Area, Quality and Protection of Alvar Communities

SOLEC Indicator #8129 (in part)

Purpose

This indicator assesses the status of one of the 12 special lakeshore communities identified within the nearshore terrestrial area. Alvar communities are naturally open habitats occurring on flat limestone bedrock. They have a distinctive set of plant species and vegetative associations, and include many species of plants, molluscs, and invertebrates that are rare elsewhere in the basin. All 15 types of alvars and associated habitats occurring in the Great Lakes-St. Lawrence basin are globally imperiled or rare.

Ecosystem Objective

Conservation of alvar communities relates to IJC Desired Outcome 6: Biological Community Integrity and Diversity. A four-year study of Great Lakes alvars completed in 1998 (the International Alvar Conservation Initiative - IACI) evaluated conservation targets for alvar communities, and concluded that essentially all of the existing viable occurrences should be maintained, since all types are below the minimum threshold of 30-60 viable examples. As well as conserving these ecologically distinct communities, this target would protect populations of dozens of globally significant and disjunct species. A few species, such as Lakeside Daisy (*Hymenoxis herbacea*) and the beetle *Chlaenius p. purpuricollis*, have nearly all of their global occurrences within Great Lakes alvar sites.

State of the Ecosystem

Alvar habitats have likely always been sparsely distributed, but more than 90% of their original extent has been destroyed or substantially degraded by agriculture and other human uses. Approximately 64% of the remaining alvar area occurs within Ontario, with about 16% in New York State, 15% in Michigan, 4% in Ohio, and smaller areas in Wisconsin and Quebec.

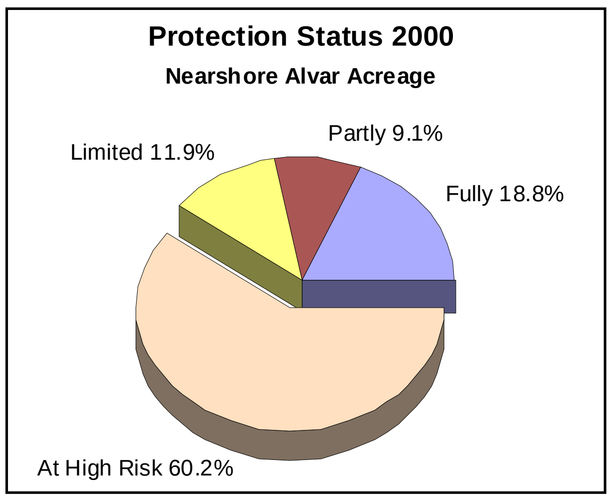
Data from the IACI and state/provincial alvar studies was screened and updated to identify viable community occurrences. Just over 2/3 of known Great Lakes alvars occur close to the shoreline, with all or a substantial portion of their area within 1 km of the shore.

Note that typically several different community types occur within each alvar site.

	Total in Basin	Nearshore
No. of alvar sites	82	52
No. of community occurrences	204	138
Alvar acreage	28,475	20,009

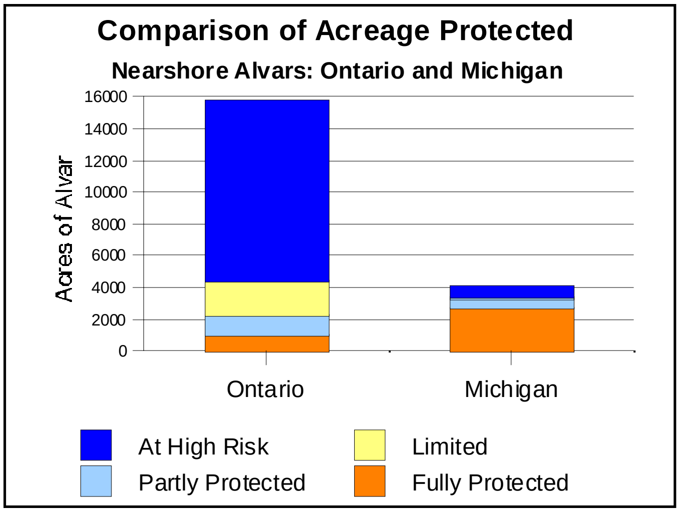
Among the 15 community types documented, six types show a strong association (over 80% of their acreage) with nearshore settings. Four types have less than half of their occurrences in nearshore settings.

