# Lake Huron
# Binational Partnership

# 2008-2010 Action Plan

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# I. Executive Summary

Since its formal endorsement by the Binational Executive Committee in 2002, the Lake Huron Binational Partnership ("the Partnership") has coordinated lakewide environmental activities in the Lake Huron basin. The United States Environmental Protection Agency, Environment Canada, Michigan's Departments of Environmental Quality and Natural Resources, and Ontario's Ministries of Environment and Natural Resources form the core of the Partnership by providing leadership and coordination. A flexible membership is being promoted on an issue-by-issue basis, which is inclusive of other agencies and levels of government, Tribes/First Nations, non-government organizations, and the public.

The approach in Lake Huron differs from the Lakewide Management Plans (LaMPs) of Lakes Superior, Michigan, Erie and Ontario in that it focuses on pollution reduction activities in areas of obvious importance, such as Areas of Concern (AOCs), and directly pursues on-the-ground activities to protect areas of high-quality habitat within the Lake Huron basin. Existing stakeholder and agency forums are used as much as possible to support the goals of the Partnership. The Partnership maintains a close association with the Remedial Action Plan efforts in AOCs, the Great Lakes Fishery Commission's Lake Huron and Lake Huron Technical Committees, the State of the Lakes Ecosystem Conference (SOLEC), and domestic efforts that support the Partnership.

This 2008-2010 Action Plan provides updated information on environmental trends, identifies priority issues, and promotes management activities to be pursued over the next two-year cycle. Consistent with an adaptive management approach, the Action Plan tracks progress on issues identified in the previous cycle, including contaminants in fish, changes in food web structure and protection of critical habitat, and has been expanded to address emerging issues, such as observed increases in nearshore algae and diseases such as botulism and viral hemorrhaghic septicemia (VHS).

Over the past two-year cycle, the Partnership has successfully used a streamlined approach to coordinate the many environmental activities impacting Lake Huron. We look forward to expanding on our past efforts and advancing the binational protection and restoration of the Lake Huron ecosystem.

# II. Introduction

### The Lake Huron Basin

The Lake Huron drainage basin is defined by an expansive watershed and abundance of shoreline habitat. Lake Huron has over 30,000 islands and, as a result, has the longest shoreline of any lake in the world. One of these islands, Manitoulin Island, is the largest island of any freshwater lake on Earth. Lake Huron's drainage basin is larger than any other Great Lake, and its relatively undisturbed nearshore areas support a high diversity of aquatic and riparian species of importance to the Great Lakes region. Over 40 species of rare plants, five rare reptile species, and 59 fish species are found in the coastal wetlands of Lake Huron. Lake Huron's coast remains diverse and has retained significant remnants of historic fish and wildlife habitat. Saginaw Bay, Georgian Bay and the North Channel support some of the most extensive high quality coastal habitat in the Great Lakes region.

The U.S.-Canada border divides the main basin of Lake Huron almost in half. The Canadian portion of the Lake, including Georgian Bay, is wholly within the Province of Ontario. The U.S. portion is entirely within the State of Michigan. The drainage basin on the Ontario side (86,430 square kilometers or 33,500 square miles) covers twice the area, has approximately five times the shoreline, and roughly 300,000 fewer residents than in Michigan. While the Lake Huron watershed is home to about 2.5 million people, both sides of Lake Huron have relatively low human population densities. The Lake Huron basin contains no major metropolitan areas. The largest urban centers in the basin are Sudbury and Sault Ste. Marie on the Ontario side and Flint, Saginaw and Bay City on the Michigan side. With populations under 120,000, these urban areas are relatively small compared to urban areas in the more populous Great Lake basins.

Lake Huron is the third largest freshwater lake in the world in terms of area, and the sixth largest in volume. Its average depth is 59 metres (195 feet). The average retention time for water in Lake Huron is 22 years. This long retention time makes Lake Huron, and the other Great Lakes, susceptible to the build up of persistent toxic substances that can bioaccumulate in fish, fish-eating wildlife and humans.

Rocky shores associated with the Precambrian shield cover the northern and eastern shores of Georgian Bay and the North Channel; limestone dominates the shores of Manitoulin Island, the northern shore of the Bruce Peninsula the north shore, including Drummond Island, and "Straits" area of the Main Basin, the Thunder Bay area, the north shore of Michigan's 'Thumb' peninsula, as well as Lake Huron's midlake reefs known as 6-Fathom Bank and Yankee Reef. Glacial deposits of sand, gravel, and till predominate in the remaining portions of the shore. Mining of limestone, nickel, uranium, copper, platinum and gold has been an important activity in the northern portion of the Lake Huron basin. The Lake Huron basin is also heavily forested in the northern region, and more urbanized in the southernmost portion of the lake. Much of the the Saginaw River watershed and the "thumb" area of Michigan, along with the Bruce Peninsula and the southeast shore of the main basin is dominated by agricultural land use (e.g., field crops) and supports many beef and dairy farms.

Though residential land use makes up a small percentage of current total land use in the Lake Huron basin, much of the recent development has occurred along the coast. In the past 20 years, and as more people begin to retire, there has been increasing development pressure for cottages and year-round retirement properties in rural areas. Undoubtedly, the next 20 years will bring more development to the coastal regions of the basin, especially as urban populations continue to grow and more people desire to live in less densely populated areas.

### The Areas of Concern

In 1987, as part of an effort to clean up the most polluted areas in the Great Lakes, Canada and the United States identified five Areas of Concern (AOCs) in the Lake Huron basin: Spanish Harbour (Ontario), Severn Sound (Ontario), Collingwood Harbour (Ontario), Saginaw Bay (Michigan), and the St. Marys River, which connects Lakes Huron and Superior (a binational AOC). Canada and Ontario have recognized Spanish Harbour as an "Area in Recovery" where all remedial actions have been implemented and the environment will take some time to recover. Severn Sound was delisted as an AOC in 2003, and the Collingwood Harbour AOC, was delisted in 1994. The causes of impairment within the remaining AOCs continue to be addressed; fish and wildlife habitat, fish and wildlife populations, and environmental quality are subsequently recovering.

**The Partnership**

In 2002, the federal, state and provincial agencies that manage binational environmental activities under the Great Lakes Water Quality Agreement (GLWQA) formally endorsed the formation of a Lake Huron Binational Partnership ("the Partnership") to prioritize and coordinate environmental activities in the Lake Huron basin. The United States Environmental Protection Agency (USEPA), Environment Canada (EC), Michigan's Departments of Environmental Quality (MDEQ) and Natural Resources (MDNR) and Ontario's Ministries of Environment (OMOE) and Natural Resources (OMNR) form the core of the Partnership, by providing leadership and coordination. However, the Partnership emphasizes the importance of maintaining a flexible membership, which is inclusive of other agencies and levels of government, Tribes/First Nations, non-government organizations (NGOs), and the public on an issue-by-issue basis.

The Partnership builds upon the efforts that were begun by the MDEQ's Office of the Great Lakes during the Lake Huron Initiative ("the Initiative"). In 2000, the Initiative developed an Action Plan for Lake Huron which outlined priority programs and initiatives. The Initiative identified basin-wide priority actions necessary to address use impairments, critical pollutants, habitat, and biodiversity. The Initiative's Action Plan was updated in 2002. Since 2004, many of the activities outlined in Action Plan have been addressed by the Partnership.

The Partnership facilitates information sharing and priority setting for binational environmental protection and restoration activities of importance in the Lake Huron basin and promotes cooperation and collaboration towards shared objectives that are unachievable by individual agencies alone. Public consultation is an important component of the Partnership's activities in the Lake Huron basin, particularly on a project-specific level. Those individuals and organizations which have a direct interest in an issue are encouraged to participate or provide input to project direction and implementation. The Partnership agencies work with existing mechanisms and groups, as much as possible, to consult with and provide outreach information to the public. To support this outreach, a series of stand-alone fact sheets were produced on the following topics: The Lake Huron Binational Partnership, Contaminants in Fish, Contaminants in Wildlife, Developing Environmental Objectives for Fish Communities, Lake Huron GIS, and Changes in the Lake Huron Fish Community. In addition, two fact sheets were developed on domestic activities in support of the Partnership, including The Canadian South-East Shore Working Group and Phosphorus Concentrations in Saginaw Bay, Michigan.

The Partnership has developed a process for identifying priority issues and efforts needed to ensure a healthy Lake Huron basin and watershed. The binational work plan includes U.S., Canadian, and joint actions that focus on short term project implementation and longer-term priority setting goals.

**The Issues**

The participants of the Partnership have agreed upon three binational issues to focus on:

- Contaminants in fish and wildlife,
- Biodiversity and ecosystem change, and
- Fish and wildlife habitat.

These key issues were given priority for immediate action, while other issues will be tracked and added as the Partnership pursues an iterative process of updating and expanding activities over time. The types of activities which address the binational issues include:

- Documenting the status and trends of contaminants in fish and wildlife causing fish consumption restrictions;
- The identification of potential sources of contaminants and implementation of reduction measures;
- Determining the scope and causes of observed changes in ecosystem structure and function;
- The impact of invasive species on food web dynamics, fish communities and biodiversity; and,
- Evaluating, protecting, and restoring critical habitat such as wetlands, fish spawning areas, and nesting sites for waterbirds.

While these topics are being addressed binationally, other issues are the subject of Canadian or U.S. domestic activities. These include the restoration of beneficial uses in the AOCs, and other local issues, such as fouling of beaches by algae and bacteria. The Partnership facilitates the sharing of information between countries on these domestic issues.

Lake Huron basin's size and multiple binational political jurisdictions require coordination among existing basinwide natural resource programs and local initiatives. In order to streamline activities and minimize costs, the Partnership interacts closely with representatives of these existing programs. One example of the collaborative effort is the Partnership's close ties to the Great Lakes Fishery Commission's (GLFCs) Lake Huron Technical Committee (LHTC). The LHTC has representation on the Partnership committee, informing the Partnership of the LHTC activities and recommendations, such as the Environmental Objectives document developed for Lake Huron fish community. Success also requires collectively engaging local governments whose authority and local decision making has a significant impact on the sustainability of localized natural resources and communities throughout the Lake Huron basin. While governmental agencies are in a position to provide leadership, success depends on leveraging both governmental and non-governmental organization (NGO) involvement and resources.

# III. Fish and Wildlife Contaminants

**Introduction**

Contaminant concentrations in fish from Lake Huron have been monitored over time in order to assess risk to human and wildlife health. Because certain contaminants bioaccumulate and biomagnify in the food chain, fish are excellent indicators of pollutants in the aquatic ecosystem. Programs have been developed and implemented to monitor contaminant concentrations in the edible portions of sport fish and in whole fish as a way to monitor risk to human and wildlife health respectively.

The Michigan Department of Environmental Quality (MDEQ), the Ontario Ministry of the Environment (OMOE), and EPA's Great Lakes National Program Office (GLNPO) collect and analyze many species of sport fish from the Great Lakes, including the Lake Huron watershed, to determine whether chemicals are present in quantities that may be of concern to those eating commercially- or sport-caught fish. Contaminants such as mercury, toxaphene, dioxins, and polychlorinated biphenyls (PCBs) can accumulate in fish, wildlife and humans and could be harmful to a developing fetus, young child or breast-feeding baby. Michigan Department of Community Health (MDCH) and OMOE determine the available fish contaminant information and place advisories on the consumption of specific species of fish depending on the levels of contaminants found. GLNPO provides Great Lakes sport fish contaminant information to the states to be incorporated into State issued advice.

Long-term (>25 yrs), basin-wide monitoring programs that measure whole body concentrations of contaminants in top predator fish (lake trout and/or walleye) and in forage fish (smelt) are conducted by the U.S. Environmental Protection Agency (USEPA) Great Lakes National Program Office (GLNPO) through the Great Lakes Fish Monitoring Program and Environment Canada (beginning in 2006, previously maintained by the Canadian Department of Fisheries and Oceans (DFO)) through the Fish Contaminants Surveillance Program. Concentrations of historically regulated contaminants such as PCBs, DDT and mercury in most monitored fish species are currently lower than they were in the late 1970s. The concentrations of other contaminants, currently regulated and unregulated, have demonstrated either slowing declines or, in some cases, increases in selected fish communities. The changes are often lake-specific and relate both to the specific characteristics of the substances involved and the biological composition of the fish community.

**Contaminant Trends in Whole Fish**

Since the 1970s, there have been significant declines in the levels of many persistent, bioaccumulative and toxic (PBT) chemicals, such as PCB, DDT, dieldrin, dioxins, and furans, in the Great Lakes basin due to bans on the use and/or production of harmful substances and restrictions on emissions. However, PBT chemicals, because of their ability to bioaccumulate and persist in the environment, continue to be a significant concern. These significant declines are no longer continuing due to changes in the environment and the sources of contaminants. Present concentrations of contaminants, such as PCBs and DDT, show general declines in Lake Huron with some year to year fluctuation. Continuing sources of contaminants include in-use PCB electrical equipment. Legacy sources are primarily sediments contaminated by historic discharges, airborne deposition, industrial and municipal discharges and land runoff.

Pesticides such as DDT, toxaphene, mirex, chlordane and aldrin/dieldrin have been banned from use in the U.S. and Canada; however, they still cycle within the environment through run-off, sediment resuspension and long range atmospheric transport. The large surface area of Lake Huron, like the other Great Lakes, makes it particularly vulnerable to atmospheric deposition of contaminants. It has relatively few contaminant point sources, and therefore relative pollutant loadings to Lake Huron from water sources are the lowest of all the Great Lakes while atmospheric sources are the highest.

Both GLNPO and DFO/EC programs have observed large fluctuations in total (Σ) DDT concentrations in lake trout in the early years of analysis followed recently by a relatively consistent year-to-year decline. Likewise, Σ DDT concentrations in smelt fluctuated between years; with a recent downward trend.

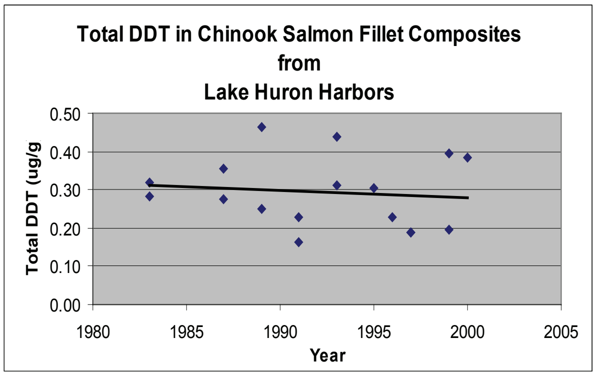


Figure 3.1 Total DDT in Chinook Salmon Fillet Composites from Lake Huron Harbors. Source: GLNPO – Great Lakes Fish Monitoring Program 2008

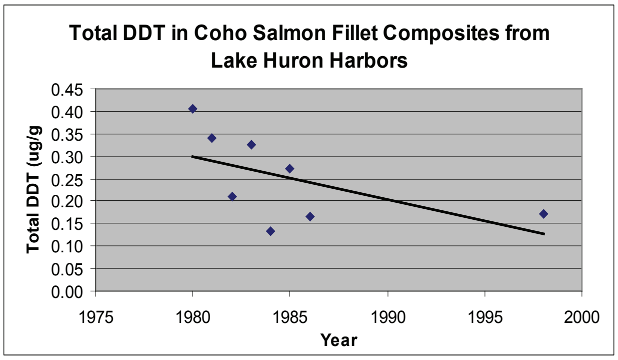


Figure 3.2. Total DDT in Coho Salmon Fillet Composites from Lake Huron Harbors. Source: GLNPO – Great Lakes Fish Monitoring Program 2008.

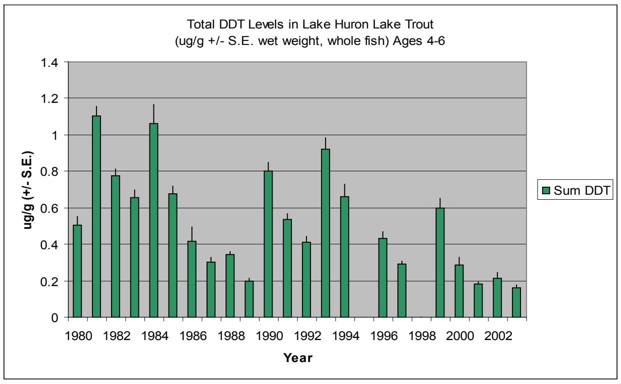


Figure 3.3. Total DDT Levels in Lake Huron Lake Trout (μg/g =/- S.E. wet weight, whole fish) Ages 4-6. Source: DFO, Great Lakes Laboratory for Fisheries & Aquatic Sciences 2005.

Both GLNPO and DFO lake trout data show a general decline in concentrations of PCBs over time. Concentrations in recent DFO lake trout samples were the second lowest ever recorded for the program. PCB concentrations in DFO smelt have fluctuated considerably over time.

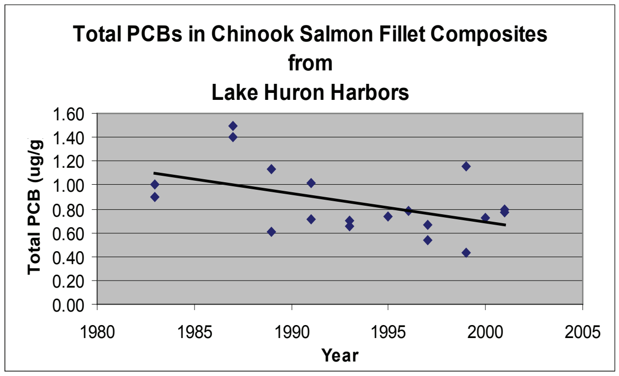


Figure 3.4. Total PCBs in Chinook Salmon Fillet Composites from Lake Huron Harbors. Source: GLNPO – Great Lakes Fish Monitoring Program 2008.

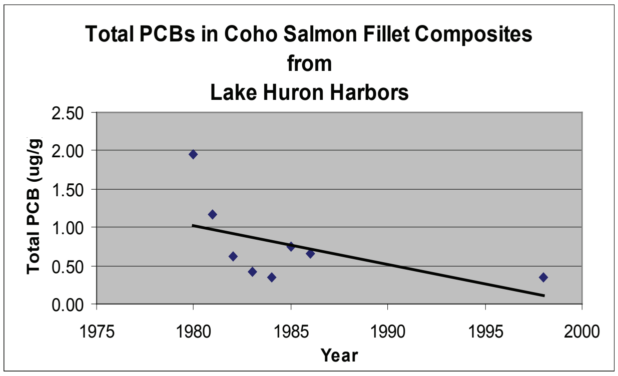


Figure 3.5. Total PCBs in Coho Salmon Fillet Composites from Lake Huron Harbors. Source: GLNPO – Great Lakes Fish Monitoring Program 2008

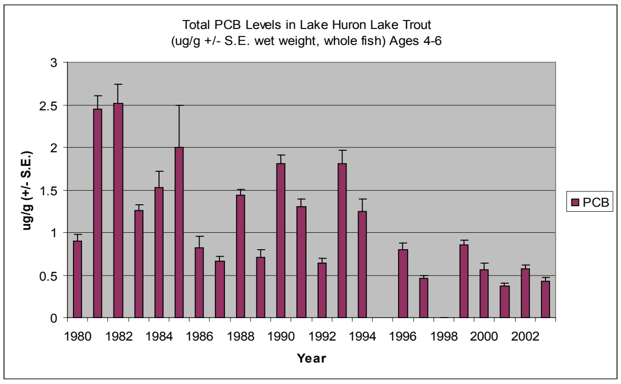


Figure 3.6. Total PCB Levels in Lake Huron Lake Trout (μg/g =/- S.E. wet weight, whole fish) Ages 4-6. Total Source: DFO, Great Lakes Laboratory for Fisheries & Aquatic Sciences 2005.

Mercury concentrations in DFO smelt fluctuated considerably between 1979 and 2003. Smelt collected in 2003 had the highest lake-wide concentration recorded since 1984.

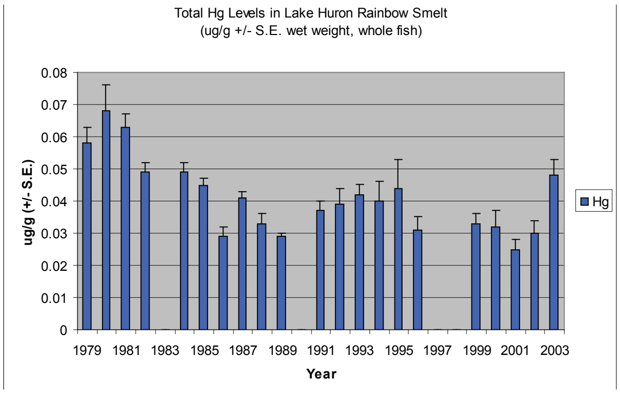


Figure 3.7. Total Mercury Levels in Lake Huron Rainbow Smelt (μg/g +/- S.E. wet weight, whole fish). Source: DFO, Great Lakes Laboratory for Fisheries & Aquatic Sciences 2005.

## Contaminant Trends in Sport Fish

In most areas of Ontario, contaminant levels have been declining or are stable due to bans on harmful substances and restrictions on emissions. Ontario sport fish contaminant analyses are based on the skinless dorsal fillet section of the fish, not the entire fish fillet as in Michigan. Ontario advisories are published biennially in the *Guide to Eating Ontario Sport Fish* (*Guide*). Fish consumption can be unrestricted (maximum eight meals per month), restricted to four, two or one meal per month, or totally restricted ("do not eat").

PCB concentrations in sport fish declined significantly in Lake Huron between 1976 and 1990. However, from 1990 to the present, the rate of decrease has diminished. Lake-wide average PCB concentrations for five year intervals in a typical (55 cm) lake trout are shown in Figure 3.6. In the late 1970's, concentrations exceeded the "do not eat" consumption limit of 1220 ng/g for the general population. Current PCB concentrations are within the 4 meal per month range (153-305 ng/g) for both the general and sensitive (women of child-bearing age and children under 15) populations. However, dioxins, furans and dioxin-like PCBs (dl-PCB) are responsible for the majority of the consumption restrictions on lake trout from Lake Huron in the 2007-08 *Guide*.

Lake-wide average dioxin/furan/dl-PCB toxic equivalent (TEQ) concentrations in 55 cm lake trout (light blue bars in Figure 3.8) declined considerably between 1990 and 2001. Analysis and inclusion of dl-PCBs in the total TEQ began in 1997 (dark blue bars figure 3.8) resulting in a significant increase in fish consumption restrictions. It is too early to determine if dl-PCB concentrations have changed significantly from 1997. Continued monitoring for these contaminants is necessary in order to determine such trends. Total TEQs for 55 cm lake trout from all years exceed the first level of consumption restriction (2.7 pg/g) resulting in a four meal per month consumption restriction. Total TEQ measurements since 1997 have also exceeded the "do not eat" consumption restriction guideline of 5.4 pg/g for the sensitive population.

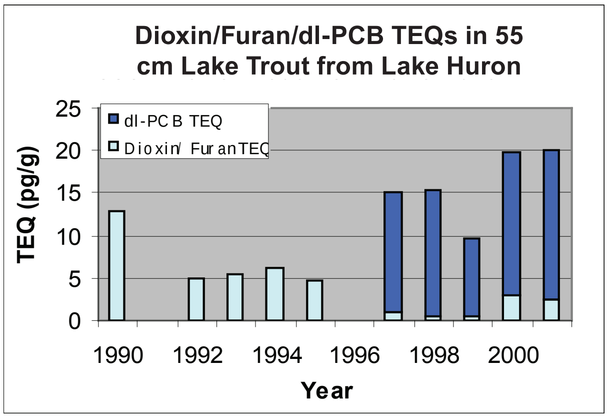


Figure 3.8. Dioxin/Furan/dl-PCB TEQs in 55 cm Lake Trout from Lake Huron. Source: OMOE, Sport Fish Contaminant Monitoring Program, 2005.

Total mercury concentrations in walleye declined considerably between 1977 and 1986 (Figure 3.9). Over the past 20 years, however, concentrations have been relatively stable, ranging from 0.2 to 0.3 µg/g. In Ontario, the unlimited consumption limit for mercury is 0.26 µg/g for the sensitive population and 0.61 µg/g for the general population. Although mercury concentrations in 45 cm walleye have exceeded the guideline for the sensitive population in the past, mercury is not a cause for restrictions in this size of walleye in more recent years. Larger sized walleye as well as other similar species (e.g. northern pike) are restricted for mercury in Lake Huron.

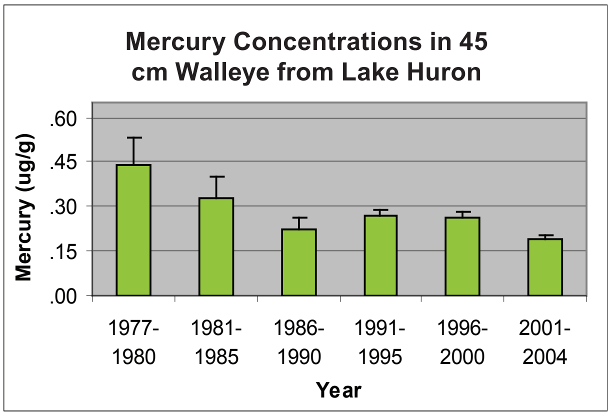


Figure 3.9. Mercury Concentrations in 45 cm Walleye from Lake Huron. Source: OMOE, Sport Fish Contaminant Monitoring Program, 2005.

PCB concentrations in Georgian Bay lake trout are generally lower than those from Lake Huron. Figure 3.10 shows PCB concentrations in typical sized lake trout collected from Georgian Bay. Concentrations in these fish meet or exceed the four-meal-per-month restriction level (153 ng/g) in all years except for 1995 and 2004. Dioxin and furan levels in lake trout from Georgian Bay between 1993 and 2001 range from 0 to 5 pg/g. Again, the addition of dl-PCBs to the TEQ has resulted in increased consumption restrictions and the consumption of 55 cm lake trout is restricted to 0 to 4 meals per month in the 2007-08 *Guide*.

