ISSUE BRIEF

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PERSISTENT ORGANIC POLLUTANTS: HAND-ME-DOWN POISONS THAT THREATEN WILDLIFE AND PEOPLE

The production and release of vast quantities of novel synthetic chemicals over the past 75 years has proved to be a great global experiment—one that now involves all life. Even before the Chemical Revolution moved into high gear at the end of World War II, the first warning sign appeared that some man-made chemicals might spell serious trouble. In 1944, scientists found residues of a man-made pesticide, DDT, in human fat. Seven years later, another study brought disturbing news of DDT contamination in the milk of nursing mothers. In the early 1950s, naturalists saw thinning eggshells and crashing populations of bald eagles and other birds. By 1962, Rachel Carson documented the growing burden of contamination in *Silent Spring*, which detailed the devastating impact of persistent pesticides on wildlife and warned about hazards to human health.

Ironically, chemicals that were developed to control disease, increase food production, and improve our standard of living are, in fact, a threat to biodiversity and human health. Because the risk from these originally well-intentioned chemicals outweighs their benefits, their continued use is no longer warranted.

Lori Mazzuca

Dolphins and other marine mammals may have suffered weakened immune systems as contaminants such as DDT and PCBs have accumulated in their bodies.

> "Chemicals that were developed to control disease, increase food production, and improve our standard of living are... a threat to biodiversity and human health."

Today, the contamination from persistent man-made chemicals is a pervasive global problem that urgently demands a global solution. Responding to the gravity of this threat, the international community has begun important steps toward stopping this unintended experiment. In June 1998, nearly a hundred nations embarked on negotiations with the goal of concluding a binding, global treaty on persistent organic pollutants (POPs) before the end of 2000. The outcome is critical since this process

World Wildlife Fund
Washington, D.C.

A Call To Action

Persistent organic pollutants (POPs), synthetic chemicals with unique and dangerous characteristics, pose a serious threat to wildlife and humans and merit global action. POPs have four common properties: persistence, bioaccumulation, global transport, and toxicity. Scientific research has revealed the alarming effects of these chemicals, which are still being used in several parts of the world and are present in all.

Due to the risks associated with POPs, action is needed by governments at the global, regional, and national levels, as well as by industry and consumers.

Although important steps have been taken, more sharply focused measures are needed, particularly at the global level. Toward that end, the global POPs treaty negotiations now under way must achieve the following critical objectives:

- Set POPs elimination as the goal;
- Embrace the "precautionary principle";
- Mandate a global ban on DDT no later than 2007;
- Ensure phaseout and cleanup costs are shared through extended producer responsibility;
- Ensure that the destruction of POPs stockpiles and associated contamination is carried out expeditiously, safely, and thoroughly;
- Support POPs-related research activities in developing countries and help those countries shift to alternatives;
- Require industry and governments to test POPs that have not been adequately tested individually or in combination; and
- Provide for transparent decision-making processes.

(For a more detailed version of these objectives, see page 17.)

will determine the scope and pace of global action against persistent chemicals.

Because of their unique properties, POPs pose a special kind of challenge that makes it impossible for any nation to remedy the problem by acting alone. POPs don't degrade readily and, even more important, they don't stay put. They can travel thousands of miles in complex journeys on air, water currents, and through the food web, making one country's contamination inevitably the world's problem. POPs are now ubiquitous.

The scientific case against the POPs targeted in the treaty negotiations has been mounting since the late 1940s. Many countries have already banned most of the chemicals in question or severely restricted their use. But their trade and use continues in some parts of the world. In many places, old stockpiles of pesticides and industrial chemicals are an increasing hazard to those who live nearby and to the world at large as they leak, leach, and evaporate into the air from dump sites and inadequate or deteriorating storage containers. Until an effective and adequately funded disposal program is put into place, POPs will continue to escape and add to the existing danger.

The 12 persistent chemicals specified in the ongoing negotiations pose a host of hazards. Acute exposure in tropical agriculture has caused large numbers of human deaths and injuries, including severe nervous system and liver damage. Numerous studies have also linked these synthetic chemicals to cancer and other significant health problems in people and wildlife. Emerging science has also recently heightened concern about typical "background" levels of these contaminants and a new kind of hazard known as "endocrine disruption." Researchers find that PCBs (polychlorinated biphenyls) and their co-contaminants can do damage at extraordinarily low doses, measured in parts per trillion, and that they are already compromising the health and intelligence of the next generation.

POPs jeopardize human and wildlife health in all parts of the world: in the tropics through the continued use of persistent pesticides; in temperate industrial regions through the release of

persistent combustion and manufacturing by-products; in many regions because of leaking stockpiles; and in wild and remote places where globe-hopping contaminants come to rest. There is no clean, uncontaminated place anywhere on Earth and no creature untouched by this chemical legacy.

Each of us now carries several hundred synthetic chemicals that were not present in the bodies of our great grandparents at the turn of the century. Every child born today has been exposed to persistent chemicals in the womb. Because these chemicals also become concentrated in breast milk due to their affinity for fatty substances, a baby can experience the heaviest exposure to contaminants in its lifetime through breast feeding. This exposure threatens the integrity of the next generation. Given these immense stakes, precaution dictates swift and strong action to eliminate the use and production of persistent chemicals. POPs by their nature cannot be managed. The time is long overdue to end this fateful legacy of hand-me-down poisons.

The Precautionary Principle

With origins in West Germany in the late 1970s, the "Vorsorgeprinzip," now widely known as the "precautionary principle," has evolved as a response to the environmental and human health impacts caused by rapid industrial growth and the inadequacies of early pollution control legislation.

In the context of chemicals, the precautionary principle responds to the complexity of environmental health problems, the paucity of information and subsequent uncertainty about cause-effect relations, and the slow pace of testing and government decision making. At its core, the principle calls for preventive, anticipatory measures to be taken when an activity raises threats of harm to the environment, wildlife, or human health, even if some cause-and-effect relationships are not fully established scientifically.

The precautionary principle has taken root in international statements of policy and legally binding agreements dealing with high-stakes environmental concerns of low scientific certainty. From UNEP's Governing Council Report on its 15th Session (1989), to the Rio Declaration on Environment and Development (Principle 15), Ozone Layer Protocol, Climate Change Convention, London (Dumping) Convention, OSPAR and North Sea-related decisions, UN Fisheries Agreement and many other agreements, the principle has gained widespread international acceptance as a guiding principle for decision making.

Although there is no universally agreed upon, specific definition that fits all situations, acceptance of the principle nonetheless reflects a significant paradigm shift in the environment-development realm of decision making.

What Are POPs?

The greatest concerns about contaminants have centered on persistent compounds—synthetic chemicals that resist the normal processes of degradation. As detailed in Table I, page 4, the 12 persistent chemicals targeted in the POPs negotiations include eight pesticides (aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, mirex, and toxaphene), two types of industrial chemicals (polychlorinated biphenyls or PCBs and hexachlorobenzene)[1], and two families of unintended by-products of the manufacture, use, and/or combustion of chlorine and chlorine-containing materials (dioxins and furans). Persistent organic pollutants are carbon-based chemical compounds and mixtures that share four characteristics: high toxicity, persistence, a special affinity for fat,

[1] Hexachlorobenzene is also a by-product of pesticide manufacture and has been used as a fungicide. PCBs also occur as by-products.

