

# NORTHERN OVEREXPOSURE



The top of the world—with its frigid expanses of water, ice, tundra, stunted forest, and wetlands—may look pristine, but the Arctic environment and its inhabitants contain surprisingly high levels of heavy metals, organic pollutants, and radiation. Although the Arctic has few significant pollution sources, the contaminants arrive courtesy of ocean currents and winds emanating from industrial regions. Once contaminants have arrived, low temperatures and limited sunlight slow their decay, and biological processes concentrate some of them to dangerous levels.

Concern about the Arctic environment increased in the 1980s, sparked by the discovery of acid precipitation in Finland and Scandinavia, high levels of polychlorinated biphenyls (PCBs) in Inuit people in

Greenland and Canada, and high levels of PCBs in polar bears living near the 80th parallel. In 1991, the eight nations of the Arctic Environmental Protection Strategy recruited 400 scientists and administrators into the Arctic Monitoring and Assessment Programme (AMAP). According to AMAP's 1997 *Arctic Pollution Issues: A State of the Arctic Environment Report*, "Certain Arctic populations are among the most exposed populations in the world to certain environmental contaminants," including PCBs, pesticides, and other persistent organic pollutants (POPs). The report concluded that, while the Arctic remains relatively clean, the peculiarities of geography, industry, climate, pollutant transport, bioaccumulation, and diet of the Arctic region create many exceptions.

The origin of the pollutants, however, is a constant: most contaminants are released by industrialized economies. Yet as Arctic residents recognize that prevention is the only cure for the widespread pollution, they remain minorities—even in most of their own nations—with little influence over the international political processes that could slow the flow of pollutants.

The growing debate over Arctic pollution is of great concern to indigenous people, whose lives and cultures are interwoven with the environment. "I haven't detected anger about the contamination yet," says Terry Fenge, research director for the Inuit Circumpolar Conference, which represents Inuit people in North America, Greenland, and Russia. "'Unease' is the best word [to describe the concern]," he says, "mainly



because to the simple question people ask—'Is my food safe to eat?'—there is no clear and simple answer."

### A Huge and Frozen Landscape

For organizational purposes, AMAP defines the Arctic as generally the region north of 60 degrees north latitude, including Alaska north of the panhandle, Canada north of the southern shore of Hudson Bay, all of Greenland and Iceland, and the northern reaches of Norway, Finland, Sweden, and Russia. Iceland is the only country located entirely inside the AMAP boundary. The majority of the population of the other seven Arctic nations lives outside the study area. The region includes 13.4 million km<sup>2</sup> of land and 20 million km<sup>2</sup> of ocean or sea ice, and has about 3.74 million permanent residents, of whom roughly 9% are indigenous. Some of the other residents descended from Europeans who moved to the Arctic five centuries or more in the past.

Solid data on environmental health are difficult to come by in the Arctic. The region's size and history as a Cold War frontier compound the problems of isolation, cold, and the variety of cultures and languages for researchers trying to study the area's population. Because nations and continents are the focus of international agencies such as the World Resources Institute and the United Nations Environmental Programme, this multinational, noncontinental region seldom appears on their radar screens. In the huge Russian Arctic, economic and social chaos, together with a tradition of secrecy, have resulted in a trickle of data about a now-apparent flood of environmental health problems. Also, epidemiology is impaired by small population sizes and the frequent lack of suitable control groups.

Health varies greatly among people in the Arctic region. In Iceland, life expectancy at birth is 77.8 years, while in Russia, life expectancy among indigenous people in the late 1980s was 54 years for men and 65 for women. Besides pollution, Arctic areas typically suffer from poor health care delivery, inadequate sewage disposal and housing, and heavy use of alcohol and tobacco. In general, the few health statistics available show the health of non-indigenous people to be generally better than that of indigenous people.

The indigenous economy exists alongside military relics of the Cold War such as abandoned nuclear reactors and submarines, and extractive industries such as mining, smelting, oil, timber, and paper. Lifestyles vary greatly. Immigrants from southern latitudes generally are more involved in extractive industries. Indigenous people and many other long-time residents depend, at least partly, on subsistence hunting of marine mammals, freshwater fish, and caribou.

