VII. Other Issues

Lake Water Levels

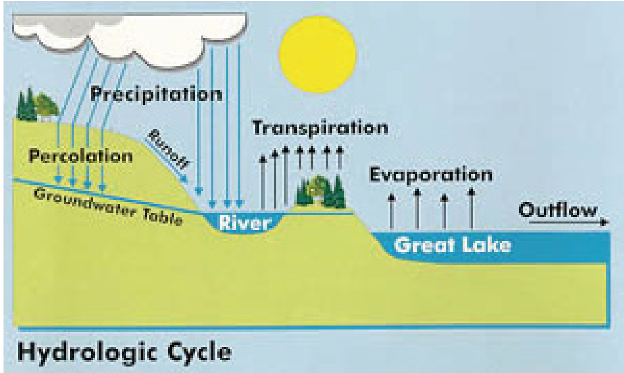
Water Level Fluctuations

Water is continually recycled and returned to the Lake Huron ecosystem through the hydrologic cycle. Moisture is carried into the Lake Huron basin most commonly by continental air masses, originating in the northern Pacific Ocean. Tropical systems originating in the Gulf of Mexico or Arctic systems originating in the north polar region also carry moisture into the basin. As weather systems move through, they deposit moisture in the form of rain, snow, hail or sleet. Water enters the system as precipitation directly on the surface of Lake Huron, runoff from the surrounding land including snowmelt, groundwater, and inflow from upstream lakes. Precipitation falling on the land infiltrates into the ground through percolation to replenish the groundwater.

Water leaves the system through evaporation from the land and water surface or through transpiration, a process where moisture is released from plants into the atmosphere. Water also leaves the system by groundwater outflow, consumptive uses, diversions and outflows to downstream lakes or rivers. Ultimately water flows out of Lake Huron through the St. Clair River.

Evaporation from the lake surface is a major factor in the hydrologic cycle of Lake Huron. Water evaporates from the surface of Lake Huron when it comes in contact with dry air, forming water vapor. This vapor can remain as a gas, or it can condense and form water droplets, causing fog and clouds. Some of this moisture returns in the form of rain or snow, completing the hydrologic cycle.

Some short-term water level fluctuations are not a function of changes in the amount of water in the lakes, but rather, due to winds or changes in barometric pressure. Short-term fluctuations, lasting from a couple hours to several days, can be very dramatic. Sustained high winds from one direction can push the water level up at one end of the lake and make the level drop by a



corresponding amount at the opposite end. This is called wind set-up or storm surge. The natural growth of aquatic plants can also affect the flow of water in the tributaries and connecting channels of the lakes. On the St. Clair River, normal ice build-up can reduce the flow in the river by about 5 percent during the winter. A serious ice jam can reduce flows by as much as 65 percent for short periods of time. Ice jams can develop in a matter of hours, but it may take several days for be relieved and water levels and flows to return to normal.

Seasonal fluctuations can also occur on Lake Huron. In the fall and early winter, when the air above the lake is cold and dry and the lake is relatively warm, evaporation from the lake is greatest. With more water leaving the lake than entering, the water levels decline to their seasonal lows. As the snow melts in the spring, runoff to the lake increases. Evaporation from the lakes is least in the spring and early summer when the air above the lakes is warm and moist and the lakes are cold. At times, condensation on the lake surface replaces evaporation. With more water entering the lakes than leaving, the water levels rise; peaking in the summer. In the early fall, evaporation and outflows begin to exceed the amount of water entering the lakes. The range of seasonal water level fluctuations on the Great Lakes averages about 12 to 18 inches from winter lows to summer highs.

Long-term fluctuations occur over periods of consecutive years and have varied dramatically since water levels have been recorded for Lake Huron. Continuous wet and cold years will cause water levels to rise. Conversely, consecutive warm and dry years will cause water levels to decline. Water levels have been measured on the Great Lakes since the 1840s. Older records may not be as accurate as current observations, since measurements were only taken at a single gauge per lake until 1918 and observations were not taken as frequently as they are today.

The effects of lake level fluctuations vary depending on the extent of the fluctuation. Fluctuating water levels can expose new surfaces to erosion. As seasons change, wind strength and direction also change, altering the path of waves and currents. Where ice forms, it redirects wave energies offshore protecting beaches, but can increase erosion of the lakebed. Ice may also exert tremendous forces that can weaken shore structures.