The current status of all nearshore alvar communities was evaluated by considering current land ownership and the type and severity of threats to their integrity. As shown in the figure, less than 1/5th of the nearshore alvar acreage is currently fully protected, while over 3/5th is at high risk.

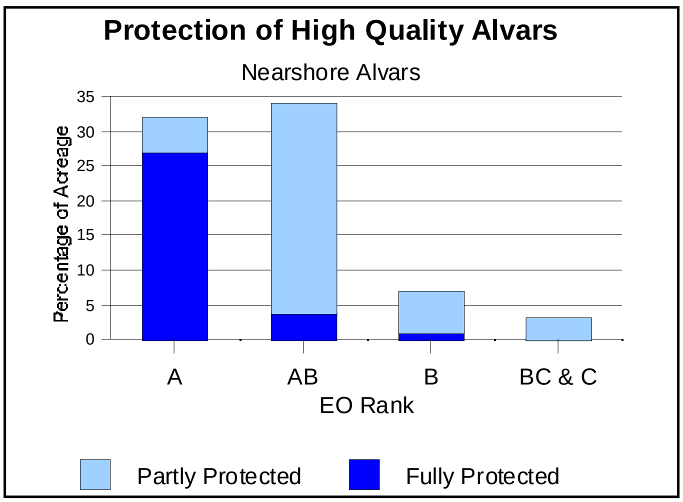


The degree of protection for nearshore alvar communities varies considerably among jurisdictions. For example, Michigan has 66% of its nearshore alvar acreage in the Fully Protected category, while Ontario has only 7%. In part, this is a reflection of the much larger total shoreline acreage in Ontario, as shown in the following figure. (Other states have too few nearshore sites to allow comparison).

Each alvar community occurrence has been assigned an "EO rank" to reflect its relative quality and condition. A



and B-ranks are considered viable, while C-ranks are marginal. As shown in the following figure, protection efforts to secure alvars have clearly focused on the best quality sites.

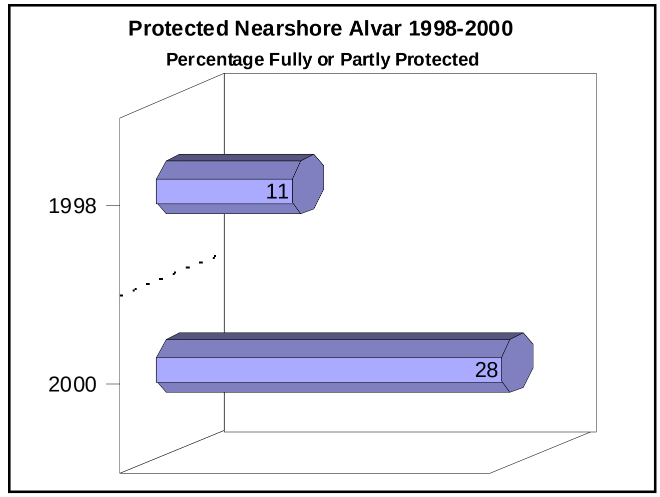


Pressure on the Ecosystem

Nearshore alvar communities are most frequently threatened by habitat fragmentation and loss, trails and off-road vehicles, resource extraction uses such as quarrying or logging, and adjacent land uses such as residential subdivisions. Less frequent threats include grazing or deer browsing, plant collecting for bonsai or other hobbies, and invasion by exotic plants such as European Buckthorn and Dog-strangling Vine.

Recent Progress

Documentation of the extent and quality of alvars through the IACI has been a major step forward, and has stimulated much greater public awareness and conservation activity for these habitats. Over the past two years, a total of 10 securement projects has resulted in protection of at least 5289.5 acres of alvars across the Great Lakes basin, with 3344.5 acres of that within the nearshore area. Most of the secured nearshore area is through land acquisition, but 56 acres on Pelee Island (ON) are through a conservation easement, and 1.5 acres on Kelleys Island (OH) are through State dedication of a nature reserve. These projects have increased the area of protected alvar dramatically in a short time.