Indigenous people stand to lose the most from contamination of their environment. Even if indigenous people had the ability to move away from the pollution, the move itself would effectively destroy their culture that is so closely linked to the land. And, because indigenous people are on the receiving end of pollution that they had virtually no role in causing, outsiders have come to view them as in need of protection.

### Pathways

The first indication that most Arctic pollution originates elsewhere came during the 1950s, when pilots in the North American Arctic noticed a thick haze that was eventu-

ally traced to sulfates and dust from lower latitudes. Since then, scientists have isolated various "pathways" in the environment, including air, water, ice, and migratory animals, that transport pollutants from lower latitudes to the region. Some airborne pollutants can reach the Arctic in just a week, but other volatile organics move north in a series of jumps: they volatilize, condense, and revolatilize until they reach a temperature at which they remain condensed. This ability to continue traveling makes these POPs a global problem.

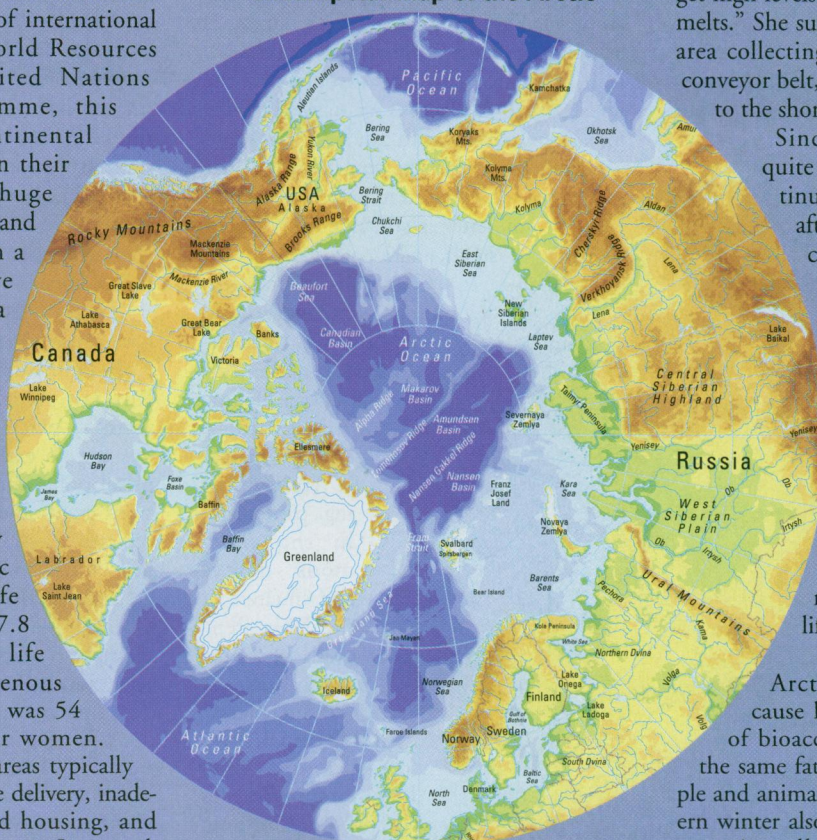
Water also plays a part. Levels of the pesticide hexachlorocyclohexane in 10 Russian rivers were as high as 54 ng/liter, far above the next highest river tested by AMAP (about 3 ng/liter in the Yukon River in Canada). Several Russian rivers also show evidence of continued use of DDT, lindane, and other widely banned pesticides.

Transport mechanisms may explain the spotty distribution of pollutants such as the disturbing POP concentrations in shoreline areas of the Svalbard archipelago, Greenland, and Canada. According to Stephanie Pfirmann, chair of environmental science at Barnard College in New York City, "There's growing evidence that you get high levels of PCBs in places where ice melts." She suspects that the "huge surface area collecting airborne POPs" acts as a conveyor belt, delivering the contaminants to the shore or the melting zone.

Since some pathways operate quite slowly, pollution will continue in the Arctic for decades after the last offending chemicals are released, says David Scrivener, who studies international regulation of the Arctic at Keele University in the United Kingdom. "If we are trying to reassure a pregnant Inuit woman about PCBs or dioxins in her breast milk, whatever we do about [reducing emissions in industrial countries] will not make a difference in her life for decades."

