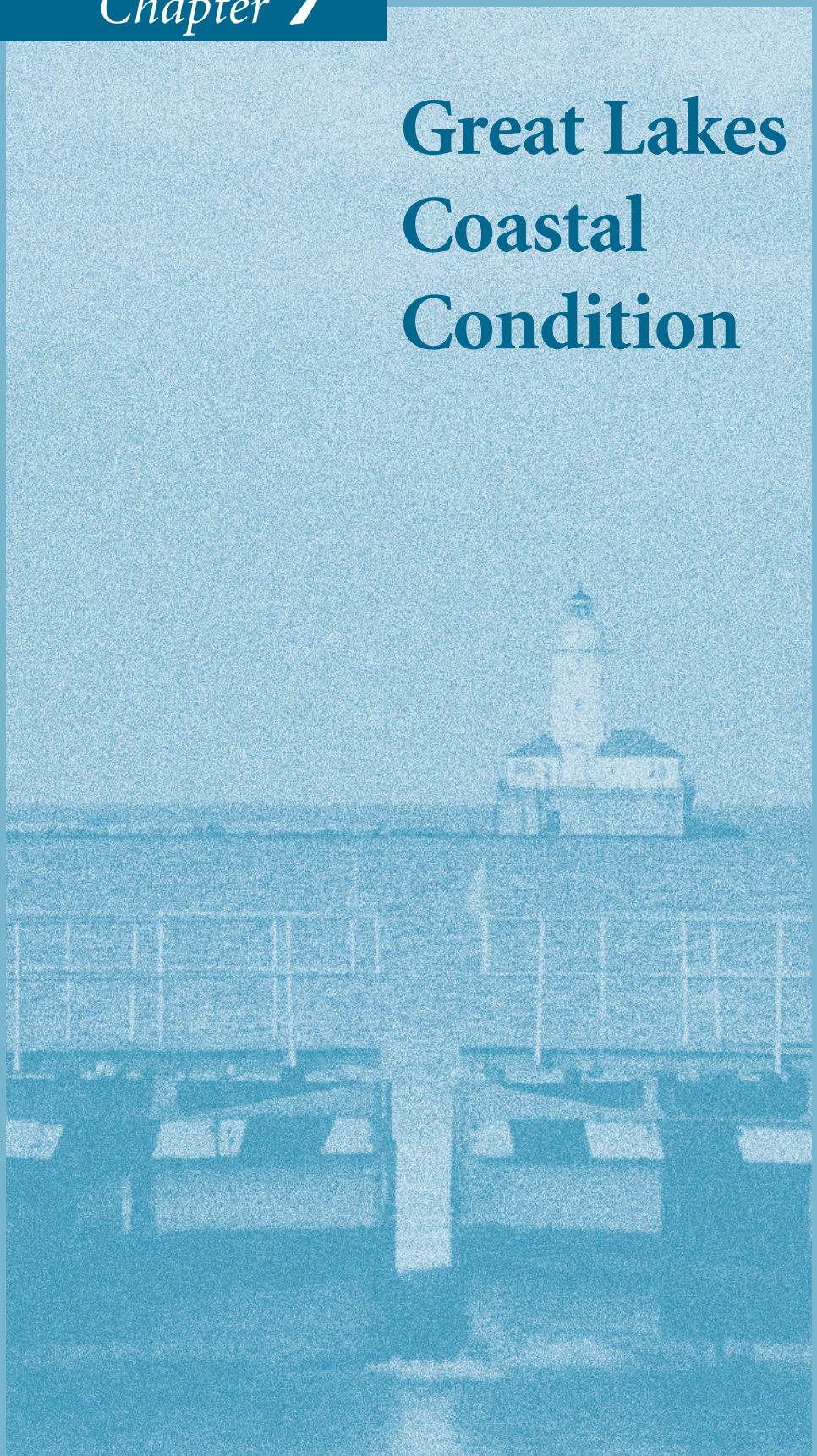
Chapter 7

Great Lakes Coastal Condition



Chapter 7

Great Lakes Coastal Condition

Based on available information from various monitoring efforts, ecological conditions in the Great Lakes are borderline poor (Figure 7-1). The open waters of the approximately 290,000 square miles of the Great Lakes are monitored annually by EPA's Great Lakes National Program Office (GLNPO), in conjunction with NOAA and USGS. A fixed site design has been used to characterize water quality and, in recent years, the composition of the phytoplankton, zooplankton, and benthic communities. The limnology (lake science) program provides information on key environmental factors that influence the aquatic ecosystem of the Great Lakes. Annual monitoring began in 1983 for Lakes Michigan, Huron, and Erie; in 1986 for Lake Ontario; and in 1992 for Lake Superior (Figure 7-2). The sampling strategy is to collect water and biota samples at specific water depths from a select set of locations in each lake twice a year. The limnology program focuses on the open lake basins (water greater than 98 feet in depth and greater than 3 miles from shore). At key stations, and as part of special studies, sediment samples are taken as well. For known or suspected problem areas, such as the Great Lakes Areas of Concern, sampling is also performed in the nearshore zone. This zone includes numerous bays and rivers connecting the lakes.