The nearshore areas of Lake Huron are by far the most diverse and productive part of the lake's ecosystem and may be dramatically impacted by lake level fluctuations. This interface includes small wetlands nestled in scattered bays to extensive wetlands such as those along Saginaw Bay Georgian Bay and the North Channel. Nearly all species of Great Lakes fish rely on nearshore waters for everything from permanent residence, to migratory pathways, to feeding, nursery grounds and spawning areas. In Canadian water, particularly Georgian Bay and the North Channel, where different shoreline conditions exist, many wetlands have been significantly reduced in size through drying.

Water levels also have a profound impact upon the economic viability of commercial shipping and recreational boating on Lake Huron. In the U.S., for example, the federal government maintains deep-draft harbors and dredged channelways to support commercial navigation. Along the Lake Huron shoreline, the government also maintains shallow-draft recreational harbors.

Current Lake Levels

As illustrated in Figure 7.1, Lake Huron water level were above Chart Datum (176.0 metres International Great Lakes datum 1985) from 1967 to 2007, with record high lake levels reported in 1986. Currently, Lake Huron water levels are in a continuing period of decline. In November, 2008, monthly mean water level was 576.7 feet or 25 inches below average and 5 inches above the record low. Precipitation over the last year was about 2.4 inches below average while evaporation has been above average. Current projections show that the lake will decline 6 inches more than the normal seasonal decline because of decreased precipitation and increased evaporation. The lake will remain about 27 inches below its long-term average. If the lake experiences very dry conditions, water levels could approach record lows.

International Upper Great Lakes Study

The five-year International Upper Great Lakes Study (IUGLS) was officially launched by the International Joint Commission (IJC) in March, 2007 to evaluate options for improvements to the existing St. Marys River regulation plans and to investigate potential hydraulic changes in the St. Clair River. To accomplish

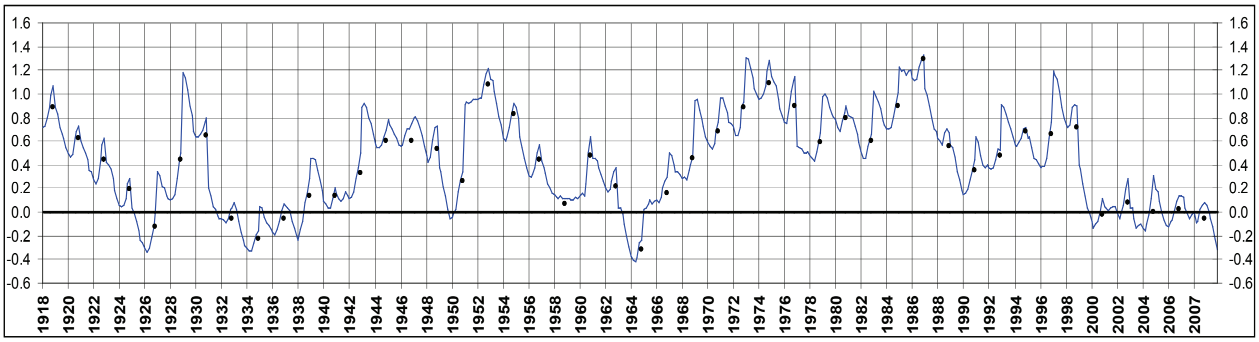


Figure 7.1. Monthly and Yearly Mean Water Levels for Lake Huron 1918-2007 (The Canadian Hydrographic Service).

this, the IUGLS will conduct a number of investigations including but not limited to:

- Reviewing the operation of the structures controlling the outflow of water from Lake Superior to determine how best to meet contemporary and emerging needs, interests and preferences for managing the system in a sustainable manner;
- Investigating how hydraulic changes in the St. Clair River affect lake levels; and
- Investigating the impacts of climate variability and climate change on long-term lake levels and their impacts on the major uses of the lakes.

To help accomplish these investigations, the IJC and the IUGLS has established a series of Resource Evaluation Groups that will be responsible for investigating various components of the issue. These will include groups to examine the coastal zone, recreational boating and tourism, the ecosystem, commercial navigation, hydrological and hydraulic modeling, domestic, industrial, and municipal water uses, hydropower and common data needs.