Pollution reaching the Arctic might be too dilute to cause harm except for the process of bioaccumulation. Unfortunately, the same fat that allows indigenous people and animals to survive the harsh northern winter also stores the many fat-soluble organic pollutants. The accumulation begins when lichen or phytoplankton—the bases of the terrestrial and marine food chains—absorb pollutants. By the time

Circumpolar Map of the Arctic



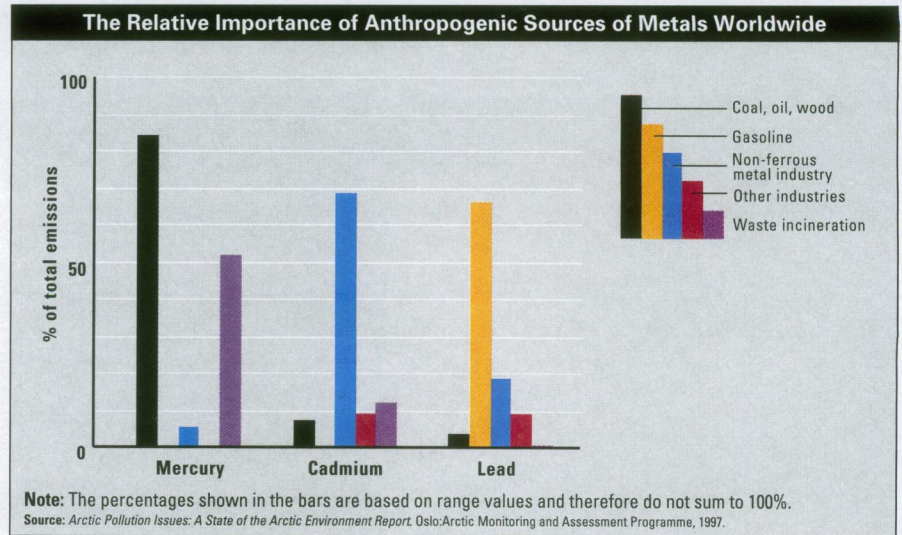
Source: Arctic Pollution Issues: A State of the Arctic Environment Report. Oslo: Arctic Monitoring and Assessment Programme, 1997.



they reach the top of the food chain, these pollutants can be greatly magnified: the AMAP report found that caribou in Canada's Northwest Territories had 10 times as much PCB as the lichen on which they grazed. Wolves preying on the caribou had another six-fold increase in PCB concentration.

### Meet the Contaminants

Chief among these fat-soluble, long-distance pollutants are the POPs—mainly pesticides and PCBs. A study published in *Chemosphere* in 1997 by Eric Dewailly, a professor of environmental medicine at Laval University in Québec, Canada, and a Québec provincial health officer, and colleagues showed that pooled blood from 499 Québec Inuit adults had a mean total PCB concentration of 4.3 mg/kg lipids, compared to 0.13 mg/kg for residents of southern Québec. Among the Inuits, the 2,3,7,8-tetrachlorodibenzo-*p*-dioxin equivalent was 184.2 ng/kg lipids, compared to 26.1 ng/kg for the southerners. In Greenland, Peter Bjerregaard, the former health officer for Greenland and a current member of the Greenland Health Research Council, says, "Blood levels of PCBs and pesticides are very high—twice as much as the eastern Canadian Arctic and 20 times as high as southern Canada." Arctic lead levels have fallen greatly since the 1970s, largely due to lead's gradual elimination from gasoline, and the remaining lead



poses little problem because it does not bioaccumulate.