Table I. The 12 POPs Designated for International Action*

I. PESTICIDES

Hexachlorobenzene (HCB): Fungicide used for seed treatment of wheat, onions, sorghum. Found as impurity in several pesticide formulations. Also found as an industrial by-product.	**Endrin:** Insecticide used mainly on field crops such as cotton and grains. Used as a rodenticide to control mice and voles. Also used to combat birds.
Mirex: Stomach insecticide used to combat fire ants and leaf cutters, harvester termites, mealybug, and harvester ants. Also used as a fire retardant in plastics, rubber, and electrical goods.	**Toxaphene:** A mixture of more than 670 chemicals used as an insecticide, primarily to control insect pests on cotton and other crops. Used to control ticks and mites in livestock and to kill unwanted fish in lakes.
Chlordane: Broad spectrum contact insecticide used on agricultural crops including vegetables, small grains, maize, other oilseeds, potatoes, sugarcane, sugar beets, fruits, nuts, citrus, cotton, and jute. Used on home lawns and gardens. Also used in control of termites.	**Heptachlor:** Stomach and contact insecticide, used primarily against soil insects and termites. Also used against cotton insects, grasshoppers, some crop pests, and to combat malaria.
DDT: Insecticide used on agricultural crops, especially cotton. Currently used primarily for disease vector control.	**Aldrin and dieldrin:** Insecticides used for crops like corn, potatoes, and cotton. Also used for termite control.

Pesticides Note: Wildlife and humans can come in contact with the above-listed pesticide chemicals by breathing contaminated air, by eating contaminated food, or by drinking or washing in contaminated water. Exposure to the fetus occurs when it absorbs chemicals that the parent has accumulated.

II. INDUSTRIAL CHEMICALS

Polychlorinated biphenyls (PCBs): Used for a variety of industrial uses, including in electrical transformers and large capacitors, as heat exchange fluids, as paint additives, in carbonless copy paper, and in plastics.	**Hexachlorobenzene (HCB):** An industrial chemical used to make fireworks, ammunition, synthetic rubber. Also is a by-product of the manufacture of industrial chemicals including carbon tetrachloride, perchloroethylene, trichloroethylene, and pentachlorobenzene.

Industrial Chemicals Note: PCBs have a documented history of adverse effects in wildlife and acutely exposed human populations. Some demonstrated estrogenic effects in wildlife, as well as human fetal exposures associated with neural and development changes, and long-term effects on intellectual function. HCB is toxic via inhalation, ingestion, and dermal contact, and is a WHO Class 1A "extremely hazardous" product. It is a known animal carcinogen and a "possible" human carcinogen. Shown harmful to stomach, intestines, liver, and kidneys; can affect nervous system, and cause reproductive and developmental defects. Can cross mammalian placenta to affect the unborn.

III. UNINTENTIONAL BY-PRODUCTS

Dioxins: Not produced commercially by intention and have no known use. They are by-products resulting from the production of other chemicals, like pesticides, polyvinyl chloride, and other chlorinated solvents.	**Furans:** A major contaminant from PCBs. By-product often bonded to dioxin. Actually a group of 115 cogeners with same biological effect as dioxins but less potent.

Unintentional By-product Note: Dioxins and furans can be created in emissions from the incarceration of hospital waste, municipal waste, hazardous waste, car emissions, and the incineration of coal, peat, and wood. Dioxins are formed when chlorine is burned in the presence of certain precursors to dioxin. Chlorine in incinerators comes from such sources as polyvinyl chloride (PVC), vinylidene chloride (plastic wrap), chlorinated solvents, paint strippers, and pesticides. Dioxins are formed by processes used by metal smelters, refineries, and cement kilns. Toxic effects of chlorinated dioxins appear to be due to interference with fundamental biochemical messenger systems, including reproductive disturbances, diminished intellectual capacity, and cross-generational toxic effects.

*Information extracted from *A Review of Selected Persistent Organic Pollutants*, the International Programme on Chemical Safety, December 1995; and *A POPs Primer: Understanding the Impact of Persistent Organic Pollutants on Women and the Environment*, Commonweal, WEDO, Greenpeace, March 1998.

and a propensity to evaporate and travel long distances.

Toxicity. The 12 POPs targeted for immediate action are all chlorine-containing compounds that belong to a class of chemicals known as organochlorines. Because of long-standing concerns about their high toxicity, this dozen are among the most widely studied synthetic chemicals. Numerous studies have shown that these POPs are dangerous not only at high levels, but at low levels as well. Short-term exposure to high concentrations can be fatal or result in serious illness. Lower chronic levels have been implicated in a wide array of health and environmental problems.

All 12 targeted POPs have also been recently identified as "endocrine disruptors," chemicals that can interfere with the body's own hormones. Such hormone-disrupting persistent contaminants can be hazardous at extremely low doses and pose a particular danger to those exposed in the womb. During prenatal life, endocrine disruptors can alter development and undermine the ability to learn, to fight off disease, and to reproduce.

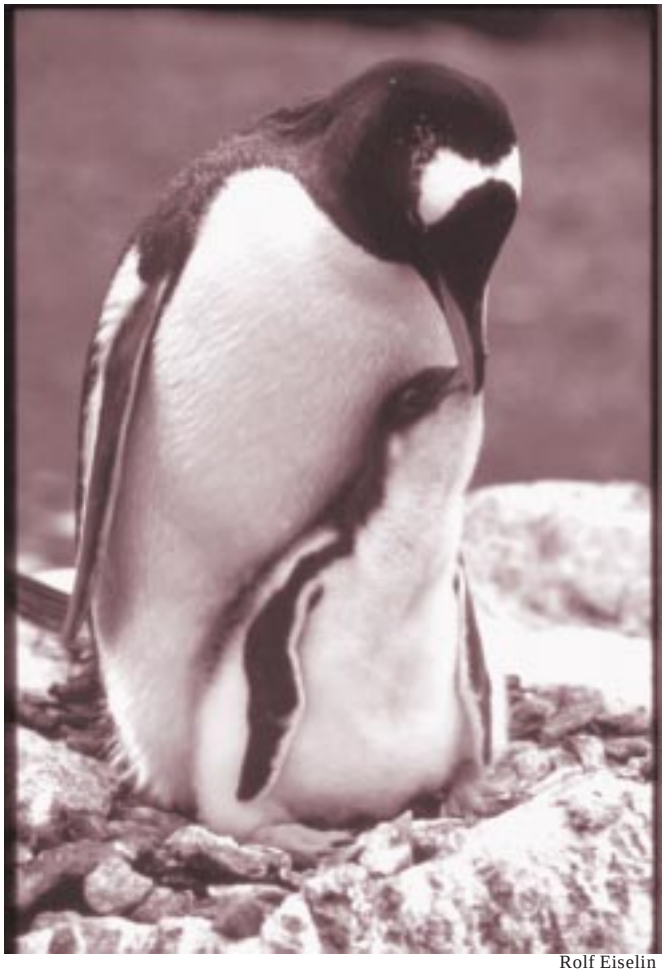
Persistence. POPs are highly stable compounds that can accumulate and remain in the environment or in body tissue for years or decades before breaking down. Chemicals characterized as "persistent" resist the natural processes of degradation—by light, chemical reactions, or biological processes—that would eventually render them harmless. Sometimes, as with DDT, the breakdown products, notably DDE, prove far more stable and persistent than the original pesticide. The body cannot readily excrete persistent contaminants except through breast feeding, so most of the targeted POPs typically have long half lives in the body and with continued exposure their concentrations grow higher over time. Persistent contaminants are now pervasive in the food web, with animal products—meat, fish, and milk, in particular—the primary routes of human exposure.