At the request of the IJC the St. Clair River portion of the Study be accelerated and is scheduled to be completed within 2 years. As part of the accelerated component of the study, the IJC will evaluate and recommend potential remedial options. The IJC Study will also review the operation of structures controlling Lake Superior outflow in relation to impacts of such operations on water levels and flows over the 5-year study period.

A recent study commissioned by the Georgian Bay Association (GBA) indicated that the volume of the St. Clair River outflow may have increased by as much as 2.5 billion gallons per day as a result of dredging and the subsequent on-going erosion of the river bed. However, determining the outflow of a river the magnitude of the St. Clair River is difficult at best. It is important to recognize that much of the information available today has a fairly high degree of uncertainty due to absence of direct measurements and imperfect models. It is difficult to draw specific conclusions from the existing data, particularly against the background of a strong and highly variable climate signal. Studies to examine the changes in the outflow of the St. Clair River were added to the original scope of the IJC Study to address specific concerns raised by the GBA study. The IJC Study will be taking great care to look at all of the factors, both natural and man-made, to comprehensively assess their relative importance to the lowering of the lake levels prior to suggesting any remedial action be taken. Any recommended structural changes in the St. Clair River would require an Order of Approval and agreement by both the U.S and Canadian governments.

Botulism

Botulism is a food-borne, paralytic illness caused by the toxin botulin and produced by the bacteria *Clostridium botulinum*. Outbreaks in Ontario waters have left dead fish, waterbirds, and mudpuppies on Lake Huron beaches. The neurotoxin is widely distributed in aquatic ecosystems; however, Type E botulism has only recently been a recurrent event since the late 1990s.

Since 1998, outbreaks of Type E botulism have been recorded on beaches between Sarnia and Tobermory; killing hundreds of shorebirds, gulls, terns, diving ducks, mergansers, grebes and loons. Botulism incidents are being now reported by the Canadian Co-operative Wildlife Health Centre at the University of Guelph on a web-based map illustrating confirmed and suspected incidents of botulism around the Great Lake basin (http://wildlife1.usask.ca/en/botulism_ontario_news.php).

It is believed that fish and wildlife are predisposed to the disease due to ecological perturbations associated with the spread of aquatic, non-native invasive species. Type E botulism toxin may proliferate in extensive zebra and quagga mussel beds on the lake bottom under anoxic conditions. Mussel predators, such as the invasive round goby, may acquire the toxin through feeding in mussel beds, and may then act as a source of toxin for predatory fish or for fish-eating birds higher in the food web. Mussel-feeding diving ducks may acquire the toxin directly, rather than via a fish ‘vector’. Scavengers such as gulls may acquire the toxin through consumption of toxin-containing carcasses, and shorebirds through consumption of toxic invertebrates. It is speculated that there may be links with nearshore algae blooms; however, more science is needed to determine this as well as the mode of transmission up the food chain and risks to native wildlife populations due to these persistent outbreaks.

Viral Hemorrhagic Septicemia (VHS)

Viral hemorrhagic septicemia (VHS) has been considered the most serious viral disease of salmonids reared in freshwater environments in Europe. The recent outbreak in the Great Lakes region appears to be a new strain of the virus. This new strain is responsible for die-offs in the following species: muskellunge, smallmouth bass, northern pike, freshwater drum, gizzard shad, yellow perch, black crappie, bluegill, rock bass, white bass, redhorse sucker, bluntnose sucker, round goby, and walleye. The disease transmits easily between fish of all ages. Some fish will show no external signs of infection, while others have bulging eyes, bloated abdomens, abnormal behavior, and skin hemorrhaging. Infected fish may also have lesions that look like those caused by other fish diseases, thus requiring specific testing for confirmation.(APHIS 2006) VHS causes disease in fish but does not pose any threat to public health. (MDNR 2007)

VHS was first detected in the Bay of Quinte, Lake Ontario in 2005. It was later identified as a causative agent in a 2003 fish die-offs in Lake St. Clair by analyzing archived samples. Outbreaks and confirmation of the disease has been documented in a number of fish species in other Great Lakes waters, including Lake Huron (USDA-APHIS 2006). The re-analysis of archived whitefish samples from the Cheboygan area confirmed the presence of the VHS in Lake Huron as early as 2005. The disease was subsequently confirmed in lake whitefish, walleye, and Chinook salmon samples collected from northern Lake Huron in 2006. Special regulations have been implemented in Michigan in an attempt to prevent the spread of the disease, particularly into inland waters of the state (MDNR 2007).

