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# An Overview of Great Lakes Threats: Sources and Priorities Agricultural Nonpoint Impairments Role in Overall Problems

This overview describes the challenges currently considered to be of highest concern for the Great Lakes ecosystem, based on a variety of assessments, including recent efforts to characterize threats to the Lakes by the Great Lakes Council of Governors, the Great Lakes Regional Collaboration, and the Great Lakes Coalition. Based on these assessments, it was clear that nonpoint source threats, especially those related to agriculture, are significant. They are the focus of this overview, and other priority concerns for the Great Lakes ecosystem are also outlined briefly.

There is no simple rating offered that quantifies the percent or degree of "blame" associated with the impairments to the Great Lakes Problems are interrelated, and often result from point and nonpoint source pollution that originates on land, water or air. For example, contaminated sediments are often a mixture of eroded soils from cropland and urban areas, together with chemicals such as old organochlorine pesticides, PCBs, and heavy metals. Such contamination may originate from runoff, a factory pipe, a smokestack, or from other modes of long-range transport. These chemicals may become more or less available in aquatic ecosystems depending on factors such as temperature, nutrient balance, and even water levels and disturbance.

## Brief Description of Great Lakes Basin

The five Great Lakes – Superior, Michigan, Huron, Erie, and Ontario, hold one-fifth of the fresh water on the earth's surface and 80 percent of the lakes and river water in North America. Less than 1 percent of the water in the Great Lakes (GL), however, is replaced each year by precipitation. The GL basin, including the water and land area that drains into the lakes, covers 766,000 square kilometers (295,700 square miles.)

There are over one hundred tributaries that discharge to the Great Lakes within the United States. These include a limited number of large rivers and river systems, such as the Maumee River that drains over 4 million acres in three states. About 52 percent of the Great Lakes Basin is forested; 35 percent is in agricultural uses; 7 percent is urban/suburban; and 6 percent is in other uses. Major commerce and industries in the Basin include manufacturing, tourism, and agriculture. The basin includes part of the province of Ontario, and portions of eight states (Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin). Almost 20 percent of the U.S. population and 40 percent of the Canadian population resides within the Basin.

Commercial and industrial development has been intense along many tributaries to the Great Lakes. While there has been a decline in heavy industry along coastal areas, historic land use management has resulted in a number of legacy problems that pose long-term challenges. Great Lakes shorelines are experiencing increasing pressures from residential and recreational use.

Across the Basin, sprawl continues to expand the footprint of urban/residential use into farmlands, especially around major cities.

## Major Concerns in Basin

The Council of Great Lakes Governors issued a report in December 2004 that outlined "Programs, Funding Streams and Critical Gaps," which was prepared by Policy Solutions Ltd. in Chicago (http://www.cglg.org/projects/priorities). This report outlined nine priorities for Great Lakes Restoration and Protection:

1. Ensure the sustainable use of our water resources while confirming that the States retain authority over water use and diversion of Great Lakes waters.
2. Promote programs to protect human health against adverse effects of pollution in the Great Lakes ecosystem.
3. Control pollution from diffuse sources into water, land and air. [1]
4. Continue to reduce the introduction of persistent bio-accumulative toxics into the Great Lakes ecosystem.
5. Stop the introduction and spread of non-native aquatic invasive species.
6. Enhance fish and wildlife by protecting and restoring coastal wetlands and fish and wildlife habitats.
7. Restore to environmental health the Areas of Concern identified by the International Joint Commission as needing remediation.
8. Standardize the methods by which information is collected, recorded and shared within the region.
9. Adopt sustainable use practices that protect environmental resources and may enhance the recreational and commercial value of our Great Lakes.

