Chapter 6

Habitat, Terrestrial Wildlife, and Aquatic Communities Progress Reports

Wild rice at Kakagon Slough. Photo credit: Janet Keough, US EPA.

Lake Superior Lakewide Management Plan 2008

Chapter 6 Contents

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6.0 ABOUT THE CHAPTER

The Habitat, Aquatic Communities, and Terrestrial Wildlife Committees of the Binational Program have cooperated to compile this chapter of the LaMP 2008. This chapter highlights actions taken to restore and protect fish, wildlife, and their habitats in the Lake Superior basin since the release of the LaMP 2006 Report. These committees are part of a historic and unique collaborative endeavor by Lake Superior resource managers to protect, maintain, and restore aquatic and terrestrial wildlife and high-quality habitat sites in Lake Superior basin and the ecological processes that sustain them. The committees are comprised of technical personnel from federal, state, provincial, and tribal natural resource agencies.

Over the past two years, the three committees have worked together to refine and revise a set of "Ecosystem Goals" that contain Strategic Outcomes, specific Goals, and Subgoals that the committees have determined are necessary to achieve and protect a diverse, healthy, and sustainable Lake Superior ecosystem. Although a version of these goals was originally included in the LaMP 2006, revisions were needed to better organize the goals and to accommodate emerging issues like climate change (see sidebar). In addition, the goals were expanded to include issues related to the aquatic ecosystem. A public comment period was held to gather input on the draft goals. The Ecosystem Goals are scheduled to be finalized in 2008.

Draft Ecosystem Goals Acknowledge the Need to Plan for Climate Change

During the recent revision of the Ecosystem Goals (see adjacent text), it became clear that unless agencies understand and plan for predicted climate change, a great deal of money and time could be spent on projects with little likelihood of success. In addition, the committees recognized that the Lake Superior basin should do its part to try and reduce emissions of greenhouse gases. These realizations prompted the development of four goals related to climate change under the umbrella of a Strategic Outcome that states **"Human activities in the Lake Superior basin mitigate the contribution of greenhouse gases to the environment. Ongoing climate change adaptive management strategies are pursued in the Lake Superior basin."** The four goals are to: 1) understand the impacts of climate change and the limits to the ability to predict and model these impacts on specific ecosystems and local regions, 2) review and revise Conservation and Restoration Plans in the basin as required based on the climate scenarios developed in the goal above, 3) help the Lake Superior Basin stakeholders adapt to climate change impacts, and 4) make Lake Superior a net carbon reduction area that reduces greenhouse gas emissions.

The draft goals that were released for public comment can be found in Chapter 3 of this LaMP (see Section 3.1). Once final, the committees intend to work toward the fulfillment of the goals and subgoals, and plan to use the goals as a tool to track progress. The committees and the Binational Program as a whole hope that, when final, all agencies and organizations around the Lake can use these goals as a guide to achieve our shared vision for Lake Superior.

6.1 ACCOMPLISHMENTS/PROGRESS

The following chapter recognizes many accomplishments over the past two years; however, readers should note that these are not all of the actions that have been taken to restore and protect the basin. The committees are tracking projects completed in furtherance of the LaMP; these represent a sample of projects initiated and/or completed in the past two years. The format of this chapter contains sections discussing broad, watershed-scale projects, updates on native and non-native species efforts, and outreach and education initiatives (see Chapter 2 for additional outreach efforts).

6.1.1 Watershed Initiatives/Protection/Restoration

This section presents updates on initiatives to protect or restore the ecological health of the Lake Superior watershed.

Important Habitat in the Lake Superior Basin. The Lake Superior Binational Program emphasizes protective measures for fish, plant, and other wildlife habitat over costly restoration once damage has occurred. Nonetheless, restoration is critical in areas where ecological functions are impaired. In 1991, the governments of Michigan, Minnesota, Wisconsin, and Ontario agreed to identify critical habitats and continue habitat reclamation projects already under way to restore fisheries, wildlife, and wetlands in the basin. As a result, the Habitat Committee produced a map showing important habitat in the Lake Superior basin and the ecological features of each site. In 2006, the map was revised to include additional information about the sites already listed, and to identify other important habitat areas within the Lake Superior basin. Copies of the map are available—simply contact one of the Habitat Committee co-chairs listed at the end of this chapter.

Canadian Watercourse Stewardship Project Update. Benthic macro-invertebrates are indicator species that respond to ecosystem changes faster than other members of the aquatic community. Trends and changes in aquatic invertebrate populations and community structure can serve as indicators of short-term, action-required stresses that may ultimately influence the aquatic community of Lake Superior. These organisms are the focus of the Watercourse Stewardship Project, a joint endeavour between the Superior Work Group and the Binational Forum. The benthic community composition in a number of Lake Superior tributary streams that are considered to be “healthy” is being compared to that found at selected sites in areas that are believed to be impaired in order to determine the biological health of these waterways. The stewardship component of this project involves public education and the creation of a “Citizen’s Guide to Monitoring Water Quality” that allows the general public to sample stream communities and determine local water quality conditions. Bug Trading Cards were also produced to encourage youth to take an interest in the region’s waterways and the organisms that live in them.

Monitoring Forest Management Impacts on the Headwaters of Lake Superior Migratory Brook Trout Rivers – Lake Superior’s Forest Fish. Planned forest management activities within Lake Superior tributaries that support coaster brook trout have raised concerns about the

potential impacts of changes in flow regimes and stream temperature. Increases in peak flow and stream temperatures, as well as alterations to groundwater inputs, that may result from forest management activities have the potential to alter in-stream habitat structure and thermal regimes and adversely affect the spawning and rearing habitat that is critical to brook trout. Researchers with Ontario's Centre for Northern Forest Ecosystem Research in Thunder Bay are evaluating forest landscape characteristics (e.g., geology, forest type, topography) and have established monitoring reaches to measure stream flow, temperature, and biological characteristics (e.g., water chemistry, aquatic invertebrates, fish communities) in Lake Superior watershed streams catchments. The study uses a before/after, control/impact design to evaluate the influence of different levels of watershed timber harvest on stream flows, water temperature, and biological characteristics of small streams that contribute directly and indirectly to brook trout habitat. The study will help quantify the risks posed by forest management activities to brook trout habitat and will provide recommendations to mitigate risks during forest management planning.

Hog Island and Newton Creek Habitat Master Plan. The Hog Island and Newton Creek Ecological Restoration Master Plan provides a blueprint for the restoration of natural communities and ecosystem processes for Newton Creek, the Hog Island Inlet, and Hog Island in Superior, Wisconsin. Historically, this area has been contaminated by industrial discharges and a former municipal combined sewer overflow. From 1997 to 2005, multiple partners remediated the contaminated sediments in Newton Creek and Hog Island Inlet. Through a process of stakeholder engagement and collaboration, the Ecological Restoration Master Plan intends to build upon the success of these remediation efforts by proposing a guiding vision as well as specific goals, objectives, and actions that will help to restore terrestrial, riparian, wetlands, and aquatic habitats; increase ecosystem biodiversity and resilience; and reduce threats to the natural communities in the area. The plan also intends to increase environmental awareness, community enjoyment, and economic vitality through passive recreational, educational, and stewardship opportunities. Because the area is part of the St. Louis River Area of Concern (AOC), the restoration of Hog Island, Hog Island Inlet, and Newton Creek is a critical link in a much larger process to preserve the Great Lakes.

Watershed Plans Spreading Across Michigan's Upper Peninsula. Since 2006, several more watershed plans have been approved by the Michigan Department of Environmental Quality (MDEQ) including the Sault Ste. Marie Watershed Plan and the Salmon Trout River Watershed Plan. Watershed plans in Michigan are approved by the MDEQ as meeting requirements under either Section 319 of the Clean Water Act or for accessing state funding through the Clean Michigan Initiative (CMI). Encouragement of watershed plan development throughout the Lake Superior basin is one of the objectives of the Habitat Committee. Each of the watershed plans shares the objectives of promoting coordinated and collaborative actions amongst stakeholders and providing guidance for implementation of actions that will reduce existing water quality impacts and provide a basis for protection from future impacts. The following watershed plans have been approved by MDEQ in the Lake Superior basin:

- Whetstone Brook and Orianna Creek Watersheds – City of Marquette;
- Chocolay River Watershed – Marquette County;
- Munising Bay Watershed – City of Munising and Alger County;
- Lower Dead River Watershed – City of Marquette;

- Trap Rock River Watershed – Keweenaw and Houghton Counties;
- Otter River Watershed – Houghton, Baraga and Ontonagon Counties;
- Sault Ste. Marie Watershed – City of Sault Ste. Marie; and
- Salmon Trout River – Marquette County.

Figure 6-1. Watershed management plans lead to restoration actions. The Whetstone and Orianna Creek Watershed Management Plan for Marquette, Michigan, identified this old abandoned culvert on the Orianna Creek as causing erosion and sedimentation to the stream, as well as being a barrier to fish passage. Photo credit: Superior Watershed Partnership.

Figure 6-2. In 2007, a grant from US EPA Great Lakes National Program Office allowed the Superior Watershed Partnership, Upper Peninsula Resource Conservation and Development Council, and Michigan Waterfowl Association to remove the culvert and stabilize the banks of Orianna Creek. Photo credit: Superior Watershed Partnership.

Field Evaluation of Water Crossings in the Lake Superior Basin. Roads and water crossings constructed during forest management operations are widely considered to pose a significant risk to fish and fish habitat. The Ontario Ministry of Natural Resources (OMNR) and the Canada Department of Fisheries and Oceans (DFO) have jointly developed *The Protocol for the Review of Water Crossings Proposed Through the Forest Management Planning Process.* The protocol includes a "Risk Evaluation Procedure" to evaluate the potential risk posed by planned water crossings. The goal of this study is to conduct a field-based evaluation of water crossings installed following the review and risk evaluation to determine the effectiveness of the protocol at mitigating risk. The field survey will focus on Lake Superior tributary river systems, some of which are used by migratory fishes in Lake Superior, including coaster brook trout. These systems are particularly sensitive to habitat fragmentation resulting from improperly constructed crossings. The project will develop an efficient field monitoring protocol, quantify risk factors associated with water crossings, and contribute to the validation and revision of the review protocol.

Habitat Manipulation Study Attempts to Improve Habitat for Brook Trout. The lack of quality spawning and early fry stage rearing habitat is severely limiting brook trout population abundance on the Little Sioux River. Rehabilitation of Lake Superior brook trout is a top

priority of Wisconsin's Lake Superior Basin Brook Trout Management Plan, the Lake Superior Fisheries Management Plan, and the Lake Superior LaMP.

A graduate student from the University of Minnesota-Duluth is conducting a habitat improvement project on the Little Sioux River that will re-expose natural habitat features critical to brook trout that are buried under excessive sand. The objectives of this project are to measure changes in physical habitat, invertebrates, and fisheries before and after a habitat improvement project. Sand movement will be restored and critical spawning features re-exposed by manually removing the footprints of old beaver dams, small woody debris, and overhanging speckled alder.

Michipicoten River Hydroacoustic Assessment of Fish Passage Relative to Regulated Flows. Lake Superior fish access up the Michipicoten River is limited by a hydroelectric power development several kilometres up river from the lake. Excellent spawning habitat exists below the dam; however, these areas are subject to dewatering and flushing on a regular basis as the hydro facility holds or releases water. The OMNR is presently undertaking acoustic enumeration of both spring and fall spawning runs in relation to flow over a three-year period. The findings will highlight the effects on native species and ecosystem function. This information will be used to support decision-making in the river management planning process.

The Paradise Island Nature Reserve. The Thunder Bay Field Naturalists Club, a non-profit organization, purchased Paradise Island, which is located in the Lake Superior National Marine Conservation Area and the Lake Superior Archipelago on the south side of St. Ignace Island, south of Nipigon. The island is about 28 hectares (60 acres) and is exposed to the open waters of Lake Superior. Paradise Island is recognized by the OMNR as an Area of Natural and Scientific Interest (ANSI) because of its extensive raised cobble beaches, unusual stunted windswept vegetation, and arctic disjunct plants. The majority of the island was privately owned and slated for cottage development. The Thunder Bay Field Naturalists have added this property to its 385 hectares (950 acres) of ecologically-significant land holdings in the region. This project was supported by the Greenlands Program, an OMNR-Nature Conservancy of Canada initiative. Additional support for this purchase was provided by two Canadian conservancy organizations: the EJLB Foundation and the McLean Foundation.

Nipigon River Land Acquisition: Gapen's Pool

Gapen's Pool. Photo credit: OMNR.

Brook trout have very specific habitat needs, requiring sites with substantial groundwater springs for successful spawning and incubation. While such locations are relatively rare in Lake Superior, there are three known spawning sites on the lower Nipigon River, attracting lake-dwelling brook trout from across Nipigon Bay and beyond. The major spawning area is in Gapen's Pool, where massive springs fed by groundwater create perfect opportunities for spawning. This area is currently in a relatively undisturbed condition, although much of the surrounding landscape is developed. In the LaMP 2006, the protection of Gapen's Pool was identified as a "Next Step" that needed to occur in order to protect critical lake and tributary habitat.

The property adjacent to this critical spawning area consists of 24 hectares (60 acres) of vacant land positioned along the east bank of the Nipigon River south of Lake Helen and is the major recharge area for groundwater discharging into the northeast corner of Gapen's Pool. In March 2007, Trout Unlimited Canada successfully purchased this property with the support of the OMNR and its partner the Lake Superior Advisory Committee, Parks Canada, Trout Unlimited U.S., and through the generous donations of individuals, corporations, and foundations. A conservation plan will be developed to protect and conserve the critical functions that this property provides to brook trout in the Nipigon River specifically, and to the restoration efforts in Lake Superior.

Graphic depiction of Nipigon River area. Photo credit: OMNR.

Great Lakes Environmental Indicators (GLEI) Project Update. The US EPA funded a five-year major competitive research grant (2001-2006) to the University of Minnesota-Duluth to develop a new generation of environmental indicators for coastal regions of the U.S. Great Lakes. The project focused on the coastal and nearshore zone for the entire U.S. portion of the Great Lakes from Lake Ontario to Lake Superior. The project included over 27 scientists in a consortium of 10 universities and was a cooperative agreement with US EPA's Mid-Continent Ecology (MED) Division in Duluth.

The final report for the project was completed in the spring of 2006, and a special issue of the *Journal of Great Lakes Research* [Vol. 33 (Special Issue 3), 2007] that primarily focuses on results from the GLEI effort will be released in 2008. A full copy of the report can be found at the following website: http://glei.nrri.umn.edu/default/documents/GLEI_final_VersionVIII.pdf

Overall, the GLEI effort measured eight major responses, each with different sampling methodologies and sample size requirements. These indicators included populations of amphibians, birds, diatoms, fish, macroinvertebrates, and wetland plant communities. In addition, contamination due to polycyclic aromatic hydrocarbons (PAHs) and land cover in the U.S. Lake Superior basin was characterized. Field sampling was completed with a random stratified design that incorporated over 200 stressor variables among six major categories: agriculture, atmospheric deposition, land cover-land use, human population densities, point source pollution, and shoreline modification. Field sampling was completed primarily in 2002 and 2003, while the landscape characterization was completed for 1992 and compared with the characterization for 2001 to determine land use change. The number of sites sampled in the Lake Superior coastal region for the various components were the following: 110 sites for birds, 12 sites for PAH contamination, 40 sites for diatoms, 32 sites for fish and macroinvertebrates, and 25 sites for wetland vegetation. In addition, US EPA-MED sampled more than 15 sites as well as extensive regions of the nearshore zone in the western portion of Lake Superior.