Future Actions

Because of the large number of significant alvar communities at risk, particularly in Ontario, their status should be closely watched to ensure that they are not lost. A re-assessment of their status every 2-3 years would be appropriate. Major bi-national projects hold great promise for further progress, since alvars are a Great Lakes resource, but most of the unprotected area is within Ontario. Projects could usefully be modelled after the 1999 Manitoulin Island (ON) acquisition of 17,000 acres, which took place through a cooperative project of The Nature Conservancy of Canada, The Nature Conservancy, Federation of Ontario Naturalists, and Ontario Ministry of Natural Resources.

For Further Information

A baseline database of both nearshore and basin-wide alvar occurrences has been developed, along with an analysis report: *Status of Great Lakes Alvars 2000*. Results from the IACI are summarized in *Conserving Great Lakes Alvars* (1999), available from The Nature Conservancy Great Lakes Program Office in Chicago.

Acknowledgments

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Extent of Hardened Shoreline

SOLEC Indicator #8131

Purpose

This indicator assesses the extent of hardened shoreline through construction of sheet piling, rip rap, or other erosion control structures.

Ecosystem Objective

Shoreline conditions should be healthy to support aquatic and terrestrial plant and animal life, including the rarest species.

Anthropogenic hardening of the shorelines not only directly destroys natural features and biological communities, it also has a more subtle but still devastating impact. Many of the biological communities along the Great Lakes are dependent upon the transport of shoreline sediment by lake currents. Altering the transport of sediment disrupts the balance of accretion and erosion of materials carried along the shoreline by wave action and lake currents. The resulting loss of sediment replenishment can intensify the effects of erosion, causing ecological and economic impacts. Erosion of sand spits and other barriers allows increased exposure and loss of coastal wetlands. Dune formations can be lost or reduced due to lack of adequate nourishment of new sand to replace sand that is carried away. Increased erosion also causes property damage to shoreline properties.

State of the Ecosystem

The National Oceanic and Atmospheric Administration (NOAA) Medium Resolution digital Shorelines dataset was compiled between 1988 and 1992. It contains data on both the Canadian and U.S. shorelines, using aerial photography from 1979 for the state of Michigan and from 1987-1989 for the rest of the basin.

From this dataset, shoreline hardening has been categorized for each Lake and connecting channel. Table 1indicates the percentages of shorelines in each of these categories. The St. Clair, Detroit, and Niagara Rivers have a higher percentage of their shorelines hardened than anywhere else in the basin. Of the Lakes themselves, Lake Erie has the highest percentage of its shoreline hardened, and Lakes Huron and Superior have the lowest.

In 1999, Environment Canada assessed change in the extent of shoreline hardening along about 22 kilometers of the Canadian side of the St. Clair River from 1991-1992 to 1999. Over the 8-year period, an additional 5.5 kilometers (32 percent) of the shoreline had been hardened. This is clearly not representative of the overall basin, as the St. Clair River is a narrow shipping channel with high volumes of Great Lakes traffic. This area also has experienced significant development along its shorelines, and many property owners are hardening the shoreline to reduce the impacts of erosion.

Future Pressures on the Ecosystem

Shoreline hardening is not generally reversible, so once a section of shoreline has been hardened, it can be considered a permanent feature. As such, the current state of shoreline hardening likely represents the best condition that can be expected in the future.

Pressure will continue to harden additional stretches of shoreline, especially during periods of high lake levels. This additional hardening in turn will starve the downcurrent areas of sediment to replenish that which eroded away, causing further erosion and further incentive for additional hardening. Thus, a cycle of shoreline hardening can progress along the shoreline.

The future pressures on the ecosystem resulting from existing hardening will almost certainly continue, and additional hardening is likely in the future. The uncertainly is whether the rate can be reduced and ultimately halted. In addition to the economic costs, the ecological costs are of concern, particularly the further lost or degradation of coastal wetlands and sand dunes.