The Great Lakes Regional Collaboration (GLRC) used the work of the Great Lakes governors as a basis for developing a "Strategy to Restore and Protect the Great Lakes" issued in July 2005 as a Draft Action Plan (http:www.glrc.us). The Collaboration resulted from Executive Order (EO) 13340 signed by President Bush in May 2004. The EO created a cabinet level task force (Chaired by EPA Administrator) to bring an unprecedented level of collaboration and coordination to accelerate protection and restoration of the Great Lakes (see attached materials). Eight strategy teams were established to develop a basin wide strategy. The teams are: Habitat/Species, Indicators and Information, Persistent Bioaccumulative Toxics, Invasive Species, Sustainable Development, Coastal Health, Nonpoint Source (predominately ag issues), and Area of Concern Restoration/Sediments. The strategy teams are comprised of representatives from federal, state, tribal, provincial, county, and city organizations, NGOs, and private citizens.

[1] Under Item 3 of the Council of Great Lakes Governors priorities for restoration and protection, sources and pathways identified for controlling pollution from diffuse sources include run-off from agriculture, urban areas and construction activities, air deposition, brownfields, and urban infrastructure and runoff. The report indicates that a detailed list containing specific identification, characterization and quantification of clean-up and control options and costs to address these diffuse pollution sources does not exist, and says that "Funding of remedial investigations and feasibility studies is a necessary precondition for framing a strategy to address this priority."

The GLRC strategy includes 8 key recommendations, summarized below. Several recommendations, including 5 and 8 relate to nonpoint issues and management of agricultural lands:

1. stop the introduction of more **aquatic invasive species** (AIS) to prevent significant future ecological and economic damage to the Great Lakes.
2. need significantly more **habitat conservation and species management.**
3. minimize human health risks to drinking water and from recreation by taking actions to protect and clean up impaired **near shore waters and coastal areas.**
4. dramatically accelerate the cleanup process at these **areas of concern** (AOC).
5. **nonpoint sources of pollution** contribute significantly to problems in the Areas of Concern, as well as to other locations in the Great Lakes, including the open waters. Actions to address these problems include:
    a. wetland restoration;
    b. restoration of buffer strips;
    c. improvement of cropland soil management;
    d. implementation of comprehensive nutrient and manure management plans for livestock operations; and
    e. improvements to the hydrology in watersheds.
6. address threats from **toxic pollutants** to human and wildlife health.
7. recognize need for a **sound information base and representative indicators** to understand what is happening in the system and communicate to the public, to decision makers, and all others involved.
8. ensure the long term **sustainability** of the Great Lakes resources, in areas of land use, agriculture and forestry, transportation, industrial activity, and many others.

In 2004, a summit sponsored by The Wege Foundation brought together over 100 individuals with expertise on Great Lakes issues as part of the "Healing Our Waters" effort, which resulted in a report characterized as a "Magna Carta for the Great Lakes." The Healing Our Waters effort also led to development of a Great Lakes Coalition, which is being coordinated by the National Wildlife Federation and the National Parks Conservation Organization.

The Healing Our Waters/Great Lakes Coalition document focused on three main priorities:
1. Restore Great Lakes Water Quality
2. Prevent and control non-native aquatic invasive species
3. Clean up concentrated toxic pollution.

Under Priority 1, agricultural practices that contribute runoff of herbicides, pesticides, nutrients, sediments, and other pollutants from farmers' fields are listed as significant concerns, along with forestry, manufacturing, and energy production. Problems specifically mentioned include dams, sewer (combined and sanitary) overflows, and emissions of mercury, carbon dioxide and sulfur dioxide. Global warming is indicated as a threat to water quality due to concerns for dropping water levels and other impacts.

## Nonpoint Problems

Nonpoint source impacts vary greatly in frequency and severity across the Great Lakes. Polluted runoff impacts have been particularly severe in the coastal wetlands, near shore areas, and tributaries that once buffered the Lakes from environmental damage. Other prime impact areas include western Lake Erie, Saginaw Bay, Green Bay, the coastal region of Ohio, selected Areas of Concern (AOCs), and selected tributaries or near-shore areas, according to the Great Lakes Regional Collaboration (see attached materials).

