Extent, Condition and Conservation Management of Great Lakes Islands
Indicator #8129

Overall Assessment

Status:	**Mixed**
Trend:	**Undetermined**
Primary Factors Determining Status and Trend	**The Framework for Binational Conservation of Great Lakes Islands will be completed in 2007. The following results reflect detailed analysis from Canadian islands and preliminary results from the US. This project has created the first detailed binational map Great Lakes islands. This includes the identification of 31,407 island polygons with a total coastline of 15,623 km.** **This project has established baseline information that will be used to assess future trends.**

Lake-by-Lake Assessment

Lake Superior

Status:	Good
Trend:	Undetermined
Primary Factors Determining Status and Trend	Detailed analysis for Canada only. Total (Canada and US) of 2,591 island polygons. St. Mary's River has 630 island polygons. Canadian islands in Lake Superior have the lowest threats score in the basin. A high proportion of these islands are within protected areas and conservation lands. Overall condition is good. These islands include a high number of disjunct plant species.

Lake Michigan

Status:	Not Assessed
Trend:	Undetermined
Primary Factors Determining Status and Trend	Detailed analysis not completed. Total of 329 island polygons.

Lake Huron

Status:	Mixed
Trend:	Undetermined
Primary Factors Determining Status and Trend	Detailed analysis for Canada only. Total (Canada and US) of 23,719 island polygons (includes Georgian Bay). These islands tend to be more threatened in the south compared to the north. A large number of protected areas and conservation lands occur in the northern region. Southern regions are more developed, and under increasing pressures from development. These islands include high number of globally rare species and vegetation communities.

Lake Erie

Status:	Mixed
Trend:	Undetermined
Primary Factors Determining Status and Trend	Detailed analysis for Canada only. Total (Canada and US) of 1,724 island polygons. Other island polygons with Lake St. Clair/ St. Clair River (339), Detroit River (61) and Niagara River (36). These islands include a mix of protected areas and private islands. Islands in the western Lake Erie basin have some of the highest biodiversity values of all Great Lakes islands.

Lake Ontario

Status:	Mixed
Trend:	Undetermined
Primary Factors Determining Status and Trend	Detailed analysis for Canada only. Total (Canada and US) of 2,591 island polygons (including upper St. Lawrence River). Many of these islands have high threat index scores and a long history of recreational use. One of the highest building point counts. Few areas have been protected.

Purpose

•To assess the status of islands, one of the 12 special lakeshore communities identified within the nearshore terrestrial area.

Ecosystem Objective

To assess the changes in area and quality of Great Lakes islands individually, and as an ecologically important system; to infer the success of management activities; and to focus future conservation efforts toward the most ecologically significant island habitats in the Great Lakes.

State of the Ecosystem

Background

There are 31,407 islands that have been idnetified in the Great Lakes (Figure 1). The islands range in size from no bigger than a large boulder to the world's largest freshwater island, Manitoulin, and often form chains of islands known as archipelagos. Though not well known, the Great Lakes contain the world's largest freshwater island system, and are globally significant in terms of their biological diversity. Despite this, the state of our knowledge about them as a collection is quite poor.

By their very nature, islands are vulnerable and sensitive to change. Islands are exposed to the forces of erosion and accretion as water levels rise and fall. Islands are also exposed to weather events due to their 360-degree exposure to the elements across the open water. Isolated for perhaps tens of thousands of years from the mainland, islands in the past rarely gained new species, and some of their resident species evolved into endemics that differed from mainland varieties. This means that islands are especially vulnerable to the introduction of non-native species, and can only support a fraction of the number of species of a comparable mainland area.

Some of the Great Lakes islands are among the last remaining wildlands on Earth. Islands must be considered as a single irreplaceable resource and protected as a whole if the high value of this natural heritage is to be maintained. Islands play a particularly important role in the "storehouse" of Great Lakes coastal biodiversity. For example, Michigan's 600 Great Lakes islands contain one-tenth of the state's threatened, endangered, or rare species while representing only one-hundredth of the land area. All of Michigan's threatened, endangered, or rare coastal species occur at least in part on its islands. The natural features of particular importance on Great Lakes islands are colonial waterbirds, neartic-neotropical migrant songbirds, endemic plants, arctic disjuncts, endangered species, fish spawning and nursery use of associated shoals and reefs and other aquatic habitat, marshes, alvars, coastal barrier systems, sheltered embayments, nearshore bedrock mosaic, and sand dunes. New research indicates that nearshore island areas in the Ontario waters of Lake Huron account for 58% of the fish spawning and nursery habitat and thus are critically important to the Great Lakes fishery. Many of Ontario's provincially rare species and vegetation communities can be found on islands in the Great Lakes.

Pressures

By their very nature, islands are more sensitive to human influence than the mainland and need special protection to conserve their natural values. Proposals to develop islands are increasing. This is occurring before we have the scientific information about sustainable use to evaluate, prioritize, and make appropriate natural resource decisions on islands. Island stressors include development, invasive species, shoreline modification, marina and air strip development, agriculture and forestry practices, recreational use, navigation/shipping practices, wastewater discharge, mining practices, drainage or diversion systems, overpopulation of certain species such as deer, industrial discharge, development of roads or utilities, abandoned landfills, and disruption of natural disturbance regimes.