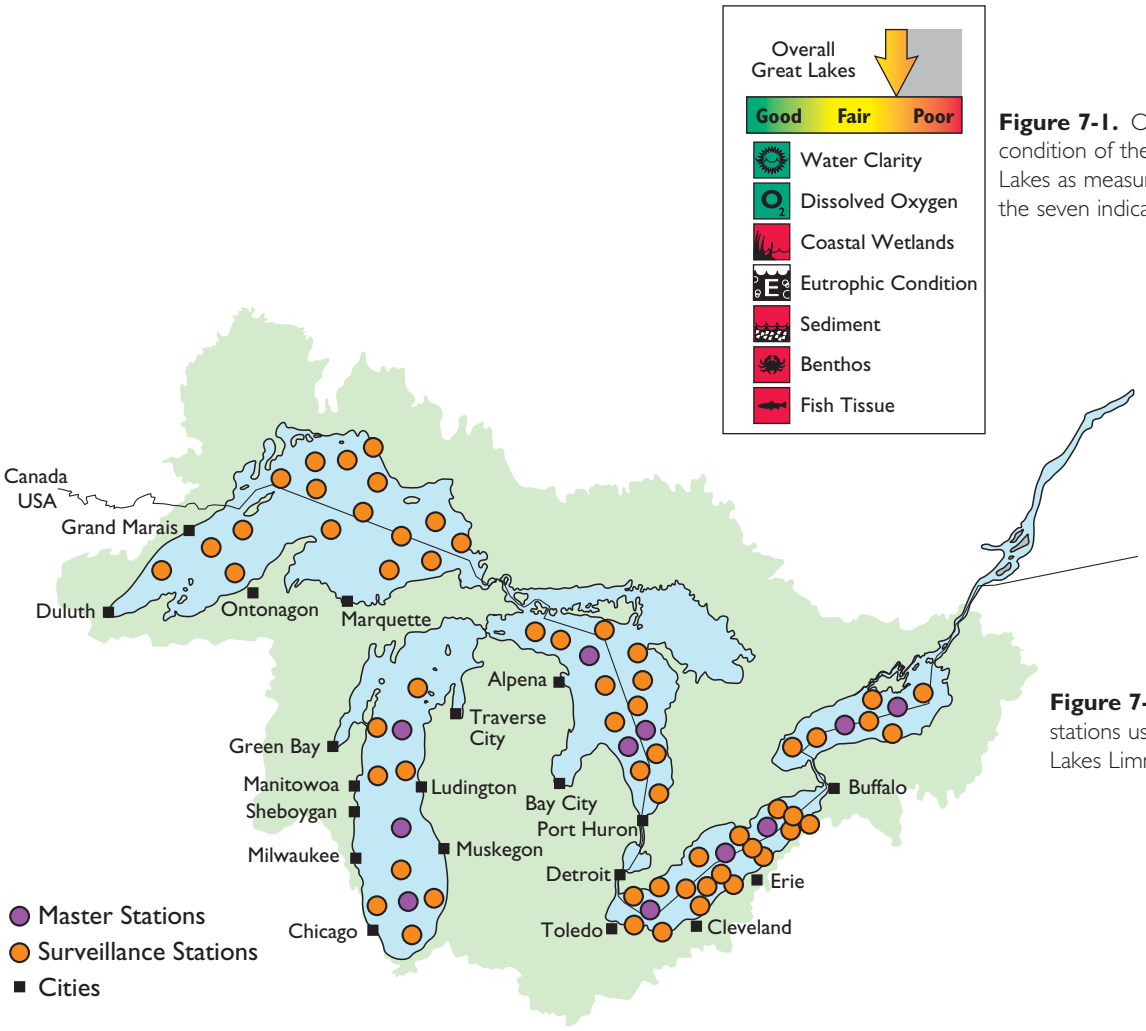


Figure 7-1. Overall condition of the Great Lakes as measured by the seven indicators.

Figure 7-2. Monitoring stations used by the Great Lakes Limnology Program.

Probabilistic surveys like those completed for the Northeast, Southeast, and Gulf Coasts do not exist for the Great Lakes region. Therefore, spatial estimates of ecological condition consistent with those calculated in earlier chapters cannot be determined. However, existing monitoring data from long-standing programs have been used to assess ecosystem condition to the extent possible.

Fishing from the Great Lakes shore (Courtesy of USDA Natural Resources Conservation Service).

Coastal Monitoring Data

Water Clarity

Water clarity in the Great Lakes is good. Water clarity, as measured by a Secchi disc, has increased in all lakes except Lake Erie over the last decade. Lake Ontario Secchi disc depths have increased nearly 100%. In Lake Ontario, for example, light penetration has increased from 3.1 meters (pre-1990 measurements) to 6.7 meters (post-1990 measurements).

Dissolved Oxygen

Dissolved oxygen conditions in the Great Lakes are generally good. However, dissolved oxygen in Lake Erie continues to be a persistent problem. Anoxic conditions (less than 0.5 mg/L) often occur in late August and continue until turnover occurs in fall. Although the frequency and extent of oxygen depletions have decreased considerably from the 1970s and 1980s, that trend leveled off in the late 1990s.

Coastal Wetland Loss

During the 200-year period between the 1780s and the 1980s, 51% of wetlands in the Great Lakes area were lost (Figure 7-3). The largest reductions were observed in Ohio (90%) and the smallest in Minnesota (42%).

Eutrophic Condition

The Great Lakes were not included in NOAA's National Estuarine Eutrophication Assessment, so data similar to those used in previous chapters to assess eutrophic condition are not available. However, chlorophyll *a* concentrations (a symptom of eutrophication potential) are stable throughout the lakes with the exception of the central and western basins of Lake Erie.

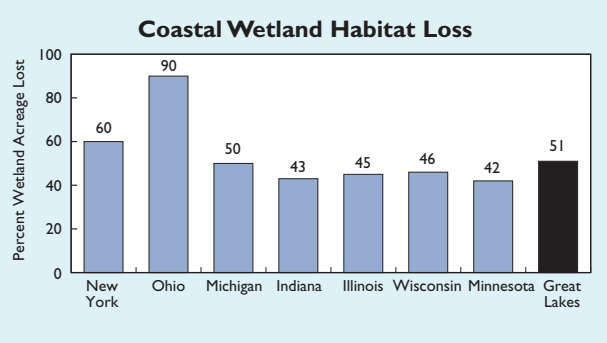


Figure 7-3. Percent wetland habitat loss from 1780 to 1980 by state and for the Great Lakes overall (Dahl, 1990; Turner and Boesch, 1988).