Five main nonpoint source pollution stressors identified by the GLRC Strategy Draft Action Plan in 2005 are:

1. Nutrients
2. Contaminants
3. Pathogens
4. Sedimentation
5. Altered flow regimes.

These stressors enter the Great Lakes through three primary pathways: surface runoff, groundwater infiltration, and atmospheric deposition. Nonpoint source pollution in each of these forms damages flora and fauna in the Lakes, threatens human health, reduces recreational opportunities, and increases the costs to treat drinking water and to dredge harbors and marinas The total input of stressors from nonpoint source pollution today considerably exceeds that from point sources, reports the GLRC. Work on point sources approaches a point of diminishing returns, and funding to increase point source control beyond 90 percent or 95 percent is less effective than providing the same amount of funding to address nonpoint sources.
The Collaboration lists the fundamental barriers to addressing nonpoint source pollution more effectively, as authority, funding, and coordination (GLRC 2005).

The International Joint Commission (IJC) report on "Pollution in the Great Lakes Basin from Land Use Activities" (IJC 1978) reported: "PLUARG finds that the Great Lakes are being polluted from land drainage sources by phosphorus, sediments, some industrial organic compounds, some previously-used pesticides, and potentially some heavy metals.

The U.S. and Canada have been working in a collaborative role since 1994 to report on the state of the Great Lakes using an indicator approach. Indicator suites for coastal wet lands, forests, open water, etc., have been developed and are being reported on a consistent basis for the past few years. Upon completion of the suite of indicators for the Great Lakes Basin, US and Canada will be able to jointly report on the state of the Great Lakes based on these stressor indicators. A new major initiative is being planned to develop a suite of indicators for the agriculture sector in the Great Lakes Basin in late 2005, under the primary responsibility of the Great Lakes Commission.

The United States and Canada have cooperated in identifying 43 Areas of Concern (AOCs) in the Great Lakes Basin of special need for cleanup. Rural nonpoint-related problems are indicated as a cause of impairments in 19 or about 45 percent of the AOCs (GLRC 2005). To put this in perspective, sediments contaminated with persistent toxicants from point sources that

include industry, mining, and leaking landfills and Superfund sites have been identified as serious problems in 30 AOCs. Stormwater runoff and combined sewage overflows (CSOs), primarily from urban sources, are indicated as a major source of problems in 18 AOCs. [2]

Under the U.S. – Canada Great Lakes Water Quality Agreement, Lake-wide Management Plans (LaMPs) are required for each of the Great Lakes. Each of the LaMPs have developed goals for stressors in each respective basin. Specific goals and objectives for the ag sector are referenced in each LaMP. Details for each lake are available on U.S. Great Lakes National Program Office (GLNPO) web site, http://www.epa.gov/glnpo/gl2000/lamps/index.html.

In Ontario, new legislation in 2005 known as Ontario's *Clean Water Act* was to address recommendations from the Walkerton Inquiry which pertain to the protection of drinking water sources. The legislative guidance recommends that: "Drinking water sources should be protected by developing watershed-based source protection plans. Source protection plans should be required for all watersheds in Ontario" (D.R. O'Connor 2002). The report also calls for The Ministry of the Environment to ensure that draft source protection plans are prepared through an inclusive process of local consultation. "Where appropriate, this process should be managed by conservation authorities" (D.R. O'Connor 2002).

Erosion/Sedimentation

Erosion, sedimentation has been characterized as one of the main environmental concerns in the Great Lakes basin (Bartholic, 2005). Sediment dredging projects cost over $20 million in the Great Lakes each year. Erosion of over 902 million tons of soil in the Great Lakes states each year is estimated, with about 67 percent (or 604 million tons) of that occurring on cropland, stripping nutrients valued at over $3 billion (Great Lakes Commission 1987). Sediment affects the Great Lakes System primarily as a carrier of phosphorus and the other contaminants, contributing to the overall pollution of the lakes. In Ontario, suspended sediments have been found to be a carrier of phosphorus, trace metals and pesticides from farmlands to streams to lakes.