The results indicated that agriculture and population density had major influences on the indicator responses for all of the components studied. Strong signals in birds, diatoms, fish, and macroinvertebrates were observed in areas where either agriculture was predominant in the landscape or where human population densities were greatest. Considerable variation in responses was exemplified at different spatial scales and many at surprisingly large scales. PAH contamination was found in several of the major areas of industrial activity such as in the St. Louis River of Minnesota and Wisconsin. Land use change in the Lake Superior basin was not as extensive as found in the southern and eastern portions of the U.S. Great Lakes basin; however, there was some conversion of forested areas to urbanized, residential, or ex-urbanization areas within the basin. In general, the Lake Superior basin and nearshore areas, as indicated from the biological responses measured, were in relatively good condition compared to many portions of the southern and eastern U.S. Great Lakes coast. However, many wetland and high-energy shores had conditions that were approaching the highly degraded regions of the southern and eastern U.S. Great Lakes areas. These data provide some of the most extensive and comprehensive sampling ever completed for a substantial portion of the U.S. Lake Superior coastal region. These data also provide a solid baseline that will allow comparisons to be made with future changes in coastal resources, and will potentially provide a mechanism to track further degradation or improvements in health of the coastal region of Lake Superior.

The special issue of the *Journal of Great Lakes Research* referenced above will include 22 peer-reviewed papers. These papers are listed in the reference section at the end of this chapter.

Great Lakes Wetlands and Habitat Initiative. The Great Lakes Regional Collaboration's (GLRC) December 2005 *Strategy to Protect and Restore the Great Lakes* identifies habitat and wetlands degradation as a key threat and provides recommendations for protection and restoration. The GLRC's Wetlands and Habitat Initiative is working to address these recommendations. As a first step, the initiative is focused on protecting and restoring 200,000 acres of wetlands in the Great Lakes basin. Efforts to date include:

- Establishment of a Steering Committee with members from federal agencies; state, local, and tribal governments; and non-governmental organizations (NGOs) to help guide the initiative.
- Development of a habitat project and funding database to link projects with funding sources for restoration projects.
- Request for data in order to provide an estimate of the number of wetland acres protected, restored and improved by federal agencies and their partners since the release of the December 2005 GLRC Strategy.
- Production of a report that describes progress, the habitat project and funding database, key issues, and next steps. The report is under final review for release to the public.

Whittlesey Creek National Wildlife Refuge Update. The Whittlesey Creek National Wildlife Refuge was established along Lake Superior near Ashland, Wisconsin, in 1999 by the U.S. Fish and Wildlife Service (USFWS). Whittlesey Creek is a small refuge with a big impact on the lake and local communities. Acquisition includes the coastal wetland at the head of Chequamegon Bay, three tributary streams, and their floodplains. Habitats were altered since early European settlement by logging, farming, road and railroad building, and stream dredging. Native brook trout were almost extirpated from the Whittlesey Creek watershed. The USFWS has been acquiring lands, restoring habitats, and rehabilitating brook trout populations over the past eight years.

Figure 6-3. White pine planted in Whittlesey creek refuge. Photo credit: Darienne McNamara, USFWS.

During 2006 and 2007, activities at the refuge included projects in four areas. First, almost 5,000 trees were planted in the floodplains of Whittlesey Creek and Little Whittlesey Creek, where land had been cleared and farmed in the late 1800s and early 1900s. Second, a stream restoration project involved replacing a culvert that was a barrier to fish within the refuge with one that is now passable for fish and other aquatic life. The project opened four miles of stream to fish passage above the former barrier, providing important habitat for brook trout. Third, 10 acres of wetland in the refuge was

hydrologically restored in 2006. This restoration allowed sheet-flow on the floodplain and created several shallow pools for migratory birds. Native sedges, grasses, and forbs were planted on about two acres of the site in 2007. Finally, the USFWS and Wisconsin Department of Natural Resources (WDNR) are conducting an experiment to examine whether a self-sustaining migratory brook trout population can be established in Whittlesey Creek by stocking, enacting protective regulations, and improving habitat improvement. The stocking component involves paired stocking of multiple life stages of two Isle Royale strains with known lake-dwelling life history.

These activities advance goals and objectives that are part of the Refuge's Habitat Management Plan and the Brook Trout Plan for Wisconsin's Lake Superior basin. In addition, they advance the restoration of an important habitat site as identified on the Binational Program's map of important habitat conditions in the Lake Superior basin.

Fond du Lac Band of Lake Superior Chippewa is Restoring an Important On-Reservation Watershed. The Fond du Lac Resource Management Division (RMD) is engaged in a comprehensive hydrologic study and restoration activities in the Stoney Brook watershed, which encompasses over half of the reservation at 59,248 acres. Its headwaters include the reservation's premier wild rice lakes, designated as "Outstanding Reservation Resource Waters" in the Band's federally-approved Water Quality Standards. The Stoney Brook watershed was extensively ditched under judicial order in the early 1900s to drain wetlands and open up acreage for crop agriculture, which was generally unsuccessful. The substantial hydromodification of this ditch system persists and has resulted in detrimental fluctuating water levels in the wild rice lakes, significant stream and riparian habitat impairment, and disconnected wetlands throughout the watershed.

Recent activities in the watershed include:

- The development of a continuous hydrologic model using extensive field data;
- The development of a comprehensive Stoney Brook Watershed Management Plan that will incorporate management objectives including water level management in wild rice lakes, identifying stream and ditch reaches for habitat restoration, improving wetland function and forest management, and providing a road map for future implementation projects; and
- The construction of control structures to assist in water level management of wild rice lakes, and use of mechanical cutters and harvesters to remove several hundred acres of aquatic plants that have succeeded in the areas that once supported wild rice. Coupled with aggressive re-seeding efforts, these management activities will help restore much of the lost wild rice resource within the reservation.

Watershed Health Initiative Aimed at Reducing Runoff. Many groups throughout the Lake Superior basin are taking a keen interest in their watershed. A group of government, nonprofit, industry representatives, and citizens called the Wisconsin Lake Superior Basin Partner Team developed a watershed health initiative aimed at slowing the flow of water runoff from the land in the Lake Superior basin. Land use changes over the last century have increased the volumes and rate that water runs off the land, resulting in flooding, erosion, and sedimentation in streams.

As a result, Lake Superior tributaries in Wisconsin have changed shape and character and carry a heavy load of sand and sediment.

Figure 6-4. Ashland County (Wisconsin) Land Conservation Committee Chairman George Mika discusses agriculture's role in the Marengo River Watershed at an information meeting.
Photo credit: S. Schultz, Stable Solutions LLC.

The Partner Team obtained funding from the Great Lakes Commission and U.S. Forest Service to develop guidance for hydrologic assessment as the first step in watershed planning. The group applied the U.S. Forest Service and U.S. Department of Interior "Framework for Analyzing the Hydrologic Condition of Watersheds" to the Marengo River watershed as a test case. Based on that experience, the group developed a guide adapted to the unique needs of the Lake Superior basin. The guide provides a step-by-step process that describes how to assemble a review team, find mapping information, find information for Lake Superior basin watersheds, and how to evaluate watershed features. The hydrologic condition assessment identifies the most important factors or activities that affect the timing, volume, and velocity of water runoff. The guide and the Marengo River Watershed Test Case were completed in 2007. Partner Team members will present the guide to groups interested in watershed planning. The guide and Marengo test case documents are available from the University of Wisconsin-Extension Lake Superior Basin Educator and at http://basineducation.uwex.edu/lakesuperior/watershedmgmt.htm.

Figure 6-5. Silver Creek culvert failure in 2003. Photo credit: S. Schultz, Stable Solutions LLC.

6.1.1.1 Special Designations

National Marine Conservation Area Established on Lake Superior. In October 2007, the Government of Canada announced the creation of the country's newest National Marine Conservation Area (NMCA). More than 10,000 square kilometres of Lake Superior, including the lakebed, islands, and north shorelands within the NMCA boundaries, make up the largest freshwater marine protected area in the world. NMCAs are part of the Parks Canada family of protected areas. They consist of protected zones and cooperatively managed multiple-use areas where activities such as commercial fishing and shipping continue. Dumping, mining, oil and gas exploration and extraction are prohibited within the park boundaries.

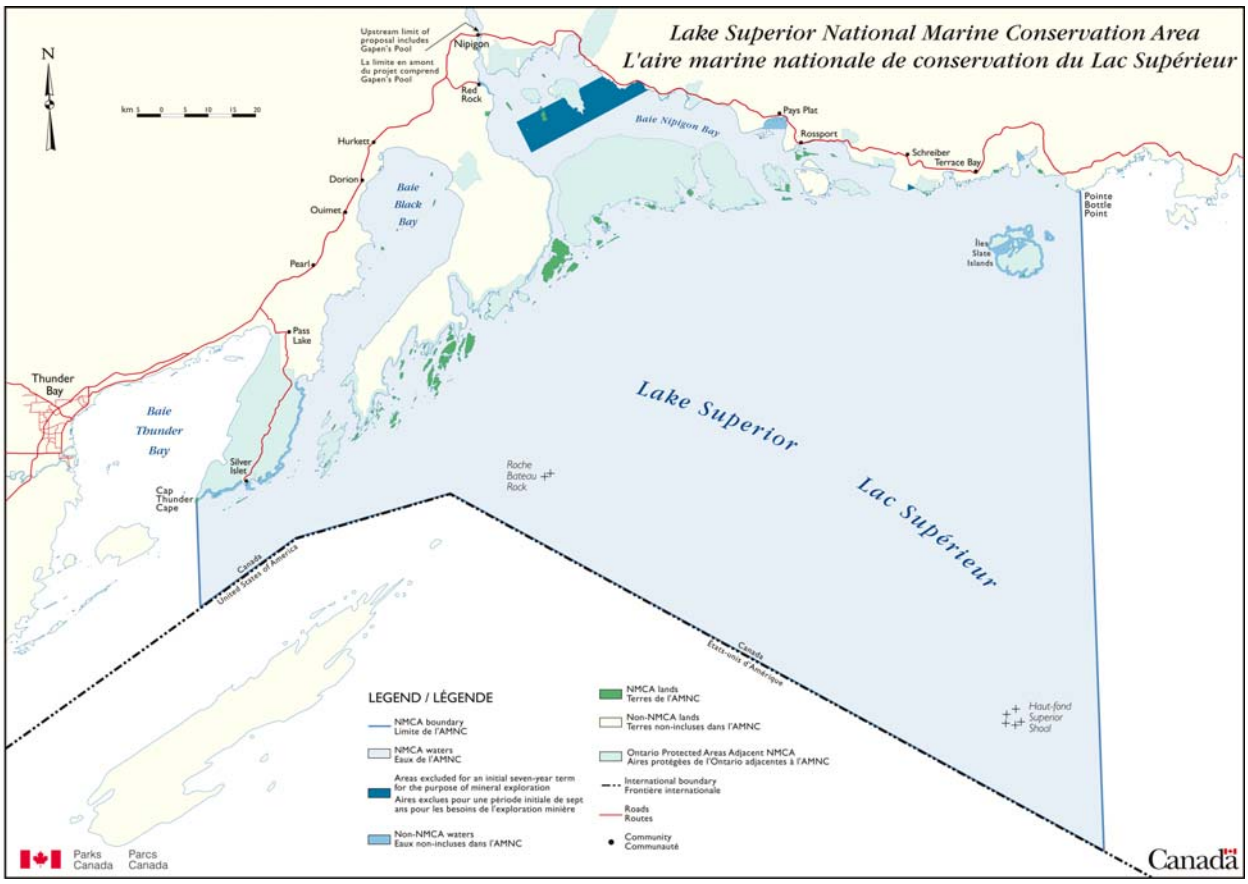


Figure 6-6. The National Marine Conservation Area in Lake Superior, established by the Government of Canada in 2007, represents the largest freshwater marine protected area in the world. Photo credit: Parks Canada.

Outstanding Resource Water Protection in Wisconsin. New rules relating to Lake Superior basin waters to better protect Lake Superior from wastewater pollution were adopted by the Wisconsin Natural Resources Board on April 26, 2006. The new rules will create a consistent approach across Minnesota, Michigan, and Wisconsin in implementing the Governors' agreement to manage Lake Superior as a zero discharge demonstration zone. Under revisions to Wisconsin's administrative code, the designation of Lake Superior tributaries currently classified as Outstanding Resource Waters (ORW) is expanded to trigger additional levels of protection. These proposals modify the existing ORW designation for selected tributaries to include a one-quarter-mile arc within Lake Superior at the mouth of each of those tributaries. In addition, waters within one-quarter mile of the islands of the Apostle Islands National Lakeshore would also be classified as ORW. A third part would prohibit any new or increased discharges of the targeted pollutants to waters of the basin unless the discharge was the result of utilization of best technology in process or control.

NERR Site Selection Process Underway in Wisconsin. The National Estuarine Research Reserve (NERR) System is a nationwide network of protected coastal estuaries that are designated and supported through the National Oceanic and Atmospheric Administration (NOAA). The NERR program integrates research, outreach, and stewardship activities related to estuary resources, including Great Lakes freshwater estuaries. NERR sites represent a formal

partnership between federal and state governments, but they also often include a variety of other partners and resources. There is local, statewide, and national interest in designating a Wisconsin Lake Superior NERR site, which would represent only the second freshwater estuary site in the nationwide NERR system.

In September of 2006, Wisconsin initiated the process of selecting a Lake Superior site to nominate for NERR designation. The process built upon previous and ongoing grassroots efforts to raise awareness and appreciation of Lake Superior's freshwater estuaries. The University of Wisconsin-Extension, Wisconsin Department of Administration-Coastal Management Program, and WDNR are leading this process for the State of Wisconsin. Representatives from over 25 organizations assisted by participating in two project teams. The process evaluated 35 sites located on Lake Superior's southern shore for their suitability as a NERR site, and evaluation criteria were used to narrow the list of potential sites to three options. Community input was then gathered regarding the remaining candidate NERR sites. In early 2008, state agency representatives will use the gathered information to recommend a Lake Superior site to Wisconsin's governor for nomination to NOAA as a Wisconsin NERR site.

National Forests Consider Special Designations. All four national forests within the Lake Superior basin (Hiawatha, Ottawa, Chequamegon-Nicolet, and Superior) have had forest plan revisions since 2004. These plans help address many of the LaMP watershed, habitat, terrestrial wildlife, and fisheries issues, and all are available online through http://www.fs.fed.us/r9/. Research Natural Areas (RNA's) are part of a national network of natural areas designated in perpetuity for research and education and/or to maintain biological diversity on National Forest Service lands. RNA's are designed for non-manipulative research, observation, and study. The National Forest Service has identified 69 candidate RNA's (forestwide data—not all are in the Lake Superior basin). These will be evaluated further for possible designation as RNA's.

Salmon Trout Designated as "Endangered River." In their 2006 report *America's Most Endangered Rivers*, the conservation group American Rivers has designated the Salmon Trout River in the Upper Peninsula of Michigan as the fourth most endangered river in the U.S. This is not a formal governmental designation but a local designation by a private group.

A proposed nickel/copper sulfide mine will be constructed directly beneath the river, if mining permits are approved. The Salmon Trout River flows into Lake Superior west of Marquette, Michigan, and has the only known remaining breeding population of coaster brook trout on the southern shore of Lake Superior. Significant efforts to restore and enhance this brook trout population are ongoing, and a Management Plan was recently approved for the watershed.

