

Water Quality

Key Findings

- The biological, chemical and physical characteristics of water affect its ability to sustain life and its suitability for human consumption and use. Several water quality issues have persisted for decades, including sedimentation, nutrient overenrichment and bacterial and toxic contamination.
- Many human activities yield waste products such as sewage, runoff, urban industrial releases and air pollution that affect the quality of water. Likewise, landscape modifications can undermine the natural processes of water purification through wetlands and infiltration of water through soil into groundwater.
- Although freshwater quality in many parts of North America is good, a significant portion of North American surface freshwater is degraded. A similar assessment of groundwater is not possible, but in certain areas it is known to be degraded by nitrates, pesticides and salinity.
- Conventional pollutant discharges from industrial point sources have largely fallen over the last 30 years in North America, but nonpoint and diffuse pollutant sources such as agricultural runoff, stormwater runoff and atmospheric deposition have become relatively larger contributors to impairment of water quality.

Water quality refers to the physical, chemical and biological characteristics of surface and groundwater. These characteristics affect the ability of water to sustain human communities, as well as plant and animal life.

What Is the Environmental Issue?

The health of humans, wildlife and ecosystems depends on adequate supplies of clean water. But as populations grow and expand into previously undeveloped areas, governments are finding it more and more difficult to ensure water quality. The byproducts of this growth—increased and accelerated runoff, sewage, inadequate infrastructure, land clearing, industrial point sources, air pollution—also pose risks for water quality. Meanwhile, development can undermine the self-maintenance of water resources—wetlands and infiltration of water through soil are the natural ways in which water is purified. Draining wetlands and impervious paving reduce these natural purification processes in terrestrial and aquatic ecosystems.

The three North American countries have different definitions and procedures for measuring surface water quality. A comparable assessment of North American water quality is therefore challenging. But it is clear that, based on national reporting, the overall percentage of North American surface freshwater in degraded condition is significant.

Canada's water quality index, which is based on various parameters such as nutrients, assesses surface freshwater quality for its ability to protect aquatic life, including fish, invertebrates and plants; it does not assess the quality of water for human consumption or use. According to the most recent information available, freshwater quality in southern Canada was rated "excellent" or "good" at 44 percent of monitored sites, "fair" at 33 percent of sites, and "marginal" or "poor"



at 23 percent of sites. Phosphorus, a nutrient derived mainly from human activities and a key driver of the water quality index, is a major concern for surface freshwater quality in Canada. Phosphorus levels exceeded limits set under the water quality guidelines for aquatic life over half the time at monitored sites.

In the United States, over 40 percent by length of small wadeable streams sampled in 2004–2005 showed substantial disturbances to sensitive communities of small water-dwelling

of impairment were excess levels of nutrients, metals (primarily mercury), sediment and organic enrichment from agricultural activities; hydrologic modifications; atmospheric deposition; and discharges from industrial, unknown or unspecified sources.

Mexico monitors surface water for biochemical oxygen demand (BOD), fecal coliform, nitrogen, phosphorus and other substances. BOD measures the amount of oxygen consumed by microorganisms in decomposing organic matter

levels of nitrogen and phosphorus in surface water are also a problem for Mexico. Elevated levels of pollutants containing these elements were detected at a majority of monitored sites.

Pollution and contaminants associated with surface water also affect groundwater: point source contamination (bacteria, organics), nonpoint source pollution from agriculture (nitrates and pesticides), industrial contamination (heavy metals, organic compounds), and naturally occurring contaminants such as arsenic. Groundwater depletion can create cracks, fissures and fractures through land subsidence that permits contaminants to enter deeper groundwater aquifers. Salt water intrusion into coastal aquifers is a problem throughout the Gulf of Mexico and Gulf of California regions of Mexico and the United States as salt water replaces the freshwater being removed from the aquifer. Because there are no comprehensive surveys or sources of information on groundwater, regional patterns or trends in groundwater quality for North America are unknown.