Management Implications

Based on the results of assessments of island values, biological significance, categorization, and ranking, the Binational Collaborative for the Conservation of Great Lakes Islands will soon recommend management strategies on Great Lakes islands to preserve the unique ecological features that make islands so important. In addition, based on a proposed threat assessment to be completed in 2005, the Collaborative will recommend management strategies to reduce the pressures on a set of priority island areas.

Comments from the author(s)

The Great Lakes islands provide a unique opportunity to protect a resource of global importance because many islands still remain intact. The U.S. Fish and Wildlife Service's Great Lakes Basin Ecosystem Team (GLBET) has taken on the charge of providing leadership to coordinate and improve the protection and management of the islands of the Great Lakes. The GLBET island initiative includes the coordination and compilation of island geospatial data and information, developing standardized survey/monitoring protocols, holding an island workshop in the fall of 2002 to incorporate input from partners for addressing the Great Lakes Island indicator needs, and completion of a Great Lakes Island Conservation Strategic Plan.

A subset of the GLBET formed the Binational Collaborative for the Conservation of Great Lakes Islands. Recently, the Collaborative received a habitat grant from the Environmental Protection

Agency's Great Lakes National Program Office (GLNPO) to develop a framework for the binational conservation of Great Lakes islands. With this funding, the team has developed:
1) An island biodiversity assessment and ranking system (based on a subset of biodiversity parameters) that will provide a foundation to prioritize island conservation;
2) A freshwater island classification system; and
3) A suite of indicators that can be monitored to assess change, threats, and progress towards conservation of Great Lakes islands biodiversity.

To date, the Collaborative has tentatively proposed ten state, five pressure, and two response indicators. We anticipate developing additional response indicators and may be able to incorporate existing Great Lakes response indicators. The island indicators are still being evaluated and are not final. Final selection of indicators will take place in 2005-2006, and will be based on relevance, feasibility, response variability, and interpretation and utility. The Collaborative is currently drafting the Framework for the Binational Conservation of Great Lakes Islands, which is expected to be submitted for public and peer review in the fall of 2006.

The information conveyed by a science-based suite of island indicators will help to focus attention and management efforts to best conserve these unique and globally significant Great Lakes resources.

Acknowledgments
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SOLEC 2006

Costal Environment	No. Individual Islands	No. Islands/ Complexes	Biodiversity Score		Threat Score	
			Mean	Range	Mean	Range
Georgian Bay 1	3992	595	85.2	0-345	1.3	0-65
Georgian Bay 2	17615	848	90.2	0-290	11.8	0-52
Georgian Bay 3	38	22	93.9	57-244	8.2	1-46
Georgian Bay 4	36	18	95.8	47-195	5.7	1-33
Georgian Bay 5	290	90	103.6	39-300	4.0	1-44
Georgian Bay 6	225	119	92.8	46-401	9.7	1-581
Lake Erie 1	0	0	0	0	0	0
Lake Erie 2	15	15	151.7	87-388	11.2	1-88
Lake Erie 3	2	2	92.5	91-94	1.0	1
Lake Erie 4	66	13	198.9	154-340	4.8	1-32
Lake Erie 5	2	2	90.5	87-94	2.0	1-3
Lake Erie 6	1461	30	203.4	81-333	9.7	1-41
Lake Erie 7	21	18	88.4	57-143	7.7	1-42
Lake Erie 8	17	4	144.5	96-164	2.3	1-6
Lake Huron 1	887	173	103.4	39-490	8.2	1-179
Lake Huron 2	31	19	85.0	57-137	3.4	1-22
Lake Huron 3	8	5	127.0	114-145	2.8	1-4
Lake Ontario 1	0	0	0	0	0	0
Lake Ontario 2	9	7	108.6	90-148	2.3	1-5
Lake Ontario 3	34	13	127.0	86-190	7.0	1-27
Lake Ontario 4	74	32	131.5	83-231	3.3	1-22
Lake Ontario 5	603	171	114.1	44-302	3.7	1-143
Lake Superior 1	167	117	84.6	39-290	2.2	1-25
Lake Superior 2	1228	459	81.2	37-288	2.0	1-40
Lake Superior 3	495	160	71.7	40-195	2.4	1-28
Lake Superior 4	77	28	97.2	57-253	3.3	1-26
Lake Superior 5	246	45	93.6	49-275	8.8	1-138
St. Clair 1	21	11	119.7	84-187	22.1	1-46
St. Clair 2	234	25	162.2	92-336	9.2	1-68
St. Clair 3	53	11	160.3	102-239	6.0	1-36
St. Clair 4	1	1	116	116	2	2
St. Clair 5	41	14	162.1	79-231	11.5	1-36
St. Lawrence 1	337	111	92.4	44-211	19.5	1-81

Table 1. Biodiversity and Threats Scores for Great Lakes Islands (Canada only), by coastal environment.
Source: Framework for Binational Conservation of Great Lakes Islands