According to the American Rivers report, "The threat of contamination from acid mine drainage is a concern in any sulfide mining operation, and the proposed Eagle Mine project is no exception. Because the ore body is located directly under the river, and the mining site will be directly adjacent to this, any acid mine drainage that occurs would have a direct impact on river and groundwater quality. Such contamination in the river could bring serious harm to water quality — potentially contaminating the drinking water supply, and seriously harming the natural habitat of the unique native species. Even minute quantities of these toxins are deadly to juvenile coaster brook trout."

6.1.2 Native Species Rehabilitation/Protection

The following section describes progress in efforts to rehabilitate or protect native species in the Lake Superior basin.

Herptile Work Update. As discussed in the LaMP 2006, reptiles and amphibians have been identified as a critical group of species to be monitored by the State of the Lake Ecosystem Conference (SOLEC) and the LaMP 2000, as they are sensitive to human-caused perturbations and chemical contaminants, and many species are in decline worldwide. Dr. Steve Hecnar (Lakehead University, Ontario), and Dr. Gary Casper (Great Lakes Ecological Services and Casper Consulting) have developed and field-tested a basinwide amphibian and reptile monitoring program during 2006 and 2007. Representative sampling sites on both the Canadian (Thunder Bay and Lake Superior Provincial Park) and U.S. (Pictured Rocks National Lakeshore, Michigan, and Moquah Barrens, Wisconsin) portions of the Lake Superior basin were sampled. Project components include monitoring site selection, intensive multi-species surveys, database and data repository development, and statistical analyses. Statistical analyses will utilize a proportion of area occupied (PAO) model that is capable of incorporating data from existing monitoring programs for basinwide analysis.

While data analysis is still underway, preliminary results suggest that detection probabilities vary among species, sites, sampling sessions, and methods. Most species expected at sampling sites were detected, and it is believed that some highly effective sampling techniques have been documented. The final report is due in the spring of 2008.

Results should be applicable throughout the Lake Superior basin for use in amphibian and reptile habitat protection and restoration. The ability will be established to monitor up to 21 species and determine trends in species occupancy. The ability to detect species declines or increases will have direct bearing on both aquatic and terrestrial habitat management for these species within the basin's forests, grasslands, wetlands, lakes, and streams.

Mapping of Important Fish Habitat. Efforts continue to develop a relationship between habitat quantity and quality and fish production in Lake Superior (LaMP 2006). Our knowledge of what substrates are present (sand, clay, gravel, cobble), in what surficial quantity, at what depth, and exactly where they are relative to other substrates or bottom features is slowly increasing.

Since 2006, several new substrate mapping projects were completed that target habitat for native lake sturgeon, brook trout, walleye, and lake trout in nearshore waters and tributary sites. Recent projects include Buffalo Reef (see next article below), Gull Island, and Sand Cut shoals in Wisconsin waters. Between 2005 and 2007, seventeen lentic areas encompassing 1,718 hectares have been mapped, and a total of 196 hectares have been treated for sea lamprey larvae. Future developments include the incorporation of remote-sensing data to improve the classification of sea lamprey habitats.

Wave Energy and Water Currents Move Stamp Sands Toward Buffalo Reef. Mining wastes, such as the stamp sands (the crushed ore from copper mining), leach concentrations of metals in water that have been found above toxicity thresholds for many animal and plant

species. Mining wastes have been identified in the Lake Superior LaMP 2000 as a principal stress to aquatic habitat in Lake Superior.[1]

The Gay Peninsula, located along the eastern shore of the Keweenaw Peninsula immediately south of the town of Gay, Michigan (and its copper smelter), is composed almost entirely of stamp sands. Tribal fish harvesters have become increasingly concerned about the movement of stamp sands and effects that the deposits may have on Buffalo Reef, an important spawning reef for lake trout and lake whitefish located south of the Gay Peninsula. The impairment of this reef could lead to a decline in important species and impact the tribal population that depends on this resource. Buffalo Reef is an important spawning area in Lake Superior (Goodyear et al. 1982).

The lakebed was classified into seven categories, and four of those were acoustically distinct types of sand substrate. As indicated in the Canadian National Water Research Institute's (NWRI's) report, the acoustic classification method was not able to distinguish areas of stamp sand from areas of native sands. This may be due to mixing of sands that has occurred since the stamp sands were deposited. Further work should be done to ascertain whether a clear boundary exists between native sands and stamp sands. A visual inspection of samples collected in the field by the NWRI indicates that the area of sands immediately north of Buffalo Reef appears to be stamp sands regardless of its acoustic signature. Field staff also observed transport and mixing of sands due to wave action. Therefore, despite the uncertainty regarding the precise nature of the sands, it is reasonable to assume that stamp sands continue to be transported from the areas immediately surrounding the Town of Gay into areas of Lake Superior immediately north of Buffalo Reef.

Differences between Deep and Shallow Forms of Lake Trout. Deepwater forms of lake trout, abundant in Lake Superior, were once present in Lakes Michigan and Huron. The effort to restore self-sustaining populations of lake trout to the Great Lakes has been ongoing for over 50 years. These efforts have focused nearly exclusively on the lean (shallow-water) form and have been successful only in Lake Superior. Researchers have estimated that approximately 50 percent of the volume of Lakes Michigan, Huron, and Ontario are unpopulated due to lost deepwater forms of fish, including lake trout (Eshenroder and Burnham-Curtis 1999). This estimate reinforces the idea that rehabilitation of lake trout in the Great Lakes will not be complete until a diversity of body forms is restored (Krueger and Ihssen 1995; Eshenroder and Krueger 2002).

Rehabilitation of deepwater lake trout will require a scientific basis for understanding deepwater forms and how they differ from those found in shallow water. In 2006 and 2007, researchers from the Great Lakes Fishery Commission (GLFC), USFWS, and National Park Service (NPS) sampled all forms of lake trout around Isle Royale, Michigan. The GLFC research team will examine phenotypic and genetic diversity of lake trout in the Isle Royale region of Lake Superior and compare that with fish from Great Slave Lake, Great Bear Lake, Lake Mistassini, and the Klondike Reef area of Lake Superior. This work will help determine whether lake trout morphs in Lake Superior and Great Slave Lake represent biologically discrete groups or a continuum of body shapes. The relation of body shape to body size, lake, depth at capture, and diet will also be determined.

[1] Lake Superior LaMP 2000, pp. 8-10.

Figure 6-7. Siscowet have a high fat content, unlike nearshore lean lake trout. Photo credit: Michigan Department of Natural Resources, Marquette, Michigan.

Siscowet Surplus Production Dynamics. Fisheries management agencies around Lake Superior are jointly assessing siscowet (a deepwater lake water variety) populations to gain a broader understanding of their ecological role in Lake Superior. Information on relative abundance, food habits, and age and size composition are needed. These fish have a high fat content (unlike nearshore lean lake trout), and interest has been expressed in developing a siscowet commercial fishery to harvest them for their omega-3 oil content. In anticipation of a new fishery, agencies are working to determine the annual sustainable yield of siscowet that could be expected. It is from this type of information that interested parties will determine whether rendering siscowet for their oil is economically feasible.

Important Prey Fish in Lake Superior - Learning About Cisco Survival at Various Life Stages. The two largest remaining lake herring or cisco commercial fisheries on the Great Lakes are supported by the Thunder Bay and Black Bay, Lake Superior, stocks. Lake herring are also an integral component of the Lake Superior pelagic fish community and a forage base for top predator fish species in Lake Superior. The sustainability of these fisheries relies on controlling the harvest in relation to the size of the populations. With support from the OMNR, the United States Geological Survey-Biological Resources Division (USGS) research ship the *Kiyi* is conducting fall acoustic surveys in these waters. These surveys, to estimate the abundance of pre-spawning cisco, in conjunction with commercial monitoring of the harvest, will provide biomass estimates of the spawning stocks and, ultimately, exploitation rates.

Figure 6-8. Acoustic surveys are being conducted in Lake Superior to determine the sustainability of cisco commercial fisheries. Photo credit: USGS.

Wolf Delisted in Upper Great Lakes. The U.S. removed the western Great Lakes population of gray wolves from the federal list of threatened and endangered species in 2007. The action was taken by the USFWS in recognition of the success of gray wolf recovery efforts under the Endangered Species Act.

Gray wolves were previously listed as endangered in the lower 48 states, except in Minnesota, where they were listed as threatened. The USFWS's removal of the gray wolf from the endangered and threatened species list applied only to the Western Great Lakes Distinct Population Segment (DPS), which includes all the areas currently occupied by wolf packs in

Minnesota, Michigan, and Wisconsin, as well as areas in these states in which wolf packs may become established in the future. A portion of this population is found in the Lake Superior basin.

When the wolf was first listed as endangered in the 1970s, only a few hundred wolves remained in Minnesota. Recovery criteria outlined in the Eastern Timber Wolf Recovery Plan include the assured survival of the gray wolf in Minnesota and a population of 100 or more wolves in Wisconsin and Michigan for a minimum of five consecutive years. The recovery plan identified 1,250 to 1,400 as a population goal for Minnesota. The region's late winter gray wolf population now numbers approximately 4,000 and occupies portions of Wisconsin, Michigan, and Minnesota. Wolf numbers in the three states have exceeded the numerical recovery criteria established in the species' recovery plan.

The Michigan, Minnesota, and Wisconsin Departments of Natural Resources (DNRs) have developed plans to guide future wolf management actions. Protection of wolves, control of problem animals, consideration of hunting and trapping, as well as maintenance of the long-term health of the wolf population will be governed by the appropriate state or tribe.

Figure 6-9. In 2007, the western Great Lakes population of gray wolves was removed from the federal list of threatened and endangered species. Photo credit: National Park Service.

Once a species is removed from Endangered Species Act protection, there are several safeguards to help ensure it continues to thrive, including a mandatory five-year monitoring period. The USFWS also has the ability to immediately relist a species on an emergency basis, if monitoring or other data show that is necessary.

Who's Eating Whom in the Western Arm of Lake Superior. Lake Superior's fish community continues to change due to recovering lake trout populations, naturalization of introduced salmonids, declines in rainbow smelt populations, and fluctuating cisco year classes. One recently completed study used bioenergetics modeling of predator fish in the western arm of Lake Superior, including Minnesota and Wisconsin waters, to provide a comprehensive picture of community dynamics. Simulations of consumption by predators in 2000 and 2004 revealed current trends, and enabled comparisons to previous studies in the late 1980s and early 1990s. Modeling results were completed in 2007 for nearshore and offshore areas, for three ecoregions representing geographically distinct areas, and for Minnesota and Wisconsin waters within the western arm. Results indicate that the western arm of Lake Superior is at or near carrying capacity for predators. Lean lake trout are responsible for most consumption of rainbow smelt and coregonines, while the deepwater form of lake trout known as siscowet ranks second in

predatory consumption. Although individual Chinook salmon consumed more prey fish per unit time than did any other species, they along with other potadromous species played minor roles in total consumption. Because most predators in the western arm are wild fish, and survival of stocked predators has declined dramatically, managers no longer have the ability to control prey populations through stocking. Periodic hydroacoustic assessments of forage fish populations, predator diet monitoring, and bioenergetics analyses of predator consumption are warranted to track predator-prey dynamics, provide data for management of the fisheries, and quantify the allocation of prey species for the commercial fishery in the western arm of Lake Superior.

Efforts to Monitor and Report on the Status of Shortjaw Cisco in Lake Superior. The shortjaw cisco is one of four forms of deepwater ciscoes known in Lake Superior and is designated as threatened across Canada. Since the 1800s, ciscoes have been extensively fished commercially in the Great Lakes. Shortjaw cisco were preferred due to their large size and relative ease of capture. Overexploitation, invasive species, and habitat impairment have been responsible for the dramatic decline of this once abundant species. Little is known about the biology of this species, and the setting of recovery targets, critical habitat, and allowable harm all hinge on knowledge of biology, taxonomy, and population parameters such as population size, growth, and mortality. Initial investigations on Lake Superior have determined that shortjaw cisco are sparsely distributed and occur at historically low densities. For the past two years, OMNR and DFO have partnered in sampling efforts to determine the distribution, abundance, and life history of this species. This work will contribute to recovery planning for this species.

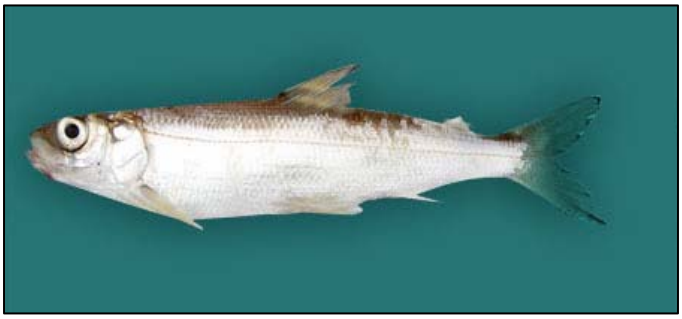


Figure 6-10. Shortjaw cisco. Photo credit: K. Schmitt, OMNR.

Coaster Brook Trout Subject of Federal Review. On March 20, 2008, the USFWS announced in the Federal Register the 90-day finding on a petition to list the U.S. population of coaster brook trout (*Salvelinus fontinalis*) as endangered. The USFWS found that the petition contained substantial scientific or commercial information indicating that listing the U.S. population of coaster brook trout may be warranted. With the publication of the notice, the USFWS began a status review of the coaster brook trout. At the conclusion of the status review, the USFWS will issue a 12-month finding on the petition. To ensure that the status review of the coaster brook trout is comprehensive, the USFWS is soliciting scientific and commercial information regarding the coaster brook trout throughout its range. More information is available at http://www.fws.gov/midwest/eco_serv/soc/fish/cobr/index.html.

Factors Limiting Brook Trout Abundance Examined. Factors limiting brook trout abundance in tributary streams along the Wisconsin shore of Lake Superior are not well defined but are important for developing strategies to rehabilitate the fishery for migratory coaster brook trout. Salmonid abundance in 38 stream reaches within 22 streams in 12 watersheds was measured to evaluate associations between salmonid abundance and stream habitat. Brook trout are more abundant in headwaters but are present in downstream reaches. Although brook trout abundance differs between upstream and downstream reaches, size structure appears similar. The downstream reaches differ in some of the habitat variables measured (flow, depth, width) but are also warmer. Both the brook trout distribution and the assemblage composition suggest that brook trout distributions are influenced by temperature. Brown trout abundance is not different between stream reaches, nor is coho abundance, and no consistent relation between abundance of brook trout and other salmonids was observed. Based on this observation and the explanatory power of the temperature and community data, we would not recommend pursuing competition studies. The most meaningful approach to brook trout conservation in these systems is to protect the groundwater and vegetation that maintain cold water.

On the Brook Trout Restoration Trail

Around Lake Superior, agencies and research continue to address knowledge gaps related to rehabilitation/restoration needs of brook trout in Lake Superior and its tributary streams. In Nipigon Bay, Ontario, and at Pictured Rocks National Lakeshore, Michigan, researchers with OMNR, DFO Canada, and Northern Michigan University are engaged in a multi-year tagging and stationary fish logging station study to investigate what causes some brook trout to remain in their native streams for life, while others leave the streams to inhabit the Lake Superior environment. The projects are also attempting to identify at what stage some young brook trout leave their native streams and what environmental conditions might trigger their emigration.