Data are also available for nutrient input into the Great Lakes. Nitrate and silica continue to increase in all lakes. Phosphorus concentrations have stabilized in all lakes with the exception of Lake Ontario, where phosphorus continues to decline at a slow rate of 0.3 mg/L per year. Only Lake Erie exceeds the phosphorus objectives set by the United States and Canada (15 mg/L), by about 60% in the western basin and by about 10% to 20% in the central and eastern basins. Input of chloride compounds from human activities (brines, road salt, etc.) has resulted in increased chloride concentrations in the Great Lakes. The rate of increase is slow (0.1 mg/L per year) in Lakes Michigan, Huron, and Superior (Figure 7-4), and it is decreasing from previously elevated levels in Lakes Erie and Ontario. Overall water quality in Lakes Superior, Michigan, and Huron is good, with elevated chloride levels being observed in Lake Ontario and elevated phosphorus concentrations observed in Lake Erie.

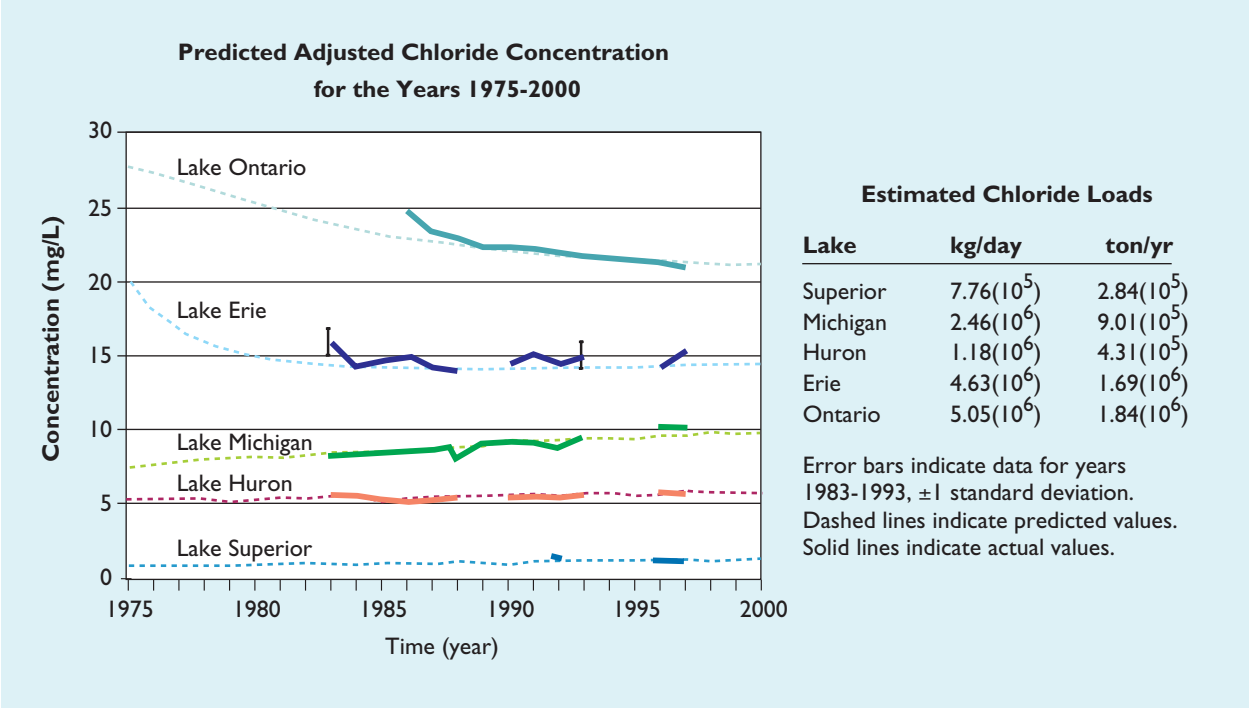


Figure 7-4. Predicted chloride concentrations in the Great Lakes from 1975 to 2000.

Photo: © John Theilgard

Great Lakes Indian Fish and Wildlife Commission Issues Fish Consumption Information for Tribal Members

Eleven sovereign tribal governments, located in Minnesota, Wisconsin, and Michigan, make up the Great Lakes Indian Fish and Wildlife Commission (GLIFWC). The Commission's purpose is to protect and enhance treaty-guaranteed fishing on the Great Lakes and inland territories ceded under the Chippewa treaties and to provide cooperative management of these resources.

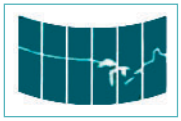
http://www.GLIFWC.org

As part of its responsibilities, the GLIFWC publishes booklets and reports to inform tribal members of the health benefits and risks of consuming fish caught in the wild. Eating a diet rich in fish offers many health benefits, including the prevention of heart disease by regular consumption of omega-3 fatty acids found in fish. Consuming fish can also be potentially harmful because of the levels of contaminants such as mercury that are found in fish from some Great Lakes areas.

The GLIFWC website (www.GLIFWC.org) provides access to reports, pamphlets, and maps to help tribal members decide where to fish, how much fish to eat, and what types of fish to eat. For example, the GLIFWC has developed maps of mercury contamination in walleye for a number of different fishing areas. The maps, which are available on the website and in seasonal publications from the GLIFWC, indicate the locations where walleye of certain sizes may contain harmful levels of mercury. The publications also issue specific advice for sensitive subpopulations, such as women of childbearing age and children under age 15, who are more susceptible to harm from contaminants.