Howard Buffett

Animals like polar bears that feed at the top of the food web are exposed to high concentrations of POPs that accumulate in their body fat.

Affinity for fat. POPs are not soluble in water, but they dissolve readily in fats and oils. Because of their resistance to degradation and this affinity for fat, POPs accumulate in the body fat of living organisms and become more concentrated as they move from one creature to another onward and upward in the food web. In this way, extremely small levels of such contaminants in water or soil can magnify into a significant hazard to predators who feed at the top of the food web such as dolphins, polar bears, herring gulls, and people. In Lake Ontario, for example, the tissue of herring gulls may contain 25 million times the concentration of PCBs found in the lake's water.

Global travelers. POPs share a notable physical and chemical characteristic that makes them highly mobile and capable of traveling to the ends of the Earth. These compounds are semi-volatile, a property that allows them to occur either as a solid or a vapor depending on the temperature. Once a persistent contaminant has evaporated, it can travel great distances in air masses, often hitchhiking on particles in the atmosphere like dust.



Rolf Eiselin

Penguins in Antarctica have been contaminated with POPs that were produced thousands of miles away.

Through a process known as the "grasshopper effect," persistent chemicals jump around, evaporating in warm conditions and then settling in cool spots. When the temperature is right, POPs will again take flight and continue hopscotching travels that carry them anywhere and everywhere on Earth. Scientists detect them wherever they look in the world, even in regions where these synthetic chemicals have never been used. The pesticide toxaphene now contaminates fish in wilderness lakes in the Canadian Arctic, but there are no records of its use anywhere near that region. Toxaphene is often found in much higher concentrations than other organochlorines found in the Arctic. Persistent contaminants typical of industrial regions like the Great Lakes have been found in albatrosses on remote Midway Island in the middle of the Pacific. The penguins in Antarctica have become contaminated with a breakdown product of the pesticide chlordane and other persistent chemicals.

Emerging concerns. In the ongoing investigation of synthetic chemical hazards, scientists have come to understand how two particular characteristics of the 12 POPs under discussion—their tendency to accumulate in fat and their hormonal activity—combine to pose a special danger to the next generation. Throughout a woman's lifetime, the store of persistent contaminants mounts in her body fat. By unfortunate coincidence, the demands of pregnancy and breast feeding draw down these fat reserves, so a load of contaminants a mother has taken decades to accumulate passes on to her baby in a very short time. Even worse, these hormone-disrupting contaminants hit the baby at the most vulnerable period in its entire life.

During early development, hormones orchestrate key events such as sexual differentiation and the construction of the brain, so synthetic chemicals that interfere with hormone messages, including all the targeted POPs, can disrupt development and cause lifelong damage. In one study on dioxin, a fetus proved 100 times more sensitive to this hormone-disrupting POP than did an adult. A single low dose of dioxin to a pregnant rat at a critical moment in pregnancy did permanent damage to the reproductive systems of her pups, which showed notably diminished male sexual

behavior and a sperm count drop of as much as 40 percent. The dose used in this experiment is very near the levels of dioxin and related compounds reported in people in industrialized regions such as Europe, Japan, and the United States.

Pervasive Harm

Following the ban or restrictions on the use of certain POPs, contaminant levels have declined from peak levels in many industrial countries over the past three decades. Not all trends are favorable, however. Contrary to the widespread impression, POPs are not an old problem that has already been addressed, let alone solved. A recent study of North Pacific minke whales found increasing levels of contamination from chlordane and PCBs—an indication, according to the research team, of "continuous fresh input of PCBs and [chlordane] in the North Pacific marine environment." Whatever the trends, environmental levels remain high enough to continue to affect people and wildlife. The existing global burden of POPs must be reduced and eliminated as quickly as possible.

Although some POPs-related studies have taken place in developing countries, few if any provide baseline data on levels and effects of POPs. Therefore, up to this point in time the bulk of the data has come from studies undertaken in industrialized countries. Resources must be provided to fill these critical gaps in POPs-related data. This is all the more urgent as exposure of people and wildlife to POPs in the developing world can be much more direct—at or near the point of release—than in the industrialized world. The lack of such baseline work, however, should in no way delay action on POPs.

> "Some sensitive species have disappeared altogether because of total reproductive failure linked to chemicals on the POPs list."

Effects on Wildlife

An extensive body of scientific evidence documents the devastating toll of persistent contaminants on wildlife. In many parts of the world, wild species show signs of disrupted sexual development and a diminished ability to reproduce. Some sensitive species have disappeared altogether because of total reproductive failure linked to chemicals on the POPs list.

Threatened beluga whales. In the St. Lawrence River, the beluga whales suffer from an astonishing list of afflictions—several kinds of cancer, twisted spines and skeletal disorders, ulcers, pneumonia, bacterial and viral infections, thyroid abnormalities—seldom if ever seen in belugas living in less polluted water. Although levels of persistent contaminants in the river have dropped markedly in the past three decades, the belugas still show high levels of the targeted POPs, especially the young who acquire the contaminants from their mother's milk. One young whale found dead had 10 times more PCBs in its body than the level necessary to qualify as hazardous waste under Canadian law. Ongoing research on this population indicates that widespread hormone disruption is undermining reproduction and preventing recovery of the population.

Alligator abnormalities. POPs have also been linked to the stunted penises and reproductive failure in the alligators in Florida's Lake Apopka. Alligator eggs collected there had relatively high levels of a variety of contaminants, including toxaphene, dieldrin, and the DDT breakdown products DDE and DDD. Although the abnormally small penises are the most dramatic symptom, male and female alligators also suffer from profound but invisible disruption of their internal reproductive organs and from skewed hormone levels. A

The Fate Of Whales

The oceans have become the final resting place for many of the persistent chemicals produced in large volume over the past 75 years. As these POPs build in the marine environment, they pose a particular hazard to the ocean's top predators such as the large-toothed and baleen whales.

After industrialized countries acted to ban several of the 12 priority POPs in the early 1970s, the concentration of contaminants declined in European and North American waters between the late 1970s and mid-1980s. Since the late 1980s, contaminant levels for most POPs have held steady in these regions, but elsewhere in the world PCBs in marine systems appear to be increasing. Scientists have reported significant increases in PCBs and hexachlorobenzene (HCB)—both among the 12 priority POPs—in minke whales in the Antarctic and North Pacific. In short, there has been no decline in widespread persistent chemical pollution in marine animal tissue since the mid-1980s.

As a consequence, large whales carry levels of PCBs and dioxins at or above the levels reported to cause significant neurological problems in humans exposed in the womb. Human studies have found that current background body burdens of PCBs, dioxins, and furans can affect the immune system and have been linked to mild changes in thyroid hormone levels in offspring due to prenatal exposure.

