Muir's death, Glacier Bay National Monument was created in 1925. In 1980, both national monuments became national parks with the passage of the Alaska National Interest Lands Conservation Act (ANILCA).

The modern era of creating conservation units in Alaska began in 1958 with the founding of the Alaska Conservation Society. The society united people working to protect the Arctic National Wildlife Range, created in 1958 by executive order of President Eisenhower. The range, which is located in northeastern Alaska, was the focus of major conservation interest throughout the debate in Congress on Alaska becoming a state.

A large segment of Alaskans feared that the state would not be able to safeguard wildlife and scenic values as effectively as the federal government. This issue was disputed during the development of the Alaska Native Claims Settlement Act (ANCSA, 1971) and the subsequent Alaska National Interest Lands Conservation Act (ANILCA, 1980).

Alaska Native Claims Settlement Act (ANCSA)

Two events served to organize and focus efforts by Alaskan Natives towards obtaining compensation for their ancestral lands: the creation of the state of Alaska in 1959, which authorized the state to select 104 million of Alaska's 375 million acres, and plans by the federal government to create a harbour on the northwest coast of Alaska using nuclear explosives.

Tundra Times, a newspaper edited by Howard Rock, was soon in print, and acted to inform and unite Alaska's citizens. In 1966, the first state wide meeting of Alaskan Native leaders convened in Anchorage. Soon afterwards, the Alaska Federation of Natives (AFN) was established for the purpose of carrying the Native message to Congress. Previously, Tlingit Indian leader William Paul had made most of the effort. The coming together of the many different peoples and interests that represent Alaskan Natives through the establishment of AFN ranks among the great political feats in North American history.

Alaskan conservationists encouraged Native land claims to ensure that public interest in wild lands and wildlife habitat were recognized during the early stages of the Alaska lands divisions. With the help of conservationists, the AFN convinced Secretary of the Interior Stuart Udahl to sign, as his last act in office in January 1968, a public land order withdrawing 262 million acres of unreserved public lands in Alaska from selection by the state. The order also exempted from consideration "all forms of appropriations and dispositions under public land laws" to ensure that the land would be available "for the determination and protection of the rights of the Native Aleuts, Eskimos and Indians of Alaska."

Since Alaska had only selected 26 million acres by this time, or about one quarter of its entitlement, the state paid attention to the land order. Until then, claims made by Alaskan Natives had largely been brushed aside by the state government and business interests in Alaska. Conservation interests also rose to the forefront when it became apparent that the government would have to seriously consider the claims.

By 1966, the Alaska Wilderness Council had brought conservation groups in Alaska together with national groups such as the Sierra Club, the Wilderness Society and others. All of these groups carried their favourite areas for protection in Alaska to the table and their preferred agency for providing that protection. Federal and state resource and land agency employees were key members of the various groups, which met in small cities and towns in Alaska to coordinate the fulfillment of their dreams.

Former Governor of Alaska Walter Hickel became the secretary of the interior in 1968. In 1969, he travelled to Alaska with state Senator Ernest Gruening to attend public hearings on the creation of a national park in the Wrangell-Saint Elias area. In the same year, George Harzog, the head of the National Park Service, met with representatives from government and private interests in Alaska, and conveyed the Park Service's support for efforts to create new national parks in the state.

The two key figures in Congress who would become responsible for the passage of ANCSA were Senator Henry (Scoop) Jackson, Chairman of the Senate Interior Committee and Morris (Moe) Udahl, Chairman of the House Interior. Both men were important players in the development of ANCSA and ANILCA, a process that involved the administrations of four presidents.

Working with the staff of Senator Jackson and Congressman Udahl, and principally with Bill Van Ness of Jackson's staff, conservation groups within and outside of Alaska began to secure their interests as ANCSA progressed through the Congress in 1969 and 1970. It appeared that passage of the bill might take several years until the fate of the Prudhoe Bay oil pipeline, which had been proposed to move vast amounts of oil south from the North Slope, came into debate in 1968.

In 1970, five Athabascan villages along the pipeline corridor were successful in securing a court injunction that prevented Secretary Hickel from issuing a federal right-of-way for the project. This spurred Congress to expedite the passage of ANCSA, thereby granting $962.5 million US and 44 million acres to 13 newly established Alaska Native regional corporations and 206 village corporations.

After watching land withdrawals under ANSCA vary from between 4 and 80 million acres during a three-year negotiation period, conservationists decided to become forthright about their own desires and succeeded in convincing the administration of President Nixon and Congress to support Section 17 (d)(2) provisions of ANCSA. The provisions directed the secretary of the interior to withdraw up to 80 million acres of public lands for possible addition to the national wildlife refuges, parks, forests and wild and scenic river systems. These withdrawn lands came to be known as "national interest" lands.

Also established within ANCSA was the Joint Federal/State Land Use Planning Commission for Alaska, an agency with two major responsibilities: (1) to ensure the intent of Congress was met by the implementation of ANCSA, and (2) to make recommendations to the president and Congress on national interest lands designations. The commission was co-chaired by a federal representative appointed by the president, and the governor of Alaska or an appointee. Both chairmen had veto power. The secretary of the interior and the governor each appointed four commissioners, one of whom had to be a Native Alaskan. Except for US citizenship, there were no requirements on other commissioners. The commission was the principal public forum outside of the Congress in which the destiny of Alaskan public lands was developed.

Alaska National Interest Lands Conservation Act (ANILCA)

By the time ANCSA passed, conservationists had already been developing their position on how federal lands should be administered in Alaska over a three-year period. By March of 1973, they were able to present a proposal for the protection of 84 million acres within national parks and wildlife refuges to Secretary of the Interior Roger Morton. The conservationists did not recommend an expansion of the national forests system.

The Land Use Planning Commission created an interagency planning group which had 92 members at its peak, and which ratified, over a two-year period, many of the recommendations pertaining to national interest lands that had been made to Secretary Morton in 1973. Representatives of the Alaskan business community and the state government largely rejected the recommendations, and referred to the entire Section 17 (d)(2) process as a land lock up. At this time, 7,611,000 acres were included in national park units in Alaska, equal to 2% of the state's total acreage. The national wildlife refuge system consisted of 23,338,758 acres or about 6% of the state's acreage, and the Forest Service controlled about 23 million acres, or less than 6% of the total land area. Alaskans preferred the Forest Service in the main, because it was regarded as a pro-development agency, rather than a protector of natural values and wildlife habitat.