Future Actions

Shoreline hardening can be controversial, even litigious, when one property owner hardens a stretch of shoreline that may increase erosion of an adjacent property. The ecological impacts are not only difficult to quantify as a monetary equivalent, but difficult to perceive without an understanding of sediment transport along the lakeshores. The importance of the ecological process of sediment transport needs to be better understood as an incentive to reduce new shoreline hardening. An educated public is critical to ensuring wise decisions about the stewardship of the

Great Lakes basin ecosystem, and better platforms for getting understandable information to the public is needed.

Further Work Necessary

It is possible that more recent aerial photography of the shoreline will be interpreted to show more recently hardened shorelines. Once more recent data provides information on hardened areas, updates may only be necessary basinwide every 10 years, with monitoring of high-risk areas every 5 years.

Acknowledgments

Authors: John Schneider, US Environmental Protection Agency, Great Lakes National Program Office, Chicago, IL, Duane Heaton, US Environmental Protection Agency, Great Lakes National Program Office, Chicago, IL, and Harold Leadlay, Environment Canada, Environmental Emergencies Section, Downsview, ON

Lake/Connecting Channel	**70-100%** Hardened (%)	**40-70%** Hardened (%)	**15-40%** Hardened (%)	**0-15%** Hardened (%)	**Non-** structural Modifications (%)	**Unclassified** (%)	**Total** Shoreline (km)
Lake Superior	3.1	1.1	3.0	89.4	0.03	3.4	5,080
St. Marys River	2.9	1.6	7.5	81.3	1.6	5.1	707
Lake Huron	1.5	1.0	4.5	91.6	1.1	0.3	6,366
Lake Michigan	8.6	2.9	30.3	57.5	0.1	0.5	2,713
St. Clair River	69.3	24.9	2.1	3.6	0.0	0.0	100
Lake St. Clair	11.3	25.8	11.8	50.7	0.2	0.1	629
Detroit River	47.2	22.6	8.0	22.2	0.0	0.0	244
Lake Erie	20.4	11.3	16.9	49.1	1.9	0.4	1,608
Niagara River	44.3	8.8	16.7	29.3	0.0	0.9	184
Lake Ontario	10.2	6.3	18.6	57.2	0.0	7.7	1,772
St. Lawrence Seaway	12.6	9.3	17.2	54.7	0.0	6.2	2,571
All 5 Lakes	5.7	2.8	10.6	78.3	0.6	2.0	17,539
All Connecting Channels	15.4	11.5	14.0	54.4	0.3	4.4	4,436
Entire Basin	7.6	4.6	11.3	73.5	0.5	2.5	21,974

Contaminants Affecting Productivity of Bald Eagles

SOLEC Indicator #8135

Purpose

The indicator assesses the number of fledged young, number of developmental deformities, and the concentrations of organic and heavy metal contamination in bald eagle eggs, blood, and feathers. The data will be used to infer the potential for harm to other wildlife and human health through the consumption of contaminated fish.

Ecosystem Objective

This indicator supports monitoring of progress under the Great Lakes Water Quality Agreement for several of the Annexes. Under Annex 2, it will track progress under the Remedial Action Plans (RAPs) and Lakewide Management Plans (LaMPs) for several of the beneficial use impairments including effects on wildlife habitat, presence of developmental deformities, and degradation of wildlife populations. Under Annex 12, concentrations of persistent toxic substances within the tissues of a top-level predator of the Great Lakes will be tracked, and trends can be drawn. Under Annex 13, pollution from non-point sources will also be tracked since many pairs of eagles nest in areas away from point sources of pollution.

State of the Ecosystem

The Great Lakes ecosystem may be slowly recovering, based on the current measures used for the bald eagle. These are: 1) Concentrations of DDT Complex, PCB, PCDD, PCDF and other organic contaminants and mercury and other heavy metals in Bald Eagle eggs, blood, and feathers; 2) number of fledged young produced; and 3) number of developmental deformities.