Because whales depend on their hearing for navigation and communication, recent laboratory studies linking PCB exposure to impaired hearing raises new and important concerns about the future of whales. In rats, prenatal exposure to PCBs leads to low frequency hearing loss when the rats reach adulthood. The evidence suggests that a sizeable segment of whale calves are being exposed before birth to concentrations of PCBs, dioxins, and furans comparable to levels that cause neurological damage in humans. If similar prenatal exposure also leads to hearing loss, as studies indicate, it could undermine a whale's sense of direction or interfere with communication among individuals or pods. Although insidious and invisible, damage to this vital sensory system could have major implications for the long-term survival of the ocean's great whales.

new study shows that these wildlife problems are not limited to Lake Apopka, which once had a chemical spill. The discovery of alligator hormone abnormalities and reproductive failure in other Florida lakes indicates that chronic contamination from agricultural pesticides may be as hazardous as acute incidents.

Lake trout crash. Based on persuasive new studies, dioxin now appears in part or wholly responsible for the extinction of the native lake trout in the Great Lakes. Fishery officials had blamed the trout's crash in the 1950s on overfishing, habitat destruction, and predation by an introduced parasite, the sea lamprey. But University of Wisconsin researchers have shown that trout eggs die when exposed to a concentration of as little as 55 parts per trillion of dioxin. Studies of the lake sediments indicate that contamination from dioxin and dioxin-like PCBs reached a level high enough to begin undermining trout reproduction in the 1940s.

Vanishing mink and otter. PCBs are implicated in the disappearance or decline of several animal populations in the United States and Europe. Mink began disappearing from the shoreline of the Great Lakes in the mid-1950s. Despite restrictions on DDT, PCBs, and other persistent chemicals, mink have not yet returned. Studies done by Michigan State University biologists have demonstrated that mink are highly sensitive to PCBs. British researchers have also linked PCBs to the parallel

decline among otters in Britain and Europe in the 1950s: Their analysis, showing that otters have disappeared in regions downwind from major industrial areas, points to the likely role of atmospheric transport.

Recent work on the Columbia River in the Pacific Northwest region of the United States found delayed or inadequate reproductive tract development in male otters as well as a significant dose-response relationship between these problems and synthetic contaminants such as certain PCBs, dioxins, and pesticides. More heavily contaminated young males had smaller bones (baculums) within their penises as well as lighter testicles. The animal with the greatest burden of contaminants had no testicles at all.

Abnormal behavior in wildlife. Over the years, scientists have reported behavioral changes in wildlife contaminated with persistent man-made chemicals. In gull and tern colonies in the Great Lakes, the Pacific Northwest, California, and Massachusetts, field researchers have found nests with twice the normal number of eggs, which is a sign that the birds occupying the nests were two females instead of the expected male-female pair. In some Lake Ontario colonies, birds showed behavioral aberrations, including less inclination to defend their nests or sit on their eggs, which increased predation and diminished the hatching and survival of the chicks.

WWF/F.O. Gorman

Dramatic die-offs of thousands of seals and other marine mammals are now thought to be linked to POPs contamination.

Marine mammal die-offs. Over the past decade, scientists have also documented that contaminants, such as DDT, PCBs, and dioxins, weaken the immune systems of marine mammals and that animals become more vulnerable to disease as they accumulate increasing levels in their bodies. Based on this evidence, it now appears that contaminant-induced immune suppression may have contributed to the dramatic marine epidemics that killed thousands of seals, dolphins, and porpoises in the late 1980s and early '90s. The dramatic die-offs hit populations in the Baltic and North Seas, the Mediterranean, the Gulf of Mexico, the North Atlantic, the eastern coast of Australia, and even the seals in Lake Baikal in Siberia.

Effects on People

Because people and wildlife share a common environment, they carry the same mix of persistent man-made chemicals in their bodies. It is, therefore, not surprising that humans seem to be suffering increasingly from the same health problems reported in laboratory animals and in wildlife exposed to one or more of the dozen POPs. These problems include immune

The Plight of the Inuit

An alarming result of the global experiment with POPs is the plight of indigenous people in the Arctic—an environment long-regarded as one of the Earth's few remaining pristine places. More than a decade ago, Canadian researchers conducting a study on human breast milk contamination in an industrial region went to a remote Inuit village in Arctic Canada looking for a control group with less exposure to contaminants. They were stunned by the results of their analysis. Contrary to their expectations, the level of PCBs in the breast milk of the Inuit women was five times higher than the level measured in women from Canada's industrial region. Although these Inuit women lived 1,600 miles from the smokestacks of southern Ontario and 2,400 miles from the industrial centers in Europe, they had the highest levels found in any human population except those contaminated in industrial accidents.

The POPs that now contaminate the Arctic environment arrive by wind and water currents. As POPs have condensed, settled, and accumulated in the Arctic, the contamination has passed up the food web to the seals, polar bears, and narwhals that are components of the Inuit diet. The concentration of fat-loving persistent contaminants such as PCBs in the polar bear can be 3 billion times greater than in sea water.

Canadian health officials have reported that many children in Inuit villages are plagued with chronic infections, which they suffer at rates 10 to 15 times higher than children in southern Quebec. Studies have found abnormalities in the immune systems in these children and documented that vaccinations for smallpox, measles, polio, and other diseases often fail because these children do not produce the necessary antibodies. This could make these children much more vulnerable to disease.

The high levels of POPs in Inuit women also raised concerns about the danger of neurological impairment and behavioral changes in their children. Doctors Sandra and Joseph Jacobson, whose Great Lakes research found significant learning and behavior problems in children exposed in the womb to PCBs and other persistent contaminants, are now undertaking a similar study on Inuit infants in cooperation with Canadian public health authorities.

dysfunction, neurological and behavioral abnormalities, and reproductive disorders.

Although the pattern of evidence is highly suggestive, it is virtually impossible to answer questions about the impact of these persistent chemicals on human health directly or definitively. Because everyone carries a load of these chemicals, there is no unexposed population to study as a control group. Moreover, scientists for ethical reasons do not conduct experiments on people. Nevertheless, the weight of the evidence indicates strongly that chronic exposure to POPs is a hazard to human health that more than justifies precautionary action to eliminate them.

Impaired immune systems. Human studies in Sweden and Canada have linked dietary intake of PCBs and other persistent contaminants to immune system abnormalities. The Swedish study noted a correlation between the amount of PCBs, dioxins, and furans in the diet and important reductions in the population of natural killer cells, which play a key role in the body's defense against cancer. The Canadian researchers reported that children who were exposed to high levels of persistent contaminants experienced 10 to 15 times higher rates of infection than comparable

children. A recent Dutch study exploring the impacts of background levels of contaminants on children's development linked immune system changes in infants to their exposure to PCBs and dioxin before and around birth. This, the researchers noted, may presage such later difficulties as immune suppression, allergies, and autoimmune disease.