The International Joint Commission

Formed under the 1909 Boundary Waters Treaty, the International Joint Commission (IJC) acts as an objective advisor to both the United States and Canada in the management of transboundary waters. IJC is involved in issues affecting all transboundary waters including the Columbia River Basin, Red River Basin, and Great Lakes/St. Lawrence River Basin. The IJC provides a comprehensive assessment every 2 years of progress made to meet the goals set in the 1978 Great Lakes Water Quality Agreement (GLWQA). It accomplishes this through the actions of several councils, including the Great Lakes Science Advisory Board, Great Lakes Water Quality Board, and Council of Great Lakes Research Managers. The IJC releases biennial reports on the progress of the parties in meeting the terms of the Agreement; these are followed up by review meetings called by the parties to undertake actions under the terms of the Agreement. Additionally, the Annex 2 Advisory Committee provides guidance and review of Remedial Action Plans (RAPs) and Lakewide Management Plans (LaMPs) developed under GLWQA.



International Joint Commission
Commission mixte internationale

Members of the International Joint Commission

- Annex 2 Advisory Committee
- Council of Great Lakes Research Managers
- Great Lakes Science Advisory Board
- Great Lakes Water Quality Board
- International Lake Champlain Board of Control
- International Lake Superior Board of Control
- International Niagara Board of Control
- International St. Lawrence River Board of Control
- International Air Quality Advisory Board

Sediment Contaminants

EPA's Great Lakes National Program Office has determined that polluted sediments remain as the largest major source of contaminants to the Great Lakes food chain. Under the Great Lakes Water Quality Agreement, the governments of the United States and Canada identified 43 Areas of Concern having significant impairments of beneficial use (Figure 7-5). Over 2,000 miles (20%) of the shoreline are considered impaired because of sediment contamination, and fish consumption advisories remain in place throughout the Great Lakes. On the U.S. side of the border, sediments have been assessed at 26 Great Lakes locations, and over 1.3 million cubic yards of contaminated sediments have been remediated over the past 3 years. However, the challenge is so great that sediment remediation has so far been completed at only 1 of the 43 Areas of Concern.

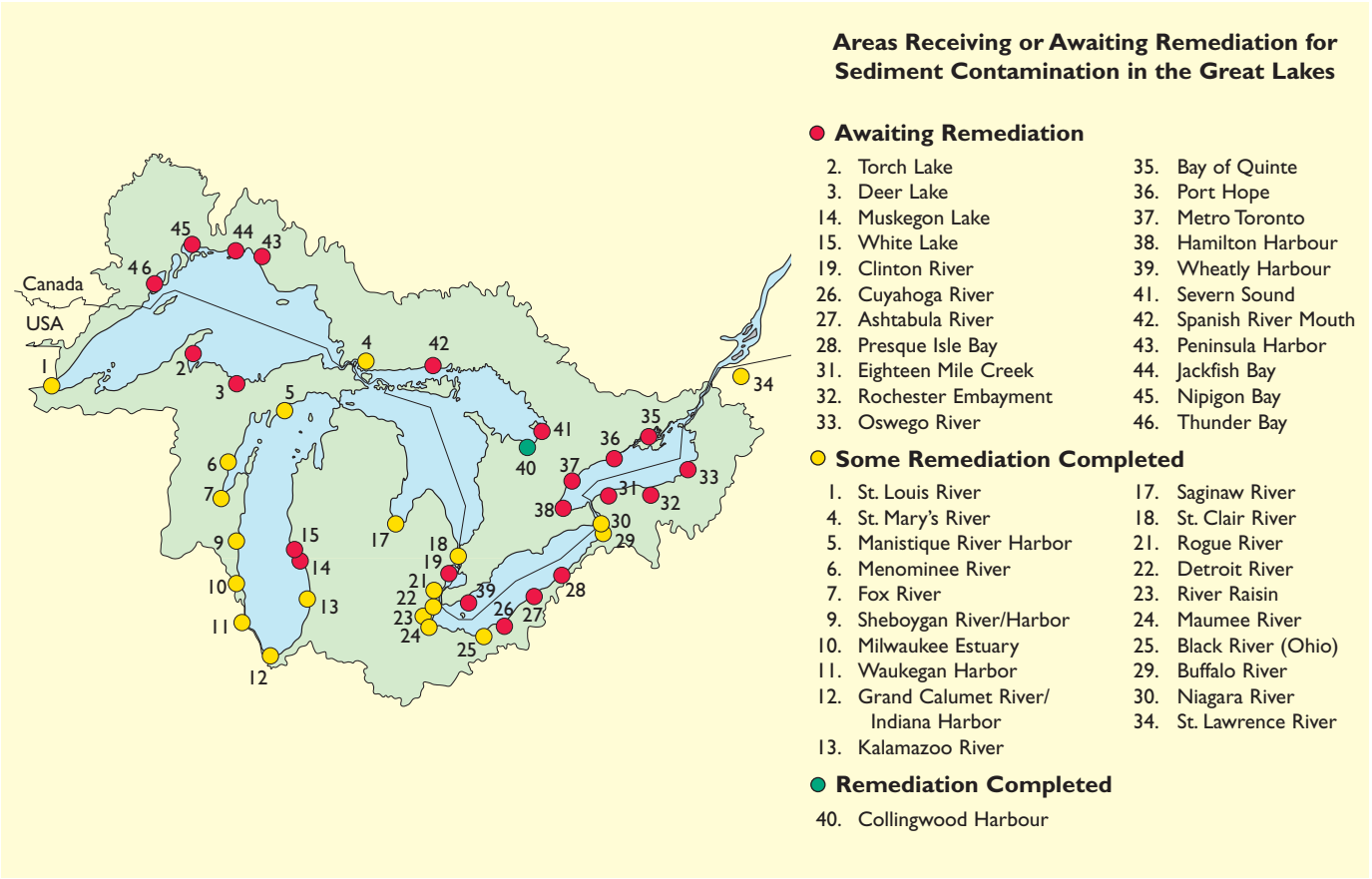


Figure 7-5. Great Lakes Areas of Concern receiving or awaiting remediation for sediment contamination.

