

Appendix H:
Water Quantity Impacts on Great Lakes – St.
Lawrence River Organisms

Measurement Converter Table

U.S. to Metric

Length

feet x 0.305 = meters

miles x 1.6 = kilometers

Volume

cubic feet x 0.03 = cubic meters

gallons x 3.8 = liters

Area

square miles x 2.6 = square kilometers

Mass

pounds x 0.45 = kilograms

Metric to U.S.

Length

meter x 3.28 = feet

kilometers x 0.6 = miles

Volume

cubic meters x 35.3 = cubic feet

liters x 0.26 = gallons

Area

square kilometers x 0.4 = square miles

Mass

kilograms x 2.2 = pounds

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APPENDIX H:

Water Quantity Impacts on Great Lakes - St. Lawrence River Organisms

Introduction

The Great Lakes - St. Lawrence River basin was formed by the forces of water and ice. While water is the root of existence for all organisms, a functioning ecosystem thrives on a healthy environment and the interactions among a complex arrangement of species. Although many species and their functions are not fully understood, it is apparent that each every species plays an important role in the ecosystem.

In this appendix, organisms have been separated by taxonomic classifications. Four kingdoms belong to this domain: Protista, Fungi, Plantae and Animalia. The Kingdom Protista is composed of protist species that are unicellular, colonial, or multicellular. They are carbon sinks and form the base of the aquatic food chain. These protists include algae (phytoplankton), slime molds and protozoans (zooplankton). Protists are generally found in aquatic environments since their locomotive capabilities are minimal, although slime molds are found in moist terrestrial systems. The Kingdom Fungi are mostly multicellular decomposers, represented by mushrooms, molds, yeasts and lichens. Fungi are nutrient recyclers that make carbon and nutrients available for uptake by plants. The Kingdom Plantae is composed of multicellular, autotrophic organisms that photosynthesize to fix inorganic carbon into organic molecules. This kingdom is represented by mosses, ferns, conifers and flowering plants. These plants are the primary producers of the system, providing food for the Kingdom Animalia. The Kingdom Animalia consists of invertebrates, fish, amphibians, reptiles, birds and mammals.

Appendix G, *Water Quantity Impacts on Great Lakes – St. Lawrence River Ecosystems*, describes the habitats of the Great Lakes - St. Lawrence River region and recommends ways to improve the understanding of relationships between hydrology and ecosystem health. As an essential component to habitats, the various classes of organisms found in Great Lakes habitats are described in this appendix. Furthermore, this appendix assesses the current state of data and information for each particular group of organisms. As a part of the Great Lakes Biohydrologic Information Systems Study, data and information related to organisms are inventoried and presented in the last section of this appendix. The information generated by this inventory is summarized in the body of this appendix by organism group. Additionally, gaps in data and information for each organism group are assessed in the body of this appendix. However, different from the other appendices of this study, recommendations to fill these information gaps are not developed.

In conducting the search for data on water withdrawals and how they affect organisms, it became clear that little information is currently available on this topic. While many organisms have been intensively studied, others are greatly lacking in basic ecological data. To determine the effects of water withdrawals on every organism in the system is a bit redundant when we can determine the effects of withdrawals on the habitat, for it is the

habitat that determines the species assemblage. The scope of this study does not support the cost or time to assess impacts to individual organisms.

Nevertheless, it would be of great importance in the aquatic environment to determine how water withdrawal affects *Diporeia spp.*, a tiny shrimp-like crustacean and plankton since these organisms form the base of the aquatic food web. These organisms are currently State of Lakes Ecosystem Conference (SOLEC)¹ indicator organisms and future funding should be funneled to research these keystone organisms.

In summary, this appendix:

- 1) describes the grouping of organisms found in the Great Lakes - St. Lawrence River basin;
- 2) describes the data and information currently available for each organism group; and
- 3) identifies gaps in these data and information.

Protists

Algae

Algae are simple single-celled, colonial, or multi-celled, aquatic plants. Aquatic algae are mostly microscopic plants that contain chlorophyll; grow by photosynthesis; and lack roots, stems and leaves (Reid and Holland, 1997). They absorb nutrients from the water or sediments and are usually the major source of organic matter at the base of the food web in lakes. Millions of species of bacteria and fungi play a critical role in breaking down organic material and reprocessing the nutrients to make them available for algae to continue growing (Reid and Holland, 1997). In addition to sitting at the foundation of the food web that supplies energy to all other organisms on the planet, algae have the potential to act as a "carbon sink," sucking up and storing excess carbon dioxide and moderating climate change.

Algae, as well as plants, are responsible for transforming carbon dioxide from the atmosphere into the usable forms of carbon that serve as the building blocks for life by photosynthesis. Freely suspended forms are called phytoplankton; forms attached to rocks, stems, twigs and bottom sediments are called periphyton. Algae are a major food source in the aquatic ecosystem. Zooplankton, mussels, larval fish, and other small fish thrive on algae, phytoplankton and periphyton.

Algae are often overlooked, but they are very important to riverine health. Rivers and streams typically contain hundreds of algal species and many indicate environmental health by their presence under specific water-quality conditions. Excess nutrients such as nitrogen and phosphorus originating from fertilizers or animal wastes usually will increase the amount of nuisance algal growth. The resultant dense mats of algae can choke off waterways to boaters

¹ SOLEC is hosted by the U.S. Environmental Protection Agency and Environment Canada on behalf of the two countries. These conferences are held every two years in response to a reporting requirement of the binational Great Lakes Water Quality Agreement (GLWQA). The purpose of the Agreement is "to restore and maintain the physical, chemical and biological integrity of the Great Lakes Basin." The conferences are intended to report on the state of the Great Lakes ecosystem and the major factors impacting it and to provide a forum for exchange of this information amongst Great Lakes decision-makers.

and, through decay and respiration can reduce oxygen to levels lethal to fish and other aquatic organisms (Reid and Holland, 1997).

Altered water flow and levels can have several effects on the aquatic algal communities. Water flow is slowed by natural or manmade impediments, making calmer waters. Calmer water lets in more sunlight and slower moving water usually has a higher temperature. This changes the algal communities and algal species that are accustomed to low oxygen levels thrive, often forming algal blooms or mats and decreasing the available amount of oxygen to other organisms (Reid and Holland, 1997). Algal populations are also decreased with an increase in water movement (Munawar and Munawar, 2000).

The U.S. Geological Survey (USGS) has distributional data of aquatic species and habitats including algae for all the Great Lakes. The Fish and Wildlife Service (FWS) has algae studies for east-central Lake Superior. NOAA has seasonal and spatial distributional data for algal blooms in Saginaw Bay, Lake Superior and is developing a invasive species database that include algae for all of the Great Lakes. U.S. Environmental Protection Agency (USEPA) has several phytoplankton studies throughout the Great Lakes and is working on phytoplankton spatial data for Saginaw Bay. Environment Canada has biological information, including 20-year overview of algal species, for the St. Lawrence River. Environment Canada monitors phytoplankton populations under SOLEC (State of the Lakes Ecosystem Conference) as a Great Lakes indicator.

The understanding of phytoplankton and their role in the Great Lakes Ecosystem is weak. Although numerous research efforts on phytoplankton exist in the Great Lakes, little effort has been made to standardize methodology to ensure data quality and comparability (Munawar and Munawar, 2000). Most of the information referenced above is in report format. It would be useful to have algal species distribution, population size and vertical migration in a standardized spatial database for the entire Great Lakes system. Seasonal variation in species could be determined and the affects of water levels on algal diversity and abundance could be determined with the use of GIS.

Slime Molds

The slime molds are not closely related to any other living organisms. They are unicellular, multicellular and colonial at different stages of their life cycles. They thrive in moist environments with decaying organic matter, bacteria and yeasts. There are two main groups of slime molds: cellular and plasmodial. When there are high numbers of bacteria available as food, cellular slime molds are solitary amoeboid cells that engulf bacteria. When bacteria become scarce, the amoeboid cells aggregate into a sluglike colony, which soon grow into a multicellular reproductive structure. In these two stages, the individual cells secrete a slimy covering coated with cellulose. Many slime molds thrive in forests within and on moist bark, rotting logs, leaf litter, dung and soil. They are significant decomposers, contributing to the maintenance of nutrient cycling. They are also utilized as food for many protozoa, nematodes, small arthropods and other small creatures.

Temperature and moisture have been shown to be the primary factors influencing seasonal distribution (Moore, 2002). While slime molds are dependent on a moist environment,

precise knowledge of how water regimes influence these organisms is absent. It is likely that a lowered water table would limit the abundance and distribution of these organisms, which in turn would limit the amount of nutrient recycling or decomposition.

Knowledge of slime mold ecology is severely lacking. Currently, less than 20 people in the United States actively study these organisms (Moore, 2002). As a result, the knowledge of their ecology is limited to the particular location where these individuals carry out their research.

Protozoans

The name protozoa means “first animal” and they are often referred to as zooplankton. Protozoans play an indispensable role in biogeochemical cycles and therefore also in the biosphere (Klijn, 1994)). They are abundant in deep lake waters as well as near the surface. Ponds, streams, rivers, swamps, most soil and even the very acidic water caused by industrial pollution contain some species of protozoa. Protozoans typically obtain their nutrition by engulfing food particles and small nutrient molecules from the environment. Protozoans consume a variety of prey. Many smaller protozoans feed on bacteria, some use algae as food and others that are large enough may consume other protozoans. As the principal hunters and grazers of the microbial world, protozoans/zooplankton play a key role in maintaining the balance of bacterial, algal and other microbial life. They are an important food source for larger creatures such as fish and invertebrates and form the basis of many food chains.

Any disturbance such as nutrient enrichment, fish introductions, thermal discharges or toxic effluents that alter the composition of the zooplankton community could ultimately affect the rest of the system (Schneider *et al.*, 1989). Research on protozoans has mainly focused on these types disturbances, and little is known about the impacts of water quantity on protozoans. However, it is conceivable that a change in hydrologic regime would affect the diversity and abundance of the protozoan population which would in turn upset the entire aquatic ecosystem.

The USGS has distributional data of aquatic species and habitats, including protozoans, for all the Great Lakes. Additionally, the USGS also has zooplankton data for the nearshore of Lake Erie and for the Sleeping Bears Dunes National Lakeshore. NOAA has information on the zooplankton of Lake Michigan and a report on the effects of the zebra muscle on protozoans from Saginaw Bay. The USEPA has a biological open water surveillance program for all of the Great Lakes and information on the zooplankton from Lakes Michigan and Ontario. The USEPA and Environment Canada have created the SOLEC indicator database, monitoring zooplankton populations in the Great Lakes.

A long term monitoring study of zooplankton distribution, diversity, vertical migration and abundance should be developed to determine if water levels affect the livelihood of these organisms. Distribution is not well documented (Klijn, 1994).

Fungi

Mushrooms

The mushroom is a significant element of the forest ecology. Mushrooms decompose brush and dead or diseased trees releasing nutrients back into the ecosystem. This assists in recycling critically limited nutrients such as nitrogen back into the soil. The visible part of a mushroom is the fruiting body that produces and releases spores for reproduction when temperature and moisture conditions are optimal (Kendrick, 2002). The living part of the mushroom is underground in the form of hyphae, tiny web-like filaments (Alexopoulos *et al.*, 1996). Typical forest mushrooms include morels (*Morchella* spp.), giant puffballs (*Calvatia gigantea*), death caps (*Amanita phalloides*), and Old man of the woods (*Strobilomyces confusus*). Mushrooms not only make nutrients available for a number of plants, they are also a food source for many woodland animals, including slugs, insects, squirrels, rabbits, and turtles. Mushrooms depend on moist conditions to develop their fruiting bodies for reproduction (Starr, 2000). It is unlikely that a lowered water table will adversely affect most mushrooms.

No government agencies are currently collecting data on mushrooms. NatureServe has distributional data on species and habitat throughout the Great Lakes - St. Lawrence River basin. The Chicago Field Museum has an online database of fungal information for the Great Lakes - St. Lawrence River basin. Research is needed to determine how cumulative water withdrawals will affect mushrooms.

Molds and Mycorrhizae

Like mushrooms, molds and mycorrhizae are decomposing fungi, releasing nutrients back into the system. However, a few molds are also parasitic, living off a host plant or animal and sacrificing the host's health (Stamets, 1999-2004). Water molds are found in wet environments, especially in freshwater sources and near the upper layers of moist soil. Some water mold species, such as *Saprolegnia*, can cause disease in fish. These parasitic molds are typically thought of as biologically evil causing much damage to a number of plant and animal species; however, a new species called *Taxomyces andreanae* produces minute quantities of the anti-carcinogen Taxol which is a proven treatment for breast cancer (Stone, 1993). Many plants have a similar relationship with mycorrhizae, fungi found in the soil that promote plant growth and nutrient absorption. Rather than merely decomposing organic matter, they have a vital symbiotic relationship with trees and other green plants.

At least 80 percent of all land plants, including all trees, have mycorrhizal fungi (Starr, 2000). The plant "feeds" the fungus some of the carbohydrates it makes through photosynthesis. In return, the fungus increases the plants' root absorption of water and certain essential minerals, such as phosphorus and magnesium. Without mycorrhizal fungi, most plants, including the grasses, would not survive and thrive. Knowledge of how water quantity affects molds and mycorrhizae is poorly understood. It is unlikely that a lowered water table will have much affect on the livelihood of these organisms. No agencies are collecting data on molds or mycorrhizae. At a minimum, distributional data on these organisms are needed.

Yeasts

Yeasts are crucial components of the food chain. For each plant and animal, there are specific microorganisms associated with that particular species. Industrial and agricultural yeasts have been well described, however, not much is known about their ecological roles. Yeasts provide a source of sterols for invertebrates and stimulate growth and nitrogen-fixing in bacteria. They also provide a mechanism for uptake, accumulation and transformation of phosphorus for use in the food web. Yeasts, in the natural environment, are poorly understood. It is unlikely that a lowered water table will have much affect on the livelihood of these organisms. No agencies are collecting data on yeasts. At a minimum, distributional data on these organisms are needed.

Lichen

Lichens are the result of a fungus intertwined with an algae or cyanobacteria. Algae put together and excrete a certain carbohydrate that is taken up and used as food by the fungus. Fungi provide water, minerals and shelter for algae. Together, lichens exploit habitats where the fungi or the algae could not survive independently, typically on rocks, bark or poor soil. Lichens play important roles in the complex food webs of forests, providing food sources for many organisms. For example, certain lichen species provide food for Flying Squirrels (*Glaucomys sabrinus*), the prey for many owls, hawks, martens and weasels. Other lichens are important winter food sources for browsing deer and elk. Many other lichens play an important ecological role in the fixation of nitrogen for the forest.