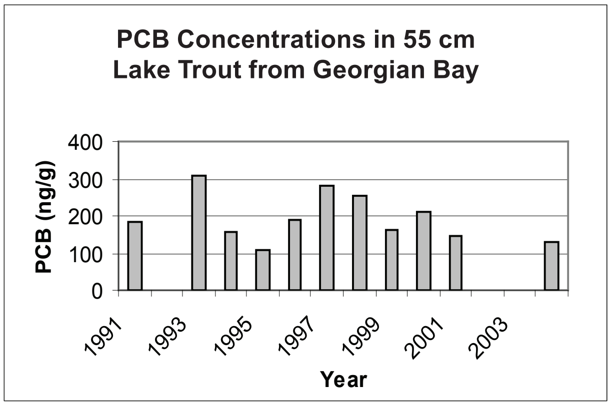


Figure 3.10. PCB Concentrations in 55 cm Lake Trout from Georgian Bay. Source: OMOE, Sport Fish Contaminant Monitoring Program, 2005.

The PCB levels in lake trout in the North Channel have declined since 1983 (Figure 3.11). Recent levels are below the consumption restriction guideline.

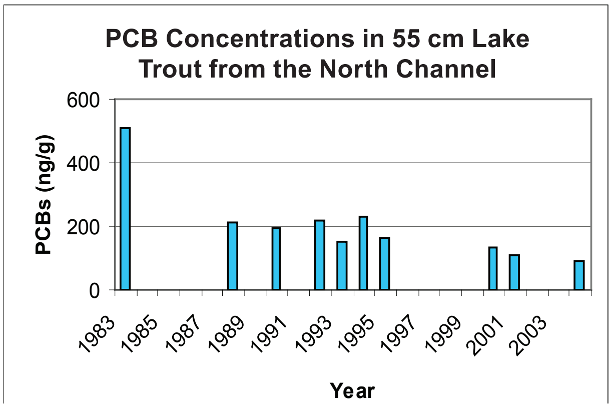


Figure 3.11. PCB Concentrations in 55 cm Lake Trout from the North Channel. Source: OMOE, Sport Fish Contaminant Monitoring Program, 2005.

Toxaphene concentrations in 55 cm lake trout from Georgian Bay exceeded the consumption guideline (235 ng/g) between 1995 and 1997. Since then, toxaphene concentrations have decreased and were not the cause of consumption restrictions in the 2007-08 Guide. Toxaphene concentrations in 55 cm lake trout from the North Channel exceeded the consumption guideline in 1988 but are now below detection.

Overall, the proportion of consumption restrictions for fish from Georgian Bay (22%) is much less than those for Lake Huron (61%). In the North Channel, the proportion of fish consumption restrictions (40%) is also lower than in Lake Huron.

Fish Consumption Advisories

Individual Great Lakes States and Tribes and the Province of Ontario issue specific consumption advice for how much fish and which species are safe to eat for a wide variety of contaminants. Fish consumption advisories are based on guidelines developed through research and review of toxicological data. Recently Health Canada has revised downward their Tolerable Daily Intakes (TDIs) for PCBs and dioxins, which has increased the frequency of consumption restrictions caused by PCBs and dioxins and decreased the frequency of those caused by toxaphene and mirex/photomirex.

In comparison to the other Great Lakes, such as Lake Ontario, contaminant concentrations are relatively low in Lake Huron fish. Nevertheless, fish consumption advisories exist for the open lake and all Areas of Concern (St. Marys River, Saginaw Bay and the Spanish River). On the Ontario side, fish restrictions have increased due to revisions in the consumption guidelines. Advisories differ by species, size and location, so it is important to check advisories in effect for the appropriate area.

In the Ontario waters (including Georgian Bay, North Channel and St. Marys River) generally, the restrictions on trout, salmon, carp and channel catfish are caused by dioxins/furans/dl-PCBs (Figure 3.12). The restrictions on other species (such as walleye and northern pike) are usually caused by mercury. In total, 44 percent of the advice given for Lake Huron sport fish results in some level of consumption restriction (either 4, 2, 1 meals/month or "do not eat").

Section III

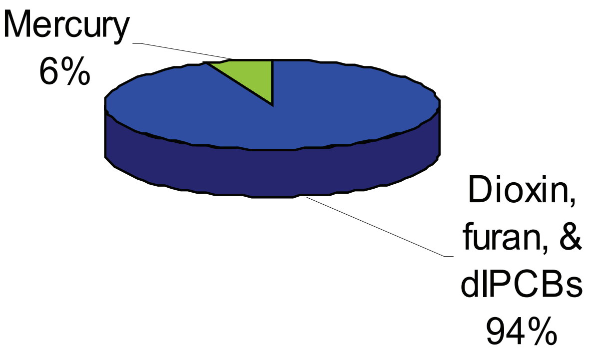


Figure 3.12. Source: OMOE, Sport Fish Contaminant Monitoring Program, 2008.

In the Michigan waters (including Saginaw Bay and the St. Marys River), generally, the restrictions on trout, salmon, carp, channel catfish, burbot, northern pike, walleye, white bass, white suckers, white perch and yellow perch are caused by PCBs. The other restrictions are caused by dioxins or mercury.

Based on the most recent information the current status of sport fish consumption advisories for both Ontario and Michigan are as shown below:

**PCBs** – In Michigan waters, almost every sample collected from Lake Huron exceeded the trigger level used by the Michigan Department of Community Health to issue sport fish consumption advisories for the protection of women of child bearing age and children under 15. Sport fish consumption advisories cover 15 species of Lake Huron fish. In addition, fish from several Lake Huron tributaries are covered by sport fish consumption advisories due to elevated concentrations of PCBs. The status is similar in the Ontario waters with PCBs causing many of the consumption restrictions.

**Toxaphene** – Past toxaphene concentrations in several species of Lake Huron fish including lake trout, lake whitefish and brown trout have been above the OMOE sport fish consumption advisory trigger level. However, recent toxaphene concentrations are at or below detection, and cause less than one percent of the consumption restrictions.

**Dioxins** - Lake trout, lake whitefish, catfish, white bass and carp have dioxin/furan/dl-PCB concentrations that exceed the trigger level used by both the MDCH and the OMOE to issue sport fish consumption advisories. In addition, fish from the Saginaw River watershed are covered by advisories due to elevated dioxin concentrations.

**Chlordane** - Chlordane concentrations in Lake Huron lake trout on the U.S. side no longer exceed the sport fish consumption advisory trigger level. In Ontario, levels of chlordane are very low and do not cause any fish consumption restrictions.

**Mercury** - The methylated form of mercury readily bioaccumulates in fish tissue and a number of characteristics influence the methylation of mercury in the aquatic environment. Mercury methylation occurs more readily in inland lakes than in the Great Lakes. Therefore, sport fish consumption advisories due to elevated levels of mercury are more prevalent in fish from inland lakes within the Lake Huron watershed rather than

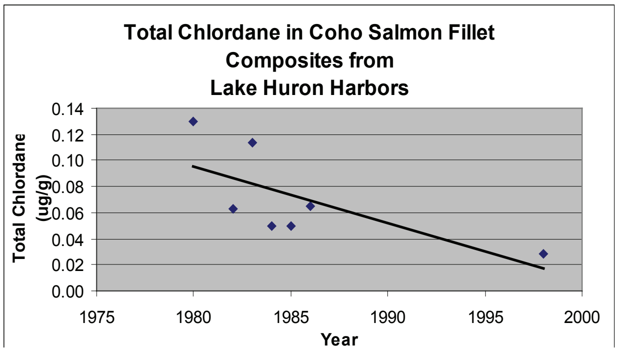


Figure 3.13. Total Chlordane in Coho Salmon Fillet Composites from Lake Huron Harbors. Source: GLNPO – Great Lakes Fish Monitoring Program 2008.

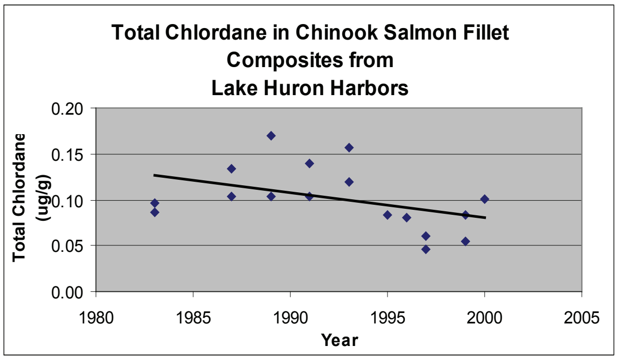


Figure 3.14. Total Chlordane in Chinook Salmon Fillet Composites from Lake Huron Harbors. Source: GLNPO – Great Lakes Fish Monitoring Program 2008.

in fish collected from Lake Huron. Nevertheless, consumption of some species in Lake Huron are restricted due to mercury contamination, such as yellow perch, walleye, rock bass and northern pike in Ontario and walleye in Michigan.

**DDT/PBB** - Concentrations of DDT and PBB rarely exceed sport fish consumption advisory trigger levels in Lake Huron fish. The only area of the Lake Huron watershed where concentrations are elevated is the Pine River located in the Saginaw River watershed.

Additional Information

For more information regarding the fish consumption advisory programs in Michigan and Ontario go to the following web sites:

- Michigan: www.michigan.gov/mdch-toxics click on "Michigan Fish Advisory"
- Ontario: www.ontario.ca/fishguide

**Contaminants in Lake Huron Wildlife**

Introduction

In the early 1970s, fish-eating birds nesting in the Lake Huron basin, such as eagles, herring gulls and double-crested cormorants, suffered eggshell thinning, which led to breeding failure and a decline in population levels. Much of the reproductive failure was caused by exposure to various contaminants in the fish that they ate. By the 1990s, concentrations of many persistent toxic contaminants, such as PCBs, had been greatly reduced and most fish-eating bird populations recovered. However, some problems associated with contaminants continue to occur in a small percentage of bird populations in localized areas. It is important to analyze contaminants over time (temporal) and at various locations (spatial) to identify potential problem areas and sources. This information has been compiled and is available in "*Current Status, Trends and Distributions of Aquatic Wildlife along the Canadian Shores of Lake Huron*" K.D. Hughes, CWS Technical Report Series Number 441, 2006.

The Canadian Wildlife Service (CWS) of EC has been monitoring contaminant concentrations in herring gull eggs at up to 15 Great Lakes sites since 1974. The three Lake Huron sites are: Channel-Shelter Island (in Saginaw Bay), Double Island (off Blind River), and Chantry Island (off Southampton) (Figure 3.15). The program tracks temporal and spatial trends in contaminant levels and effects in this top avian aquatic predator.

The MDEQ began a similar annual gull egg monitoring project in 1999 that augmented the CWS work. Michigan sites include the outer Saginaw Bay, Alpena, St. Ignace and Sault Ste. Marie. MDEQ data are reviewed each year and new contaminant parameters are considered for analysis.

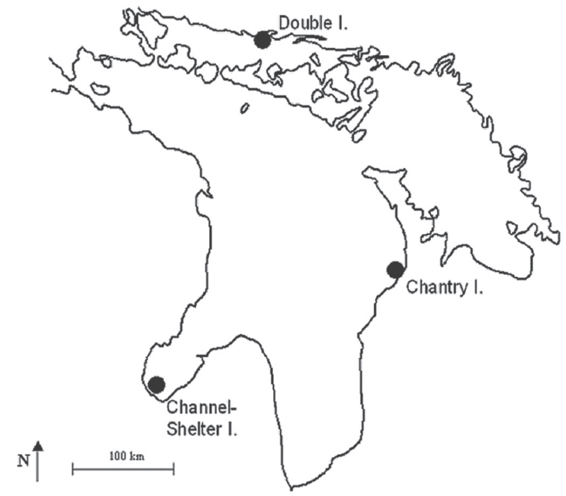


Figure 3.15. Location map of the three Lake Huron herring gull monitoring sites.

In addition to herring gull egg monitoring, the CWS occasionally measures contaminants in eggs from double-crested cormorants, ring-billed gulls, black-crowned night-herons, great black-backed gulls, and several species of terns.

Contaminant Trends in Fish-Eating Birds

Contaminants levels have declined dramatically at all three CWS Lake Huron sites since 1974, although the rates of decline for some compounds slowed during the 1990s. In spite of these declines, PCB and dioxin levels in gull eggs from Channel-Shelter Island continued to remain elevated compared to the other Great Lakes sites. While major point sources of chemical contaminants are not found on the Canadian side of Lake Huron, atmospheric deposition, agricultural runoff, re-suspension of sediments and leaching of soils from landfill sites contribute to the steady state that has been evident since the 1990s. Year-to-year fluctuations in contaminant levels result from changes in food type and abundance, which may be affected by the severity of winter on the Great Lakes.

High concentrations of brominated diphenyl ethers (BDEs) in Great Lakes herring gulls have recently been identified as a concern. BDEs are known to impact thyroid function and growth in some wildlife. Total BDE in herring gull eggs sampled from Double and Chantry Islands in 2000 were low (308-320 µg/kg) in comparison to other Great Lakes sites (1400 µg/kg in Green Bay), largely due to their remoteness from large urban/heavy industrial centres.

In general, the CWS monitoring of double-crested cormorants, ring-billed gulls, black-crowned night herons, great black-backed gulls, and several species of terns has indicated that egg contaminant concentrations at Lake Huron sites were lower than other Great Lakes sites.

Figures 3.16 through 3.21 indicate trends in the levels of contaminants in herring gull eggs at the three CWS Lake Huron sites.

Legend: □ Chantry Island △ Double Island ◇ Channel Shelter Island

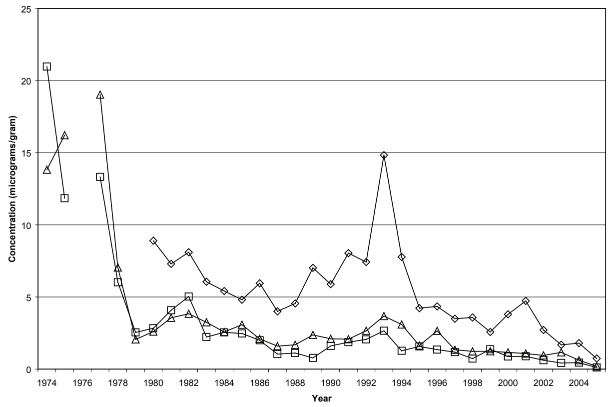


Figure 3.16. DDE concentrations in herring gull eggs at Channel-Shelter Island, Double Island and Chantry Island. Source: Canadian Wildlife Service 2005.

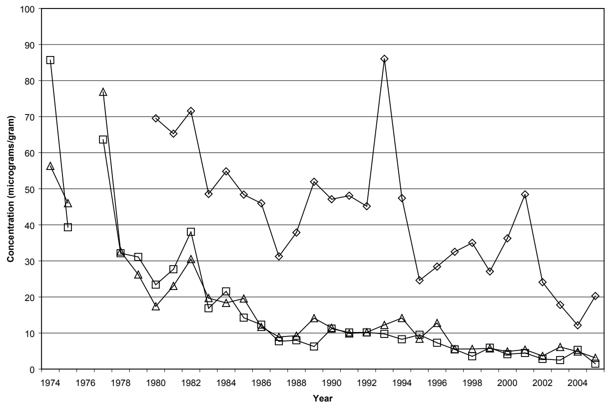


Figure 3.17. PCB 1254-1260 concentrations in herring gull eggs at Channel-Shelter Island, Double Island and Chantry Island. Source: Canadian Wildlife Service 2005.

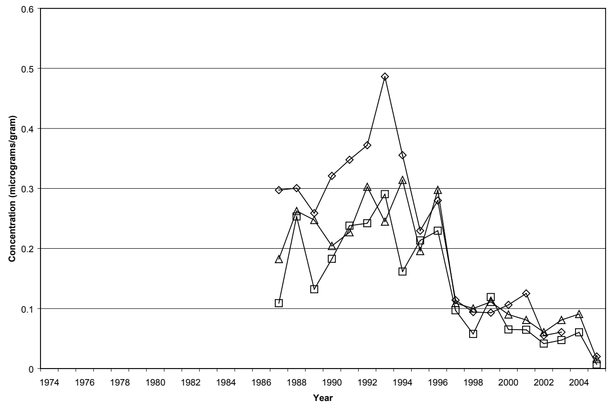


Figure 3.18. Total Chlordane concentrations in herring gull eggs at Channel-Shelter Island, Double Island and Chantry Island. Source: Canadian Wildlife Service 2005.

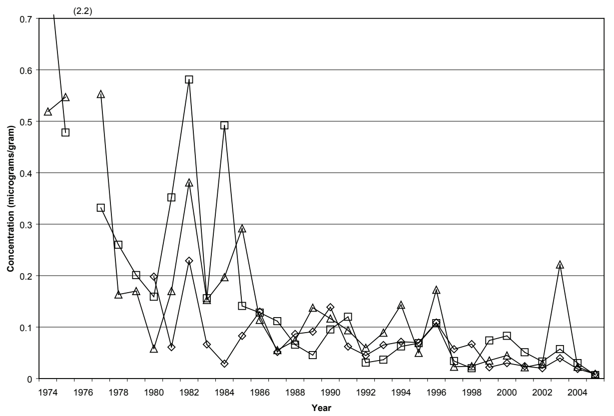


Figure 3.19. Mirex concentrations in herring gull eggs at Channel-Shelter Island, Double Island and Chantry Island. Source: Canadian Wildlife Service 2005.

Legend: □ Chantry Island △ Double Island ◇ Channel Shelter Island

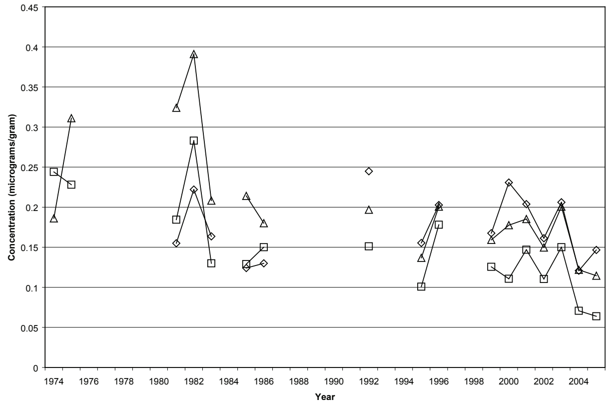


Figure 3.20. Mercury concentrations in herring gull eggs at Channel-Shelter Island, Double Island and Chantry Island. Source: Canadian Wildlife Service 2005.

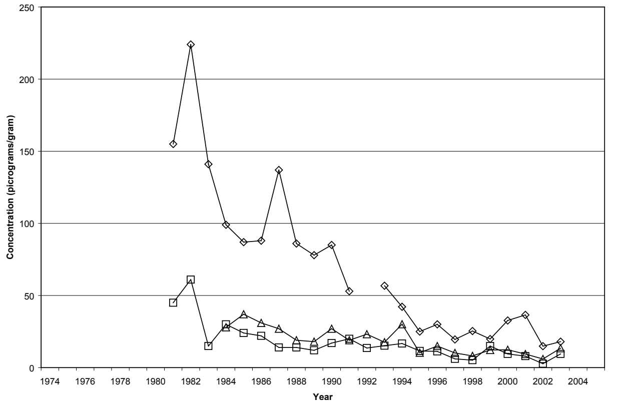


Figure 3.21. 2378-TCDD concentrations in herring gull eggs at Channel-Shelter Island, Double Island and Chantry Island. Source: Canadian Wildlife Service 2005.

Monitoring of waterfowl hunted from Georgian Bay and Sault Ste. Marie found that organochlorines, PCBs and mercury concentrations in pectoral muscle were low and did not pose a risk to wildlife. One exception was a common merganser taken from Sault Ste. Marie, which had the highest PCB concentrations of all waterfowl and game birds collected across Canada from 1987 to 1995. The reason for these high levels is unknown (Braume *et al.* 1999).

*Bald Eagles/Osprey*

Bald eagles are very sensitive top level predators and often considered the ultimate contaminant indicator species. Eagles are returning to the Great Lakes region, and their blood contaminant concentrations can be used as an indicator of contaminant exposure and trends. In recent years, elevated contaminant concentrations have been found in some eaglet blood samples taken from Georgian Bay and Lake Huron watersheds (e.g., Saginaw River, Shiawassee Cutoff), although 1999-2001 samples were significantly lower than in 1987-1992.

Exposure to heavy metals has been identified as a concern for bald eagles. Several bald eagles found dead in the last few years in Ontario have had elevated levels of both mercury and lead in their bodies. The life span of an adult bird, length of time birds use a given nest site, and the age of new breeding birds are important factors which determine how reproductively successful nesting bald eagles are on the shores of Lake Huron.

Ospreys are often used as local indicators in areas where there are few or no bald eagles. During 1991-1993, DDE concentrations in osprey eggs and blood samples were significantly higher in Georgian Bay than at inland sites in Ontario (Martin et al. 2003). Mean concentrations of DDE were lower than the critical value (4.2 μg/g) associated with significant eggshell thinning; however, 20% of eggs from Georgian Bay were above this level. In terms of heavy metals, all samples taken from the St. Marys River and Georgian Bay (1991-1993) had mercury concentrations below those expected to cause adverse effects on reproduction. With the exception of Georgian Bay, the osprey population on the Canadian side of Lake Huron does not appear to be affected by the current level of contaminants.

<u>Wild Game Contaminants from the Tittabawassee River Flood Plain</u>

The Michigan Department of Community Health (MDCH) has determined that consumption of dioxin-like compounds (DLCs) found in the liver of white-tailed deer and in turkey meat, with and without the skin, harvested from the flood plain area of the Tittabawassee River downstream of Midland, Michigan presents a public health hazard. MDCH determined that consumption of DLCs found in the muscle meat of deer and squirrel harvested from the flood plain area of the Tittabawassee River downstream of Midland present a potential public health hazard to women of childbearing age and children under the age of 15. The Dow Chemical Company (Dow) conducted a study to determine if wild game consumption was a route of human exposure from DLC contamination in flood plain soils and sediments. After reviewing the data from the Dow study, the State of Michigan issued a Wild Game Advisory on September 14, 2004, advising that hunters and their families should not eat deer liver or turkey meat harvested from the flood plain of the Tittabawassee River. The advisory further cautioned women of childbearing age and children under the age of 15 to eat only one meal per week of deer and squirrel muscle meat. Samples of deer muscle and liver, turkey, and squirrel were taken in two areas in the floodplain downstream of Midland and at a comparison location upstream of Midland. Levels of dioxin in the wild game harvested in the floodplain downstream of Midland are higher than levels found in game harvested from a location upstream of Midland (2 to 120 times higher). The data indicates that these toxins are accumulating in land animals that are fairly low on the food chain. As these animals are eaten by their predators, further biomagnification (increased contamination of animals higher on the food chain) is expected. Additional ecological risk assessment work is needed to determine the significance of this contamination and to determine the level of cleanup necessary to protect the ecology of the Tittabawassee River as well as human health.

<u>Other Wildlife</u>

Snapping turtles are ideal indicators of contaminant exposure due to their sedentary nature, their position as a top predator in the food chain, and their ability to accumulate high levels of contaminants over the course of their long lives. Geographic variation in contaminant levels has been shown to be similar to the variation reported for herring gull eggs at Great Lakes sites. Mink and otter are also sensitive indicators of mercury in the aquatic environment, as both live in wetland habitat near the shoreline and consume various amounts of fish in their diet. Mink are one of the most susceptible mammals to PCBs, resulting in reproductive problems and death. Trends in mink populations have followed those of fish-eating birds; the population began to decline in the mid 1950s and was lowest in the early 1970s, but recovered somewhat in the 1980s. Because otter have a lower rate of reproduction they are more susceptible to contaminants, and as a result, populations have been slower to recover.

Total mercury concentrations in otter tissues from near Parry Sound were higher than those in mink tissues, possibly due to their more fish-based diet compared to mink. Mercury levels in otter hair were within the range found in studies in southern Ontario. Levels reported for Lake Huron otter were well below those where negative impacts could have been expected.

<u>Conclusions</u>

In summary, wildlife information has indicated that PCBs, chlordane, dioxins and DDT are a concern in the Lake Huron basin although, with the exception of Saginaw Bay (PCBs, dioxin), concentrations are low compared to the other Great Lakes. Concentrations have declined significantly since the early 1970s, but still remain at levels associated with deformities and reproductive effects in several local watersheds in Michigan, especially Saginaw Bay. Data collected on the Ontario side of Lake Huron indicated that wildlife species contaminant concentrations were generally not at levels of concern, although sporadic elevated measurements support the need for continued ongoing monitoring.

**References**

Braune, B.M., *et al*. 1999. Chemical residues in waterfowl and gamebirds harvested in Canada, 1987-95. Canadian Wildlife Service Tech. Rep. Ser. No. 326. 422 pp.

Dioxins in Wild Game Taken from the Tittabawassee River Floodplain South of

Midland, Midland and Saginaw Counties, Michigan. EPA ID# MID980994354

April 29, 2005. Prepared by Michigan Department of Community Health under a cooperative agreement with Agency for Toxic Substances and Disease Registry.

# IV. Aquatic Ecosystem

**Aquatic Ecosystem Change**

Since French explorer Étienne Brûlé first saw Lake Huron in 1612, the lake ecosystem has undergone many changes. Among the most significant changes to the fish community have been the invasion of rainbow smelt (*Osmerus mordax*) in the 1920's, followed by alewife (*Alosa pseudoharengus*) and the sea lamprey (*Petromyzon marinus*) in the 1930s. Sea lamprey predation and overfishing led to the collapse of lake trout (*Salvelinus namaycush*) by the 1950's in most of Lake Huron (although two remnant stocks barely survived). With no predators to control alewife and smelt populations their numbers exploded and nuisance die-offs of alewives commonly littered beaches during the 1960s.

The turnaround came with sea lamprey control in the 1960s which allowed the survival of stocked Pacific salmon (*Oncorhynchus* spp.), lake trout and other predators. Restocking controlled both smelt and alewife populations, prevented nuisance alewife die-offs and resulted in exceptionally good fishing.