However, much of the U.S. data on the impacts of erosion into the Great Lakes has been based on the surrounding eight states as a whole rather than for just the in-basin portion of the states, which makes it hard to accurately assess impacts to the Great Lakes. Several of the Basin states, including Illinois, Indiana and Pennsylvania, are major agricultural states, but have relative small land areas within the Basin. Generally, the areas within the Basin itself have deep soils that are eroding at low rates. These areas are not considered highly erodible and so have not been eligible for some conservation programs, yet they may still be causing water quality problems as a result of close proximity to the Great Lakes or tributaries (Great Lakes Commission 1987).

Bartholic (2005) in a study for the Institute of Water Research at Michigan State University, estimated the total sediment load from agricultural croplands under conventional tillage in the

[2] Currently, 32 Areas of Concern (AOCs) are listed on the U.S. EPA website at http://www.epa.gov/glnpo/aoc/. The total of 43 includes 26 located entirely within the United States; 12 located wholly within Canada; and 5 that are shared by both countries.

Great Lakes basin as 15.6 million tons/year, with 7.1 million tons/year from reduced tillage and 2.6 million tons per year under no-till croplands[3]. Basinwide, there are approximately 8.5 million tons of sediment dredged annually from navigation channels and tributaries by the U.S. Army Corps of Engineers (USACE), states, municipalities, private marina operators, and industry. The Corps alone expends over $20 million annually for dredging and has spent over $300 million on confined disposal facilities for contaminated sediments from Great Lakes navigation channels (USACE/USEPA in prep). A study by the Ohio State University in the Maumee River Basin concluded that soil conservation efforts to reduce the sediment load by 15% would reduce the costs to the Corps for dredging and confinement of sediments from the navigation channel by $1.3 million dollars per year (Sohngen 2001). Another perspective of the damages caused by sediment contamination is the overall scale of costs for cleanup of AOCs, estimated by EPA to be between $2-7 billion (USACE 2005).

There a number of other "market based" costs of soil erosion and excessive sediment loads that have not yet been quantified. Municipalities and industries must expend increased costs for treating potable and industrial water supplies to remove elevated levels of suspended sediments following rainfall runoff. Flood damages to public facilities and private landowners are increased when soil erosion reduces the capacity of the watershed to absorb flood waters, aggravating overbank flooding and streambank erosion. The useful life of reservoirs and impoundments are reduced as excessive sediment loadings accumulate and take up valuable flood storage space. Recreational businesses are impacted when swimming and other water-based recreational opportunities are impaired by storm-induced high bacteria counts and/or sedimentation of ponds and small lakes and beaches. Excessive sediment loadings also impact the multibillion dollar sport and commercial fishing industry on the Great Lakes through the loss of aquatic habitat.

Soil erosion and excessive sediment loadings are also responsible for "nonmarket" costs that are not easily quantified in economic terms. These include generally degraded water quality and diminished fish and wildlife habitat. (Sohngen 2001). Sediment contamination has been linked to 11 of the 14 beneficial use impairments identified in the Great Lakes Water Quality Agreement, including fish flesh tainting, fish tumors and abnormalities, and restrictions on fish and wildlife consumption (IJC 1997).

Bartholic (2005) has assessed over 100 GL sub-watersheds, based on USGS 8-digit HUCs, considered potentially high contributors to sediment. The named top 10 watersheds with potentially high erosion and sediment loading to Great Lakes tributaries: 1) Maumee, OH and IN 2) Seneca River, NY 3) Grand River, MI 4) Saginaw River, MI 5) St. Joseph River, MI, IN 6) Upper Genesse River, NY 7) Sandusky River, OH 8) Wolf River, WI 9) Manitowoc-Sheboygan River, WI 10) Kalamazoo River, MI. According to the U.S. Army Corps of Engineers (USACE) Great Lakes Tributary Modeling Status Report (2005): "sources of the sediments may be in areas of the watershed that are far removed from the portion of the waterway that is feeling the impact of excessive sediments or sediment contamination. In addition, the mobility of sediments presents a real challenge to those evaluating their impacts. Sediment production and transport are concentrated during relatively brief periods of time. **For example, the amount of sediment**