Cross stream antennas at the logging station record movement of fish tagged with internal transponders. Photo credit: OMNR.

Lake Superior Shoreline Waters Surveyed for Coasters. Tribal and federal agencies involved with coaster brook trout rehabilitation and stocking conducted surveys of coasters along over 100 km of shoreline waters in Lake Superior in 2006 and 2007. Coaster surveys occurred along the Grand Portage Indian Reservation in Minnesota; Red Cliff Reservation and Chequamegon Bay, Wisconsin; Keweenaw and Huron Bays, and Isle Royale, Michigan.

Walleye Rehabilitation and the Black Sturgeon River Dam. Restoration efforts for walleye in Black Bay have progressed from that reported in the LaMP 2006 report. Recent work has led to the conclusion that the construction of the Black Sturgeon Dam in the 1960s was the primary cause for the collapse and subsequent failure of the population to recover due to loss of access to spawning habitat. Radio tracking by OMNR and DFO has demonstrated that both walleye and

lampreys are present at the base of the dam in the spring. The dam benefits the Lake Superior ecosystem as a barrier to sea lamprey spawning but also prevents recovery of walleye by denying access to historic spawning areas. With this conflict revealed, work has begun with the Great Lakes Fishery Commission barrier task team to develop options for fish passage at the Black Sturgeon Dam. The OMNR and its agency and public partners are approaching the process with a number of objectives: (1) restore the natural ecological function of the Black Sturgeon River, (2) re-establish historical migration routes for native fish species (e.g., walleye, lake sturgeon), and (3) limit movement of non-native species (sea lamprey, Pacific salmon) into the Black Sturgeon watershed.

Figure 6-11. The Black Sturgeon Dam blocks walleye access to historic spawning areas, preventing walleye recovery in Black Bay. Photo credit: OMNR.

Walleye Rehabilitation in the Lower Nipigon River and Nipigon Bay. Restoration efforts of walleye in the Nipigon River system have been underway for many decades via transfer stocking of adults, zero harvest regulations, and habitat rehabilitation. With indications that walleye stocks may be responding, OMNR has undertaken a synthesis of all the data collected to date to determine the population trajectory. Moving forward, the historic walleye spawning area in the river is being assessed for its present condition and potential for future use by spawning fish. This area is thought to comprise the main spawning areas for the Nipigon Bay walleye population. A trap netting and telemetry study in partnership with the Red Rock Indian Band and Ontario Power Generation is also underway to determine the status of walleye in Nipigon Bay and identify important habitat.

Levels of Persistent Toxics in Nestling Bald Eagles in Lake Superior and in Adjacent Inland Waters. In 2006, the U.S. NPS's Great Lakes Inventory and Monitoring Network (GLKN) began long-term monitoring of persistent, bioaccumulative toxics (PBTs) using bald eagle nestlings as sentinels. Sampling was conducted at Apostle Islands National Lakeshore, St. Croix National Scenic Riverway, and Mississippi National River and Recreation Area in 2006 and 2007. Blood and feather samples were collected and analysis performed for PCBs, DDT (including breakdown products DDE and DDD), mercury, lead, and three emerging contaminants (PBDE, PFOS, and PFOA). The latter three contaminants are widely used as flame retardants (PBDE) and water/stain repellents (PFOS and PFOA) and have come under increasing scientific and regulatory scrutiny.

Preliminary results of the 2006 data indicate that, when compared to the past work of others, PCBs and DDE concentrations in Lake Superior eaglets continue to decline from highs in the 1970s. However, active DDT was found in three of ten nestlings sampled on Lake Superior, but only one of 26 nestlings from inland areas. Mercury concentrations were lowest in nestlings from Lake Superior and the Greater Twin Cities and highest in nestlings along the upper portions of the St. Croix and Namekagon Rivers where extensive wetlands likely contribute to its

production and availability. Lead concentrations were highest in nestlings from the Twin Cities but were generally low elsewhere. Patterns of occurrence for PBDEs mirrored those of PCBs, highlighting the similarity in transfer pathways and the persistence of the two chemical groups. PBDEs were found in all nestlings sampled, and the data suggest a near doubling of the concentrations in nestlings along the south shore of Lake Superior over the last five years. Levels of PFOS were highest in the Greater Twin Cities, followed by the Lake Superior nests, and levels were lowest in the upper St. Croix and Namekagon River system.

The GLKN plans to sample the three parks on a two-years-on and two-years-off basis. The next sampling is planned for 2010 and 2011.

White River Fish Passage Concern. Two extensive log jams are present in the White River, Wisconsin, as a result of poor logging practices and an emergency release of water from a dam malfunction. These log jams may prevent lake sturgeon passage upstream to historic spawning habitat. In 2006, the USFWS and Bad River Band of Lake Superior Chippewa began a two-year project to determine whether lake sturgeon are able to swim upstream past the log jams during spring flows regulated by the dam.

Lake sturgeon adults were captured, tagged, and released in the lower river, downstream of the log jams. Sampling was also conducted upstream of the log jams to determine if tagged lake sturgeon could move past the log jams. A second means to determine if spawning run fish were able to access upstream spawning habitat was to capture larval sturgeon during their downstream drift, which occurs shortly after hatching.

Adult spawning run lake sturgeons were captured each year in the lower river downstream of the log jams. Flow in 2006 was about 150 cubic feet per second (cfs) below the long-term average, which ranged from about 300 to 500 cfs during the spawning period. Only a single lake sturgeon was captured upstream of the log jam, and no larval sturgeon were encountered. In 2007, flow was again low and averaged about 200 cfs during the spawning period. However, seven adults were captured upstream of the log jams, and successful reproduction was confirmed by the capture of a larval lake sturgeon.

Figure 6-12. Larval lake sturgeon. Photo credit: USFWS Ashland, Wisconsin.

2006 Great Lakes Lake Sturgeon Coordination Meeting. In November 2006, the third Great Lakes Lake Sturgeon Coordination Meeting was held in Sault Ste. Marie, Michigan. The purpose of these meetings is to provide a forum to foster communication and exchange of information relating to the study, management, and restoration of lake sturgeon in the Great Lakes basin, to address priority research and assessment needs, and to address selected emerging issues. Over 120 individuals attended the meeting, representing more than 40 different entities

including state, tribal/First Nation, federal and provincial governments, academic, private, and other NGOs.

As with previous meetings, the 2006 Coordination Meeting addressed several focus areas and emerging topics. The four focus areas covered were habitat use and juvenile ecology, genetics and management implications, streamside rearing, and assessment technologies. The emerging issue theme addressed sturgeon legal issues such as illegal harvest, increased market interest for caviar as world sturgeon stocks decline, and the proposed listing of the lake sturgeon as an endangered or threatened species in parts of Canada.

Streamside Lake Sturgeon Culture for the Ontonagon River. Lake sturgeon were once abundant in the Ontonagon River, Michigan, but adults were not recovered during several survey attempts in the 1980-1990s by the Michigan DNR and USFWS. Stocking began in 1998 and continued until 2004 from eggs collected from a local, wild fish stock but reared in a traditional hatchery. To increase the likelihood for imprinting, which takes place in very newly hatched fish, a streamside rearing facility that utilizes water from the Ontonagon River was established. In 2007, young lake sturgeon were raised from approximately 85,000 eggs taken from a population in a nearby river. Eggs were fertilized, incubated, and hatched. Approximately 1,000 young were successfully reared to 6 inches in length and were released into the Ontonagon River in the fall of 2007. Streamside rearing will again take place in 2008 at the facility, and some individual fish remaining from the 2007 effort will be tracked using radio telemetry.

Assessment of Lake Sturgeon Stocking and Rehabilitation Progress. Assessments of the rehabilitation stocking effort in the Ontonagon River have been limited in scope and conducted primarily in the river. To evaluate stocking progress and to describe the status of lake sturgeon in Lake Superior near the Ontonagon River, the USFWS, Keweenaw Bay Indian Community, Michigan DNR, and Great Lakes Indian Fish and Wildlife Commission initiated a pilot project to assess juvenile lake sturgeon. The project utilized the fall walleye index netting (FWIN) protocol developed in Ontario (Morgan 2002).

Prior to being stocked, a microscopic coded wire tag is inserted in the snout of each fish. During surveys, each juvenile lake sturgeon captured is checked for the presence of a coded wire tag to determine if it is a stocked or naturally produced fish. In 2006 and 2007, ninety-seven juvenile lake sturgeon ranging from 401 mm to 986 mm were captured. Coded wire tags were detected in 84 fish, positively identifying them as stocked fish. In addition, a thumb-nail-size piece of tissue was collected from the fins of all fish without a coded wire tag. Fin clips will be genetically analyzed to determine the parental stock of these fish. The sturgeon captured were tagged and released. If these fish are captured during future Lake Superior survey work, agencies will obtain data on the growth and movement of these fish.

Flow Manipulation Study for Lake Sturgeon Rehabilitation. On the Kaministiquia River in Thunder Bay, OMNR and Ontario Power Generation continue to partner in a detailed radio telemetry study aimed at documenting the migratory response of spawning lake sturgeon to controlled flow conditions over Kakabeka Falls. The movement of adult sturgeon up to the historic spawning area at the falls is being monitored and is followed by a detailed larval drift netting assessment to document spawning success under the different annual spring flow

conditions set out by the study plan. Work also continues to monitor the movements of radio-tagged adult sturgeon on the Black Sturgeon River via remote data loggers. These fish are also barred from accessing historic spawning areas by the Black Sturgeon Dam. In Nipigon Bay, preliminary investigations on the Gravel River are underway to determine if reproduction is occurring (drift netting for larvae).

Figure 6-13. OMNR and Ontario Power Generation are partnering in a flow manipulation study for lake sturgeon rehabilitation. Photo credit: OMNR.

6.1.2.1 Lower Trophic Level Research and Monitoring

LaMP 2006 reported on multi-agency cooperative efforts to sample the lower trophic levels of the Lake Superior food web.[2] Sampling and analysis of previously collected data continued in 2006 and 2007 by researchers from Environment Canada, DFO, OMNR, University of Minnesota-Duluth, Michigan Technological University, University of Wisconsin-Superior, WDNR, US EPA Great Lakes National Program Office and Mid-Continent Ecology Division, and USGS. Objectives are to assess the density and biomass of lower trophic level invertebrates, as well as spatial and temporal variations in nearshore and offshore areas of Lake Superior. Organisms comprising the lower trophic levels include phytoplankton, zooplankton, *Mysis* (tiny free-swimming crustaceans), and *Diporeia* (tiny bottom-dwelling amphipods) across the lake. A summary of the activities, progress, and select findings of these agencies are described below. Numerous publications and reports will be generated by this research.

[2] LaMP 2006. Chapter 6, pp. 13-16. Available at: http://www.epa.gov/glnpo/lakesuperior/.

Zooplankton

As described in detail in LaMP 2006, the offshore summer crustacean communities in Lake Superior are dominated by calanoid copepods, particularly the large, deep-living species *Limnocalanus macrurus* and *Leptodiaptomus sicilis*. Cladocerans make up a relatively small proportion of summer biomass, with the cladoceran community dominated by the large non-daphnid species *Holopedium gibberum*, a taxon typically associated with oligotrophic (cold, low nutrient) waters. Both total biomass levels and community composition have remained relatively consistent over the last decade.

Diporeia

Researchers have documented dramatic declines in *Diporeia* abundance and distribution in the lower Great Lakes. This has generated concerns that fish, particularly lake whitefish that rely heavily on these organisms for food, will be affected. In Lake Superior, *Diporeia* are most abundant in waters less than 100 m and tend to increase with depth from inshore to offshore (Figure 6-14). Within this depth zone, densities have remained relatively stable over time (Figure 6-15). At most sites deeper than 100 m, *Diporeia* densities have shown an overall downward trend during the monitoring period, although there has also been substantial variation.

One project, sponsored by the Michigan Great Lakes Protection Fund, has resulted in a description of the natural history of Lake Superior *Diporeia*, including nutrition (lipid content, gut fullness) and production (length-weight relationships, production to biomass ratios and year class structure). Progress has also been made in relating the distribution of amphipods to the deposition of organic carbon in Lake Superior and to the primary production in nearshore regions.

Scientists used the results of their *Diporeia* studies to develop a depth-based sampling scheme with coverage across Lake Superior. This design includes nearly 50 sites including many that have been monitored for up to 10 years.

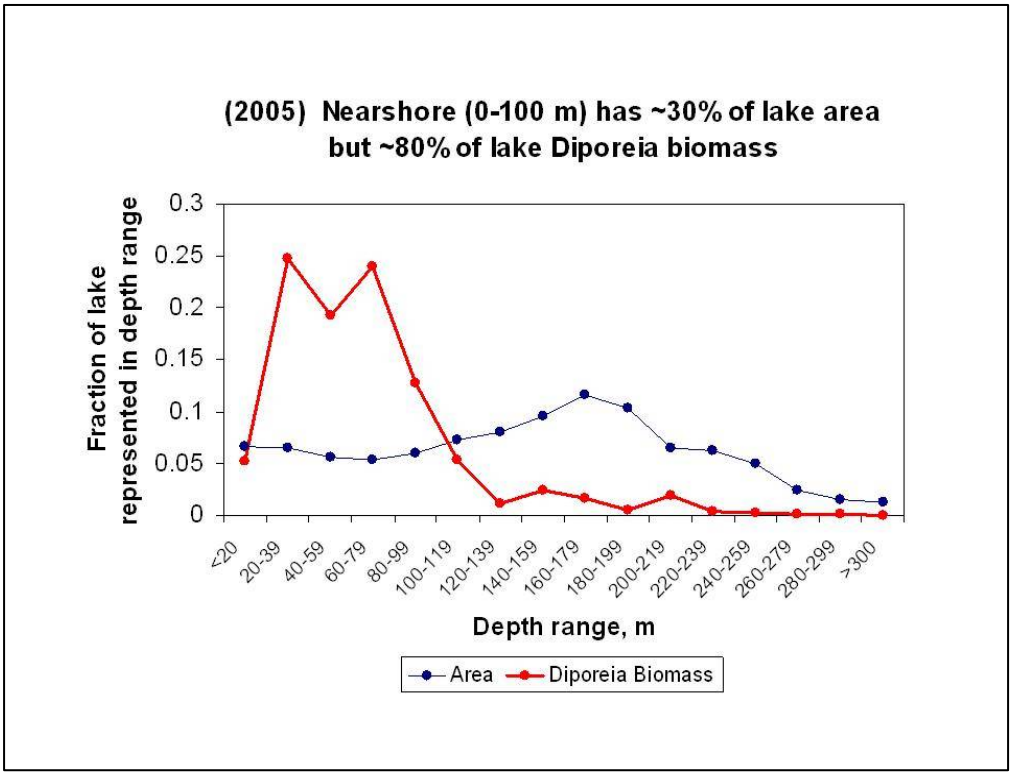


Figure 6-14. Abundance of Diporeia in Lake Superior at varying depths. Source: US EPA.