Learning and behavior problems. In an ongoing study, researchers at Wayne State University in Detroit, Michigan, have documented significant learning and attention problems in children exposed prenatally to PCBs and other persistent contaminants passed on by mothers who had eaten Lake Michigan fish in the six years prior to pregnancy. At age 11, the most highly exposed children had difficulty paying attention, suffered from poorer short- and long-term memory, were twice as likely to be at least two years behind in reading comprehension, and were three times as likely to have low IQ scores. This work is striking not only because of the lasting impact seen in the children, but also because the fish-eating mothers were not highly contaminated. The levels measured in their bodies fall on the high end of what is considered the "normal" background range in the human population. In a similar U.S. study at the State University of New York (Oswego), researchers found measurable neurobehavioral deficits in the newborn children of women who had eaten the equivalent of 40 pounds of POPs-contaminated Lake Ontario salmon in a lifetime. These children showed abnormal reflexes, a shorter attention span, and an intolerance to stress. The Oswego study has been the first to document a wide range of effects on temperament stemming from prenatal exposure to contaminants.

The role of PCBs and dioxin in learning and behavior problems. In a recent review of the scientific evidence, a branch of the U.S. Public Health Service concluded that PCBs and dioxins are responsible at least in part for the neurological and behavioral deficits reported in children

WWF's DDT Reports

Even though banned decades ago in industrialized countries, thousands of tons of the deadly pesticide DDT are still used each year, mainly to fight malaria. Citing the availability of safer and often more effective alternatives, WWF is calling for a phaseout and eventual ban on DDT production and use by the year 2007.

WWF has published two recent reports that provide the rationale for those proposed policy and regulatory actions. In June 1998, at the opening session of the global POPs treaty negotiations in Montreal, WWF released *Resolving the DDT Dilemma*, which draws on a range of six insect-borne disease control programs in Africa, India, the Philippines, South America, and India. At the second negotiating session in Nairobi in January 1999, WWF released a complementary *Hazards and Exposures* report, which summarizes the current state of knowledge regarding the health and environmental effects of DDT and synthetic pyrethroids. The complete texts of the six case studies is forthcoming in 1999.

Those case studies and scientific findings support WWF's view that DDT should be characterized by WHO and others as a "pesticide of last resort" to be used only when no other vector control methods (including other pesticides) are available and likely to be effective. This change should be an interim step, effected as soon as possible, en route to the global phaseout and ban, under the auspices of the global POPs treaty. Copies of these reports are available from WWF at 202.778.9625, or at toxics@wwfus.org.

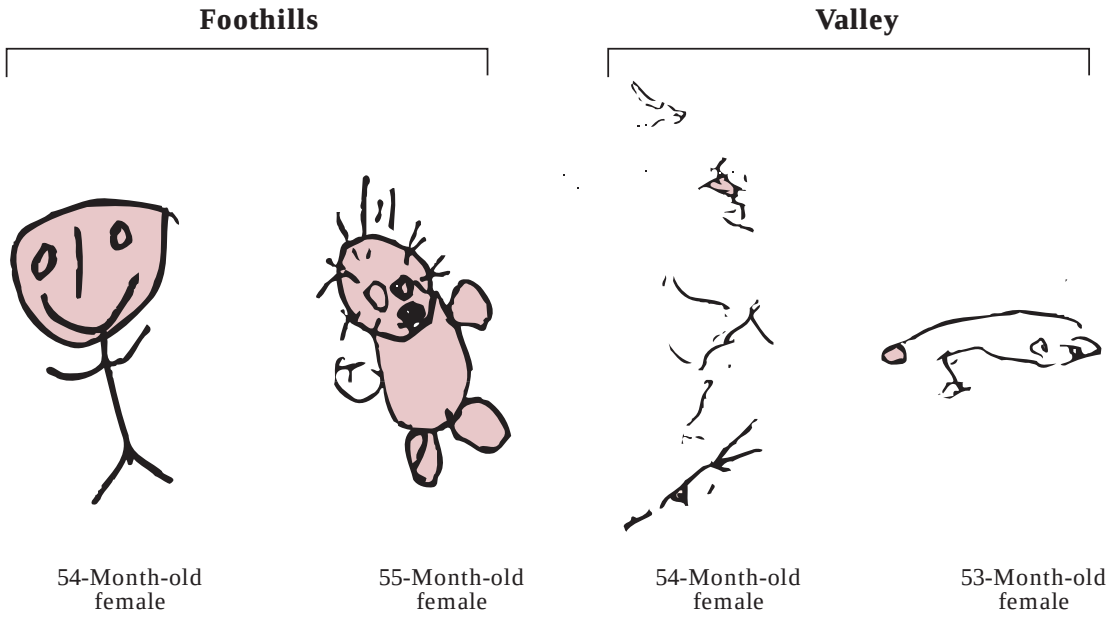


Figure 1. Representative drawings of a person by 4-year-old Yaqui children from the valley and foothills of Sonora, Mexico

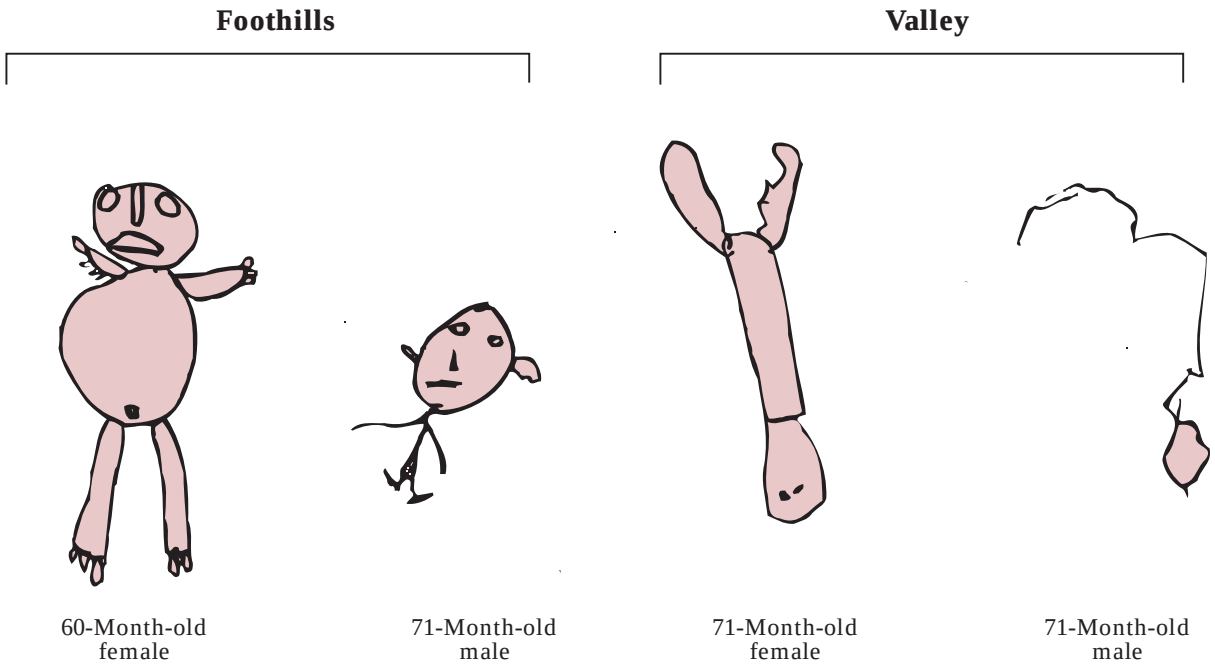


Figure 2. Representative drawings of a person by 5-year-old Yaqui children from the valley and foothills of Sonora, Mexico

Source: Guillette EA, Meza MM, Aquilar MG, Soto AD, and Garcia IE. An anthropological approach to the evaluation of preschool children exposed to pesticides in Mexico. Environ Health Perspect 106(6):347-353 (1998).

exposed in the womb. This assessment by the Agency for Toxic Substances and Disease Registry notes the "remarkable parallels" in the human epidemiological evidence and corroboration from wildlife and laboratory evidence: "[T]he collective weight of the evidence indicates that certain PCB/dioxin-like compounds found in fish… can cause neurobehavioral deficits. Further, these compounds have produced some effects in some Great Lakes fish consumers."