3. The sediment load is the fraction of total erosion that reaches the Great Lakes and its tributaries.

**mobilized during an intense storm, lasting a few days, may be greater than the total amount mobilized during the a period of several years of normal flows and lesser storms."**[4]

Goals of the Great Lakes Regional Collaboration Nonpoint Team, include measurably reducing hundreds of thousands of tons of sediment, pounds of phosphorous loading, and pounds of nitrogen loading in to the Great Lakes basin, with several interim milestones to be achieved by 2020, including installation and continued use of management practices on cropland, especially those that increase crop residue left on the surface. They specify a goal of a 40 percent reduction in sediment loss from croplands, which will result in greater water clarity, greater desirable aquatic plant growth, less algae, better fish habitat, and less sedimentation of bays and harbors. The 40 percent reduction is estimated to cost $24 million annually over 5 years, based on a cost of $60/acre to achieve a 2.5 ton/acre reduction in soil loss (see attached materials).

Nutrient Enrichment and Phosphorus

Increasing levels of nitrogen basinwide in the lower Great Lakes and their tributaries have been identified by recent studies (Eadie 2005). The problem is evident in the long-term increases in the concentrations of nitrate, and nitrite nitrogen in Erie and Ontario waters, where both lakes may now be beyond a doubling from historically very low background levels of nitrogen. Contributors are thought to include moderately high levels of nitrogen in shallow ground water and streams due to the continuing applications of nitrogen fertilizers and the discharge of treated wastewater.

At the levels being found, aquatic species are a concern even if human health is not yet threatened. Out of 7,800 tests of drinking water sources in the Great Lakes basin, there were only four reported exceedances of nitrate levels over accepted human health standards of 10 mg/l. However, a large test of about 8,000 water samples in the Lake Erie Basin, reported that 19.8 percent of the samples had nitrate levels above 3 mg/l, a concentration known to cause physical and behavioral abnormalities in some amphibian species in the laboratory (Lake Erie Lakewide Management Plan 2004; U.S. EPA and NR CAN 2004; IJC Science Advisory Board Biennial Report 1997-1999; Rouse et al. 1999).

One of the major issues for the Great Lakes in the 1970's to 1980's was eutrophication of lakes from phosphorus enrichment due to excessive loadings from point and nonpoint sources including agriculture. Following the implementation of the phosphorus load reduction plan in both the U.S. and Canada, in-lake concentrations of phosphorus were reported at or below model predicted concentrations. Massive fish kills and algal blooms subsided and the lakes returned to acceptable conditions. Once again, though, phosphorus conditions in the lakes are a significant concern.

P is increasing again in the central basin of Lake Erie, leading to a return of the lake's hypoxic, or "dead," zone, even though long-term records of the Lake's nutrient status had indicated gradually decreasing phosphorus levels for the period 1983-2000. The amounts of nutrients present in the water in early spring are thought to be a particular problem, extending a trend that

4 Highlighting added for emphasis.

was first seen in 1995. Much of the variation in the amount of phosphorus entering the lake over the last few years is considered due to the intensity and timing of storms, which cause flooding and erosion, rather than to municipal inputs (Eadie 2005; Lake Erie Lakewide Management Plan 2004; IJC Science Advisory Board Biennial Report 1997-1999).

US and Canadian governments have cooperated to solve these problems through the International Joint Commission (IJC). The Great Lakes Water Quality Agreement, signed in 1972, required both countries to develop phosphorus load reduction plans. Mathematical nutrient models were completed and established phosphorus targets for all five lakes which were later incorporated into amendments to the Great Lakes Water Quality Agreement of 1977. Each country then took phosphorus load allocations for each lake and apportioned load reductions between point and nonpoint sources. The portion of the P load determined to be from point sources was controlled in part through detergent phosphorus bans, NPDES phosphorus limits of 1 mg/l in sewage effluent from sewage treatment plants over 1 million gallons per day and similar controls from industrial discharges.