Alaskans then surprised themselves by electing Jay Hammond, an avowed conservationist and former Fish and Wildlife Service agent, as governor in 1974. Hammond's first appointment to his cabinet was the person who conveyed the conservationists' recommendations to Secretary Morton in 1973. Although he was the Republican candidate for governor, Hammond selected eight Democrats and eight Republicans to his initial cabinet. The new administration brought a decidedly more environmentally oriented perspective to discussions brought before the Land Use Commission and the Congress.

Governor Hammond had his own ideas about how national interest lands should be disposed in Alaska, which included placing most of the acreage under discussion into a new classification called "Alaska national lands." This would grant Alaskans more freedom in using these lands for hunting and other traditional uses than they expected under either a park or refuge administration. The idea was not well received by Congress, the Ford Administration, or the federal members of the Land Use Commission.
Meanwhile, the implementation of ANCSA was underway and the Cook Inlet Regional Native Corporation was working with the state of Alaska to obtain better lands than they had been given selection rights to in the original legislation. The land trade would involve state lands, some already patented, and federal lands that had been designated for addition to conservation units. The state chairman designee of the planning commission, David Jackman, was opposed to the trade, but the governor was for it, so he fired Jackman.

The governor then asked Walter Parker, his Commissioner of Highways, to take the state chairman position. Parker said he supported Jackman and would not take the position until the commission had voted on the Cook Inlet issue. The governor then appointed George Rogers as interim state chairman, the commission voted in favour of the land trade, and Parker officially took over as state chairman.

The governor and his new state chairman were soon in Washington, DC, to resolve the two most contentious issues impeding the classification of national interest lands. These were the transportation rights of the state and private individuals across national interest lands and subsistence rights of Alaskan Natives and other rural residents living a subsistence lifestyle.

Both of these problems were eventually addressed within individual titles in ANILCA. The transportation title has not been used thus far because only one road was proposed (which was routed through a conservation unit), and because Congress acted to provide access before the state and the National Park Service could make use of the procedures laid out in ANILCA.

The subsistence title was based on providing greater access to the state-administered regulatory process for the taking of fish and game to rural residents. Initially, it appeared that the process would work, and the people of Alaska voted 60% in favour of a state law matching the federal subsistence title. However, a lawsuit was filed which challenged the state legislative action as unconstitutional under the Alaska State Constitution, and in 1988 the Alaska State Supreme Court supported the plaintiff's position by a vote of three to two. This forced a federal take-over of subsistence regulation of both fish and game by ANILCA. The Alaska legislature has resolutely refused to take further action to regain control of fish and game regulation in federal lands in Alaska.

One result of the passage of ANILCA in 1980 was an increase in national park acreage to 51,196,000 acres, or 14% of Alaska's total land area. Approximately 51,196,000 acres of this area has been classified under the new status of national preserve. This designation incorporates some of the features Governor Hammond had hoped for in his early proposal for Alaska national lands.

National wildlife refuges increased in total area to 76,058,758 acres or 20% of the state's total acreage. The expansion recognized that wildlife and wildlife habitat protection had been key issues motivating most of the individuals directly involved in developing ANILCA.

The Forest Service gained no additions, and indeed witnessed the conversion of 3,036,000 acres of national forest to national monuments under Forest Service administration. In addition, approximately 5, 361,899 acres were converted to wilderness designation, thus effectively removing them from multiple use management.

Wilderness designations were among the hardest fought issues in ANILCA. At one time, The Wilderness Society and its allies believed that some 90 million acres of Alaska could be protected as wilderness. In the final bill, 59,312,899 acres were designated, a figure about midway between the 33 million acres recommended by the Land Use Commission and the 90 million desired by the House of Representatives and the Carter Administration.

Left unresolved in ANILCA was the fate of oil exploration on the coastal plain of the Arctic National Wildlife Refuge. It is still unresolved now, 20 years after the passage of ANILCA.

Federal land management agencies and their respective conservation units in Alaska

Traditionally, three basic management systems have governed stewardship of federal lands:

1. Wildlife Conservation: lands managed expressly or primarily for protecting and conserving wildlife populations and habitat. These lands are managed under the national wildlife refuge system.

2. Multiple Use: Wildlife conservation is only one aspect of management. Sustainable public use and enjoyment through recreation, hunting, fishing, mineral and natural resource extraction, etc. are permitted. Lands include public resource lands and national forests.

3. Single Use: Lands are devoted to purposes other than wildlife conservation, but may convey aspects of wildlife conservation through management plans. Single use lands include: National parks and monuments, wilderness areas, marine sanctuaries and military reservations.

Determination of permitted activities is based upon the stated purpose of the conservation unit. In practice, various activities occur largely at the discretion of local land managers or the secretaries of interior and agriculture, depending on the conservation units in question. Congress must authorize proposed activities inconsistent with the legislated purposes of a specific conservation unit.

US Fish and Wildlife Service – National Wildlife Refuges (NWR): The US Fish and Wildlife Service (FWS) is established under the Department of the Interior. The only conservation units managed by the FWS are national wildlife refuges (NWRs). The purpose of creating NWRs is to protect large segments of intact ecosystems that provide habitat for birds, fish and mammals. In addition to requiring comprehensive management plans for all NWRs in Alaska, ANILCA defines general and specific purposes of each NWR.

In order of priority, the purposes of NWRs in Alaska are to:

1. Conserve the natural diversity of fish and wildlife populations and habitats
2. Fulfill international treaty obligations
3. Ensure water quality and necessary quantity within the refuge
4. Provide opportunities for continued subsistence use by local residents (This provision is a purpose of nearly all Alaska NWRs)*

*This purpose must be consistent with purposes one and two and is subservient to them.

However, Title VIII of ANILCA states that uses of public lands in Alaska must have the least adverse impact on rural subsistence users; thus balancing restrictive measures afforded by purposes one and two.

The significance of ANILCA to national wildlife refuges in Alaska is described under Title III. Special regulations for Alaska refuges are outlined in 50 CFR 36 and supplemental general NWRS regulations found in Title 50 CFR, chapter one, subchapter C.