Lichens are dependent on water. Their life cycle is dependent on the presence of water. During times of drought, lichens cease to reproduce and grow. When water is more plentiful, they resume growth and reproduction. Specific literature on how water withdrawal affects these organisms does not exist, but the effects are likely minimal.

Only a few agencies collect information on lichens. The U.S. Department of Agriculture (USDA) Forest Service has distributional and biological information on lichens in the Great Lakes - St. Lawrence River basin. NatureServe also has distributional information on lichens in the Great Lakes - St. Lawrence River basin. Environment Canada has biological information for the St. Lawrence River. The Ontario Ministry of Natural Resources (OMNR) has distributional data for lichens in Ontario Further research is needed to determine the impacts of water withdrawal on these organisms.

Plants

Mosses

Mosses, liverworts and hornworts are bryophytes, non-vascular plants adapted to moist habitats. Bryophytes form extensive mixed communities and contribute significantly to community structure and ecosystem functioning. They are critical to the survival of a tremendous diversity of organisms, including insects, millipedes and earthworms. Many arthropods are dependent on mosses and liverworts as habitat or as a food source. The moss' nutrient-rich, spore-producing capsules are particularly palatable to some insects and mollusks such as slugs. Mosses are also a food source for birds and mammals in cold environments and are eaten by geese, ducks, sheep and rodents. In addition to providing an

important food source, mosses also provide seed beds for the larger plants of the community. They capture and recycle nutrients that are washed with rainwater from the canopy and they bind the soil to keep it from eroding. Mosses are “pioneer” species - the first organism to inhabit areas highly degraded by human action (Shaw and Goffinet, 2000).

Mosses are especially sensitive to air pollution (Adams and Preston, 1992). They have a low tolerance of rivers that are dammed, polluted and contain fine sediments (Lopez *et al.*, 1997). They are most demanding of rapid currents, clean water and rocky/open gravel conditions. They are extremely dependent upon water for their survival and reproduction and are therefore typically found in moist areas like creeks and forests (Shaw and Goffinet, 2000). Some bryophytes, however, are able to survive in areas with little or no rainfall.

The USDA Forest Service has distributional and biological information on mosses in the Great Lakes - St. Lawrence River basin. The Natural Resources Conservation Service (NRCS) has distributional and biological information for plants, mosses, liverworts, hornwort and lichens in the Great Lakes - St. Lawrence River basin. NatureServe also has distributional information on mosses in the Great Lakes - St. Lawrence River basin. The National Biological Information Infrastructure has online information on plants, mosses, liverworts, ferns and animals of the Great Lakes - St. Lawrence River basin. Environment Canada has biological information for the St. Lawrence River and in conjunction with the USEPA has created the SOLEC indicator database for the Great Lakes - St. Lawrence River basin, including the presence of bryophytes. The OMNR has distributional data for mosses in Ontario. While data exists for mosses, further research is needed to determine the impacts of water withdrawal on these organisms.

Ferns

Ferns and other seedless vascular plants are found all over the world, from sea-level to high mountains. They are descended from some of the oldest plants of the earth's history, being found as fossils dating back nearly 400 million years (Starr, 2000). A very diverse group of plants, ferns are found primarily in moist tropical areas, thinning out to the north. Ferns play an important role in ecological succession, often colonizing rock crevices, old fields, or open marshes preparing the soils and providing a seedbed for woody vegetation.

Ferns are dependent upon moist conditions, utilizing water droplets to aid in fertilization. Ferns are the “amphibians” of the plant kingdom, still connected to the aquatic habitats of their ancestors (Starr, 2000). Like other bryophytes, ferns are sensitive to water pollution, yet it is not known how lowered water tables affect these plants.

The USDA Forest Service has distributional and biological information on ferns in the Great Lakes - St. Lawrence River basin. The NRCS has distributional and biological information for ferns in the Great Lakes - St. Lawrence River basin. NatureServe also has distributional information on ferns in the Great Lakes - St. Lawrence River basin. The National Biological Information Infrastructure has online information on ferns of the Great Lakes - St. Lawrence River basin. Environment Canada has biological information for the St. Lawrence River and in conjunction with the USEPA has created the SOLEC indicator database full of biodiversity information for the Great Lakes - St. Lawrence River basin, including the

presence of bryophytes. The OMNR has distributional data for plants in Ontario. The Canadian Endangered Species Conservation Council has a species status report that compiles the efforts of provincial, territorial and federal monitoring programs. The National Museum of Natural Sciences has an atlas of rare plants in Ontario. While distributional data exists for ferns, further research is needed to determine the impacts of water withdrawal on these organisms.

Conifers

Conifers are gymnosperms meaning that they have “naked seeds” that are grown in cones and not visible (Starr, 2000). They generally have scale-like or needlelike leaves and bear seeds exposed on cone scales. The Great Lakes - St. Lawrence River basin is home to a variety of conifers including pines (*Pinus* spp.), spruces (*Picea* spp.), firs (*Abies* spp.), cypress (*Taxodium* spp.) and cedars (*Thuja* spp.). Many conifers are well adapted to moderate or dry sites, and a few are able to exist on wet sites. Examples of these hydrophytic (moisture loving) plants include the bald cypress (*Taxodium distichum*) and balsam fir (*Abies balsamea*), with balsam fir being able to tolerate a wide range of sites from nearly dry to wet.

Conifers, like all plants are dependent on water. However, a reduction in water tables will likely have little affect on most of these species. Bald cypress will likely be the most affected by water withdrawals, although no data exists to back this statement. Most important to the health of all plants is soil moisture. Lack of soil moisture will cause a reduction in photosynthesis, limits the uptake of CO₂, and restricts the mass movement of nutrients into the roots (Kimmins, 1987).

Several agencies collect distributional and ecological data on conifers, however little is know on how water withdrawals affect these trees. The USDA Forest Service has distributional and biological information on conifers in the Great Lakes - St. Lawrence River basin. The NRCS has distributional and biological information for conifers in the Great Lakes - St. Lawrence River basin. NatureServe also has distributional information on conifers in the Great Lakes - St. Lawrence River basin. The National Biological Information Infrastructure has online information on conifers of the Great Lakes - St. Lawrence River basin. Environment Canada has biological information for the St. Lawrence River and in conjunction with the USEPA has created the SOLEC indicator database for the Great Lakes - St. Lawrence River basin. The OMNR has distributional data for conifers in Ontario. The National Museum of Natural Sciences has an atlas of rare conifers in Ontario. Further research is needed to identify effects of cumulative water withdrawal on the sustainability of conifer stands across the basin.

Flowering Plants

Flowering plants, also known as angiosperms, produce reproductive structures commonly referred to as flowers. Many flowering plants evolved with pollinators (i.e., birds, insects and other animals) which contributed to their successful existence on the land for over 100 million years (Starr, 2000). These plants play a major role in everyday life and range in species from grasses to perennials, trees and shrubs. They provide the ecosystem with clean air and water, food and medicine. All plants remove CO₂ from the air, producing clean air to the ecosystem. They also stabilize the soil with their roots and prevent erosion. Wetland

plants filter sediments and pollutants from drinking water. Nearly all fruits and vegetables come from flowing plants. Several medicines are derived from plants, including aspirin, atropine and cocaine.

Alterations of the hydrologic regime will likely affect plant species. Certain plants are adapted to various moisture and light levels. Changes in water quantities and/or light levels lead to changes in the plant species assemblage, altering the habitat, the animals that depend on that habitat and quite possibly the ecosystem (Kimmins, 1987). A single species can play a crucial role, having a kind of domino effect on the community that is disproportionate to its abundance (Mackenzie and Ball, 2001). Water shortages lead to the development of less dense vegetation which leads to low productivity (Kimmins, 1987). Alterations in groundwater flow rates are most likely to severely affect aquatic and semi-aquatic plant species and the habitats in which they live (Bay, 1967), while upland plants or those adapted to drier sites will display little if any changes.

The USDA Forest Service has distributional and biological information on plants in the Great Lakes - St. Lawrence River basin. The NRCS has distributional and biological information for plants in the Great Lakes - St. Lawrence River basin. The USGS has image, biological and distributional data for aquatic plants of the Great Lakes. The USGS also has distributional data for plants along the upper Mississippi River. The NOAA is creating distributional and biological databases on invasive species of the Great Lakes. NatureServe also has distributional information on plants in the Great Lakes - St. Lawrence River basin.

The National Biological Information Infrastructure has online information on plants and animals of the Great Lakes - St. Lawrence River basin. The Great Lakes Indian Fish and Wildlife Commission have online distributional and biological data on invasive plant species in Michigan, Wisconsin and Minnesota. Environment Canada has biological information for the St. Lawrence River, and in conjunction with the Great Lakes, have created an indicator database full of species information for the Great Lakes - St. Lawrence River basin. The OMNR has distributional data for plants in Ontario. The Canadian Endangered Species Conservation Council has an orchid status report that compiles the efforts of provincial, territorial and federal monitoring programs. The National Museum of Natural Sciences has created an atlas of rare plants in Ontario. While many agencies collect information on flowering plants, more research is needed to determine the impacts of water withdrawal on these organisms.

Animals

Invertebrates

Nearly 90 percent of the world's animal species are invertebrates, animals lacking backbones (Starr, 2000). Insects, the most diverse group of animals, and mollusks are common invertebrates in the Great Lakes - St. Lawrence River region. Many insects are important pollinators, ensuring seeds for next year's plants and agricultural crops. Monarch butterflies are pollinators and travel thousands of miles to their wintering grounds in Mexico. These invertebrates provide an important food source for many animals.

In the terrestrial environment, invertebrates provide food for a number of primary consumers, including moles, amphibians, snakes, turtles, birds, raccoons and opossums. Aquatic invertebrates form a large base of the aquatic food web, providing food for a number of fish, turtles, amphibians and waterfowl (EC, 2000). Aquatic invertebrates spend part or all of their life cycles in the water and include insects (such as *Diporeia* spp.), crustaceans, mollusks (including native and zebra mussels) and worms.

Changes in water quantity can have great impacts on invertebrates. Low water levels can lead to higher concentrations of pollutants, creating very poor environmental conditions where few organisms survive. Insects such as black fly larva or leaches are common in these environments.

Reduction in flow can also alter the macroinvertebrate community causing some species to increase and others to decrease in abundance (Wood, 1998) Also, invasive invertebrates such as zebra mussels, can impact available water to industry and the public by clogging water intake valves due to their proliferation.

The USGS has compiled distributional and biological information for native and non-native invertebrates in the Great Lakes. The USGS also has compiled ecological data for the Lake Erie nearshore, data on the linkage between sediment contaminants and the health of fish and invertebrate communities in Lake Erie and information on burrowing mayflies in the Great Lakes - St. Lawrence River region. NOAA has information on the long-term trends of macroinvertebrate populations in southern Lake Michigan. NOAA also has compiled zebra muscle data from Saginaw Bay and is currently working on an online database of invasive species of the Great Lakes - St. Lawrence River region.

The USEPA is monitoring the bottom-dwelling invertebrates, wetland invertebrates, native freshwater mussels, mayflies (*Hexagenia* spp.) and benthic amphipods such as *Diporeia* species of all the Great Lakes and in conjunction with Environment Canada they have created a SOLEC indicator database full of species information for the Great Lakes - St. Lawrence River basin. NatureServe has distributional information on invertebrates in the Great Lakes - St. Lawrence River basin. Environment Canada has compiled biological information for the St. Lawrence River. The OMNR has distributional data for invertebrates in Ontario. The Canadian Endangered Species Conservation Council creates butterfly status reports from provincial, territorial and federal monitoring programs. While extensive data exist for invertebrates, further research is needed to determine how water withdrawals will impact these organisms.

Fish

Over 100 species of fish live in the Great Lakes - St. Lawrence River basin (EC, 2000). Fish inhabit a variety of aquatic ecosystems from the open waters of the Great Lakes to wetlands, streams and rivers. These fish have evolved to depend on the structural diversity and variable flow inherent to these systems. Deforestation, pollution, over fishing and invasive species have devastated native fish fauna. Several species of ciscoes, a unique deepwater fish, are now extinct. Even with the detrimental changes to the Great Lakes' environment, the variety of fish in these lakes remains among the richest in North America (EC, 2000).

Aquatic ecosystems are defined by hydrologic processes and any changes in water quantity can have a great impact on fish species (McKnight, 1998). Yellow perch, lake trout and whitefish numbers are declining in the Great Lakes (TNC, 1997). Physical alteration, habitat loss and degradation, water withdrawal, overexploitation, pollution and the introduction of invasive species all contribute to declines in native freshwater species. Building a dock, draining a swamp and clearing natural debris from the water alter aquatic habitats and often make them unsuitable for the resident species (TNC, 1997). This decreases the biodiversity of an area and alters the ecosystem (Gowing *et al.*, 1998).

Fish depend on the topography, substrate type and cover structures for feeding, hiding and reproduction. Sedimentation, channelization and dredging are all activities that change the structure and composition of the bottom and make it inhabitable for native fish species (TNC, 1997). Channelization and bank stabilization are processes for straightening a river and smoothing its sides. This results in low habitat heterogeneity, higher water velocity and the elimination of shallow-water and floodplain habitats (TNC, 1997). Channelization eliminates species that employ slow-moving waters in their life cycle. In the process of straightening a river, marshes are destroyed and once functioning floodplains are deemed useless along with fish, such as catfish and bullheads, which utilize the floodplain in their life cycle. High suspended sediment levels, low dissolved oxygen levels and high water temperatures, effect the quality of aquatic habitat, with resulting impacts on fish health and population sizes.

Fish migrate to spawn, feed, reach rearing areas and seek refuge from predators or harmful environmental conditions such as freeze-up of a lake or stream. The success of upstream migration is limited by the presence of barriers which can impede or even eliminate the passage of fish. If the migrating fish do make it upstream, they're often too exhausted to spawn. If they have to spawn in densely-populated downstream areas, their offspring are often forced to compete for any available nursery habitat. If migration is delayed or halted by barriers, the life cycle may be disrupted resulting in limited populations.

The USGS has compiled long-term biological and contaminant data, as well as distributional and biological information of native and non-native fish in the Great Lakes. The USGS also has information on the spatial movements of lake trout in Lake Huron, ecological data for the Lake Erie nearshore, data on the linkage between sediment contaminants and the health of fish and invertebrate communities in Lake Erie, predator prey data for Lake Superior and distributional data on species in the upper Mississippi River system. The National Park Service has compiled fish studies near Isle Royal. The NOAA has fishing records for the U.S. waters of the Great Lakes and is currently developing online distributional and biological information for Great Lakes aquatic invasive species. The NOAA is also developing a model to depict the influence of lake dynamics on fish populations and a report on the long-term and recent changes in Lake Michigan's food web. NatureServe has distributional data and information on fish in the Great Lakes. The National Biological Information Infrastructure has online information on fish of the Great Lakes - St. Lawrence River basin.