The original Lake Huron ecosystem had lake trout as the main predator together with burbot (*Lota lota*) in the deeper waters, and walleyes (*Sander vitreus*) being the main nearshore area predator. The historic preyfish base was dominated by cisco (or lake herring) (*Coregonus artedii*) and a number of other species of deepwater ciscos (*Coregonus* spp.) including the bloater (*Coregonus hoyi*), with sculpins (*Cottus* spp. and *Myoxocephalus quadricornis*), lake whitefish (*Coregonus clupeaformis*) and round whitefish (*Prosopium cylindraceum*) contributing to a lesser extent.

The historic Lake Huron off-shore ecosystem had fewer predator species (dominated by the then very abundant lake trout) and many more prey fish species than the present fish community. The current ecosystem has more predator species (although their total biomass is lower than that of lake trout before their near extinction) than before the lake trout collapse and introduced species remain prominent. Prey fish continue to be dominated by introduced species. Many of the original deepwater cisco species in Lake Huron are extirpated (Refer to the section divider for illustration of aquatic system).

In the 1990s the invasion of zebra and quagga mussels (*Dreissena polymorpha*, *Dreissena bugensis*) from the Caspian region changed the Lake Huron ecosystem significantly. Although the linkages are not well understood, these new invasives altered the foodweb with far-reaching consequences to the fish community. The round goby (*Neogoblus melanostomus*) another Caspian invasive, appeared shortly after the zebra mussel invasion and has become an important benthic preyfish in Lake Huron. The invasive alewife nearly disappeared after 2003. Stocking success for the introduced Chinook salmon, steelhead (rainbow) and brown trout declined as alewife numbers plummeted. Thus, Lake Huron has again seen dramatic changes to its ecosystem, this time starting with the introduction of dreissenid mussels in the early 1990s and peaking during 2003-2006, when the salmon and trout fisheries were significantly reduced in abundance, particularly in the lake's main basin. This decline in salmon and trout also occurred in Georgian Bay and the North Channel but were less dramatic. The following summary will outline some of the more significant recent changes.

<u>Lower Trophic Levels</u>

From 1998-2002, zooplankton abundance and biomass, as monitored by EPA, were relatively high. Larger zooplanters most important to prey fish, such as daphnid cladocerans, composed much of this plankton biomass. The relatively high abundance of larger zooplankton, daphnia in particular, implies low levels of planktivory. The United States Geographic Service (USGS) bottom trawling in fact documents a declining trend in prey fish biomass from 1995-2002. However, in 2003 offshore zooplankton biomass declined sharply, but bottom trawl estimates of planktivorous fish biomass also declined. Alewives virtually collapsed in 2003-04. These changes were most dramatic in the southern area of the main basin. Changes in zooplankton since 2002 are no longer as clearly linked to prey fish abundance. *Limnocalanus* spp., a large calanoid copepod that may be an important prey for ciscos and chubs, remained relatively abundant. *Limnocalanus* tends to stay near the bottom of the lake during daytime and may not be readily available to pelagic planktivores such as alewives.

National Oceanic and Atmospheric Administration (NOAA) and EPA monitoring has demonstrated that *Diporeia* (*Diporeia hoyi*), large benthic crustaceans, declined in abundance steadily from 1992-2005 and are now scarce in Lake Huron. Although not monitored consistently, the fairy shrimp, Mysis (*Mysis relicta*), another important benthic crustacean prey for the fish community, may also have declined in abundance. Both *Mysis* and *Diporeia* migrate vertically at night and, while suspended in the water column, become especially available to planktivorous fish.

The most likely causes for the observed changes in zooplankton abundance and composition are:

1. Sequestering of nutrients by invasive dreissenid mussels;
2. Replacement of zooplankton-edible forms of phytoplankton such as diatoms by bluegreen algae;
3. Predation by larger cladocerans, mainly the spiny water flea (*Bythotrephes cederstromi*);
4. Shift in planktivory by fish from macrocrustaceans (*Diporeia*) to zooplankton;
5. Extinction of the benthic-pelagic nutrient link once driven by vertically migrating macrocrustaceans and pelagic planktivorous fish;
6. Some combination of the above

Negative impacts by dreissenid mussels on native zooplankton likely include competition for primary productivity. This could lead to the sequestering of nutrients in the nearshore zone and on the bottom of the profundal zone, particularly on hard substrates most heavily colonized by dreissenids. Declining prey fish biomass measured by USGS in the offshore waters tends to fit this hypothesis. Fish prey biomass has remained rather stable in the North Channel, however. Low calcium concentrations in the North Channel recorded by Environment Canada appear to be limiting dreissenid abundance there. If true, the North Channel may serve as a kind of 'control' for the dreissenid-driven nearshore shunt hypothesis thought to be operational in the other basins of Lake Huron (Hecky *et al.* 2004).

Primary productivity is a measure of offshore production measured by EPA and EC. There have not been measurable declines in primary productivity of the offshore waters of the main basin of Lake Huron. The extent to which primary productivity has changed to forms (such as bluegreen or filamentous algae) not usable to zooplankton or the macrocrustaceans is unknown. Thus we cannot be sure if the decline in zooplankton and macrocrustacean abundance is related to reduction quality or quantity of food available to them.

The third potential cause for native zooplankton declines is through competition for food with large exotic cladocerans (specifically spiny water flea). However, this seems unlikely given that spiny water flea abundance has not increased significantly during the period of native zooplankton decline. EPA conducts sampling only twice a year, thus it is possible that some important changes in spiny water flea abundance could escape detection. The status of zooplankton may be different in Georgian Bay and the North Channel of Lake Huron compared to the main basin, especially in light of differences in calcium availability, fish abundance, and fish growth. However similar zooplankton studies are unfortunately not conducted on those basins.

The observed changes and timing of zooplankton abundance (Figure 4.1) are consistent with planktivory since adult fish prefer larger cladocerans (mainly *Daphnia* and bosminids) and calanoid copepods while larval fish prefer small nauplii (juvenile copepods), cyclopods and bosminids (cladocerans). Zooplankton, particularly the larger *Daphnia*, were relatively abundant from 1998-2002, which was also a period of declining prey fish biomass. The first sign of major declines of zooplankton in 2003 also coincided with a very large year class of alewives which may have exerted high predation pressure on zooplankton. However, this large year class survived poorly and alewives were almost absent by 2004. Despite the very low levels of abundance of the major forage fish species (rainbow smelt, lake herring, alewives and bloater) in the Main Basin after 2003, zooplankton showed no signs of recovery until 2007. USGS biomass estimates of planktivorous fish appear to be too low to account for the decline in zooplankton after 2003. If fish were driving the declines in zooplankton abundance it must be because they targeted zooplankton at a higher rate due to of the collapse of benthic macrocrustaceans (*Diporeia* and *Mysis*). A rise in zooplankton biomass was measured in 2007, but the increase was in confined to calanoid copepods, rather than in daphnids, which are more readily available to planktivorous fishes. The species composition in 2007, therefore, remained consistent with that expected of a heavily grazed zooplankton community.

Potential competition between dreissenids and the macrocrustaceans *Mysis* and *Diporeia* would most likely be for food resources, particularly seston (including detritus). However, there is no indication that *Diporeia* are energetically deprived and the competitive mechanism, if any, remains obscure. But the fact that *Diporeia* have collapsed in Lake Huron is undisputed. All major benthic invertebrate groups (*Diporeia*, oligochaeta, sphaeriidae and chironomidae) declined in abundance from the early 1970s to 2000. Benthic invertebrates declined by approximately 50% in deep waters and 75% in nearshore areas over this period. The most severe declines were seen in the amphipod *Diporeia* where large areas of the lake were devoid of this species by 2000. In 2003, sampling showed *Diporeia* declined by an additional 57% in just three years. Samples collected in southern Georgian Bay from 2000 to 2003 have shown similar declines in *Diporeia* abundance. Some additional data collected on the benthic communities in Saginaw Bay from 1987-2000 have revealed that the decline in *Diporeia* began during 1992-1993, approximately the same time that zebra mussels invaded the area. A decline of *Diporeia* in other areas of the Great Lakes also coincided with the arrival of zebra mussels. By 2007, only a few pockets of *Diporeia* remained in the main basin of Lake Huron and they appear associated with upwelling areas characterized by cooler water temperatures.

*Diporeia* have much higher caloric value than other food items, with one *Diporeia* being the equivalent in energy content to hundreds of other individual zooplankters. Many pelagic forage fish species in Lake Huron (including rainbow smelt, alewives and bloater) have traditionally utilized *Diporeia* in their diet. Declines in zooplankton abundance which following the decline of *Diporeia* might indicate a shift to an increased plankton diet to compensate for decreases in benthic macrocrustacean availability. Alternatively, loss of *Diporeia* may have reduced the availability of nutrients



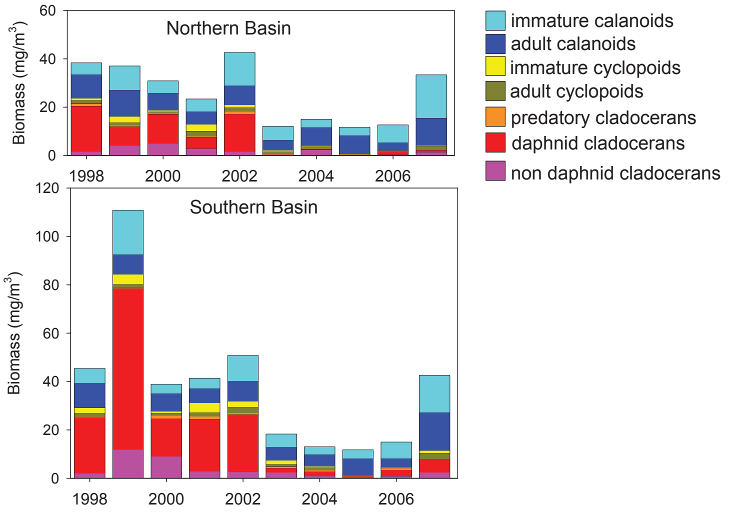


Figure 4.1. Summer zooplankton biomass, offshore waters of Lake Huron, 1998-2007. GLNPO data.

to the pelagic zone. Both *Diporeia* and *Mysis* feed on detritus settling to the bottom during daytime but undergo crepuscular migrations to and from the pelagic zone where they feed on plankton at night and, in turn, are preyed upon by planktivorous fish such as ciscos, chubs, and alewives. Since the formation of the Great Lakes during the last ice age, these glacial relics have served to transport nutrients from the benthic zone to fish of the water column. The collapse of these macrocrustaceans and their pelagic fish predators may not only have shifted predation by fish (those few remaining in the pelagic zone) to zooplankton, but also extinguished an important linkage connecting detritus settling to the benthic zone with productivity of the pelagic. Whatever the cause, the current zooplankton community of the main basin of Lake Huron is now very similar in biomass and composition to the much less productive waters of Lake Superior.

Dreissenid mussels, by removing planktonic algae, have also made waters of the Great Lakes much clearer. Increased water clarity has caused proliferation of benthic filamentous/colonial algae such as cladophora, spirogyra, and chara. The periodic dieoffs of these algae and wind events that wash the algae to shore have led to accumulations of decaying biological matter on beaches. These noxious deposits represent a loss of nutrients that otherwise would have been available to the foodweb and they also appear to be contributing to periodic outbreaks of Type E botulism.

From 2000 to 2007, zebra mussels were relatively stable or declining in abundance in areas sampled while quagga mussels showed an increase. Quagga mussels are closely related to zebra mussels but can tolerate much greater depths and are colonizing water depths that were not previously impacted by zebra mussels. Quagga mussels are now being sampled from water depths as great as 130 m.

The complexity of the foodweb and the variety of recent change agents identified to date strongly suggests that some combination of the above factors has been working to produce changes measured since 1997 in the fish community.

<u>Prey Fish</u>

*Alewife*

Along with rainbow smelt and bloaters, the alewife was, until 2004, among the three most common prey fish in Lake Huron. In 1998, there was a near collapse of adult alewives. Milder winters from 1997 to 1999 may have resulted in higher survival of young alewives which buffered the population from high predation levels and allowed for a period of recovery. From 2003 through 2007 there were very low adult numbers of alewives but an extremely large year class was produced in 2003 (Figure 4.2)

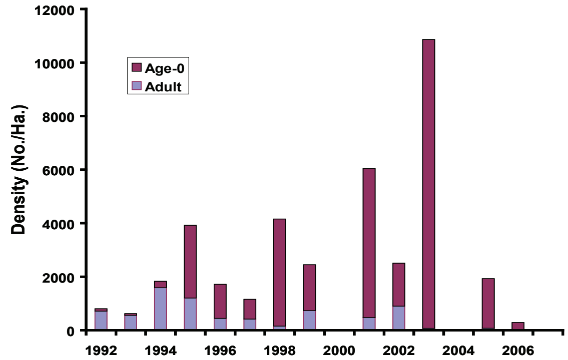


Figure 4.2. Alewife abundance in fall bottom trawls 1992-2007. No collections were made in 2000. Source: USGS data.

Ninety percent of the young of year in 2003 were less than 86 mm total length at the end of the summer, the size considered the minimum necessary to survive the winter. The 2003 year class was so abundant that competition for food sources appears to have lowered their growth and the fish were small entering the winter. Consequently, the 2003 year class did not survive, alewives have declined to record-low abundance, and the population is showing no signs of recovery.

Alewife numbers and biomass have reached near record low levels since the beginning of fishery surveys in the 1970's. This was likely due to some combination of climate, food web changes, and salmonid predation. Great Lakes winters have been the most and least severe in the past several years relative to the previous 20 years. Alewives tend to suffer lower mortality when mild winters prevail during their first year; this appears to affect their abundance for the rest of their lives. After 1995, alewife populations also experienced significant increases in predator consumption rates, principally due to increasing Chinook salmon reproduction. While alewives in 1984 reached the age of 8 years, despite increases in abundance they only survived until ages 3 to 4 by 2000-02.

Consecutive alewife recruitment failures have continued since 2003. Studies in 2004-07 reveal a 99% decline in alewife abundance from 2002. There was a slight increase in age-0 alewives observed in bottom trawls in 2005, but this was due to only a few high catches in northern regions of the lake. Adult abundance increased slightly in 2005, but their numbers remain very low compared to pre-2003 levels. As of 2007, no significant recruitment has occurred.

Given the poor survival of recent year classes, the future of alewives is uncertain. However, it's very likely that they originally invaded the upper lakes with few individuals and they have shown they can produce strong year classes during years with relatively low adult abundance. Therefore their resurgence is possible but given the extremely low numbers of adults and the low availability of zooplankton as prey, it is unlikely that adult alewives will recover, at least for some time, to their former abundance. The recovery of a strong and reproducing walleye population in Saginaw Bay and a large population of adult walleyes in Thunder Bay may further limit the potential for alewife recovery. Both bays were formerly very important spawning sites for alewives. It appears unlikely that spawning aggregations of alewives can rebuild in these bays in the face of such large walleye populations.

*Rainbow Smelt*

Similar to 2005 and 2006, the rainbow smelt population was dominated by age-0 fish in 2007. The age-0 fish were small and less than 10% of the population was larger than 100 mm. The low abundance of adult fish in 2007 suggests that the large numbers of small rainbow smelt observed in 2005 and 2006 did not translate into recruitment of larger rainbow smelt (Figure 4.3). In fact, the combined biomass for all age classes of rainbow smelt decreased by about 50% from 2005 to 2006-07 despite record-high density of age-0 fish observed in 2005. Few fish are now greater than 150 mm, whereas 200 mm adults were common in the 1970s and 1980s. The change is size structure suggests survival rates have declined. Adult smelt biomass, now in the range of 6 kg/ha, is not replacing former adult alewife biomass, which typically ranged 10-24 kg/ha. The lack of larger prey items, including smelt, could affect the growth rates and maximum sizes attained by predator fish.

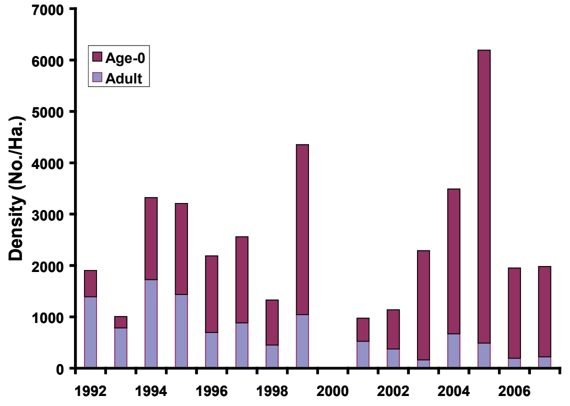


Figure 4.3. Rainbow smelt abundance in fall bottom trawls 1992-2007. No collections were made in 2000. Source: USGS data.

*Bloater*

The native bloater increased in abundance in 2004-07, with the 2007 year class being the strongest since 1992 (Figure 4.4). Historically, age-0 bloater abundance was much lower than smelt or alewives (less than 0.2 kg/ha). Bloater will therefore not significantly offset shifting predation demands resulting from the declining abundance of alewives. Adult bloaters are currently considered scarce compared to peaks in population cycles that occurred in the 1980s and mid 1990s. However, there is some evidence that individuals from the large year classes of 2005 and 2006 survived, and the adult population has increased.

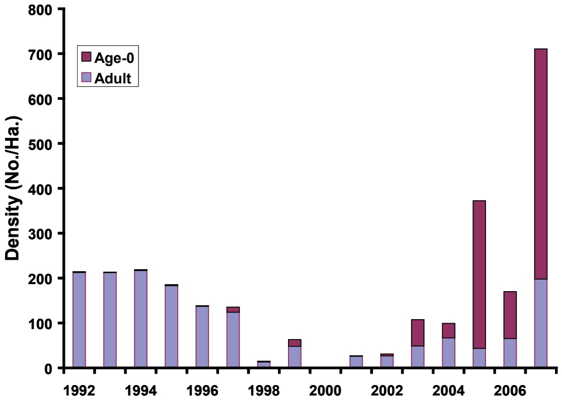


Figure 4.4. Bloater abundance in fall bottom trawls 1992-2007. No collections were made in 2000. Source: USGS data.

*Cisco*

Cisco (lake herring) have increased in Lake Huron. Ciscoes were captured for the first time in acoustic/midwater trawl surveys during 2007. Density and biomass estimates indicated that ciscoes were present at densities of slightly less than 9 individuals/ha in the main basin, and they represented about 30% of pelagic biomass. Those estimates may have been somewhat biased, but indicate that ciscoes are increasing although they are still not nearly as abundant as they are in Lake Superior.

*Sculpins, Sticklebacks and Trout-Perch*

Sculpins, sticklebacks (*Pungitius pungitius, Gasterosteus aculeatus*) and trout-perch (*Percopsis omiscomaycus*) are at lower abundance than during the previous decade. Numbers have remained consistently low since 2002 (Figure 4.5). Sculpin abundance in Lake Huron has fluctuated widely since 1992 but has been depressed since 1998. Deepwater sculpins comprise most of the total sculpin catch, while slimy sculpins are only a minor component of the deepwater fish community and were seen in low numbers in 2007. Deepwater sculpin abundance decreased from levels observed in 2006 and remains at near record-low levels. Density of ninespine sticklebacks decreased by about 50% of levels observed in 2006. Ninespine stickleback abundance has varied considerably since 1992 and low densities have been observed previously (1992-94 and 1998-99). However, the recent trend since 2001 is downward, and indicates that sticklebacks will not contribute to the fish community as an alternative prey species.

Troutperch density also continues a five-year overall decline. Their overall abundance remains low for the time series. As with sticklebacks, troutperch will not be an important alternative prey species.

Round gobies have not contributed significantly to the trawl catch and their numbers have declined in recent years. Their low representation in the trawl catch is surprising considering they contribute heavily to the diets of lake trout in the Main Basin and walleyes, catfish, drum, and smallmouth bass in Saginaw Bay and other nearshore areas.

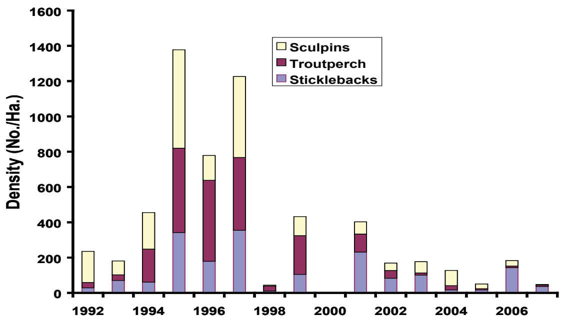


Figure 4.5. Abundance of sculpins, troutperch, and sticklebacks in fall bottom trawls 1992-2007. No collections were made in 2000. Source: USGS data.

*Prey Fish Conclusions*

Prey biomass in Lake Huron has remained low since 2004, almost totally a result of the drastic decline of alewives (Figure 4.6). Lake Huron is becoming more like Lake Superior in regards to its prey base. The availability of prey fish in Lake Huron remains in a depressed state since the collapse of alewife populations in 2003. Collections made in 2007 showed an overall increase in total prey biomass largely constituted by high numbers of small bloater and evidence of bloater recruitment to older age groups. Alewife density remains near the all-time low for the time series. Abundance of juvenile rainbow smelt was at an all-time high for this survey in 2005, but these small fish contributed little to lakewide biomass estimates in 2006 or 2007. Chinook salmon, although not native to the Great Lakes, have declined sharply due to depressed prey availability. Ecosystem stability and the future of the Chinook salmon sport fishery remain as concerns for fisheries managers and stakeholders

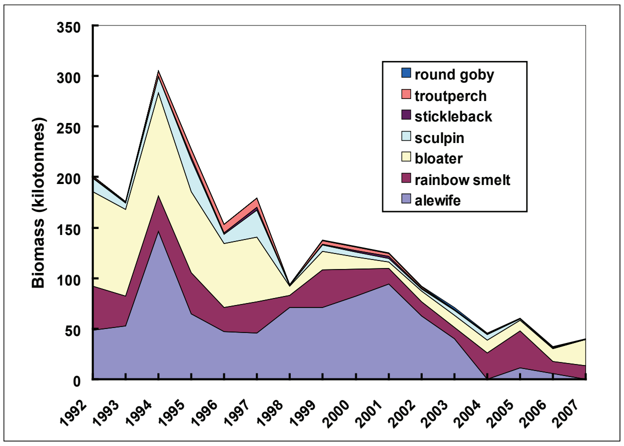


Figure 4.6. Estimated prey biomass in Lake Huron from fall bottom trawl surveys 1992-2007. Source: USGS data.

Lake Huron managers are hopeful that recent declines in alewives will allow for the expansion of the native bloater and lake herring. This will provide a more stable, better adapted prey base and will hopefully provide larger-sized prey that can support larger-sized predator fish. Continued low alewife abundance would also reduce the detrimental impact of alewife predation on the fry of other species, particularly perch, walleyes, and ciscos. Alewives are also high in thiaminase, which has been shown to inhibit reproduction of predator species that eat them by causing thiamine deficiency in their progeny (early mortality syndrome).

<u>Fish of Interest to the Recreational and Commercial Fisheries</u>

*Chinook Salmon*

Chinook were first stocked into Michigan waters of Lake Huron in 1968 and in 1985 in Ontario waters. Stocking levels have varied, peaking in 1989 at over 5 million fingerlings but averaging 4.0 million from 1986 to 2004 (Figure 4.7). Chinook salmon became the dominant predator in Lake Huron through the 1980s and 1990s. During this period, they fed mainly on non-native forage fish (alewives and smelt are their preferred diet items). With the collapse of alewives in 2003-04, Chinook salmon rapidly declined to a fraction of their former numbers (Figure 4.8). Both growth rate and survival of Chinook salmon have proved to be proportional to alewife abundance. Lake trout remain abundant in the lake due to stocking, but they exert less predation pressure on the prey base than did Chinook salmon prior to their fall.

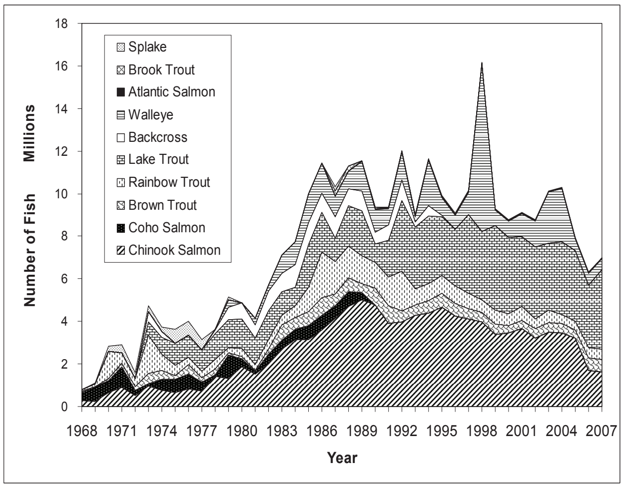


Figure 4.7. Number of predators stocked into the Lake Huron basin, 1968-2007.

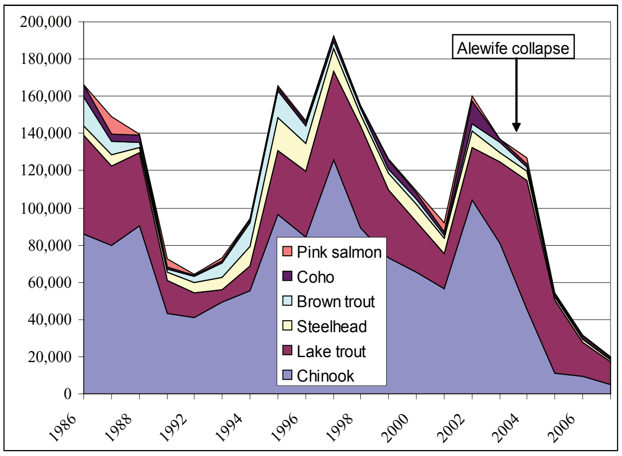


Figure 4.8. Number of trout and salmon caught at 10 Main Basin Index Ports, Michigan waters, Lake Huron, 1987-2007.