Permitted activities in NWRs include: sightseeing, photography, hiking, camping, sport hunting, fishing (state/federal managed), trapping (by state/federal laws), commercial fishing and related activities (require special use permits), subsistence activities, use of snow machines, motor boats and other traditionally used motor craft, fixed wing aircraft (generally permitted) and helicopters (require special use permits).

National Forest Service – National Forests: The National Forest Service (FS) is established under the Department of Agriculture. In Alaska, the FS manages national forests, for the purposes of:

1. Protection of forest;
2. Securing favourable water flow; and
3. Furnishing a supply of timber.

Multiple use activities are permitted on Forest Service lands as long as they are deemed compatible with these statutorily expressed purposes.

Special significance of ANILCA to the Forest Service is outlined in Title V.

National Park Service: National parks, preserves, and wild and scenic rivers

The National Park Service (NPS) is authorized by Congress under the Department of the Interior. The NPS was created in 1916 to promote and regulate the use of federal lands in order to protect them and leave them unimpaired for the enjoyment of generations of people. There are 16 designated categories of protected areas under NPS management authority. Each category confers a different level of protection. NPS management units in Alaska are limited to national parks, monuments, preserves and wild and scenic rivers.

The special significance of ANILCA to the National Park Service is described in Title II. Regulations for NPS lands in Alaska are outlined in 36 CFR 14, Part 13.

National Parks are generally large natural areas characterized by a wide variety of natural attributes, and often have cultural or historic significance. National parks are nominated by the US Congress and ratified by the president. National park lands are open to all forms of non-consumptive use. Fishing, hunting, mining, and other consumptive activities are prohibited. Subsistence activities are permitted where specifically authorized by the NPS.

A single distinctive feature such as a significant archaeological site or geological feature generally identifies National Monuments. Monuments are managed in the same manner as parks and have the same restrictions on human activities.

National Preserves are very similar in size and structure to National parks. Unlike parks and monuments, preserves permit hunting and trapping. Mineral exploration and extraction are prohibited unless authorized by prior existing claims or rights (granted prior to establishment of the preserve).

Wild and Scenic River System has three classifications defined under the Wild and Scenic Rivers Act. Criteria for classification include scenic features, wilderness characteristics and recreational opportunities. The wild classification is the most restrictive of development or incompatible uses, as it stresses preservation of the wilderness aspect of rivers. The scenic classification permits some intrusions into the natural landscape.

Bureau of Land Management – National Recreation and Conservation Areas: ANILCA established the Steese National Conservation Area and the White Mountains National Recreation Area to be administered by the Bureau of Land Management (BLM). Lands administered by the BLM are managed under principals of multiple use and sustainable yield. Consumptive activities such as mineral extraction are permitted if deemed compatible with other statutorily identified purposes of specific conservation units.

National Conservation Areas are federal lands set aside to ensure multiple use, sustained yield and maintenance of environmental quality. Steese NCA identifies caribou and the Birch Creek Wild and Scenic River as special features to protect.

National Recreation Areas are administered in a way as to best provide public outdoor recreation use and enjoyment and for conservation of scenic, scientific, historic, fish and wildlife and other values contributing to public enjoyment.

The significance of ANILCA to Bureau of Land Management lands is defined under Title IV.

Wilderness areas: Public lands applicable to the Wilderness Act are under the jurisdiction of the FS, FWS, NPS and BLM. Designation of wilderness areas follows land inventory, evaluation and subsequent recommendations to the president by federal land management agencies. Wilderness areas are nominated by the president and designated by Congress.

The Alaska Lands Act (ANILCA) obtained special stipulations in the Wilderness Act permitting the following activities within Alaskan wilderness areas (WAs):

- Subsistence activities, including hunting, fishing, trapping, berry gathering and timbering for firewood and cabins are generally permitted (provided there is a traditional or customary use of the lands)

- Hunting, fishing, and trapping are permitted in national forest, national wildlife refuge and national preserve units, but not in national park WAs
- Public recreation and safety cabins will continue to be maintained and may be replaced. A limited number of cabins may be built as necessary
- A special use permitting system for cabins, homesites, use of temporary campsites and equipment related to wildlife harvests will continue in national forest WAs
- Fish habitat enhancement programmes will be initiated in national forest WAs
- Special use permitting system for guides and outfitters will continue for national forest and national wildlife refuge WAs
- Access to private, state and Native lands is guaranteed
- Use of fixed wing aircraft, boats, snow machines, and non-mechanized surface transport may continue for traditional activities and to provide access to villages and home sites.

Important legislation affecting the designation and management of conservation units in Alaska

Alaska Statehood Act (1958): Drafted when Alaska was admitted into the United States. The new state obtained title and the right to select more than 104 million acres from the total land area of 375 million acres for the purpose of ensuring its economic survival. Native rights to land claims were vague and conflicting interests between Natives and the state during the selection of these lands soon developed. A federal freeze of all state land selections ultimately resulted, which forced Congress to finally address Native claims to Alaskan lands through ANCSA.

Wilderness Act (1964): Legislation for long-term preservation of habitat by sparing substantial areas of public lands from the most damaging forms of human land use and development. The act prohibits commercial enterprises and permanent roads within designated wilderness areas. The act conveys sharp restrictions on temporary roads, mechanical transport and construction of installations. Applications for mining and mineral leasing were prohibited in 1983.

Alaska Native Claims Settlement Act (1971) ANCSA: Legislated the terms by which Alaskan Natives acquired title to their lands. Established 13 Native corporations and an organization for village corporations, and granted them approximately 44 million acres of federal land in Alaska, and a cash settlement of nearly one billion dollars. ANCSA enhanced public involvement in public lands issues by establishing 10 regional advisory councils comprised of local people to evaluate policy and natural resource management plans. ANCSA permitted further filings of state land selections authorized under the Alaska Statehood Act.

D1- All unreserved public lands withdrawn from all forms of appropriation under public land laws (including mining and mineral leasing laws) for a 90-day period following passage of ANCSA and review by the secretary of the interior to determine whether any portion of these

lands should be reclassified to permanently withdraw (protect them) or open them to public appropriations.
D2- Lands withdrawn by the secretary of the interior from all forms of public appropriation under public land laws, including mining and mineral leasing laws, and from selection under the AK Statehood Act, and by regional corporations under ANCSA Section 11 for addition to, or creation as units of the national park, forest, wildlife refuge, and wild and scenic rivers systems.