Policies and regulations are rapidly adapting to the developing state of science. It is expected that fishermen and recreational boaters will continue to be asked to adhere to best management practices while fishing or boating in waters where VHS has been found, including thoroughly cleaning fishing equipment, boats, and trailers before using them in a new body of water, as well as eliminating the transfer fish from one body of water to another. Agencies managing the maritime industry are working with their stakeholders to identify additional practices which will eliminate the spread of VHS within the Great Lakes.

Beaches and Bacterial Contamination

The beaches of Lake Huron draw thousands of tourists and cottagers annually to its shoreline. Lake Huron beaches are concentrated mostly in the southern half of the main basin, from Port Huron to Saginaw Bay in the Michigan, and from Sarnia to Sauble Beach in Ontario, referred to as Lake Huron Southeast Shore. There are also significant beaches in Nottawasaga Bay and Severn Sound in southern Georgian Bay, on southern Manitoulin Island, and several small beaches near Thessalon and Blind River in the North Channel .

County health departments in Michigan and Ontario regularly monitor levels of *Escherichia coli* (*E. coli*), a bacterial indicator organism, in waters adjacent to public beaches and compare their *E. coli* levels against State or provincial water quality standards. When *E. coli* levels exceed these guidelines, public health advisories notify the public that, beaches are posted (Ontario) with signs advising against swimming, or closed (Michigan) for swimming. Health departments continue to sample the beach for *E. coli* until levels fall within acceptable levels, before the public is notified the beach is safe for swimming.

E. coli lives in the digestive systems of humans and other warm-blooded animals. Most strains are not dangerous, but they can indicate the presence of other disease-causing bacteria. There are a variety of sources that contribute bacteria and other pathogens to the surface water. The sources of *E. coli* include:

- Illicit waste connections to storm sewers or roadside ditches;
- Septic systems;
- Combined and sanitary sewer overflows;
- Storm (rain) runoff;
- Wild and domestic animal waste, and;
- Agricultural runoff.

The Ontario side of Lake Huron contains well over 100 public beaches. Ongoing monitoring by municipal Health Units throughout the province at those beaches has found that, on average, the amount of time beaches are posted each year is very low (around 3%), or between 2 and 3 days per swimming season (depending on the length of the season).

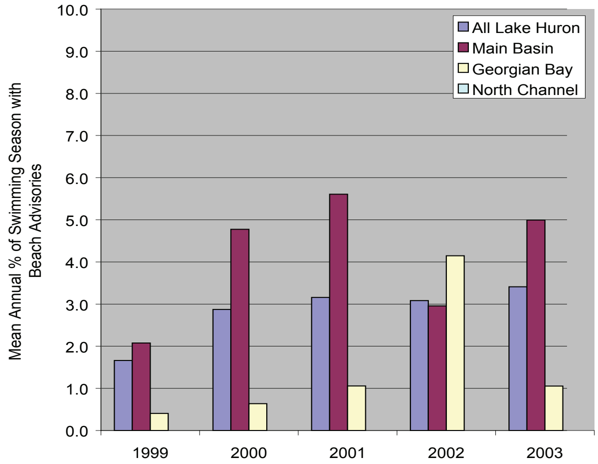


Figure 7.2: Mean annual percentage of swimming season that beaches on the Canadian side of Lake Huron were posted with beach advisories, for the period 1999-2003.

Within the Canadian southeast shore area of Lake Huron, more prolonged beach postings have been occurring. In order to address this issue a Southeast Shore Working Group comprised of various federal and provincial government agencies was formed to determine, coordinate and implement appropriate management actions. In February 2004, the Lake Huron Science Committee, led by MOE, was initiated to conduct a science-based examination of bacterial inputs to beaches of the Huron County Shoreline.

The final report of the science committee "*Sources and Mechanisms of E. coli (bacteria) Pollution to the Lake Huron Shoreline of Huron County*" was released in April of 2005. This report provided a summary of past studies, monitoring and implementation activities completed within the study area and an outline of next steps.

