Each of the indicators above provides information about conditions at a particular point in time. However, we also would like information about trends over time. Is the atmospheric pressure rising, falling or staying the same? Indicators measured repeatedly over time provide the basis for tracking trends in environmental conditions.
looking at a number of indicators together, we can assess whether the whole system is getting better or worse or staying the same.

- Dieldrin concentrations show a general decrease in concentrations with recorded values 3-4 times higher at the Pelee station.
  insecticide usage could explain these higher concentrations.

- β-Endosulphan concentrations show no sign of long-term decrease as there has been no restriction on its use as a broad-spectrum insecticide.
  substantially higher at Pt. Petre as compared to Sibley.

Detectable insecticide concentrations in the environment vary widely as a result of the physical and chemical properties of the substance, where it is used, how much is used and the weather conditions under which it was applied.
the pesticide, 75% or more of what is applied can be lost to the atmosphere over time.
returned to the environment through atmospheric deposition causing potentially harmful impacts to fish and wildlife, human health, habitat and water quality.

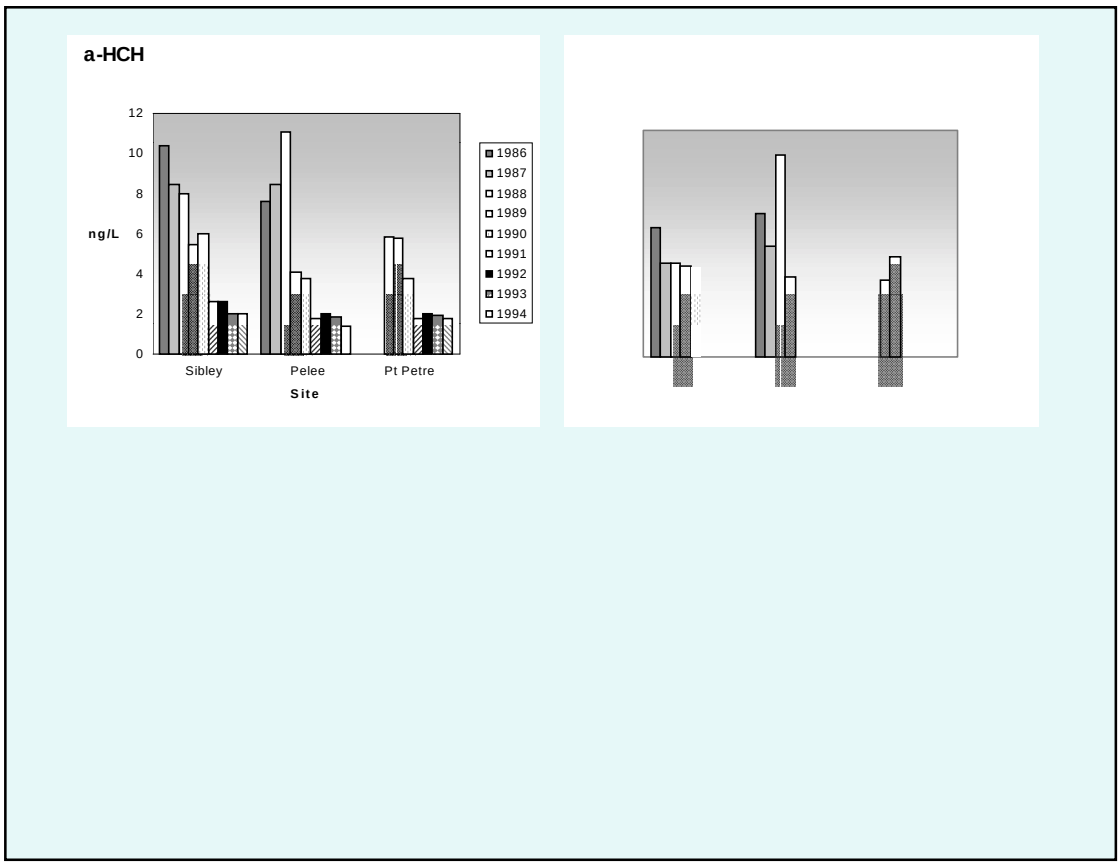


Figure 11a-d. α-HCH, Lindane, Dieldrin and β-endosulphan concentrations found in precipitation at Sibley (Lake Superior), Pelee (Lake Erie) and Point Petre (Lake Ontario).
Source: IADN, 1998.