Benthic Condition

The condition of the Great Lakes according to benthic indices is poor. Benthic invertebrate communities were sampled during the summers of 1997 and 1998 (Figure 7-6). Deep water sites in the Great Lakes support relatively taxa-poor benthic assemblages. Lakes Superior, Michigan, Huron, and Erie support fairly distinct benthic communities with significant similarity among sampling sites within each lake. In contrast, Lake Ontario benthic assemblages varied greatly from site to site. Recent studies undertaken in cooperation with NOAA and others have revealed precipitous declines in populations of certain benthic invertebrates, particularly a small shrimp-like crustacean (*Diporeia spp*), which resides at the base of the benthic food chain. *Diporeia* populations in Lake Michigan, for example, have plummeted in all 10 sites sampled; further studies are under way to identify the causes.

Much more data are available for biotic communities sampled in open water in the Great Lakes. Diatom collections were completed in all five lakes in the spring and summer of 1998 (Figure 7-7). Diatoms are used in the Great Lakes monitoring as an overall indicator of ecological condition. Phytoplankton populations in spring were overwhelmingly dominated by centric diatoms with the exception of Lake Superior. Within-lake communities were relatively homogeneous with the exception of Lake Erie. Both diatom dominance and species richness decreased in the summer, as would be expected. Zooplankton surveys were completed in conjunction with the diatom sampling. Zooplankton represent an indicator of primary consumers in Great Lakes food chains and are food items for many fish species. Unlike phytoplankton communities, zooplankton communities exhibited very low species richness in the spring throughout the Great Lakes. All lakes were dominated by copepods with abundances and species richness increasing through the summer months.

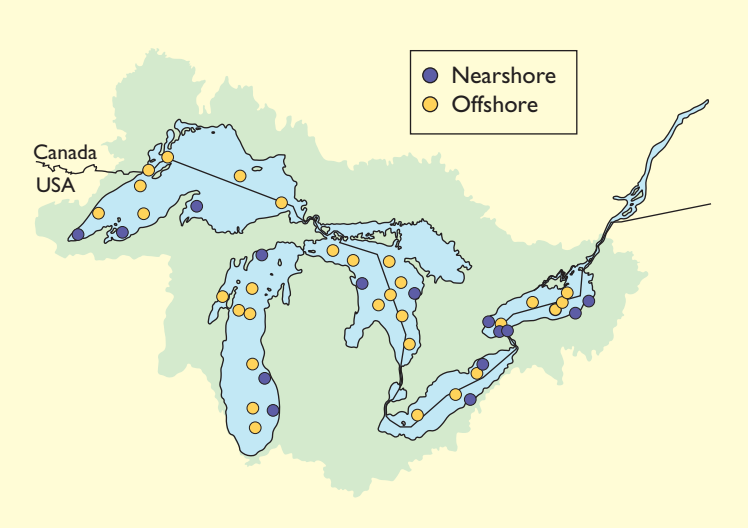


Figure 7-6. Sites sampled for benthic invertebrates in 1997 and 1998.

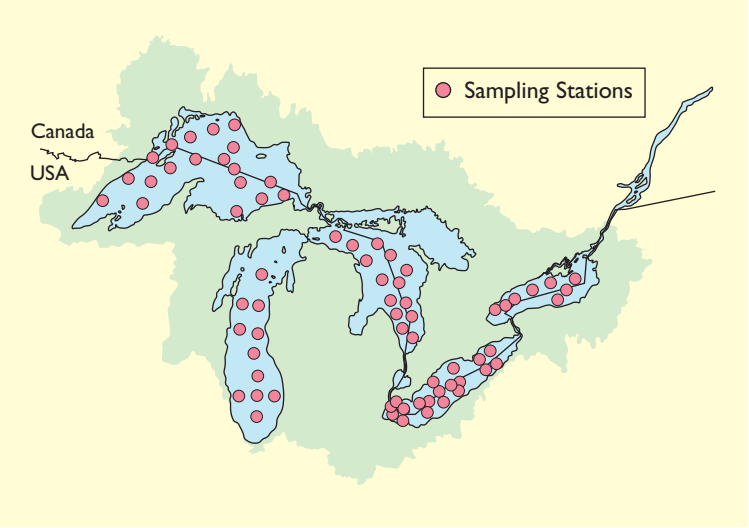


Figure 7-7. Sampling stations used for diatom collection in 1998.

Invasion of the lakes by the zebra mussel (*Dreissena polymorpha*) in the 1980s has dramatically altered the food web of the Great Lakes and considerably altered the community composition of phytoplankton, zooplankton, and benthos, favoring some fish species at the expense of others and changing the pathways and impacts of bioaccumulative contaminants. Populations of certain lesser-known invertebrate invaders, such as the spiny water flea (*Bythotrephes cederstroemi*) and the fishhook flea (*Cercopagis pengoi*), are also burgeoning in some locations, with *Cercopagis* outnumbering all other zooplankton species in specific parts of Lake Ontario in a 1999 survey. These species both compete with and prey upon native zooplankton, while serving as less desirable forage for most Great Lakes fish.