To address overwhelming phosphorus loads from nonpoint sources particularly from agriculture, the U.S. Environmental Protection Agency's Great Lakes National Program Office (GLNPO) supported nutrient management and erosion reduction demonstration projects promoting no-till agricultural practices (including creation of the Conservation Tillage Technology Information Center, now the Conservation Technology Information Center), animal waste handling practices, soil erosion control technologies, and Black Creek watershed demonstration project. To this end, closer relationships were established between federal and state agricultural program and conservation districts on the U.S. side in the Great Lakes Basin (US EPA Internal Communication 2005).

In 2005, the Great Lakes Regional Collaboration in the U.S., coordinated through GLNPO, identified as part of its Nonpoint Action Strategy, the goal of reducing livestock agriculture's contribution to nonpoint source loading by 40-70 percent through comprehensive nutrient management planning and practice implementation, at an estimated cost of $106 million over 5 years.

Pesticides

In its 1995-97 report, the IJC Science Advisory Board reported pesticide use was viewed by participants as much less problematic than it was even a decade earlier, in part because of the advent of new products with short half-lives and low persistence, and also because of improved pesticide storage, handling and user training programs. Previous IJC activities documented the extent of row crop pesticide usage (IJC 1993-95 Priorities Report) and a series of workshops was held assessing the feasibility of partnerships to reduce the delivery of row crop pesticides to the Great Lakes.

Although Atrazine use has decreased[5] in the Lake Michigan basin and loading to Lake Michigan had decreased since the early 1980s, concentrations are once again rising. A 2005 EPA memo

5 Herbicides may include Atrazine, yet not necessarily list the compound on the label.

summarizing agricultural issues for the Great Lakes, noted the following concerns: Model forecasts indicate that under present loading, Atrazine concentrations will continue to increase for approximately 200 years in Lake Michigan. To maintain the 1995 concentration of 40 ng/L, tributary loads would have to be decreased by a third or more. Studies of mass balance indicates that about 70% of the external Atrazine load to Lake Michigan is from tributaries. The remainder is from the air (primarily rainfall/ wet deposition) and other sources. The largest loss is through the Straits of Mackinac outflow to Lake Huron. Largest tributary loads of Atrazine originate from the St. Joseph, Grand, Fox, and Kalamazoo Rivers. Greatest concentrations in the Lake are typically observed in Green Bay and in the southeastern portion of the southern basin along the Michigan coastal area during the spring and summer.

While no specific pesticide-related goals are presented by the GLRC, goals and milestones related to sediment and buffer strip implementation mention reducing pesticide runoff as a desired benefit. The IJC Ninth Biennial Report on Great Lakes Water Quality (1998) presented a goal of reducing herbicide loads to the Great Lakes by at least 30 percent by 2005 (see attached materials).

## Other Priority Problems

### Bacterial Contamination

Bacterial contamination of coastal areas and beaches is a serious concern in the Great Lakes, directly threatening human health and safety. It results from both point sources (sewage treatment plants, combined sewage overflows and failing septic systems) and nonpoint sources (primarily livestock waste, pet droppings, and feces from geese and gulls). The United States has set a goal that by 2010, 90 percent of monitored, high-priority beaches around the Great Lakes will meet standards for bacteria (E. coli and fecal coliform) for more than 95 percent of the swimming season (U.S. EPA and NR CAN 2004).

### Climate Change

Climate change is being recognized as a long-term potential threat to the Great Lakes, which will likely exacerbate a number of other problems. Several recent reports document a long list of concerns related to climate change impacts on the Great Lakes, including increased pollution and decreases in water levels. One of the likely impacts on water quality, highlighted by this report and others, is the concern that higher intensity precipitation events expected under most climate change scenarios, will bring increased nonpoint source pollution and more frequent and severe flooding (Kling et al. 2003; USACE 2003; Sousounis and Bisanz eds. 2000).