The Ohio Department of Natural Resources (ODNR) has spatial data on larval walleye in western Lake Erie. The Michigan DNR has biological information about fish in Michigan. The Michigan Department of Environmental Quality (MDEQ) has information on the inland fish of Michigan. The USEPA and Environment Canada have created the SOLEC indicator database with species information for fish habitat, Salmon and Trout, Walleye, Lake Trout, Lake Sturgeon, Sea Lamprey, Spottail Shiners, preyfish, nearshore and wetland fish of the Great Lakes - St. Lawrence River basin.

Environment Canada has biological information for the St. Lawrence River, has spawning and migration information for the fish of the Great Lakes shorelines and GIS data on the effects of effluent on fish in the Canadian waters of the Great Lakes. The OMNR has distributional data for fish in Ontario and a report on the effects of fish habitat modification in Batchewana Bay, Lake Superior. The Canadian Endangered Species Conservation Council has a species status report that compiles the efforts of provincial, territorial and federal monitoring programs. The Great Lakes Sport Fishing Council has distributional and biological information on invasive species and their effects on the Great Lakes.

The Great Lakes Fishery Commission has compiled historic information on commercial fisheries and an online database of fish habitat for the Great Lakes. The Lake Huron Technical Committee has a GIS inventory of aquatic resources for Lake Huron and is currently integrating basin-wide data. A variety of agencies are conducting research on fish, although little is being done to determine the impacts of cumulative water withdrawal on these organisms.

Amphibians

Amphibians are cold-blooded vertebrates that have a dual life cycle, generally developing in the water and spending most of their adult life on land. Not only can they breathe through their gills (if present) and their nose/mouth, but also they can use their skin as a respiratory surface for gas exchange (Starr, 2000). The Great Lakes - St. Lawrence River region is home to 32 species of amphibians which include tiger salamanders (*Ambystoma tigrinum*), central newts (*Notophthalmus viridescens*), leopard frogs (*Rana pipiens*), bullfrogs (*Rana catesbeiana*) and spring peepers (*Pseudacris crucifer*) (Fuller *et al.*, 1995). Amphibians are major consumers of insects, with individual frogs capable of eating hundreds of insects each day (Starr, 2000). These animals provide an abundance of food for fish, other amphibians, snakes, turtles, lizards, raccoons, opossums, and foxes.

Amphibians depend on water during early development and reproduction. They are often used as indicators of environmental health since they are exposed to elements both in the water and on land. A reduction in water would likely lead to a decrease in available forage and breeding habitats. It is likely that water withdrawals will affect the abundance of amphibians, however, research is lacking on the impacts of water withdrawal on these animals.

The USDA Forest Service has compiled distributional and biological information on amphibians in the Great Lakes - St. Lawrence River region. The USGS has distributional and biological information, as well as long-term monitoring programs, on amphibians

throughout the Great Lakes - St. Lawrence River region. The USGS also has locations and information about amphibian malformations and invasive species.

The USEPA and Environment Canada have created the SOLEC indicator database with information on wetland amphibian communities for the Great Lakes - St. Lawrence River basin. NatureServe has distributional data and information on amphibians in the Great Lakes. The National Biological Information Infrastructure has online information on amphibians of the Great Lakes - St. Lawrence River basin. The National Wildlife Federation has a volunteer frog monitoring program in the Great Lakes - St. Lawrence River region.

The U.S. and Canada have teamed together to monitor birds and amphibians of marshes in the Great Lakes - St. Lawrence River region. The Michigan and Minnesota DNRs have frog population and distribution information from volunteer frog call surveys in their states. The Wisconsin DNR and the Nature Conservancy have compiled distributional, biological and historic reptile and amphibian information. Environment Canada has amphibian information for the St. Lawrence River. The OMNR has distributional data for amphibians in Ontario. The Canadian Endangered Species Conservation Council has a species status report that compiles the efforts of provincial, territorial and federal monitoring programs. Further research is needed to study how changes in water quantity and movement influences amphibians.

Reptiles

Reptiles are cold-blooded vertebrates with tough, dry, scaly skin that restricts water loss from their body. Fifty-one species of reptiles are found in the Great Lakes - St. Lawrence River basin, examples include the box turtle (*Terrapene carolina*), painted turtle (*Chrysemys picta*), snapping turtle (*Chelydra serpentina*), garter snake (*Thamnophis sirtalis*), massasauga rattlesnake (*Sistrurus catenatus*) and the five-lined skink (*Eumeces fasciatus*) (Fuller *et al.*, 1995). The majority of these reptiles feed on insects, amphibians, fish, other reptiles and small mammals. Reptiles provide a food source for a number of large birds, mammals and other reptiles.

Many reptiles, specifically turtles and water snakes, are highly associated with the water. For that reason, turtle eggs are often used to determine contaminant levels in the aquatic system. Semi-aquatic reptiles spend much of their time foraging in or on the water. Some turtles even hibernate in the murky bottoms of the lakes and ponds. Little research exists on how water quantity and movement influences reptiles.

The USDA Forest Service has compiled distributional and biological information on reptiles in the Great Lakes - St. Lawrence River region. The USGS has distributional and biological information on reptiles throughout the Great Lakes - St. Lawrence River region and information on invasive species. The USEPA and Environment Canada have created the SOLEC indicator database including information on contaminants in snapping turtle eggs across the basin. NatureServe has distributional data and information on reptiles in the Great Lakes.

The Wisconsin DNR, Minnesota DNR, Michigan Natural Features Inventory, Michigan DNR and the combined Wisconsin DNR and the Nature Conservancy have distributional and biological reptile information. Environment Canada has biological information for the St. Lawrence River. The OMNR has distributional data for reptiles in Ontario. The Canadian Endangered Species Conservation Council has a species status report that compiles the efforts of provincial, territorial and federal monitoring programs. Further research is needed to determine the impacts of cumulative water withdrawal on reptiles within the Great Lakes – St. Lawrence River system.

Birds

Over 130 species of birds inhabit the Great Lakes - St. Lawrence River basin (Fuller *et al.*, 1995). More than 30 species of waterfowl use the Great Lakes and their coastal wetlands, with the greatest species diversity occurring during the spring and fall migrations (EC, 2000). The Great Lakes - St. Lawrence River basin is situated along the Mississippi and Atlantic flyways which bring hundreds of millions of birds through the area twice each year. These birds play important roles seeds dispersers, insect eaters and rodent controllers. They also support tourism with large numbers of bird-watching enthusiasts coming into the region during migration.

Water is a very important habitat component of many birds' life cycles. Water is both consumed for rehydration and bathed in for cleanliness. Several species of birds are also highly associated with the water, spending the majority of the day in the water foraging, these animals include the bald eagle (*Haliaeetus leucocephalus*), ducks (*Anas* spp.), shorebirds, and loons. Many shorebirds and waterfowl often migrate north and south hopping from one waterbody to the next. Because these animals are highly dependent on the water, it is likely that lower water supplies, and hence water levels, will negatively impact these species.

Several agencies collect data on birds. The USDA Forest Service has distributional and biological information on birds in the Great Lakes - St. Lawrence River region. The USGS has several projects with distributional and biological information on birds throughout the Great Lakes - St. Lawrence River region and information on invasive species. The U.S. Fish and Wildlife Service (USFWS) has distributional and biological information on nesting birds in Pennsylvania.

The USEPA and Environment Canada have created the SOLEC indicator database with information on breeding bird diversity and abundance, coastal wetland bird community health and contaminants in colonial nesting waterbirds for the Great Lakes - St. Lawrence River basin. NatureServe has distributional data and information on birds in the Great Lakes.

The Michigan DNR has compiled information of birds in Michigan and provides access to this information on-line. Michigan State University has a report on the limiting factors of waterfowl in Great Lakes wetlands and deep water habitats. The Wisconsin Society for Ornithology has abundance, distribution and biological information for breeding birds in Wisconsin. New York Department of Environmental Conservation (NYDEC), Ohio DNR, Illinois DNR and Ontario also have breeding bird studies for their state or province.

Environment Canada has biological information for the St. Lawrence River and distributional and biological information for birds in Ontario. The OMNR has distributional data for birds in Ontario.

The Canadian Endangered Species Conservation Council has a species status report that compiles the efforts of provincial, territorial and federal monitoring programs in Canada. The Canadian Wildlife Service conducts waterfowl surveys at Hamilton Harbor on Lake Ontario. The U.S. and Canada have teamed up to monitor marsh birds of the Great Lakes - St. Lawrence River region. The National Audubon Society has online information on the biology and distribution of winter birds in the U.S. and Canada. [Aves.net](#) is a good source for online information on the biology and distribution of winter birds in Ohio. Although much data is currently being collected on birds, further research is needed to determine the impacts of cumulative water withdrawal on birds in the Great Lakes – St. Lawrence River system.

Mammals

Mammals are warm-blooded vertebrates with hair and mammary glands. Most mammals of the Great Lakes - St. Lawrence River region are terrestrial, however a few are highly aquatic including the muskrat (*Ondatra zibethicus*), water shrew (*Neomys fodiens*), beaver (*Castor canadensis*), moose (*Alces alces*) and river otter (*Lutra canadensis*). The mammals of the Great Lakes - St. Lawrence River region assume their positions at the top of the food web from primary producers to top consumer. Many of the top predators such as the gray wolf (*Canis lupis*), the bobcat (*Lynx rufus*) and the mountain lion (*Felis concolor*) have disappeared from their traditional territory leading to large populations of deer and heavily browsed forests.

Mammals are mostly composed of water and highly depend on it for their survival. Lakes, ponds, wetlands and streams are utilized by mammals daily for drinking water. Some mammals, such as muskrats, beavers and humans alter the flow of streams and rivers by building dams. Unlike human dams, the dams built by beavers and muskrats are highly susceptible to damage by floods and other natural events. Beaver dams, while considered annoying to some, create habitat for many other species including trout, frogs, salamanders and moose. These dams also provide diversity in the form of plant species assemblage and varying habitat types.

Water withdrawals will greatly impact mammals by decreasing the amount of available plant for food (Muzik, 1998). Muzik (1989) found that muskrat populations decreased six fold with a 38% loss of surface water and a 36% loss of shoreline. This loss of shoreline and surface water also affected fish and waterfowl habitats.

The USDA Forest Service has distributional and biological information on species in the Great Lakes - St. Lawrence River region. The USGS has information on invasive species throughout the Great Lakes - St. Lawrence River region. The USEPA and Environment Canada have created an indicator database full of species information for the Great Lakes - St. Lawrence River basin. NatureServe has distributional data and information on animals in the Great Lakes. The Michigan DNR has biological information online for Michigan

mammals. Environment Canada has biological information for the St. Lawrence River. The OMNR has distributional data for animals in Ontario. The Canadian Endangered Species Conservation Council has a species status report that compiles the efforts of provincial, territorial and federal monitoring programs.

Further studies should be conducted to determine likely effects of cumulative water withdrawal on mammals within the Great Lakes – St. Lawrence River system.

Organisms Data and Information Inventory

Presented hereafter is an inventory of data and information holdings related to organisms within the Great Lakes - St. Lawrence River basin. The inventory does not contain all available information on organisms in the Great Lakes - St. Lawrence River basin, especially information generated from private industries and small academic projects. Rather, it is an inventory of information and data holdings from federal agencies and regional conservation initiatives.

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CLASSIFICATION	AGENCY OF COLLECTION	DATA SET/ INFORMATION BASE	PURPOSE/ DESCRIPTION	GEOGRAPHICAL DOMAIN	TIME PERIOD	LAST UPDATED	ACCESS TO DATA/INFO (OR KEY CONTACT)	
P r o t i s t s	Algae	Environment Canada	Biodiversity Portrait of the St. Lawrence River	Consolidation of scientific information and data on the physical and biotic characteristics of the region from the past 3 years.	St. Lawrence River, Canada	2000-2003	http://www.gc.ec.gc.ca/faune/biodiv/en/table_contents.html	
		EPA - GLNPO	Biological Open Water Surveillance Program of the Laurentian Great Lakes	Dominant phytoplankton species by biovolume (lakewide averages)	Lake Huron, Lake Ontario, Lake Michigan, Lake Erie, Lake Superior	1998 (spring and summer) Other Years May Be Avail.	N/A	http://www.epa.gov/glnpo/monitoring/plankton/zooannrpt98/REPORT.pdf
		EPA - GLNPO and SUNY at Brockport	Changes in Phytoplankton Size-Class Abundance and Species Composition	Phytoplankton and zooplankton collected at off-shore sites of Lake Michigan	Lake Michigan	1983-1992	N/A	http://jglr.org/1998/num3/24_3_637-657.pdf
		EPA - GLNPO and SUNY at Brockport	Epilimnetic Phytoplankton and Zooplankton Biomass and Species Composition (Lake Michigan)	Common phytoplankton species occurrence in Lake Michigan	Lake Michigan	1983-1992	N/A	http://www.epa.gov/glnpo/monitoring/plankton/mich83-92/index.html
		EPA - GLNPO and SUNY at Brockport	Epilimnetic Phytoplankton and Zooplankton Biomass and Species Composition (Lake Ontario)	Common phytoplankton species occurrence in Lake Ontario	Lake Ontario	1986-1992	N/A	http://www.epa.gov/glnpo/monitoring/plankton/ont86-92/index.html
		NOAA - GLERL	Temporal and Spatial Distributions of Microcystis blooms in Saginaw Bay and Lake Erie	Water samples were collected on Saginaw Bay during Microcystis bloom for ground truth in the development of a satellite derived Microcystis map product.	Saginaw Bay, Lake Huron	1999	N/A	George Leshkevich george.leshkevich@noaa.gov http://www.glerl.noaa.gov/res/Task_rpts/cmleshk03-3.html
		University of Montreal, Dept of Biology; Environment Canada	Periphyton in the St. Lawrence River: A 20-Year Overview	Comparison of common algal species at three sites in the St. Lawrence River	St. Lawrence River, Quebec, Canada	1973, 1982, 1994-1995	N/A	http://jglr.org/1998/num1/24_1_105-117.pdf
		US Dept of the Interior - Fish and Wildlife Service National Fisheries Research Center; University of Michigan - Center for Great Lakes and Aquatic Sciences	Periphyton Accumulation at Remote Reefs and Shoals in Lake Superior	Distribution of detritus and periphyton on the lakebed in east-central Lake Superior	East-Central Lake Superior	1985 (August)	N/A	http://jglr.org/1991/num3/17_3_412-418.pdf
		USGS - Great Lakes Science Center	Great Lakes Aquatic Gap Analysis Project	To evaluate the biological diversity of aquatic species and their habitats, and to identify gaps in the distribution and protection of these species and their habitats within the Great Lakes basin.	All Great Lakes	2003-future	continuous	http://www.glscc.usgs.gov/GLGAP.htm
		US Dept of the Interior - Fish and Wildlife Service	Algae studies	?	?	?	?	
		Environment Canada & U.S. EPA	SOLEC Indicator Database	The database was designed primarily to assist the SOLEC Indicator Group organize and sort the hundreds of indicators that were identified for the Great Lakes.	Great Lakes Region	1998 - ?	?	http://www.on.ec.gc.ca/solec/pdf/appendix5-v4.pdf
NOAA - Great Lakes Environmental Research Lab	Great Lakes Aquatic Nonindigenous Species Database Project	Presently, there are 162 aquatic nonindigenous species in the Great Lakes. However, there is no readily accessible on-line information database of these species. We believe such a database would be a useful addition to the Great Lakes on-line information resources, and, if constructed appropriately, would also serve as a useful scientific and community reference tool.	Great Lakes Region	2003-future	N/A	http://www.glerl.noaa.gov/res/Task_rpts/nsreid10-3.html		
Slime Molds								