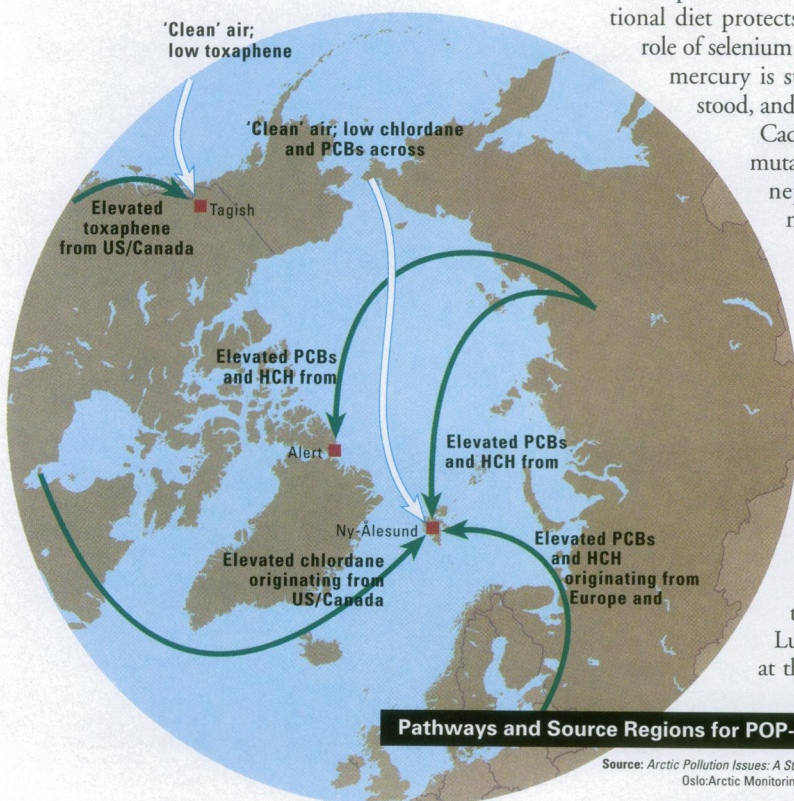
Mercury, which is emitted from local rocks as a result of various weathering processes and from fossil fuel combustion in the south, is rapidly becoming a problem in the Arctic. According to AMAP, about 40% of mercury in the Arctic comes from natural sources. Although Greenlanders carry high levels of mercury, they do not show the expected toxicity, apparently due to high levels of selenium in their diet. "It's important how the mercury is provided," says Carl Hild, a senior research associate at the University of Alaska at Anchorage's Institute for Circumpolar Health Studies. "The traditional diet protects you from it." The role of selenium in protecting against mercury is still not fully understood, and is controversial.

Cadmium—a teratogen, mutagen, carcinogen, and nephrotoxin (it accumulates in the kidneys over a lifetime of exposure)—originates mainly in Arctic mining, particularly in the enormous mines and smelters of the Kola Peninsula of northwestern Russia. A 1995 study of cadmium and hypertension by P.V. Luoma and colleagues at the Regional Institute

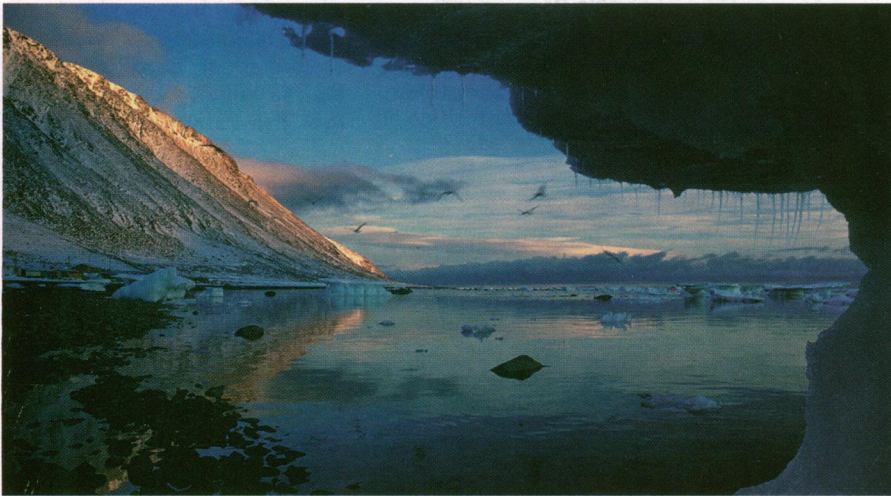
of Occupational Health in Oulu, Finland, published in *Science of the Total Environment*, found the highest blood levels of cadmium in caribou herders who lived nearest the smelters. The authors concluded that "cadmium exposures may have harmful health effects in Arctic Finland," emphasizing the importance of "reducing pollution from industrial sources in the Kola Peninsula." Elsewhere, heavy consumption of cigarettes is blamed for high levels of cadmium. A study by Dewailly and colleagues in the May 1997 issue of the *Journal of Toxicology and Environmental Health* concluded that non-smokers had a cadmium level typical of non-smokers elsewhere, but that levels among smokers were high enough to warrant "energetic public health interventions." High levels of cadmium have also been shown to damage vitamin D metabolism and cause decalcification of bones.