Section IV

Balancing predator numbers with available prey has always been a difficult task in the Great Lakes. In the 1980s, Lake Michigan Chinook salmon consumption rates exceeded their prey availability and resulted in reduced growth rates and an outbreak of bacterial kidney disease (BKD) in the stressed fish. This resulted in a decline in predator abundance for a number of years.

By interagency agreement, Lake Huron stocking levels of predator species were capped at 1990 levels in 1991 (8.33 million salmonids) until such time as more information was available on the predator versus prey balance. In 1998, catch rates were very high and the condition (or plumpness) and growth of Chinook were very low due to the low abundance of alewives as prey. A computer tool named the "Lake Huron Consume Model" indicated prey consumption demand was exceeding prey availability. Bioenergetics modeling confirmed that Chinook salmon were the dominant predator in the lake. Stocking was consequently reduced by nearly 20% in 1999. A large year class of alewives produced in 1998 provided a good food source for Chinook salmon in 1998 and 1999, and growth rates recovered. However, alewives again declined in 2003 and were nearly absent by 2004. This resulted in record low average sizes of Chinook salmon that were in very poor condition with many exhibiting signs of chronic malnutrition. Most Chinook salmon stomachs observed in the main basin of Lake Huron were empty in 2005. When present, food items were dominated by rainbow smelt and sticklebacks. Alewives were nearly absent in the diet and most prey consumed were too small in size to be well suited to such a large predator. Despite concerns that declines in growth would result in disease outbreaks similar to the situation that occurred in Lake Michigan, to date BKD levels have remained relatively low and stable.

Ongoing low abundance of alewives in since 2003 has resulted in the lowest catch and harvest rates on record for Chinook salmon in the main basin.

Growth, condition and catch rates of Chinook salmon in Georgian Bay and the North Channel from 2000 to 2007 declined, but apparently not to the same levels observed in the main basin. This indicates that prey fish status differs among the basins of Lake Huron. Hydroacoustic surveys conducted by the United States Geological Survey (USGS) in 2004-07 revealed that Georgian Bay and the North Channel had the highest densities of prey fish biomass in Lake Huron. Smelt appear to be much more abundant in these two basins, which has likely been sustaining Chinook salmon and limiting declines in growth rates. Environment Canada monitoring shows that calcium concentrations are relatively low in the North Channel and may be limiting dreissenid abundance and, thus, foodweb disruption there.

In the late 1960s until the early 1990s, the number of Chinook salmon caught by anglers was proportional to the number of fish stocked. This started to change by the mid 1990s, and, even though stocking numbers were stable or declining, catch rates increased. Use of the "Consume" model in the late 1990s, made it apparent that the level of natural reproduction of Chinook salmon in Lake Huron was a critical unknown and could have a significant impact on predator demand. Initial estimates used in the model were 20% to 50% natural production depending on the basin, but these were only very rough estimates provided by management agencies.

Historically, little was known of the levels of natural reproduction of Chinook salmon in Lake Huron. In the 1980s, some wild fish were observed, mainly in Georgian Bay and the North Channel. Studies of young-of-the-year fish in the early 1990s indicated that less than 30% of the Chinook salmon were wild in Michigan waters.

Because of the uncertainty of the estimated levels of natural reproduction and the potential significant influence of reproduction on predator demand for food, a joint international study was designed and initiated in the early 2000s. From 2000 to 2003, all Chinook salmon stocked into Lake Huron were marked. Lake Michigan also contributed to the study since movement of Chinook salmon between Lakes Huron and Michigan has been documented. Assessment consisted of sampling fish from around the lake during June to August, prior to when the fish would be homing back to their natal streams.

This time period was chosen to assure estimates of wild fish were not biased by sampling elevated concentrations of hatchery fish homing to areas where they were originally stocked.

Results collected in 2003 to 2005 were surprising. In Michigan waters, 82% of the Chinook salmon were unmarked and presumed wild. The number was even higher in Ontario waters: unmarked Chinooks made up roughly 98% of Georgian Bay's harvest and 86% of the North Channel's. The results were consistent between the four years of the study. It is presumed that the majority of the natural reproduction in Lake Huron is from Ontario waters since most of the cold-water streams in the State of Michigan have been dammed and are inaccessible for spawning. As a result of this study and declining prey supplies, stocking of Chinooks in Michigan waters of Lake Huron was again reduced in 2006, by about 50%.

In the 1990s, the spawning runs of Chinook salmon in all areas of the lake consisted mainly of fish aged 3 to 5. Today the runs are dominated by age 2 and 3 fish. A shorter life span was once a disadvantage in that fish would be spawning at smaller sizes with fewer eggs, resulting in less likelihood of their contributing to future generations. Today it is evidently an advantage to spawn early while still able to contribute some energy to reproduction; large, older Chinooks are no longer favored due to the relatively low biomass and small size of prey fish since the foodweb change.

With no strong year classes of alewives in the foreseeable future, Chinook salmon are unlikely to regain their former position as the Main Basin's dominant predator.

*Lake Trout*

Lake trout were the original dominant predator in the Lake Huron ecosystem. Unsustainable harvest practices and sea lamprey predation led to their demise in the main basin of Lake Huron in the 1940s and their almost complete disappearance in Georgian Bay and the North Channel by the mid 1950s. Two small remnant populations survived in Iroquois Bay and Parry Sound.

Efforts to rehabilitate this species and return the lake to some semblance of its historic balance have resulted in the stocking of over 74 million pure strain lake trout during 1968-2007 (Figure 4. 6).

Half of the current stocking occurs in the main basin, with the other half split between Georgian Bay and the North Channel. Initially, stocking was done nearshore but recently more offshore stocking has occurred.

Lake trout in Parry Sound, a location of one of the two remnant stocks, have been deemed rehabilitated. This was accomplished through a combination of stocking and strict harvest controls. Lake trout natural reproduction has been observed in ten other locations in Lake Huron at various levels but to date no other locations have been fully rehabilitated.

Until recently the majority of observations of natural reproduction had been in embayment areas (Owen Sound, South Bay, Iroquois Bay, Parry Sound, Thunder Bay). Since 1984, a total of 270 wild young-of-the-year lake trout have been caught in MDNR bottom trawls in Thunder Bay, MI. The highest catch was in 1990 at 43 fish but numbers steadily declined through the 1990s and 2000s and no young-of -year fish were caught in 2002 or 2003. In 2004, 11 were caught, and another 15 in 2005. No young-of-year were taken in 2006, but 26 were taken in 2007. During 2007, all but 4 of the 26 young lake trout were caught in July. By late August none could be found. Either the young lake trout were not surviving or they were leaving the nursery grounds sooner then in earlier years. Twenty-two wild young-of–the-year lake trout were incidentally captured by USGS bottom trawling during prey assessment surveys in 2004 and an additional 11 in 2005. In 2004 the USGS fish were captured in the main basin over a wide area. By 2007 lower numbers were caught and only in the northern site near Detour. Evidently, lake trout reproduction rose somewhat after the collapse of alewives, but the numbers measured since 2004 have not yet been sufficient to be considered a major step toward recovery.
In the Main Basin, the percentage of lake trout lacking hatchery fin clips remains low and near background levels except at 6-Fathom Bank, about

45 miles offshore of Harrisville, where US Fish and Wildlife Service monitoring encountered 38 unclipped, presumably wild, lake trout per 1,000 ft of gillnet effort during assessment of the spawning population there during October 2007.

Lake trout reproduction has been generally higher in years of low alewife abundance. Peak years in the MDNR trawling in Thunder Bay were 1986-1990, when a total of 137 wild juveniles were taken. These fish were from years when alewife abundance was relatively low and lake trout spawning stock was high. The decline in alewives in 2004 and 2005, in addition to higher abundances of adult lake trout and lower sea lamprey predation associated with increased control, likely played a role in the more recent observation of lake trout natural reproduction. Alewives appear to limit natural reproduction of lake trout through both direct predation on fry and thiamine deficiency complex. Lake trout with a high proportion of alewives in their diet can accumulate thiaminase. This results in low thiamine levels in lake trout eggs and significant reductions in hatching success and fry survival.

Thiamine levels in lake trout eggs have been monitored in Lake Huron at several locations since 1996. In 2004-07, many areas of the lake showed declines in the number of lake trout reproductively impaired by low egg thiamine concentrations. This suggests that these lake trout are finding alternative food sources to alewives. Spring assessment netting has shown that more than half of the diet of lake trout in the main basin now consists of round gobies, indicating that a diet of gobies results in higher egg thiamine levels than one dominated by alewives

Adult stocks of lake trout have generally risen in the Main Basin since 1998. In 1998 the first successful control efforts were completed in the St. Marys River and in 2000 harvest restrictions were prescribed for Michigan's Native American commercial fishery that reduced fishing mortality substantially. Lake trout, in combination with walleyes (both native species) now share the role of leading predator fish in the Main Basin. Although the rehabilitation of lake trout has proven to be a long and difficult process, some success has been achieved in re-establishing spawning stocks and reproduction. The demise of alewives appears to provide an opportunity to build on the accomplishments achieved to date. The successful rehabilitation of lake trout in Lake Superior has provided the proof that rehabilitation of this native species in the Great Lakes is attainable.

*Percids (Walleye and Yellow Perch)*

Walleye historically were the dominant near-shore predator in Lake Huron. They are found in discrete populations in all three basins. Many localized populations are in various states of reduced abundance compared to historic levels. These declines are attributed to high fishing pressure, habitat alterations, water pollution, and effects of alewives. Since the majority of walleye populations spawn in rivers and require clean cobble spawning grounds they are very vulnerable to habitat degradation.

Saginaw Bay historically had the largest abundance of walleyes in Lake Huron but their numbers declined in the 1940s due to year class failures attributed to habitat loss, pollution, overfishing, and alewife predation on walleye fry. Key requirements for rehabilitation have been improvement of water quality, which has taken place under provisions of the Clean Water Act, restrictive fish harvest regulation, and stocking. Walleye year class strengths have been monitored in Saginaw Bay since the mid 1980s. A larger then usual year class was detected in 1998, a year of low adult alewife abundance. The 2003 year class was extraordinary large, almost five times the 1998 record, and corresponded in time with the collapse of adult alewives (Figure 4.9).

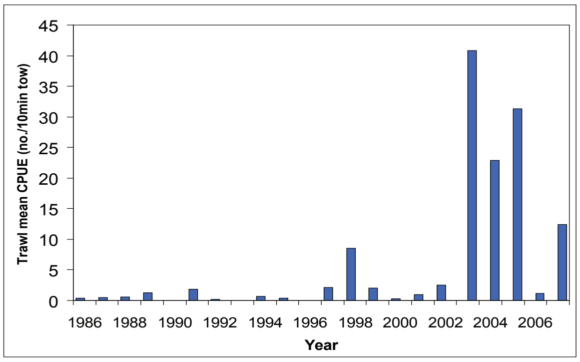


Figure 4.9. Trawl catch rates of age-0 walleyes, Saginaw Bay 1986-2007. Source: MDNR data.

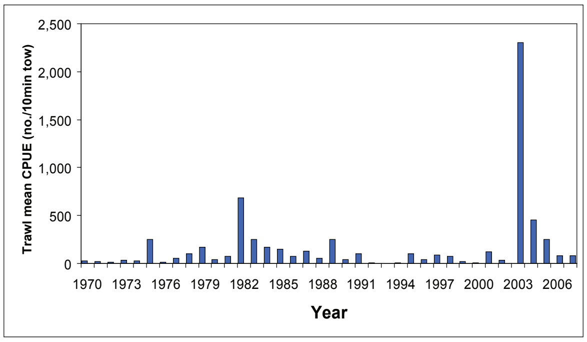


Figure 4.10. Trawl catch rates of age-0 yellow perch in Saginaw Bay 1970-2007. Source: MDNR data.

Only 28% of the large 2003 year class could be attributed to stocked fish. Ideal climatic conditions and low alewife abundance are credited for this large year class. Similar large year classes were observed in Lakes Erie and Michigan in 2003. However, very strong year classes also were produced in Saginaw Bay in 2004, 2005, and 2007 that cannot be attributed to favorable climatic conditions; thus, the lack of alewives appears to be the chief factor in the ongoing reproduction success of walleyes in Saginaw Bay.

As the large year classes of 2003 and 2004 entered the recreational fishery, walleye harvest rose sharply and reached modern-record levels in 2007. Nearly 750,000 pounds of walleyes were harvested in Michigan waters by anglers during 2007. Walleyes now dominate the recreational fishery in Michigan waters.

Yellow perch (*Perca flavescens*) in Lake Huron have traditionally been an important species for both angling and commercial harvest and as prey, particularly for walleyes. As with walleyes, perch also experienced an unprecedented large year class in 2003 (Figure 4.10).

The 2004 and 2005, year class strengths were much lower than 2003 but still among the highest of record. Over-winter survival of recent year classes of yellow perch has been poor. Presumably the large year classes were competing with each other for limited food resulting in reduced fitness heading into winter. Predation pressure by predators, particularly walleyes, was also a factor in the poor survival of recent yellow perch year classes.

Reductions in alewife abundance seem to be benefiting reproduction of native walleyes and yellow perch. Good year classes of both species are likely to continue on a regular, if not annual, basis if alewives are maintained at low numbers. This will hopefully provide for a sustained recoveries of the yellow perch and walleye populations. Managers will need to be cognizant of other limiting factors to the percid populations, including prey supply and potential for rising exploitation.

*Coregonids (Lake Whitefish, Bloater, Lake Herring, Shortjaw Cisco)*

Lake whitefish are the most abundant and widely distributed member of the off-shore benthic community, occupying all areas of Lake Huron. They are the most sought after commercial fish species and have accounted for greater than 80% of the total commercial yield since 2000. Commercial yield of lake whitefish has declined from its peak in 1998 but harvest is still substantial and remains higher than at any other time in the last two centuries (Figure 4.11).

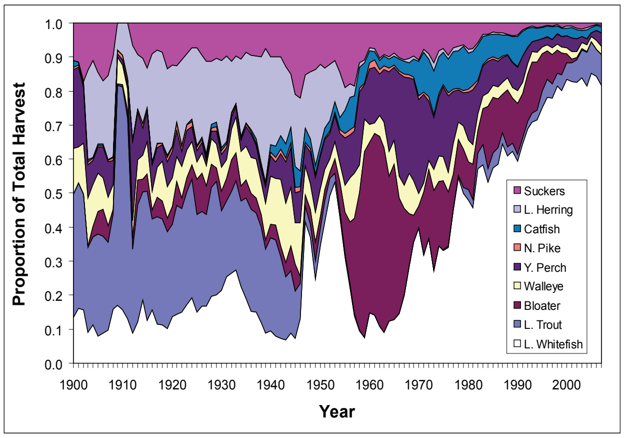


Figure 4.11. Commercial Harvest of Major Species in Lake Huron, 1900 to 2007.

Recent declines in the market price of lake whitefish have contributed to a drop in commercial fishing effort and yield. Declines in both mean weight at age and condition began in the late 1980s and early 1990s and continued through 2002. The mean weight at age appears to have stabilized or slightly increased since 2003. Declines in lake whitefish growth are likely related to the reduction of Diporeia as a diet item, which has resulted in reduced lipid content in whitefish. Dreissenid mussels and mysis are now the principal components of their diet.

In recent years lake whitefish have changed their distribution and are found in deeper water, possibly a result of an increase in water transparency related to the dreissenid invasion. Since 1997, large floating plumes of green algae (*Cladophora* spp.) have fouled commercial gear reducing catchability of lake whitefish. This increase in cladophora is probably related to increased water clarity as well. The change in distribution has led to increased numbers of lake trout being caught incidentally when the commercial fishery is targeting lake whitefish; this has been particularly evident since 2000. This incidental bycatch of lake trout has more serious consequences when in gillnets than in trapnets because the trapnet catch is usually live and at least 85% can be released without consequence. Most lake trout caught in gillnets are dead or moribund when brought aboard.

Bloater and the shortjaw cisco (*Coregonus zenithicus*) are the only two remaining deepwater ciscoes currently found in Lake Huron. The shortjaw cisco is considered endangered and is only located in limited areas in Georgian Bay. The commercial catch of bloaters declined dramatically in Lake Huron during 2000 to 2007 (Fig. 4.9). The reductions in catch occurred concurrently with observed declines in abundance and recruitment.

Lake herring are found in all three basins of Lake Huron but their distribution is restricted. They are common in the St. Marys River, North Channel, in waters of the north shore between the straits of Mackinac and Drummond Island, and in eastern Georgian Bay. Lake herring are not found in Michigan waters south of the Straits of Mackinac, but they are occasionally caught in the Ontario waters of the southern main basin. Unlike lake whitefish, growth rates of lake herring, based on mean weight-at-age, appear to be more stable. Abundance of lake herring appears to be slowly increasing in its core habitat of Georgian Bay and the North Channel and Ontario waters of the southern main basin. Managers are hopeful that increases in lake herring abundance will occur in the absence of alewives.

Saginaw Bay was traditionally a prime area for lake herring but very few are seen there today even when they appear to be increasing in other areas of the lake. Lake Huron managers are currently reviewing options for re-introducing this species to the Saginaw Bay and Thunder Bay areas through stocking and have been promoting their increase in abundance in other areas of the lake through harvest control.

*Lake Sturgeon*

The lake sturgeon is classified as "threatened" by the Department of Natural Resources under the authority of the endangered and threatened species provisions of Section 36503 of 1994 PA 451, MCL 324.36503. Canada is currently reviewing the status of Lake Sturgeon and this review could lead to an "at risk" designation for the species.

Lake sturgeon numbers declined precipitously during the early 20th century due to overfishing and construction of dams, which blocked access to and/or inundated spawning habitats crucial for the species' reproduction. While fishing controls are now in place that sharply limit or prohibit harvest, most spawning barriers remain. Removal of certain key dams and barriers to spawning habitat is essential for the recovery of this species.

The historically most important spawning habitats for lake sturgeon were in the mainstem sections of Lake Huron's larger tributaries such as the Thunder Bay, Au Sable, and Saginaw River sytems on the Michigan side and the Maitland, Saugeen, Nottawasaga, and Mississagi rivers on the Ontario side of Lake Huron. At least some spawning habitats for sturgeon in all of these above listed tributaries are now blocked or inundated by dams. Spawning habitat and a vibrant spawning population remain in the St. Clair River near the Bluewater Bridge and further downstream near Lake St. Clair. Consequently, measurable numbers of lake sturgeon remain in the southern management units of Lake Huron but the species is scarce or virtually absent in most other basins. Successful spawning persists in the lower Mississagi River, where a measurable population also persists. Recent studies suggest there may be a small reproducing population in the St. Marys River that spawns in the rapids at Sault Ste. Marie.

There is uncertainty regarding the risk posed by foodweb change for lake sturgeon. Native prey for sturgeon has been replaced by dreissenids and round gobies. Although sturgeon readily feed on gobies, the long-term outlook for sturgeon is guarded if Type-E botulism persists in Lake Huron. Gobies are thought to be vectors of the neurotoxin produced by *Clostridium botulinum*, the bacteria responsible for botulism. Lake sturgeon have been among the species of fish identified in botulism-kill areas of the Great Lakes.

<u>Fishery Management Goals</u>

Fish Community Objectives (FCO) for Lake Huron were developed in 1995, and in most cases, reflected yield targets for species or species groupings based on historic commercial fishery landings from 1912-1940. An emerging realization is that historic harvests, and even current harvest levels for some species, may not be sustainable in the long-term. Historic commercial fishery practices, such as switching to different targeted species, fishing different fish stocks, and changes in fishing effort and fishing power, may all have masked the steady decline of fish populations over this historic time period.

In addition, the current ecosystem may not be as productive for some species as in the past because non-native prey species are not as efficient in linking primary and secondary production of the lake to higher food webs, including fish, as were historic species. For example, dreissenids have largely replaced *Diporeia* but are not nearly as rich in essential lipids and do not act as nutrient vectors between the benthic and pelagic communities. The diversity of ciscos that once inhabited the lake was probably more effective in transferring energy to larger lake trout than the round goby, which tends to be quite small. The introduction of non-native species such as zebra and quagga mussels and the spiny water flea may also divert much of the primary and secondary production of the lake to different pathways, making it unavailable to top predators.

The non-native Chinook salmon, which feed almost exclusively on alewives and smelt, are less likely to make the transition to feeding on newly invasive benthic species than indigenous lake trout. The lake trout has a much more varied diet, would historically have utilized some portion of the available benthic prey, and appears now to be doing so by consuming large numbers of round gobies. Gobies rarely appear in diets of Chinook salmon. Thus, the outlook for Chinook salmon, which until 2003 was the most important recreational species of Lake Huron in terms of economic activity generated by its fishery, appears bleak. It is doubtful that Chinook salmon will continue to contribute significantly to the harvest target set for salmonids in the FCOs.

The drafters of the FCOs had no way of anticipating the upheaval to Lake Huron's foodweb that came on the heels of their report. Revised FCOs will need to address such issues as: how will species of interest to Lake Huron's stakeholders respond to the new foodweb? What levels of harvest is sustainable for species such as walleyes, lake whitefish, yellow perch, and lake trout? Historical records are of questionable relevance because historical harvests were sustained by a foodweb that no longer exists. The number of changes the lake is currently undergoing makes strategic planning and fish population modelling particularly difficult. Are the changes currently occurring in Lake Huron permanent? Is productivity of the lake's pelagic zone going to continue to be low? If the introduction of additional exotic invaders is not stopped, this will continue to limit predictive capacity and sound strategic planning for the lake.

To better facilitate the cooperative management of fisheries resources a framework for inter-jurisdictional coordination of fisheries management based upon an ecosystem context was developed. This "ecosystem approach" to fisheries management recognizes that the resources of the Great Lakes must be managed as a whole, that healthy fish communities require stable, healthy, food webs, functional, interconnected, diverse habitats (including those in tributaries), and clean water. In order to support the FCOs, Environmental Objectives (EOs) were recently developed to describe the biological, chemical and physical needs of these desired fish communities. Implementation strategies and funding for remedial actions identified in the EOs are needed. Pollution of sediments with persistent contaminants, particularly in tributaries to Saginaw Bay, has resulted in widespread concern over the advisability of consuming fish products from Saginaw Bay and its tributaries. Correcting this issue and making stream habitats currently blocked by man-made barriers available to migrating fish, rank as key targets for future habitat work. Removal of barriers to spawning sites is probably the single most effective tool available to managers in restoring lake sturgeon and other potadromous species on Lake Huron.

Traditionally, the impacts of industrialization and human population density on Lake Huron have not been as great as some of the other Great Lakes. However, Michigan's rich supply of fresh water is likely to make the shores of the Great Lakes increasingly attractive to industry and power generating utilities. In addition, growing production of biofuels will increase the percentage of Lake Huron's watershed that is under intensive agricultural production, with the potential for attendant increases in nonpoint nutrient enrichment and sediment loading of tributaries. Lake Huron is also vulnerable to future potential anthropogenic impacts due to its close proximity to highly populous areas and its popularity as a destination for millions of cottagers, tourists and anglers; timely strategic planning to protect and enhance habitat is very important. The mounting development pressures on Lake Huron from improved highways, increases in year round residents, and diminishing resources in other locations, will likely increase harvest and development pressure and strain the achievement of resource sustainability. Continued vigilance is needed to insure that future development on Lake Huron is done in a sound ecologically sustainable manner while efforts to seek solutions to existing problems continue to occur.

A summary of issues identified in the Lake Huron Environmental Objectives is provided below:

*Spawning and Nursery Habitats*

**Maintain, protect and restore the integrity and connectivity of <u>wetland</u> spawning, nursery and feeding areas throughout the Lake Huron basin.** Coastal wetlands throughout Lake Huron provide critical spawning, nursery and feeding habitat for a variety of fish species. Northern pike (*Esox lucius*) and muskellunge (*Esox masquinongy*) spawn exclusively in wetland areas whereas other species such as yellow perch, walleye, and minnow species use these areas as nursery and feeding sites. Historical losses of Lake Huron wetlands through drainage, infilling and other physical alterations have been significant. Many remaining wetlands are degraded or no longer accessible due to shoreline armoring. Spawning and nursery wetland habitats identified as priority areas in the draft Environmental Objectives are: Saginaw Bay, St. Marys River, Les Cheneaux Islands, Eastern Georgian Bay and North shore of North Channel.

**Protect and restore connectivity and functionality of tributary spawning and nursery areas throughout the Lake Huron Basin.** The Lake Huron watershed is the largest of the Great Lakes with numerous rivers and streams draining into the basin. The principal spawning and nursery habitats for a variety of species, including lake sturgeon (*Acipenser fluvescens*), walleye, pacific salmonids, and suckers (*Catostomus* spp.) are found in these tributaries. Unfortunately, rivers and streams are some of the most altered and disrupted habitats in the Lake Huron basin. Many of the watersheds draining into Lake Huron have barriers to upstream access and have flow regimes that have been altered as a result of watershed land-use changes or hydro-electric generation needs. Spawning and nursery tributary habitats identified as priority areas in the draft Environmental Objectives are: Saginaw Bay watershed, St. Marys River, Garden River, Mississagi River, Spanish River, Moon River, Severn River, Nottawasaga River, Saugeen River, Au Sable River and Thunder Bay River.

**Protect and restore reef spawning areas throughout the Lake Huron Basin.** Lake Huron is a deep oligotrophic lake with a fish community that was historically dominated by deep dwelling species such as lake trout, whitefish and ciscoes. Most of these species utilize offshore or nearshore reefs for spawning purposes. Nearshore and offshore reefs are one of the most common habitat features throughout the Lake Huron basin. For the most part these habitats have not been physically altered to the same extent as other habitat types, however, the colonization of these habitats by invasive species such as zebra mussels and round goby (*Neogoblus melanostomus*) has accelerated in recent years and may in time degrade the quality of these habitats. Spawning and nursery reef habitats identified as priority areas in the draft Environmental Objectives are: Saginaw Bay, Manitoulin Island, Western shore of Bruce Peninsula (including Fishing Islands complex), Georgian Bay, Thunder Bay, Drummond Island, Mackinaw Island, Six Fathom Bank and Yankee Reef.