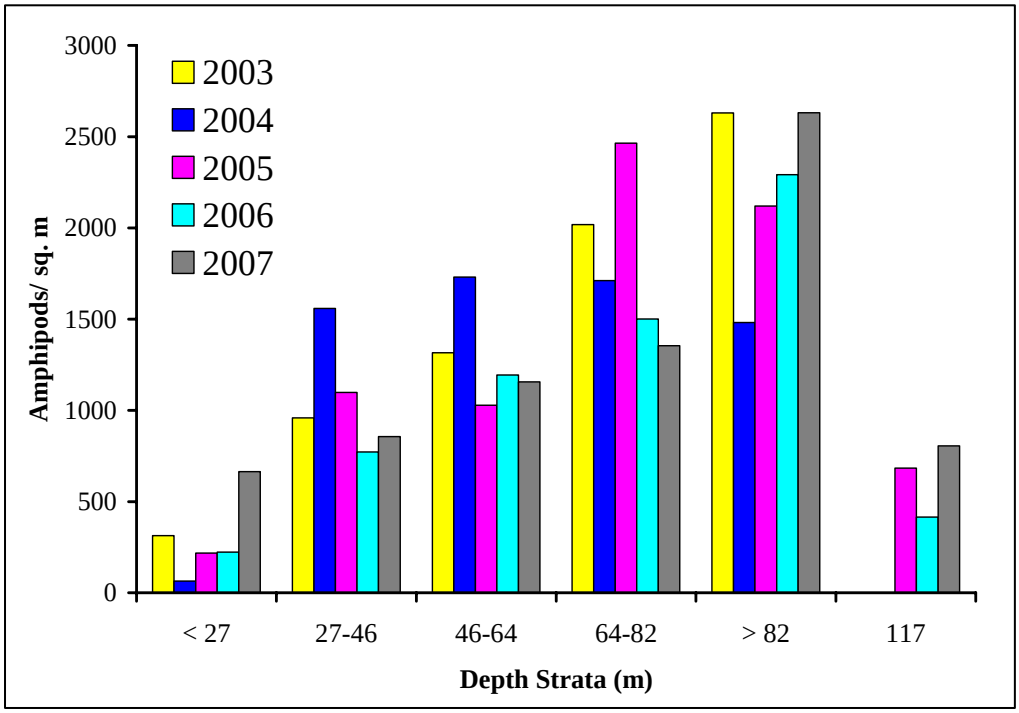


Figure 6-15. Diporeia abundance related to depth strata in Wisconsin waters of Lake Superior. Source: Steve Schram, WDNR.

Mysis

Mysis, commonly known as the opossum shrimp, is the largest invertebrate in Lake Superior. It occupies primarily hypolimnetic waters and has a simple lifecycle of approximately 2 years in Lake Superior. *Mysis* exhibits diel vertical migration, migrating up in the water column at dusk and descending to deeper water at dawn. *Mysis* eat detritus, phytoplankton, zooplankton, and benthos and are an important prey item for most species of fish at one life-stage or another.

Mysis were sampled during spring, summer, and fall in 2005. In 2006, a subset of sites from 2005 was sampled in each of the three seasons; while a number of new sites were sampled once during summer. The total number of sampling events in 2005 was 60, with 10, 18, and 32 stations visited in spring, summer, and fall. Slightly more stations were sampled in offshore waters than in nearshore waters, with the demarcation at 80 m. In 2006, fewer sites were sampled, but these will provide information on inter-annual variability.

Figure 6-16. *Mysis* were sampled in offshore and nearshore Lake Superior waters in both 2005 and 2006 to assess variations on density with depth. Photo credit: USGS.

Mysis density on a per-square-meter basis was greater in offshore than in nearshore waters across all three seasons (Figure 6-17). Mean density ranged from about 140 to 165 individuals/m^2 in offshore waters. Mean density in nearshore waters was about 30 individuals/m^2 in spring and fall but was higher in summer at about 80/m^2. The higher estimate in summer was due to one station with density estimates around 285/m^2. Mean density at each station increased with depth, similar to findings from other Great Lakes. A comparison of density estimates in Lake Superior compared to the other Great Lakes both historically and today is shown in Figures 6-18 and 6-19.

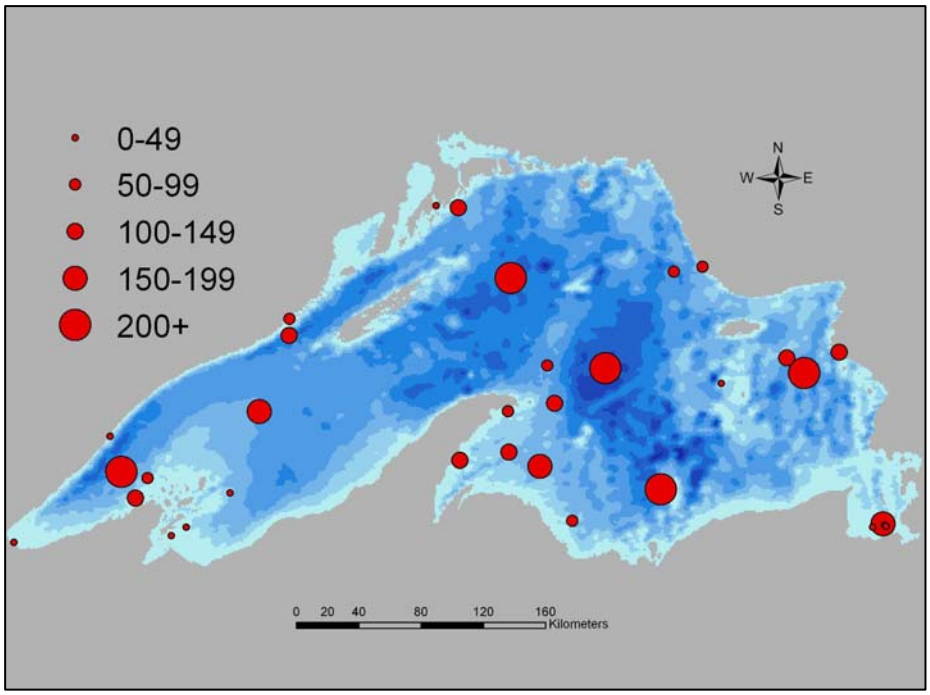


Figure 6-17. Mean density averaged among seasons for each station in 2005. Circle size is representative of *Mysis* density, with blue water showing bathymetry. Source: USGS.

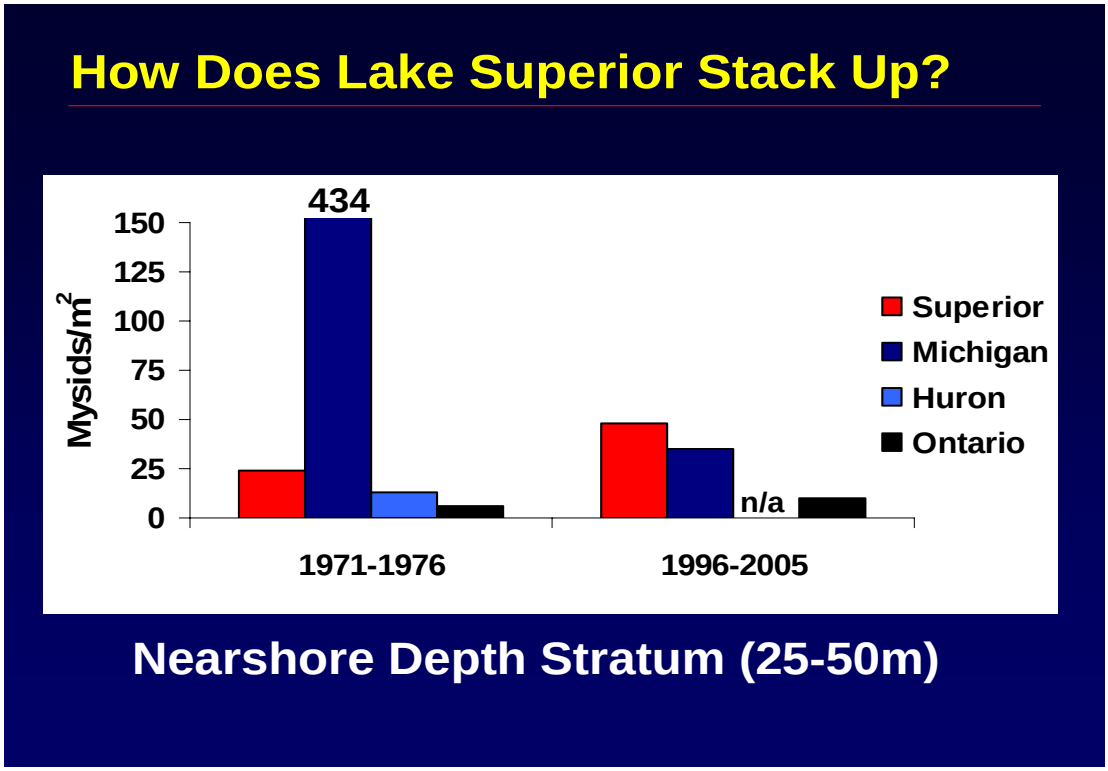


Figure 6-18. *Mysis* density in the Great Lakes at nearshore depths, 1971-1976 and 1996-2005. Source: USGS and US EPA.

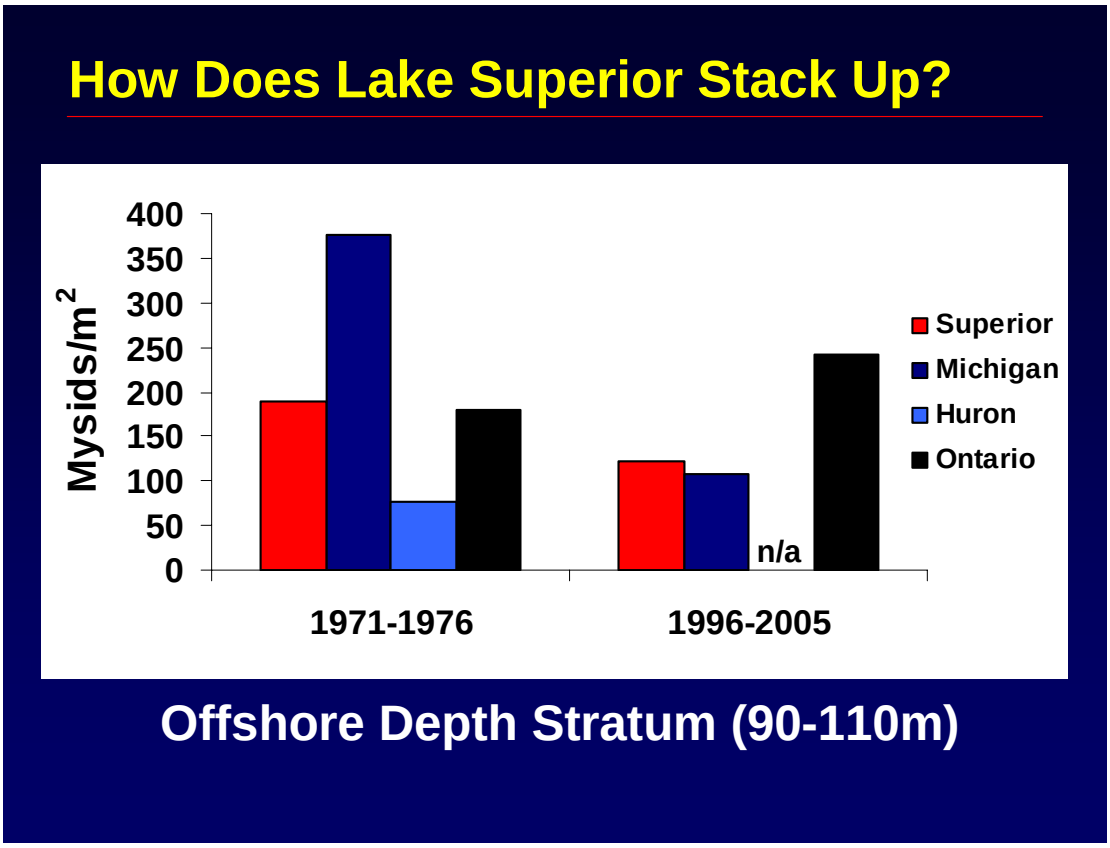


Figure 6-19. *Mysis* density in the Great Lakes at offshore depths, 1971-1976 and 1996-2005. Source: USGS and US EPA.

Putting the Pieces Together in Lake Superior. Lower trophic level samples collected in 2005 and 2006 are part of a larger study that also involves fish. These data will be used to examine food web relations in both nearshore and offshore waters, with particular emphasis on the importance of *Mysis* and *Diporeia* to the entire fish community. To understand Lake Superior dynamics, and to manage the fisheries as effectively as possible, it is important to integrate "top-down" (focus on fisheries) and "bottom-up" (focus on the physical/chemical environment, and the lower trophic levels) approaches, since abiotic and physical features provide the hydrologic and geochemical context in which all biologic interactions occur. One method of achieving this integration is through the use of ecological models, which are capable of integrating across multiple trophic levels and provide a statistically testable means for ecosystem assessment.

An upcoming study will use biomass size spectrum modeling to examine variability in trophic transfer resulting from differing food chain lengths, nearshore versus offshore environments, and anthropogenic development along the Lake Superior shoreline. In addition to the biomass size spectrum modeling, a detailed diet analysis of the gut contents of the predominant planktivorous and piscivorous fish species in the lake will be conducted. Overall, this research will provide comprehensive information on diet preferences in economically valuable fish communities, the identification of functional groups in the Lake Superior ecosystem, new information for fisheries

modeling, and multiple evaluations of the similarities and differences between the nearshore and offshore communities in this large lake.

The detailed diet analysis of the offshore communities will provide insight into the food preferences of the offshore community and allow comparisons of prey consumption with trawl and hydroacoustic estimates of prey availability, and thus identification of whether prey availability might be limiting offshore populations. Diet analyses of the nearshore food webs will provide a more comprehensive understanding of nearshore diet preferences, and findings can be extrapolated to apply to the other Great Lakes, indicating a set of reference conditions for some of the threatened or extirpated native species in the other Great Lakes (e.g., lake trout, all sculpin species, and siscowets lake trout).

One of the most significant findings to date is that 90 percent of all kiyi (deepwater chub) stomachs contained solely *Mysis*, as opposed to cisco (lake herring), which contained a mixture of zooplankton species. This result shows a potentially important difference in food sources in the two most abundant prey fish species in the lake.

6.1.3 Nuisance Species Developments/Efforts

Emerald Ash Borer (EAB) Update. This insect was introduced into North America sometime in the 1990s. It was first reported killing ash (genus *Fraxinus)* trees in the Detroit and Windsor areas in 2002. It continues to spread, and infestations have been found in the eastern Upper Peninsula and throughout lower Michigan, Ohio, northern Indiana, northern Illinois, Maryland, and recently in Pennsylvania and Toronto, Ontario (Figure 6-20).

Within the Upper Peninsula, EAB was first detected at Brimley State Park in Chippewa County in September 2005 and more recently was found at Straits State Park in Mackinac County in November 2007. Quarantines are in place prohibiting the transport of ash wood from either county. At Brimley State Park, all ash trees greater than one inch in diameter were removed within a half mile of the detection site. As yet, no additional EAB have been detected within this area. At Straits State Park, officials are determining the extent of the infestation before prescribing control or eradication strategies. To date, over two thousand trap trees have been established throughout the Upper Peninsula to facilitate EAB detection.