Heavy metals and acid precipitation have caused local ecological disasters in the Kola Peninsula and elsewhere along the Russian Arctic Ocean, where "dead zones"—places where no vegetation can live due to extreme soil acidity and heavy metal pollution—extend as far as 100 km from giant smelters. Indeed, the desire to restrain Russia's smelting industry was a key Finnish motive for starting the political process that culminated in the Arctic Council—an eight-nation organization that aims to facilitate cooperation on issues related to the environment and sustainable development in the Arctic.

The Russian continental shelf has a number of nuclear problems, including nuclear waste and abandoned nuclear submarines and submarine reactors. Elsewhere, the main radioactive contaminant is cesium 137, a leftover from atmospheric testing of nuclear weapons. According to Bliss Tracy, a research scientist at the Radiation







**Crystal clear contamination?** The once-pristine waters of the Arctic show evidence of contamination from sources around the world.

Protection Bureau at Health Canada, lichen are very efficient in soaking up contaminants, which are then concentrated in the caribou who eat the lichen. He says that during nuclear testing in the region during the 1950s and 1960s, doses of radiation from cesium 137 were around 5 milliSieverts (mSv) among caribou-eating people. Today's doses are closer to 0.1 mSv, he adds, well below the current general population exposure limit of 1 mSv per year. While general exposure levels of radiation are not threatening right now, what Tracy calls "surprising" levels of polonium 210 in northern Saskatchewan—possibly originating in radon from uranium mines—still contaminate caribou.

### Global Warming and Ozone Depletion

Many global climate models predict that warming at high latitudes will be the most dramatic result of greenhouse warming. And yet there's "lots of fear, but little information" on the topic, says Elizabeth Weatherhead, a researcher at the University of Colorado in Boulder and lead author of the AMAP report chapter on global change. "The jury is still out on almost everything related to climate change in the Arctic," she says. "The extent and volume of sea ice, the extent of glaciers are all controversial."

Anecdotal reports from Alaska tell of "increasing erosion and reports that ice hut walls are melting for the first time in 100 years," Weatherhead says. But while surface temperatures have been rising by 1.5°C per decade in central Siberia and central North America, they have been falling in Scandinavia. Weatherhead warns that warming of the tundra could have global effects due to the huge amount of carbon and methane locked up in per-

mafrost. "The Arctic is a traditional sink of carbon, but with a warming of the tundra, it becomes a source of carbon, and becomes a primary positive feedback [on climate]," she says.

Fenge cautions that significant global warming could also have human impacts if it interferes with traditional hunting and fishing. After a radical change in climate and habitat, he warns, "there would no longer be an Inuit culture as we know it." And that melting would also undermine the human-built structures on permafrost, including roads, oil wells, and houses.

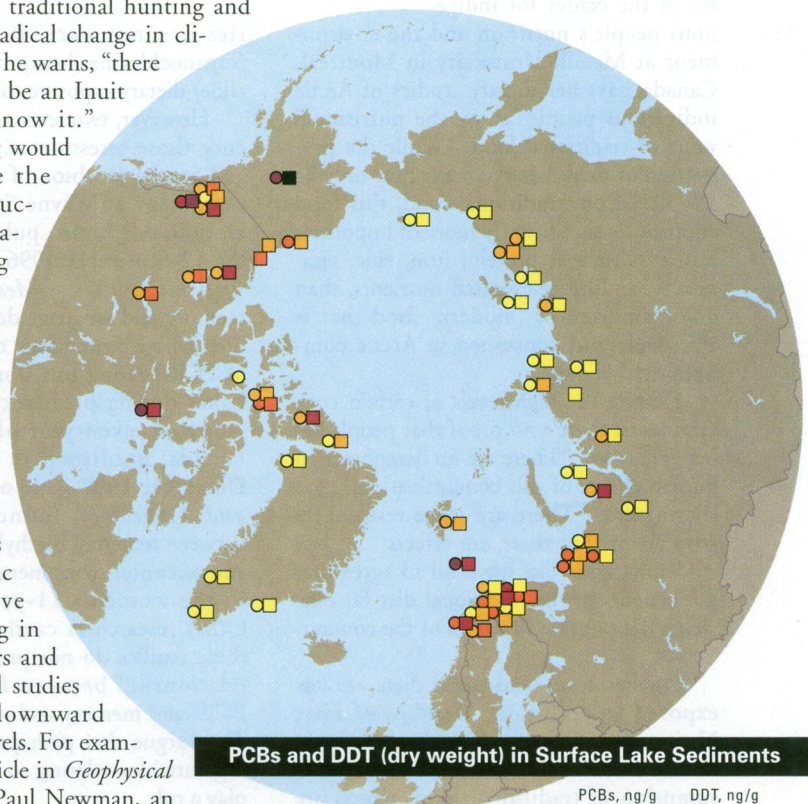
Less defined is the threat of ozone depletion due to anthropogenic chemicals in the stratosphere. Weatherhead says that major Arctic ozone holes have begun appearing in the past few years and notes that several studies have shown a downward trend in ozone levels. For example, in a 1997 article in *Geophysical Research Letters*, Paul Newman, an atmospheric physicist at NASA's Goddard Space Flight Center, and colleagues found a 10.7% per decade decline in ozone in areas north of 63 degrees during March, the worst month for depletion.