Overall, the condition of phytoplankton, zooplankton, and benthic communities in the Great Lakes varies considerably from lake to lake and within each lake. Lake Superior appears healthy and diverse, in part because of its upstream location and because it is too cold to favor certain invading organisms, such as the zebra mussel. The condition of the biotic communities of the lower four lakes is more mixed. More information on Great Lakes National Program Office (GLNPO) indicators is available on the Internet: http://www.epa.gov/glnpo/monitor.html.

Fish Tissue Contaminants

The condition of the Great Lakes as measured by fish tissue contaminants is poor, although levels of contaminants in fish and wildlife have declined dramatically from peak levels in the 1970s and 1980s. Chemical contamination resulting in fish consumption advisories is one of the greatest environmental problems in the Great Lakes.

In summary, the overall condition of the Great Lakes has improved dramatically despite local occurrences of sediment contamination and lake-by-lake fish advisories. However, ecological conditions of the Great Lakes are still in question as the continuing impacts of invasive species are sorted out. The success of efforts to remediate sediments in these areas will continue to be realized in further reductions in fish tissue contaminant concentrations—although advisories are still in effect throughout the lakes. Substantial challenges remain and conditions must be measured periodically to ensure that improvement continues. Programs like the multiagency Coastal Monitoring and Research Strategy (part of the Clean Water Action Plan) and Coastal 2000 will support GLNPO in providing this continuing surveillance.

Assessments and Advisories

Clean Water Act Section 305(b) and 303(d) Assessments

The Great Lakes states assessed 4,950 miles (90%) of their 5,521 miles of Great Lakes shoreline for their 1998 305(b)water quality reports. Only 2% of the assessed shoreline waters fully support their designated uses, 2% are threatened for one or more uses, and the remaining 96% are impaired by some form of pollution or habitat degradation (Figure 7-8). Individual use support for Great Lakes shoreline is shown in Figure 7-9.

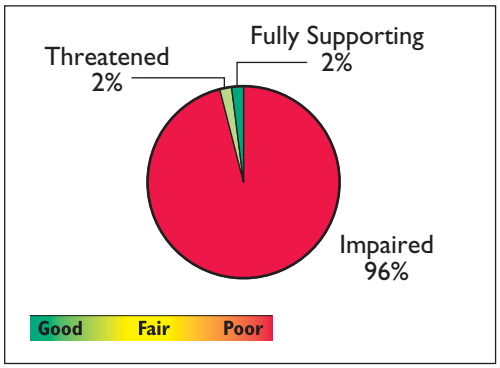


Figure 7-8. Water quality for assessed Great Lakes shoreline (U. S. EPA).

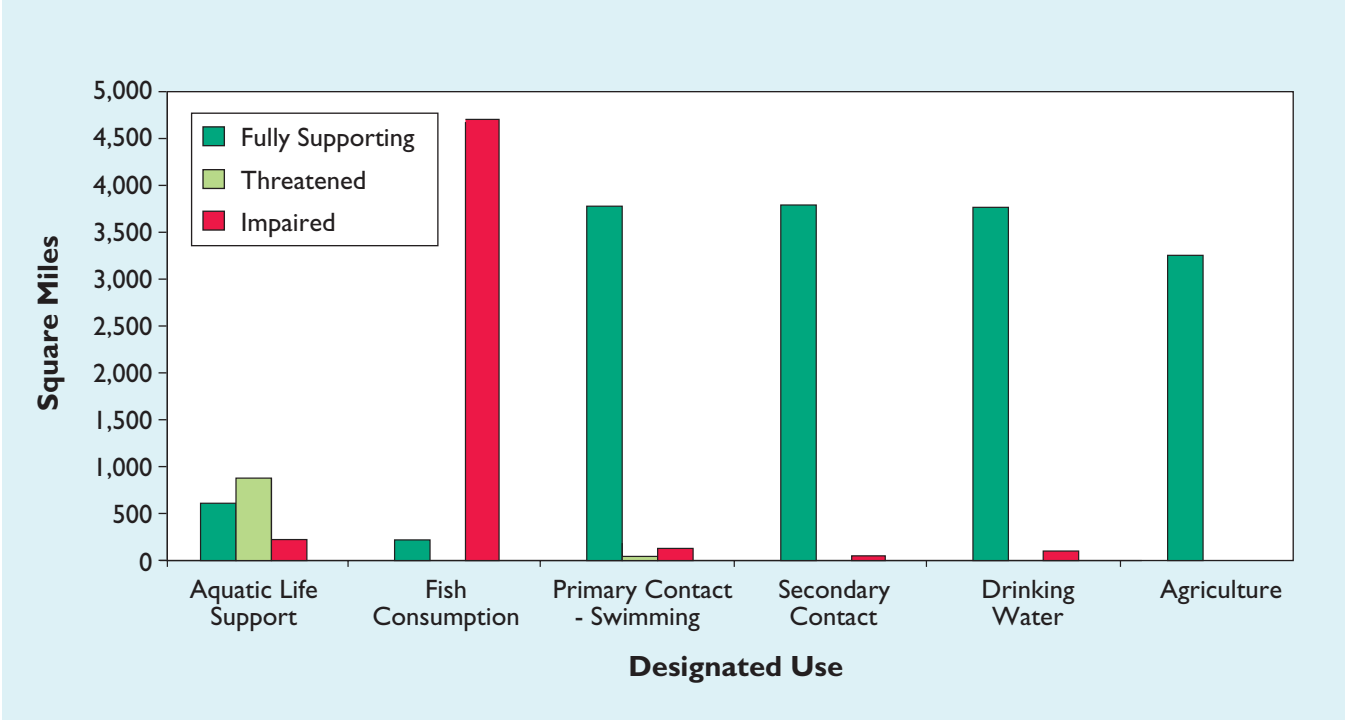


Figure 7-9. Individual use support for assessed Great Lakes shoreline (U.S. EPA).