Based on the first year of the Michigan Biosentinel Eagle Project, the concentrations of p,p-DDE, Total PCBs, and mercury in blood plasma and feathers of nestling bald eagles are either stable, or declining from concentrations observed in the late 1980s and early 1990s. While the majority (>95%) of egg concentrations are still greater than NOAECs for PCBs and p,p'-DDE, in a few, isolated shorelines, they have been below the NOAECs (Figures 1 and 2). No trends are apparent for the entire Great Lakes population of bald eagles in either analysis. The NOAEC concentrations for PCBs were 4.0 mg/kg and 2.7 mg/kg for p,p'-DDE.

The number of developmental deformities observed has increased over time. This may be due to the lesser importance of the egg shell thinning related to p,p-DDE as a negative impact to the ability of eagles to reproduce.

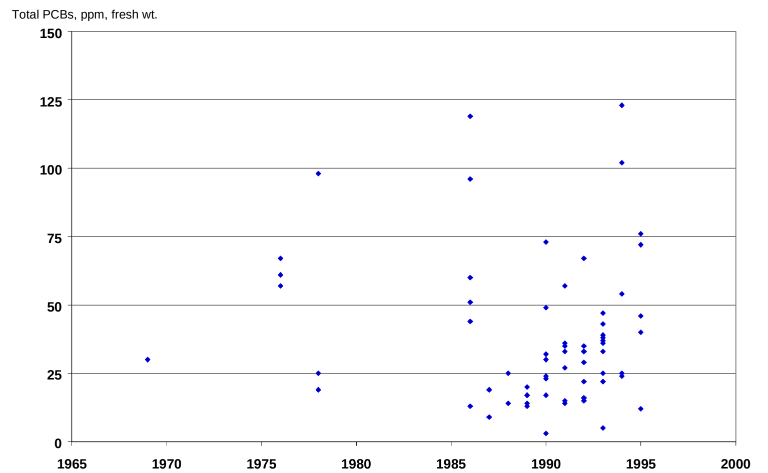

Figure 1. Concentrations of Total PCBs, mg/kg, fresh wet weight in unhatched bald eagle eggs collected from the Great Lakes, 1968-1995.
(Source: Bowerman *et al.* 1998)

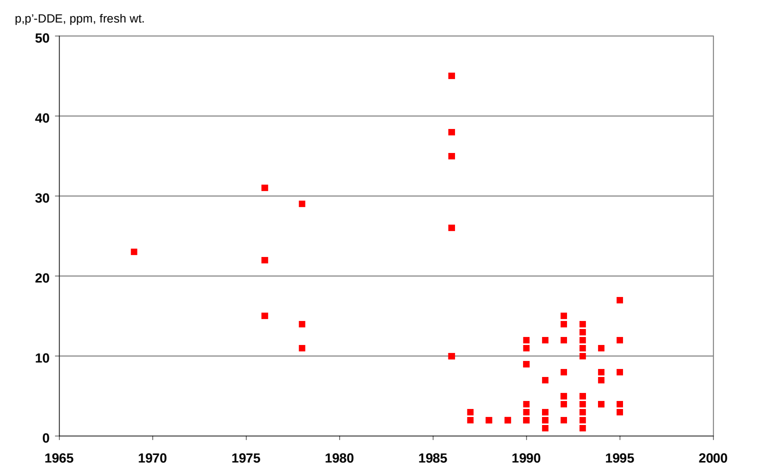

Figure 2. Concentrations of p,p'-DDE, mg/kg, fresh wet weight in unhatched bald eagle eggs collected from the Great Lakes, 1968-1995.
(Source: Bowerman *et al.* 1998).

No developmental deformities have been observed since 1995 in nestling eagles, however, the effort to visit nests along the shorelines of the Great Lakes has also declined with the state of Michigan being the sole exception.

The number of nestling eagles fledged from nests along the shorelines of the Great Lakes has steadily increased from 6 in 1977 to over 200 in 2000. Eagles nesting along Lake Erie and along the Wisconsin shoreline of Lake Superior have been consistently above the 1.0 young per occupied nest criteria for the past few years. Other areas of Lakes Superior, and the entirety of Lakes Michigan and Huron, have not attained this level. In 2000, the first record of a nesting pair of bald eagles along the shoreline of Lake Ontario was observed. One young fledged and an unhatched egg was collected by Peter Nye of New York DEC. The approximate areas of the Great Lakes shorelines that have nesting eagles is shown in Figure 3.