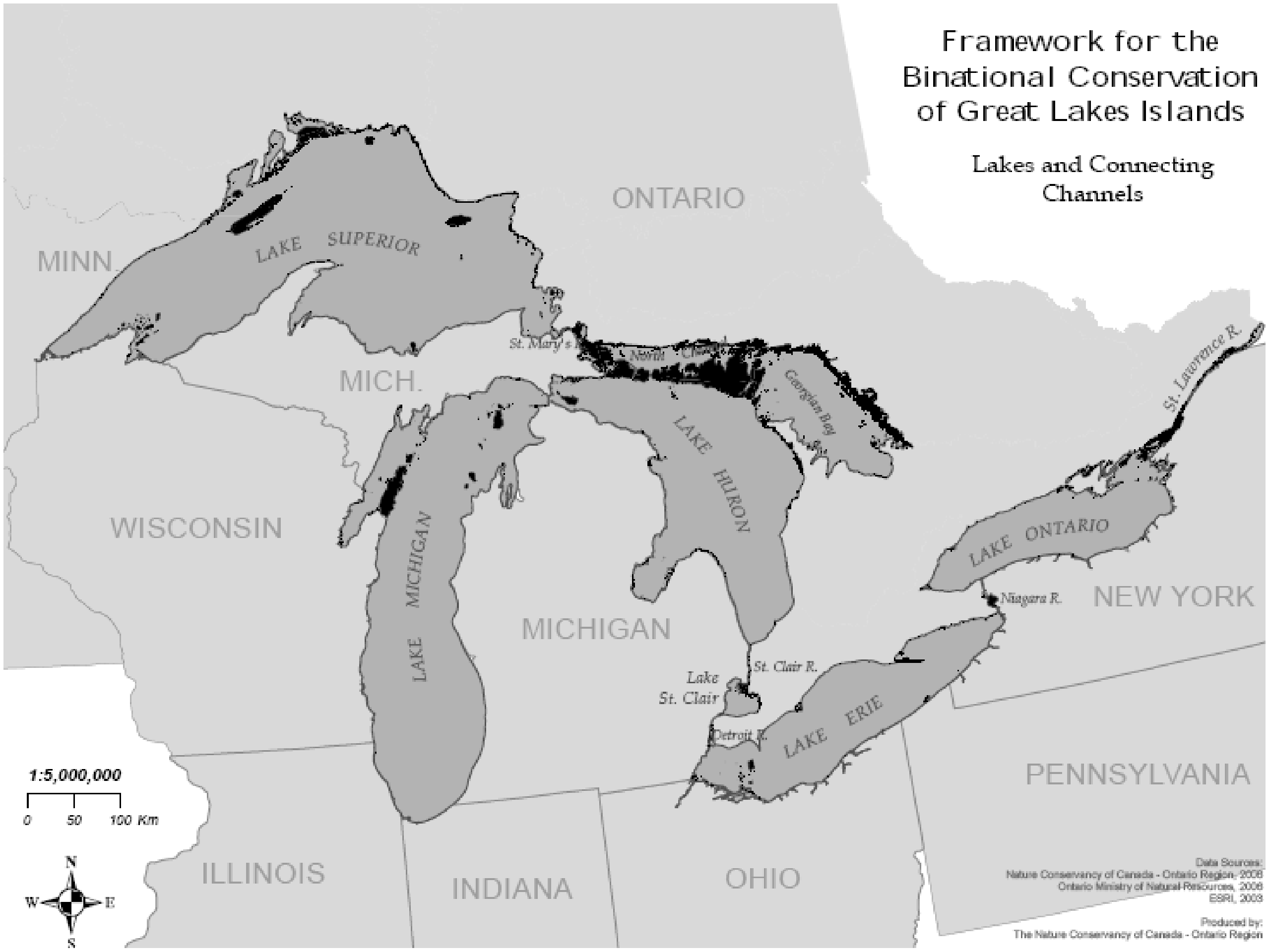

Figure 1. Islands of the Great Lakes.
Source: Framework for the Binational Conservation of Great Lakes Islands

Extent of Hardened Shoreline

Indicator #8131

Assessment: Mixed, Deteriorating

Purpose

- To assess the extent (in kilometres) of hardened shoreline along the Great Lakes through construction of sheet piling, rip rap, or other erosion control structures.

Ecosystem Objective

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

State of the Ecosystem

Background

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 of the shoreline 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.

Status of Hardened Shorelines in the Great Lakes

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 1). Figure 1 indicates 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 (Figure 2). In 1999, Environment Canada assessed change in the extent of shoreline hardening along about 22 kilometres of the Canadian shoreline of the St. Clair River from 1991-1992 to 1999. Over the eight-year period, an additional 5.5 kilometers (32%) 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.

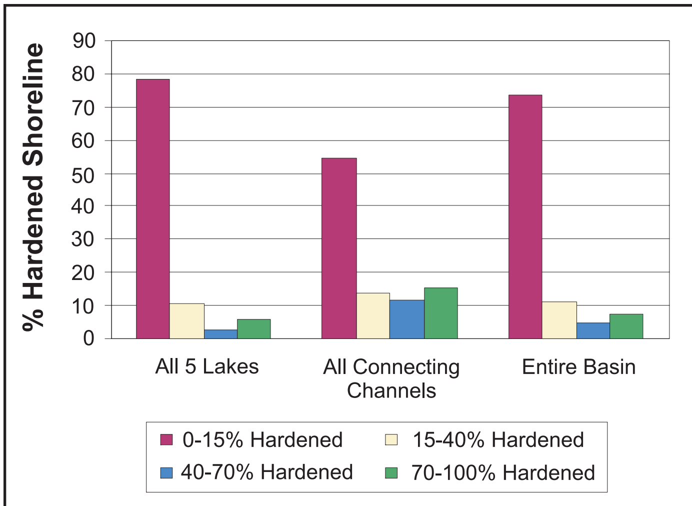

Figure 1. Shoreline hardening in the Great Lakes compiled from 1979 data for the state of Michigan and 1987-1989 data for the rest of the basin.
Source: Environment Canada and National Oceanic and Atmospheric Administration