Contaminated Sediments

Contaminated sediments are a major cause of environmental problems and a key factor in many impairments to beneficial uses of the Great Lakes. All of the Great Lakes Areas of Concern have contaminated sediments. This universal obstacle to environmental recovery in AOCs poses a challenge to restoring 11 of the 14 beneficial use impairments identified in Annex 2.1.c of the Great Lakes Water Quality Agreement.

Declining Fish and Wildlife

Great Lakes fish populations have been subject to severe pressures from over-fishing, pollution, habitat degradation, and invasions by non-native species. Governments have sought to compensate by setting fish quotas, reducing pollution, and trying to control invasive species. As a result, some native fish species are making a comeback in some areas.

Flooding

Flooding may become more common and extreme because of the interaction of more frequent intense rainstorms with urbanization and other land management practices that increase pavement and other impervious surfaces and degrade the natural flood-absorbing capacities of wetlands and floodplains. In rural areas, channelization and agricultural drainage may exacerbate potential for flooding. The results are likely to be increased erosion, and additional water pollution from nutrients, pesticides, and other contaminants (Kling et al. 2003).

Flow & Channel Alterations

Alterations in the natural hydrology of surface and ground water in the Great Lakes basin, such as in the form of water withdrawals, dams that alter timing of natural flow regimes, channelization, and agricultural drainage, all change the structural and functional integrity of the physical, chemical, and biological elements in these ecosystems. Dams restrict flood flows, support timber harvesting, generate hydropower, and store water for irrigation as well as potable and commercial use. There are 2,075 dams that are 6 feet or higher in the Great Lakes Basin (Graf 1999). Sediment accumulation in the small lakes and impoundments above these dams has reduced the loading of sediments discharged downstream. Removal of dams is being considered at many locations, and the fate of the accumulated sediments behind them is a concern. Channelization affects the rate of water movement and influences the water balance between surface and base flows. Straightening or deepening of channels to support commercial shipping and recreational boating has also altered Great Lakes tributaries (USACE Great Lakes Tributary Modeling Status Report 2005)

Analyses of flow regimes in Michigan's portion of the basin at 53 sites over two distinct 20-year records, ending in 1950 and 1998, documented numerous changes, including increased runoff and flow magnitudes (high and low) measures, which were thought to be attributable to an overall increase in precipitation, changing land uses related to increases in impervious surfaces, and associated stormwater conveyance, and dams. "Changing land use, impervious surfaces, storm drains, drainage canals, farm tiles and seasonal removal of vegetation all create more

responsive or “flashy” flow regimes, while also lowering base flow because groundwater recharge is reduced (Allan and Hinz 2004). The authors also note that the cumulative effects of dams on larger tributaries in the basin tend to make flow more predictable, which may mask the influence of climate change.

The anticipated results and benefits of protecting, conserving, and improving the hydrology of watersheds will be reduced infrastructure costs due to elevated stream flows and excessive sediment loadings, improved shipping capacity, increased public use, and improved aquatic ecosystem health (GLRC 2005). The GLRC Nonpoint Team identified the goal of improving flow regimes and hydrology to meet sediment reduction goals and restore sustainable biological communities.

Habitat Loss & Restoration of Ecological Integrity

More than 50 percent and perhaps as much as 70 percent of historic Great Lakes wetlands have already been lost. This loss --through filling or draining -- is primarily due to agriculture, urban uses, shoreline development, and resource extraction. These same causes continue to threaten the remaining Great Lakes wetlands. The loss of wetlands poses special problems for hydrological processes and water quality because of the natural storage and cleansing functions of wetlands.

The Great Lake Regional Collaboration Nonpoint Team identified the goal of protecting existing wetlands and restoring wetlands in both urban and rural areas so that rivers, streams and lakes across the Great Lakes region function as healthy ecosystems. Wetland priority areas for the Great Lakes exist in many active ongoing plans. Priority areas with active partnerships and implementation teams include several watersheds currently active under USDA’s Conservation Reserve Enhancement Programs in the Saginaw Bay watershed, the Maumee River watershed, and the western and central Lake Erie watersheds (OH and PA), River Raisin and Macatawa watersheds (MI), eastern Wisconsin riparian areas, and areas noted in the National Strategy to Restore Coastal and Estuary Habitats.