Priority actions are ongoing and include the University of Guelph's Microbial Source Tracking (MST) project to look at MST techniques to characterize isolates of *E. coli* from water and sediment samples in primarily agricultural tributaries (18 Mile Creek) to the shores of Lake Huron. This project was funded through the Ontario Ministry of the Environment's Best in Science Program. The Maitland Valley Conservation Authority looked at hydrological modeling and field testing of un-gauged tributaries discharging to the shoreline of Lake Huron to aid in modeling water quality at the shores of the lake. Environment Canada has completed work along the Lake Huron shores looking at the presence and persistence of *E. coli*

Table 7.1. Results of *E. coli* monitoring of beaches in the Michigan portion of Lake Huron.

Year	Number of Beaches Monitored	Number of Samples (Daily Means)	Number of Samples (Daily Means) Exceeding Standard	Percent of Samples Exceeding Standard
1999	0	0	-	-
2000	1	1	0	-
2001	28	318	7	2.2
2002	42	568	15	2.6
2003	54	778	22	2.8
2004	50	753	24	3.2
2005	50	690	34	4.9
2006	65	653	25	3.8

in groundwater below beaches. And finally the Ontario Ministry of the Environment has been working in collaboration with Wilfred Laurier University to understand the role algae plays with respect to bacteriological persistence at the beach.

In 2007 three Blue Flag beaches were recognized on Lake Huron. The Blue Flag Program which was started in France in 1985 and has since gained international recognition and respect is an eco-label awarded to beaches that achieve high standards in water quality, environmental education, environmental management and safety and services. The three beaches along Lake Huron with the Blue Flag designation include Station Beach in Kincardine, Sauble Beach on the South Bruce Peninsula and Wasaga Beach at the Wasaga Beach Provincial Park located on Georgian Bay. Beaches moving forward in their quest for designation are the Town of Goderich and Sarnia's Canatara Park. Within Canada, the Blue Flag program is run by Environmental Defense.

Under Section 303(d) of the U.S. federal Clean Water Act, Michigan is required to identify waters that are not attaining water quality standards. Table 7.2 identifies specific areas within the Lake Huron watershed of Michigan that are identified as being impaired by pathogens.

Beaches and Algal Fouling

Increased biological productivity in the Saginaw Bay, primarily due to eutrophication, has resulted in an increase in organic debris washing up on area swimming beaches. This organic debris consists of decomposing algae, aquatic plants, and small invertebrate animals. The smell and unsightliness of this beach debris prompted citizen complaints and concern about recreational activities at Saginaw Bay recreational areas.

The "muck" problems in Saginaw Bay are not a new development. Foul smelling, shoreline deposited materials have been documented on beaches in Saginaw Bay since at least the 1960s. Recently, excessive algal growth or "muck," has covered the shoreline in parts of the Great Lakes, especially Saginaw Bay, with a perceived increase in duration and spatial distribution compared to past years. A new development, the detection of human fecal indicators in the material has resulted in public concerns related to the potential human health implications of contact with the material.

The "muck" is predominantly comprised of the algae *Cladophora* which is now becoming more abundant because of invasive species, i.e. zebra mussels and quagga mussels. The subsequent degradation of the aesthetic value

Table 7.2. Areas in the Michigan portion of the Lake Huron watershed identified as being impaired by pathogens. Source: MDEQ, 2006.

Major Drainage Basin	Impaired Area
Eastern Upper Peninsula	Kinross Lake Beach, St. Marys River
Thunder Bay River	Lake Huron Starlite Beach
Au Gres-Rifle River	Saginaw Bay Singing Bridge Beach
Kawkawlin-Pine River	Saginaw Bay Brissette Beach Township Park, Kawkawlin River Boat Launch Beach, Saginaw Bay Wenona Beach, Saginaw Bay City State Recreation Area Beach, Saginaw Bay South Linwood Township Park Beach
Birch-Willow River	Lake Huron Forester County Park Beach, Lake Huron Kraft Road Beach
Tittabawassee River	Cedar River Campground Beach, Tittabawassee River
Shiawassee River	Shiawassee River Cole Park Beach, Bad River, Ringwood Forest County Park Beach, Holly Drain/Three Mile Creek
Flint River	Burdick Drain, C.S. Mott Lake Bluebill Beach, Potters Lake
Cass River	Cass River Heritage Park, Duff Creek and S. Br. Cass River Beach, Cass River Beach

of the beaches has resulted in great concern among the public, especially local homeowners.