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CLASSIFICATION	AGENCY OF COLLECTION	DATA SET/ INFORMATION BASE	PURPOSE/ DESCRIPTION	GEOGRAPHICAL DOMAIN	TIME PERIOD	LAST UPDATED	ACCESS TO DATA/INFO (OR KEY CONTACT)
Protozoans	NOAA - GLERL	Tumor-like Anomalies in Lake Michigan Zooplankton	To get insight into possible consequences to zooplankton populations.	Lake Michigan	1999-2002	NA	Henry Vanderploeg henry.vanderploeg@noaa.gov http://www.glerl.noaa.gov/res/Task_reports/edyvander09-2.html
	USGS - Great Lakes Science Center	Lake Erie Near Shore	Contains general ecological data, including larval & juvenile fish, benthic invertebrates, zooplankton, and limnological parameters using three different sampling designs.	Lake Erie	2000-2002	?	Scott Nelson scott_nelson@usgs.gov (734) 214-7243
	USGS - Great Lakes Science Center	Great Lakes Aquatic Gap Analysis Project	To evaluate the biological diversity of aquatic species and their habitats, and to identify gaps in the distribution and protection of these species and their habitats within the Great Lakes basin.	All Great Lakes	2003-future	continuous	http://www.glsc.usgs.gov/GLGAP.htm
	USGS - Great Lakes Science Center	Study of the Application of Limnetic Zooplankton as a Bioassessment Tool for Lakes of Sleeping Bear Dunes National Lakeshore	Zooplankton—animals suspended in water with limited locomotion—tend to be widely distributed geographically, fulfill many functional roles, have short generation times, and are subject to both top-down and bottom-up trophic influences in a lake ecosystem. All of these characteristics make them excellent candidates for use in lake monitoring and characterization. The lakes of Sleeping Bear Dunes National Lakeshore are popular recreation sites, and as such, they are vulnerable to anthropogenic impacts. In this study, we explored the usefulness of zooplankton as a monitoring tool for these inland lakes. Using biological indicators is a common practice; zooplankton have specifically been used in many ways to explore their usefulness in monitoring. In this study, both zooplankton and water chemistry were sampled to determine their interrelationships.	Sleeping Bear Dunes National Lakeshore	2002	2002	http://www.glsc.usgs.gov/new/Inland%20Lakes%20Zooplankton.pdf?whitman=&zooplankton+in+great+lakes
	Environment Canada & U.S. EPA	SOLEC Indicator Database	The database was designed primarily to assist the SOLEC Indicator Group organize and sort the hundreds of indicators that were identified for the Great Lakes.	Great Lakes Region	1998 - ?	?	http://www.on.ec.gc.ca/solec/pdf/appendix5-v4.pdf
	U.S. EPA - GLNPO	Results from the Great Lakes National Program Office's Biological Open Water Surveillance Program of the Laurentian Great Lakes 1998	This monitoring is intended to fulfill the provisions of the Great Lakes Water Quality Agreement calling for periodic monitoring of the lakes to: 1) assess compliance with jurisdictional control requirements; 2) provide information on non-achievement of agreed upon water quality objectives; 3) evaluate water quality trends over time; and 4) identify emerging problems in the Great Lakes Basin Ecosystem.	All Great Lakes	1938-1998	2000	http://www.epa.gov/glnpo/monitoring/plankton/zooannrpt98/REPORT.pdf
	EPA - GLNPO	Biological Open Water Surveillance Program of the Laurentian Great Lakes	Dominant zooplankton species by biovolume (lakewide averages)	Lake Huron, Lake Ontario, Lake Michigan, Lake Erie, Lake Superior	1998 (spring and summer)	N/A	http://www.epa.gov/glnpo/monitoring/plankton/zooannrpt98/REPORT.pdf
	NOAA - GLERL	Research Monitoring of the Lake Michigan Ecosystem Research	Archived zooplankton samples. A summary of temporal changes in biological and environmental variables.	Southern Lake Michigan basin	1984-2002	2002	Stephen Lozano steve.lozano@noaa.gov http://www.glerl.noaa.gov/res/Task_reports/cmlozano13-1.html

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CLASSIFICATION		AGENCY OF COLLECTION	DATA SET/ INFORMATION BASE	PURPOSE/ DESCRIPTION	GEOGRAPHICAL DOMAIN	TIME PERIOD	LAST UPDATED	ACCESS TO DATA/INFO (OR KEY CONTACT)
P r o t i s t s	Protozoans	EPA - GLNPO and SUNY at Brockport	Epilimnetic Phytoplankton and Zooplankton Biomass and Species Composition (Lake Michigan)	Common phytoplankton species occurrence in Lake Michigan	Lake Michigan	1983-1992	N/A	http://www.epa.gov/glnpo/monitoring/plankton/mich83-92/index.html
		EPA - GLNPO and SUNY at Brockport	Epilimnetic Phytoplankton and Zooplankton Biomass and Species Composition (Lake Ontario)	Common phytoplankton species occurrence in Lake Ontario	Lake Ontario	1986-1992	N/A	http://www.epa.gov/glnpo/monitoring/plankton/ont86-92/index.html
		NOAA - GLERL	Effects of the Zebra Mussel (<i>Dreissena polymorpha</i> Pallas) on Protozoa and Phytoplankton from Saginaw Bay, Lake Huron	Studied direct effects of the grazing activities of the zebra mussel on the natural assemblage of planktonic protozoa and algae from Saginaw Bay, Lake Huron.	Saginaw Bay, Lake Huron	1994-1995	N/A	Peter Lavrentyev http://sgnis.org/publicat/papers/proto.pdf
F u n g i	Mushrooms	Field Museum	Singer Index Database	The index and a bibliography of Singer's 440 mycology publications are presented as a searchable database.	Great Lakes states and beyond	1935-1997	N/A	Quixin Wu qwu@fmnh.org Gregory Mueller gmueller@fmnh.org http://fm1.fieldmuseum.org/collectio ns/search.cgi?dest=singer
		Conservation organizations, federal government, international agencies, and private sector partners (http://www.natureserve.org/aboutUs/partners.jsp)	NatureServe website	Provides scientific information about species and terrestrial ecosystems. Includes description, distribution, status, and trend information on most native and introduced plant and animal species. Also includes classification and descriptions for upland and wetland ecosystems as well vegetation types included in the U.S. National Vegetation Classification. Contains links to methods documentation used by Natural Heritage programs. Specific contacts at NatureServe may provide access to multi-jurisdictional data on locations of rare species throughout the United States. Up to date occurrence data for species, as well as mapped locations of ecosystem, community, and natural areas are available through individual Natural Heritage programs in ON, MN, WI, IL, IN, MI, OH, PA, and NY.	International, National, and State Information	1974-2003	continuous	http://www.natureserve.org/getData/index.jsp
	Molds							
	Yeasts							

Organisms Data and Information Inventory

CLASSIFICATION	AGENCY OF COLLECTION	DATA SET/ INFORMATION BASE	PURPOSE/ DESCRIPTION	GEOGRAPHICAL DOMAIN	TIME PERIOD	LAST UPDATED	ACCESS TO DATA/INFO (OR KEY CONTACT)
Fungi	Lichens	Environment Canada	Biodiversity Portrait of the St. Lawrence River	Consolidation of scientific information and data on the physical and biotic characteristics of the region from the past 3 years.	St. Lawrence River, Canada	2000-2003	http://www.qc.ec.gc.ca/faune/biodiv/en/table_contents.html
		USDA Forest Service	Fire Effects Information System	This database contains synoptic descriptions, taken from current English-language literature of almost 900 plant species, about 100 animal species, and 16 Kuchler plant communities found on the North American continent. The emphasis of each synopsis is fire and how it affects each species. Background information on taxonomy, distribution, basic biology and ecology of each species is also included.	USA	? - Present	Constantly Updated http://www.fs.fed.us/database/feis/index.html
		Ontario MNR - Science and Information Branch (The Nature Conservancy of Canada, The Natural Heritage League, and The Nature Conservancy)	Natural Heritage Information Center - Element (Species) Database	Element of Biodiversity is the term coined by NatureServe used to refer to a species, subspecies, vegetation community, or special feature of the landscape. An Element Occurrence is defined as a location in the province where an Element has existed on a permanent or regular basis. What constitutes an occurrence depends on the element. For example, a bird occurrence is usually defined as a breeding area or migration staging area, but not a single sighting by a bird-watcher. A plant or vegetation community occurrence is usually any place where it occurs naturally.	Ontario	1983 -2003	Mar-03 http://www.mnr.gov.on.ca/MNR/nhic/
		Conservation organizations, federal government, international agencies, and private sector partners (http://www.natureserve.org/aboutUs/partners.jsp)	NatureServe website	Provides scientific information about species and terrestrial ecosystems. Includes description, distribution, status, and trend information on most native and introduced plant and animal species. Also includes classification and descriptions for upland and wetland ecosystems as well vegetation types included in the U.S. National Vegetation Classification. Contains links to methods documentation used by Natural Heritage programs. Specific contacts at NatureServe may provide access to multi-jurisdictional data on locations of rare species throughout the United States. Up to date occurrence data for species, as well as mapped locations of ecosystem, community, and natural areas are available through individual Natural Heritage programs in ON, MN, WI, IL, IN, MI, OH, PA, and NY.	International, National, and State Information	1974-2003	continuous http://www.natureserve.org/getData/index.jsp
Plants	Mosses	USDA - NRCS	PLANTS Database	Provides standardized information about the vascular plants, mosses, liverworts, hornworts, and lichens of the U.S. and its territories.	National, State, County Data	N/A	Constantly Updated http://plants.usda.gov/index.html
		Federal, state, international, non-government, academic, and private industry partners (http://www.nbi.gov/about/partner/)	National Biological Information Infrastructure	Data, references, and research on a wide variety of biological disciplines.	National and International	? - Present	Constantly Updated http://www.nbi.gov/disciplines/index.html

Organisms Data and Information Inventory

CLASSIFICATION	AGENCY OF COLLECTION	DATA SET/ INFORMATION BASE	PURPOSE/ DESCRIPTION	GEOGRAPHICAL DOMAIN	TIME PERIOD	LAST UPDATED	ACCESS TO DATA/INFO (OR KEY CONTACT)
P l a n t s	Mosses	Ontario MNR - Science and Information Branch (The Nature Conservancy of Canada, The Natural Heritage League, and The Nature Conservancy)	Natural Heritage Information Center - Element (Species) Database	Element of Biodiversity is the term coined by NatureServe used to refer to a species, subspecies, vegetation community, or special feature of the landscape. An Element Occurrence is defined as a location in the province where an Element has existed on a permanent or regular basis. What constitutes an occurrence depends on the element. For example, a bird occurrence is usually defined as a breeding area or migration staging area, but not a single sighting by a bird-watcher. A plant or vegetation community occurrence is usually any place where it occurs naturally.	Ontario	1983 -2003	Mar-03 http://www.mnr.gov.on.ca/MNR/nhic/
		Environment Canada	Biodiversity Portrait of the St. Lawrence River	Consolidation of scientific information and data on the physical and biotic characteristics of the region from the past 3 years.	St. Lawrence River, Canada	2000-2003	http://www.gc.ec.gc.ca/faune/biodiv/en/table_contents.html
		Conservation organizations, federal government, international agencies, and private sector partners (http://www.natureserve.org/aboutUs/partners.jsp)	NatureServe website	Provides scientific information about species and terrestrial ecosystems. Includes description, distribution, status, and trend information on most native and introduced plant and animal species. Also includes classification and descriptions for upland and wetland ecosystems as well vegetation types included in the U.S. National Vegetation Classification. Contains links to methods documentation used by Natural Heritage programs. Specific contacts at NatureServe may provide access to multi-jurisdictional data on locations of rare species throughout the United States. Up to date occurrence data for species, as well as mapped locations of ecosystem, community, and natural areas are available through individual Natural Heritage programs in ON, MN, WI, IL, IN, MI, OH, PA, and NY.	International, National, and State Information	1974-2003	continuous http://www.natureserve.org/getData/index.jsp
		Environment Canada & U.S. EPA	SOLEC Indicator Database	The database was designed primarily to assist the SOLEC Indicator Group organize and sort the hundreds of indicators that were identified for the Great Lakes.	Great Lakes Region	1998 - ?	? http://www.on.ec.gc.ca/solec/pdf/appendix5-v4.pdf
		USDA Forest Service	Fire Effects Information System	This database contains synoptic descriptions, taken from current English-language literature of almost 900 plant species, about 100 animal species, and 16 Kuchler plant communities found on the North American continent. The emphasis of each synopsis is fire and how it affects each species. Background information on taxonomy, distribution, basic biology and ecology of each species is also included.	USA	? - Present	Constantly Updated http://www.fs.fed.us/database/feis/index.html