Gain in Restored Wetland Area by Type

State Indicator (4511)

This indicator was chosen to measure the success of rehabilitation efforts across the basin. With extensive areas of coastal wetlands lost each year as a result of various threats, it is important to track where and to what extent efforts have been made to create additional wetlands, or rehabilitate lost or seriously degraded wetland area. Another indicator in the suite, Coastal Wetland Area by Type, will address the total loss (or gain) of coastal wetland area in the Great Lakes basin. The area, quality and type of restored wetlands is important. Current information presents rehabilitation effort for wetlands in the whole basin, distinguishing neither coastal ones, nor wetland types, nor enhancements of existing wetland areas from 'new' restored area. These distinctions should be monitored and separated from changes in wetland area and type caused by natural water level fluctuations.

From April 1994 through May 1999, projects to rehabilitate or create more than 2,500 hectares of wetlands have been completed in the Canadian Great Lakes basin, with an additional 1,340 hectares in progress.

The Great Lakes Wetlands Conservation Action Plan (GLWCAP) is a Canadian program of federal and provincial governments as well as non-governmental organizations with a common goal to create, reclaim, rehabilitate and protect wetland habitat in the lower Great Lakes basin. One of the aims of this program is to rehabilitate or create 6,000 hectares of wetland by the year 2001.

The following are some of the projects and programs occurring around the U.S. Great Lakes.

- The U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, U.S. Coast Guard and the Michigan departments of Natural Resources and Environmental Quality recently participated in a multi-agency winter navigation agreement that will protect the St. Marys River and more than 13,300 acres of Michigan's coastal wetlands. In the agreement, there are provisions to protect more than 75 miles of riverine habitat and wetlands from the effects of the early navigation season.

- Through partnerships, the Michigan Private Lands Office has completed 22 wetland restorations totaling 160 acres. The Michigan Wildlife Habitat Foundation, through a cooperative agreement, completed the bulk of these restorations with additional restorations completed through the Kalamazoo Conservation district. Partners, including landowners, contributed approximately 50 percent of the cost of the projects.

- Nearly 11,000 acres of wetlands have been restored through the U.S. Department of Agriculture Wetlands Reserve Program in the Great Lakes watershed within Wisconsin. These 126 sites are long-term restorations or permanent easements, providing flood control, improved water quality, and wildlife habitat in the North American Flyway.

Sediment Flowing into Coastal Wetlands

Pressure Indicator (4516)

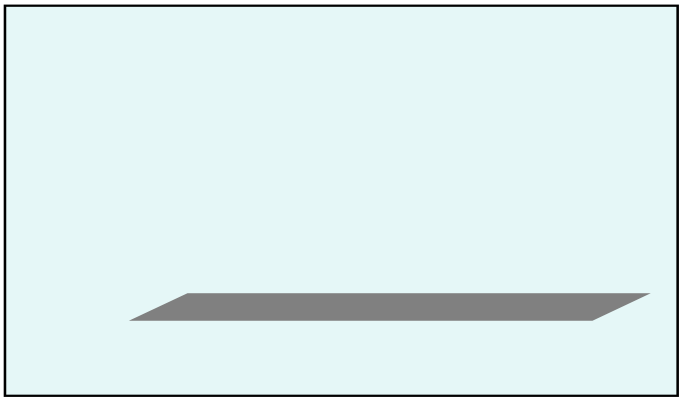
A major stressor affecting coastal wetlands is change in the location and movement of sediments. Where sediments feed barrier beaches and sand spits that protect wetlands, sediment reduction can shrink protection barriers and expose wetlands to wave attack. If excess sediments are deposited into existing wetlands, they can bury submergent vegetation and affect fish spawning and other functions. As little as 0.25 centimetres deposition of excess sediment can have a significant effect on the germination of many wetland plant species.

Human activities in the Great Lakes basin have substantially altered the amount and particle size of sediments flowing into the Great Lakes. Increased sediment loads entering coastal wetlands are largely due to changes in land use in the upstream watersheds. Changes include reduction of vegetated cover, increased agricultural runoff, urbanization, construction, and logging activities.