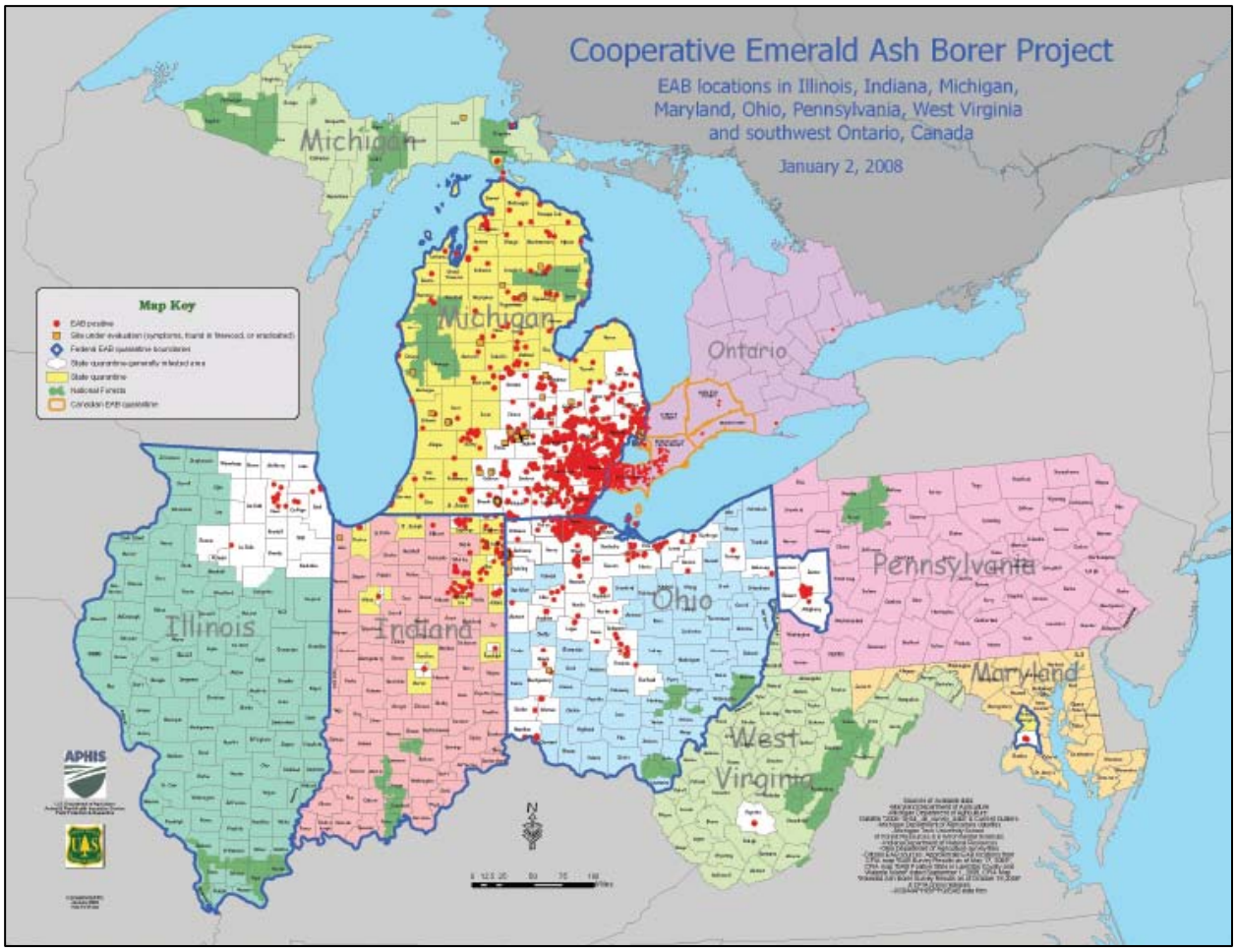


Figure 6-20. The Emerald Ask Borer continues to spread, with infestations in the eastern Upper Peninsula and throughout lower Michigan, Ohio, northern Indiana, northern Illinois, Maryland, Pennsylvania, and Ontario. Source: U.S. Department of Agriculture.

Invasive Free Zone Update. The goal of this long-term project, initiated in 2005, is to create an invasive free zone (IFZ) by eradicating invasive plants and restoring wildlife habitat on the Whittlesey Creek National Wildlife Refuge, associated private lands, and adjacent U.S. Forest Service property at the Northern Great Lakes Visitor Center (720 acres total). The project applies a systematic approach to control invasive species and restore wildlife habitat on a landscape scale. The first phase involved mapping to determine the extent of invasive species within the project boundary. In 2006, the focus shifted to treatment, and the restoration of infested areas began in 2007. After two years of refining mapping and treatment methods, project staff wrote a long-term management plan that can be found online at www.fws.gov/midwest/WhittleseyCreek/.

Another document developed as part of this project is the Invasive Free Zone Guidebook. It provides a resource for those who would like to establish an IFZ elsewhere and provides information to allow any interested agency, organization, or individual to create a new IFZ based on the original demonstration project. The guidebook can be found at

http://www.fws.gov/midwest/WhittleseyCreek/documents/IFZGuidebook.pdf. In addition to the guidebook, project staff are available to provide technical assistance. The Eastern Region of the U.S. Forest Service (a member of the Binational Program) has issued a challenge to national forests to create new IFZs, and other agencies are showing interest as well. Project staff hope to leverage existing support to continue the IFZ project and ultimately expand the existing boundaries of the IFZ to eradicate invasive species on a larger scale.

Figure 6-21. Members of the 2007 Youth Conservation Corps and IFZ staff at the Chequamegon Bay Invasive Free Zone. Photo credit: USFWS.

VHS - New Aquatic Invasive Species Cause for Concern in Great Lakes. Viral Hemorrhagic Septicemia (VHS) is a deadly fish virus that has been recently detected in lower Great Lakes freshwater fish. It has NOT yet (as of March 2008) been found in Lake Superior. VHS can infect a wide range of fish species and has been the cause of large fish kills in other parts of the Great Lakes. The VHS found within the Great Lakes is closely related to the VHS strain detected within Atlantic and eastern Gulf of St. Lawrence waters. VHS is considered an invasive species (not native to the Great Lakes), but scientists are not sure how it arrived. It may have come in with migrating fish from the Atlantic Coast, it may have hitch-hiked in ballast water from ships, or it may have been introduced by infected fish being imported, stocked, or used for bait. Other potential ways of spreading the virus are recreational boating/angling or waterfowl movements.

We now know that VHS was the cause of Great Lakes fish kills as early as 2003. This virus was diagnosed for the first time in the Great Lakes as the cause of large fish kills in Lake Huron, Lake St. Clair, Lake Erie, Lake Ontario, and the St. Lawrence River in 2005 and 2006.

Thousands of muskies, walleye, lake whitefish, freshwater drum (sheepshead), yellow perch, gizzard shad, redhorse, and round gobies died. Many chinook, white bass, emerald shiners, smallmouth bass, bluegill, black crappie, burbot, and northern pike were diseased but did not die in large numbers. This is the first time a virus has affected so many different fish species from so many fish families in the Great Lakes. VHS has no impact on human health.

Figure 6-22. While VHS has no impact on human health, the virus can kill infected fish. Photo credit: Dr. Jim Winton, USGS.

VHS is transmitted when infected fish shed the virus in their urine and reproductive fluids. VHS particles in the water infect gill tissue first, and then move to the internal organs and the blood vessels. The blood vessels become weak, causing hemorrhages in the internal organs, muscle, and skin. Fish can also be infected when they eat an infected fish. Fish that survive the infection will develop antibodies to the virus. Antibodies will protect the fish against new VHS infections for some time. However, the concentration of antibodies in the fish will drop over time, and the fish may **start shedding virus** again. This may create a cycle of fish kills that occurs on a regular basis.

Lake Superior features unique fishery resources, and several tribal entities, state agencies, and national parks are charged with their management and protection. In the fall of 2007, the NPS organized a meeting in conjunction with the *Making a Great Lake Superior 2007* conference in Duluth, Minnesota, to discuss the VHS threat and potential prevention and response strategies. In January 2008, a workshop was held at US EPA's Great Lakes National Program Office in Chicago that included representatives of the NPS, Grand Portage Band, and other tribal, federal, state, and academic entities to draft a VHS prevention, containment, and response plan.

The plan is focused on (1) preventing contamination of the waters of the four units of the National Park System located in the Lake Superior basin and the Grand Portage Indian Reservation, (2) detecting the introduction of VHS, and (3) responding to VHS detection and outbreaks. The plan will assist park and tribal managers, staff, and cooperators in assessing the risk of VHS introduction and, subsequently, planning and implementing the appropriate levels of prevention and monitoring actions for their area based upon that risk. The plan also provides a framework for response. The plan includes an analysis of the risks posed by the various pathways, or vectors, for transmission of the virus; a listing of known measures to prevent or contain the virus; an overall plan for the prevention of or response to the virus in the four National Park System units and the Grand Portage Indian Reservation and recommendations for enhancing cooperation with tribes, agencies, and other organizations. Emergency recommendations for the parks and the Grand Portage Band include an outreach campaign; boat decontamination; restrictions on the use of bait; and ensuring that agency operations and practices do not spread the virus, including agency-controlled vessel ballast water. The plan can

be viewed at http://www.nps.gov/piro/naturescience/upload/VHS%20Plan%20-%20Final%202008Mar14.pdf.

How Can You Help?

- Drain all water from your boat, motor, bilge, live wells, trailer, containers, bait buckets, coolers, and fishing equipment before leaving the lake or shoreline.
- Clean and disinfect all recreational equipment with a 10 percent household bleach/water solution. Chlorine is known to kill VHS.
- Do not move live or dead fish (including unused minnows), fish eggs, or fish parts between waters. All fish must be dead before leaving the landing or shoreline. Ice your catch, and discard your minnows in secure trash.
- Do not use minnows unless they were purchased from a certified bait dealer.
- Do not release live fish into wild waters (i.e., unused bait minnows, exotic ornamental fish).
- Remove all visible plants, animals, and mud from your boat and trailer before leaving shoreline.
- Know and follow state, tribal, and federal regulations on VHS prevention actions.

Aquatic Invasive Species
Complete Prevention Plan Under Development

Background and Purpose

Lake Superior has been the focus of special protection and restoration initiatives for many years in recognition of its unique status among freshwater lakes in the world. Its ecosystem and economy have been severely impacted by aquatic invasive species and it remains at serious risk for introduction of new aquatic species through a number of open pathways those species use to enter the lake. To address this risk, the Lake Superior Workgroup initiated development of a prevention plan for aquatic invasive species in 2006. The purpose of the plan is to develop a Lake Superior Aquatic Invasive Species Complete Prevention Plan to close pathways for new invasions based primarily on:

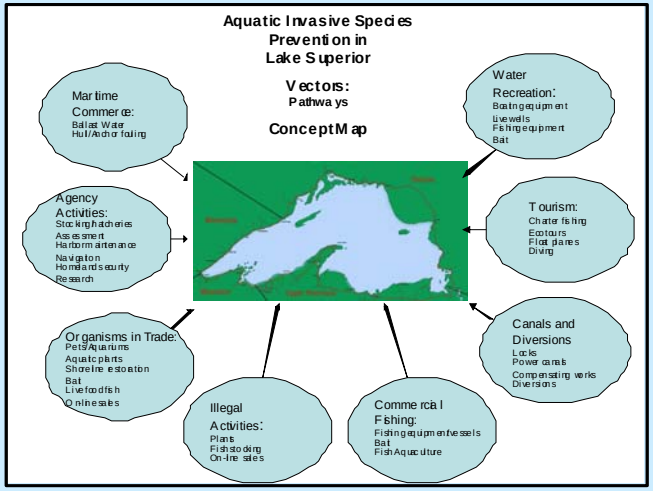
- The U.S. Great Lakes Regional Collaboration AIS prevention recommendations
- U.S. and Canadian federal prevention programs and regulations
- State and Provincial prevention programs and regulations
- Lake Superior Lakewide Management Plan
- Other key available documents and information

The prevention plan will include:

- A focus on prevention of new species introductions to Lake Superior
- Closure of pathways used by aquatic invasive species
- Coordination of programs and actions between the U.S. and Canada
- Monitoring/rapid response capacity for new invasions

Progress

The project originated with the Habitat and Aquatic Communities Committees of the Lake Superior Workgroup in 2006. A Project Team was established in 2007 and a concept map for identifying vectors and the associated pathways by which aquatic invasive species enter Lake Superior was drafted. The draft concept map with the outline of vectors/pathways is at the end of this chapter. The concept map and plan outline was presented at the Making a Great Lake Superior conference in October, 2007 and ideas for stakeholder input to the plan were solicited. A draft plan is now under development. For an outline of upcoming actions with regard to the development of the plan, see Section 6.2.4.



Current Status of Sea Lampreys. The estimated abundance (with 95 percent confidence interval) of spawning-phase sea lampreys in Lake Superior in 2007 was 65,500 (51,300-97,400) (Figure 6-23). Spawning-phase sea lamprey abundance has been 94,000 on average since 2000, which is equivalent to the average population found in Lake Superior in the early 1980s. Although this is approximately 10 percent of pre-control spawning-phase sea lamprey abundance, it remains above the estimated target levels of 35,000 spawners required to achieve the fish community objective of 5 marks per 100 fish. Wounding rates also continue to show an upward trend since 2000.

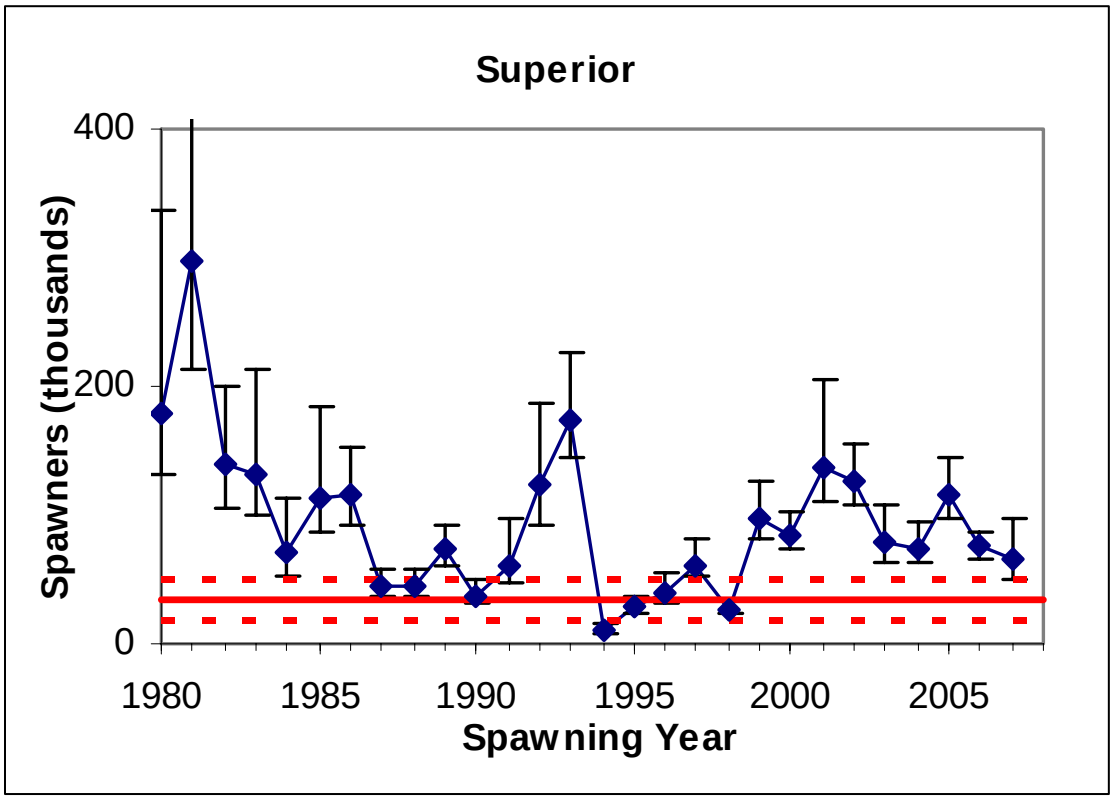


Figure 6-23. Abundance of spawning-phase sea lampreys with 95 percent confidence intervals from 1980 to 2007. The solid red line represents the suppression target of 35,000 spawning-phase sea lampreys; the dashed red lines are the 95 percent confidence intervals for the target. Source: DFO-Sea Lamprey Control.