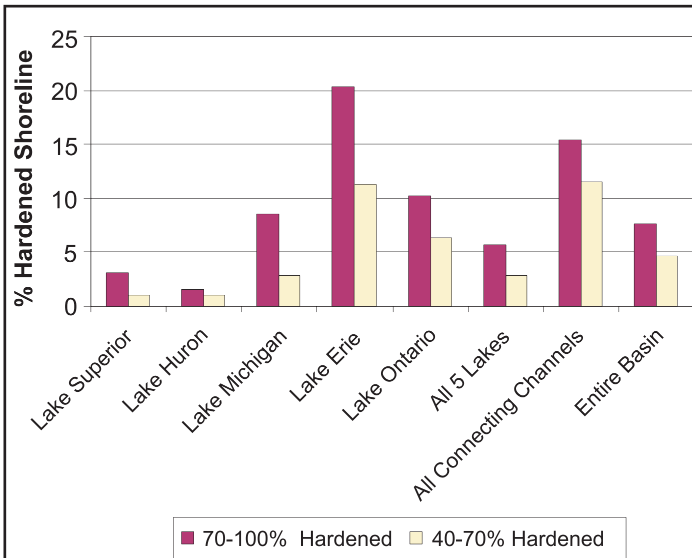

Figure 2. Shoreline hardened by lake compiled from 1979 data fro the state of Michigan and 1987-1989 for the rest of the basin.
Source: Environment Canada and National Oceanic and Atmospheric Administration

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

Table 1. Percentages of shorelines in each category of hardened shoreline. The St. Clair, Detroit and Niagara Rivers have a higher percentage of their shorelines hardened than anywhere else in the basin. Lake Erie has the highest percentage of its shoreline hardened, and Lakes Huron and Superior have the lowest.
Source: National Oceanic and Atmospheric Administration

Pressures

Shoreline hardening is generally not 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. Additional stretches of shoreline will continue to be hardened, 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 percent further lost or degradation of coastal wetlands and sand dunes.

Management Implications

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.

Acknowledgments

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Sources

The National Geophysical Data Center, National Oceanic and Atmospheric Administration (NOAA). Medium resolution digital shoreline, 1988-1992. In *Great Lakes Electronic Environmental Sensitivity Atlas*, Environment Canada, Environmental Protection Branch, Downsview, ON.

Authors' Commentary

It is possible that current 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 basin-wide every 10 years, with monitoring of high-risk areas every 5 years.

Last Updated

State of the Great Lakes 2001

Contaminants Affecting Productivity of Bald Eagles

Indicator #8135

Assessment: Mixed, Improving

Purpose

- To assess the number of territorial pairs, success rate of nesting attempts, and number of fledged young per territorial pair as well as the number of developmental deformities in young bald eagles;
- To measure concentrations of persistent organic pollutants and selected heavy metals in unhatched bald eagle eggs and in nestling blood and feathers; and
- To infer the potential for harm to other wildlife caused by eating contaminated prey items.

Ecosystem Objectives

This indicator supports annexes 2, 12, and 17 of the Great Lakes Water Quality Agreement.

State of the Ecosystem

As the top avian predator in the nearshore and tributary areas of the Great Lakes, the bald eagle integrates contaminant stresses, food availability, and the availability of relatively undeveloped habitat areas over most portions of the Great Lakes shoreline. It serves as an indicator of both habitat quantity and quality.

Figure 1. Approximate nesting locations of bald eagles (in red) along the Great Lakes shorelines, 2000.
Source: W. Bowerman, Clemson University, Lake Superior LaMPs, and for Lake Ontario, Peter Nye, and N.Y. Department of Environmental Conservation

Concentrations of organochlorine chemicals are decreasing or stable but still above No Observable Adverse Effect Concentrations (NOAECs) for the primary organic contaminants, dichlorodiphenyl-dichloroethene (DDE) and polychlorinated biphenyls (PCBs). Bald eagles are now distributed extensively along the shoreline of the Great Lakes (Figure 1). The number of active bald eagle territories has increased markedly from the depths of the population decline caused by DDE (Figure 2). Similarly, the percentage of nests producing one or more fledglings (Figure 3) and the number of young produced per territory (Figure 4) have risen. The recovery of reproductive output at the population level has followed similar patterns in each of the lakes, but the timing has differed between the various lakes. Lake Superior recovered first, followed by Erie and Huron, and most recently, Lake Michigan. An active territory has been reported from Lake Ontario. Established territories in most areas are now producing one or more young per territory indicating that the population is healthy and capable of growing. Eleven developmental deformities have been reported in bald eagles within the Great Lakes watershed; five of these were from territories potentially influenced by the Great Lakes.