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CLASSIFICATION	AGENCY OF COLLECTION	DATA SET/ INFORMATION BASE	PURPOSE/ DESCRIPTION	GEOGRAPHICAL DOMAIN	TIME PERIOD	LAST UPDATED	ACCESS TO DATA/INFO (OR KEY CONTACT)	
P l a n t s	Ferns	Conservation organizations, federal government, international agencies, and private sector partners (http://www.natureserve.org/aboutUs/partners.jsp)	NatureServe website	Provides scientific information about species and terrestrial ecosystems. Includes description, distribution, status, and trend information on most native and introduced plant and animal species. Also includes classification and descriptions for upland and wetland ecosystems as well vegetation types included in the U.S. National Vegetation Classification. Contains links to methods documentation used by Natural Heritage programs. Specific contacts at NatureServe may provide access to multi-jurisdictional data on locations of rare species throughout the United States. Up to date occurrence data for species, as well as mapped locations of ecosystem, community, and natural areas are available through individual Natural Heritage programs in ON, MN, WI, IL, IN, MI, OH, PA, and NY.	International, National, and State Information	1974-2003	continuous	http://www.natureserve.org/getData/index.jsp
		Environment Canada & U.S. EPA	SOLEC Indicator Database	The database was designed primarily to assist the SOLEC Indicator Group organize and sort the hundreds of indicators that were identified for the Great Lakes.	Great Lakes Region	1998 - ?	?	http://www.on.ec.gc.ca/solec/pdf/appendix5-v4.pdf
		National Museum of Natural Sciences	Atlas of the Rare Vascular Plants of Ontario	?	Ontario	? - 1987	N/A	Sharon Dobush sharon.dobush@mnr.gov.on.ca 705-825-3415
	Conifers	USDA - NRCS	PLANTS Database	Provides standardized information about the vascular plants, mosses, liverworts, hornworts, and lichens of the U.S. and its territories.	National, State, County Data	N/A	Constantly Updated	http://plants.usda.gov/index.html
		Federal, state, international, non-government, academic, and private industry partners (http://www.nbio.gov/about/partner/)	National Biological Information Infrastructure	Data, references, and research on a wide variety of biological disciplines.	National and International	? - Present	Constantly Updated	http://www.nbio.gov/disciplines/index.html
		Ontario MNR - Science and Information Branch (The Nature Conservancy of Canada, The Natural Heritage League, and The Nature Conservancy)	Natural Heritage Information Center - Element (Species) Database	Element of Biodiversity is the term coined by NatureServe used to refer to a species, subspecies, vegetation community, or special feature of the landscape. An Element Occurrence is defined as a location in the province where an Element has existed on a permanent or regular basis. What constitutes an occurrence depends on the element. For example, a bird occurrence is usually defined as a breeding area or migration staging area, but not a single sighting by a bird-watcher. A plant or vegetation community occurrence is usually any place where it occurs naturally.	Ontario	1983 -2003	Mar-03	http://www.mnr.gov.on.ca/MNR/nhic/
		Environment Canada	Biodiversity Portrait of the St. Lawrence River	Consolidation of scientific information and data on the physical and biotic characteristics of the region from the past 3 years.	St. Lawrence River, Canada	2000-2003		http://www.qc.ec.gc.ca/faune/biodiv/en/table_contents.html

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P l a n t s	Conifers	Conservation organizations, federal government, international agencies, and private sector partners (http://www.natureserve.org/aboutUs/partners.jsp)	NatureServe website	Provides scientific information about species and terrestrial ecosystems. Includes description, distribution, status, and trend information on most native and introduced plant and animal species. Also includes classification and descriptions for upland and wetland ecosystems as well vegetation types included in the U.S. National Vegetation Classification. Contains links to methods documentation used by Natural Heritage programs. Specific contacts at NatureServe may provide access to multi-jurisdictional data on locations of rare species throughout the United States. Up to date occurrence data for species, as well as mapped locations of ecosystem, community, and natural areas are available through individual Natural Heritage programs in ON, MN, WI, IL, IN, MI, OH, PA, and NY.	International, National, and State Information	1974-2003	continuous	http://www.natureserve.org/getData/index.jsp
		Environment Canada & U.S. EPA	SOLEC Indicator Database	The database was designed primarily to assist the SOLEC Indicator Group organize and sort the hundreds of indicators that were identified for the Great Lakes.	Great Lakes Region	1998 - ?	?	http://www.on.ec.gc.ca/solec/pdf/appendix5-v4.pdf
		National Museum of Natural Sciences	Atlas of the Rare Vascular Plants of Ontario	?	Ontario	? - 1987	N/A	Sharon Dobush sharon.dobush@mnr.gov.on.ca 705-825-3415
		USDA Forest Service	Fire Effects Information System	This database contains synoptic descriptions, taken from current English-language literature of almost 900 plant species, about 100 animal species, and 16 Kuchler plant communities found on the North American continent. The emphasis of each synopsis is fire and how it affects each species. Background information on taxonomy, distribution, basic biology and ecology of each species is also included.	USA	? - Present	Constantly Updated	http://www.fs.fed.us/database/feis/index.html

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P l a n t s Flowering Plants	USDA - NRCS	PLANTS Database	Provides standardized information about the vascular plants, mosses, liverworts, hornworts, and lichens of the U.S. and its territories.	National, State, County Data	N/A	Constantly Updated	http://plants.usda.gov/index.html
	Federal, state, international, non-government, academic, and private industry partners (http://www.nbi.gov/about/partner/)	National Biological Information Infrastructure	Data, references, and research on a wide variety of biological disciplines.	National and International	? - Present	Constantly Updated	http://www.nbi.gov/disciplines/index.html
	Ontario MNR - Science and Information Branch (The Nature Conservancy of Canada, The Natural Heritage League, and The Nature Conservancy)	Natural Heritage Information Center - Element (Species) Database	Element of Biodiversity is the term coined by NatureServe used to refer to a species, subspecies, vegetation community, or special feature of the landscape. An Element Occurrence is defined as a location in the province where an Element has existed on a permanent or regular basis. What constitutes an occurrence depends on the element. For example, a bird occurrence is usually defined as a breeding area or migration staging area, but not a single sighting by a bird-watcher. A plant or vegetation community occurrence is usually any place where it occurs naturally.	Ontario	1983 -2003	Mar-03	http://www.mnr.gov.on.ca/MNR/nhic/
	Environment Canada	Biodiversity Portrait of the St. Lawrence River	Consolidation of scientific information and data on the physical and biotic characteristics of the region from the past 3 years.	St. Lawrence River, Canada	2000-2003		http://www.qc.ec.gc.ca/faune/biodiv/en/table_contents.html
	Canadian Endangered Species Conservation Council	Wild Species 2000 Report	Overview of the status of Canada's species, bringing together the results of Provincial, Territorial, and Federal monitoring efforts	Canada	To be released every 5 years	2000	http://www.wildspecies.ca/en/HomeE.html
	Bird Studies Canada	Changes in Distribution and Abundance of Submersed Macrophytes	Percent occurrence of several plant species in the diets of six species of diving ducks	Inner Bay at Long Point Bay, Ontario (Lake Erie)	1992-1994	N/A	http://jglr.org/1999/num4/25_4_783-798.pdf
	MSU, Dept of Fisheries and Wildlife	Increased Abundance and Depth of Submersed Macrophytes in Response to Decreased Turbidity	Submersed macrophyte communities and turbidity (near-shore) in Saginaw Bay	Saginaw Bay, Lake Huron	1991-1993	N/A	http://jglr.org/1995/num4/21_4_476-488.pdf
	SUNY Brockport, Dept of Biological Sciences	Occurrence of Macrophytes in the Near Shore Waters	Macrophyte biomass at selected sites. Summer turbidity levels.	Lake Ontario	1986 (June to October)	N/A	http://jglr.org/1988/num4/14_4_405-410.pdf
	USDA Forest Service	Fire Effects Information System	This database contains synoptic descriptions, taken from current English-language literature of almost 900 plant species, about 100 animal species, and 16 Kuchler plant communities found on the North American continent. The emphasis of each synopsis is fire and how it affects each species. Background information on taxonomy, distribution, basic biology and ecology of each species is also included.	USA	? - Present	Constantly Updated	http://www.fs.fed.us/database/feis/index.html

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P l a n t s Flowering Plants	Conservation organizations, federal government, international agencies, and private sector partners (http://www.natureserve.org/aboutUs/partners.jsp)	NatureServe website	Provides scientific information about species and terrestrial ecosystems. Includes description, distribution, status, and trend information on most native and introduced plant and animal species. Also includes classification and descriptions for upland and wetland ecosystems as well vegetation types included in the U.S. National Vegetation Classification. Contains links to methods documentation used by Natural Heritage programs. Specific contacts at NatureServe may provide access to multi-jurisdictional data on locations of rare species throughout the United States. Up to date occurrence data for species, as well as mapped locations of ecosystem, community, and natural areas are available through individual Natural Heritage programs in ON, MN, WI, IL, IN, MI, OH, PA, and NY.	International, National, and State Information	1974-2003	continuous	http://www.natureserve.org/getData/index.jsp
	USGS - Great Lakes Science Center	Card Image Data	Various collections of benthic invertebrates, Hexagenia, macrophytes, etc.	All Great Lakes	1960s - 1980s?		Scott Nelson scott_nelson@usgs.gov (734) 214-7243
	USGS - Great Lakes Science Center	Great Lakes Aquatic Gap Analysis Project	To evaluate the biological diversity of aquatic species and their habitats, and to identify gaps in the distribution and protection of these species and their habitats within the Great Lakes basin.	All Great Lakes	2003-future	continuous	http://www.glsc.usgs.gov/GLGAP.htm
	USGS-UMESC	Long Term Resource Monitoring Program	The mission of the Long Term Resource Monitoring Program is to provide decision makers with the information needed to maintain the Upper Mississippi River System as a viable multiple-use large river ecosystem. The long-term goals of the Program are to understand the system, determine resource trends and impacts, develop management alternatives, manage information, and develop useful products.	The Five Upper Mississippi River System states (Illinois, Iowa, Minnesota, Missouri, and Wisconsin).	1987-present	annually	http://www.umesc.usgs.gov/ltrmp.html
	NOAA - Great Lakes Environmental Research Lab	Great Lakes Aquatic Nonindigenous Species Database Project	Presently, there are 162 aquatic nonindigenous species in the Great Lakes. However, there is no readily accessible on-line information database of these species. We believe such a database would be a useful addition to the Great Lakes on-line information resources, and, if constructed appropriately, would also serve as a useful scientific and community reference tool.	Great Lakes Region	2003-future	N/A	http://www.glerl.noaa.gov/res/Task_reports/nsreid10-3.html
	Great Lakes Indian Fish & Wildlife Commission	Exotic Plant Information CENTER	This page has been established to raise awareness of several invasive non-native plants and their ecological impacts in the upper Great Lakes region. We hope to provide effective tools for your educational, management, and research needs.	Michigan, Wisconsin, Minnesota	1989-present	N/A	http://www.glifwc.org/epicenter/
	Environment Canada & U.S. EPA	SOLEC Indicator Database	The database was designed primarily to assist the SOLEC Indicator Group organize and sort the hundreds of indicators that were identified for the Great Lakes.	Great Lakes Region	1998 - ?	?	http://www.on.ec.gc.ca/solec/pdf/appendix5-v4.pdf

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P l a n t s	Flowering Plants	National Museums of Canada	The Arctic-Alpine Element of the Flora at Lake Superior	?	Lake Superior	? - 1981	N/A	Gwenyth Foley gwenyth.foley@mnr.gov.on.ca 807-877-5113
		National Museum of Natural Sciences	Atlas of the Rare Vascular Plants of Ontario	?	Ontario	? - 1987	N/A	Sharon Dobush sharon.dobush@mnr.gov.on.ca 705-825-3415
A n i m a l s	Invertebrates	Ontario MNR - Science and Information Branch (The Nature Conservancy of Canada, The Natural Heritage League, and The Nature Conservancy)	Natural Heritage Information Center - Element (Species) Database	Element of Biodiversity is the term coined by NatureServe used to refer to a species, subspecies, vegetation community, or special feature of the landscape. An Element Occurrence is defined as a location in the province where an Element has existed on a permanent or regular basis. What constitutes an occurrence depends on the element. For example, a bird occurrence is usually defined as a breeding area or migration staging area, but not a single sighting by a bird-watcher. A plant or vegetation community occurrence is usually any place where it occurs naturally.	Ontario	1983 -2003	Mar-03	http://www.mnr.gov.on.ca/MNR/nhic/
		Environment Canada	Biodiversity Portrait of the St. Lawrence River	Consolidation of scientific information and data on the physical and biotic characteristics of the region from the past 3 years. Fishery assessment based on the number of scallop drag tows . Observations made by Fisheries and Oceans Canada	St. Lawrence River, Canada	1991-1997		http://www.qc.ec.gc.ca/faune/biodiv/en/table_contents.html
		Water Systems Analysts; University of Western Ontario - Dept of Biology; Ontario Ministry of Environment & Energy	Factors Influencing Changes in Nearshore Benthic Community	Nearshore benthic communities surveyed at 5 and 20 m, on the Canadian side of Lake Ontario	Canadian side of Lake Ontario	1981, 1991	N/A	http://jglr.org/2000/num3/26_3_272-286.pdf

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A n i m a l s I n v e r t e b r a t e s	NOAA - GLERL	Long-Term Trends in Benthic Populations	Continuing project that monitors trends in benthic macroinvertebrate populations in southern Lake Michigan. Samples collected at 40 sites in the southern basin.	Southern Lake Michigan basin	1980-1981, 1986-1987, 1992-1993, 1998-1999, 2000, 2002?	2002?	Tom Nelepa thomas.nalepa@noaa.gov http://www.glerl.noaa.gov/res/Task_reports/cmnalepa13-2.html
	MSU, Dept of Fisheries and Wildlife	Increased Abundance and Depth of Submersed Macrophytes in Response to Decreased Turbidity	Submersed macrophyte communities and turbidity (near-shore) in Saginaw Bay	Saginaw Bay, Lake Huron	1991-1993	N/A	http://iglr.org/1995/hum4/21_4_476-488.pdf
	Canadian Endangered Species Conservation Council	Wild Species 2000 Report	Overview of the status of Canada's species, bringing together the results of Provincial, Territorial, and Federal monitoring efforts	Canada	to be released every 5 years	2000	http://www.wildspecies.ca/en/Home_E.html
	NOAA - GLERL	Effects of the Zebra Mussel (<i>Dreissena polymorpha</i> Pallas) on Protozoa and Phytoplankton from Saginaw Bay, Lake Huron	Studied direct effects of the grazing activities of the zebra mussel on the natural assemblage of planktonic protozoa and algae from Saginaw Bay, Lake Huron.	Saginaw Bay, Lake Huron	1994-1995	N/A	Peter Lavrentyev http://sgnis.org/publicat/papers/protozoa.pdf
	USGS-UMESC	Long Term Resource Monitoring Program	The mission of the Long Term Resource Monitoring Program is to provide decision makers with the information needed to maintain the Upper Mississippi River System as a viable multiple-use large river ecosystem. The long-term goals of the Program are to understand the system, determine resource trends and impacts, develop management alternatives, manage information, and develop useful products.	The Five Upper Mississippi River System states (Illinois, Iowa, Minnesota, Missouri, and Wisconsin).	1987-present	annually	http://www.umesc.usgs.gov/trmp.html
	Conservation organizations, federal government, international agencies, and private sector partners (http://www.natureserve.org/aboutUs/partners.jsp)	NatureServe website	Provides scientific information about species and terrestrial ecosystems. Includes description, distribution, status, and trend information on most native and introduced plant and animal species. Also includes classification and descriptions for upland and wetland ecosystems as well as vegetation types included in the U.S. National Vegetation Classification. Contains links to methods documentation used by Natural Heritage programs. Specific contacts at NatureServe may provide access to multi-jurisdictional data on locations of rare species throughout the United States. Up to date occurrence data for species, as well as mapped locations of ecosystem, community, and natural areas are available through individual Natural Heritage programs in ON, MN, WI, IL, IN, MI, OH, PA, and NY.	International, National, and State Information	1974-2003	continuous	http://www.natureserve.org/getData/index.jsp
	USGS - Great Lakes Science Center	Lake Erie Environmental Investigations	Contains data from a study done on Lake Erie tributaries demonstrating the linkage between sediment contaminants and fish health, fish communities and invertebrate communities.	Lake Erie	1980s - 1990s?		Scott Nelson scott_nelson@usgs.gov (734) 214-7243
	USGS - Great Lakes Science Center	Lake Erie Near Shore	Contains general ecological data, including larval & juvenile fish, benthic invertebrates, zooplankton, and limnological parameters using three different sampling designs.	Lake Erie	2000-2002	?	Scott Nelson scott_nelson@usgs.gov (734) 214-7243