Mercury most often enters North American water resources via the deposition of mercury emitted to the air from mining, industrial processes, and combustion of fossil fuels, municipal and medical waste.

creatures, indicating significant pollution and habitat modification. The most widespread stressors were nitrogen, phosphorus, streambed sediments and riparian disturbance. About a third of sampled stream length contained high nitrogen or phosphorus concentrations, and a quarter revealed streambed sediments or riparian disturbance. As of 2002, almost half of assessed stream length and lake area and one-third of assessed bay and estuarine areas were not clean enough to support human uses such as fishing and swimming. The leading causes

in water. The greater the BOD, the more rapidly oxygen is depleted in the stream and the more stress is placed on higher forms of aquatic life. In 2006, 16 percent of monitored sites had an average annual BOD of more than 30 milligrams per liter, indicating unacceptable contamination under Mexican standards. Fecal coliform are bacteria fed by human or animal waste that serve as indicators of contamination. In 2006, 58 percent of monitored sites in Mexico had average annual concentrations above acceptable levels for drinking water. And, as in the rest of North America,

Why Is This Issue Important to North America?

Sustainable access to clean water is vital to the human and ecological life of North America. As North Americans have experienced the vulnerability and finite nature of clean water supplies, they have realized that they must protect and conserve this essential resource. Water quality concerns that have persisted in North America over the last 30 years include sedimentation,

Sites in which algal blooms have led to animal and plant deaths in North American coastal waters (1993–2002)



Source: Institut français de recherche pour l'exploitation de la mer.



eutrophication, pathogenic diseases and persistent toxics (mercury and organic chemicals).

Sedimentation

Soil erosion and sedimentation (deposition of eroded soil) in lakes, waterways and coastal areas are major water quality problems throughout North America. Although erosion, sediment transport and sedimentation are natural processes, human activity may exacerbate these processes in certain parts of the continent, and in local or regional situations may be the primary cause. Sediment affects water quality by reducing water clarity, smothering aquatic habitats and acting as a transport mechanism for pollutants such as pesticides and fertilizer. In the United States, sedimentation is associated with over 60 percent of degraded stream miles. Similarly, Environment Canada has identified sediment as a Canadian water quality issue, whereas in Mexico, soil erosion is a major environmental issue. Erosion and sedimentation stem primarily from human modification of the landscape. As populations continue to grow and land use changes, sedimentation will continue to be an issue.

Eutrophication and Nutrient Overenrichment

Eutrophication and high nutrient loadings affect both freshwater and coastal systems. In eutrophication, excessive plant growth (bloom) occurs in water bodies receiving excessive nutrient loads. Eutrophic conditions can occur naturally in lakes as they age and in estuaries, but in North America human activities have led to widespread nutrient levels and eutrophication that far exceed natural levels. Eutrophication encourages the growth of toxic algae, which in some instances in the marine environment is also known as “red tide” (see map). Decomposition of these excess algal blooms reduces the level of oxygen in the water to the point that other organisms die (hypoxia).

Canada, Mexico and the United States all struggle with nutrient overenrichment of water resources caused by poor sewage treatment, use of fertilizers and deposition of combustion byproducts (nitrogen oxides). In the United States, about 55 percent of freshwater impairments and some 20 percent of coastal system (estuaries, bays) impairments stem from nutrient loads or eutrophication. The Gulf of Mexico dead zone, a product of nutrient inputs (primarily nitrogen) from the Mississippi River basin, is the largest expanse of human-caused hypoxia in the Western Hemisphere. In Canada, similar concerns have arisen about St. Lawrence estuary hypoxia caused by factors such as nitrogen.

Pathogens

Contamination of water resources with pathogenic organisms (as indicated by fecal coliform bacteria) is still a concern in many areas of North America. The source of pathogen contamination of most concern is poorly treated and untreated sewage. In some areas, however, agricultural operations and wildlife are also a factor. Although 71 percent of the US population is served by sewage treatment plants, beaches were closed or health advisories were issued because of bacterial contamination for 18,000 instances in 2003, up from 3,000 days in the mid-1990s. A similar portion (72 percent)



Walleye fishing.

of the Canadian population is served by sewage treatment plants, but municipal wastewater discharges still represent one of the largest sources of pollutant releases by volume to Canadian waters. In Mexico, where only 35 percent of the people are served by sewage treatment plants, bacterial contamination of freshwater and coastal systems is a significant issue.