Joint Federal-State Land Use Planning Commission: A commission formed by 10 federal and state appointees representing diverse interests, which developed recommendations for the secretary of the interior and Congress regarding the selection and "highest and best use" of lands in Alaska. The commission also improved state/federal coordination and consultation regarding land use and resource allocations and helped minimize conflict between the state and Native groups on issues of land selection.

Alaska National Interest Lands Conservation Act (1980) – ANILCA: This lands bill originated within the passage of ANCSA in 1971, which, under section 17(d)(2), authorized the secretary of the interior to withdraw land from all forms of appropriation under public land laws including mining and mineral leasing laws, and from state and Native regional corporation land selections. ANILCA protected entire ecosystems by placing more than 97 million acres of Alaska [d(2) lands] into new or expanded parks and refuges. These lands doubled the size of both national wildlife refuge and national park systems and protect 25 free-flowing rivers in Alaska – nearly doubling the nation's wild and scenic river system. Fifty two million acres were classified as wilderness – tripling the national wilderness preservation system.

The International Biological Station Lena Nordenskiöld – history, concepts, experiences and future plans

Vladimir I Pozdnyakov
International Biological Station Lena-Nordenskiöld, Yakutsk, Russia
67000 Russia, Yakutsk, Dzerzhinsky str.3
Email: sterh@sakha.com

The International Biological Station (IBS) Lena-Nordenskiöld was established in the Lena Delta according to a Memorandum of Mutual Understanding between the Sakha Republic (Yakutia), WWF-Sweden and WWF International in 1993 in Stockholm, Sweden. The station was inaugurated on July 22, 1995 by Michail Nikolaev, President of the Sakha Republic (Yakutia) and HRH Prince Philip, Duke of Edinburgh.

The main objectives of the IBS are to: organize and undertake complex research on arctic ecosystems in Yakutia, inventory biodiversity, and conduct ecological monitoring and research into sustainable uses of natural resources. The location of the IBS in one of the most ecologically significant regions in the Arctic (Solomonov & Pozdnyakov, 1997) allows the station to conduct research that is not only relevant to the Lena Delta area but also to the entire arctic region.

The stated major areas of investigation for the IBS are:

1. Study of biological resources in the Lena Delta and adjacent sections of the Laptev Sea;
2. Study of the structure and functioning of subarctic and arctic ecosystems, both terrestrial and aquatic; and
3. Implementation of ecological monitoring projects including monitoring of cryolithozone, soils, vegetation cover, wildlife, climatic and geophysical conditions, and water, air and soil pollution.

Naturally, the staff employed by the station will not be able to complete all of these tasks.

Since its establishment, the IBS has been a focal coordinating point for interdisciplinary studies relating to the current state of natural delta complexes in the Lena system and in neighbouring areas.

Since 1993, monitoring has been undertaken within the framework of the Arctic Expedition Program organized by the Yakut International Centre for Development of the Northern Territories (SD RAS). Research projects in 1995–1996 included: formation and dynamics of soil cover in tundra landscapes, structure and evolution of plant communities in mountain tundras, features and dynamics of hydrobiont communities (zooplankton, zoobenthos, ichthiofauna) in delta reservoirs, and status of and responses to changes in ambient factors in bird populations and land vertebrates. This research involved staff from the Institute for Biological Problems of Cryolithozone (Yakutia), the SD RAS; the Lena Delta State Reserve; the Ministry for Nature Protection, the Republic of Sakha (Yakutia) and the IBS.

In 2000, research on the biodiversity of the Lena Delta resumed according to special scientific programmes established by the Sakha Republic. These programmes involved the participation of scientists working in the Lena Delta, and were designed to take full advantage of the resources offered by the IBS. In 1996, the IBS hosted the first joint international expedition to the delta within the framework of a Russian-German scientific collaboration, the Laptev Sea Systems Project. Scientists from the Research Centre for Marine Geosciences in Kiel (GEOMAR, Germany), the RF State Scientific Centre; the Arctic and Antarctic Research Institute (St Petersburg); the Lena Delta State Reserve and the IBS Lena-Nordenskiöld took part in this project (Kassens, 1996a, b).

This year's expedition focused on the temporal period of most rapid environmental change, (based on oceanographic, ecological and sedimentary evidence) the spring ice break up. In 1998–2000 research projects administered under the Laptev Sea System 2000 programme continued and were expanded to include the terrestrial ecosystems of the Lena Delta (Rachold & Grigoryev, 1999, 2000).

The expeditions worked in coastal areas of the Laptev Sea, on the Laptev Sea Flaw Polynya, in the Lena Delta and in the New Siberian Islands. It is important to note that as many as 70 researchers have participated in field studies annually through this programme and that the Lena Delta State Reserve and the IBS collaborated on important biological projects. In addition to studying the influence of the Lena River on natural processes in the Arctic, the scientists are interested in the delta's floral and faunal communities, which are very rich and diverse.

A number of expeditions have undertaken work at the IBS and in the Lena Delta, including the following: The Institut fur Vogelforschung, Vogelwarte Helgoland, Germany (Exo & Stepanova, 2000, in press); Centre d'Etudes et de Documentation sur les Milieux Polaires and Groupe de Recherches en Ecologie Arctique, Dijon, France (Gilg et al., 2000); International Expedition of the Institute of Ecology and Evolution, Russian Academy of Science, Moscow. Scientists from Germany, France, Great Britain, Sweden, the Republic of South Africa and the Republic of Sakha (Yakutia).

In 1997 alone, 13 professional ornithologists were involved in research in different areas of the Lena Delta. Their work resulted in the addition of 122 species to the bird list for the region, representing a 20% increase in species. This example demonstrates the effectiveness of these investigations.