Information is even sketchier regarding ground-level ultraviolet light, Weatherhead adds. "Although it's too soon to talk about

trends, we know UV responds to ozone, so we can have a great deal of confidence that as ozone goes down, UV will go up." While increased UV exposure may not spark an epidemic of skin cancer since skin is usually covered in the Arctic, it does cause snow blindness and harms both animal immune systems and the primary productivity of ecosystems.

### Is My Food Safe to Eat?

Since the major route of exposure to radiation, heavy metals, and POPs among Arctic people is the food chain, should they be warned to stop eating such traditional foods as caribou, whale, and seal? "It's a very difficult and sensitive issue to deal with," says Fenge, who says Inuit people are starting to worry about contamination issues. "POP contamination is insidious and invisible. It doesn't hit you every day, yet I think there's a growing awareness." Fenge points out that transportation costs make store-bought food unaffordable to many local people and says hunting "lies at the core and heart of



Source: Arctic Pollution Issues: A State of the Arctic Environment Report. Oslo: Arctic Monitoring and Assessment Programme, 1997.





**Trusting in tradition.** Indigenous populations in the Arctic are the most affected by contamination of their traditional food sources such as caribou, seal, and fish. However, scientists say that changing to a more modern diet may be even worse for these people's health.

what it means to be Inuit." He says, "There are cultural and spiritual benefits of [traditional] food. It's just not possible—politically or otherwise—to advise people to stop eating highly nutritious [traditional] food when you have a less than clear understanding of the health risks associated with it."

Harriet Kuhnlein, director of the center for indigenous people's nutrition and the environment at McGill University in Montréal, Canada, says her dietary studies of Arctic indigenous peoples show the nutritional value of traditional food. "While the proportion of total dietary energy may only be 25–30% from traditional food, this food contributes significantly more of important nutrients such as protein, iron, zinc, vitamin A, and other essential nutrients, than does imported or 'modern' food that is affordable and consumed in Arctic communities," she says.

Despite the high levels of certain contaminants, there's no proof that people are being harmed. "There are no demonstrated human effects of this contamination," says Bjerregaard. "There are some researchers who claim that there are effects . . . but epidemiologists like me tend to agree that the benefits of the traditional diet far outweigh the possible ill effects of the contaminants."

Furthermore, land-based diets are less exposed to pollution. "Studies of First Nations peoples in the Canadian Arctic do not raise the same alarms about the consumption of traditional food, which are primarily land- rather than sea-based," says Kuhnlein. "The type of traditional food consumed and how high on the food chain the consumption is are the most important considerations for the people involved." She adds that members of Indian communities in the Northwest and Yukon territo-



ries are not exceeding contaminant (organochlorine, heavy metal, or radionuclide) dietary exposure tolerances.