The states reported the following individual use support for their assessed estuarine and coastal waters (Table 7-1). Figure 7-10 shows the leading pollutants that cause use impairments.

Table 7-1. Individual Use Support for Assessed Coastal Waters Reported by States on the Great Lakes under Section 305(b) of the Clean Water Act

Individual Uses	Shoreline Assessed as Impaired (mi)	% of Total Shoreline Assessed
Aquatic Life	210	12%
Fish Consumption	4,747	96%
Swimming	101	3%
Secondary Contact	41	1%
Drinking Water	80	2%
Agriculture	0	0

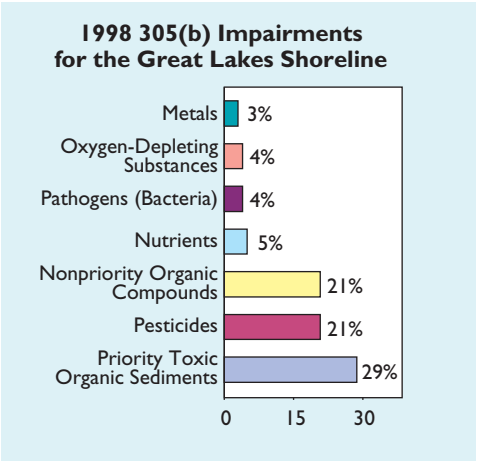


Figure 7-10. The leading pollutants that cause use support impairment of assessed Great Lakes shoreline (U.S. EPA).

State Fish Consumption Advisories

Fishing in the Great Lakes area is a way of life and a valued recreational and commercial activity for many people. To protect their citizens from the risks of eating contaminated fish, the eight states bordering the Great Lakes had a total of 32 fish consumption advisories in effect in 2000 for waters of the lakes and the connecting waters. Every Great Lake was under at least one advisory, covering 100% of the U.S. coastline (Figure 7-11). Michigan, which borders four of the five Great Lakes and encompasses four of the six connecting waterbodies, issued the greatest number of advisories (eight).

Great Lakes fish consumption advisories were issued for a total of five pollutants: mercury, mirex, chlordane, dioxins, and PCBs.

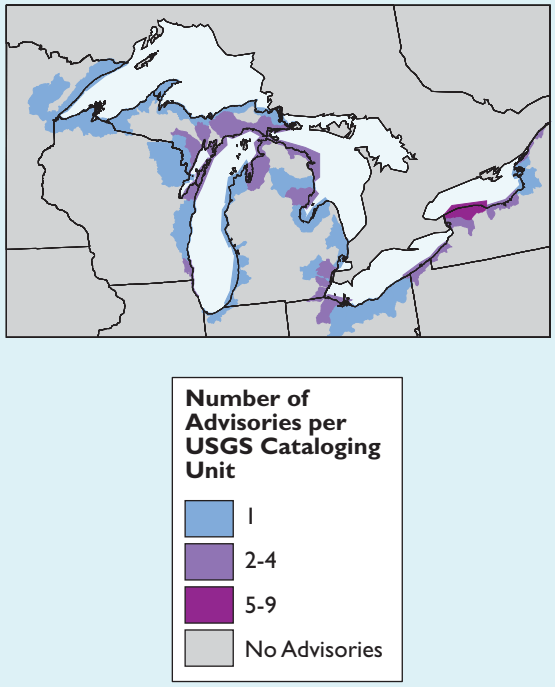


Figure 7-11. 100% of U.S. Great Lakes shoreline was under fish consumption advisory in 2000.

Most of the advisories (48%) were issued for PCBs (Figure 7-12). Lake Superior, Lake Michigan, and Lake Huron were under advisory for three pollutants each in 1999 (Table 7-2). It should be noted that some of the advisories were of limited geographic extent, and advisories in most locations apply primarily to larger, older specimens high in the food chain.

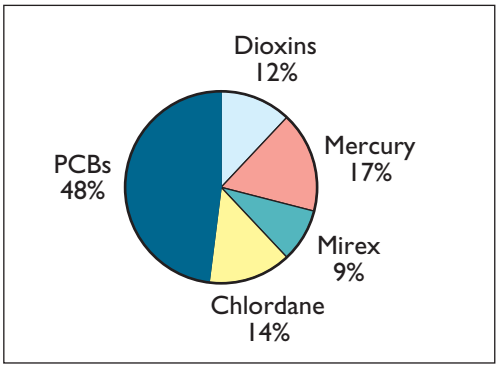


Figure 7-12. Great Lakes advisories were issued for five pollutants (U.S. EPA NLFWA, 2000c).

Table 7-2. Fish Advisories Issued for Contaminants in Each of the Great Lakes

Great Lakes	PCBs	Dioxins	Mercury	Chlordane	Mirex
Lake Superior	●		●	●	
Lake Michigan	●		●	●	
Lake Huron	●	●		●	
Lake Erie	●				
Lake Ontario	●	●			●

Species under fish consumption advisory in 1999 in at least one of the Great Lakes or connecting waters:

Largemouth bass	Round goby	Freshwater drum
Rock bass	American eel	Bluegill sunfish
Smallmouth bass	Lake herring	Brook trout
White bass	White perch	Brown trout
Bloater	Yellow perch	Lake trout
Bowfin	Northern pike	Rainbow trout
Brown bullhead	Redhorse	Siscowet trout
Burbot	Silver redhorse	Splake trout
Common carp	Chinook salmon	Steelhead trout
Quillback carpsucker	Coho salmon	Walleye
Catfish	Pink salmon	Whitefish
Channel catfish	Gizzard shad	Lake whitefish
Chub	Smelt	White sucker
Black crappie	Lake sturgeon	Longnose sucker

Beach Closures

EPA's Great Lakes National Program Office has conducted a beach closures monitoring program since 1983. Since 1998, the program has been merged into EPA's national tracking program. Health authorities in all eight Great Lakes states submitted beach monitoring and closing information to EPA in 1999. Of the 583 beaches on the U.S. side of the Great Lakes, information was submitted on 327. About 20% of the 327 reported beaches (67 beaches) were closed at least once during the 1999 season (Figure 7-13). Of the reporting beaches that had closures, all but one had monitoring programs in place. Most beach closures were the result of elevated bacteria levels and sewage caused by runoff, stormwater, wildlife, sanitary and combined sewer overflows, or other unknown causes. A few beaches were closed because of weather, wave action, or presence of aquatic weeds.