In 2006, the MDEQ organized a science committee to address potential human health risks associated with the muck on the shores of Saginaw Bay. The MDEQ asked the science committee to address the *E. coli* and pathogen risks and specifically address citizen concerns on the presence of *E. coli* in material in the Saginaw Bay area. Because there has been only limited sampling of the muck, the report recommended that a comprehensive environmental sampling plan be developed to better characterize sources, potential health risks and management strategies.

The science committee report identified the need for broad public outreach on methods to reduce the exposure to the muck. Local health departments have issued advisories indicating the importance of avoiding contact with the muck, good hygiene when coming in contact with the muck, washing the skin after contact and avoiding the muck altogether if a person has cuts or open sores. In addition the Michigan Department of Community Health is working with the local health departments to encourage the public to report to the local health department any illness that they believe might be tied to exposure to the beach, muck or water.

In 2007, Dr. Joan Rose, Professor, Michigan State University analyzed *E. coli* samples collected at the public beach at the Bay City State Recreation Area. The samples reportedly indicate evidence of enterococci bacteria that are only found in human waste. Enterococci bacteria are used by U.S. EPA as an additional indicator to indicate the presence of disease-causing organisms. Dr. Rose indicated three important points as a result of her findings: 1) if a person comes in contact with the muck it is important that they are aware of and follow the local health departments' advisories calling for good hygiene practices, 2) the testing procedure does not discriminate between sources of human bacteria (discharges from septic tanks or municipal combined sewer overflows), and 3) the test procedure does not account for non-human bacteria which may also be present. More testing is expected to occur during the summer 2008.

On the Canadian side of Lake Huron, there have also been periodic complaints of algal fouling, especially along the southeastern shore area. The washed algae on the shore, and subsequent decay, can be aesthetically unpleasant if present in large amounts.

Since 2003, the Ontario Ministry of the Environment, along with Environment Canada, continue their work to determine the causes and environmental conditions leading to algal fouling. Initial findings show two species of green algae *Cladophora* and *Chara* with distinctly different ecologies responsible for the shoreline fouling. Fouling by *Cladophora* is localized near areas of suspected nutrient discharge. Fouling by *Chara* is more widespread, seemingly recent and without clear cause at this time, however, nutrient enrichment has not been ruled out as a contributing factor to the problem.

While many nutrient sources may contribute to this issue including tributary discharges to the lake, shoreline development (septics) and wildlife (gulls/geese/cormorants) inputs, the need for further study has been identified. This algal problem involves a complex interaction between land-based nutrient inputs and ecological processes operating within the lake. The process is particularly challenging in the general area of Point Clark, due to the mixture of human activities and ecological factors that stimulate algae growth and result in washed-up algae on the shoreline. A study is currently being initiated by the Ontario Ministry of the Environment and will be conducted in partnership with the University of Waterloo. This study will examine such factors as tributary and groundwater discharge to the shoreline, changing habitat availability and biological stimulation via environmental changes induced by invasive species. Research such as this will continue to inform our approach to improve the quality of Lake Huron.

While efforts to fully understand this issue locally are underway on the ground efforts continue through local stakeholders to reduce nutrient loadings. Funding for beneficial management practices (BMP) is being provided to landowners through a variety of programs. Further efforts include a regulatory component to reduce nutrient inputs, including phosphorous to Lake Huron includes the inspection of sewage treatment plants to monitor compliance with discharge limits as well as the inspection of large livestock operations for compliance with the *Nutrient Management Act*. In addition, many municipalities are now engaged in septic system re-inspection programs.

Occurrences of blue-green algae blooms in the protected bays and inlets of Georgian Bay have led to increased concern about inputs of nutrients from shoreline cottages and developments as well as internal cycling of phosphorus within the bays. In the fall of 2003, Sturgeon Bay, a small inlet along the north-east coast of Georgian Bay just north of Parry Sound, was subject to a warning from the local health unit advising residents to restrict use of water from the bay for any purposes including swimming, drinking, bathing, and any other domestic uses. The advisory has not been lifted to date and blooms continue to appear in the fall as the Sturgeon Bay Water Quality Action Group, led by the Township of the Archipelago continues to research the causes and possible solutions to the problem. Additional monitoring and research may assist in identifying the factors controlling the blooms however in the meantime the township will evaluate remedial options and consult with the public on recommended treatments in 2008. An education campaign to inform local residents about what they can do to reduce nutrient releases from their properties is ongoing.