However, two recent studies may influence those assessments. Joseph Jacobson and Sandra Jacobson of the department of psychology at Wayne State University in Detroit, Michigan, published a study in the 12 September 1996 issue of the *New England Journal of Medicine* that found memory and language deficits among children whose mothers ate the largest amount of PCB-bearing fish from the U.S. Great Lakes during pregnancy. A prospective study of seven-year-olds in the Faroe Islands, published in the November–December 1997 issue of *Neurotoxicology and Teratology*, found a relationship between maternal methylmercury exposure and attention span, memory, and language in the women's 11-year-old children. Other researchers caution, however, that these studies do not prove a cause–effect relationship between fetal exposure to PCBs and mercury and the mental deficits. They argue that perhaps other confounding variables relating to poverty may also play a role.

Dewailly is conducting a prospective cohort study that will compare diet, drugs, and contaminants to neurobehavioral and immune measures in 300 Canadian and Greenland Inuit newborns. The data, he says, will not be available for several years.

Polluted food can also have economic

effects. Helgi Jenssen, a biochemist in the monitoring and assessment department of Iceland's Office of Marine Pollution Control, notes that fish comprise 60–70% of Iceland's exports, and worries that a contamination scare could jeopardize sales.

### Effects of Modernization

The ongoing pollution of the Arctic is set against a backdrop of widespread modernization of the Arctic's social and economic structure. Evidence indicates that when traditional cultures are stressed, people and health suffer. One study cited by AMAP showed that, in one district of the Russian North, disease rates were 50% higher among indigenous people who lived a settled versus a traditional life. Moreover, psychological disorders were 250% more common among the settled people. Suicide rates are generating increasing concern in Canada and Greenland. "The suicide rate is

probably higher in Greenland than anywhere else in the world," notes Bjerregaard. "It's not sensible to attribute it to any one component of modernization, but certainly [it] has something to do with modernization." In Canada, says Fenge, suicide rates among hunters soared when the seal pelt market crashed after pressure from animal rights activists.

Reversing the process of modernization does seem to help. Robert Keith, director of the Canadian Arctic Resources Council, says that when indigenous communities give financial support to hunters and fishers, "there's an improvement in the quality of life, and a remarkable decline in pathologies. Substance and alcohol abuse, spouse abuse, and disease go way down, and nutrition goes up."

So-called modern foods can also pose a health hazard in their own right. The rate of diabetes has more than doubled among one group of Inuits in Alaska since 1962, says Sven Ebbesson, a medical researcher and professor in the Institute of Marine Science at the University of Alaska at Fairbanks, who notes that, "Siberian [Inuits] have one-tenth the incidence of diabetes. We think it is because they do not eat as much processed foods and they are more physically active."

One "modern" disease that may not affect indigenous people is seasonal affective disorder, or SAD, caused by low levels of light during the winter. Says Bjerregaard,



"The problems among indigenous people are so vast . . . that nobody in Greenland takes an interest in SAD." Yet among newcomers, SAD can be a problem. In Alaska, a study found that 35% of nonnatives had indications of SAD's sleep and mood disturbances. Lawrence Duffy, an Arctic health researcher at the University of Alaska at Fairbanks, suspects that changes in melatonin and other hormone levels associated with SAD could explain high rates of depression and suicide in the Arctic.

### Solutions

What can be done to counter the Arctic's environmental health problems? To Keith, the most important step is to "rebalance" the relationship between indigenous peoples and governments, and give native peoples more political and economic voice in their affairs. Such a process began in Canada's North in 1975, he says, when indigenous people started negotiating rights to their traditional lands. "We see a great deal of significance in these land claims," he says.

On January 7, Canada officially apologized to its 1.3 million indigenous people for more than a century of abuses. The action expressed the government's "profound regret for past actions of the federal [g]overnment which have contributed to these difficult pages in the history of our relationship together."

The claim settlements are part of a general strengthening of political and cultural structures in the Arctic. Three indigenous-culture consultants to the AMAP process (the Inuit Circumpolar Conference, the Saami Council—representing the Saami people of northern Scandinavia—and the Association of Indigenous Peoples of the North, Siberia,

and the Far East of the Russian Federation) cooperated to urge Arctic governments to continue studies begun under AMAP. In a joint statement in June 1997 the groups said, "Research on effects, though complex, costly, and difficult, must be undertaken so we can understand and quantify actual threats to the Arctic environment and its peoples."