A review of the past five years of activity at the Lena-Nordenskiöld IBS confirms that the first stage of the centre's development has been achieved, although only the first and part of its second stated tasks have been successfully completed. The next phase in the development of the IBS will involve the organization of ecological monitoring projects in the Lena Delta. This will enable analyzes of natural and anthropogenic processes within a circumpolar context and the development of effective measures to preserve the richest natural resources. It is impossible to meet these objectives without the assistance of international nature conservation organizations. Specific steps that should be taken include:

1. Advertising scientific research possibilities that will result in the protection of arctic nature and undertaking cooperative research efforts using existing research stations and protective territories;
2. Involving scientific organizations in cooperative research projects in key areas in the Arctic, including the Lena Delta and the Lena-Nordenskiöld IBS;
3. Organizing and coordinating cooperation and collaboration among researchers and research stations and creating a network of arctic stations; and
4. Fund-raising to support research projects that will yield results widely applicable to ecological nature protection throughout the north.

Realizing these objectives will increase intellectual, material and financial resources to support the work of the Lena-Nordenskiöld IBS and other work carried out in the Lena Delta, and will create favourable conditions for the further development of the station.

In conclusion, it is important to note that the Lena-Nordenskiöld IBS is functioning in spite of the difficulties described, and is gradually developing a data bank on the natural features of the region. This data bank is derived from the results of private research and is not only the property of the Sakha Republic, but of all people in the Arctic.

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Biological resources and conservation concerns in Arctic Yakutia

NG Solomonov
Institute of Cryolitozone's Biological Problems, SD RAS, Yakutsk

VN Vasiliev
Yakut International Center for the Northern Territories' Development, SD RAS, Northern Forum Academy
677891 Russia, Yakutsk, 2 Petrovski str.
Email: v.n.vasiliev@internord.ysn.ru

Almost half of the vast territory of Yakutia, which is distinguished by diverse landscapes and ecosystems, lies within the Arctic. Within its boundaries are harsh polar deserts, endless tundra plains and lakes, the deltas of the largest northeastern Siberian rivers, arctic islands, vast plains, the Verknoyansk and Polous mountain ranges and the Chekanov and Pronchishev ridges in the Arctic. Naturally, this landscape diversity is reflected locally in plant and animal communities. However, many plant and animal species are largely restricted to the southern edges of the territory and are represented by few individuals. Ecosystems are simple in structure, and hence unstable.

In recent decades, anthropogenic impacts on nature have increased. The first ecological catastrophes occurred exactly in Arctic Yakutia. In 1942-1946 in the delta and lower reaches of the Lena River, fish plants - Trophimovskiy, Bykovskiy, Olenekskiy and Tit-Arinskiy - were established and whitefish was harvested intensively. As a result, fish populations in the Lena Delta have been so reduced that numbers of some economically important species have not recovered until recently. Tin mining in the Khroma River in the 1960s–80s contaminated the river, and contributed to the deterioration of its ecosystems. By the early 1980s, 4 of its 14 species of fish and 50 of its 62 zooplankton species had disappeared. These examples illustrate the fragility of northern ecosystems and the importance of managing them responsibly.

The biological resources of arctic Yakutia have been relatively well investigated. The first biological studies in the territory were initiated between 1925–30 by the Yakut Expedition of the USSR Academy of Sciences. The scope of research expanded significantly after scientific organizations, particularly the Yakut Division of the USSR Academy of Sciences and the Yakut State University, were established in 1949 and 1956 respectively. Significant inventory work on the territory's flora and fauna had been conducted by the 1970s (Karavayev, 1958; Usanova & Perfilieva, 1974; Sherbakov, 1975; Komarenko & Vasilieva, 1966; Kirillov, 1972; Vorobiev, 1963; Tavrovskiy, et al, 1971; and others). Studies of the biological resources of Yakutia's northern regions have been ongoing until the present time.

Vegetation and tundra studies have focused on two main areas of research. The first, botanical research, has primarily concerned taxonomic studies of plant species. At present, 659 vascular plants, 956 species of algae, 403 lichens and 447 mosses are known to occur in Yakutia (Stepanova, 1986; Yegorova et al, 1991). The second principle area of research has been the productivity of tundra vegetation. Aerial mapping and vegetation and soil descriptions are available for an enormous area of the continental tundra and the arctic islands. Detailed plant and soil descriptions of model areas covering a 5–10km radius have enabled comparisons of plant and soil cover characteristics in various parts of the Yakutian tundra. Of particular interest are the results of long-term studies of tundra productivity, the impact of reindeer herding on tundra ecosystems in the Allaikhovskiy and Ust-Yanskiy uluses, and the impacts of motorized vehicles on vegetation (Andreyev & Galaktionova, 1993; Karpov, 1991; and others).

Sparse taiga forest stretches from the Anabar and Olenek basins in the west to the low mountains of the Kolyma River basin. Between 1991–1994 Russian-Swedish and Russian-American expeditions studied the effects of climate change on tree growth variability in the Indigiro-Alazeisk River area of northeastern Yakutia. The researchers determined that the oldest living larch trees (more than 1000 years old) are found in northern Yakutia and that it is possible to reconstruct a dendroscale spanning 2000 or more years.

A variety of projects involving joint research on wildlife resources by Russian and foreign partners have also been undertaken. Numbers of spectacled eiders were investigated together with American researchers. It was determined that two populations of spectacled eider inhabit the Indigirka Delta and Prikolymskay tundra. In total, the population numbers about 100,000 birds. A cooperative study of the ecology of the white crane is also being planned, which will involve ornithologists from Yakutia, Japan, China and the International Crane Fund. Recent inventories have shown that there are between 1,500–1,600 Siberian white cranes in nesting areas, instead of the 250–600 cranes believed earlier. Migration patterns of reindeer have been established using satellite telemetry. WWF-Germany has supported a project leading to the creation of the “Kytalyk” Nature Reserve. Research on consumptive species, such as grouse, water birds, northern reindeer, bighorn sheep, alpine (arctic) hare and other species is also being conducted.

Studies of the ecology of tundra reindeer have continued for more than 10 years. This has involved research into population dynamics and the impacts of natural and anthropogenic factors on reindeer populations. Hunting regulations and bag limits have been developed to ensure the rational use of reindeer herds by humans. Of special interest are data on changes in the behaviour and migratory characteristics of tundra reindeer populations following the appearance of humans.