*Shoreline Processes*

**Protect and rehabilitate nearshore habitats and reestablish the beneficial structuring forces of natural water exchanges, circulation, and flow that they provide.** The alteration of nearshore areas due to human activities has been widespread throughout the Lake Huron basin but has been most pronounced in the populated areas in the southern part of the basin. Shoreline straightening, infilling, dredging, and other such activities alter nearshore currents, increase erosion and deposition of fine sediments and leads to the loss of habitat diversity. Since a majority of fish species inhabiting the basin use nearshore areas at some point in their life-cycle, altering these areas results in the loss of fish production and change in fish community structure. Priority areas identified in the draft Environmental Objectives for protection and rehabilitation are Saginaw Bay, Central and south-east shore of main basin, St. Marys River, Southern Georgian Bay, Thunder Bay, Les Cheneaux Islands and Eastern Georgian Bay/North Channel.

*Food Web Structure and Invasive Species*

**Protect and where possible enhance or restore fish community structure and function by promoting native species abundance and diversity and avoiding further invasive species introductions.** Fish communities throughout the Lake Huron basin have undergone substantive change over the last century. Historically, the offshore fish communities were characteristic of a large, deep oligotrophic lake with lake trout and burbot being the dominant predators, and a variety of cisco species being the dominant prey species. In the nearshore waters, a relatively greater diversity of predators (walleye, northern pike, muskellunge, bass (*Micropterus* spp.)) were present as well as benthivores (sturgeon, suckers, channel catfish (*Ictalurus punctatus*)) and forage fish (herring, yellow perch, cyprinids). A variety of factors have been implicated in the loss or extinction of species in the basin and prominent among them is the proliferation of invasive species such as lamprey, alewives, rainbow smelt, and zebra mussels. Priority areas identified in the draft Environmental

Objectives for protection and enhancement and rehabilitation of fish community structure are the main basin, Saginaw Bay, St. Marys River, Les Cheneaux Islands and Severn Sound.

*Water Quality*

**Protect and restore water quality throughout the Lake Huron basin and especially in the AOCs in order to avoid reductions in fish production and reduce or remove contaminant burdens from the fish community.** Water quality throughout the Lake Huron basin has shown gradual improvement since the early 1970's. Some localized nutrient enrichment problems exist in Saginaw Bay and southeastern main basin and in northeastern Manitoulin Island. Acid rain and heavy metal contamination is still a localized issue in some parts of the North Channel and Georgian Bay. Consumption restrictions due to contaminant levels are in place throughout the basin for a variety of fish species. Priority areas identified in the draft Environmental Objectives for protection and restoration of water quality are Saginaw Bay, St. Marys River, Severn Sound, Southern Georgian Bay, central and northern Georgian Bay, North Channel, and southeast main basin.



Invasive Species

Lake Huron has been dramatically and forever changed by the invasion of non-native species, which have decimated native fish populations, and in some cases, permanently impacted fish communities. Invasive species are defined as species that do not originate in the Lake Huron ecosystem and have been introduced either intentionally or accidentally. Invasive species threaten the diversity and abundance of native species and the ecological stability of infested waters.

The introduction of invasive species into Lake Huron has altered or disrupted existing relationships and ecological processes. This disruption can cause significant changes to the Lake Huron ecosystem such as alterations of food webs, nutrient dynamics, reproduction, sustainability, and biodiversity. Invasive species have few natural enemies such as pathogens, parasites and predators. Without coevolved parasites and predators, they out-compete and even displace native populations. Not only do invasive species compete with native species for food and habitat, they may also increase cycling of persistent bioaccumulative chemicals in the food chain. For example, research has shown that zebra mussels and round gobies are contributing to the cycling and bioaccumulation of PCBs.

The recent invasion of zebra and quagga mussels, round gobies, the spiny water flea, white perch (*Morone americana*) and ruffe (*Gymnocephalus cemuus*) into Lake Huron heightens the uncertainty for expectations from the ecosystem.

The following is a description of a number of invasive species having a significant impact on the Lake Huron aquatic ecosystem.

***Sea Lamprey*** - The sea lamprey has been a serious problem in the Great Lakes for more than 50 years. An adult lamprey can consume, and subsequently kill, up to 40 pounds of fish in just 12 to 20 months. The St. Marys River, which flows between Lake Superior and Lake Huron has become the most important spawning area for lampreys in the Great Lakes. By the1990s the St. Marys River was producing more sea lampreys than all other Great Lakes spawning tributaries combined.

Successful rehabilitation of Lake Huron lake trout populations has been hindered because of the high number of sea lamprey. Without question, the sea lamprey problem in northern Lake Huron, with increased lamprey production from the St. Marys River, is the most severe impediment to a healthy fish community in the lake.

Cost-effective sea lamprey control on the St. Marys, once thought to be impossible, may now be within reach because of a special program developed by biologists and research scientists working under the direction of the GLFC. During 1998 and1999, more than 840 hectares of the St. Marys River were treated with Bayluscide 3.2% Granular Sea Lamprey Larvicide. Additional treatments of sea lamprey "hot-spots" in the river have been conducted in more recent years. The larvicide treatments reduced the number of larval sea lampreys in the river by nearly 45%. Enhanced trapping and release of sterile male lampreys in the river reduced the reproduction potential by an estimated 92%. Although the GLFCs fish community objective for sea lamprey (75% reduction) was not met for the year 2000, the objective for 2010 (90% reduction) is attainable. However, funding for sea lamprey control remains at approximately 65% of that needed to fully fund the program.

***Round Goby*** - The round goby are a small fish that feed chiefly on bivalves, amphipod, crustaceans, small fish, and fish eggs. Consumption studies of fish suggest round gobies might have a detrimental impact on native species through competition for food and predation on eggs and young fish. To help control the expansion of the goby into other waterways, river barrier systems are being implemented along with aggressive public education programs. Unfortunately, no effective measures have been found to decrease established populations of goby. Goby have continued to spread in Lake Huron and have been found in increasing numbers in the diets of lake trout, walleye, and burbot. There are concerns that this could increase contaminant levels in predators. In addition, although the mechanisms are not well understood gobies are implicated in recent outbreaks of botulism. Concerns also exist that gobies will out-compete native fishes, especially sculpins, and predate on the eggs and young of other fish, reducing both the diversity and density of prey and predators in the lake.

***Eurasian Ruffe*** - The Eurasian ruffe was first identified in 1995 in Thunder Bay near Alpena, Michigan. Ruffe adapt well to various environments, mature quickly, and spawn over an extended period of time. Ruffe populations initially grew in number, yet they did not spread from the Thunder Bay region of Lake Huron. Fortunately, they have not been detected in Thunder Bay since 2003. Hopefully, this species will disappear from Lake Huron.

***Spiny Water Flea*** - The spiny water flea was first discovered in Lake Huron in 1984 and is believed to have entered the waters of the Great Lakes through discharged ballast water. The spiny water flea has now colonized all offshore areas of the lake. Although its average length is rarely more than 1.5 cm, this predacious zooplankter can have a profound effect on a lake's plankton community.

***Zebra and Quagga Mussels*** - Zebra mussels reproduce rapidly and are able to form dense layered colonies of over one million per square metre. Zebra mussels are a serious threat to the Lake Huron ecosystem because they have tremendous filtering capacity for sediments and phytoplankton. In many regions of the Great Lakes zebra mussels have had severe impacts on many native unionids and are of special concern to threatened and endangered species of bi-valves. Also, zebra mussels are a serious concern because they contribute to the cycling of contaminants by removing PCBs from the sediments and reintroducing them into the food web. Quagga mussels are similar to zebra mussels in many respects but they do prefer deeper water. They therefore have the potential to detrimentally impact aquatic species that use the deeper portions of the lake.

***Other Aquatic Nuisance Species*** - Eurasian watermilfoil (*Myriophyllum spicatum*) is one of the most common species found in Saginaw Bay. Populations have thrived since the introduction of zebra mussels that contributed to higher water clarity. Eurasian watermilfoil is detrimental to Lake Huron because it reroutes nutrients from plankton, depriving energy to the fish community. Purple loosestrife is a perennial wetland plant that is impacting Lake Huron wetland ecosystems by out-competing native vegetation and changing the structure, function and productivity of the wetlands they invade. The plant can form dense monoculture stands sometimes hundreds of hectares in size. The fishhook water flea (*Cercopagis*), is one of the most recent invasive species to Lake Huron. Fishhook water fleas are a problem because, like the spiny water flea, they get tangled in the lines of both recreational and commercial fishery nets and have a large appetite for zooplankton. Further, ecological disruptions have not been completely determined, therefore, the fishhook water fleas are being closely monitored.

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# V. Aquatic and Coastal Habitat

The Lake Huron Binational Partnership has identified degradation and loss of historical habitat in tributaries, near shore, and coastal wetland habitats as major stressors to the Lake Huron ecosystem. Although many of the ecosystems have been fragmented and others nearly eliminated, the Lake Huron basin exhibits a high level of diversity in its natural environments. The basin's coastal marshes, islands and rocky shorelines, sand dunes, alvars, tributaries, savannahs and prairies contain features that are either unique to, or are best represented within the Lake Huron watershed. The health of the lake and its biological diversity is directly related to the health of each of these habitat components.

**Coastal Wetlands**

Coastal wetlands are intermediate zones linking the open waters of the Great Lakes with their watersheds. Despite being fundamentally important to assure the biological diversity and health of the Great Lakes ecosystem, coastal wetland area and quality is declining (Ingram, 2004; Mayer et al., 2004). However, knowledge of coastal wetland functions and their socio-economic and ecological importance has improved and recent scientific attention has raised the profile of coastal wetlands providing a current picture of the health, integrity and the potential for management (Krieger *et al.*, 1992; AEHMS, 2004).

Four basic wetland types are found in the Great Lakes basin: swamps, marshes, bogs and fens. Fens, or meadow marshes, commonly occur in Lake Huron and are identified as globally imperiled (Natural Heritage Information Centre, 1995). Swale complexes are also found along the shores of Lake Huron between dunes or ridges. Coastal wetlands can also be separated into lacustrine, riverine, or barrier-protected systems based on their dominant hydrologic source and connectivity to the lake (Albert et al., 2003).

Coastal wetlands have important ecological, economic and social functions and values. Those connected with the lake and tributary system perform important functions for Lake Huron through their contributions to hydrology, deposition of sediments, particle entrapment, nutrient retention, storage and exchange to recipient waters. Other functions include provision of habitat and the foundation for a complex food web. These wetland functions provide crucial societal values: water quality improvement, flood attenuation, shoreline protection, human food and recreational use, landscape diversity and carbon storage (Loftus et al., 2004; Mayer et al., 2004).

Estimates on the number of fish species utilizing coastal wetlands for spawning, nurseries and food sources vary from 59 (Prince et al., 1992; Jude and Pappas, 1992) to over 90% of the approximately 200 fish species in the Great Lakes (Liskauskas et al., 2004). A rich variety of amphibians and reptiles require these wetlands for breeding, development, foraging, hibernation and refuge (Hecnar et al., 2002; Hecnar, 2004). Important staging and nesting areas are provided for waterfowl and other avian species during the reproductive and migration seasons (Prince et al., 1992).



<u>Coastal Wetland Distribution and Inventories</u>

The Great Lakes Coastal Wetland Consortium (GLCWC) identified 1255 Lake Huron wetlands for Ontario totaling 16,086 hectares (9,749 acres); the greatest amount of coastal wetlands relative to other Great Lakes on the Canadian shoreline. An additional 800 wetlands were identified on the Michigan shoreline totaling 44,335 hectares (109,554 acres) (Figure 5.1). The true wetland area for Ontario is expected to be much higher; however, photo coverage is required to permit inventory for remote areas of the North Channel and Georgian Bay (Ingram, 2004). The wide distribution of wetlands in these areas lends itself to the use of remote sensing technology to obtain an inventory and identify environmental impacts due to human-related and natural alterations. McMaster University researchers are using IKONOS satellite imagery and ground truthing to more accurately delineate and map wetlands in eastern Georgian Bay.

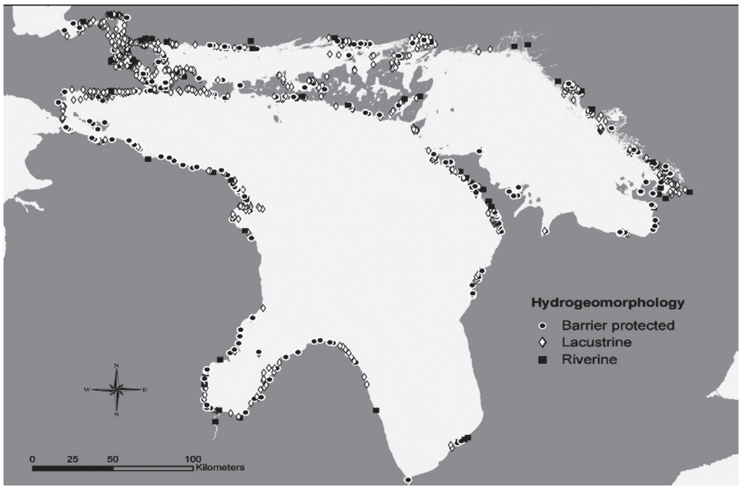


Figure 5.1. Distribution of Lake Huron coastal wetlands by hydrogeomorphic type.

Coastal Wetland Stressors

Coastal wetlands experience continual stress from natural and anthropogenic influences. While present lake levels are within the range of historic natural variation, global warming and human activities could potentially result in a trend towards even lower water-level cycles (Jalava et al., 2005). Exploitation of wetland soils exposed above the low water line is yet another management concern (Albert and Minc, 2004). Other deleterious impacts to wetland habitat include diking, draining, filling, road construction, non-native species, marinas, boat channel dredging, and non-point source pollution.

Coastal Wetland Status and Indicators of Health

While a small fraction of pre-settlement wetlands remain (Krieger et al., 1992), no comprehensive estimate of wetland loss is available for the Canadian and U.S. sides of Lake Huron. Large scale wetland loss has not occurred in northern Lake Huron and Georgian Bay because of is sparse population and its highly irregular, and in some cases remote shoreline. However, cottage, marina, and subdivision development continue to pressure wetlands.

Various indicators have been proposed to track improvement or deterioration of wetlands throughout the Great Lakes (Ingram, 2004; Lawson, 2004), with those of Chow-Fraser and colleagues (2006) used extensively in Lake Huron. McMaster University researchers evaluated more than 100 wetlands throughout the Bruce Peninsula, eastern Georgian Bay and the North Channel using a Water Quality Index to rank wetlands according to the degree of anthropogenic disturbance. Habitat quality was calculated using scores for Wetland Fish, Zooplankton and Macrophyte Indices (Chow-Fraser et al. 2006). Compared with 93 other Great Lakes coastal wetlands, Georgian Bay and the North Channel are in the "very good" to "excellent" categories. Most wetlands showing signs of degradation are in southeastern Georgian Bay are "moderately degraded".

Lake Huron Coastal Wetland Priority Management Areas

Priority coastal wetland management areas and attributes are provided below. Additional information and wetland-relevant fish community objectives can be found in the Great Lakes Fishery Commission's Environmental Objectives for Lake Huron (Liskauskas et al., 2004).

*Saginaw Bay*

Saginaw Bay is recognized as a rich biological resource representing the largest freshwater coastal wetland area in the United States. Historically, Saginaw Bay contained one of the largest wetland/lake prairie complexes in the

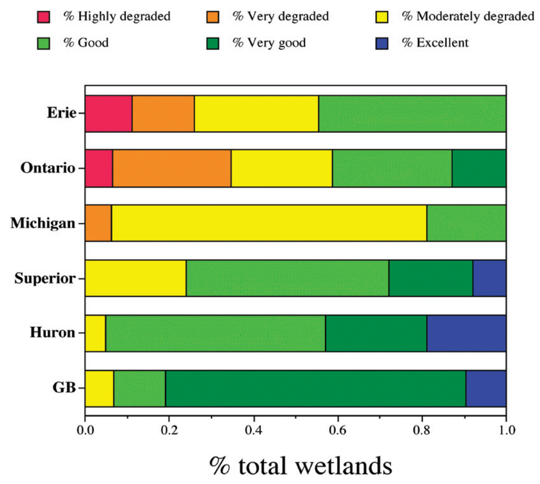


Figure 5.2. Comparison of Great Lakes coastal wetland health.

Great Lakes region and supported the largest population of yellow perch, walleye, northern pike and muskellunge populations. It continues to be important for yellow perch, smallmouth bass, largemouth bass, black crappie, sunfish, rock bass, and channel catfish. Massive land use changes since the mid-1880s have significantly altered the quantity, diversity and quality of wetland. Reports indicate that only 6070 hectares (15,000 acres) of the nearly 14973 hectares (37,000 acres) of emergent vegetation around Saginaw Bay remain today. The upper watershed development is causing sedimentation and contamination of sediments. The area still experiences shoreline development pressure and wetland loss and is impacted by exotic species. Many of the remaining coastal wetlands are no longer connected to the lake.

A restoration strategy has been developed for Saginaw Bay which focuses on preserving coastal marsh areas and upland buffers. It clearly identifies vulnerable areas so that governmental agencies, local conservation/environmental organizations and concerned citizens can monitor their status, enhance enforcement of existing laws and conduct educational programs.

*Les Chenaux Islands*

This area contains extensive coastal wetlands and has experienced some historic loss. The area supports a diverse fish community and is critical habitat for yellow perch and northern pike. Stressors include nutrient enrichment problems and shoreline development pressures. Priority actions consist of continued wetland monitoring and evaluation.

*Bruce Peninsula, Eastern Georgian Bay and North Shore of North Channel*

Wetlands are interspersed throughout these shorelines and still require assessment. The area supports a diverse warm and cool water fish community. Muskellunge and northern pike utilize these coastal wetlands for spawning. The area also supports a high diversity of smallmouth bass, largemouth bass, black crappie, sunfish and rock bass. More than half of the wetlands along the central coast, the western coast of the Bruce Peninsula and southern Georgian Bay have suffered recent losses (EC and OMNR 2003). Wetland area in southern Georgian has decreased since 1951 (Severn Sound -68%; Penetanguishene/Hog Bay -18%) (Severn Sound Remedial Action Plan, 1993). Severn Sound and Magnetawan Rivers are under intense recreational and developmental pressure. Impacts from exotic species are becoming more prominent. The Spanish River delta wetlands are currently recovering from historic environmental impacts and are a site of muskellunge recovery. Priorities include additional inventories, monitoring and recovery of these wetlands.

### Alvars

Alvar communities of the Lake Huron basin warrant special interest because of their rarity and unique assemblages of flora and fauna. Alvars are naturally open areas of thin soil over flat limestone or dolostone with grassland, savanna and sparsely vegetated rock barrens (Catling and Brownell 1995). The limestone on which most of Lake Huron alvars are found was deposited about 450 million years ago and overlies the granite and quartzite of the Precambrian shield. The Bruce Peninsula and Manitoulin Island sites are distinctive in having species associated with fen-like wetlands on cool limestone pavements (Brownell and Riley, 2000). The Bruce Peninsula, Manitoulin Island and Maxton Plains, on Michigan's Drummond Island, rank as the largest, most intact and least disturbed alvars in the world (Rescheke et al., 1999).

A number of endemic species have evolved to survive only in this environment and are restricted to alvar sites in the Lake Huron region (Brownell and Riley, 2000). Forty-three plant species regarded as rare in Ontario occur on alvars (Rescheke et al., 1999). A list of more than 300 species from groups including beetles, leafhoppers, sawflies and butterflies have also been identified (Bouchard and Wheeler, 1997). Alvars offer other significant interests such as their genetic diversity, natural history recreation, education and biological research.

<u>Distribution and Factors Affecting Alvar Habitat</u>

Many alvar species have a worldwide distribution restricted to the Great Lakes shores and are of global, regional, state/provincial significance. Lake Huron alvar communities are scattered in an arc that follows the Niagara Escarpment from upper Michigan through southern Ontario and to northwestern New York. The Great Lakes contain 95% of the world's alvars, with 64% occurring in Ontario and 15% in Michigan State.

Grassland and pavement alvars are classified as provincially and globally imperiled by The Nature Conservancy (Catling and Brownell 1995). More than 90% of the original extent of alvars has been lost and much of the remaining alvar ecosystem has been degraded due to a variety of anthropogenic factors including:

- Loss to quarries and collection of glacial boulders, rubble and slabs for landscaping;
- All-terrain vehicles and disruption of local hydrological patterns;
- Intensive grazing resulting in species loss and invasion of non-native plants;
- Collection of "at risk" plants and old-growth cedars by bonsai collectors;
- Logging of trees from alvar savannas, and
- Rural development, trailer parks and cottage construction (Rescheke et al., 1999).
- Lake Huron Alvar Conservation

Alvar conservation is an International Joint Commission (IJC) desired outcome of Biological Community Integrity and Diversity. Local, regional and international conservation initiatives are underway to identify and protect Great Lakes basin alvars. One of the most significant is the International Alvar Conservation Initiative (IACI). The initiative is coordinated by the Great Lakes Program of The Nature Conservancy (U.S.) and operated through an Alvar Working Group (Reschke et al., 1999).

Two comprehensive reports have been published providing a conservation blueprint for alvars in the U.S. and Canada. Ontario Nature coordinated Ontario activities of the IACI to produce 'The Alvars of Ontario' (Brownell and Riley, 2000). Additional information and priority action recommendations can be found in the technical report 'Conserving Great Lakes Alvars' compiled on behalf of the Alvar Working Group by Reschke and colleagues (1999). A natural-features gap analysis was conducted and areas most in need of protection relative to the amount of existing alvars in Ontario were identified as follows: Manitoulin, North Channel and La Cloche Island and Peninsula and Carden Plain.

### Coastal Dunes

Lake Huron dune systems are a unique and fragile resource that provides significant recreational, economic, scientific, geological, scenic, botanical, educational and ecological benefits to basin residents and visitors. Sand deposits forming coastal dunes along the shores of Lake Huron were laid down over the last 3000 to 4000 years, since post-glacial Lake Nipissing began to recede. They are the result of offshore sandbars, fluctuating water levels, strong winds, and stabilizing reeds and grasses that build the dune and set the stage for plant succession. Lake Huron dunes are considered rare, as many are comprised of remnant sand supplies incapable of regenerating themselves if damaged. The dune ecosystem has unique physical characteristics. In Ontario, the major dune types are, beach dunes, which consist mostly of sand and develop on the low-lying shores of Lake Huron, and perched dunes, which consist of sand as well as other loose material and sit on a plateau above the shore (Jalava, 2004; Peach, 2005). The major dune types In Michigan are dune and swale complexes, parabolic dunes and traverse dunes. Dune and swale complexes consist of a series or roughly parallel dunes that form as the water gradually drop. Parabolic dunes are defined by their U-shape and are found only in moist environments with extensive vegetation cover. Traverse dunes are believed to be originally formed in shallow bays (Albert, 2000).

Distribution

Sand dunes are found primarily along the southern shores of Manitoulin Island, the western shore of the Bruce Peninsula south to Grand Bend, and the southern portion of Georgian Bay. Smaller dunes are found on the Michigan shores of Lake Huron, mostly from Saginaw Bay northward. These dune systems support a distinct ecosystem which develops in succession from pioneer grasses to shrubs and eventually forest. These in turn support an important habitat for many unique and specialized species at risk. Dune plants have evolved special adaptations to the extreme heat as well as nutrient deficient soil. In addition to seed production, some of these plants send out horizontal root stems under the surface which develops into new growth short distances away. The root systems provide structure, making them far more durable than what appears.

Threatened plant species of the dunes include: Houghton's goldenrod (*Solidago houghtonii*), existing only along the northern shores of Lake Huron, dwarf lake iris (*Iris lacustris*) and the Pitcher's thistle (*Cirsium pitcheri*), which grows in the sand dune systems of Lakes Huron (Jalava, 2004). The federal, state and provincial endangered piping plover (*Charadrius melodus*) relies on the shoreline for nesting along the northern Michigan shoreline and successfully nested at Sauble Beach in 2007. The prairie warbler, a rare breeding bird in Michigan, nests among the shrubs on and in the lee of the foredune, as far north as Rogers City on Lake Huron. Several populations of Hine's emerald dragonflies, a U.S. federally endangered species, have recently been discovered within the marly swales near St. Ignace, Michigan (Albert, 2000).

Current Factors Affecting Dune Ecology

Lake Huron dunes have been subject to increasing degradation as more people impact the resource valued for its recreation and relaxation (Jalava, 2004). Dunes have not only become threatened by developmental pressures along the lakeshore, but also because the public are unaware of the value and function of dunes. Destruction of vegetation makes the dunes unstable, increases wind erosion and causes the coastline to recede. The fragile nature of dunes and the impacts of vehicles are well documented (Peach, 2004). Backshore areas subjected to heavy vehicle and pedestrian traffic have decreased top and root production, percent cover, and diversity of vegetation compared with unaffected areas (Peach, 2005). Some human related threats to dunes include: dune removal or alteration due to cottage development and parking; damage to plants and habitat from foot traffic and vehicles; habitat fragmentation from human caused breaches and blow-outs; non-native plant species, and impacts to dunes, including vehicle and pedestrian traffic (Jalava, 2004).

Coastal Sand Dune Conservation

Current research emphasizes the need to conserve Lake Huron coastal dunes and their biodiversity, to consider a long term vision, and understand the long term benefits achieved from protecting this resource (Peach, 2005). The Lake Huron Centre for Coastal Conservation has been working with local municipalities, community groups, schools, and individuals to help them better understand and appreciate beach and dune systems. A "*Beach and Dune Guidance Manual*" was developed for the Town of Saugeen Shores to inform and educate town employees about the form, function and vulnerabilities of the dune systems along their waterfront, and to provide guidance to avoid negative impacts to the dunes (Peach, 2007). The Michigan Natural Features Inventory, with the Michigan Coastal Zone Management Program, produced an educational brochure entitled, "*Borne of the Wind – An Introduction to the Ecology of Michigan's Sand Dunes*" as an educational tool for protection of coast dunes (Albert, 2000).