Loss of open spaces and farmland, and development for urban, suburban and industrial purposes also threatens habitats and reduces ecological integrity. The changes that come from more intensive land development include modified hydrology, increases in the extent of impervious surfaces, and degraded and destroyed wetlands and floodplains that could absorb runoff and attenuate pollutants. Increasing impervious surfaces in a watershed by 10-20 percent, causes 35-50 percent increases in surface runoff (Kling et al. 2003). Paved surfaces also behave as heat sinks, raising air and stream water temps. Development pressures in much of the Great lakes region are expected to increase, especially around major cities and popular recreational areas.
A variety of invasive, non-native species are considered one of the most serious threats to the ecological integrity of the Great Lakes. Humans have deliberately or accidentally introduced more than 160 new species into the Great Lakes basin, forever changing its species mix. Species of special concern include zebra mussel, alewives and goby populations. The newcomers can displace native species by eating them or out-competing them for food or other aspects of habitat.
Slow progress is being made in the long-term fight against aquatic invasive species (AIS). Stopping the invasion of non-native species requires a variety of strategies, primarily aimed at

requiring ships entering the Great Lakes to first exchange their ballast in open salt water, where there should be no organisms that can survive in fresh water. Regulations and guidelines also apply to recreational boating, and include anglers and even pet shops and aquarium owners.

In 2002, an underwater electric barrier was installed in the Chicago Sanitary and Ship Canal, designed to keep non-native carp that escaped into the Mississippi River system from moving north into the Great Lakes, and to prevent the invasive ruffe from moving from the lakes into the Mississippi (US EPA and NR CAN 2004). The Great Lakes Regional Collaboration has an AIS Strategy Team report that includes six major steps to stop AIS introductions and to manage invasives already in the basin.

Persistent Toxic Substances

Over the years, the Great Lakes have been polluted by a wide range of heavy metals and chemicals that include industrial solvents, power plant emissions, and pesticides. Sources include manufacturing, mining, landfills, shipping, and agriculture. Persistent toxic chemicals in the Great Lakes pose a variety of related concerns that directly impact human and animal health. These substances are the sources of polluted sediments and contamination of fish, leading to fish consumption advisories.

Over the past 20 years, considerable progress has been made in the control and management of point and nonpoint sources of chemical contaminants. Reduced loadings of contaminants have, in general, resulted in a 50-70 percent reduction of contaminant levels in fish between the early 1970s and the mid 1980s. However, since the mid 1980s, ambient levels of contaminants appear to have generally either leveled off or their rate of decrease has slowed substantially.

Fish consumption advisories remain in effect in all of the Great Lakes. It is believed that the major reason why contaminant levels in fish have generally leveled off and health advisories on human consumption of fish remain in effect is that there are continued inputs of contaminants from the atmosphere, groundwater discharge, surface runoff, and contaminated sediment. The lakes have also become now a source of contaminants to the atmosphere, which in turn, deposits contaminants back into the lakes (IJC 1998).

Water Quantity and Decreasing Water Levels

Concern over water withdrawals and tapping of aquifers in the Great Lakes Basin has been steadily increasing. A 1999 permit from the Ontario government allowed bulk water shipments from the Great Lakes, which led to considerable public outrage and laws in Ontario to ban diversions. On the U.S. side of the border, prohibitions on diversions in the U.S. Water Resources Development Act (WRDA) are being questioned. In 2004, a study by the U.S. Geological Survey showed that, for the first time, groundwater pumping had reversed the direction of flow away from Lake Michigan, which represents the largest concentration of unfrozen fresh surface water in the western hemisphere (Kling et al. 2003). The Council of Great Lakes Governors, with Ontario and Quebec, have been negotiating a set of standards and rules to permit and limit diversions from the Great Lakes, building on previous water laws. This Agreement and Compact for Annex 2001 document, known as the “2005 draft” is still under

review.

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