Indigenous people do not want to be just passive beneficiaries of environmental knowledge. Through their close relationship with the environment, they have a wealth of traditional ecological knowledge. "They're hunters, fishers, and trappers, and still have a vibrant knowledge of what's going on," Fenge says. A recent study of members of 29 Inuit and Cree Indian communities near Hudson Bay found that local people see an accelerated rate of ecological change caused by global warming, industrial processes, and habitat destruction.

Roda Gray, chairperson of the nutrition and health committee of the Canadian government's Baffin Island Ottawa Project, which coordinates health services to that Arctic region, insists that local people need clear data about the risks of contamination. "No matter how much information there is, there's always a scientist who says the opposite. That's very disturbing to me," she says. Scientists studying toxicology, she adds, "never agree, never. Some people say 'don't worry,' some say 'don't feed your baby.' It's very important that scientists know that this is confusing people."

As AMAP prepares another round of research, the NIEHS is helping sponsor an international pollutant biomarker conference for spring 1999, with Arctic issues as a focus. In addition, Alaska has been pro-

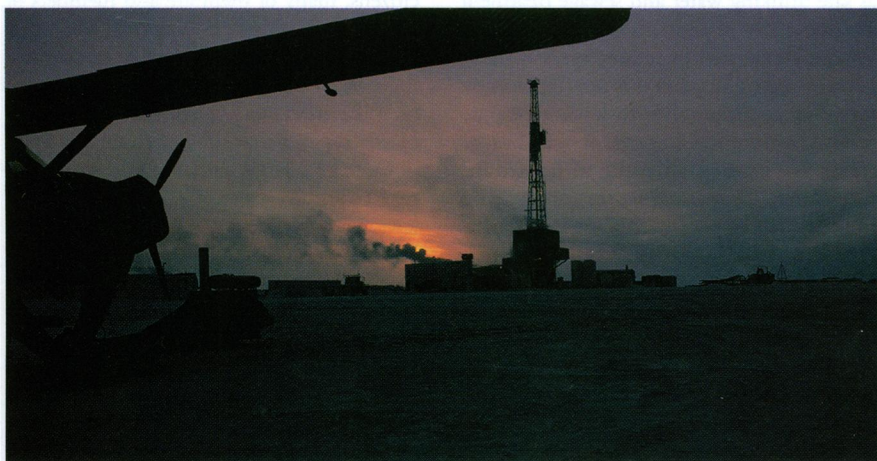
posed as a focus of the U.S. federal government's upcoming children's environmental health grants. Responding to criticism that the United States didn't participate fully in AMAP (data for Alaska were missing from the AMAP report, for example), Philip Chen, the Department of Health and Human Services representative to the federal Arctic Research Policy Committee, says, "[The conference] will show the world that Arctic research is not dead in the United States."

Since the widespread pollution of the Arctic will be difficult and maybe impossible to clean up, the only real solution is a global emphasis on prevention. Yet the slow pace of change irritates many observers. "We are very frustrated that even though AMAP has done a good job of finding contaminants, the government has not responded to it," Gray says. "When you're in the middle of all this, it's very scary." The effectiveness of reducing emissions at the source has been proven by the successful controls on lead in gasoline, and on PCBs, DDT, and chlordane. POPs control negotiations are now the focus of the United Nations Economic Commission for Europe, which includes North America.

After years of preparation, a treaty was signed in 1996 establishing the Arctic Council. Yet that milestone only fed the disquiet. "It's very disappointing that there doesn't seem to be much evidence of concerted action from the Arctic states, beyond foreign ministers standing up at the [United Nations] and making 'motherhood and apple pie' speeches," says Scrivener. "There's very little sense of a single Arctic voice."

As observers await international action, they are left to ponder whether residents should be warned that their traditional food contains poisons. "We don't have enough evidence to change the life of the people," says Dewailly. "These are subsistence people, and the effects of this batch of contaminants has to be weighed against the whole economic, cultural, and nutritional question." At stake, he says, "is a loss of confidence in their environment—this major part of their lives—in history, in the current time, and in the future."

David J. Tenenbaum



**Modern problems, modern solutions.** Scientists and policy makers agree that the countries that contribute to Arctic contamination through such modern industries as oil drilling, mining, and smelting must also contribute their efforts to finding sustainable solutions for the Arctic environment.