Future Pressures
The current and future pressures on nesting eagles of the Great Lakes ecosystem are: 1) the continued exposure, through food chain mechanisms, to environmental pollutants and their detrimental effects on reproduction; 2) other human related pressures on nesting eagles due to disturbances near nest sites; 3) in some areas of the Great Lakes, food availability plays some role in productivity; 4) loss of habitat due to development; 5) for eagles nesting above barrier dams, the potential for fish passage of contaminated Great Lakes fishes; and, 6) potential increases in mortality due to loss of protection after delisting from the U.S. Endangered Species list.

Future Activities
Progress toward elimination of sources and inputs to the lakes of persistent toxic substances would mitigate the first pressure. Management plans for nesting, roosting, and perching habitat for eagles along the lakeshores is important for mitigation of the other stressors. Education of the public on how to interact with eagles during the critical periods of their reproductive cycle, when solitude is necessary, is another, continuing means of mitigation. Use of risk assessment and environmental impact analysis is critical prior to loss of barrier dams along Great Lakes tributaries, to ensure that fish-dependent wildlife are not negatively impacted should fish passage be implemented.

Further Work Necessary
Under the Clean Michigan Initiative, Michigan DEQ has increased its surveillance and monitoring of bald eagles, to determine trends in concentrations of persistent toxic substances. Michigan, will therefore, maintain a statewide eagle survey which can also be used for a baseline for other regions of the Great Lakes. The state of Ohio and the Province of Ontario have stopped banding nestling eagles along Lake Erie in recent years,