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CLASSIFICATION	AGENCY OF COLLECTION	DATA SET/ INFORMATION BASE	PURPOSE/ DESCRIPTION	GEOGRAPHICAL DOMAIN	TIME PERIOD	LAST UPDATED	ACCESS TO DATA/INFO (OR KEY CONTACT)
Animals Invertebrates	USGS - Great Lakes Science Center	Card Image Data	Various collections of benthic invertebrates, Hexagenia, macrophytes, etc.	All Great Lakes	1960s - 1980s?		Scott Nelson scott_nelson@usgs.gov (734) 214-7243
	USGS - Great Lakes Science Center	Great Lakes Aquatic Gap Analysis Project	To evaluate the biological diversity of aquatic species and their habitats, and to identify gaps in the distribution and protection of these species and their habitats within the Great Lakes basin.	All Great Lakes	2003-future	continuous	http://www.glsc.usgs.gov/GLGAP.htm
	USGS - Center for Aquatic Resource Studies	Nonindigenous Aquatic Species	Provided are scientific reports, online/realtime queries, spatial data sets, regional contact lists, and general information. The data is made available for use by biologists, interagency groups, and the general public.	USA	N/A	N/A	http://nas.er.usgs.gov
	NOAA - Great Lakes Environmental Research Lab	Great Lakes Aquatic Nonindigenous Species Database Project	Presently, there are 162 aquatic nonindigenous species in the Great Lakes. However, there is no readily accessible on-line information database of these species. We believe such a database would be a useful addition to the Great Lakes on-line information resources, and, if constructed appropriately, would also serve as a useful scientific and community reference tool.	Great Lakes Region	2003-future	N/A	http://www.glerl.noaa.gov/res/Task_reports/nsreid10-3.html
	USGS - Great Lakes Science Center	Burrowing Mayflies (Hexagenia) as Indicators of Ecosystem Health	They choose to study the burrowing mayfly, Hexagenia, as an indicator species because it was historically abundant in Great Lakes mesotrophic (moderately nutrient enriched) waters, it is intolerant of polluted water, which caused their extirpation from those environments in the 1940-50's, it has recovered in one of those previously polluted environments after significant pollution reduction, it is ecologically important as a trophic indicator, linking detrital (bottom litter) energy resources directly to the many fish species that feed on Hexagenia and the highly visible mating swarms that tell the informed public that the water body is healthy.	Great Lakes Region	?	?	http://www.glsc.usgs.gov/newinfo/burrowing_mayflies.htm
	University of Michigan - Museum of Zoology	Michigan Odonata Survey	The purpose of the MOS is to encourage the study of Odonata; document the species that occur in Michigan; obtain better data on the abundance and distribution of federal and state-listed species; define the flight periods and ranges for the species that are found in the state; record pertinent information on locality, habitat, phenology, and ecology in a database for use in publications devoted to the Odonata fauna of the state of Michigan; and to produce an atlas of Michigan Odonata for use by scientists and amateurs alike.	Great Lakes Region	1996-present	continuous	http://insects.umzm.lsa.umich.edu/MICHODO/mos.html

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A n i m a l s	Invertebrates	Environment Canada & U.S. EPA	SOLEC Indicator Database	The database was designed primarily to assist the SOLEC Indicator Group organize and sort the hundreds of indicators that were identified for the Great Lakes.	Great Lakes Region	1998 - ?	?	http://www.on.ec.gc.ca/solec/pdf/appendix5-v4.pdf
		U.S. EPA - GLNPO	Benthic Invertebrate Biomonitoring	Benthic invertebrates are longer lived than most planktonic organisms, and thus can integrate the effects of environmental conditions over longer periods of time. Additionally, they are relatively sedentary and are therefore easier to sample than nektonic organisms, such as fish. Many benthic invertebrates are detritivores, feeding on organic material produced in the pelagic zone. These organisms are often important components of fish diets, and thus provide an important link between pelagic production and higher trophic levels.	All Great Lakes	1997-present	N/A	http://www.epa.gov/glnpo/monitoring/indicators/benthic97/paper.htm
		Ohio Sea Grant	New Research Suggests Zebra Mussels have Minor Effect on Lake Erie's Microbenthic Community	The microbenthic community, composed of non-harmful bacteria and benthic fungi, is one of the least studied communities of the Great Lakes. These organisms, many of which reach 10 to 100 million cells per gram of sediment, are responsible for many of the lake's key ecosystem functions. Significant components of the phosphorus, nitrogen, and carbon biogeochemical cycles, for example, are all performed by these organisms.	Lake Erie	2000	N/A	Robert Heath rheath@kent.edu Jill Jentes jentes.1@osu.edu http://www.sg.ohio-state.edu/publications/releases/Aug-4-00.html
	Fish	Federal, state, international, non-government, academic, and private industry partners (http://www.nbio.gov/about/partner/)	National Biological Information Infrastructure	Data, references, and research on a wide variety of biological disciplines.	National and International	? - Present	Constantly Updated	http://www.nbio.gov/disciplines/index.html
		NOAA - GLERL; University of Michigan; University of Wisconsin - Milwaukee	Modeling the Influence of Lake Circulation Patterns, Upwelling Events, and Turbulence on Fish Recruitment Variability	A model-based approach used to evaluate the relative effects of lake physics and trophodynamics for understanding fish recruitment in Lake Michigan.	Lake Michigan	Using data from 1998 (Spring and Summer)	In Progress	Dmitry Beletsky dima.beletsky@noaa.gov http://www.glerl.noaa.gov/res/Task_reports/beletsky02-1.html
		NOAA - GLERL	Changes in the Pelagic Food Web of Southern Lake Michigan	Document expected long-term and recent changes in the pelagic food web. Building on GLERL pelagic monitoring program (1994-1998).	Southern Lake Michigan basin	1994-2002	2002?	Henry Vanderploeg henry.vanderploeg@noaa.gov http://www.glerl.noaa.gov/res/Task_reports/nsvander10-2.html
		Environment Canada	Great Lakes Environmental Sensitivity Atlas and Database	Provides initial information regarding fish spawning and fish migration.	U.S. and Canada Great Lakes shorelines	1991-1994		http://www.on.ec.gc.ca/emergency/eviro-sensitivity-atlas/intro-e.html
		Environment Canada	Biodiversity Portrait of the St. Lawrence River	Consolidation of scientific information and data on the physical and biotic characteristics of the region from the past 3 years.	St. Lawrence River, Canada	2000-2003		http://www.gc.ec.gc.ca/faune/biodiv/en/table_contents.html
		MDNR	Selected species and habitat information	Provides links to scientific information about species and ecosystems	Michigan	N/A	N/A	http://www.michigan.gov/dnr/0,1607,7-153-10370_12145--,00.html
		Michigan DEQ	Cooperative Lakes Monitoring Program	Volunteer eutrophication monitoring of Michigan's inland lakes and streams. Parameters include nitrogen and phosphorus, chlorophyll, sedimentation rates, transparency, dissolved oxygen, fish samples, and water temperature	Michigan inland lakes and streams	1974-present	2002	http://www.mi-water-cmp.org/cooperative_lakes_monitoring_pro1.htm

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Animals Fish	Ontario MNR - Science and Information Branch (The Nature Conservancy of Canada, The Natural Heritage League, and The Nature Conservancy)	Natural Heritage Information Center - Element (Species) Database	Element of Biodiversity is the term coined by NatureServe used to refer to a species, subspecies, vegetation community, or special feature of the landscape. An Element Occurrence is defined as a location in the province where an Element has existed on a permanent or regular basis. What constitutes an occurrence depends on the element. For example, a bird occurrence is usually defined as a breeding area or migration staging area, but not a single sighting by a bird-watcher. A plant or vegetation community occurrence is usually any place where it occurs naturally.	Ontario	1983 -2003	Mar-03	http://www.mnr.gov.on.ca/MNR/nhic/
	Great Lakes Fishery Commission	Commercial Fish Production in the Great Lakes 1867-2000	Annual Commercial Fish Production from 1867 to 2000, Gill Net Catches of Lake Trout at variety of locations from 1929 to 1937	Great Lakes	1867 to 2000	Aug-02	http://www.glfc.org/databases/commercial/commerc.asp
	Great Lakes Fishery Commission	Fish Habitat Database	The Fish Habitat Database is a synthesis of extensive information on habitat requirements and characteristics of selected Great Lakes fish species.	Great Lakes	N/A	N/A	http://www.glfc.org/fishmgmt/habitat/contents.htm
	Lake Huron Technical Committee	Lake Huron GIS Project	Although the primary objective of this project is to integrate data from across the basin into a common database to provide an inventory of basin-wide aquatic resources, many new layers and tools are also being developed to ensure that the decision support system is a powerful tool for analysis of whole-system responses to management alternatives.	Lake Huron	1999 - Present	Constantly Updated	http://www.glfc.org/LakeHuronGis/
	Canadian Endangered Species Conservation Council	Wild Species 2000 Report	Overview of the status of Canada's species, bringing together the results of Provincial, Territorial, and Federal monitoring efforts	Canada	to be released every 5 years	2000	http://www.wildspecies.ca/en/HomeE.html
	University of Michigan Biological Station	Correlations between Development of Coastal Marsh Fish Communities in Les Cheneaux in the Eastern Upper Peninsula of Michigan	Looks at the impacts of human development on fish communities	Northern Lake Huron	N/A	N/A	Paul Webb pwebb@umich.edu

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CLASSIFICATION	AGENCY OF COLLECTION	DATA SET/ INFORMATION BASE	PURPOSE/ DESCRIPTION	GEOGRAPHICAL DOMAIN	TIME PERIOD	LAST UPDATED	ACCESS TO DATA/INFO (OR KEY CONTACT)	
Animals	Fish	Conservation organizations, federal government, international agencies, and private sector partners (http://www.natureserve.org/aboutUs/partners.jsp)	NatureServe website	Provides scientific information about species and terrestrial ecosystems. Includes description, distribution, status, and trend information on most native and introduced plant and animal species. Also includes classification and descriptions for upland and wetland ecosystems as well vegetation types included in the U.S. National Vegetation Classification. Contains links to methods documentation used by Natural Heritage programs. Specific contacts at NatureServe may provide access to multi-jurisdictional data on locations of rare species throughout the United States. Up to date occurrence data for species, as well as mapped locations of ecosystem, community, and natural areas are available through individual Natural Heritage programs in ON, MN, WI, IL, IN, MI, OH, PA, and NY.	International, National, and State Information	1974-2003	continuous	http://www.natureserve.org/getData/index.jsp
		NOAA - Fisheries	Commercial Catch (COMCAT)	Daily fishing records for US waters of the Great Lakes.	USA	1971-present	continuous	http://www.st.nmfs.gov/st1/commercial/
		USGS - Great Lakes Science Center	Research Vessel Catch (RVCAT)	Contains trawl and gillnet data including total catch, length frequency, individual fish (length, weight, sex, age, prey, etc.)	All Great Lakes	1954-present	continuous	Scott Nelson scott_nelson@usgs.gov (734) 214-7243
		USGS - Great Lakes Science Center (with the help of OMNR, MDEQ, FWS and CORA)	Coded Wire Tag	Contains the history of captured coded wire tag lake trout.	Lake Huron	?	?	Scott Nelson scott_nelson@usgs.gov (734) 214-7243
		USGS - Great Lakes Science Center	Lake Erie Environmental Investigations	Contains data from a study done on Lake Erie tributaries demonstrating the linkage between sediment contaminants and fish health, fish communities and invertebrate communities.	Lake Erie	1980s - 1990s?		Scott Nelson scott_nelson@usgs.gov (734) 214-7243
		USGS - Great Lakes Science Center	Lake Erie Near Shore	Contains general ecological data, including larval & juvenile fish, benthic invertebrates, zooplankton, and limnological parameters using three different sampling designs.	Lake Erie	2000-2002	?	Scott Nelson scott_nelson@usgs.gov (734) 214-7243
		USGS - Great Lakes Science Center	Contaminant Chemistry	Contains fish tissue archive and organic pesticide and PCB results since the early '70s. Also contains some contaminant sediment data.	All Great Lakes	1970s - Present	?	Scott Nelson scott_nelson@usgs.gov (734) 214-7243
		USGS - Great Lakes Science Center	Interagency Cisco Database	Small mesh gillnet captures of Cisco (chubs) from Lake Superior, contributed by MN DNR, WI DNR, MI DNR, Kewanaw Bay & Redcliff tribes & CORA)	All Great Lakes	?	?	Scott Nelson scott_nelson@usgs.gov (734) 214-7243
		USGS - Great Lakes Science Center	Interagency Predator Prey Database	Lake Superior returns of several predator species contributed by all agencies in Cisco database plus OMNR	Lake Superior	?	?	Scott Nelson scott_nelson@usgs.gov (734) 214-7243
USGS - Great Lakes Science Center	Great Lakes Aquatic Gap Analysis Project	To evaluate the biological diversity of aquatic species and their habitats, and to identify gaps in the distribution and protection of these species and their habitats within the Great Lakes basin.	All Great Lakes	2003-future	continuous	http://www.glsc.usgs.gov/GLGAP.htm		