Aquaculture

Cage aquaculture operations in Ontario are located primarily in the North Channel of Lake Huron with one operation in Parry Sound. These commercial operations raise rainbow trout for domestic consumption. Cage aquaculture operations discharge nutrient-enriched organic fish waste material, predominantly faecal waste and some food waste, into the environment which can result in localized environmental effects. The degree of environmental effect will vary according to site-specific physical conditions. Sites with limited flushing and connectivity to the open waters (e.g. Type 1 and 2 sites) are more sensitive to discharges from cage aquaculture operations, therefore are more susceptible to water quality issues such as hypolimnetic oxygen depletion or occurrence of nuisance algae (OMOE, 2001). Sites that are more energetic with exposure to the deep offshore waters (i.e. Type 3 sites) possess a greater assimilative capacity and are less sensitive to discharges from cage aquaculture operations (OMOE, 2001). Proper siting of these facilities is important for minimizing the ecological effects of this industry on the natural environment.

Additional concerns include fish health, habitat and community (OMNR, 2007). These concerns, including water and sediment issues, are currently being addressed through the Coordinated Application and Review Guide for Cage Aquaculture Sites in Ontario. Various levels of government are co-operatively developing detailed guidelines for assessment and monitoring of cage aquaculture operations. The Guide and the companion Decision Support Tool (DST) transparently outlines the operating, monitoring and reporting conditions and will assist in the review of applications for new cage aquaculture licenses and the re-issuance of existing licenses.

This industry is important for the northern economy, providing a desired product with significant economic benefits (MNDN, 2001) and federal and provincial government agencies are working towards ensuring the ecologically sustainable growth of the cage aquaculture industry (OMNR, 2007).

Global Climate Change

According to the Intergovernmental Panel on Climate Change (IPCC), North America is projected to warm between 3.6-18 °F (2-10 °C) by 2100, depending on the region (IPCC, 2007). The large range in warming reflects large projected increases in Arctic temperatures in northern Alaska and Canada, uncertainties in future emissions, the climate's response to those emissions, and the difficulty of projecting future climate change at the regional level.

The following list, while not comprehensive, provides illustrative examples of some of the higher likelihood effects of climate change in the Great Lakes region (IPCC, 2007):

- Lowered lake and river levels, resulting from warmer temperatures and increased evaporation, impact recreation and shipping;
- Warming lake and river temperatures leading to reductions in many fish stocks (trout and salmon) and more favorable conditions for others (bass, sunfish, walleyes);
- Decrease in water quality leading to habitat loss and eutrophication;
- Increased agricultural productivity in many regions resulting from increased carbon dioxide and warmer temperatures.
- Higher summer heat and increase in heat-related morbidity and mortality, especially in urban areas; reduced winter cold stress with associated decrease in cold-related mortality.
- Global climate change may also cause greater demand for fresh water, and any reduction or loss of fresh water in other regions of North America, would heighten water demand and may place greater pressure on Great Lakes governments to allow water withdrawal and/or diversion and water-based industrial development (electrical power plants, ethanol and hydrogen production).

Mitigation approaches are currently being developed by countries, including promoting of renewable energy, energy efficiency (including building retrofits/green buildings), low-emission transportation, reducing waste, and recycling materials.

Lake level declines could create large-scale economic concern for virtually every user group in the Great Lakes basin. Dramatic declines also could compromise the ecological health of the Lake Huron, particularly in the highly productive nearshore areas. Besides natural climatic variability and potential man-made climate change, other factors can affect long-term fluctuations, including changes in consumptive use, channel dredging or encroachment and crustal movement.

Low Level Contaminants

Recent advances in chemical detection techniques have revealed the presence of low concentrations of chemical contaminants that were previously not known to be present. Studies in other aquatic systems have detected a wide range of chemicals including the following: personal care products (e.g., soaps and perfumes), human and veterinary drugs (e.g., antibiotics), natural and synthetic hormones, plasticizers, insecticides, fire retardants, and caffeine. Many of these substances discharge from waste water treatment facilities, which were not originally designed treat them. Concentrations of these chemicals almost never exceed standards set for drinking water, but there are no standards for many substances because their presence was not previously known. The primary concern with low-level contaminants is that they may serve as endocrine disrupters that affect growth, maturation, and reproduction of aquatic organisms. Another concern is that while these substances may not exceed standards, mixtures may produce synergistic effects. The problem is so new that many basic questions are unanswered.

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