**Lake Huron Islands**

Lake Huron contains some of the most extensive freshwater island archipelagos in the world, with estimates exceeding 36,000 islands (Jalava et al., 2005). As a result, Lake Huron has the longest shoreline of any lake in the world, extending some 6,159 kilometers or 3827 miles. The modern configuration of the Lake Huron islands has existed for approximately the past 5000 years and can be divided into three groups: 1) limestone and dolostone islands associated with Manitoulin and Drummond Islands and the Bruce Peninsula, 2) archipelagos of nearshore Precambrian Shield islands in eastern Georgian Bay and the North Channel and, 3) the low-erodible islands in Saginaw Bay. The Thunder Bay/Misery Bay Archipelago also hosts a variety of protected limestone reefs, embayments, and beach types that are among the most important spawning and nursery sites for lake whitefish and lake trout in Lake Huron. Most of the Great Lake coastal meadow marshes are found among the gneissic islands (Jalava et al., 2005).

Due to their isolation, islands are important conservation areas that support distinctive flora and fauna and unique landscape features such as dunes, alvars, swamps, bogs and marshes (Vigmostad, 1999). While islands have always been important to fish, birds and other wildlife, this is now intensified as mainland habitats experience significant fragmentation and loss to human development. Great Lakes islands provide relatively undisturbed, and in some cases pristine, habitat conditions similar to those that existed prior to European settlement.

Islands provide stopover sites and refugia for many migratory birds. Protection of these stopover sites for landbirds may be critical as mortality rates may be much higher during migration compared to that in stationary periods (Ewert et al., 2004). According to 1999 survey results, 156 Georgian Bay islands supported colonial waterbird colonies (Jalava et al., 2005), while roughly 160,000 nesting pairs of colonial waterbirds were counted by the Canadian Wildlife Service from 1998-2001 (Hughes, 2004). Islands also provide habitat for fish spawning and nursery (Manny and Kennedy, 2004), support unique plant communities and diverse assemblages of amphibians and reptiles including the endangered eastern massasauga rattlesnake (*Sistrurus catenatus catenatus*), eastern foxsnake (*Elaphe gloydi*) and the spotted turtle (*Clemmys guttata*) (Hecnar et al., 2002).

<u>Current Factors Affecting Island Habitat</u>

Among the most significant threats to Lake Huron islands are (1) development, especially in the Les Cheneaux and eastern Georgian Bay region, which results in habitat loss, fragmentation, and loss of natural processes in shoreline stretches and near shore waters, and (2) spread of invasive species, particularly in Saginaw Bay where islands under public ownership are being invaded by non-native animal and plant species such as *Phragmites*, zebra mussel, and Eurasian carp that may alter ecological and trophic-level dynamics. Other threats include loss of vegetation and thus modification of ecological communities due to over browsing by deer, and potential effects of climate change. Threats related to recreation, mining, shoreline hardening, alteration of substrate in nearshore waters due to dredging, and contaminants all may have consequences to the biota and processes that maintain biota on islands. Well documented stresses continue to degrade these important ecosystems (Ewert et al., 2004; Jalava et al., 2005).

Island Conservation

The biological significance and diversity of Great Lakes islands was awarded global significance in a 1995 Canada-U.S. workshop and the 1996 SOLEC. Important scientific studies and island conservation approaches have been implemented such as the Biological Ranking Criteria for Conservation of Islands in the Laurentian Great Lakes (Ewert et al., 2004) and the Binational Collaborative for the Conservation of Great Lakes Islands.

A recent study, entitled "*Biodiversity and Conservation of Lake Huron's Islands*" provides the most comprehensive biodiversity assessment of Lake Huron islands, with over 23,000 islands mapped. While almost 50% of islands within central and northern Georgian Bay are within regulated protected areas, almost none of the islands in the East Christian Island Peninsula and Nottawasaga Bay region are protected. The most threatened island regions in Ontario include the eastern coast of Georgian Bay and the northern coast of Lake Huron along the Bruce Peninsula and Manitoulin Island (Kraus et al., 2007).

In Michigan, most islands in Saginaw Bay are under State or US government ownership, and many islands of the Thunder Bay region, near Alpena, are protected as part of the Michigan Islands National Wildlife Refuge or by Michigan Nature Association. In the northern Lake Huron portion of Michigan, a smaller proportion of islands (or parts of islands) are under public or non-governmental ownership. Round Island, near Mackinac Island, is a designated Wilderness Area by the US federal government (Kraus et al., 2007).

Kraus, et al (2007) identify some of the priority islands for biodiversity within Lake Huron for Ontario, and will soon complete a parallel analysis for the US. Based on the assessments of island values, biological significance, categorization, and ranking, the Collaborative will recommend management strategies for Great Lakes islands to preserve the unique ecological features that make islands so important. Results from a proposed threat assessment will also provide recommended management strategies to reduce the pressures on a set of priority island areas. Islands need to be integrated into both regional and local conservation and land use planning to recognize the distinctive needs and high importance of these unique systems.

**Lake Huron Reefs**

Defined as bedrock exposures beneath the surface of lake Huron, these often serve as important spawning habitats for lake whitefish (as in the reef complexes of Thunder Bay and the Fishing Islands), walleye (Saginaw and Thunder Bays) and lake trout (Thunder Bay, 6-Fathom Bank reefs, Yankee Reef, Grindstone City reefs). They also have become heavily colonized by dreissenid muscles and now serve as perhaps the most productive substrate type in Lake Huron. Their heavy colonization by dreissenids could be affecting their usefulness as spawning habitat. Excessive biomass of dreissenids on some reef sites may be leading to episodic low-oxygen events that, in turn, could be favorable to *Clostridium botulinum*, leading to Type-E botulism outbreaks. There is no systematic inventory of the locations and extent of these bedrock outcroppings. A geological inventory of the lake bed would permit estimation of the location and extent of these types of habitats, improve mapping and inventory of potential spawning habitats, and help to direct biological assessments of benthic fish communities associated with reef habitats.

**Tributaries**

Over 10,000 km (6213.7 miles) of tributary habitat were at one time accessible to fish in Lake Huron. Two-thirds of the Lake Huron watershed is located in Canada, thus an even greater amount of tributary habitat was available to fish in Ontario waters (Liskauskas et al., 2004). Tributaries are the primary conduit for drainage of waters from the basin's landscape to Lake Huron. Tributaries supply Lake Huron and its associated nearshore ecosystem with water and nutrients, and provide important fish and wildlife habitat (Crosbie and Chow-Fraser, 1999). The tributaries, in turn, depend on upland vegetation to regulate the nutrients and solids entering the waterways, and for input of energy and material. Biodiversity elements of tributaries depend upon the oxygenation of water and the balance of nutrients and organic materials to maintain favorable habitat conditions. Tributaries are critical spawning and nursery habitats for one-third of fishes in the Great Lakes (Liskauskas et al., 2004). Tributaries provide important habitat and migration corridors for a myriad of wildlife. Protecting and restoring the accessibility and function of tributary habitats throughout the Lake Huron basin will ensure that critical fish habitat is available as well as preserving the genetic diversity of fish and wildlife by maintaining access to these corridors.

Factors affecting Lake Huron Tributaries

Historically, Lake Huron was connected to a diverse array of stream and inland lake habitats and tributaries were important sources of cool, high quality water, as well as spawning and nursery habitats. Fish were excluded from many of these areas in the 1800's through the construction of mill dams (and later hydroelectric facilities) and water quality deteriorated steadily through the 1970's as point sources of domestic and industrial waste proliferated. In warm and cool water streams in the southern and western parts of Lake Huron, lake fish populations are exclude from tributaries and habitat has been degraded through urbanization, poor agricultural practices, and physical alteration of stream channels. Although delivery of sediments to nourish nearshore processes is an important function of tributaries, excessive loading can be damaging to stream biota, especially bottom-dwelling invertebrates. Excessive sediments can also damage estuarine marshes. Sediment loading concomitant with the bound contaminants have buried historically important spawning habitats and altered community dynamics of intolerant macroinvertebrates. While stressors such as point sources of pollution have largely been controlled during the past 25 years, many dams continue to fragment streams where historical spawning occurred for adfluvial fish (fish that live in the open waters and use tributaries for spawning) (Figure 5.3). In many situations, below-dam habitat is degraded due to the altered hydrology and increased water temperatures, influencing water quality and physical habitat including the distribution of aquatic plants and suspended sediments. Dams are almost certainly the single most important impediment to recovery of lake sturgeon, a species presently classed as Threatened by the State of Michigan.

Apart from dams, obstructions and sedimentation, the principle environmental concerns for Lake Huron tributaries are as follows: low discharge; low gradient; lack of deep habitat; lack of spawning habitat; temperature change; exploitation; fluctuating discharge and poor water quality (Michigan Department of Environmental Quality, 2002). Many Lake Huron tributaries continue to be degraded by runoff from residential, agricultural,

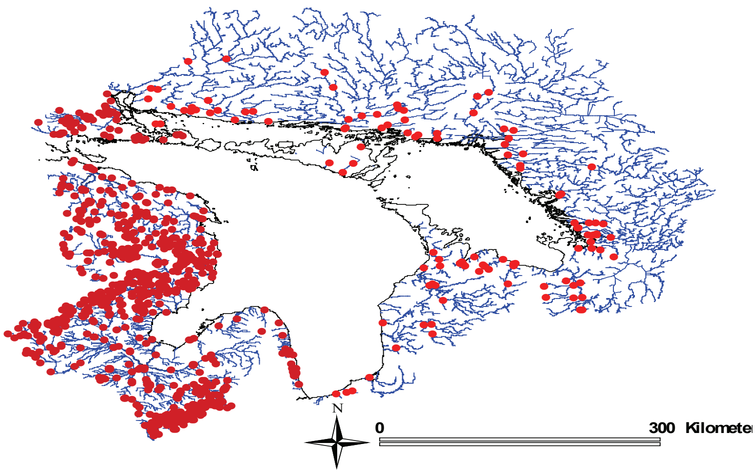


Figure 5.3. Distribution of dams in the Lake Huron watershed.

industrial and commercial land use. High levels of nutrients from fertilizers and other chemicals, along with excessive soil erosion threaten the water quality and thus impact this habitat for wildlife.

Priority Management Areas for Tributary Management

The lost connectivity, altered water temperatures, water quality and hydrological flow regimes of watershed tributaries draining into the Lake Huron basin needs to be restored to more natural conditions in order for Lake Huron to achieve its full potential for fish and wildlife production.

Priority management areas have been identified by the Great Lakes Fishery Commission through the development of Environmental Objectives for Lake Huron. See section IV Fishery Management Goals (p. 31) for a list and description of issues.

Additional information and fish community objectives relevant to tributary habitat can also be found on the Great Lakes Fishery Commission's web site at www.glfc.org.

**Lake Huron Habitat Protection, Restoration and Conservation**

Many efforts to protect restore, and conserve important habitat is ongoing in the Lake Huron watershed. A variety of forums have developed habitat-specific conservation plans for key components of the Lake Huron ecosystem. These plans represent the critical thinking of governmental managers, technical experts, and informed stakeholders. The Lake Huron Binational Partnership recognizes the importance of this work and encourages the continuation of these efforts. While some of the watershed is managed by Federal, Provincial, and State governments, the Partnership also recognizes the key role that local governments, municipalities, and private landowners play in ensuring the functional integrity of Lake Huron and its flora and fauna. The Partnership looks forward to further developing collaborative efforts that assist non-governmental land owners in their efforts to restore and protect the Lake Huron ecosystem. Several of these activities are listed in the Action Plan of this document.

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# VI. Areas of Concern

**Areas of Concern in Lake Huron**

In 1987, four Areas of Concern (Collingwood Harbour, Severn Sound, Spanish Harbour, and Saginaw River/Bay) were identified within the Lake Huron watershed, as well as the binational St. Marys River. Collingwood Harbour and Severn Sound in Canada were delisted in 1994 and 2003, respectively. Monitoring is ongoing in the AOCs to ensure that environmental quality is maintained. Each of the remaining Areas of Concern (AOCs) is being addressed through on-going programs, as described below.

For more information on AOCs, see the following websites:

- In Canada: http://www.on.ec.gc.ca/water/raps/intro_e.html
- In the United States: http://www.epa.gov/glnpo/aoc/index.html

Spanish Harbour, Ontario

At the Spanish Harbour AOC, all recommended actions were completed and in 1999, the area was the first in the Great Lakes to be recognized as an Area in Recovery. Sediments contaminated with trace metals (Nickel and Copper) in the river, harbour and Whalesback Channel are being monitored for natural recovery. . The benthic assessment of sediment (BEAST) methodology was applied to 15 sites in Spanish Harbour and in the Whalesback Channel in 2006. A risk-based, decision-making framework for the management of contaminated sediment, recently developed by the Canada-Ontario Agreement Sediment Task Group, was applied to the Spanish Harbour study. Data was used to refine previous modeling efforts to offer some predictions to estimate the recovery period. Draft results are currently being reviewed. At the same time, new developments in scientific risk assessment techniques have illustrated the need to revisit delisting criteria. Reviews and revisions of the benthos criteria will be completed in 2009.

A six year muskellunge re-introduction program involving many partner organizations has been completed and initial assessments are showing some very promising results. Wild young of the year muskie have been caught in Spanish Harbour for the first time in many years. See the Remedial Action Plan (RAP) for more details of OMNR projects in the AOC.

Saginaw River/Bay, Michigan

The Saginaw Bay watershed is one of Michigan's most diverse areas. The watershed is 14,016 square km (8,709 square miles) in size and is America's largest contiguous freshwater coastal wetland system. The watershed's rich resources support agriculture, manufacturing, tourism, outdoor recreations, and a vast variety of wildlife. The watershed is also affected by a variety of urban and rural environmental stressors, including industrial discharge, nonpoint source pollution, and habitat degradation. The Saginaw River/Bay AOC boundary extends from the head of the Saginaw River (at the confluence of the Shiawassee and Tittabawassee Rivers) to its mouth and includes the entire Saginaw Bay area.

The first Saginaw River/Bay Remedial Action Plan RAP completed in 1988 identified sediment contaminated with organic compounds (e.g., dioxins, furans and PCBs), fish consumption advisories, degraded fisheries and loss of significant recreational values as the major reasons for the AOC designation. Following substantial remedial progress within the AOC, the RAP was updated in 1994. The 1994 RAP identified and described 12 beneficial use impairments (BUIs) known to occur in the Saginaw River/Bay AOC. In 2001, the *Targeting Environmental Restoration in the Saginaw River/Bay Area of Concern (AOC): 2001 Remedial Action Plan Update* provided a list of targeted conditions that were viewed as important steps toward delisting the designated BUIs in the AOC (PSC, 2002). The restoration priorities identified in the RAP included remediation of contaminated sediment, nonpoint pollution control, coastal wetland protection, and habitat restoration. In early 2008, the MDEQ completed a RAP Update which outlines remedial actions and BUI assessment results that have occurred since the 2001 RAP Update (MDEQ, 2008).

Many pollution reduction regulations and programs have been instituted since the designation of the Saginaw River/Bay AOC. Some have been aimed at reducing pollution in general across the country. Others have been focused in the AOC specifically. All have served, directly or indirectly, to improve the water quality conditions in the Saginaw River/Bay AOC.

The following are examples of progress that has been made since the 2001 RAP Update:

- With support from the Partnership for the Saginaw Watershed (the Partnership), the MDEQ formed two technical committees to assess the restoration status of the Restrictions on Drinking Water Consumption or Taste and Odor Problems and Tainting of Fish and Wildlife Flavor BUIs. For each BUI, the technical committee determined that restoration criteria outlined in the MDEQ's *Guidance for Delisting Michigan's Great Lakes Areas of Concern* (Guidance) had been met (MDEQ, 2006). In the May, 2007, a public meeting was held to discuss the restoration status of the drinking water BUI and to solicit public comment. The community expressed support for removing this BUI. The removal recommendation documentation was developed and submitted to the USEPA-GLNPO in January 2008 for consideration. A public meeting will be scheduled in the early 2008 to discuss the restoration status of fish flavour BUI.
- The Saginaw watershed is one of three priority watersheds under the Michigan's Conservation Reserve Enhancement Program (CREP). Implemented in 2001, the CREP is a 15-year program to reduce sediment, phosphorus, and nitrogen loadings entering the surface water of the Saginaw Bay, Macatawa River, and River Raisin watersheds. Through September 2007, the Saginaw Bay watershed has had the largest number of acres enrolled (47,976) in the program, and the highest percentage (79%) of all the CREP implementation sites. All 22 counties in the Saginaw Bay watershed have implemented CREP practices. The counties in the Saginaw Bay watershed with the most acreage enrolled in the program include Saginaw (9,369), Huron (8,337), Tuscola (7,196), and Arenac (5,036). The CREP program has installed over 29,000 acres of filter strips and restored over 14,000 acres of wetlands in the Saginaw Bay Watershed.
- In June 2006, the MDEQ Director requested the participation of a wide range of stakeholders on the MDEQ's Phosphorus Policy Advisory Committee. The charge to the committee was to identify the major source categories of phosphorus loadings to Michigan's surface waters, and for each of these categories, to review and compile the voluntary and regulatory management approaches that are being or could be used to control phosphorus. The Advisory Committees findings were reported in *Phosphorous Policy Advisory Committee: Final Report* (PSC, 2007). These findings will augment the Saginaw Bay Phosphorus Reduction Strategy, in place since 1987, and will lead to further improvements in phosphorous loading in the Saginaw Bay.
- The Saginaw Bay Coastal Initiative (SBCI) was launched in August, 2006 to coordinate regional efforts to support innovative approaches for expanding local tourism and economic development, while enhancing resource protection and improving the quality of the environment within the Saginaw Bay area. Many activities have taken place under the SBCI. The following are just a few examples of projects that have

been implemented to specifically address water quality issues, more information on these and other SBCI projects can be accessed through the SBCI website at: http://www.michigan.gov/deq/0,1607,7-135-7251_30353_42900---,00.html

- The Saginaw Bay Science Committee Pathogen Work Group was formed to address potential human health risks associated with the accumulation of the algal material on the shores of Saginaw Bay. The science committee was charged to address issues and needs regarding *Escherichia coli* (*E. coli*), pathogen risks, and to specifically address citizen concerns on the presence of *E. coli* in detritus material in the Saginaw Bay area. The findings of the Science Committee were reported in the *Saginaw Bay Coastal Initiative: Potential Public Health Risks Associated with Pathogens in Detritus Material ("Muck") in Saginaw Bay.*
- A Saginaw Bay High Quality Wetland Protection Technical Work Group has been formed to identify wetlands that are critical to Saginaw Bay and inform local authorities of the various methods that may be used to preserve these areas.
- Beginning in 2007, in response to the growing need to address the rapid spread of *Phragmites* in Saginaw Bay, the MDEQ and other stakeholders implemented a *Phragmites* control demonstration project along selected reaches of Phragmites infested public and private owned shorelines. The results of the demonstration project will be used to develop a public outreach and educational brochure describing treatment options, associated state permit requirements, and restoration opportunities.
- Ongoing remedial efforts continue to address contaminated sediments and floodplain soils within the watershed, including Saginaw Bay and Saginaw River.
- Significant progress has been made in conserving and restoring habitat within the Saginaw River/Bay AOC. Numerous local, state, and federal actions have permanently protected and restored large areas of fish and wildlife habitat. In particular, there has been significant private and non-profit investment of time and resources to protect and restore coastal wetland and fish spawning habitat. The Saginaw Bay Watershed Initiative Network (WIN), for example, was established to address sustainable community issues through balancing economic, social, and environmental priorities. Numerous projects have been funded to protect and restore the Saginaw Bay watershed. More information on WIN projects can be found on the WIN website at: www.saginawbaywin.org.
- In January 2008, the National Oceanic and Atmospheric Administration awarded a regional consortium of Great Lakes area universities and research organizations $760,000 for the first year of a five-year, $3.8 million pilot project to develop a new approach to analyzing and managing the cumulative effects of climate change, land use, invasive species, and other environmental stressors on Saginaw Bay and its surrounding ecosystem.

<u>Binational Area of Concern: St. Marys River</u>

The St. Marys River is a 112 km (70 mile) connecting channel between Lakes Superior and Huron and is subject to many activities under the binational RAP. Accomplishments on the Canadian side have included process improvements at the Algoma Steel mill, the addition of secondary treatment at the East End Wastewater Treatment Plant, installation of sewage overflow tanks, rehabilitation of the sewer system in areas of high infiltration, the development of wetland protection strategies, the recovery of walleye populations, the design of habitat features in the city's waterfront development, and installation of an activated sludge treatment facility to reduce the oxygen demand and suspended solids in the discharge water of the St. Marys Paper mechanical pulp mill. Another accomplishment was the Environmental Management Agreement between Algoma Steel, Environment Canada (EC), and the Ontario Ministry of Environment (OMOE), which resulted in many improvements to both air and wastewater discharges.

Current RAP projects on the Canadian side include a spring rainbow creel survey conducted by OMNR in 2006 and 2007 and a short duration lake herring creel survey in Potagannissing Bay in 2007. Tissue was also collected and sent to the OMOE for contaminant analysis. In addition, a RAP Coordinator was hired in January of 2008 to assist in implementing the RAP and provide leadership on consultation with community participants in the implementation of the RAP. This was made possible by Canada-Ontario Agreement (COA) funding in a unique partnership of the Sault Ste. Marie Region Conservation Authority, the OMOE and EC.

In Michigan's portion of the AOC, the Cannelton Industries site dredging began in September 2006 and was completed in 2007. The $8 million (U.S.) cleanup eliminated approximately 227 000 kilograms (500,000 pounds) of chromium and 11 kilograms (25 pounds) of mercury from the St. Marys River. The only known remaining contaminated site in Michigan's portion of the AOC is the decommissioned manufactured gas plant downstream of the Sault Edison power plant beside MCM Marine. Consumers Energy has removed a total of 10 435 tonnes (11,503 tons) of contaminated soil and 6 821 tonnes (7,519 tons) of contaminated sediment from the site. Following removal, the upland areas, shoreline, and nearshore river bottom were stabilized and improved. The need for removal of additional river-based sediments is currently being investigated.

In the spring of 2007, the St. Marys River Binational Public Advisory Council (BPAC) received a PAC support grant from MDEQ to develop the fish and wildlife restoration criteria and Restoration Plan for Michigan's portion of the AOC. The BPAC is also currently in the process of comparing criteria outlined in the Stage 2 RAP with Michigan's statewide Guidance criteria. Determination of the final suite of criteria for Michigan's portion of the AOC is expected to be complete by the end of June, 2008. Binational consultation will occur throughout the entire process. The MDEQ will proceed with approving the BUI restoration criteria for the Michigan side of the St. Marys River AOC, as it has with other Michigan AOCs, by the end of 2008.

There have been a number of activities carried out cooperatively in the St. Marys River AOC. Since 1999, the St. Marys River Fisheries Task Group, of which the OMNR and the Michigan Department of Natural Resources (MDNR) are members, has conducted sport fish harvest, fish population and annual young of the year walleye surveys on the river. Since 2006, the Task Group has completed an angler fish harvest survey, a fish population gillnet survey, and an annual young of the year walleye electrofishing survey. Reports published by the Task Group may be viewed at http://www.glfc.org/lakecom/lhc/lhchome.php#pub.

In addition to monitoring the St. Marys River fisheries, binational cooperation has occurred to address water quality issues. In response to concerns from residents about beach closings and water quality along the north shore of Sugar Island in the Lake George Channel in the summer of 2006, U.S. and Canadian agencies partnered with local and tribal representatives to form the Sugar Island Monitoring Work Group in 2007. The purpose of the Work Group was to develop and carry out a coordinated monitoring plan for the St. Marys River along the north shore of Sugar Island and the Lake George Channel. Members of the Work Group conducted water quality monitoring, characterized the severity of water quality impairment, and identified potential sources of bacteria and floating solids.

The U.S. and Canadian agencies, in corporation with the Work Group, also held the Sugar Island and Lake George Channel Public Symposium in May, 2007, at the Cisler Center, Lake Superior State University in Sault Ste. Marie, Michigan. The purpose of the Symposium was to provide the public with information about water quality impairments observed in 2006, and to discuss the coordinated monitoring and event response procedures planned by Work Group members during 2007. After over 17 weeks of monitoring, the Work Group ceased monitoring operations for the winter (though regulatory monitoring continues year-round). In total, over 800 samples were collected. The Work Group is now in the process of preparing a report and developing recommendations for another coordinated monitoring effort in 2008.

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# VII. Other Issues

### Lake Water Levels

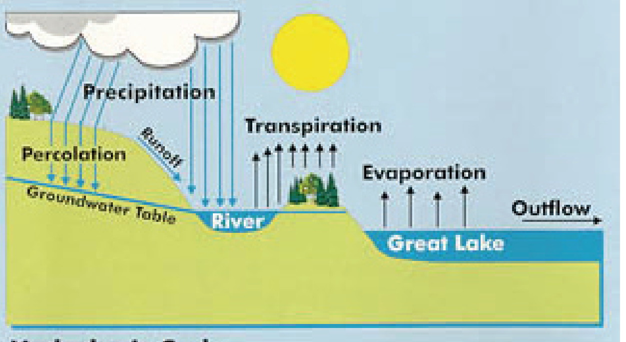
Water Level Fluctuations

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.