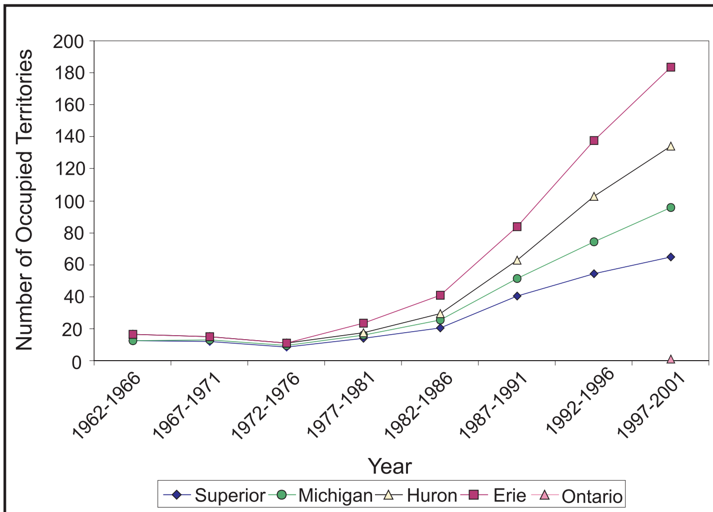

Figure 2. Average number of occupied bald eagle territories per year by lake.
Source: David Best, U.S. Fish and Wildlife Service; Pamela Martin, Canadian Wildlife Service; and Michael Meyer, Wisconsin Department of Natural Resources

Pressures

High levels of persistent contaminants in bald eagles continue to be a concern for two reasons. Eagles are relatively rare and contaminant effects on individuals can be important to the well-being of local populations. In addition, relatively large habitat units are necessary to support eagles and continued development pressures along the shorelines of the

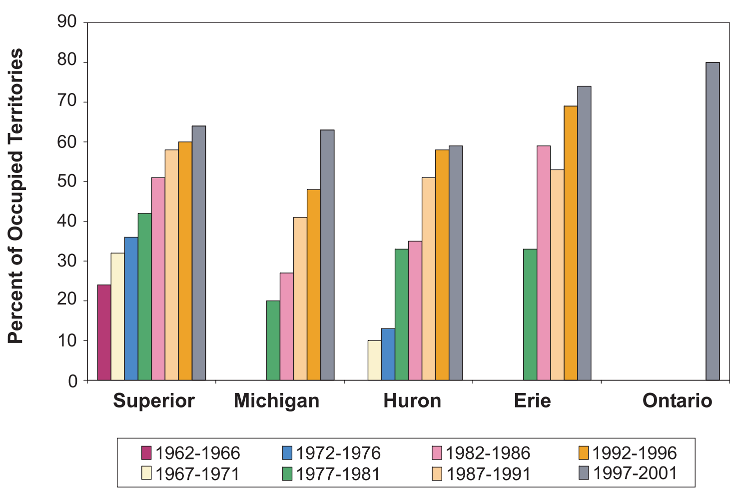

Figure 3. Average percentage of occupied territories fledging at least one young.
Source: David Best, U.S. Fish and Wildlife Service; Pamela Martin, Canadian Wildlife Service; and Michael Meyer, Wisconsin Department of Natural Resources

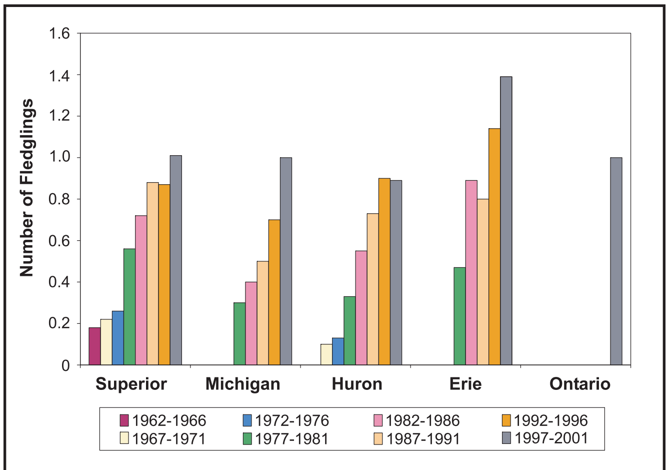

Figure 4. Average number of young fledged per occupied territory per year.
Source: David Best, U.S. Fish and Wildlife Service; Pamela Martin, Canadian Wildlife Service; and Michael Meyer, Wisconsin Department of Natural Resources

Great Lakes constitute a concern. The interactions of contaminant pressures and habitat limitations are unknown at present. There are still several large portions of the Great Lakes shoreline, particularly around Lake Ontario, where the bald eagle has not recovered to its pre-DDE status despite what appears to be adequate habitat in many areas.

Management Implications

The data on reproductive rates in the shoreline populations of Great Lakes bald eagles imply that widespread effects of persistent organic pollutants have decreased. However, there are still gaps in this pattern of reproductive recovery that should be explored and appropriate corrective actions taken. In addition, information on the genetic structure of these shoreline populations is still lacking. It is possible that further monitoring will reveal that these populations are being maintained from surplus production from inland sources rather than from the productivity of the shoreline birds themselves. Continued expansion of these populations into previously unoccupied areas is encouraging and might indicate several things; there is still suitably undeveloped habitat available, or bald eagles are adapting to increasing alteration of the available habitat.

Acknowledgments

Authors: Ken Stromborg, U.S. Fish & Wildlife Service;
David Best, U.S. Fish & Wildlife Service;
Pamela Martin, Canadian Wildlife Service; and
William Bowerman, Clemson University.