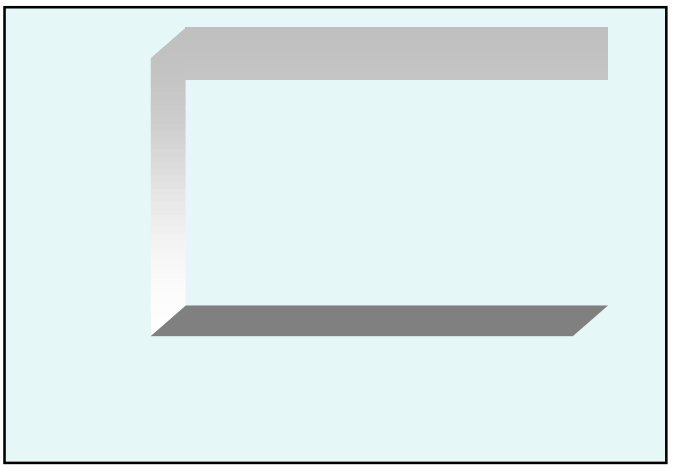
Because much of the sediment load originates in agricultural areas, sediments can carry high loads of nutrients, pesticides and other farm chemicals. High sediment concentrations cause turbidity which reduces the light reaching submergent vegetation and phytoplankton and limits plant growth.

The SOLEC 96 background paper Coastal Wetlands of the Great Lakes reported that severe sediment loading is extensive throughout the lower lakes where agricultural activity and urbanization are common, but is more localized in the upper lakes.

For many years the U.S. Geological Survey and Environment Canada have monitored sediment yields from numerous Great Lakes tributary watersheds including many associated with coastal wetlands. This provides an accessible data source. Figure 15 illustrates estimates of sediment yields from monitored Lake St. Clair coastal wetland watersheds (Canadian) between 1990 and 1996. In this case, higher yields indicate a greater human-induced pressure on the associated coastal wetlands but all years are high relative to rates for other Great Lakes wetland watersheds. The St. Clair watersheds support intensive agriculture. Information on land use changes in the watershed is needed before annual changes in sediment loads yields can be related to changes in land use patterns. The higher sediment yields in some years correspond to higher rainfall years. With climatologists suggesting that climate change might include more frequent highly erosive storms, future reduction of sediment yield from agricultural areas could be an even greater challenge than it is today.



Farmers are eligible for grants up to $1,500.00 (Can) to assist them in delivering the specified environmental remedial actions in their farm plans, once their plan has been reviewed and approved. The farm plan then becomes a stewardship guidebook for environmental management by the farmer and a reference document for further remedial or preventative actions.



Program Results

From 1993 to April 1999, there have been over 1,000 workshops held for farmers, involving almost 15,000 or a third of Ontario's farmers leading to the approval of 7,892 farm plans. Environmental Farm Plan workshops continue to be well attended and in the last several years have exceeded projected attendance. Figure 19 depicts the number of approved Environmental Farm Plans in Ontario.

United States Activities

Environmental Quality Incentives Program

The Environmental Quality Incentives Program (EQIP) works primarily in locally identified conservation priority areas where there are significant problems with natural resources. High priority is given to areas where agricultural improvements will help meet water quality objectives. EQIP offers contracts for conservation practices, such as manure management systems, pest management, erosion control, and other practices to improve and maintain the health of natural resources. Activities must be carried out according to a conservation plan.

Farmland Protection Program

The Farmland Protection Program provides funds to help purchase development rights to keep productive farmland in use. Working through existing programs, USDA joins with State, tribal, or local governments to acquire conservation easements or other interests from landowners. To qualify, farmland must meet several criteria, including having a conservation plan.

Stewardship Incentive Program

The Stewardship Incentive Program provides technical and financial assistance to encourage nonindustrial private forest landowners to keep their lands and natural resources productive and healthy. Eligible landowners must have an approved Forest Stewardship Plan and own 1,000 or fewer acres of qualifying land.

Wetlands Reserve Program

The Wetlands Reserve Program is a voluntary program to restore wetlands. Participating landowners can establish conservation easements of either permanent or 30-year duration or can enter into restoration cost-share agreements where no easement is involved. Restoration cost-share agreements establish wetland protection and restoration as the primary land use for the duration of the agreement. In all instances, landowners continue to control access to their land.