To date, sea lampreys have been collected from 137 of the 1,915 tributaries to Lake Superior. Of these, 52 receive regular treatment on a 3- to 5-year cycle, and an additional 19 have been treated at least once in the last 10 years. Barriers are in place in 15 tributaries and block access to spawning and nursery habitats, reducing sea lamprey production from these rivers.

During 2006 and 2007, a total of 62 treatments took place, comprised of 53 streams and 9 lentic areas (shallow nearshore waters at tributary mouths). This increased control effort compares to an average of 18 streams and one lentic area treated annually during the period 2000 to 2005. The effects of the increased treatment effort should be observed beginning in 2008.

Assessment of larval sea lamprey populations in support of control has remained constant since 2000 at approximately 105 streams per year. However, since 2004, greater effort has been expended in evaluating streams immediately following treatment to detect populations of sea lampreys that may have survived the lampricide application. If significant survival is suspected, the stream may be prioritized for re-treatment within the same year or one year later.

Assessment of spawning-phase populations continues in 19 tributaries to Lake Superior. Mark-recapture estimates of abundance within these tributaries are used within multiple regression models, along with other stream-specific biotic and abiotic factors, to estimate lakewide abundance of spawning-phase sea lampreys (Figure 6-23). This estimate is the primary method used to evaluate the long-term effectiveness of the sea lamprey management program in Lake Superior.

Nearshore Fish Community Assessment and Aquatic Invasive Species Monitoring. Nearshore embayments represent some of the habitat most heavily impacted by human activity in Lake Superior. In eastern Lake Superior, Batchawana Bay and Goulais Bay are areas with high shoreline development associated with both cottages and year-round homes. A three-year project is underway in these locations to monitor the health of the fish community and detect the appearance of aquatic invasive species (AIS). AIS represent a significant threat to the health of fish communities in the Great Lakes, including Lake Superior. Early detection of AIS and assessing their extent will provide valuable information for research and planning strategies to mitigate their impacts on native fish communities.

Rainbow Smelt - A Bottleneck to Native Fish Recovery?

Researchers from Michigan State University joined the USGS and OMNR in 2006 to assess impediments to ciscoe larval survival to age 1. Researchers were particularly interested in the impact of the non-native, predatory rainbow smelt. It was felt that, despite their small size, rainbow smelt may impose a big effect on the survival of newly hatched native cisco. Field investigations of this relationship demonstrated that individual rainbow smelt consumed very few larval cisco. However, because of the sheer abundance of rainbow smelt, it was estimated that rainbow smelt predation may have a profound effect on larval cisco survival and recruitment into the population. This knowledge of impacts in Lake Superior is important in planning for restoration in other areas of the lake and in the lower Great Lakes where smelt are also abundant. Finding means of releasing cisco from probable bottlenecks, like that imposed by rainbow smelt predation, could aid in cisco recovery in the Great Lakes.

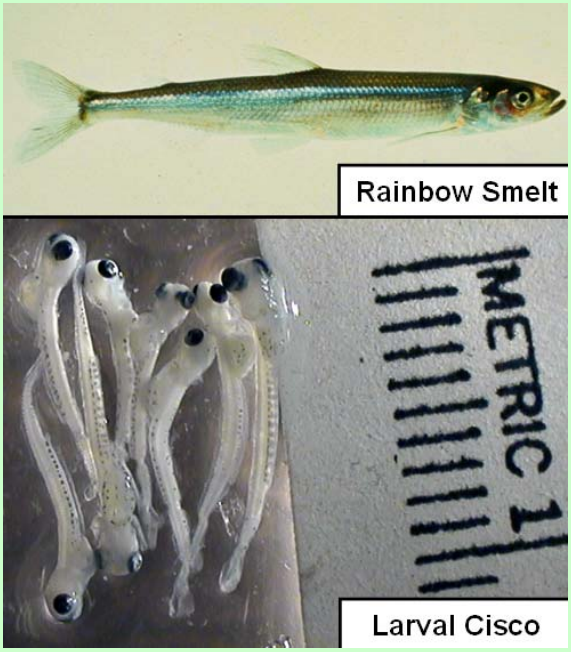


Photo credit: Great Lakes Fishery Commission.

Tracking AIS along the South Shore of Lake Superior. The USFWS Ashland, Wisconsin, fishery office conducted ruffe and other AIS surveillance with bottom trawl, trap, and fyke net surveys at 18 locations along the south shore of Lake Superior in the spring and fall of 2006 and 2007. This survey has been conducted since 1998, as called for in the Ruffe Control Plan. Other AIS species collected and monitored during these surveys include round goby, white perch, three-spine stickleback, and common carp. Additionally, information and outreach are provided to boaters, anglers, harbor masters, elementary schools, and sport fishing organizations.

Surveys are conducted on the periphery of the ruffe range and eastward where ruffe have not yet been detected to search for new infestations. In 2006, the ruffe range expanded eastward 226 km from Marquette, Michigan, to Whitefish Bay, Michigan. Ruffe were detected by USFWS field crew in Grand Marais, Michigan, and by anglers in Little Lake Harbor and Tahquamenon River. Anglers familiar with outreach materials contacted state and federal fishery offices, and specimens were identified as ruffe. No range expansion was detected in 2007. In Lake Superior, the ruffe range currently spans the entire south shore from the Duluth-Superior Harbor, Minnesota/Wisconsin, to Whitefish Bay, Michigan; and along the north shore from the Duluth-Superior Harbor to Thunder Bay, Ontario.

Preventing the Spread of AIS from Bait Buckets and Aquaculture. The potential exists for AIS to spread to uninfested waters through the transport of wild harvested baitfish and aquacultured fish. Baitfish and aquaculture industries are diverse and complex, as are their risks of spreading AIS. To deal effectively and fairly with this potential vector, it is important to characterize the industry according to its risks of spreading AIS. One approach to this problem is to apply the Hazard Analysis and Critical Control Point (HACCP) concept similar to that used by the seafood industry to minimize seafood consumption health risks. The HACCP approach concentrates on the points in the process that are critical to the safety of the product, minimizes risks, and stresses communication between regulators and the industry.

To address the potential for AIS, including some fish pathogens and parasites—often referred to as biological pollution—to spread to uninfested waters through: 1) the movement of equipment (i.e., boats, trailers, nets, waders, water collection devices, etc.) used by federal, state, tribal, and private resource researchers, managers, consultants, and enforcement personnel; and 2) the transfer of baitfish and fish raised for stocking into public and private waters, the Great Lakes Network Sea Grant offices conducted outreach and educational activities from 2004 to 2007.

Twenty-seven AIS-HACCP workshops were conducted within the Great Lakes basin, and approximately 540 individuals participated from state, federal, and tribal resource management agencies, private aquaculture, wild baitfish harvest, environmental consultants, public fish hatcheries, extension education, law enforcement, environmental consultants, and researchers. Workshops were designed with the “train the trainer” approach in mind. The AIS-HACCP video *From Net to Sale* was duplicated, and 1000 copies were allocated to project personnel for use and distribution in their training workshops. Twenty-one percent of workshop respondents to the survey reported conducting over 100 additional workshops reaching approximately 2000 individuals.

Michigan's Ballast Water Control Permit. Under its new ballast water control permit to regulate AIS discharge, the Michigan Department of Environmental Quality issued 92 permits to individual ocean-going ships in 2007. These represented 37 different companies. All ocean-going ships must obtain a permit from MDEQ for port operations and either not discharge ballast water or treat the ballast water before discharge with an approved treatment technology. All permits issued in 2007 were for no discharge of ballast water; no ships installed approved treatment to allow discharge. None of the permitted ships conducted port operations in Michigan's Lake Superior ports.

6.1.4 Education/Outreach Initiatives

The following section discusses initiatives related to outreach and education efforts.

Connecting The Coast – A New Service Learning Web Site Empowering Students to Solve Lake Superior Issues. Complex environmental issues face the Lake Superior region, its communities, and citizens. A new service learning web-based curriculum, called "Connecting the Coast" (CTC), challenges students to help solve these issues.

CTC is targeted to high school students, as future Lake Superior community leaders. It guides students through an investigation of research compiled by the Lake Superior Binational Program on critical environmental issues as identified in the Lake Superior LaMP.

The CTC curriculum uses a "systems" approach, stressing the interaction of social, economic, and natural resource forces in an investigation of critical issues. The CTC moves students from discovery to action as they design their own projects that result in personal or community change to address a critical issue. The curriculum incorporates reflection as a way students can examine the outcomes of their service learning experience through self-directed evaluation and sharing.

The CTC web site (http://connectingthecoast.uwex.edu) includes hundreds of photos, interactive links, references, and fun activities students can use to explore issues, project ideas, and ways to reflect on their experience. Historic and cultural viewpoints are integrated into the curriculum to broaden perspectives on each issue. (See also Chapter 8, section 8.1 of LaMP 2008.)

Two Outreach Videos on Invasive Species Produced. The Great Lakes Indian Fish and Wildlife Commission received funding from state and federal agencies to produce two episodes of the television program *Discover Wisconsin*. One episode focused on AIS and featured a variety of lake user groups including fishermen, resort owners, tribal members, and scuba divers. It highlighted the fact that AIS affect nearly everyone, and everyone shares the responsibility to prevent their spread. The cooperative efforts of various government agencies, tribes, and non-governmental groups were also highlighted. The episode aired in June of 2006 and will be rebroadcast twice.

The other episode focused on terrestrial invasives and featured a variety of user groups impacted by terrestrial invasive species including private woodland owners and tribal members. A variety of cooperative efforts around the State of Wisconsin were featured to shed light on current

education outreach and control efforts. The episode aired in June of 2007 and will be rebroadcast twice.

Lake Superior Education and Outreach Programs Get Basin Students and Residents on the Water. Lake Superior Research Institute (LSRI) and University of Wisconsin-Extension (UW-Extension) Partnership at University of Wisconsin-Superior (UW-Superior) have developed a partnership over the past 10 years to develop and implement watershed education programs in the basin. A number of programs have been implemented with the support of a network of educators in the region, as well as external grant funds. Several of the programs utilize the UW-Superior research vessel, the *LL Smith, Jr.*, to provide on-the-water programs for a variety of audiences that include citizens, children in grades K through 12, college students, and teachers. A program that targets local government officials, *A View From the Lake*, was developed through a partnership with Minnesota Sea Grant and is an extension of a Lake Superior Non-point Education for Municipal Officials (NEMO) program. This initiative has brought information on the connection between land use and water quality to communities at eight ports in western Lake Superior and reaches over 400 people per season. In addition to *A View From the Lake* program, other groups that use the vessel each season include ten to twelve 5th grade classes for their Lake Superior unit, Elderhostel programs, teacher training, and university programs. Approximately 900-1,100 people participate in programs on the lake each year.

Other programs at UW-Superior include a citizen stream volunteer monitoring program, teacher training and assistance with Lake Superior-based curriculum development, coastal wetland research, and assistance to local planning committees who want to incorporate protection of water resources into their comprehensive plan. A watershed education resource center that loans a variety of sampling equipment as well as microscopes and other resources is maintained on campus. As a result of these programs, citizen volunteers are monitoring 15 streams in the Lake Superior basin (Wisconsin and Minnesota), the school district of Superior has incorporated Lake Superior-based units into the 6th and 7th grade curricula, staff are working with Douglas County, Wisconsin, on their comprehensive plan, and three coastal wetlands are being monitored by researchers, students, and volunteers in order to evaluate the health of these estuaries.

Managing Woodlands in the Clay Plain of Lake Superior. There are nearly 3 million acres of forest land along Wisconsin's Great Lakes coasts. As resource managers, loggers, and landowners have become familiar with the basic concepts and principles of forestry, including the implementation of Forestry Best Management Practices (BMPs) for Water Quality, they are asking more sophisticated questions on forest management that reflect regional or site specific concerns. In order to address management questions that are specific to the Lake Superior watershed, the WDNR Division of Forestry compiled forest management recommendations for lands in Lake Superior's red clay region and for lands with trout streams draining to Lake Superior.

Managing Woodlands for Wisconsin's Coastal Trout Streams (WDNR, PUB-FR-386 2007) provides an overview of trout ecology and how the health of trout streams can be impacted by the condition of forests. Considerations for landowners on how to control runoff and

sedimentation and protect trout streams during forest management activities are included in the guide.

Managing Woodlands on Lake Superior's Red Clay Plain (WDNR, PUB-FR-385 2007) describes the high potential for erosion and the unstable slopes common along Lake Superior's southern shore. Information is provided on how landowners can conduct sustainable forestry activities by slowing the flow of water runoff.

Technical reports, table-top displays, and information and training workbooks were also created as part of this grant project. The technical reports contain much more detailed information and are intended for someone with a background in forestry, fisheries, or soils. The displays are available for use at conferences, fairs, workshops, or other events. Information and training workbooks contain all of the materials discussed above for each subject area, along with full-day and hour-long PowerPoint presentations.

6.2 CHALLENGES AND NEXT STEPS

The Habitat, Terrestrial Wildlife, and Aquatic Communities Committees have identified a number of challenges as we move forward in the implementation of the LaMP for Lake Superior. In general, all committees will continue to encourage projects by partner agencies and governments that further the objectives of the LaMP. All the agency partners are acting within their areas of jurisdiction with the good of the Lake Superior basin in mind. Many of the committees' and partners' accomplishments are highlighted in this report. The committees will remain focused on forwarding the message, "complete all projects with the big lake in mind."

The committees have identified five broad action areas: Information Gathering, Monitoring, Communication, Planning, and Stewardship. Taking effective actions in these areas can be said to represent the overall challenges to achieving a sustainable Lake Superior ecosystem that is a global model for resource management.

More specifically, active and continuous *information gathering* is required to help us understand and piece together the intricacies of the complex relationship between living organisms and their physical environment. *Monitoring* may take many forms and is ultimately designed to direct management activities and policy development. Monitoring of population trends (change, stability), or research-oriented monitoring to gain an understanding of the cause and effect of specific actions on species or habitats, or why a project was a success or failure, will provide sign posts to improve future management within the lake basin. Together, these actions will provide insight and knowledge that can be communicated to governments, policy makers, planners, managers, and citizens of the basin. This will enable informed and effective *communication* about the links between land and resource use and ecosystem health with industry, business, landowners, and the public. Moving toward actively *planning* at a basinwide scale will assist in addressing the gaps in, and impediments to, sustainable resource management of land and water resources, help speak to the needs of today, and prepare us for future challenges. Finally, addressing *stewardship* needs will help foster the development of a healthy basin ecosystem that is resilient to perturbations from human activities and provides a broad

range of sustainable benefits to its citizens. This category of active stewardship actions includes those "on-the-ground" activities that most directly impact the ecosystems that make up the basin.