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Authors' Commentary

Monitoring the health and contaminant status of Great Lakes bald eagles should continue across the Great Lakes basin. Even though the worst effects of persistent bioaccumulative pollutants seem to have passed, the bald eagle is a prominent indicator species that integrates effects that operate at a variety of levels within the ecosystem. Symbols such as the bald eagle are valuable for communicating with the public. Many agencies continue to accomplish the work of reproductive monitoring that results in compatible data for basin-wide assessment. However, the Wisconsin Department of Natural Resources and Ohio Department of Natural Resources programs are diminished as the result of budgetary constraints, while Michigan Department of Environmental Quality, New York State Department of Environmental Conservation and Ontario Ministry of Natural Resources programs will continue for the near future. In the very near future, when the bald eagle is removed from the list of threatened species in the United States, existing monitoring efforts may be severely curtailed. Without the required field monitoring data, overall assessments of indicators like the bald eagle will be impossible. Part of the problem with a lessened emphasis on wildlife monitoring by governmental agencies is the failure of initiatives such as the State of the Lakes Ecosystem

Conference (SOLEC) process to identify and designate programs that are essential in order to ensure that data continuity is maintained. Two particular needs for additional data also exist. There is no basin-wide effort directed toward assessing habitat suitability of shoreline areas for bald eagles. Further, it is not known to what degree the shoreline populations depend on recruiting surplus young from healthy inland populations to maintain the current rate of expansion or whether shoreline populations are self-sustaining.

Last Updated
State of the Great Lakes 2005

Population Monitoring and Contaminants Affecting the American Otter

Indicator #8147

Assessment: Mixed, Trend Not Assessed

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.

Ecosystem Objective

As a society we have a moral responsibility to sustain healthy populations of American otter in the Great Lakes/St. Lawrence basin. 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. 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 in otter tissue samples should be less than the No Observable Adverse Effect Level found in tissue sample from mink. The importance of the American otter as a biosentinel is related to International Joint Commission Desired Outcomes 6: Biological Community Integrity and Diversity, and 7: Virtual Elimination of Inputs of Persistent Toxic Chemicals.

State of the Ecosystem

A review of State and Provincial otter population data indicates that primary areas of population suppression still exist in southern Lake Huron watersheds, lower Lake Michigan and most Lake Erie watersheds. Data provided from New York Department of Environmental Conservation (NYDEC) and Ontario Ministry of Natural Resources (OMNR) suggest that otter are almost absent in western Lake Ontario (Figure 1). Most coastal shoreline areas have more suppressed populations than interior zones.

Areas of otter population suppression are directly related to human population centers and subsequent habitat loss, and also to elevated contaminant concentrations associated with human activity. Little statistically-viable population data exist for the Great Lakes populations, and all suggested population levels illustrated were determined from coarse population assessment methods.

Pressures

American otters are a direct link to organic and heavy metal concentrations in the food chain. It is a relatively sedentary species and subsequently synthesizes contaminants from smaller areas than wider-ranging organisms, e.g. bald eagle. Contaminants are a potential and existing problem for many otter populations throughout the Great Lakes. Globally, indications of contaminant problems in otter 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.

Management Implications

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 the near future. In addition, if the surveys are conducted frequently, the trend data may become useful. There was agreement among resource managers on the merits of aerial survey methods to index otter populations, although these methods are only appropriate in areas with adequate snow cover. NYDEC, OMNR, Federal jurisdictions and

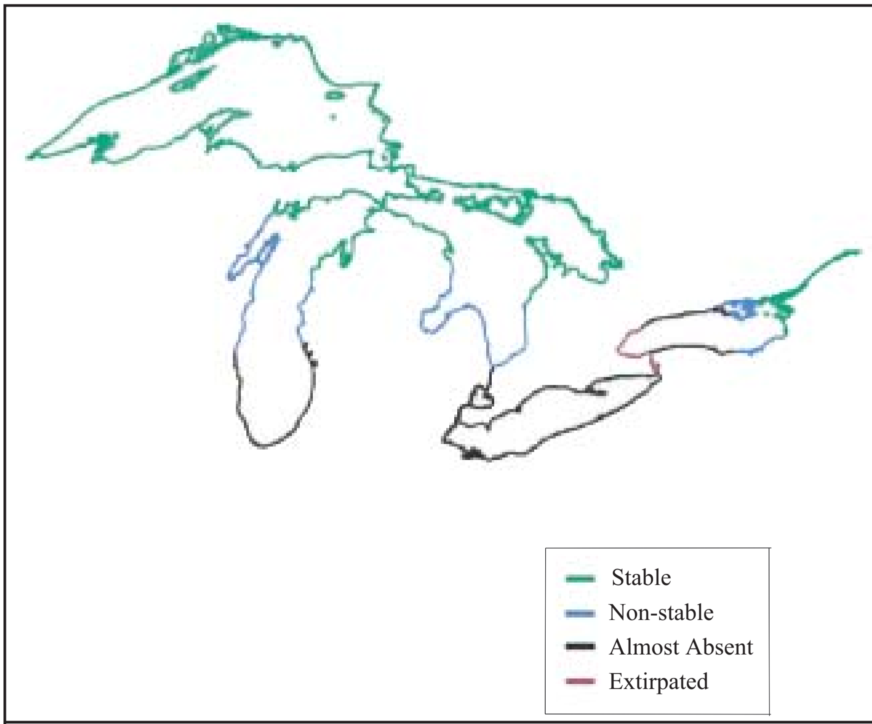

Figure 1. Great Lakes shoreline population stability estimates for the American otter.
Source: Thomas C.J. Doolittle, Bad River Band of Lake Superior Tribe of Chippewa Indians

Tribes on Great Lakes coasts indicated strong needs for future assessments of contaminants in American otter. Funding, other than from sportsmen, is needed by all jurisdictions to assess habitats and contaminant levels, and to conduct aerial surveys.