Wildlife Habitat Incentives Program

The Wildlife Habitat Incentives Program provides financial incentives to develop habitat for fish and wildlife on private lands. Participants agree to implement a wildlife habitat development plan. USDA and program participants enter into a cost-share agreement for wildlife habitat development. This agreement generally lasts a minimum of 5 years.

Sustainable Agriculture Research and Education Program

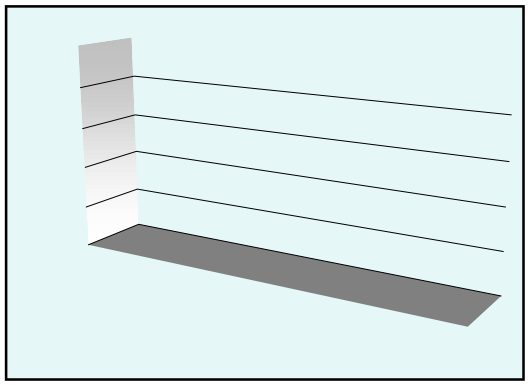
The Sustainable Agriculture Research and Education (SARE) program works to increase knowledge about – and help farmers and ranchers adopt – practices that are economically viable, environmentally sound and socially responsible. To advance such knowledge nationwide, SARE administers a competitive grants program first funded by Congress in 1988.

For the combined years 1997 - 1998, 78 grants were awarded within the eight Great Lakes states. As the outreach arm of SARE, the Sustainable Agriculture Network (SAN) provides national leadership in facilitating information exchanges in support of sustainable agriculture. Information is produced in a variety of formats, including print, World Wide Web, and electronic books, or diskette versions.

Giant Canada Goose -"Nuisance" Species on the Rise

For several decades prior to 1962, the Giant Canada Goose (*Branta canadensis maxima*) was thought to be extinct. Its rediscovery that year began a rapid restoration of the subspecies throughout its previous range (Figure 20). While many municipalities in the Great Lakes basin now consider this species a nuisance, its restoration is actually considered a success story. The geese are well adapted to living in populated and urbanized areas and goose-human conflicts are increasing. Municipalities request permits and assistance in dealing with the problems incurred by the geese in such areas as parks, golf courses and beaches. The agricultural community is also in need of assistance to prevent the geese from damaging crops.

In response to the high goose populations, regulatory agencies are implementing hunting regulations to increase the kill of Giant Canada Geese, while protecting other subspecies of migrant Canada Geese. Some communities are also getting involved in goose capture and relocation projects, while others are now considering the use of border collies to scare geese from areas such as airport runways and golf courses.



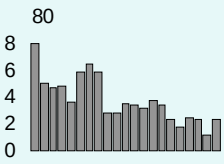
Source: Breeding Bird Survey, 1996.

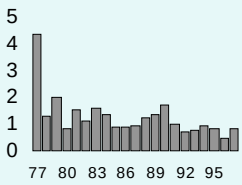
Double Crested Cormorant

The Double Crested Cormorant (*Phalacrocorax auritus*) was near extinction in the 1970s as a result of drastic impacts from toxic chemicals. From 1973 to 1993, however, the cormorant population increased over 300 fold to more than 38,000 pairs (Figure 21). The cormorant is Lakes than at any time in its previously recorded history because of decr Great Lakes basin and changes in the preyfish populations in the Lakes.

The growth in cormorant populations seen in the early 1990s is no longer evident. It is difficult for a species to maintain such growth rates as resources such as food and habitat become limiting. It is likely that the cormorant populations will stabilize sometime in the future.

Some interest groups in the Great Lakes basin believe that the population of cormorants is having a significant impact on fish populations.





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Note:

1. et weight +/- S.E., whole fish, age 4+ yrs., NA - not analyzed
2. eight +/- 95% C.I., whole fish, composite samples, 600-700 mm size range (Lake Erie data are for walleye in the 400-500 mm size range)

Figure 26. PCB and DDT found in Whole Lake Trout (1977-1997). ote the different scales between lakes).

Source: Department of Fisheries and Oceans Canada, 1998, and U.S. Environmental Protection Agency, 1998.