Hydrologic Cycle

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

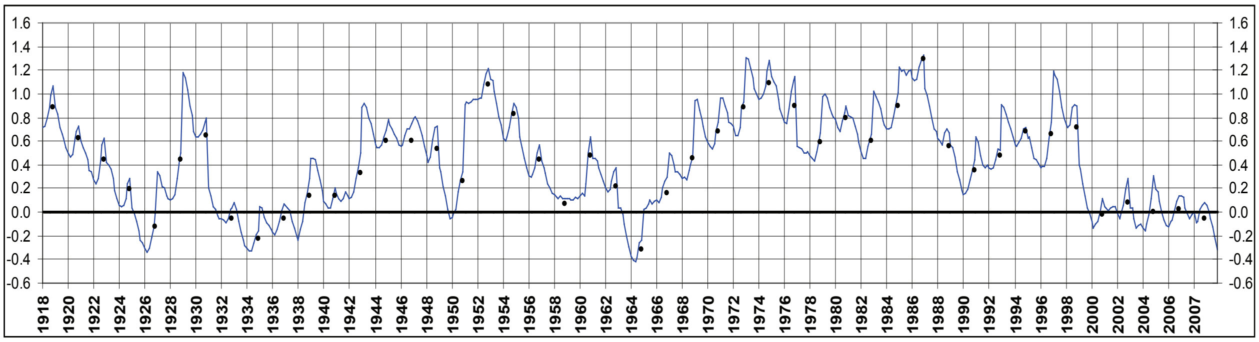



Figure 7.1. Monthly and Yearly Mean Water Levels for Lake Huron 1918-2007 (The Canadian Hydrographic Service).

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).

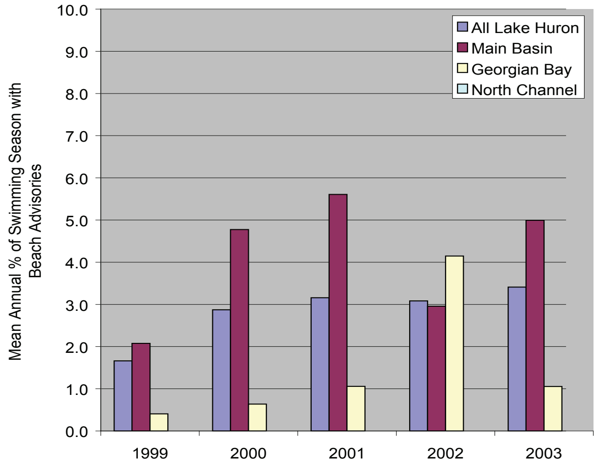



Figure 7.2: Mean annual percentage of swimming season that beaches on the Canadian side of Lake Huron were posted with beach advisories, for the period 1999-2003.

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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# VIII. Action Plan

Table 8.1. Status of 2006-2008 Management Cycle and Identification of High-Priority Actions for the 2008-2010 Management Cycle.

| Action | Responsible Agency | Status |
|---|---|---|
| Activities Addressing Contaminants in Fish and Wildlife | | |
| Natural Resources Damage Assessment for Saginaw River/Bay AOC | MDEQ, USFWS | Ongoing |
| Velsicol Chemical Corporation Superfund Site (including Pine River sediment cleanup) | Pine River Sediment Cleanup | Ongoing |
| Investigation of Dioxins and Interim Response Actions in the Saginaw River and Bay Watershed | MDEQ, USEPA | Ongoing |
| Assessment of Persistent Bioaccumulative Toxic Chemicals in Michigan Fish from Several Trophic Levels | MDEQ, Annis Water Resources Institute Grand Valley State University Richard R. Rediske, Ph.D. | New for 2008-2010 Cycle. |
| Activities Addressing Nutrient and Bacteria Issues | | |
| Agricultural Buffer Strips in the Saginaw Bay Area | MDEQ, Michigan Department of Agriculture (MDA), U.S. Department of Agriculture (USDA) | Ongoing |
| Adopt a Watershed Project: nutrient, bacteria & contaminant reductions | EC – ECB,EP, OMAFRA, OMOE, Conservation Authorities, local watershed groups | Completed in 2006-8 Cycle |
| Saginaw Bay Coastal Initiative | MDEQ | Ongoing |
| Saginaw Bay Science Committee Pathogen Work Group | MDEQ | Completed |
| Phosphorus Policy Advisory Committee | MDEQ/Local Stakeholders | Completed |
| Bacterial Beach Monitoring | MDEQ, Local health departments, USEPA | Ongoing |
| Lake Huron Southeast Shore Project - a Partnership Project | EC – ECB,EP, OMAFRA, OMOE, Conservation Authorities, local watershed groups | Ongoing |
| Southeast Shore Economic impact survey | EC, MOE, Conservation Authorities | New for 2008-2010 Cycle. |
| Southeast Shore Green Ribbon Program | EC, MOE, Conservation Authorities | New for 2008-2010 Cycle. |

| Lake Huron Binational Partnership 2008-2010 Action Plan | | |
|---|---|---|
| **Action** | **Responsible Agency** | **Status** |
| Southeast Shore Algal Fouling | OMOE – Environmental Monitoring and Reporting Branch | New for 2008-2010 Cycle. |
| Managing the Impact of Multiple Stressors in Saginaw Bay | NOAA, MDEQ, MDNR | New for 2008-2010 Cycle. |
| Activities Addressing Fish and Wildlife Habitat/Populations | | |
| Presque Isle County Green Infrastructure Project | USEPA-GLNPO | Completed in 2006-2008 Cycle |
| Colonial waterbird population surveys | EC – CWS, USFWS | Ongoing |
| Fish Passage Program | USFWS Alpena NFWCO | Ongoing |
| AIS Surveillance and Nearshore Fish Community Monitoring | USFWS Alpena NFWCO | Ongoing. |
| Lake Sturgeon Restoration | USFWS Alpena NFWCO | Ongoing |
| Lake Trout Rehabilitation, Assessment, and population management | USFWS Alpena NFWCO, MDNR, Alpena Station CORA, OMNR | Ongoing |
| Brown and rainbow trout and Chinook salmon stocking, assessment, population management | MDNR and OMNR | Ongoing |
| Assessment of recreational harvest | MDNR and OMNR | Ongoing |
| Nearshore fishery assessment | MDNR and OMNR | Ongoing in Ontario, expanded in Michigan in 2008 |
| Cisco (lake herring) rehabilitation | OMNR, MDNR, and CORA | Ongoing since 2006 |
| Fishery restoration through cormorant population management | MDNR and U.S. Department Agriculture APHIS | Ongoing since 2005 in Les Cheneaux, since 2007 in Thunder Bay |
| Treaty Fishery Unit | USFWS Alpena NFWCO | Ongoing |
| Partners for Fish and Wildlife Program | USFWS Alpena NFWCO | Ongoing |
| Saginaw Bay Walleye Recovery Plan | MDNR Fisheries Division and collaborating partners | Ongoing |
| Saginaw Bay Fish Community Assessment | MDNR Fisheries Division | Ongoing |
| Fish community survey of the St. Marys River | MDNR, OMNR, CORA, USFWS, & other members of the St. Marys River Fisheries Task Group | Ongoing |
| Annual Fish Community Assessments | USGS- Great Lakes Science Center (GLSC) | Ongoing |
| Lake Huron Nearshore Monitoring | MDEQ<br>Purdue University | New for 2008-2010 Cycle. |

| Lake Huron Binational Partnership 2008-2010 Action Plan | | |
|---|---|---|
| **Action** | **Responsible Agency** | **Status** |
| Saginaw Bay Coastal Initiatve - Identification of High Quality Wetlands | MDEQ | New for 2008-2010 Cycle. |
| *Phragmites* control demonstration project | MDEQ | New for 2008-2010 Cycle. |
| Activities to Increase Understanding of Ecosystem Change, Biodiversity and the Impact of Exotic Species | | |
| Benthic Macroinvertebrate Community Trends of Lake Huron | NOAA-GLERL, with assistance from EPA, EC, MDEQ, OMNR, and NWRI | Ongoing from 2007 Year of Coordinated Monitoring. |
| Studies to Determine Diets and Condition of Forage Fish | NOAA-GLERL, with assistance from EPA | Ongoing from 2007 Year of Coordinated Monitoring. |
| Changes in the Lower Food Web of Saginaw Bay | NOAA-GLERL | Ongoing. |
| Multiple Stressors in Saginaw Bay | NOAA-GLERL, MDEQ, MDNR, 4 Universities, Limno-tech | Ongoing. |
| Lake Huron Biodiversity Conservation Strategy | EC, USEPA, MNR, MOE, OMAFRA, MDEQ, MNNR, Parks Canada, and others. | New for 2008-2010 Cycle. |
| Activities at Areas of Concern | | |
| St. Marys River AOC - Canada | EC – ECB, EP, CWS | Ongoing. |
| Saginaw River/Bay AOC | MDEQ, USEPA | Ongoing. |
| St. Marys River AOC- U.S. | MDEQ, USEPA | Update completed, criteria under revision (2008), restoration work ongoing. |
| St. Marys River Marsh Monitoring Program | Bird Studies Canada | New for 2008-2010 Cycle. |
| Biotic Integrity and Habitat Assessment within the St. Marys River AOC | MDEQ, USEPA | Ongoing. |
| Saginaw River/Bay AOC Delisting Criteria | MDEQ, USEPA | Completed in 2006-2008 Cycle. |
| Biotic Integrity and Habitat Assessment within the St. Marys River AOC | MDEQ, USEPA | Ongoing. |
| The Saginaw Bay Wetland Initiative | Ducks Unlimited, MDNR, MDEQ | Phase I completed, Phase II underway. |
| Sault Ste. Marie Area Watershed Project | MDEQ | Ongoing. |
| Managing the Impact of Multiple Stressors in Saginaw Bay | NOAA Great Lakes Environmental Research Laboratory, in conjunction with several partner agencies and institutions | New for 2008-2010 Cycle. |

| Lake Huron Binational Partnership 2008-2010 Action Plan | | |
|---|---|---|
| **Action** | **Responsible Agency** | **Status** |
| Monitoring Coordination/Data Sharing | | |
| Lake Huron Geographic Information System (LHGIS) - A Partnership Project | MDNR, USEPA-GLNPO, OMNR, and other partners | Original effort completed. Collaboration on the LHGIS is ongoing. |
| Lake Huron State of the Lake Symposium, October 2006 | EC, USEPA, Aquatic Ecosystem Health and Management Society (AEHMS) | Symposium held in 2006. Publication of papers in peer reviewed journal ongoing. |
| Sugar Island Monitoring Workgroup | MDEQ/EC/OMOE/Other Local Stakeholders | New for 2008-2010 management cycle. |
| 2007 Intensive Sampling Year on Lake Huron | Facilitated by USEPA/ EC, with DFO, MDEQ, NOAA, USGS, and | Ongoing. |
| Outreach Activities | | |
| Lake Huron-Georgian Bay Watershed: A Canadian Framework for Community Action | EC, MOE, MNR, OMAFRA, First Nations, Stakeholders | Two "Think Tank" workshops and concerted effort by a steering committee and writing team produced the Framework for Community Action. |
| Lake Huron Community Action Pilot Projects in Three Canadian Watersheds | EC, DFO, MOE, MNR, OMAFRA, Nottawasaga Valley and Ausable Bayfield Conservation Authorities, Georgian Bay Biosphere Reserve Inc. | New project for 2008-2010 cycle. |
| Lake Huron Community Action Website | EC/MOE/MNR/ OMAFRA, Stakeholders | New project for 2008-2010 cycle. |
| Lake Huron Youth Summit 2007, 2008 | EC, MNR, MOE, OMAFRA, Parks Canada | Ongoing 2007 and 2008. |



**Activities Addressing Contaminants in Fish and Wildlife**

Natural Resources Damage Assessment for Saginaw River/Bay AOC

The PCB-contaminated sediment removal under the General Motors NRDA has been completed and follow-up activities including post-evaluation in the Saginaw River is underway by the MDEQ and the USFWS. Post evaluation of fish tissue under the Fish Consumption Advisory Program, as well as a caged fish effort to determine if sources have been controlled, is ongoing.

Velsicol Chemical Corporation Superfund Site (including Pine River sediment cleanup)

The Velsicol Chemical Corp Superfund site in St. Louis, Michigan consists of two main areas or operable units (OUs): The main plant site property (site of a former chemical manufacturing facility) that comprises most of OU1, and the Pine River adjacent to the plant site, OU2. Construction activities for the Pine River DDT/PBB sediment cleanup (OU2) were completed in the fall of 2006. The sediment remediation project began in 1998 as a fund-lead time-critical removal action (to address the most highly-contaminated areas of sediment) and transitioned to a fund-lead remedial action in 1999 (to address the remaining contaminated sediments in the river). The removal and remedial actions collectively removed approximately 670,000 cubic yards of contaminated sediments from the river. During the sediment cleanup, seeps from the containment system that had been constructed around the main plant site in the 1980s and observations of dense non-aqueous phase liquids (DNAPL) within and on top of the glacial till underlying the Pine River called into question the integrity of the containment system.

To prevent these releases from recontaminating the Pine River, U.S. EPA took an interim response action (during the remedial action) and installed a NAPL collection system along the northern edge of the main plant site. The Michigan Department of Environmental Quality (MDEQ) currently is conducting a remedial investigation/ feasibility study (RI/FS) at the main plant site (OU1) to look at long-term remedial options for OU1. MDEQ finalized the RI Report in November 2006 and concluded that the OU1 containment system is not functioning as designed and is not protective of human health and the environment. MDEQ currently is conducting a feasibility study to evaluate a range of potential remedial alternatives for OU1, and is also conducting additional RI fieldwork to support development of the FS report. U.S. EPA will select a remedy for OU1 following completion of the RI/FS. No remedial action work at the site is anticipated during the 2008-2009 timeframe, and no additional remedial action work is anticipated for the Pine River. The NAPL collection system will continue to be operated until a final remedy for OU1 has been implemented. Additionally, U.S.

EPA anticipates that post-sediment cleanup monitoring efforts in the Pine River (including long-term monitoring of DDT levels in fish andsediments) will begin in 2008.

Investigation of Dioxin and Other Hazardous Constituent Contamination and Interim Response Actions in the Saginaw River and Bay Watershed

It has been confirmed by recent investigations (2004-2007) that extremely elevated dioxin and furan contaminated sediments (> 10,000 ppt TEQ) from the Tittabawassee River are entering the Saginaw River and Bay AOC. Fish consumption advisories are in effect for the Saginaw River and Bay related to this dioxin. An additional wild game advisory exists for dioxin in the Tittabawassee River floodplain. In December 2007, a 1,600,000 ppt TEQ sediment sample from the Upper Saginaw River triggered an EPA CERCLA Emergency Response Action at Wicks Park, immediately below the confluence with the Tittabawassee River. In addition, sampling at the Sixth Street Turning Basin (approximately 6 miles downstream of the confluence of the Tittabawassee and Shiawassee Rivers) indicates that high levels of dioxin (up to 30,000 ppt TEQ) are present in the mobile sediment bed load of the Saginaw.

The dioxin is believed to be eroding from bank and levee deposits of the Tittabawassee River and originated as discharge over a period of time (1900's-1980's) by Dow Chemical at their Midland facility location. Dow is conducting comprehensive remedial investigations (RIWPs) defining the nature and extent of contamination in the Tittabawassee River (underway since 2006) and the Saginaw River and Bay are expected to becompleted by the end of 2008. This characterization is required as part of Dow Chemical's state-issued RCRA hazardous waste operating license.

Agency (MDEQ/EPA/USACE) and Dow Chemical studies of dioxin contamination in the Saginaw River and Bay demonstrates that sediments from the Tittabawassee River are the active source of dioxin to the Saginaw River and Bay. The final response activities for the Tittabawassee and Saginaw Rivers will be identified and implemented as part of MDEQ's Resource Conservation and Recovery Act (RCRA) Corrective Action and the Natural Resource Damage Assessment (NRDA) process.

For additional information on Dioxin and Dioxin in the Saginaw AOC see the links below.

- Dioxin Fact Sheet: http://www.michigan.gov/documents/Dioxin_Factsheet_82359_7.pdf
- MDEQ Dioxin Information Page: http://www.michigan.gov/deq/0,1607,7-135-3311_4109_9846_9847-43808--,00.html

Assessment of Persistent Bioaccumulative Toxic Chemicals in Michigan Fish from Several Trophic Levels

Working with MDEQ, Grand Valley State Univeristy will conduct an investigation of PBDEs in fish from multiple trophic levels in Saginaw Bay and the waters near the Les Cheneaux Islands in Lake Huron, among other areas in the Great Lakes. The locations represent systems with varying degrees of anthropogenic impact and have significant sport fisheries with respect to angler usage and fish production. Forage and predator species will be collected from each location and analyzed for PBDE congeners and fat content. The higher trophic level fish collected in this project will also be analysed for PCB congeners and mercury in a manner consistent with the MDEQ Fish Contaminant Monitoring Program and use Pentwater Lake as a reference system. These data will provide important information concerning the concentrations of these bioaccumulative chemicals in fish and how they are distributed in the food web, as well as inform efforts in Michigan Areas of Concern.

New for the 2008-2010 management cycle.

**Activities Addressing Nutrient and Bacteria Issues**

Agricultural Buffer Strips in the Saginaw Bay Area

The MDEQ has been working closely with the Michigan Department of Agriculture to implement a federal-state-local conservation partnership program, referred to as the Conservation Reserve Enhancement Program (CREP), to reduce significant environmental effects related to agriculture in the Saginaw Bay watershed. Eligible conservation practices include filter strips, riparian buffer strips, field windbreaks, and wetland restorations. The MDEQ and the U.S. Department of Agriculture has provided cost sharing for the implementation of Natural Resources Conservation Service approved conservation practices, monitoring, and permanent conservation easements. The success of the program will be measured in reduced sediment, phosphorus, nitrogen, pesticide, and pathogen inputs to surface waters and improved water quality in the Saginaw River and Saginaw Bay.

Through September 2007, the Saginaw Bay watershed has had the largest number of acres enrolled (47,976) in the program, and the highest percentage (79%) of all the CREP implementation sites. All 22 counties in the Saginaw Bay watershed have implemented CREP practices. The counties in the Saginaw Bay watershed with the most acreage enrolled in the program include Saginaw (9,369), Huron (8,337), Tuscola (7,196), and Arenac (5,036). The CREP program has installed over 29,000 acres of filter strips and restored over 14,000 acres of wetlands in the Saginaw Bay Watershed.

Adopt a Watershed Project: Nutrient, Bacteria & Contaminant Reductions

Environment Canada's Adopt a Watershed pilot project (completed March 2008) focused on communities adopting watersheds to promote ecosystem health by caring for water, land, air, and conserving biodiversity and species at risk. Subwatersheds in Huron, Bruce and Lambton Counties along the southeast shore were targeted and promoted the protection of ecosystem, healthy communities and sustainable agriculture industry by education and stewardship. The project supplemented and was built on existing programs in the watershed and on forming partnerships. The objectives were to: promote the adoption of sub-watersheds by rural communities; increase rural community awareness of water and air quality issues, biodiversity conservation and protection of species at risk within the rural landscape; assist community/sector/stakeholder working groups to access technical and financial support to develop and implement strategic action plans to secure ecosystem health within their sub-watershed; realize measurable reductions in the release of deleterious substances to water; reduce/eliminate house-hold garbage burning to reduce/eliminate the release of toxins to air; raise awareness on the need to control invasive species and to conserve biodiversity and to protect species at risk and celebrate the achievements of the sub-watershed project through media releases and a community gathering. Upon completion of the pilot projects, two communities in the Pine River and St. Joseph's area of the Lake Huron watershed submitted successful applications for Environment Canada's Community Action Fund (EcoAction) to implement best management practices on properties along with contributing landowners. A final report on the pilot project will be completed by fall, 2008 and successful strategies for "adopt a watershed" are being incorporated into other Lake Huron pilot projects and in the Lake Simcoe watershed.

Saginaw Bay Coastal Initiative

Through the Saginaw Bay Coastal Initiative, the DEQ and other state agencies will be working with citizens, local government officials, and multiple regional and federal agencies to develop and implement a comprehensive approach to promoting environmentally sound economic development and resource restoration in the Saginaw Bay coastal areas by: Identifying methods to enhance the economic development of the Saginaw Bay coastal area and the quality of its parks and beaches and other natural areas; seeking partnerships to develop new cultural, recreational, and social resources for Bay area citizens and visitors; and working with local interests to improving water quality in Saginaw Bay and its associated waterways. For more information, see: http://www.michigan.gov/deq/0,1607, 7-135-7251_30353_42900---,00.html.

*Saginaw Bay Science Committee Pathogen Work Group*

In 2007, the MDEQ Director organized a Saginaw Bay Science Committee Pathogen Work Group to address the issue of excessive algal growth, detritus or "muck" covering the shoreline in parts of the Great Lakes (in particular Saginaw Bay). The Science Committee was charged with addressing issues and needs regarding *E. coli* pathogen risks, and specifically, address citizen concerns on the presence of *E. coli* in detritus material in the Saginaw Bay area.

The findings of the Science Committee were reported in the *Saginaw Bay Coastal Initiative: Potential Public Health Risks Associated with Pathogens in Detritus Material ("Muck") in Saginaw Bay.*

*Phosphorus Policy Advisory Committee*

In June 2006, the MDEQ Director requested the participation of a wide range of stakeholders on the MDEQ's Phosphorus Policy Advisory Committee. The charge to the Advisory Committee was to identify the major source categories of phosphorus loadings to Michigan's surface waters, and for each of these categories, to review and compile the voluntary and regulatory management approaches that are being or could be used to control phosphorus. Based on that review, the Advisory Committee developed findings and recommendations to help advance phosphorus management strategies protective of Michigan's surface waters, taking into consideration effectiveness, costs of implementation, feasibility, and the potential reductions associated with the various phosphorus control options.

The Advisory Committees findings were reported in *Phosphorous Policy Advisory Committee: Final Report* (PSC, 2007). These findings will augment the Saginaw Bay Phosphorus Reduction Strategy, in place since 1987 and lead to further improvements in the phosphorous load in the Saginaw Bay.

*Bacterial Beach Monitoring*

In FY08, the MDEQ will be committing funding to local health departments along Saginaw Bay for water quality analyses. MDEQ is working with the local health departments to implement beach sanitary surveys to identify potential sources of *E. coli* and possibly additional genetic testing of *E. coli*. MDEQ will be conducting sanitary surveys focusing on animal feedlot operations in areas suspected to be contributors to the *E. coli*.

MDEQ is in the process of evaluating Discharge Monitoring Reports to identify permitted facilities that may not be in full compliance with permit requirements, and any follow-up action will be taken as appropriate.

The MDEQ has requested funding from USEPA to undertake additional baseline studies that would include genetic testing to determine the origin of *E. coli*.

MDEQ will be providing funding for the development of the Kawkawlin River restoration plan, an area suspected to be a contributor to the *E. coli* problem.

MDNR and MDEQ have been working with local leaders using beach grooming equipment at the Bay City State Recreation Area to minimize the muck problem. To date, the success has been limited and the muck has continued to accumulate. The MDNR and the MDEQ will continue to evaluate the effectiveness of the shoreline maintenance equipment and work with the local community leaders towards a solution.



New for 2006-2008 management cycle.

Lake Huron Southeast Shore Project - a Partnership Project

The Lake Huron South East (SE) Shores Working Group continues to provide a forum for further collaboration on research and monitoring on a range of issues, including microbial pollution, affecting the Lake Huron shoreline.

In May, 2005, the Ontario Ministry of the Environment released the Lake Huron Science Committee's report entitled, "*Sources and Mechanisms of Delivery of E. coli (bacteria) Pollution to the Lake Huron Shoreline of Huron County*." Studies in 2006 have been completed including: characterization of spatial/temporal variability of *E. coli* in the swash zone of specific beaches; tracking *E. coli* from septics, including plume characterization; characterization of *E. coli* discharge from groundwater to lake; and, infiltration rates of *E. coli* through beach sand.

Lake Huron Southeast Shore Tourist – Economic Impact Study

The Lake Huron south east shore working group will undertake tourist surveys to understand spending habitats during beach visits as well as what tourists are looking for in beach visits.

With assistance from Ryerson University, the members of the south east shore will utilize an existing survey (completed in 2007) to address the economic impact of beach postings and closures caused by *E. Coli* along the south east shore of Lake Huron.

Lake Huron Southeast Shore Green Ribbon Program

In Spring 2007, the Lake Huron Centre for Coastal Conservation with Environment Canada funding support prepared a draft guide outlining a program to recognize coastal communities who are actively engaged in beach stewardship activities and implementing Best Management Practices. The Green Ribbon program resembles the International Blue Flag program in requiring recipients to meet a series of environmental stewardship and environmental education criteria. While the Blue Flag program targets high use municipal public beaches, the Green Ribbon program focuses on lower use rural beaches.

The Green Ribbon program continues to be under development and the Coastal Centre is working with local beach associations to pilot the program. It is intended that the program be offered publicly in the summer of 2008.

Sturgeon Bay Blue Green Algae Blooms and the Water Quality Action Group

Scientists from Environment Canada and the Ontario Ministries of Environment and Natural Resources through their participation on the Sturgeon Bay Water Quality Action Group are providing ongoing scientific advice and monitoring support to the evaluation of causes and possible solutions to blue green algae blooms in Sturgeon Bay. The group, lead by the Township of the Archipelago has initiated a consultant's study to assess the options for and feasibility of remediating Sturgeon Bay waters. Options have been evaluated and discussions continue amongst responsible agencies and a public meeting is scheduled for June 2008.

Managing the Impact of Multiple Stressors in Saginaw Bay

In January 2008, the National Oceanic and Atmospheric Administration awarded a regional consortium of Great Lakes area universities and research organizations $760,000 for the first year of a five-year, $3.8 million pilot project to develop a new approach to analyzing and managing the cumulative effects of climate change, land use, invasive species, and other environmental stressors on Saginaw Bay and its surrounding ecosystem. (See also the "Activities Addressing Fish and Wildlife Habitat/Populations.")

New for 2008-2010 management cycle.

**Activities Addressing Fish and Wildlife Habitat/Populations**

Presque Isle County Green Infrastructure Project

Support North East Michigan Council of Government's (NEMCOG) effort to provide ecological information and tools to local units of government, organizations and landowners in Presque Isle County, The project is an innovative partnership between NEMCOG and Michigans Nature Features Inventory (MNFI), with guidance provided by a locally-based steering committee. The projects will address biodiversity and ecosystem change and support the conservation of fish and wildlife habitat.