Acknowledgments
Thomas C.J. Doolittle, Bad River Band of Lake Superior Tribe of Chippewa Indians, Odanah, WI.

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Authors' Commentary
All State and Provincial jurisdictions use different population assessment methods, making comparisons difficult. Most jurisdictions use survey methods to determine populations on state- or provincial-wide scales. Most coarse population assessment methods were developed to assure that trapping was not limiting populations and that otter were simply surviving and reproducing in their jurisdiction. There was little work done on finer spatial scales using otter as an indicator of ecosystem heath.

In summary, 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 could index the largest extent of Great Lakes coastal populations due to their registration requirements. Michigan registers trapped otter to an accuracy of 1 square mile. However, other population measures of otter health, such as reproductive rates, age and morphological measures, are not tied to spatial data in any jurisdiction, but are pooled together for entire jurisdictions. If carcasses are collected for necropsy, the samples are usually too small to accurately define health of Great Lakes coastal otter verses interior populations. Subsequently, there is a large need to encourage and fund resource management agencies to streamline data for targeted population and contaminant research on Great Lakes otter populations, especially in coastal zones.

Last Updated
State of the Great Lakes 2003

Biodiversity Conservation Sites
Indicator #8164

Overall Assessment

Status:	**Not Assessed**
Trend:	**Undetermined**
Primary Factors Determining Status and Trend	Information on Biodiversity Conservation sites is limited at this time making it difficult to assess the status and trend of this indicator.

Lake-by-Lake Assessment

Lake Superior

Status:	Not Assessed
Trend:	Undetermined
Primary Factors Determining Status and Trend	Not available at this time.

Lake Michigan

Status:	Not Assessed
Trend:	Undetermined
Primary Factors Determining Status and Trend	Not available at this time.

Lake Huron

Status:	Not Assessed
Trend:	Undetermined
Primary Factors Determining Status and Trend	Not available at this time.

Lake Erie

Status:	Not Assessed
Trend:	Undetermined
Primary Factors Determining Status and Trend	Not available at this time.

Lake Ontario

Status:	Not Assessed
Trend:	Undetermined
Primary Factors Determining Status and Trend	Not available at this time.

Purpose

- To assess and monitor the biodiversity of the Great Lakes watershed.

Ecosystem Objective

The ultimate goal of this indicator is to generate and implement a distinct conservation goal for each target species, natural community type and aquatic system type within the Great Lakes basin. Through establishing the long-term survival of viable populations, the current level of biodiversity within the region can be maintained, or even increased. This indicator supports Great Lakes Quality Agreement Annexes 1, 2 and 11.

State of the Ecosystem

Background

In 1997, the Great Lakes Program of The Nature Conservancy (TNC) launched an initiative to identify high priority biodiversity conservation sites in the Great Lakes region. Working with experts from a variety of agencies, organizations, and other public and private entities throughout the region, a collection of conservation targets was identified. These targets, which represented the full range of biological diversity within the region, consisted of globally rare plant and animal species, naturally occurring community types within the ecoregion, and all aquatic system types found in the Great Lakes watershed.

In order to ensure the long-term survival of these conservation targets, two specific questions were asked: how many populations or examples of each target are necessary to ensure its long-term survival in the Great Lakes ecoregion, and how should these populations or examples be distributed in order to capture the target's genetic and ecological variability across the Great Lakes ecoregion? Using this information, which is still limited as these questions have not been satisfactorily answered in the field of conservation biology, a customized working hypothesis, i.e. conservation goal, was generated for each individual conservation target. Additionally, to effectively and efficiently achieve these conservation goals, specific portfolio sites were identified. These sites, many of which contain more than one individual target, support the most viable examples of each target, thus aiding in the preservation of the overall biodiversity within the Great Lakes region.

With support from TNC, the Nature Conservancy of Canada has undertaken a similar initiative, identifying additional targets, goals, and conservation sites within Ontario, Canada. However, as the commencement of this project occurred some time after the U.S. counterpart, there is a wide discrepancy in the information that is currently available.

Status of Biodiversity Conservation Sites in the Great Lakes Basin

Within the U.S. portion of the Great Lakes region, 208 species (51 plant species, 77 animal species and 80 bird species) were identified. Of these, 18 plant species and 28 animal species can be considered endemic (found only in the Great Lakes region) or limited (range is primarily in the Great Lakes ecoregion, but also extends into one or two other ecoregions). Furthermore, 24 animals and 14 plants found within the basin are recognized as globally imperiled. Additionally, 274 distinct natural community types are located throughout the ecoregion: 71 of which are endemic or largely limited to the Great Lakes, while 45 are globally imperiled. The Great Lakes watershed also contains 231 aquatic system types, all of which are inextricably connected to the region, and thus do not occur outside this geographical area.

A total of 501 individual portfolio sites have been designated throughout the Great Lakes region: 280 of which reside fully within the U.S., 213 are located entirely in Canada, while the remaining 8 sites cross international borders. However, there is an uneven distribution among the conservation priority sites found in the U.S., as over half are completely or partially located within the state of Michigan. New York State contains the second greatest number of sites with 56; Wisconsin, 29; Ohio, 25; and Minnesota, 20. Furthermore, 9 sites are located within the state of Illinois, 7 sites in Indiana, while only 2 sites are found in the state of Pennsylvania (11 sites cross state borders, while one international and one U.S. site cross more than one border). The sizes of the selected portfolio sites have a wide distribution, ranging from approximately 60 to 1,500,000 acres; with three-fourths of the sites having areas which are less than 20,000 acres.