Table 3.

3.2 Lake Updates

Information presented in the indicators will help us determine the state of major ecosystem components of the Lakes. As has already been mentioned, the information is incomplete at this time, the gaps are too big to make a thorough assessment of the health of the Great Lakes basin ecosystem. To help give a more complete picture of the state of the Lakes, the folloo-5ÿystem. at this time, the gaps are too big to

- The round goby was first found in the Duluth-Superior Harbor in July 1995. To date, the infestation remains in the lower harbor where populations are growing and expanding rapidly. No other confirmed sighting have been reported in Lake Superior, its tributaries or inland lakes within the Basin. Like the other Great Lakes, it is expected that they will displace native fishes such as mottled sculpin and out compete others for food and habitat. A current density of round gobies are 918 per hectare, while in some areas of the Great Lakes densities are over 100 per square metre. The infestation is expected to continue to grow and expand.

- Spiny waterflea was first found in Lake Superior in 1987 likely discharged from the ballast water of ships travelling from the other Great Lakes. It has since spread to 29 inland lakes in the Great Lakes basin. Spiny waterflea can cause subtle effects on Great Lakes fisheries by competing with small fish for food (plankton). Spiny waterflea populations generally "bloom" in late summer when water temperatures warm, however, in 1999 there have been few reports of them collecting on fishing lines, downrigger cables and commercial fishing equipment. They are usually found in the western arm of Lake Superior, the Apostle Islands, and eastern Lake Superior, including Batchawana Bay.

- Rusty crayfish were found in the Duluth-Superior Harbor in June 1999. This is the first time that they have been found in the western basin of Lake Superior, likely released as live bait by non-resident anglers or from the ballast water of ships. They are a very aggressive species that can displace native crayfish populations. While their impacts will be site specific, they can literally clear cut an area of aquatic vegetation — reduce food and habitat for other species (including fish nursery habitat), allow for increased shoreline erosion and sediment resuspension, and can feed on the eggs of native fishes. The other known infestation of rusty crayfish in Minnesota waters of Lake Superior is in the Pigeon River.

Species Recovery

- Lake sturgeon - The trend is for a slight increase in population, but these numbers are still much below historic levels. There are completed rehabilitation plans and active rehabilitation programs planned for this species.
- Walleye - There are also completed rehabilitation plans for this species. Walleye numbers are stable or increasing in U.S. waters (the stocks are fully or nearly recovered).
- Lake herring are recovering, but have not fully recovered as yet. There has been low natural reproduction over the last seven years, although the lake herring in the system are getting larger and stronger. The biomass numbers have been increasing even though the total abundance has decreased slightly.
- Lake trout are now considered a naturally reproducing population and there has been very little stocking since 1997.

3.2.2 Lake Michigan

Exotic Species

- Round gobies have invaded Green Bay. They were first observed in the harbor at Escanaba, MI, several years ago and have recently been sampled in Sturgeon Bay, WI.
- Zebra mussels have recently moved upstream in the Fox River and are now established in Lake Winnebago in Wisconsin.

Species Recovery

Yellow perch in southern Lake Michigan appear to have spawned successfully in 1998. While this is good news in terms of reversing a seven-year trend of poor recruitment, the 1998 year class is relatively small compared to the large year classes of the 1980s that produced the large harvest in the late 1980s to early 1990s. A multi-agency research group is conducting extensive lakewide investigations to determiønlactors