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A n i m a l s Fish	USGS - Center for Aquatic Resource Studies	Nonindigenous Aquatic Species	Provided are scientific reports, online/realtime queries, spatial data sets, regional contact lists, and general information. The data is made available for use by biologists, interagency groups, and the general public.	USA	N/A	N/A	http://nas.er.usgs.gov
	NOAA - Great Lakes Environmental Research Lab	Great Lakes Aquatic Nonindigenous Species Database Project	Presently, there are 162 aquatic nonindigenous species in the Great Lakes. However, there is no readily accessible on-line information database of these species. We believe such a database would be a useful addition to the Great Lakes on-line information resources, and, if constructed appropriately, would also serve as a useful scientific and community reference tool.	Great Lakes Region	2003-future	N/A	http://www.glerl.noaa.gov/res/Task_reports/nsreid10-3.html
	Great Lakes Sport Fishing Council	Exotic Species and their effects on the Great Lakes	A series of informational links to help anglers learn more about the invasion of these unwanted exotics.	All Great Lakes	1996-2003	N/A	http://www.great-lakes.org/exotics.html
	National Park Service	Isle Royal Fish Studies	?	?	?	?	?
	Environment Canada & U.S. EPA	SOLEC Indicator Database	The database was designed primarily to assist the SOLEC Indicator Group organize and sort the hundreds of indicators that were identified for the Great Lakes.	Great Lakes Region	1998 - ?	?	http://www.on.ec.gc.ca/solec/pdf/appendix5-v4.pdf
	Environment Canada	Environmental Effects Monitoring	The Environmental Effects Monitoring program assesses the effects of effluent from industrial or other sources on fish, fish habitat and human usage of fisheries resources. Since 1992, pulp and paper mills have been required to conduct EEM studies under the Pulp and Paper Effluent Regulations. This database provides information on the mill name, geographical location and sub-lethal toxicity data.	Canada	1992-2002	N/A	http://www.ecologeris.com/details/online/
	OH DNR - Division of Geological Survey	Spatial Patterns Emphasize the Importance of Coastal Zones as Nursery Areas for Larval Walleye in Western Lake Erie	?	Western Lake Erie	? - 2000	N/A	Jonathan Fuller jonathan.fuller@dnr.state.oh.us
	International Association for Great Lakes Research	Assessment and Management of Fish Community Health in the Great Lakes: Synthesis and Recommendations	?	All Great Lakes	? - 1990	N/A	Sharon Dobush sharon.dobush@mnr.gov.on.ca 705-825-3415
	Ontario MNR	An Investigation of the Effects of Fish Habitat Modification in Batchewana Bay, Lake Superior (Projects 95-33 and 94-27)	?	Batchewana Bay, Lake Superior	? - 1996	N/A	Sharon Dobush sharon.dobush@mnr.gov.on.ca 705-825-3415
	Institute for Environmental Studies, University of Toronto	The Fish and Fisheries of Canadian Lake Superior	?	Lake Superior	? - 1982	N/A	Sharon Dobush sharon.dobush@mnr.gov.on.ca 705-825-3415
USGS-UMESC	Long Term Resource Monitoring Program	The mission of the Long Term Resource Monitoring Program is to provide decision makers with the information needed to maintain the Upper Mississippi River System as a viable multiple-use large river ecosystem. The long-term goals of the Program are to understand the system, determine resource trends and impacts, develop management alternatives, manage information, and develop useful products.	The Five Upper Mississippi River System states (Illinois, Iowa, Minnesota, Missouri, and Wisconsin).	1987-present	annually	http://www.umesc.usgs.gov/ltrmp.html	

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A n i m a l s A m p h i b i a n s	Federal, state, international, non-government, academic, and private industry partners (http://www.nbi.gov/about/partner/)	National Biological Information Infrastructure: FrogWeb	FrogWeb is a web-based resource developed by the USGS National Biological Information Infrastructure (NBII), a broad, collaborative program dedicated to providing increased access to data and information on the nation's biological resources. FrogWeb provides access to information and educational materials on amphibian declines and malformations.	National and International	? - Present	Constantly Updated	http://www.frogweb.gov/
	USGS	Northern American Reporting Center for Amphibian Malformations Data Sets	Presented online via clickable maps down to the county-level. Based on submitted observations.	United States		2000	http://www.npwr.usgs.gov/narcam/
	USGS	Amphibian Research and Monitoring Initiative National Database	In development, this database will store amphibian survey data, including information about sampling methods, species observed, habitat, water chemistry, etc. Data retrieval will be accessible online. ARMI Atlas reports county-level (sub-county level for some states).	United States	2002-2004		http://edc2.usgs.gov/armi/
	Bird Studies Canada, EC - Canadian Wildlife Service, U.S. EPA's Great Lakes National Program Office	Marsh Monitoring Program	Monitoring populations of marsh birds (53 species) and amphibians (13 species) over time on a variety of spatial scales through survey efforts of volunteers	Great Lakes states and Ontario	1995-1999		http://www.bsc-eoc.org/mmpreport.html
	National Heritage Inventory Program (Wisconsin DNR and The Nature Conservancy)	Wisconsin Herpetological Atlas	The Herp Atlas produces a computerized database of amphibian and reptile distribution, based on records obtained from museum collections, field surveys, literature, and field notes provided by volunteer observers throughout the state.	Wisconsin	1986-present	9-Mar-98	http://www.mpm.edu/collect/vertzo/herp/atlas/atlas.html
	Ontario MNR - Science and Information Branch (The Nature Conservancy of Canada, The Natural Heritage League, and The Nature Conservancy)	Natural Heritage Information Center - Element (Species) Database	Element of Biodiversity is the term coined by NatureServe used to refer to a species, subspecies, vegetation community, or special feature of the landscape. An Element Occurrence is defined as a location in the province where an Element has existed on a permanent or regular basis. What constitutes an occurrence depends on the element. For example, a bird occurrence is usually defined as a breeding area or migration staging area, but not a single sighting by a bird-watcher. A plant or vegetation community occurrence is usually any place where it occurs naturally.	Ontario	1983 -2003	Mar-03	http://www.mnr.gov.on.ca/MNR/nhic/
	Canadian Endangered Species Conservation Council	Wild Species 2000 Report	Overview of the status of Canada's species, bringing together the results of Provincial, Territorial, and Federal monitoring efforts	Canada	to be released every 5 years	2000	http://www.wildspecies.ca/en/Home_E.html
	Environment Canada	Biodiversity Portrait of the St. Lawrence River	Consolidation of scientific information and data on the physical and biotic characteristics of the region from the past 3 years.	St. Lawrence River, Canada	2000-2003		http://www.gc.ec.gc.ca/faune/biodiv/en/table_contents.html
MDNR	Michigan Frog and Toad Survey	Monitor long-term abundance and distribution of populations	Michigan	Annual (1996-2002)	2002	http://www.michigan.gov/dnr/1,1607,7-153-10370_12143_12194---,00.html	

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A n i m a l s Amphibians	MDNR	Selected species and habitat information	Provides links to scientific information about species and ecosystems	Michigan	N/A	N/A	http://www.michigan.gov/dnr/0,1607,7-153-10370_12145---00.html
	USDA Forest Service	Fire Effects Information System	This database contains synoptic descriptions, taken from current English-language literature of almost 900 plant species, about 100 animal species, and 16 Kuchler plant communities found on the North American continent. The emphasis of each synopsis is fire and how it affects each species. Background information on taxonomy, distribution, basic biology and ecology of each species is also included.	USA	? - Present	Constantly Updated	http://www.fs.fed.us/database/feis/index.html
	National Wildlife Federation	Frogwatch USA	Frogwatch USA is an educational frog and toad monitoring program started by the USGS in 1999. The program relies on citizen volunteers to gather information on frog populations throughout the United States. The USGS maintains a primary role in the scientific analysis of Frogwatch data.	United States	1999 - Present	2003	http://www.nwf.org/frogwatchUSA/
	Conservation organizations, federal government, international agencies, and private sector partners (http://www.natureserve.org/aboutUs/partners.jsp)	NatureServe website	Provides scientific information about species and terrestrial ecosystems. Includes description, distribution, status, and trend information on most native and introduced plant and animal species. Also includes classification and descriptions for upland and wetland ecosystems as well vegetation types included in the U.S. National Vegetation Classification. Contains links to methods documentation used by Natural Heritage programs. Specific contacts at NatureServe may provide access to multi-jurisdictional data on locations of rare species throughout the United States. Up to date occurrence data for species, as well as mapped locations of ecosystem, community, and natural areas are available through individual Natural Heritage programs in ON, MN, WI, IL, IN, MI, OH, PA, and NY.	International, National, and State Information	1974-2003	continuous	http://www.natureserve.org/getData/index.jsp
	MN DNR - Division of Ecological Services, Non-game Wildlife Program	Minnesota Frog & Toad Calling Survey	Provides dot maps of all MN frogs.	Minnesota	1996-2002	N/A	http://files.dnr.state.mn.us/volunteer/ng/frogtoad_survey/Frog&toadsurvey.pdf
	USGS - Great Lakes Science Center	Great Lakes Aquatic Gap Analysis Project	To evaluate the biological diversity of aquatic species and their habitats, and to identify gaps in the distribution and protection of these species and their habitats within the Great Lakes basin.	All Great Lakes	2003-future	continuous	http://www.glsc.usgs.gov/GLGAP.htm
	USGS - Center for Aquatic Resource Studies	Nonindigenous Aquatic Species	Provided are scientific reports, online/realtime queries, spatial data sets, regional contact lists, and general information. The data is made available for use by biologists, interagency groups, and the general public.	USA	N/A	N/A	http://nas.er.usgs.gov
	Environment Canada & U.S. EPA	SOLEC Indicator Database	The database was designed primarily to assist the SOLEC Indicator Group organize and sort the hundreds of indicators that were identified for the Great Lakes.	Great Lakes Region	1998 - ?	?	http://www.on.ec.gc.ca/solec/pdf/appendix5-v4.pdf

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A n i m a l s	Amphibians	USGS - Patuxent Wildlife Research Center	North American Amphibian Monitoring Program (NAAMP)	The NAAMP is a collaborative effort among regional partners, such as state natural resource agencies and nonprofit organizations, and the U.S. Geological Survey (USGS) to monitor populations of vocal amphibians. The USGS provides central coordination and database management.	Indiana & Pennsylvania, soon to be all USA	1999-present	annually	http://www.mp2-pwrc.usgs.gov/NAAMP/
	Reptiles	MSU Extension	Michigan Natural Features Inventory	Rare and declining plants and animals, natural communities and ecosystems native to Michigan	Michigan	Historical (?) - present	Constantly Updated	Dennis Albert 517-335-4580 albertd@michigan.gov http://web4.msue.msu.edu/mnfi/home.cfm
		National Heritage Inventory Program (Wisconsin DNR and The Nature Conservancy)	Wisconsin Herpetological Atlas	The Herp Atlas produces a communterized database of amphibian and reptile distribution, based on records obtained from museum collections, field surveys, literature, and field notes provided by volunteer observers throughout the state.	Wisconsin	1986-present	9-Mar-98	http://www.mpm.edu/collect/vertzo/herp/atlas/atlas.html
		Minnesota DNR- Minnesota County Biological Survey	Natural Heritage Information System	Provides information on Minnesota's rare plants, animals, native plant communities and other rare features. County-by-county survey of natural communities. Information available upon request.	Minnesota	1987 to present		http://www.dnr.states.mn.us/ecological_services/nhnrp/nhis.html
		Wisconsin DNR	Wisconsin Natural Heritage Inventory Data Sets	Contains information on the status and distribution of endangered resources and georeferenced data on species and natural communities available down to the county level.	Wisconsin			http://www.dnr.stae.wis.us/org/land/her/hni/NHI_ims/onlineedb.htm
		Environment Canada	Biodiversity Portrait of the St. Lawrence River	Consolidation of scientific information and data on the physical and biotic characteristics of the region from the past 3 years.	St. Lawrence River, Canada	2000-2003		http://www.qc.ec.gc.ca/faune/biodiv/en/table_contents.html
		Ontario MNR - Science and Information Branch (The Nature Conservancy of Canada, The Natural Heritage League, and The Nature Conservancy)	Natural Heritage Information Center - Element (Species) Database	Element of Biodiversity is the term coined by NatureServe used to refer to a species, subspecies, vegetation community, or special feature of the landscape. An Element Occurrence is defined as a location in the province where an Element has existed on a permanent or regular basis. What constitutes an occurrence depends on the element. For example, a bird occurrence is usually defined as a breeding area or migration staging area, but not a single sighting by a bird-watcher. A plant or vegetation community occurrence is usually any place where it occurs naturally.	Ontario	1983 -2003	Mar-03	http://www.mnr.gov.on.ca/MNR/nhic/
		Canadian Endangered Species Conservation Council	Wild Species 2000 Report	Overview of the status of Canada's species, bringing together the results of Provincial, Territorial, and Federal monitoring efforts	Canada	to be released every 5 years	2000	http://www.wildspecies.ca/en/Home_E.html
		MDNR	Selected species and habitat information	Provides links to scientific information about species and ecosystems	Michigan	N/A	N/A	http://www.michigan.gov/dnr/0,1607,7-153-10370_12145---00.html

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A n i m a l s	Reptiles	USDA Forest Service	Fire Effects Information System	This database contains synoptic descriptions, taken from current English-language literature of almost 900 plant species, about 100 animal species, and 16 Kuchler plant communities found on the North American continent. The emphasis of each synopsis is fire and how it affects each species. Background information on taxonomy, distribution, basic biology and ecology of each species is also included.	USA	? - Present	Constantly Updated	http://www.fs.fed.us/database/feis/index.html
		Conservation organizations, federal government, international agencies, and private sector partners (http://www.natureserve.org/aboutUs/partners.jsp)	NatureServe website	Provides scientific information about species and terrestrial ecosystems. Includes description, distribution, status, and trend information on most native and introduced plant and animal species. Also includes classification and descriptions for upland and wetland ecosystems as well vegetation types included in the U.S. National Vegetation Classification. Contains links to methods documentation used by Natural Heritage programs. Specific contacts at NatureServe may provide access to multi-jurisdictional data on locations of rare species throughout the United States. Up to date occurrence data for species, as well as mapped locations of ecosystem, community, and natural areas are available through individual Natural Heritage programs in ON, MN, WI, IL, IN, MI, OH, PA, and NY.	International, National, and State Information	1974-2003	continuous	http://www.natureserve.org/getData/index.jsp
		USGS - Great Lakes Science Center	Great Lakes Aquatic Gap Analysis Project	To evaluate the biological diversity of aquatic species and their habitats, and to identify gaps in the distribution and protection of these species and their habitats within the Great Lakes basin.	All Great Lakes	2003-future	continuous	http://www.glsc.usgs.gov/GLGAP.htm
		USGS - Center for Aquatic Resource Studies	Nonindigenous Aquatic Species	Provided are scientific reports, online/realtime queries, spatial data sets, regional contact lists, and general information. The data is made available for use by biologists, interagency groups, and the general public.	USA	N/A	N/A	http://nas.er.usgs.gov
		Environment Canada & U.S. EPA	SOLEC Indicator Database	The database was designed primarily to assist the SOLEC Indicator Group organize and sort the hundreds of indicators that were identified for the Great Lakes.	Great Lakes Region	1998 - ?	?	http://www.on.ec.gc.ca/solec/pdf/appendix5-v4.pdf
Birds	Ontario MNR - Science and Information Branch (The Nature Conservancy of Canada, The Natural Heritage League, and The Nature Conservancy)	Natural Heritage Information Center - Element (Species) Database	Element of Biodiversity is the term coined by NatureServe used to refer to a species, subspecies, vegetation community, or special feature of the landscape. An Element Occurrence is defined as a location in the province where an Element has existed on a permanent or regular basis. What constitutes an occurrence depends on the element. For example, a bird occurrence is usually defined as a breeding area or migration staging area, but not a single sighting by a bird-watcher. A plant or vegetation community occurrence is usually any place where it occurs naturally.	Ontario	1983 -2003	Mar-03	http://www.mnr.gov.on.ca/MNR/nhic/	