Inventories of biological resources have paid special attention to rare and endangered plant and animal species. In 1987, 331 plant species and 68 bird and mammal species were documented, including many endangered species found on the "Red List" for the Yakut ASSR. A species list has now been finalized for inclusion in the second edition of the list. Some of the vascular plants included in the first edition have been removed and other species have been added. Presently, 325 endangered species are listed, and 7 mosses, 9 lichens and 10 mushrooms were added in 2000. Another 14 insects, 8 fish, 3 amphibians, 2 reptiles, 11 birds and 1 mammal will be included in the next edition. Yakutian zoologists will be participating in a cooperative project of the International Bird Protection Union and Research Center and the Japanese Wild Bird Society that will involve the development of a "Red List" of Asian Birds and a list of key ornithological territories in Asia (KOTR). Among the 21 potential KOTR of international significance identified in Yakutia, 19 are located within the Arctic.

In collaboration with foreign partners, ecological studies of the Siberian white crane and the spectacled eider were conducted. The so-called eastern population of Siberian white crane inhabits Yakutia. The central and western populations winter in different locations in western Siberia: the central population winters in India and the western population winters in Iran. Both populations have been severely reduced. In 1964, 200 cranes wintered in India, in 1975 only 63 were observed and in 1981 only 34 were left. Since 1992, only 3–5 birds have been documented during winter there. A similar situation has been observed in Iran, where nine birds wintered in 1993, 1995 and 1996. Both populations are considered endangered. It was therefore all the more gratifying when 2,800 cranes were observed in the winter in the Poyankhu lakes in the Yanszy Valley in 1993–1994. According to N. Germogenov's data, no less than 1,500 birds of these birds migrated to the Allaikhovskaya tundra in Yakutia. This positive news instills hope that the crane will gradually return to its bygone numbers.

Interesting studies of the ecology, habitat and nesting sites of the spectacled eider have been conducted in collaboration with biologists from the US Fish and Wildlife Service. In the early 1970s, this species was relatively numerous throughout northeastern Siberia and along the west coast of Alaska. However, a catastrophic reduction in the size of the Alaskan population has occurred in recent decades. This has provided the impetus for joint research efforts between Russian and American scientists aimed at evaluating population size, habitat, reproduction, spring and fall migration routes, predator relationships and other aspects of the ecology of the spectacled eider in the Indigirka Delta. An important finding of the three-year research project was the discovery that the spectacled eider inhabits the mouth of the Kolyma River and the Omulyakh Inlet in the East Siberian Sea, thus forming large aggregations in the Indigirka Delta and coastal tundra between the Kolyma River and the Chukochya River. A total of 55–56 thousand birds have been counted in the two areas. Unlike the Alaskan population of spectacled eider, the Yakutian population has maintained its historical size.

Of great importance to the conservation of endangered plant and animal species is the establishment of protected areas. In 1996, the Kytalyk Nature Reserve was created with the financial and scientific support of WWF-Germany and the Sakha Ministry for Nature Protection. The reserve aims to protect habitat utilized by the Siberian white crane and other endangered species. The reserve also protects an important nesting area for the Indigirskaya spectacled eider. The positive effect of protected areas on endangered animal populations has been previously documented in the Ust-Lenski Nature Reserve and the Chaigurgino, Elon and Khroma nature reserves.

The further development of protected areas in northern Yakutia is essential. A unified system of arctic protected areas that includes the Ust-Lenski Nature Reserve, Momski National Park, and the Terpei, Tumus and Medvezhi island reserves should be established that is based on a common management programme aimed at conserving northern biodiversity. This programme should involve monitoring of cryolitozone, seismic processes, air temperature dynamics, precipitation quantity and characteristics, core ecosystem types, and common plant and animals and species that have been entered on the "Red List". In terms of biological monitoring, the Lena Delta is very favourably positioned.

The Ust-Lenski State Nature Reserve and the Lena-Nordenskiöld International Biological Station are located within the Lena Delta. Recently, there have been significant research efforts based in these locations, as part of a project of the Arctic Expedition coordinated by the Yakut International Center for the Northern Territories' Development, Siberian Division, RAS.

Yakutian cosmophysicists have carried out research into relationships between the Sun and Earth over the past 40 years. Additionally, permafrost scientists, biologists, geologists, and seismologists from academic institutions in Yakutia and foreign regions have conducted long-term or periodic monitoring studies in the Lena Delta.

Since its establishment in 1986, the Ust-Lenski State Nature Reserve has annually published an edition of the "*Nature Chronicles*". Data from systematic meteorological research are included in the chronicle. Of special interest are data on the population sizes of common bird and mammal species in the Lena Delta, such as Siberian and collared lemmings, northern reindeer, brent goose, Bewick's swan and peregrine falcon.

It is obvious that the establishment of a network of regional ecological monitoring stations (in the Lena Delta and its lower reaches, the deltas of the Yana, Indigirka and Kolyma rivers, the central Verkhoyansk Range and other locations) will be necessary to obtain objective data on the dynamics of global and local ecological processes. A united circumpolar system of monitoring stations should be gradually established through the coordinated efforts of the Arctic Council, WWF, and others.

Summary of final presentations

By: Brian McCaffery
US Fish and Wildlife Service
Email: brian_mccaffery@fws.gov

Northern Forum Expedition

Nikolai Nakhodin
Executive Director, Sub-secretariat of the Northern Forum inYakutsk
Email: severssf@mail.ru

Under the auspices of the Northern Forum, we conducted an expedition to a region of the Olenek River for which there is almost no ornithological information, from 24 May to 14 June 2000. The area has many lakes and bogs, and a rich variety of birds. We observed more than 70 species, including many listed in the Red Book, and found five active white-tailed sea eagle nests. We had hoped to visit with local people to learn about indigenous knowledge of Siberian cranes, but encountered no one along the 750km of river that we surveyed. We hope to organize local bird surveying efforts (in particular for the Siberian crane). The expedition was very well supported by the local administration, which provided equipment and supplies. We are planning a larger expedition in 2001 and welcome participation from other researchers.

Hydrological research in the Lena Delta

Katya Obramova
Hydrobiological Institute /Lena Delta State Reserve
Email: tikzap.sakha@rex.iasnet.ru

Zooplankton are a major link in aquatic food chains, but until recently, the Lena Delta and the Laptev Sea were poorly known. We established a network of monitoring stations for sampling zooplankton in a variety of habitats, including channels, lakes, and polygonal ponds, as well as the marine waters of the Laptev Sea. Since 1993, Russian-German expeditions in the Laptev Sea have allowed us to sample plankton at 200 stations (accessed five times by ship and two times by helicopter), including the great Siberian polynya. The main topics considered in our studies include: species composition, distribution, density, biomass, seasonal and annual dynamics, life cycles, ecology and physiology, trophic links, daily movements, water quality, and food availability for fish. To date, we have increased the species list for the region by 40 species, including several not previously recorded in Eurasia, and some previously unknown to science.