Pesticide jeopardy to children. A recent study in Mexico reported striking differences in the development of children exposed to agricultural pesticides compared to children with minimal pesticide exposure. In this work, researchers tested two groups of four- and five-year-old children living in the Yaqui Valley region in northwestern Mexico. The two groups were similar in all respects, ranging from ethnicity to diet, save for their exposure to pesticides. The families living in the foothills are ranchers who rely almost exclusively on traditional methods of pest control such as intercropping. The valley dwellers, on the other hand, live in an agricultural area that has seen heavy synthetic pesticide use since the 1940s. Samples of human breast milk and cord blood taken from valley women contained high levels of persistent contaminants including several targeted POPs: aldrin, endrin, dieldrin, heptachlor, and DDE. In tests developed to measure growth and development, the pesticide-exposed valley children fell far behind their foothill-dwelling peers. The valley children exhibited decreased physical stamina in a jumping test, a lack of eye-hand coordination evident in their decreased ability to catch a ball, diminished memory, and a notable inability to draw a person (see figures, page 12), which is used as a nonverbal measure of cognitive ability. The mix of pesticides used in the valley includes many synthetic chemicals—POP-listed compounds as well as non-persistent pesticides—that jeopardize neurological development.

Male reproductive problems. People also appear to be suffering increasingly from reproductive problems that laboratory and wildlife studies have linked to persistent contaminants that act like hormones—problems such as diminished sperm counts, genital defects, and testicular cancer. A recent medical study reports a doubling of the genital defect hypospadias in male infants in the United States between the 1970s and 1980s, which—together with similar reports of increasing incidence from five European countries and Japan—signals a disturbing health trend. This defect arises from incomplete masculinization of the male genitals and is reported in laboratory experiments in which males are exposed prenatally to anti-androgens like DDE.

In recent decades, the incidence of cancer of the testicles in men under age 34 has been increasing rapidly in many countries. Recent studies suggest this cancer in young men arises from events early in life or even in the womb, as evidenced by the higher rates of testicular cancer among men with developmental defects such as hypospadias and undescended testicles.

During the past five years, medical researchers' published reports of dramatic declines in sperm counts and increasing sperm abnormalities over the past half century have caused a contentious debate about whether these changes are, indeed, real. Two of Europe's leading reproductive researchers have hypothesized that increasing exposure to environmental estrogens, which include several POPs, is likely to be responsible not only for lowered sperm counts, but also for genital defects, testicular cancer, and other male reproductive abnormalities. Based on animal studies, it is also clear that humans are currently exposed to levels of dioxin roughly equiva-

lent to levels that have caused significant sperm-count drops in male rats exposed in the womb. As researchers probe the cause of the reported human sperm-count declines and other male reproductive problems, POPs stand high on the list of suspects.

Moving Against POPs

The obligation to take action on POPs stems from the 1992 Earth Summit in Rio de Janeiro. There, over 170 governments committed in their "Agenda 21" to eliminating the emissions and discharge of organohalogen and other synthetic compounds that threaten to accumulate to dangerous levels.

Building on that foundation, the UN Environment Programme's May 1995 Governing Council agreed to initiate an expedited assessment of the 12 priority POPs and their alternatives. In June 1995, the governments of Canada and the Philippines held an International Experts Meeting on POPs in Vancouver. The final consensus statement of that meeting stated that, "There is enough scientific information on the adverse human health and environmental impacts of POPs to warrant coherent action at the national, regional, and international level. This will include bans, phase-outs and provisional severe restrictions for certain POPs."

With this scientific consensus in hand, a global UNEP conference convened in November 1995 in Washington. Although its focus was on protection of the marine environment from land-based activities, special attention was devoted to POPs, with a high-level ministerial segment agreeing by consensus that, "[i]nternational action is needed to develop a global, legally binding instrument, amongst other international and regional actions, for the reduction and / or elimination of emissions and discharges, whether intentional or not, and where appropriate, the elimination of the manufacture and use of [the 12 priority POPs]."

Building on this backdrop of scientific reviews and calls for global action, the Intergovernmental Forum on Chemical Safety (IFCS) developed recommendations in 1996 which also concluded that sufficient evidence existed to warrant a global treaty to minimize the risk from the 12 specified POPs. IFCS called for immediate action by UNEP and the World Health Assembly to reduce or eliminate POPs emissions and discharges. In February 1997, the UNEP Governing Council endorsed IFCS's recommendations and agreed by consensus to move forward with treaty negotiations.

The ongoing UNEP POPs negotiations build on several global, regional, and national decisions that address POPs and other hazardous chemical issues. (Table II on page 15 addresses where POPs have been banned, restricted, or are still in use. The sidebar on page 18, "Relevant Agreements," reflects a number of global and regional approaches that complement the proposed POPs treaty.)

At the opening of the negotiations in June 1998, UNEP Executive Director Klaus Töpfer declared that the ultimate goal for this treaty must be the elimination of POPs production and use, not simply better management. As negotiators move forward, they must wrestle with a number of issues that stand in the way of realizing that aim.

Officials from the World Health Organization (WHO) and delegates from several developing countries have questioned the elimination of DDT because of its major role in combating malaria and other insect-borne diseases. Malaria poses a threat to at least 2.5 billion people in more than 90 countries and contributes every year to 3 million deaths—over half among children under five years old. Although the WHO and its experts have slowly embraced disease fighting methods that reduce the reliance on DDT, African delegates stress the need to find and fund cost-effective alternatives. (For WWF's work on DDT, see box on page 11.)