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A n i m a l s	Birds	Environment Canada	Great Lakes Environmental Sensitivity Atlas and Database	Areas for migrating birds, breeding colonies sites, and endangered species habitat are identified on maps. Some additional information is available in the master database. Provides data and information on migratory water fowl, colonial nesting birds, wading birds shore birds and raptors.	U.S. and Canada Great Lakes shorelines	1991-1994	http://www.on.ec.gc.ca/emergency/enviro-sensitivity-atlas/intro-e.html	
		Environment Canada	Biodiversity Portrait of the St. Lawrence River	Consolidation of scientific information and data on the physical and biotic characteristics of the region from the past 3 years.	St. Lawrence River, Canada	2000-2003	http://www.gc.ec.gc.ca/faune/biodiv/en/table_contents.html	
		Canadian Endangered Species Conservation Council	Wild Species 2000 Report	Overview of the status of Canada's species, bringing together the results of Provincial, Territorial, and Federal monitoring efforts	Canada	to be released every 5 years	2000	http://www.wildspecies.ca/en/HomeE.html
		MDNR	Selected species and habitat information	Provides links to scientific information about species and ecosystems	Michigan	N/A	N/A	http://www.michigan.gov/dnr/0,1607,7-153-10370_12145---00.html
		MSU and Long Point Bird Observatory	Waterfowl Use of the Laurentian Great Lakes	Habitat and limiting factors of waterfowl in Great Lakes wetlands and deep water habitats	Great Lakes	Various years (1970s-1980s)	N/A	http://jglr.org/1992/num4/18_4_673-699.pdf
		Canadian Wildlife Service	Waterbird Surveys at Hamilton Harbor	Waterbird surveys conducted at Hamilton Harbor and Windermere Basin	Hamilton Harbor, Lake Ontario	1985-1988	N/A	http://jglr.org/1992/num3/18_3_420-439.pdf
		Bird Studies Canada, Ontario MNR, Canadian Wildlife Service, and Ontario Power Generation	Southern Ontario Bald Eagle Monitoring Program	Volunter monitoring of nesting status. Observations are presented in a report.	Southern Ontario	1983-2003	2002	http://www.bsc-eoc.org/baea2000.html
		Bird Studies Canada, EC-Canadian Wildlife Service, U.S. EPA's Great Lakes National Program Office	Marsh Monitoring Program	Monitoring populations of marsh birds (53 species) and amphibians (13 species) over time on a variety of spatial scales through survey efforts of volunteers	Great Lakes states and Ontario	1995-Present		http://www.bsc-eoc.org/mmpreport.html
USDA Forest Service	Fire Effects Information System	This database contains synoptic descriptions, taken from current English-language literature of almost 900 plant species, about 100 animal species, and 16 Kuchler plant communities found on the North American continent. The emphasis of each synopsis is fire and how it affects each species. Background information on taxonomy, distribution, basic biology and ecology of each species is also included.	USA	? - Present	Constantly Updated	http://www.fs.fed.us/database/feis/index.html		

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Animals	Birds	Conservation organizations, federal government, international agencies, and private sector partners (http://www.natureserve.org/aboutUs/partners.jsp)	NatureServe website	Provides scientific information about species and terrestrial ecosystems. Includes description, distribution, status, and trend information on most native and introduced plant and animal species. Also includes classification and descriptions for upland and wetland ecosystems as well as vegetation types included in the U.S. National Vegetation Classification. Contains links to methods documentation used by Natural Heritage programs. Specific contacts at NatureServe may provide access to multi-jurisdictional data on locations of rare species throughout the United States. Up to date occurrence data for species, as well as mapped locations of ecosystem, community, and natural areas are available through individual Natural Heritage programs in ON, MN, WI, IL, IN, MI, OH, PA, and NY.	International, National, and State Information	1974-2003	continuous	http://www.natureserve.org/getData/index.jsp
		USGS - Great Lakes Science Center	Great Lakes Aquatic Gap Analysis Project	To evaluate the biological diversity of aquatic species and their habitats, and to identify gaps in the distribution and protection of these species and their habitats within the Great Lakes basin.	All Great Lakes	2003-future	continuous	http://www.glsc.usgs.gov/GLGAP.htm
		USGS - Center for Aquatic Resource Studies	Nonindigenous Aquatic Species	Provided are scientific reports, online/realtime queries, spatial data sets, regional contact lists, and general information. The data is made available for use by biologists, interagency groups, and the general public.	USA	N/A	N/A	http://nas.er.usgs.gov
		USGS - Patuxent Wildlife Research Center	North American Breeding Bird Survey (BBS)	To monitor the status and trends of bird populations across the U.S. and Canada. The survey is based on randomly selected roadside routes that are surveyed once annually during the breeding season. The counts obtained along BBS routes are used as indices of population change. Geographic Domain: U.S. (except for Hawaii) and Canada. As a roadside survey, coverage is poor to nonexistent in a large portion of northern Canada and Alaska.	USA & Canada	1966-present	annually	http://www.mp2-pwrc.usgs.gov/bbs/
		USGS - Patuxent Wildlife Research Center	Colonial Waterbird Monitoring Database	This database serves as a clearinghouse for data obtain from surveys of breeding colonial waterbirds across the U.S. and Canada. These surveys are used to establish the status and trends of continental colonial waterbird populations.	USA & Canada	1970s - Present	2000	http://www.mp2-pwrc.usgs.gov/cwb/database/

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A n i m a l s	Birds	USGS - Patuxent Wildlife Research Center & The American Bird Conservancy	Point Count Database	The Partners in Flight (PIF) bird conservation initiative has organized a number of point count surveys to obtain information on the status and trends of songbird populations.	Variable. Some of these programs are state-based, and conduct point counts across the state. Others have a more local geographic area of interest, such as a specific wildlife refuge, state park, or similar area of management interest. Data from US Fish and Wildlife Service wildlife refuges in the Great Lakes region have been added to this database.	1995-Present	annually	http://www.mp2-pwrc.usgs.gov/point/
		National Audubon Society	Christmas Bird Count	To obtain information on the distribution, status, and trends of bird populations during the early winter season. CBCs are conducted between mid-December and early January each year. The CBC is conducted within a "circle", which is a 15-mile diameter area designated by the count coordinators so as to not overlap with any other CBC. During a single day during the count period, CBC participants attempt to count as many birds as possible within the CBC circle. The number of participants varies among the counts, from fewer than 10 to more than 200. The total numbers of birds counted, usually adjusted by unit of effort, are used as an index of bird population change over time.	Primarily the U.S. and Canada, with a small number of counts in Mexico, Central America, and the Caribbean.	1958-present	annually	http://www.audubon.org/bird/cbc/index.html
		USGS - Snake River Field Station	Mid-winter eagle survey	To obtain information on the distribution, status, and trends of wintering eagle populations on the continent. The survey is conducted once annually, usually during a two-week period in January. A variety of methods are used including aircraft and ground-based surveys, based on standardized survey routes established in each state.	USA & Canada	1979-present	annually	Karen Steenhof USGS Snake River Field Station (208) 426-5206 karen_steenhof@usgs.gov
		Wisconsin Society for Ornithology	Wisconsin Breeding Bird Atlas	The purpose of this study is to provide a permanent record of the bird species breeding in the state, provide baseline data for monitoring future changes in bird populations, assess habitat needs of breeding species and document species diversity, document abundance and distribution of rare and endangered species, provide comparisons with historical studies, complement existing or on-going avian monitoring programs in Wisconsin and in nearby states, assist international efforts to preserve neotropical migratory birds, help in land use planning by local and state governments, and assist industry in preparing environmental impact assessments.	Wisconsin	1995-2000	N/A	http://www.uwgb.edu/birds/wbba/index.htm
		New York State Department of Environmental Conservation	New York State Breeding Bird Atlas	The Breeding Bird Atlas is a comprehensive, statewide survey that will reveal the current distribution of breeding birds in New York.	New York	2000-2004	N/A	http://www.dec.state.ny.us/website/dfwmr/wildlife/bba/index.html

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A n i m a l s	Birds	OH DNR - Division of Natural Areas and Preserves	Ohio Breeding Bird Atlas	The primary goal of the Ohio Breeding Bird Atlas Project was to document the status and distribution of all birds breeding in Ohio. Additional objectives of this project included providing more accurate information on the distribution and nesting occurrences of Ohio's rare and endangered breeding birds; identifying significant habitats supporting rare or unusual species which could become the focus of preservation efforts; providing baseline data against which future changes in the status and distribution of Ohio's breeding birds can be measured; providing baseline data for the development of environmental impact statements; involving the birders of Ohio in a cooperative effort of scientific value and heightening their awareness of the state's summer birdlife.	Ohio	1982-1987	N/A	http://www.dnr.state.oh.us/dnap/OhioBirding/BreedingBirdAtlas/BreedingBirdAtlas.htm
		Aves.net	A Winter Bird Atlas for Ohio	To identify avian winter residents of Ohio.	Ohio	2003-2007	N/A	http://www.aves.net/winter-atlas/
		Federation of Ontario Naturalists, Bird Studies Canada, Canadian Wildlife Service, Ontario Ministry of Natural Resources, and Ontario Field Ornithologists	Ontario Breeding Bird Atlas	To develop an up-to-date and accurate picture of the status and distribution of all bird species throughout Ontario. It follows on the highly successful Ontario Breeding Bird Atlas carried out from 1981-1985, and is intended to help with conservation and protection of Ontario's birds through providing answers to key biological questions	Ontario	2001-2005	N/A	http://www.birdsontario.org/atlas/atlasmain.html
		Illinois Department of Natural Resources	Illinois Breeding Bird Atlas	To document the current status and distribution of the species of birds that breed in Illinois. Censuses were conducted during 1986-1991 following a standardized methodology. Three levels of breeding status are depicted on the distribution maps- confirmed, probable and possible.	Illinois	1986-1991	N/A	http://www.inhs.uiuc.edu/chf/pub/ifwis/maps/
		United States Fish and Wildlife Service Cooperative Research Unit	Pennsylvania Breeding Bird Atlas	The Pennsylvania Breeding Bird Atlas Project was a cooperative, volunteer-based survey conducted from 1983 through 1989. As part of the Gap Project, the Atlas provides the most comprehensive survey of nesting birds in Pennsylvania's history.	Pennsylvania	1983-1989	N/A	http://www.webmapping.org/data/bb_atlas.html
		Environment Canada & U.S. EPA	SOLEC Indicator Database	The database was designed primarily to assist the SOLEC Indicator Group organize and sort the hundreds of indicators that were identified for the Great Lakes.	Great Lakes Region	1998 - ?	?	http://www.on.ec.gc.ca/solec/pdf/appendix5-v4.pdf
	Mammals	Canadian Endangered Species Conservation Council	Wild Species 2000 Report	Overview of the status of Canada's species, bringing together the results of Provincial, Territorial, and Federal monitoring efforts	Canada	to be released every 5 years	2000	http://www.wildspecies.ca/en/Home_E.html
		MDNR	Selected species and habitat information	Provides links to scientific information about species and ecosystems	Michigan	N/A	N/A	http://www.michigan.gov/dnr/0,1607,7-153-10370_12145---,00.html

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A n i m a l s Mammals	Ontario MNR - Science and Information Branch (The Nature Conservancy of Canada, The Natural Heritage League, and The Nature Conservancy)	Natural Heritage Information Center - Element (Species) Database	Element of Biodiversity is the term coined by NatureServe used to refer to a species, subspecies, vegetation community, or special feature of the landscape. An Element Occurrence is defined as a location in the province where an Element has existed on a permanent or regular basis. What constitutes an occurrence depends on the element. For example, a bird occurrence is usually defined as a breeding area or migration staging area, but not a single sighting by a bird-watcher. A plant or vegetation community occurrence is usually any place where it occurs naturally.	Ontario	1983 -2003	Mar-03	http://www.mnr.gov.on.ca/MNR/nhic/
	Environment Canada	Biodiversity Portrait of the St. Lawrence River	Consolidation of scientific information and data on the physical and biotic characteristics of the region from the past 3 years.	St. Lawrence River, Canada	2000-2003		http://www.gc.ec.gc.ca/faune/biodiv/en/table_contents.html
	Conservation organizations, federal government, international agencies, and private sector partners (http://www.natureserve.org/aboutUs/partners.jsp)	NatureServe website	Provides scientific information about species and terrestrial ecosystems. Includes description, distribution, status, and trend information on most native and introduced plant and animal species. Also includes classification and descriptions for upland and wetland ecosystems as well vegetation types included in the U.S. National Vegetation Classification. Contains links to methods documentation used by Natural Heritage programs. Specific contacts at NatureServe may provide access to multi-jurisdictional data on locations of rare species throughout the United States. Up to date occurrence data for species, as well as mapped locations of ecosystem, community, and natural areas are available through individual Natural Heritage programs in ON, MN, WI, IL, IN, MI, OH, PA, and NY.	International, National, and State Information	1974-2003	continuous	http://www.natureserve.org/getData/index.jsp
	USGS - Center for Aquatic Resource Studies	Nonindigenous Aquatic Species	Provided are scientific reports, online/realtime queries, spatial data sets, regional contact lists, and general information. The data is made available for use by biologists, interagency groups, and the general public.	USA	N/A	N/A	http://nas.er.usgs.gov
	Purdue University	Wolf Ecology and Prey Relationships on Isle Royale	?	Isle Royal	? - 1974	N/A	Sharon Dobush sharon.dobush@mnr.gov.on.ca 705-825-3415
	Environment Canada & U.S. EPA	SOLEC Indicator Database	The database was designed primarily to assist the SOLEC Indicator Group organize and sort the hundreds of indicators that were identified for the Great Lakes.	Great Lakes Region	1998 - ?	?	http://www.on.ec.gc.ca/solec/pdf/appendix5-v4.pdf
	USDA Forest Service	Fire Effects Information System	This database contains synoptic descriptions, taken from current English-language literature of almost 900 plant species, about 100 animal species, and 16 Kuchler plant communities found on the North American continent. The emphasis of each synopsis is fire and how it affects each species. Background information on taxonomy, distribution, basic biology and ecology of each species is also included.	USA	? - Present	Constantly Updated	http://www.fs.fed.us/database/feis/index.html