Brent geese in the Lena Delta

Yuri Sofronov
Lena Delta State Reserve
Email: tikzap.sakha@rex.iasnet.ru

There are approximately 5,000 brent geese inhabiting maritime tundra on the Lena Delta. Colonies and isolated pairs are distributed patchily in several different areas. We have initiated brent goose ringing (banding) in Sakha with standard rings. Our future tasks involve monitoring and studying the relationships between *Branta b. bernicla* and *B. b. nigricans* in greater depth.

Global perspective on Lena River avifauna

Diana Solovieva
Ornithologist, Lena Delta State Reserve
Email: diana@DS3902.spb.edu

Three examples highlight the international importance of the Lena River Delta for bird populations: 1) Steller's eiders from our area migrate to all known wintering areas for the species, 2) Brent geese from our area migrate to multiple wintering areas including south China, North America, and The Netherlands, and 3) waders (shorebirds) from our area migrate to at least three continents (South Africa, Australia, as well as Asia).

Appendix A: Bird species list for the Lena River Delta – IBS Lena–Nordenskiold, 22–29 July 2000

Compiled by Brian J. McCaffery, USFWS, USA*

* - Additonal species may have been seen by other members of the workshop.

Red-throated loon *(Gavia stellata)*
Arctic loon *(G. arctica)*
Tundra (bewick's) swan *(Cygnus columbianus)*
King eider *(Somateria spectabilis)*
Long-tailed duck *(Clangula hyemalis)*
Rough-legged hawk *(Buteo lagopus)*
Peregrine falcon *(Falco peregrinus)*
Willow ptarmigan *(Lagopus lagopus)*
Black-bellied plover *(Pluvialis squatarola)*
Pacific golden plover *(P. fulva)*
Common ringed plover *(Charadrius hiaticula)*
Ruddy turnstone *(Arenaria interpres)*
Red-necked stint *(Calidris ruficollis)*
Little stint *(C. minuta)*
Temminck's stint *(C. temminckii)*
Pectoral sandpiper *(C. melanotos)*
Dunlin *(C. alpina)*
Curlew sandpiper *(C. ferruginea)*
Ruff *(Philomachus pugnax)*
Red-necked phalarope *(Phalaropus lobatus)*
Red phalarope *(P. fulicaria)*
Pomarine jaeger *(Stercorarius pomarinus)*
Parasitic jaeger *(S. parasiticus)*
Long-tailed jaeger *(S. longicaudus)*
Herring gull *(Larus argentatus,* pending taxonomic revision?*)*
Glaucous gull *(L. hyperboreus)*
Sabine's gull *(Xema sabini)*
Ross's gull *(Rhodostethia rosea)*
Arctic tern *(S. paradisaea)*
Snowy owl *(Nyctea scandiaca)*
Short-eared owl *(Asio flammeus)*
Common raven *(Corvus corax)*
Northern wheatear *(Oenanthe oenanthe)*
White wagtail *(Motacilla alba)*
Red-throated Pipit *(Anthus cervinus)*
Lapland longspur *(Calcarius lapponicus)*
Snow bunting *(Plectrophenax nivalis)*

A more comprehensive list of birds of the Lena Delta (co-authored by two of our hosts, Drs.Solovieva and Pozdnyakov) can be found in *Gilg et al. 2000. Birds and Mammals of the Lena Delta Nature Reserve, Siberia. Arctic 53: 118-133.*

Appendix B: Draft research proposal for the Lena-Nordenskiold Biological Station

Complex study of ecosystems in the Lena Delta

Main goals

- Investigation of terrestrial and aquatic ecosystems in the Lena Delta
- Study of ethnographic and social traditions of indigenous people
- Comparisons with the other arctic river deltas

Project Duration: January 1, 2001 – January 1, 2006

Main areas of investigation

- year-round investigation of aquatic ecosystems (ponds, lakes, river, estuaries)
- hydrochemistry
- phytoplankton
- zooplankton
- zoobenthos
- fish
- investigation of terrestrial ecosystems
- soils
- vegetation
- invertebrates
- birds
- mammals
- indigenous people
- ethnography
- sociology
- traditional sustainable resource use and its impact on ecosystems

Disciplines involved

- hydrochemistry
- landscape research
- paleogeography
- plant ecology
- entomology
- ichthyology
- mammology
- ethnography
- sociology

Appendix C: List of participants

BALDURSSON Snorri
snorri@ni.is
Executive Secretary, CAFF Secretariat
PO Box 375, 600 Akureyri, Iceland
Tel: (354) 462 3350
Fax:(354) 462 3390

BELIKOV Stanislav
arctos@glasnet.ru
Head of Laboratory, All-Russian Research Institute for Nature Protection
113628 Russia, Moscow, Znamenshoe-Sadki
Tel: (7) 095 4238 444
Fax:(7) 095 4232 322

BERGSTRÖM Mats-Rune
mats-rune.bergstrom@ac.lst.se
Principal Administrative Officer, County Administration of Västerbotten
Storgatan 71 B, 90186 Umeå, Sweden
Tel:(46) 90 107352;(46) 10 2665900
Fax:(46) 90107341

DOYLE John
jdoyle@northernforum.org
Executive Director, The Northern Forum
4101 University Drive, A.PU., Anchorage, AK 99508, USA
Tel: (1) 907 561 3280
Fax: (1) 907 561 6645

EBBINGE Bart
ebbdall@xs4all.nl
Alterra Green World Research
IBN-DLO, Alterra, PO Box 23, 6700 AA Wageningen, The Netherlands
Tel: (31) 317 478729
Fax: (31) 317 424988

EMANUELSSON Urban
urban.emanuelsson@cbm.slu.se
Director, Swedish Biodiversity Centre
PO Box 7007, 75007 Uppsala, Sweden
Tel:(46) 18 672730
Fax:(46) 18 673537