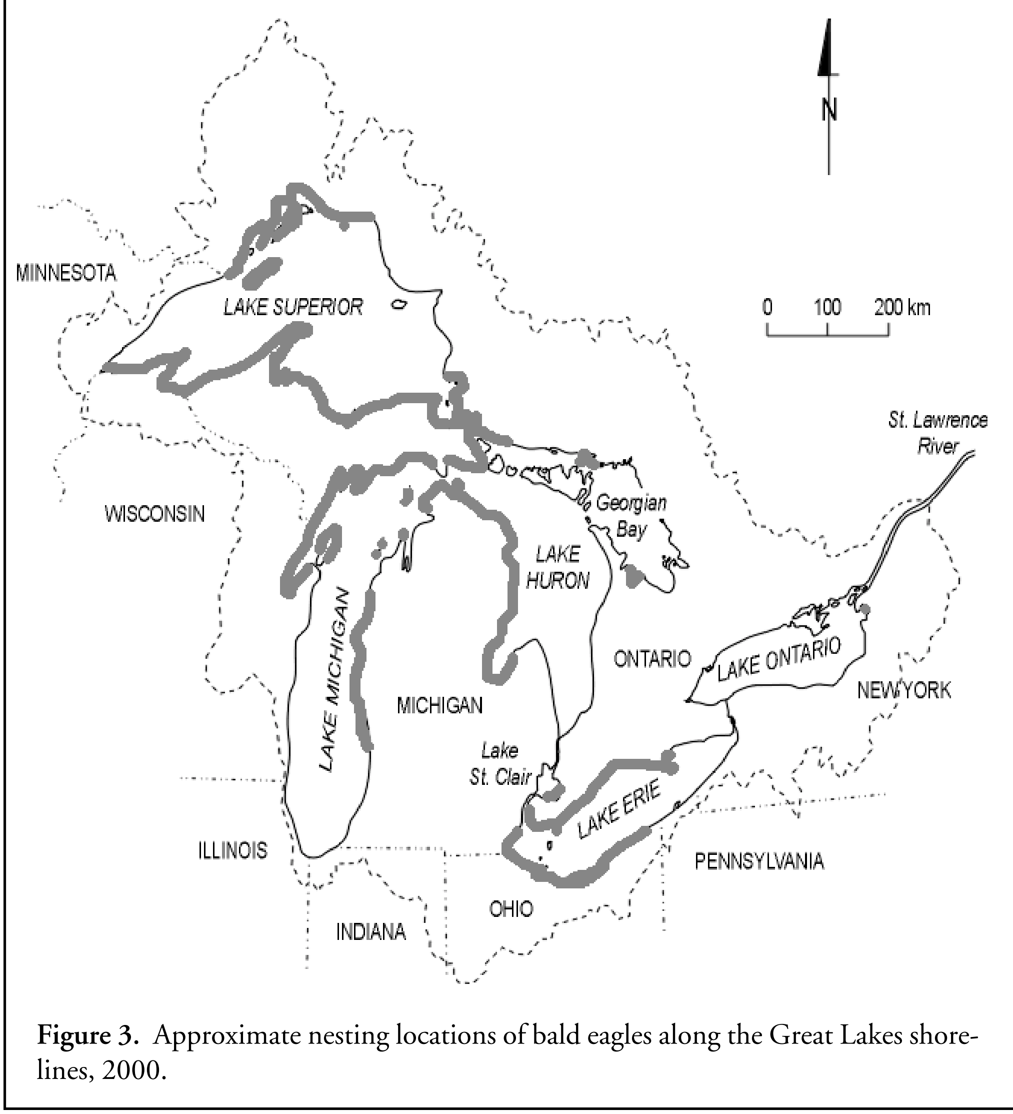

Figure 3. Approximate nesting locations of bald eagles along the Great Lakes shorelines, 2000.

but they have both maintained their eagle nesting surveys. A periodic sampling for contaminant trends should be undertaken specifically for reporting under this Indicator. To improve monitoring under this indicator we need to cover the Canadian regions of Lakes Huron and Superior better and include them in monitoring activities. Wisconsin maintains its eagle surveys and banding activities, however, decreased funding may threaten their program. A comprehensive, Basin-wide database of bald eagle nesting, contaminant, and productivity data designed for this Indicator needs to be completed. This will both improve access to data and allow for better interpretation of these data. In addition, the early 1990s survey of the entire Great Lakes shoreline to determine the amount and locations of potential nesting habitat should be repeated to document the state of this habitat and potential threats. The appropriate reporting frequency for SOLEC should be biannually.

Sources

Data for Figures 1 and 2 from Bowerman, W.W., D.A. Best, T.G. Grubb, G.M. Zimmerman, and J.P. Giesy. 1998. Trends of contaminants and effects for bald eagles of the Great Lakes Basin. Environmental Monitoring and Assessment 53(1):197-212.

Data regarding bald eagle locations (Figure 3) from Bowerman 1993, Lake Erie and Lake Superior LaMPs, and for Lake Ontario, Peter Nye, NYDEC.

Acknowledgments

Authors: William Bowerman, Clemson University, David Best, U.S. Fish & Wildlife Service, and Michael Gilbertson, International Joint Commission.

Population Monitoring and Contaminants affecting the American Otter

SOLEC Indicator #8147

Purpose

To directly measure the contaminant concentrations found in American otter populations within the Great Lakes basin and to indirectly measure the health of Great Lakes habitat, progress in Great Lakes ecosystem management, and/or concentrations of contaminants present in the Great Lakes. Importantly, as a society we have a moral responsibility to sustain healthy populations of American otter in the Great Lakes/St. Lawrence basin.

Ecosystem Objective

The importance of the American otter as a bio-sentinel is related to IJC Desired Outcomes 6: Biological Community Integrity and Diversity, and 7: Virtual Elimination of Inputs of Persistent Toxic Chemicals. Secondly, American otter populations in the upper Great Lakes should be maintained, and restored as sustainable populations in all Great Lakes coastal zones, lower Lake Michigan, western Lake Ontario, and Lake Erie watersheds and shorelines. Lastly, Great Lakes shoreline and watershed populations of American otter should have an annual mean production of > 2 young/adult female; and concentrations of heavy metal and organic contaminants should be less than the NOAEL found in tissue sample from mink as compared to otter tissue samples.