Table II. Summary of Where POPs Are Being Used, Banned, or Restricted*

Persistent organic pollutant	Areas of use (countries listed in regular type) and areas where banned/restricted (countries listed in italicized type)[1]
DDT	Permitted for import to Bhutan, Bolivia, Ethiopia, Guinea, India, Kenya, Malaysia, Mauritania, Mexico, Nepal, Philippines, Sri Lanka, Sudan, Switzerland, Tanzania, Thailand, Venezuela, and Vietnam. *Banned in Argentina, Australia, Austria, Bulgaria, Burkina Faso, Columbia, Costa Rica, Cuba, Cyprus, Denmark, Dominican Republic, Egypt, El Salvador, Ethiopia*[2]*, Finland, Fiji, Hong Kong, Indonesia, Ivory Coast, Japan, Korea, Lebanon, Liechtenstein, Mozambique, New Zealand, Nicaragua, Paraguay, Poland, Santa Lucia, Singapore, Switzerland, United States, Yemen, and Zimbabwe.* Some analysts estimate global cumulative production of DDT at 1.36 million tons.
Aldrin	Permitted in Canada for below-ground termite control. Permitted for import to Congo, Ethiopia, Malaysia, Nepal, Sri Lanka, Sudan, Tanzania, Thailand, Trinidad and Tobago, and Venezuela. Permitted in certain countries for agricultural or public health purposes, such as in Kenya for tsetse fly control and in the United States for dipping of nonfood roots/tops and mothproofing by manufacturing processes in closed systems. *Banned in United States and Russia.*
Dieldrin	Permitted for import to Congo, Ethiopia, Malaysia, Nepal, Sri Lanka, Sudan, Tanzania, Trinidad and Tobago, Uganda, and Venezuela, primarily for termite control. Used in Kenya for banding coffee trees, and in the United States for dipping of nonfood roots/tops and mothproofing by manufacturing processes in closed systems.
Endrin	Used in Dominican Republic. Manufactured or imported in United States, Philippines, and Japan.
Chlordane	Restricted use in Mexico, Canada, China, United Kingdom, Belgium, Belize, Cyprus. Permitted for import to Australia, Cuba, Ethiopia, Malaysia, Mexico, Oman, Philippines, Sri Lanka, Sudan, Tanzania, Thailand, Trinidad and Tobago. *Banned in Austria, Belgium, Bolivia, Brazil, Chile, Columbia, Costa Rica, Denmark, Dominican Republic, EU, Ecuador, El Salvador, Fiji, Germany, Guatemala, Hong Kong, Ireland, Italy, Kenya, Korea, Lebanon, Lichtenstein, Mozambique, Netherlands, Norway, Panama, Paraguay, Philippines, Poland, Portugal, Santa Lucia, Singapore, Spain, Sweden, Switzerland, Tonga, Turkey, United Kingdom, Yemen, and Yugoslavia.*
Heptachlor	Permitted for import to Burkina Faso, Costa Rica, Ethiopia, Pakistan, Sudan, Tanzania, Thailand, Togo, Trinidad and Tobago. Used in Mexico and Bulgaria for limited agricultural purposes and in the United States for termite control and dipping of roots or tops of nonfood plants.
Hexachlorobenzene	Exported by both OECD and non-OECD countries. *Banned in Austria, Belgium, former Czechoslovakia, Denmark, EU (as a pesticide), Germany, Hungary, Liechtenstein, Netherlands (as a pesticide), Panama, Switzerland, Turkey, United Kingdom (as a pesticide), Russia (as a pesticide), and Yugoslavia.*
Mirex	Currently no known manufacturers; no production data available.
Toxaphene	Manufactured in China, Pakistan, and Nicaragua. Used in Nicaragua and Zambia for agricultural purposes. *Banned in Austria, Belgium, Belize, Bolivia, Brazil, Bulgaria, Burkina Faso, Costa Rica, Cuba, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, EU, Finland, Germany, Guatemala, India, Ireland, Kenya, Korea, Liechtenstein, Mexico, Mozambique, Panama, Paraguay, Peru, Philippines, Portugal, Santa Lucia, Singapore, Switzerland, Thailand, Tonga, and United Kingdom.*
PCBs	Use has been restricted to closed electrical systems, where they remain in use throughout most of the world. *Banned in Austria, former Czechoslovakia, Finland, Germany, Liechtenstein, Netherlands, Norway, Switzerland, and United States.* Some analysts estimate global cumulative production of PCBs at 1.17 million tons.
Dioxins and Furans	Not applicable: While there are numerous industry and government programs to investigate the sources of dioxins and furans and to develop control technologies, there are no known use or emission data available at this time specific to dioxins and furans.

* Information extracted from *A Review of Selected Persistent Organic Pollutants*, the International Programme on Chemical Safety (IPCS), December 1995.

[1] Based on limited available data, this summary should serve only as a general guide, not a complete or definitive list.

[2] The discrepancy that allows the same country to import the chemical as well as report it as a banned substance is due to the fact that the information is from two different sources and indicates the sometimes contradictory nature of the information obtained.

Obsolete Stockpiles

No aspect of the POPs issue is more urgent than the problem of abandoned and obsolete stockpiles, which in countless places around the world pose a hazard that mounts with each passing day.

In Yemen, for example, a mix of pesticides buried in the mid-1980s on the Surdod Farm, a state farm project financed by the International Fund for Agricultural Development and the World Bank, is dispersing through ground and irrigation water in a spreading plume of contamination. This dump contains an estimated 33 tons of unwanted pesticides. As the contaminated area grows, it poses a serious threat to local water supplies and to the health and well-being of people living and working in the area. If action isn't taken to remove the pesticides and dispose of them properly, the estimated $400,000 cost of disposal will become even greater, and the region may face the prospect of contaminated water supplies for years to come.

An estimated 110,000 tons of obsolete or unwanted pesticides remain in stockpiles in developing countries and enormous stocks of pesticide wastes exist in Eastern Europe and parts of the former Soviet Union. These stocks contain a high proportion of highly toxic and persistent pesticides such as aldrin, DDT, chlordane, dieldrin, endrin, and heptachlor, which are escaping to the environment because of inadequate and deteriorating storage. Pesticide stockpiles can be found sitting in the open in corroded or leaking containers in urban residential areas near drinking water supplies or irrigation projects.

The situation described by Dr. Bateno Kabeto of Ethiopia's Ministry of Agriculture is typical: "[o]bsolete pesticides are found in government offices, state farms, and some enterprises... metallic containers are rusty and leaking, plastic and paper containers are torn. Large quantities of pesticides are found spilled in almost all stores." In some instances, the stockpiles are made up of chemicals supplied by international agencies to combat malaria or locust outbreaks, but never used because the pesticides, such as dieldrin, were subsequently banned.

This stockpile problem will only worsen until these stocks, stores, and environmental hot spots are identified, collected, and destroyed in a manner that does not create new POPs pollution or other environmental hazards. To accomplish this, developing countries with serious stockpile problems will need substantial financial and technical assistance from industrialized countries where newer and less hazardous destruction technologies are coming into commercial operation. Currently, gas-phase chemical reduction is the only technology that meets important technical criteria, including destruction efficiencies of effectively 100 percent for the chemicals of concern, complete containment of all residues, and no controlled releases.

Delegates from developing countries have also expressed concern about their ability to meet the obligations under the treaty and emphasized the importance of financial and technical assistance. Assistance will be needed to help countries identify and make available affordable alternatives to POPs and their sources, with those efforts emphasizing nontoxic and nonchemical alternatives. Clearly, a meaningful agreement must include significant commitments for shared responsibility, including external assistance.

Although the elimination of persistent pesticides is a concern for developing countries where they are still in use, industrialized countries face a special challenge from the unintentional by-products dioxins and furans. Many industries favor "end-of-the-pipeline" management of these POPs, rather than more funda-

mental changes that would prevent their creation. The evidence has shown, however, that efforts to manage POPs have failed and have resulted in significant, long-lasting hazards. Eliminating these hazards will require a much greater commitment in the coming years to redesign products and processes so that few if any dioxins and furans are generated.