The challenge of protecting and preserving Lake Superior and its basin require a long-term approach by governments, industry, NGOs, and individuals. In 2006, the committees noted a number of significant needs that, if successfully addressed, would make important contributions to the LaMP goals related to the Lake Superior ecosystem and, ultimately, human health. While these needs remain, progress has been made on many of them.

The committees and partner agencies have identified a number of steps that will help us begin to meet the needs and challenges described above, over the next two years. Future accomplishments continue to be dependent upon commitments by governments and other organizations, including individuals, to support the science, resource management, and legislative activities that will protect and restore the basin. During the 2008-2010 reporting period, the committees will continue to support, resource, and seek funds and partners for presently occurring projects and issues, new projects, and emerging issues.

6.2.1 Information Gathering

- ***Challenge: Provide ongoing support and maintenance of geographic information.***

Next Steps: This information is essential to the effective implementation of the LaMP, as it provides natural resource information to decision makers. One of the databases associated with the Lake Superior Decision Support System contains information on important habitat conditions in the Lake Superior basin. An updated version of the database and the corresponding important habitat conditions map is available from the following web site: http://www.nrri.umn.edu/lsgis/index.htm. The important habitat sites database has also been included in the newly created Great Lakes Basin GIS-Decision Support System produced by the Institute for Fisheries Research at the University of Michigan-Ann Arbor. Long-term maintenance of the Lake Superior GIS databases is still required. This will assist the Habitat Committee in meeting an ongoing challenge to fill information gaps on the status and trends of habitat conditions in the Lake Superior basin and develop management recommendations to protect and restore important habitat sites.

In another effort related to gathering geographic information, the Superior Work Group recently formed an Ad Hoc Mining Committee. The committee is working to develop a GIS-based tool which would be useful to decision-makers and may help to avoid damage to environmentally sensitive areas identified through the Binational Program's Important Habitat mapping effort. The Province of Ontario already publishes information in map form, locating geology and current mine workings. The Ad Hoc Mining Committee has discussed the need to find funding to compile and extend that information to the U.S. side of the basin in the coming year. For additional information on the Ad Hoc Mining Committee, see Chapter 7, section 7.1.8.

6.2.2 Monitoring

- ***Challenge: Put in place biological, community-based monitoring programs on which to base species status and trends reports.***

Next Steps: Using the GLEI project results as a baseline, continue to collect data that will allow comparisons to be made with future changes in coastal resources and provide a mechanism to track further degradation or improvements in health of the coastal region of Lake Superior.

6.2.3 Communication

- ***Challenge: Educate the public on important habitat and ecological resources in the Lake Superior basin by expanding the use of interactive information kiosks.***

Next Steps: The Habitat Committee will continue to maintain the current kiosk network and update information in the databases that support the kiosks.

- ***Challenge: Develop communication tools to present information, issues, and solutions related to the Lake Superior basin ecosystem.***

Next Steps: Continue to promote the Connecting the Coast curriculum by presenting information about its availability and use to high school and state science teachers.

Next Steps: The Habitat and Terrestrial Wildlife Committees will maintain and update their joint web site. In addition, the committees will work with the Communications Committee as appropriate to develop communication tools.

6.2.4 Planning

- ***Challenge: Develop ecologically based integrated management plans for all watersheds within the Lake Superior basin.***

Next Steps: The Superior Watershed Partnership is teaming with the Nature Conservancy to develop a watershed management plan for the Two-Hearted River in Luce County. The Two-Hearted River watershed is considered one of the most pristine wilderness watersheds on the south shore of Lake Superior. The river is a cold water trout fishery that has been designated a Michigan Natural River (Part 305, P.A. 451) and an Outstanding State Resource Water. The watershed itself is listed as an important habitat site by the Habitat Committee and contains Beavertown Lakes, McMahon Lake, and Swamp Lakes, which are also listed because of globally rare plant communities. In 2007, the Nature Conservancy completed a riparian analysis of the watershed using GIS maps and verification by field visits. The overarching goal of this analysis was to identify the functional riparian area of the Two-Hearted River system and to assess its sensitivity to further development and forest management activities based on the characteristics. The results of the analysis are being used to develop the watershed management plan and eventually, to assist Luce County in revising zoning ordinances to better protect the river.

Figure 6-24. The Two-Hearted River in Michigan's Upper Peninsula was a favorite fishing spot of author Ernest Hemingway and had a prominent place in his "Nick Adams" stories. Photo credit: Superior Watershed Partnership.

- ***Challenge: Address preventative measures related to aquatic species transport in ballast water in Lake Superior.***

Aquatic Invasive Species Complete Prevention Plan – Next Steps. There remains much to be done to protect Lake Superior from new introductions of AIS from around the world and from within the Great Lakes. Development of a complete prevention plan is proposed as a timely tool to integrate and augment all the disparate pieces of regulation and education to accomplish that protection. Canada and the U.S. share this responsibility and the Lake Superior LaMP process is uniquely positioned to establish this protection. The LaMP is the primary delivery tool for a number of binational processes dedicated to protecting the lake and also for implementing many recommendations of the U.S. Great Lakes Regional Collaboration.

When completed, the draft plan will be reviewed by the Superior Work Group, and a stakeholder comment process will be initiated. Following stakeholder input, the draft will be reviewed by the Lake Superior Task Force, and final review and approval steps will be determined.

Minnesota Pollution Control Agency Ballast Water Permit Development - Next Steps. The Minnesota Pollution Control Agency (MPCA) continues to promote additional federal efforts to control the ship-mediated spread of AIS. Given the uncertain timeline for federal action, the

MPCA is moving forward with the development of a general National Pollutant Discharge Elimination System / State Disposal System (NPDES/SDS) permit for ballast water. The permit is initially planned to cover ballast water discharges from commercial vessels on Minnesota waters of Lake Superior and associated harbors. The permit could include best management practices, monitoring requirements, specific discharge performance standards, and other requirements—all of which will combine to assure protection of Minnesota waters from AIS. A final permit is expected to be available by September 30, 2008.

- ***Challenge: Plan for sustainable land, shoreline, and water development.***

Upper Great Lakes Study Underway. The International Joint Commission appointed the International Upper Great Lakes Study Board in February 2007 to examine whether the regulation of Lake Superior outflows can be improved to address the evolving needs of the upper Great Lakes. The study area includes Lakes Superior, Michigan, Huron, and Erie, and their interconnecting channels (St. Marys River, St. Clair River, Lake St. Clair, Detroit River, and Niagara River), up to Niagara Falls.

Major topics for investigation include determining the factors that affect water levels and flows, developing and testing potential new regulation plans, and assessing the impacts of these potential plans on the ecosystem and human interests. Staff from the WDNR Office of the Great Lakes will co-chair the Ecosystem Technical Work Group.

Physical changes in the St. Clair River will be investigated early in the study as one factor that might be affecting water levels and flows. Depending on the nature and extent of the physical changes, and their potential impact on water levels and flows, the study may also explore potential remediation options.

- ***Challenge: Ensure the maintenance of healthy aquatic communities on rivers with, and those identified for, hydro power development.***

Next Steps: OMNR is working with Ontario Power Generation on a long-term study to determine the impacts of fluctuating water flows and levels on sturgeon populations in the Kaministiquia River in Thunder Bay.

- ***Challenge: Maintain continued support for LaMP projects in order to accomplish LaMP goals by continuing efforts by the LaMP to ensure governments keep the LaMP in the top priority of their funding targets.***

Next Steps: 1) Communicate to senior-level managers in the Canadian federal and Ontario provincial government the importance of the Canada-Ontario Agreement as a funding mechanism to achieve LaMP objectives; 2) List the important U.S. funding sources and means to keep LaMP priorities at the top of grant lists.

6.2.5 Active Stewardship

- ***Challenge: Protect critical lake and tributary habitats.***

Next Steps in Ontario: 1) Ontario will continue to work with Parks Canada to ensure the details in the new Lake Superior National Marine Conservation Area management plan support LaMP goals and objectives.

- ***Challenge: Cooperate with Great Lakes Regional Collaboration's Wetlands and Habitat Initiative to restore and enhance important Lake Superior upland, wetland, riparian, and tributary habitats.***

Next Steps for U.S.: Assist the U.S. Interagency Task Force in utilizing Lake Superior important habitats in setting priorities for the Wetlands and Habitat Initiative. Work with the Wetlands and Habitat Initiative to link GLRC goals with Lake Superior habitat actions and needs.

6.3 REFERENCES

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Goodyear, C.S., Edsall, T.A., Ormsby Dempsey, D.M., Moss, G.D. and Polanski, P.E. 1982. Atlas of the spawning and nursery areas of Great Lakes fishes. Volume two: Lake Superior. U.S. Fish and Wildlife Service, Washington, DC FWS/OBS-82/52.

Krueger, C.C. and P.E. Ihssen. 1995. Review of genetics of lake trout in the Great Lakes: history, molecular genetics, physiography, strain comparisons, and restoration management. J. Great Lakes Res. 21 (Supple. 1):348-363.

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The following is a list of the 22 peer-reviewed papers that will appear in the *Journal of Great Lakes Research* (JGLR) in early 2008. Papers focused exclusively on Lake Superior are highlighted in bold; however, most of the papers include data and analysis of indicators for Lake Superior.

JGLR Special Issue (Vol. 33, Special Issue 3): Coastal Indicators

1. Niemi, G.J., Kelly, J.R., and Danz, N.P. 2007. Foreword: Environmental indicators for the coastal region of the North American Great Lakes: Introduction and prospectus. *J. Great Lakes Res*. 33 (Special Issue 3).
2. Bhagat, Y., Ciborowski, J.J.H., Johnson, L.B., Uzarski, D.G., Burton, T.M., Timmermans, S.T.A., and Cooper, M.J. 2007. Testing a fish index of biotic integrity for responses to different stressors in Great Lakes coastal wetlands. *J. Great Lakes Res*. 33 (Special Issue 3).
3. Brady, V.J., Ciborowski, J.J.H., Johnson, L.B., Danz, N.P., Holland, J.D., Breneman, D.H., and Gathman, J.P. 2007. Optimizing fishing time: one vs. two-night fyke net sets in Great Lakes coastal systems. *J. Great Lakes Res*. 33 (Special Issue 3).
4. Brazner**,** J.C., Danz,' N.P., Trebitz, A.S., Niemi, G.J., Regal, R.R., Hollenhorst, T.P., Host, G.E., Reavie, E.D., Brown, T.N., Hanowski, J.M., Johnston, C.A., Johnson, L.B., Howe, R.W., and Ciborowski, J.J.H. 2007. Responsiveness of Great Lakes wetland indicators to human disturbances at multiple spatial scales: a multi-assemblage assessment. *J. Great Lakes Res*. 33 (Special Issue 3).
5. Croft, M., and Chow-Fraser, P. 2007. Development of the wetland macrophyte index to detect degree of water-quality impairment in Great Lakes coastal marshes. *J. Great Lakes Res*. 33 (Special Issue).
6. Frieswyk, C.B., Johnston, C.A., and Zedler, J.B. 2007. Identifying and characterizing dominant plants as an indicator of community condition. *J. Great Lakes Res*. 33 (Special Issue 3).
7. **Grandmaison, D.D., and Niemi, G.J. 2007. Local and landscape influence on red-winged blackbird (*Agelaius Phoeniceus*) nest success in Great Lakes coastal wetlands. *J. Great Lakes Res*. 33 (Special Issue 3).**
8. Hanowski, J.M., Danz, N.P. Howe, R.W., Regal, R.R., and Niemi, G.J. 2007. Considerations for monitoring breeding birds in Great Lakes coastal wetlands. *J. Great Lakes Res*. 33 (Special Issue 3).
9. Hollenhorst, T.P., Brown, T.N., Johnson, L.B., Ciborowski, J.J.H., and Host, G.E. 2007. Methods for generating multi-scale watershed delineations for indicator development in Great Lake Coastal ecosystems. *J. Great Lakes Res*. 33 (Special Issue 3).
10. Howe, R.W., Regal, R.R., Hanowski, J.M., Niemi, G.J., Danz, N.P., and Smith, C.R. 2007. An index of ecological condition based on bird assemblages in Great Lakes coastal wetlands. *J. Great Lakes Res*. 33 (Special Issue 3).
11. Johnston, C.A., Watson, T., and Wolter, P.T. 2007. Sixty-three years of land alteration in Erie Township. *J. Great Lakes Res*. 33 (Special Issue 3).
12. Johnston, C.A., Bedford, B., Bourdaghs, M., Brown, T.N., Frieswyk, C., Tulbure, M., Vaccaro, L., and Zedler, J.B. 2007. Plant species indicators of physical environment in Great Lakes coastal wetlands. *J. Great Lakes Res*. 33 (Special Issue 3).
13. Kang, M., Ciborowski, J.J.H., and Johnson, L.B. 2007. The influence of anthropogenic disturbance and environmental suitability on the distribution of the nonindigenous amphipod *Echinogammarus ischnus* at Laurential Great Lakes coastal margins. *J. Great Lakes Res*. 33 (Special Issue 3).
14. Kireta, A.R., Reavie, E.D., Danz, N.P., Axler, R.P., Sgro, G.V., Kingston, J.C., Brown, T.N., and Hollenhorst, T.P. 2007. Coastal geomorphic and lake variability in the

Laurentian Great Lakes: implications for a diatom-based monitoring tool. *J. Great Lakes Res*. 33 (Special Issue 3).

15. **Miller, C., Niemi, G.J., Hanowski, J.M., and Regal, R.R. 2007. Breeding bird communities across an upland disturbance gradient in the western Lake Superior region. *J. Great Lakes Res*. 33 (Special Issue 3).**
16. **Peterson, A.C., and Niemi, G.J. 2007. Evaluation of the Ohio Rapid Assessment Method for wetlands in the western Great Lakes: an analysis using bird communities. *J. Great Lakes Res*. 33 (Special Issue 3).**
17. Peterson, G.S., Sierszen, M.E., Yurista, P.M., and Kelly, J.R. 2007. Stable nitrogen isotopes of plankton and benthos reflect a landscape-level influence on Great Lakes coastal ecosystems. *J. Great Lakes Res*. 33 (Special Issue 3).
18. Price, S.J., Howe, R.W., Hanowski, J.M., Regal, R.R., Niemi, G.J., and Smith, C.R. 2007. Are anurans of Great Lakes coastal wetlands reliable indicators of ecological condition? J *J. Great Lakes Res*. 33 (Special Issue 3).
19. Reavie, E.D. 2007. A diatom-based water quality index for Great Lakes coastlines. *J. Great Lakes Res*. 33 (Special Issue 3).
20. Seilheimer, T.S., and Chow-Fraser, P. 2007. Application of the wetland fish index to northern Great Lakes marshes with an emphasis on Georgian Bay coastal wetlands. *J. Great Lakes Res*. 33 (Special Issue 3).
21. Trebitz, A.S., Brazner, J.C., Cotter, A.M., Knuth, M.L., Morrice, J.A., Peterson, G.S., Sierszen, M.A., Thompson, J.A., and Kelly, J.R. 2006. Water quality in Great Lakes coastal wetlands: basin-wide patterns and responses to an anthropogenic disturbance gradient. *J. Great Lakes Res*. 33 (Special Issue 3).
22. Tulbure, M.G., Johnston, C.A., and Auger, D.L. 2007. Rapid invasion of a Great Lakes coastal wetland by *Phragmites australis* and non-native *Typha*. *J. Great Lakes Res*. 33 (Special Issue 3).