EMELYANOVA Ludmila
ludmila@biokom.msk.ru,
nln@gol.ru
Associate Professor, Moscow State University
Moscow, Russia
Tel: (7095) 939 4717
Fax :(7095) 421-7629

EXO Michael
michael.exo@ifv.terramare.de
Institut für Vogelforschung "Vogelwarte Helgoland"
An Der Vogelwarte 21, 26386 Wilhelmshaven, Germany
Tel: (49) (0) 4421 9689 0
Fax: (49) (0) 4421 9689 55

FRANTZEN Bjørn
bjorn.frantzen@svanhovd.no
Director, Svanhovd Environmental Centre
9925 Svanvik, Norway
Tel: (47) 7902 3745

GOROKHOV Dmitri
tikzap.sakha@rex.iasnet.ru
Director, Lena Delta State Reserve
678400 Russia, Tiksi, Fiodorova 28
Tel/Fax:(7) 41167 53939

GRIGORIEV Mikhail
m.n.grigoriev@sci.yakutia.ru
Head of Cryogenic Processes Laboratory, Permafrost Institute
Russian Academy of Sciences; 677010 Yakutsk 10, Yakutia/ Russia
Tel: (7) 4112 444 736
Fax: (7) 4112 444 476

IVANSTSOVA Nadejda
nivantsova@inbox.ru

Journalist, "Yakutia" newspaper
677000 Russia,Yakutsk, Cheryshevsky str., 16/1; r.9, Yakutia newspaper
Tel: +7-4112 451225
Fax: +7-4112 421961

JENNERSTEN Ola
ola.jennersten@wwf.se

Programme Director, Agricultural Landscapes, WWF-Sweden
Ulriksdals Slott, 17081 Solna, Sweden
Tel: (46) 8 62 47 400/32, (46) 70 555 14 02
Fax:(46) 8 85 13 29

KRISTOFERSON Lars
lars.kristoferson@wwf.se

Secretary General, WWF-Sweden
Ulriksdals Slott, 17081 Soln, Sweden
Tel: (46) 8 62 47 400/32
Fax:(46) (0) 8 85 13 29

KULLERUD Lars
kullerud@grida.no

Polar Programme Manager at UNEP/GRID Arendal
Service Box 706, 4808 Arendal, Norway
Tel:(47)3703 5708
Fax:(47) 3703 5050

KRUSE Susan
susan_lapkass@fws.gov

Wildlife Biologist, U.S. Fish and Wildlife Service
1011 E. Tudor Rd., Anchorage AK 99503, USA
Tel:(907) 786 3544
Fax: (907) 786-3640

MAZOUROV Yuri
heritage@mtu-net.ru

Department head, Russian Heritage Institute
125299 Russia, Moscow, 2 Ul. Kosmonavtov
Tel: (7) 095 286 1319
Fax: (7) 095 286 1324

McCAFFERY Brian
brian_mccaffery@fws.gov

Wildlife Biologist, U.S.Fish and Wildlife Service
YukonDelta NWR, P.O. Box 346, Bethel, AK 99559, USA
Tel: (1907) 543-3151
Fax: (1907) 543-4413

NAKHODKIN Nikolai
severssf@mail.ru

Executive Director, Sub-secretariat of the Northen Forum inYakutsk
677011 Russia,Yakutsk, 30. off.331 Lenin pr., Northern Forum
Tel:(7) 4112 420-013
Fax: (7) 4112 244-046

OBRAMOVA Katya
tikzap.sakha@rex.iasnet.ru

Hydrobiological Institute /Lena-Delta State Reserve
678400 Russia, Tiksi, Fiodorova 28
Tel/Fax:(7) 41167 53939

PARKER Walter
wbparker@alaska.net

Commissioner, U.S. Arctic Research Commission
Parker Associates, US, 3724 Campell Airstrip Road, 99504 Anchorage, USA
Tel:(1) 907 333 5189
Fax:(1) 907 333 5153

POZDNYAKOV Vladimir
sterh@sakha.com

Lena-Nordenskjöld International Biological Station
67000 Russia, Yakutsk, Dzerzhinsky str.3/1
Tel: (7)411 2 241 532/-290
Fax : (7) 41 122 412 90

PROKOSCH Peter
pprokosch@wwf.no

Director, WWF Arctic Programme
P.O. Box 6784, St Olavs Plass, 0130 Oslo, Norway
Tel: (47) 22 03 65 17/18
Fax: (47) 22 20 06 66

SAKHAROVA Nina
etc@rc.msu.ru

Ecological Travels Centre ETC
119899 Russia, Moscow, MSU Science Park,korp 1, r.122
Tel: +7-095 939 2289
Fax: +7 095 932 9/ 95

SHMATKOVA Ludmila
sterh@sakha.com

Deputy Minister of Ministry Of Nature Protection
677000 Russia, Yakutsk, 3/1 Dzerzhinsky St.
Tel: (7) 4112 42 38 47
Fax:(7) 41 122 412 90

SOFRONOV Yuri
tikzap.sakha@rex.iasnet.ru

Lena-Delta State Reserve
678400 Russia, Tiksi, Fiodorova 28
Tel/Fax:(7) 41167 53939

SOLOVIEVA Diana
diana@DS3902.spb.edu

Ornithologist, Lena Delta State Reserve
678400 Russia, Tiksi, Fiodorova 28
Tel/Fax:(7) 41167 53939

STRAUSS Andrea
andrea_strauss@gmx.de

Arctic Programme; Oslo/Norway
Stralsunder Strasse 46, 17489 Greifswald, Germany
Tel:(49) 3834 897546

VASILIEV Vladimir
v.n.vasiliev@internord.ysn.ru

Deputy Director, Yakut International Center for Development of Northern Territories "Sakha Inter North"
677891 Russia, Yakutsk, 2 Petrovski str.
Tel/Fax: (7) 4112 250-323

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For further information, contact:

WWF Arctic Programme
Box 6784 St. Olavs Plass
N- 0130 Oslo, Norway
Tel : +47 22 03 65 17
Fax : +47 22 20 06 66
E-mail: arctic@wwf.no
Internet: http://ngo.grida.no/wwfap

WWF Sweden
Ulriksdals Slott
S- 1708 Solna, Sweden
Tel: +46 862 47 400
Fax: +46 885 13 29
Internet: www.wwf.se