Mercury

Mercury is a metal that accumulates in human, fish and animal tissue, sometimes reaching toxic levels (see case study). In aquatic ecosystems, mercury can enter the food chain through the action of bacteria and benthic organisms. Consumers of mercury-contaminated organisms can then accumulate mercury to toxic levels—even where concentrations of mercury in water are barely detectable.

Mercury most often enters North American water resources via the deposition of mercury emitted to the air from mining, industrial processes and combustion of fossil fuels, municipal and medical waste. In recent years, Canada and the United States have reduced their mercury emissions: Canada by 80 percent

over 1990–2003 and the United States by 45 percent over 1990–1999. However, high mercury levels in fish still account for over 90 percent of fish consumption health advisories issued in Canada and 80 percent issued in the United States for both freshwater and coastal fisheries. In 2000–2003, mercury was found in 100 percent of fish sampled as part of the national fish tissue study in the United States. Even after inputs to contaminated systems cease, mercury can continue to accumulate in the food chain for decades. And because mercury is easily transported long distances in the atmosphere, mercury emissions from other continents contribute to the mercury contamination of North American fisheries.

Persistent Organic Pollutants

Persistent organic pollutants are organic chemicals that accumulate in human and animal fatty tissue, possibly reaching toxic levels. The North American countries have long worked to reduce the use and release of persistent organic pollutants such as DDT, polychlorinated biphenyls (PCBs), dioxins and chlordane, and yet these compounds still persist in soils, sediment and fish tissue. In the United States, for example, PCBs, dioxins and furans, and DDT were widely detected in fish sampled in 2000–2003. Although long banned in the United States, PCBs were still found in 100 percent of both predator and bottom-dweller composite samples. Long-term monitoring of fish populations in the Great Lakes has documented a decline in PCBs, DDT and other persistent contaminants, but the concentrations of some of these constituents still exceed the human and wildlife health criteria in various regions of the Great Lakes.

What Are the Linkages to Other North American Environmental Issues?

Water quality is affected by activities within a watershed or groundwater recharge area, as well as by the global climate and atmospheric transport from areas farther away.

Climate Change

As climate patterns change, precipitation and runoff patterns in North America will also likely change, bringing more drought in some areas and more flooding in others. Under drought conditions, pollutants can become concentrated in water resources to harmful levels. With greater runoff and flooding, even more pollutants (by quantity and in greater varieties) are washed into surface waters.

Land Use

Several studies have identified links between quality of water resources and land use in a watershed. Land clearing can increase the transport of sediment into surface waters. Pesticides and fertilizers applied to the land can be washed into surface waters or percolate into groundwater aquifers, as can any material spilled on land, such as toxic chemicals, oil from cars or gasoline.

Energy

Levels of demand for energy are linked to water pollution. Water used in oil and gas exploration and production may become laden with toxics that must be removed before it is safe for use by humans or wildlife. Combustion byproducts from power plants, such as nitrogen oxides, sulfur dioxide and mercury, can travel long distances in the atmosphere and affect water resources far from the facility site, changing the pH, contributing nitrogen to the nutrient load and contaminating fisheries.

Biodiversity and Ecosystems

Plants and animals living in surface waters are accustomed to particular water quality conditions. If the water quality of a lake or stream changes, some plants and animals can no longer survive there. Because poor water quality is known to reduce biodiversity, the United States and Canada use the biodiversity of aquatic communities as an indicator of surface water quality. Changes in aquatic communities because of poor water quality can change the way in which the aquatic ecosystem functions, as well as the associated terrestrial plant and animal communities.