Completed. The final report can be found at: http://www.nemcog.org/Pages/...PRESQUE_ISLE_COUNTY_GREEN_INFRASTRUCTURE.htm

This planning effort provided ecological information and tools to local units of government, organizations, and landowners in Presque Isle County through an innovative partnership between NEMCOG and Michigan's natural heritage program (MNFI), with guidance provided by a locally based steering committee.

Colonial Waterbird Population Surveys

In 2007 the 4th binational decadal survey of breeding colonial waterbird populations across all of the Great Lakes began. In 2007 Lakes Superior, Michigan and Erie were surveyed. Lakes Huron and Ontario and connecting channels will be surveyed in 2008. This project determines distribution and estimates population size for ~15 special of colonial nesting waterbirds on islands and mainland sites within 2 km of Great Lakes shoreline. The survey has been conducted in the 1970s, the '80s, the '90s.

This project is ongoing through summer 2009.

Fish Passage Program

Funding and technical support, which includes information on fish habitat needs and methods to bypass barriers, is provided through this U.S. Fish and Wildlife Service program.

AIS Surveillance and Nearshore Fish Community Monitoring

Aquatic Invasive Species (ANS) and monitoring population trends of the nearshore fish community is conducted at northern Lake Huron ports and river mouths as well as the St. Marys River. These efforts help locate new AIS populations, provide information on the status of established invasive species and their potential impacts on existing fish community, and establish baseline fishery data prior to potential AIS invasions.

Fourteen ports, river mouths and channels were surveyed from 2006 to 2007. No new populations of invasive species were discovered. Established populations of round goby were monitored at eight locations. One population of Eurasian ruffe was monitored. Relative abundance and distribution data was collected on 36 species of the nearshore fish community. Annual reports and catch summaries of AIS activities is available on Alpena Alpena National Fish and Wildlife Conservation Office web site (http://www.fws.

gov/midwest/alpena). This is an ongoing effort and will continue in the 2008-2010 cycle.

Lake Sturgeon Restoration

The Alpena NFWCO has led an interagency effort in the Lake Huron– Lake Erie region of the Great Lakes to determine the status and trends of lake sturgeon stocks and has relied on cooperation from state and provincial commercial fishers to compile biological data and externally tag by-caught sturgeon to develop movement and distribution information. Additional research coordinated at the Alpena Office includes studies in the Maumee River (OH), Detroit River (MI), St. Clair River (MI), Saginaw River watershed (MI), and the St. Mary's River (MI) to determine the contribution to Lake Huron stocks and genetic profile of lake sturgeon utilizing these sites. The Alpena Office is coordinating a multi-agency effort to standardize procedures for genetic analysis and profiling of spawning stocks from numerous Great Lakes tributaries.

Habitat, spawning and population assessment studies were conducted on the Maumee River (OH), Saginaw River watershed (MI), Detroit River, and St Mary's River with final reports pending. Other efforts are ongoing and will continue in the 2008-2010 cycle.

Lake Trout Rehabilitation

The U.S. Fish and Wildlife Service (Service), USGS, MDNR, CORA and OMNR are partners in an international effort to restore lake trout to self-sustaining levels in Lake Huron. Lake trout stocking in U.S. waters of Lake Huron is conducted primarily by the Service's National Fish Hatcheries and the new stocking vessel "Baird".. Likewise, OMNR stocks lake trout in its waters of Lake Huron. All contributing agencies conduct annual fishery assessments of lake trout stocks in waters under their respective jurisdictions. Offshore reef surveys are conducted by the large vessels operated by the Service and USGS. A new element in 2008-10 will be an assessment of pre-recruit lake trout by the agencies to address the concern that younger lake trout appear to be declining in standard spring assessments.

This is an ongoing effort and will continue in the 2008-2010 cycle.

Recreational Harvest Assessment

An expandable harvest survey is conducted by MDNR at all major Michigan access sites to estimate harvest and monitor harvest trends for species of recreational importance. Biological data from the catch are also systematically recorded. The survey has documented a pronounced shift from offshore species to predominantly nearshore species since 2003. OMNR periodically estimates harvest from several important access sites in Ontario.

Stocking and Assessment of Steelhead, Brown Trout, and Chinook Salmon

MDNR and OMNR stock and assess the status of these species, which until 2003 had served as important biological controls of alewives and served to produce economically important recreational fisheries. With the collapse of alewives these programs are now under review in Michigan.

Nearshore Fishery Assessment

Both OMNR and MDNR are now assessing nearshore fish stocks along the perimeter of Lake Huron. In 2008, MDNR expanded its monitoring of Saginaw Bay and Les Cheneaux Islands to the Thunder Bay-Port Huron nearshore zone. The focus of the OMNR survey is the southern half of the Main Basin.

Lake Herring Rehabilitation

In accordance with the Lake Huron Committee's Lake Herring Recovery Guidelines, OMNR, CORA, and MDNR are investigating lake herring culture techniques and implementing protective commercial harvest regulations where needed. A larger-scale stocking effort is being contemplated for the 2008-2010 period.

Restoration of Nearshore Fish Communities Through Management of Cormorant Populations

The focus of fish production appears to have migrated to nearshore areas of Lake Huron. However, in Les Cheneaux Islands and Thunder Bay, most or nearly all annual fish production was being consumed by double-crested cormorants. In collaboration with USDA APHIS, the MDNR and CORA are reducing cormorant numbers and assessing fish community responses. Lake Superior State University is monitoring diets of cormorants during the experimental control period. The objective is to restore a balance between cormorant consumption and the desire to have a portion of the fish community made available for human harvest. Les Cheneaux study is nearing completion in 2008, the Thunder Bay study will continue through 2010.

Treaty Fishery Unit

The Alpena NFWCO Treaty Fishery Unit fulfills Department of Interior and Service federal-tribal trust responsibilities by conducting activities in support of the Year 2000 Consent Decree, a 20 year fishery allocation for 1836 Treaty waters between the federal government, state of Michigan, and 5 Native American tribes. The Treaty Fishery Unit conducts fishery assessments in Lake Huron, annually performs statistical-catch-at-age modeling as part of the Modeling Subcommittee (MSC) of the Technical Fisheries Committee to determine safe harvest limits of lake trout and lake whitefish in 1836 Treaty waters, co-chairs meetings and activities of the MSC, and provides technical assistance to tribal and state resource agencies.

This is an ongoing effort and will continue in the 2008-2010 cycle.

Partners for Fish and Wildlife Program

The Service's Partners for Fish and Wildlife (Partners) Program delivers technical assistance and funding for habitat restoration efforts on private properties. A specific focus of the program is to restore habitats for native fish and wildlife resources. The program targets wetland and grassland habitat restoration on private lands and has diversified in recent years to include riparian and in-stream habitat restoration. This partnership driven effort is delivered throughout the Lake Huron basin. The Alpena FRO delivers the program to the northern 20 counties of the lower peninsula of Michigan, which includes both Lake Huron and Lake Michigan tributaries.

From 1999-2007 the Alpena NFWCO has restored 740 acres of wetlands, improved 120 river-miles by placement of large woody debris and the improvement of stream bank erosion sites, opened 103 river-miles to fish passage with the completion of 16 projects, and restored 46 acres of grassland to native grasses on 4 sites. This is an ongoing effort and will continue in the 2008-2010 cycle.

Saginaw Bay Walleye Recovery Plan

The MDNR Fisheries Division Saginaw Bay Walleye Recovery Plan is a science-based blue print for management actions intended to achieve a self-sustaining walleye population and restore ecological balance to the fish community. Biological benefits from the recovery plan are anticipated to extend to the greater fish community, including yellow perch. The recovery plan focuses on 1) reducing stream habitat and sediment delivery to the through collaboration with partner agencies such as MDEQ and the Natural Resources Conservation Districts, as well as stakeholder watershed groups will be key to realizing this strategy, 2) achieving fish passage at key dams, 3) reef rehabilitation, and 4) increased stocking of fingerling walleye (to 2.8 million) to shift the predator/prey balance. Recovery in the Saginaw Bay will be defined as a self sustaining walleye population capable of supporting an annual yield of 1 million pounds, at a density such that growth rate of age-3 walleyes declines to 110% of the state average rate.

Production of wild walleyes has greatly increased since 2003. This is believed to be driven mainly by the decline of alewives in Lake Huron. Three relatively very strong walleye year classes have been established as a result and represent significant progress towards recovery.

The recovery plan included benchmarks for making management decisions. The threshold for deciding about the future of walleye stocking (three predominantly wild year classes out of five consecutive years) was reached in 2005. Consequently, The MDNR has not stocked Saginaw Bay since 2006.

The strong three years of wild walleyes juvenile production has caused biologists to revisit many of the widely held conclusions assumptions about factors limiting walleye reproduction in the bay. It now appears that adult alewives may be the most significant factor in reproduction suppression in most years. Despite this, the MDNR feels that the provisions of the Recovery Plan remain appropriate, including those calling for habitat improvement.

Walleye recovery has not yet been achieved in Saginaw Bay but recent developments are a substantial movement in that direction. The implementation of the Recovery Plan is ongoing.



Saginaw Bay Watershed Initiative Network (WIN): Cass River Fish Passage Study

In 2006, a WIN funded fish passage study was completed on the Cass River. In 2007, the city of Frankenmuth worked with the Corps of Engineers to complete conceptual design for fish passage at the city's dam.

New for 2008-2010 management cycle.

*Saginaw Bay Coastal Wetland Mapping*

Ducks Unlimited (DU) completed a project to map the coastal wetland vegetation along the Saginaw Bay coastline using airborne hyperspectral imagery acquired in 2002 by the U.S. EPA.

*Saginaw Bay Fish Community Assessment*

Research vessels from the Mt. Clemens and Alpena Fishery Research Stations are performing annual gillnetting and trawling surveys to assess responses of the Saginaw Bay fish community to changing environmental and biological conditions, management actions and effects of non native species.

This action is ongoing.

Fish Community Survey of the St. Marys River

To estimate trends in abundance of various fish species in the fish community of the river. Survey serves as a measure of natural reproduction, year class strength, some evaluation of walleye stocking. Survey also provides some measure of presence of exotic species. Survey is gillnet based with 44 stations being assess on a schedule (target) of approximately once every three years. First survey was completed in 1975 and a total of five such surveys have been completed.

The most recent survey was conducted in 2006 and the results can be found at on the Great Lakes Fishery Commission web page. The next survey is tentatively scheduled for 2009.

Annual Fish Community Assessments

GLSC conducts annual bottom trawl surveys at Detour, Hammond Bay, Thunder Bay (Alpena), Ausable Point (Tawas), Harbor Beach, and Goderich (Ontario). Surveys examine abundance, size and age structure of key prey species, community composition, and prevalence of exotics. Fish collections are also sampled for analysis of contaminants, energy density, genetics, epizootics, and coded wire tags (lake trout). Recent additions to the survey include *Diporeia* monitoring, analyses of mechanisms regulating diet and growth of lake whitefish, re-examination of bloater (chubs) age structure, and examination of the ecological role of invasive round gobies in deepwater habitats. Fish community assessments are expanding, with hydroacoustic studies of the pelagic community beginning in 2004, and planned additional sampling of lower trophic levels in conjunction with fish surveys.

Bottom trawling and a lakewide hydroacoustic survey were completed during 2007, and both surveys are scheduled to occur again in 2008. See www. glsc.usgs.gov for annual reports on both surveys.

Lake Huron Nearshore Monitoring

Purdue University will measure temporal and spatial trends in the nearshore biological community (benthic invertebrates and zooplankton), detect existing/spreading and newly introduced non-native aquatic species, and determine whether discernable patterns in water quality data can be detected in Lake Huron nearshore waters. The study was postponed in 2006 and is scheduled to begin in 2008.

New for 2008-2010 management cycle.

Saginaw Bay Coastal Initiative

*Wetland Protection Technical Work Group*

A Saginaw Bay High Quality Wetland Protection Technical Work Group has been formed, through the SBCI, to identify wetlands that are critical to Saginaw Bay and inform local authorities of the various methods that may be used to preserve these areas. New for the 2008-2010 management cycle.

*Phragmites Control Demonstration Project*

Beginning in late 2007, in response to the growing need to address the rapid spread of *Phragmites* in Saginaw Bay, the MDEQ and other stakeholders implemented a *Phragmites* control demonstration project along selected reaches of *Phragmites* infested public and private owned shorelines. The results of the demonstration project will be used to develop a public outreach and educational brochure describing treatment options, associated state permit requirements, and restoration opportunities. New for the 2008-2010 management cycle.

**Activities to Increase Understanding of Ecosystem Change, Biodiversity and the Impact of Exotic Species**

Trends in the Benthic Macroinvertebrate Community of Lake Huron

Benthic communities in many of the Great Lakes are currently undergoing extensive changes because of dreissenid mussels, and efforts are focused on documenting if similar changes are occurring in Lake Huron. Benthic macroinvertebrate surveys were conducted in the main basin of Lake Huron in 2000, 2003, 2007, and in Georgian Bay and North Channel in 2002 and 2007. Of most interest are changes in abundances of the amphipod *Diporeia* and dreissenid mussels (zebra and quagga).

An assessment of changes between 2003 and 2007 will be completed by late 2008.

Studies to Determine Diets and Condition of Forage Fish

This study examines the seasonal diet composition, diet selectivity, and depth distribution of forage fish in southern Lake Huron off Harbor Beach. In the context of declining populations over the past several years, this study examines food selection of these fish relative to the food items present. Of note, the amphipod *Diporeia* has been gone from this area of the lake for at least 7 years. Given this loss, fish that heavily fed on *Diporeia* now must find alternate food items.

Field work for this study was initiated in 2007. Collections of fish, zooplankton (including Mysis), and benthos were made between May and October at 7 sites between 18m and 90 m. These data will be analyzed in 2008 with no more field work planned.

Changes in the Lower Food Web of Saginaw Bay

A large study was conducted in Saginaw Bay by GLERL between 1990 and 1996 to assess the impact of the zebra mussel on the lower food web (nutrients, phytoplankton, zooplankton, and benthos).

While a portion of the collected data has been analyzed and published, current efforts will complete the analysis and provide an overall synthesis.

Multiple Stressors in Saginaw Bay

This project will develop and evaluate a series of ecosystem models to predict how fish populations, water quality, and regional economics respond to multiple stressors (I. e., land use, climate change, and invasive species in Saginaw Bay. An Adaptive Integrative Framework (AIF) will be used to facilitate the synthesis and prioritization of research and management efforts. This approach is an iterative process in which modeling outputs will identify knowledge gaps that will be filled through field collections and experimental research and will, ultimately, help management agencies identify management alternatives. This project will run through 2012.

So far, a workshop was held that brought together key modelers, researchers, and managers to outline and discuss planned activities. Several more specific workshops will include managers/ stakeholders to discuss issues and needs, and modelers/ researchers to address those needs. Synthesis of historical data and planning for collection of new data in the bay and surrounding watershed has begun.

Lake Huron Biodiversity Conservation Strategy

In keeping with the Great Lakes Water Quality Agreement (GLWQA), participants in the LHBP are developing a biodiversity conservation initiative that will advance efforts to restore, maintain and protect the chemical, physical, and biological integrity of the waters of Lake Huron and provide long-term conservation strategies for biodiversity in the watershed. The project will identify biodiversity conservation needs in the Lake Huron watershed and allow participants to meet future challenges in the Lake Huron watershed. The effort will strengthen partnerships and communication and increase awareness of Lake Huron biodiversity and is expected to build on existing initiatives such as the LHBP, Great Lakes Fishery Commission's Environmental Objectives for Lake Huron, Lake Huron-Georgian Bay Watershed Framework for Community Action, the Michigan Wildlife Action Plan and other conservation efforts around the watershed.

This initiative is being implemented through the "Lake Huron Biodiversity Conservation Strategy" effort on the Canadian side. A project team comprised of representatives from government agencies, university scientists, stakeholders, Aboriginal groups, and non-governmental conservation practitioners will lead this project. The project will include workshops throughout the watershed to engage conservation partners in both countries. A similar effort is being explored on the U.S. side.

This new project is expected to be substantially completed within the 2008-2010 management cycle.

**Activities at Areas of Concern**

St. Marys River AOC - Canada

Stage 2 implementation projects include completion of a fisheries assessment plan, wetland and shoreline evaluation and protection activities, and a $60M (CAN) upgrade to the Sewage Treatment Plant and sewer system improvements. The Algoma Environmental Management Agreement is undergoing an amendment to incorporate the reduction of air releases. A detailed sediment and benthos study was carried out in the fall of 2002, the report was finalized in 2004.

See also Activities Addressing Contaminants in Fish and Wildlife Section.

2006-2008 activities include: development of a strategy for contaminated sediment in the Bellevue Marine Park area; review of delisting criteria; wastewater characterization study; a coastal wetland assessment and protection program and the development and implementation of an overall sediment management plan for the St. Marys River.

East End Wastewater Treatment plant was upgraded to secondary treatment and the outfall pipe was relocated to deeper water.

The Bellevue Marina Sediment Management Strategy was completed.

St. Marys River Marsh Monitoring Program

The Marsh Monitoring Program, a binational marsh bird and amphibian population monitoring initiative, is providing information about the long-term health and ecological integrity of coastal and inland wetlands located in the St. Marys River AOC. In the spring and summer months of 2007, training of volunteers and monitoring occurred. The 2008 field season is currently being planned. New for the 2008-2010 management cycle.

St. Marys River AOC - U.S.

The MDEQ completed a RAP Update for the St. Marys River AOC in 2006. In the spring of 2007, the BPAC received a PAC support grant from the MDEQ to develop the fish and wildlife restoration criteria and Restoration Plan. The project is expected to be completed by the end of June, 2008. In addition to the fish and wildlife BUIs, the BPAC is currently in the process of comparing criteria outlined in the Stage 2 RAP with the statewide criteria. Determination of the final suite of criteria for Michigan's portion of the AOC is also expected to be complete by the end of June, 2008. Binational consultation will occur throughout the entire process. The MDEQ will proceed with approving BUI removal criteria for the St. Marys River AOC, as it has with other Michigan AOCs, by the end of 2008.

Sault Ste. Marie Area Watershed Project

The Sault Ste. Marie Area Watershed Project is a non-point source pollution planning project attempting to bring together the people within the Sault Area to address water quality issues, identify pollution sources, and construct a plan to reduce those sources within the watershed project area, including the Sault city limits. The Sault Project encompasses several small "sub-watersheds" of the St. Marys River that course through the city, including Ashmun Creek, Mission Creek, Seymour Creek, Shunk Creek, and the area east to Frechette Creek.

The watershed management plan was completed and approved by the MDEQ in 2007. The Chippewa/East Mackinac Conservation District has convened a steering committee to prioritize tasks and implement the project.

Biotic Integrity and Habitat Assessment within the St. Marys River AOC

LSSU is conducting a two year study to augment existing base line monitoring data (ongoing at LSSU and other organizations), to provide a mechanism to assess ecosystem health, and to provide information that may (or may not) lead to the delisting of a number of RAP beneficial use impairments (BUIs). LSSU is using multimetric indices of biotic integrity to assess habitat availability and the "health" of nine St. Marys River coastal marshes. Bio-indices will be measured (e.g., biodiversity, population genetics, and reproductive health), with a particular emphasis on upper trophic level fish. Environmental sampling and analysis of organic (total PAH and total PCB) and trace-metal contaminants in fish, sediment, and water will also be conducted. In addition, LSSU will develop a GIS database to incorporate data generated by the project to enhance evaluation and interpretation of the data collected.

All field studies have been completed and indices of biotic integrity are being developed. Further refinement and development of biotic and chemical integrity models is ongoing. A final report is to be submitted to the USEPA in the summer of 2008. Saginaw River/Bay AOC

Contaminated sediment studies as described in Section I. Support the continued development and evaluation of the Saginaw River/Bay Measures of Success report. See Activities Addressing Contaminants in Fish and Wildlife Section.

Saginaw River/Bay AOC Delisting Criteria

On May 31, 2006, the Saginaw River/Bay PAC held a meeting and voted to adopt the delisting targets included in the Guidance to evaluate the status of the AOC BUIs.

A RAP Update for the Saginaw River/Bay was completed in early 2008.

The Saginaw Bay Wetland Initiative

Ducks Unlimited and a coalition of seventeen conservation partners have conserved 4,125 acres of wetland and associated grassland habitat on public and private lands across the 22-county Saginaw Bay Watershed. Funding for Phase II of the Saginaw Bay Wetland Initiative came from a $1,000,000 federal grant from the North American Wetlands Conservation Council (NAWCC) awarded to Ducks Unlimited in 2001. Ducks Unlimited accepted this grant on behalf of the partnership that together pledged $4.07 million in matching funds toward the grant. This project was undertaken under the Michigan Joint Venture Group, organized in support of the North American Waterfowl Management Plan, and built on the success and expanded conservation efforts of the Phase I Saginaw Bay Wetland Initiative completed in 2004 that resulted in the conservation of an additional 4,178 acres of wetland and grassland habitat in the Saginaw Bay watershed.

In addition, Ducks Unlimited in partnership with 16 conservation organizations was awarded a $1 million grant from the NAWCC to conserve approximately 3,800 acres of wetlands and associated uplands in the coastal counties from northern Saginaw Bay to the Ohio border. This grant was awarded in the fall of 2005 and is expected to be completed in the fall of 2009.

Also, there are two small North American Wetland Conservation Act projects along Saginaw Bay. DU, DNR and MDHA partnered to receive a $36,105 grant from the North American Wetlands Conservation Council to improve the water level and vegetative management of 819 acres of coastal wetland, moist soil wetland and seasonally flooded crops at Nayanquing Point Wildlife Area. This project also improved 46 acres of associated upland (this project is complete). The second project is a partnership between DU, DNR, Saginaw Bay Watershed Initiative Network, Bay Area Community Foundation and Dow. Via this partnership, DU received a $75,000 grant to restore at least 135 acres of coastal wetlands at Wigwam Bay State Wildlife Area (project is ongoing).

Phase I completed, Phase II underway.

**Monitoring Coordination/Data Sharing**

Lake Huron Geographic Information System (LHGIS) - A Partnership Project

The development of the LHGIS makes all public GIS data available for wide distribution and use.

Original effort completed. Collaboration on the LHGIS is ongoing. Agencies are seeking to add all publicly-available data to the LHGIS, and are always looking for new contributors of data.

For more information on the LHGIS see: http://www.glfc.org/glgis/fact_sheets/LHGIS_fact_sheet_1204.pdf. To acquire the LHGIS, please contact Christine Geddes via email (cgeddes@umich.edu). For information on the Great Lakes GIS project, visit the Great Lakes GIS web site at: http://www.glfc.org/greatlakesgis/.

Lake Huron State of the Lake Symposium, October 2006

The Aquatic Ecosystem Health and Management Society will publish peer-reviewed articles on Lake Huron ecosystem research and monitoring results presented at the 2006 Symposium.

Sugar Island Monitoring Workgroup

Responding to residents' concerns about beach closings and water quality in the Sugar Island area in the summer of 2006, the RAP team agencies partnered with representatives from local, tribal, state/provincial, and federal agencies in Canada and the U.S. to form the Sugar Island Monitoring Work Group (SIMWG) in 2007. The agencies involved in the SIMWG include: Algoma Public Health, Chippewa County Health Department, Ontario Ministry of Environment (OMOE), MDEQ, EC, Health Canada, USEPA, Bay Mills Indian Community, and Sault Ste. Marie Tribe of Chippewa Indians (Sault Tribe). The purpose of the SIMWG is to develop and carry out a coordinated monitoring plan for the St. Marys River along the North Shore of Sugar Island. The workgroup's task is conducting water quality monitoring, characterizing the severity of water quality impairment, and identifying potential sources of bacteria and floating solids.

**Outreach Activities**

Lake Huron-Georgian Bay Watershed: A Canadian Framework for Community Action

The framework provides a comprehensive community- based approach based on best science and the use of existing and new initiatives to promote and assist local community-based projects focused on improved and sustained ecosystem health of Lake Huron.

Pilot projects initiated under the Canadian Framework for Community Action include:

- Lower Nottawasaga River Stewardship Program: Coordinated by the Nottawasaga Valley Conservation Authority, this project will work with local government agencies and community partners to plan and conduct specific stewardship activities in the Lower Nottawasaga watershed and associated Lake Huron shoreline.
- North Gullies Subwatershed Pilot Study: Coordinated by the Ausable Bayfield Conservation Authority, this project will bring interested partners together to develop a long term subwatershed plan for the North Gullies subwatershed, providing an action process to enhance and protect the area.
- Georgian Bay Biosphere Reserve Stewardship Strategy and Guideline: Coordinated by the Georgian Bay Biosphere Reserve Inc (GBBR), to increase public awareness of environmental condition, stressors and stewardship opportunities through conservation workshops, symposia and public outreach, and to initiate demonstration projects to use as good examples of stewardship, rehabilitation and best management practices and policies.

Lake Huron Community Action Website

An information resource network intended for action-oriented communities, groups and people interested in land and water stewardship activities to sustain a healthy Lake Huron and Georgian Bay environment for future generations. The website provides current information on water, fish and wildlife, wetlands and other natural resources, as well as government agencies, community organizations and funding sources across the Lake Huron watershed. The site includes an index for people to register stewardship projects and to share local knowledge of ecosystems http://www.lakehuroncommunityaction.ca.

Lake Huron Youth Summit

Grade 12 students from the Canadian Lake Huron watershed were invited to discuss environmental issues confronting the watershed and basin and ways to actively participate as environmental ambassadors in their communities. Twenty nine students attended a three-day Youth Summit at Bruce Peninsula National Park on Sept 28-30, 2007. Youth Ambassadors went on to initiate personal environmental stewardship action plans, and engaged and encouraged municipal councils and other organizations in their communities to join them in signing the Lake Huron Charter.

A second Youth Summit is being planned for the fall of 2008 in Parry Sound.