State of Great Lakes Otter

In a review of general population indices of State and Provincial otter population data indicates primary areas of population suppression still exist in western Lake Ontario watersheds, southern Lake Huron watersheds, lower Lake Michigan and most Lake Erie watersheds. Most coastal shoreline areas have more suppressed populations than interior zones and Great Lakes drainage populations.

Data provided from New York DEC and Ontario MNR suggests that otter are almost absent in western Lake Ontario. Areas of otter population suppression are directly related with human population centers and subsequent habitat loss, except for some coastal areas. Little statistically viable population data exists for the Great Lakes populations, and all suggested population levels were determined from coarse population assessment methods (see table below).

State/Province	Spatial data that includes Great Lakes drainages (method)	Visible Coastal Data	Minimum Spatial Scale	Reproductive Data	Minimum Spatial Scale Data Linked to Reproductive Data	Restoration
Minnesota	yes (registration, aerial surveys)	limited	30 mi2	yes, limited	no	no
Wisconsin	yes (registration, research)	limited	variable, Deer Management Unit	yes, mandatory, every three years	no	no
Michigan	yes (registration, research)	yes	1 mi2	yes, voluntary about 100 carcasses annually	no	no
Illinois	yes, minimal (presence/absence, surveys, model)	no	variable, watershed	yes, limited	no	recent
Indiana	yes (presence/absence, surveys, model)	no	variable, watershed	yes, limited	no	recent
Ohio	yes (presence/absence, surveys, model)	no	variable, watershed	yes, limited	no	recent
Pennsylvania	yes (minimal)	no	variable	yes, limited	no	recent
New York	yes (registration, research)	no	variable, town, county, wildlife management unit, watershed	yes (historic), limited, voluntary	no	occurring
Ontario	yes, trapper surveys	no	variable	yes, limited	no	no

Future Pressures
American otters are a direct link to organic and heavy metal concentrations in the food chain. It is a more sedentary species and subsequently synthesizes contaminants from smaller areas. Contaminants are a potential and existing problem for many otter populations on the Great Lakes. Globally indications of contaminant problems have been noted by decreased population levels, morphological abnormalities (i.e decreased baculum length) and decline in fecundity. Changes in the species population and range are also representative of anthropogenic riverine and lacustrine habitat alterations.

Future Actions
Michigan and Wisconsin have indicated a need for an independent survey using aerial survey methods to index otter populations in their respective jurisdictions. Minnesota has already started aerial population surveys for otter. Subsequently, some presence absence data may be available for Great Lakes watersheds and coastal populations. In addition, if the surveys are conducted annually the trend data may become useful.

There was agreement among resource managers on the merits of aerial surveys methods to index otter populations. The method is appropriate in areas with adequate snow cover. However, the need for habitat suitability studies in advance of such surveys is necessary prior to conducting useful aerial surveys.
New York DEC, Ohio DNR, Federal jurisdictions and Tribes on Great Lakes coasts indicated strong needs for future contaminant work on American otter.

Funding is needed by all jurisdictions to do habitat, contaminant and aerial survey work.

Further Work Necessary
All state and provincial jurisdictions use different population assessment methods making comparisons difficult. Most jurisdictions use survey methods to determine populations on a large regional scale. Most coarse methods were developed to assure that trapping is not limiting populations and that otter are adequately surviving and reproducing in their jurisdiction. There is little work done on finer spatial scales for using otter a barometer of ecosystem heath.

All State and Provincial jurisdictions only marginally index Great Lakes watershed populations by presence absence surveys, track surveys, observations, trapper surveys, population models, aerial surveys, and trapper registration data.

Michigan has the most useful spatial data that can index their Great Lakes coastal populations due to registration of trapped animals to a point of kill accuracy of 1 mi^2. However, other population measures of health such as reproductive rates, age and morphological measures are not tied to spatial data in any jurisdiction, but are pooled together for the entire areas. If carcasses are collected for necropsy the samples are usually too small to accurately define health of Great Lakes otter. Subsequently, there is a large need to encourage resource management agencies to stream line data for targeted population and contaminant research on Great Lakes otter populations, especially in coastal zones.

Acknowledgments
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