Pollutants

Greater runoff is associated with greater loading of sediments, nutrients, toxic contaminants and other pollutants—all of which have an effect on the quality of drinking water supplies and aquatic ecosystems. Meanwhile, as land is converted to urban or suburban uses, point source pollution also increases—a byproduct of the additional wastewater treatment facilities constructed to meet the needs of the expanding population and new industries. The cumulative influence of increased point and nonpoint sources can affect the suitability of water to support aquatic ecosystems and other desired water uses. The presence of new contaminants such as flame retardants, personal care products and pharmaceuticals is also beginning to be detected, although the overall and cumulative levels of risk for humans and ecosystems are still unknown. 🦋

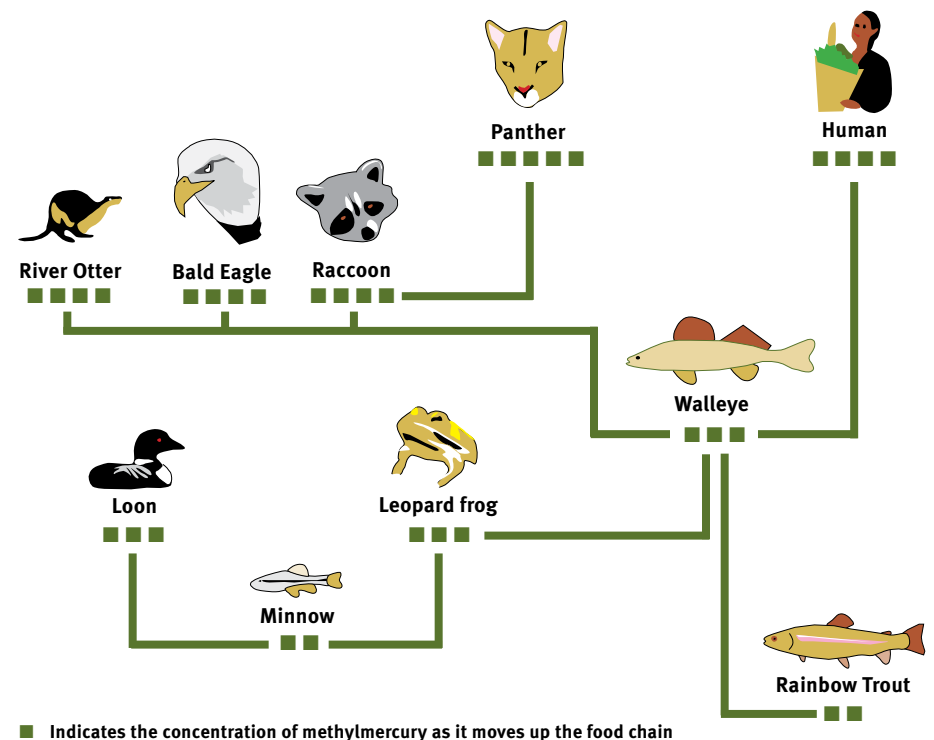
Case Study – Mercury in North American Waters

Mercury is a naturally occurring metal that can damage the liver, brain, heart, kidneys, lungs and immune system of humans, fish and wildlife. Industrialization has increased the proliferation of mercury globally. In most of its chemical forms, mercury is easily transported through the atmosphere. Atmospheric mercury is the primary source of mercury in North American freshwaters and marine waters. Indeed, virtually no place on earth is untouched by the deposition of atmospheric mercury. As a result, mercury contamination is pervasive throughout North America, occurring even in areas far from cities and industry.

Mercury concentrations in most North American waters are too low to have toxic effects on those who come in contact with or ingest the water. However, under the right conditions mercury in the water can move into the food chain. In most organisms, mercury binds to proteins and accumulates in the tissues as methylmercury. When predators eat mercury-contaminated prey organisms, the mercury from the prey's tissues is transferred to the predator's tissues (see illustration). Thus the higher an organism is in the food chain, the more it can accumulate mercury in its tissues and the greater is the potential for toxic effects.

In the freshwater and marine systems of North America, methylmercury in fish is a concern. When they ingest mercury-contaminated fish, North American birds, animals and humans face the possibility of accumulating toxic levels of mercury in their tissues. Those whose diets consist primarily of fish are at greater risk of experiencing the health effects of mercury accumulation.

Accumulation of mercury through the food chain



Source: National Wildlife Federation, <<http://www.nwf.org/mercury/bioaccumulation.cfm>>.