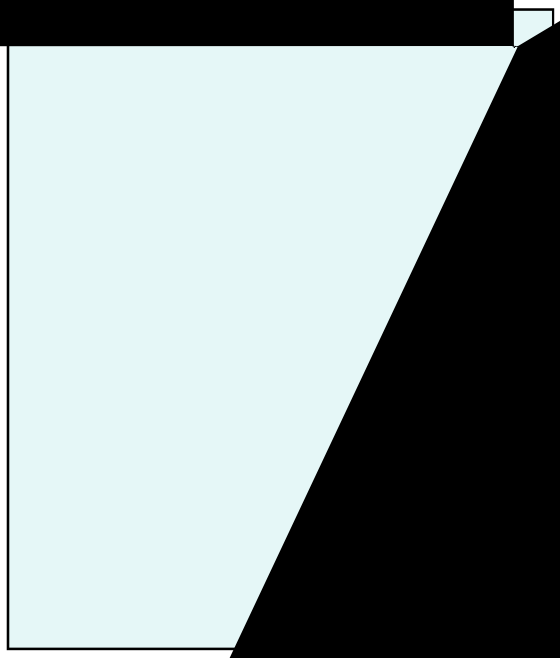

Figure 36. Individu
Source: U.S. Envi

3.2.3 Lake Hu

Sea Lamprey Control
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In June of 1998 the Lake Huron Conference was held in response to the identification of these needs. A binational gathering of government, industry, and local community initiated a much needed discussion on the issues and efforts required to ensure a sustainable Lake Huron watershed. A Steering Committee for the *Lake Huron Initiative* was identified and the decision to hold a binational Lake Huron Initiative Conference in the winter of 2000 was made. This conference will develop a framework for the Lake Huron Initiative. SOLEC background reports from 1994 and 1996, as well as State of the Great Lakes Reports from 1995 and 1997, have provided the Lake Huron Initiative Steering Committee with valuable information on the status and historic trends of issues and stresses relevant to Lake Huron.

3.2.4 Lake Erie

Beneficial Use Impairment Status

With one-third of the population of the Great Lakes basin residing in the Lake Erie watershed, the Lake is exposed to greater stress due to urbanization and agricultural intensity than any of the other Great Lakes. Despite success in controlling nutrient loadings and the resulting algal blooms, the Lake ecosystem is still subject to many other stresses.

Return of the Burrowing Mayfly

The return of the burrowing mayfly (*Hexagenia*) in the Western basin of Lake Erie is a positive indication of improved water quality in the lake. Burrowing mayflies are large aquatic insects that spend most of their two year lives in their larval form, living in shallow bottom sediments of lakes. Once numbering hundreds of individuals per square metre, populations decreased dramatically in the 1950s due to deteriorating water quality. Throughout most of the next three decades burrowing mayflies were virtually absent from their former Great Lakes habitat. Over the past five years U.S. and Canadian biologists have seen a dramatic resurgence of the mayfly in Lake Erie with numbers almost as high as they were in the early 20th century. This is good news for the entire Lake ecosystem as the mayfly is an important link in the food chain and their burrowing action resuspends nutrients necessary for plant growth. The indicator "Walleye and Hexagenia" addresses the abundance, biomass and annual production of both walleye and burrowing mayfly populations in historical, warm-coolwater, mesotrophic habitats of the Great Lakes (Appendix 1).

3.2.5 Lake Ontario

Beneficial Use Impairment Status

In May of 1998, the Lake Ontario LaMP identified the beneficial use impairments that exist lakewide in Lake Ontario, and the chemical, physical, and biological causes of these impairments (Table 5).

Table 5. Lake Ontario Lakewide Beneficial Use Impairments.

ID#			

ID#	Indicator name
6	Aquatic Habitat
8	Salmon and Trout
9	Walleye and Hexagenia
17	Preyfish Populations
18	Sea Lamprey
68	Native Unionid Mussels
72	Fish Entrainment
93	
8	

ID#	Indicator name
6	Aquatic Habitat
8	Salmon and Trout
9	Walleye and Hexagenia
17	Preyfish Populations
18	Sea Lamprey
68	Native Unionid Mussels
72	Fish Entrainment
93	Lake Trout and Scud (Diaporeia hoyi)
101	Deformities, Erosion, Lesions and Tumors in Nearshore Fish
104	Benthos Diversity and Abundance
109	Phytoplankton Populations
111	Phosphorus Concentrations and Loadings
113	Contaminants in Recreational Fish
114	Contaminants In Young-of-the-Year Spottail Shiners
115	Contaminants in Colonial Nesting Waterbirds
116	Zooplankton Populations
117	Atmospheric Deposition of Toxic Chemicals
118	Toxic Chemical Concentrations in Offshore Waters
119	Concentrations of Contaminants in Sediments Cores
120	Contaminant Exchange Between Air to Water & Water to Sediment.0069 Tw 0.9403 0 Td (Salmoyi))Tj -0.0Le72.04 0.768 Tc 0 Tw bre f 28.92 3-0.Id (Co