Negotiators also face the question of how to identify, collect, and destroy POPs that remain in obsolete stockpiles of persistent chemicals or in hot spots of environmental contamination. In a number of developing countries, obsolete pesticides, including POPs, are stored in extremely hazardous conditions, as are old PCB-containing transformers and capacitors.

Rising to the Challenge

POPs are a global problem that demand a global solution. Action to eliminate persistent man-made chemicals is long overdue. POPs jeopardize the environment, the health of wildlife, and the health, behavior, and intelligence of the next generation. The mounting scientific evidence that these dozen POPs are altering our children's ability to learn, to resist disease, and to reproduce has only added to the already compelling case for the rapid phaseout of these notorious man-made compounds.

Any global treaty must reflect the true magnitude of these stakes and heed the lessons from this century's unfortunate global experiment with persistent synthetic chemicals. Given what the emerging science is showing, it would be unconscionable to proceed with business as usual. The magnitude of the possible harm to wildlife and people makes a precautionary approach wise and necessary.

To meet this formidable challenge, the global POPs treaty now under negotiation must achieve several critical objectives:

- set the clear and unequivocal global goal of POPs elimination, allowing for a rapid, orderly, yet just program for their total phaseout;
- embrace the "precautionary principle," focusing on prevention and elimination of POPs at their source, with action taken before there is damage or conclusive scientific proof, and with a shift in the burden of proof to those whose activities threaten harm;
- mandate a global ban on the production and use of DDT no later than 2007 to provide impetus for alternative methods to combat malaria that don't threaten human health and biodiversity;
- ensure that the costs of phaseout and cleanup of POPs and their sources are shared, through extended producer responsibility, the "polluter pays" principle, and related measures that facilitate effective private sector responsibility;
- ensure that the destruction of POPs stockpiles and associated contamination is carried out expeditiously, safely, and thoroughly such that no undestroyed POPs or newly formed POPs remain;
- support and encourage POPs-related research in developing countries and help those countries shift to alternatives, e.g. more appropriate products, manufacturing and disposal processes, and pest management practices, through financial and technological assistance from industrialized countries, directly, and through multilateral development banks;
- require industry and governments to undertake aggressive programs to determine the toxicity of many persistent chemicals which have not been adequately tested individually or in combination with regard to carcinogenicity and mutagenicity, endocrine activity, and developmental, immune, neurological, and reproductive toxicity; and
- provide for transparent decision-making processes, including meaningful public participation and timely

Relevant Agreements

The following global and regional agreements provide a strong basis for the POPs negotiations under way and underscore the need for a global ban on persistent organic pollutants:

- the legally binding Prior Informed Consent Procedure for Certain Chemicals and Pesticides in International Trade (PIC Convention, 1998), which provides importing countries with a more informed basis for deciding which chemicals to accept or reject, and makes trade subject to labeling requirements and information on potential health and environmental effects;
- the 1998 UN Economic Commission for Europe's Convention on Long-Range Transboundary Air Pollution (LRTAP) POPs protocol, which aims to control, reduce, or eliminate 16 POPs [the 12 POPs in the global treaty negotiations, plus lindane, hexabromobiphenyls, polycyclic aromatic hydrocarbons (PAHs), and chlordecone];
- the global London Convention on ocean dumping of waste and other matter, whose parties agreed in 1993 to ban ocean dumping and incineration at sea of industrial wastes, which would include all chemicals;
- the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, with its September 1995 amendment banning the export of such wastes from OECD to non-OECD countries. Regional actions consistent with the Basel Convention include the 1993 Central American Regional Agreement on Hazardous Wastes, the Organization of African Unity-sponsored 1991 Bamako Convention, and the South Pacific-centered 1995 Waigani Treaty; and
- other regional conventions which also address the prevention, restriction, and elimination of chemical contaminants including the 1992 OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic, the 1996 Protocol to the Barcelona Convention for the Protection of the Mediterranean Sea against Pollution, and the 1990 Protocol to the Kuwait Regional Convention for Cooperation on the Protection of the Marine Environment from Pollution.

access to relevant government and private sector data.

Although concluding such a treaty will make POPs elimination an acknowledged global priority, that alone will not solve the problem. The full support of governments, industry, citizen groups, and consumers will be essential if we are to move energetically forward and achieve these critical goals.

Some companies have already begun to take voluntary action to change their production processes. Pulp and paper mills in Scandinavia and elsewhere have, for example, virtually eliminated their release of dioxin by shifting to chlorine-free methods of production. More such voluntary initiatives are obviously needed within various industrial sectors. At the same time, large buyers and large numbers of concerned consumers can help promote a shift in business practices away from POPs, and toward clean production.

Our decades of experience with persistent chemicals have demonstrated unequivocally that there is no way to manage POPs. The only responsible course is to eliminate their production, use, and release as quickly as possible, while recognizing and addressing the special circumstances of developing countries in need of assistance. The time has come to stop this experiment with "hand-me-down poisons" before it does more irreparable damage to wildlife, children, and adults.

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For further information about POPs, their effects on biodiversity and human health, and the global POPs treaty negotiations, visit WWF's Global Toxics Initiative Web site at http://www.worldwildlife.org/toxics. Other POPs-related resources available on the web are the United Nations Environmental Programme's POPs page at http://irptc.unep.ch/pops/, Physicians for Social Responsibility and the International POPs Elimination Network (IPEN) at http://www.psr.org/pops.htm, Greenpeace International Toxic Campaign at http://www.greenpeace.org/ctox.html, and Pesticide Action Network at http://www.panna.org/panna/.

Global Toxics Initiative

Policy work in the field of persistent organic pollutants is a key component of WWF's Global Toxics Initiative, which also concentrates on endocrine disruptors and agricultural pesticides. Although each of the three program areas—wildlife and contaminants, POPs, and pesticides—has unique characteristics, they are closely connected. Many POPs are endocrine disruptors, and several pesticides are both endocrine disruptors and POPs. The three program areas focus on the following activities:

- The **wildlife and contaminants** program addresses the evolving science of endocrine disruptors and other toxic chemicals.
- The **POPs** program centers its work on policy development and advocacy, such as aiming for the phaseout and elimination of the most deadly, persistent pollutants like DDT, PCBs, and dioxins.
- The **agricultural pesticides** program, in collaboration with farmers and growers, promotes integrated pest management (IPM) and other ecologically sound alternatives to the use of pesticides.

The Global Toxics Initiative is one of several initiatives that WWF has launched to address global threats to the Earth's environment posed by unsustainable timber trade, overexploited fisheries, profligate use of toxic chemicals that harm wildlife, and unrestrained emissions of greenhouse gases that contribute to global warming.

Addressing global threats is one of the three strategies pursued by WWF in its Living Planet Campaign—a call to action to make the close of this century and the opening of the next a turning point in the worldwide struggle to save endangered species, protect important harbors of biological diversity, and encourage changes in international policies and markets that contribute to environmental threats. To learn more about WWF's Global Toxics Initiative and the Living Planet Campaign, visit our Web site at http://www.worldwildlife.org.

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