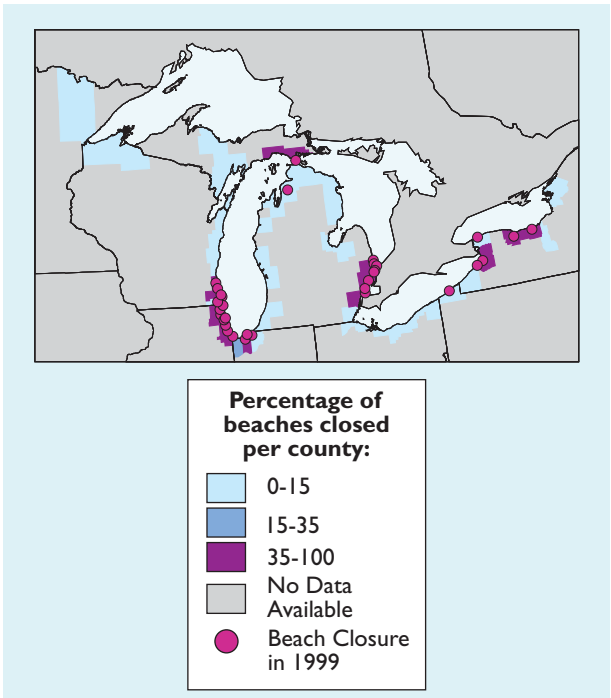


Figure 7-13. Great Lakes beach closings in 1999.

Summary

Ecological conditions in the Great Lakes, based on available information, are borderline poor (Figure 7-14). The primary problems in the Great Lakes in the 1990s were sediment contamination, benthic community condition, coastal wetland loss, and fish contaminants. Over 25% of sediments are enriched or exceed ERL/ERM guidance, benthic communities are in poorer than expected condition, and contaminant levels in fish tissue result in numerous advisories. While some improvements in these areas are being observed, there is still the potential for further degradation of benthic communities, increased fish contamination in selected areas, and decreases in dissolved oxygen.

Figure 7-14 displays the condition of the major indicators of ecological condition in the Great Lakes. Sediment contamination, benthic community condition, coastal wetland loss, and fish tissue contaminant concentrations are considered in poor condition throughout sampled portions of the Great Lakes. Dissolved oxygen conditions and water clarity are considered good for the Great Lakes. Significant strides have been made in improving the condition of the Great Lakes. However, these efforts must be continued and potentially strengthened throughout the lakes to ensure continued environmental improvement.

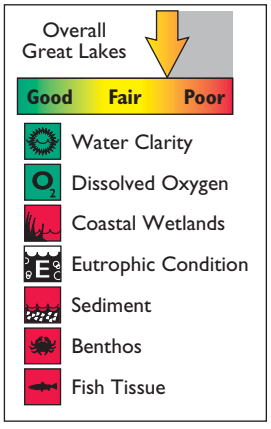


Figure 7-14. Ecological conditions in the Great Lakes are borderline poor. The primary problems in the Great Lakes are sediment contamination, benthic community condition, coastal wetland loss, and fish contaminants.

highlight

The Great Lakes National Program Office

The Great Lakes National Program Office (GLNPO), established by Congress in 1987 under Section 118 of the Clean Water Act, provides an institutional framework for efforts to protect and restore the Great Lakes ecosystem in the United States. Current GLNPO activities include

- Conducting open-lake sediment, biota, and water quality monitoring
- Funding habitat restoration and protection projects
- Coordinating Great Lakes protection efforts at all levels of government
- Working with both its Canadian counterparts and the International Joint Commission to negotiate and implement the Great Lakes Water Quality Agreement.

As part of the Great Lakes Water Quality Agreement, GLNPO and Environment Canada convene a biennial conference called the State of the Lakes Ecosystem Conference (SOLEC). Following the conferences, *State of the Great Lakes* reports were issued in 1995, 1997, and 1999. In 1998, a suite of 80 indicators was proposed to be "necessary and sufficient" to adequately represent the major Great Lakes ecosystem components, including the nearshore and offshore waters, coastal wetlands, nearshore terrestrial, human health, societal, and land use. In 2000, summary reports were prepared for 31 of the 80 indicators. These reports are available on the Internet on the SOLEC website (http://www.on.ec.gc.ca/solec) by following the links to each SOLEC conference. Additional information on SOLEC and the indicators project is available on the Internet at http://www.epa.gov/glnpo/solec.

Working with state and provincial governments, GLNPO and Environment Canada have identified 42 Areas of Concern (AOC) throughout the Great Lakes. These are the most polluted areas that will require the most immediate action. For each AOC, a Remedial Action Plan (RAP) is to be prepared by the cognizant jurisdiction, usually a state (on the U.S. side), with local involvement. For each Great Lake, a Lakewide Management Plan (LaMP) is to be prepared to address contaminant and habitat issues on a whole-lake scale. Five of the RAPs and four of the LaMPs are binational, and the LaMP for Lake Erie involves three EPA regions. The LaMPs are to be prepared cooperatively among the governments and jurisdictions with EPA as the U.S. lead.