The currently established conservation sites provide enough viable examples to fully meet the conservation goals for 20% of the 128 species and 274 community types described within the Great Lakes conservation vision. Additionally, under the existing Conservation Blueprint, 80% of the aquatic systems are sufficiently represented in order to meet their conservation goals. However, these figures might not present an accurate depiction of the current state of the biodiversity within the region. Due to a lack of available data for several species, communities, and aquatic systems, a generalized conservation goal, e.g. “all viable examples” was established for these targets. As such, even though the conservation goals may have been met, there might not be an adequate number of examples to ensure the long-term survival of these targets.

In order to sustain the current level of biodiversity, i.e. number of targets that have met their conservation goals, attention to the health and overall integrity of the conservation sites must be maintained. While approximately 60% of these sites are irreplaceable, these places represent the only opportunity to protect certain species, natural communities, aquatic systems, or assemblages of these targets within the Great Lakes region. Only 5% of all U.S. sites are actually fully protected. Furthermore, 79% of the Great Lakes sites require conservation attention within the next ten years, while more than one-third of the sites need immediate attention in order to protect conservation targets. These conservation actions range from changes in policies affecting land use, i.e. specific land protection measures (conservation easements or changes in ownership), to the modification of the management practices currently used.

Pressures

In the U.S., information was obtained from 224 sites regarding pressures associated with the plants, animals, and community targets within the Great Lakes basin: from this data four main threats emerged. The top threat to biodiversity sites throughout the region is currently development, i.e. urban, residential, second home, and road, as it is affecting approximately two-thirds of the sites in the form of degradation, fragmentation, or even the complete loss of these critical habitats. The second significant threat, affecting the integrity of more than half the sites, is the impact exerted by invasive species, which includes non-indigenous species such as purple loosestrife, reed canary grass, garlic mustard, buckthorn, zebra mussels, and exotic fishes, as well as high-impact, invasive, native species such as deer. Affecting almost half of the U.S. sites, hydrology alteration, the third most common threat to native biodiversity, includes threats due to dams, diversions, dikes, groundwater withdrawals, and other changes to the natural flow regime.

Finally, recreation (boating, camping, biking, hiking, etc.) is a major threat that affects over 40% of the sites.

Management Implications

A continuous effort to obtain pertinent information is essential in order to maintain the most scientifically-based conservation goals and strategies for each target species, community and aquatic system type within the Great Lakes basin. Additional inventories are also needed in many areas to further assess the location, distribution and viability of individual targets, especially those that are more common throughout the region. Furthermore, even though current monitoring efforts and conservation actions are being implemented throughout the watershed, they are generally site-specific or locally concentrated. A greater emphasis on a regional-wide approach must be undertaken if the long-term survival of these metapopulations is to be ensured. This expanded perspective would also assist in establishing region-wide communications, thus enabling a more rapid and greater distribution of information. However, the establishment of basin-wide management practices is greatly hindered by the numerous governments represented throughout this region, (two federal governments, 100 tribal authorities, one province, and eight states (each with multiply agencies), 13 regional and 18 county municipalities in Ontario, 192 counties in the US and thousands of local governments) and the array of land-use policies developed by each administrations. Without additional land protection measures, it will be difficult to preserve the current sites and implement restoration efforts in order to meet the conservation goals for the individual conservation targets.

Acknowledgments

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Data Sources

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List of Figures

Last updated

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Figure 1. Map of Biodiversity Conservation Sites within the Great Lakes Region.
http://www.nature.org/wherewework/northamerica/greatlakes/files/tnc_great_lakes_web.pdf

Forest Lands - Conservation of Biological Diversity
Indicator #8500

Note: This indicator includes four components that correspond to Montreal Process Criterion #1, Indicators 1, 2, 3, and 5.

Indicator #8500 Components:

Component (1) – Extent of area by forest type relative to total forest area
Component (2) – Extent of area by forest type and by age-class or successional stage
Component (3) – Extent of area by forest type in protected area categories
Component (4) – Extent of forest land conversion, parcelization, and fragmentation (Still under development for future analysis; data not presented in this report)

Overall Assessment

Status: **Mixed**
Trend: **Undetermined**
Primary Factors Determining Status and Trend: **There is a moderate distribution of forest types in the Great Lakes basin by age-class and seral stage. Additional analysis is required by forestry professionals.**

Lake-by-Lake Assessment

Lake Superior

Status: Not Assessed
Trend: Undetermined
Primary Factors Determining Status and Trend: Data by individual lake basin was not available for the U.S. at this time.

Lake Michigan

Status: Not Assessed
Trend: Undetermined
Primary Factors Determining Status and Trend: Data by individual lake basin was not available for the U.S. at this time.

Lake Huron

Status: Not Assessed
Trend: Undetermined
Primary Factors Determining Status and Trend: Data by individual lake basin was not available for the U.S. at this time.

Lake Erie

Status: Not Assessed
Trend: Undetermined
Primary Factors Determining: Data by individual lake basin was not available for the U.S. at this time.

Status and Trend

Lake Ontario

Status:	Not Assessed
Trend:	Undetermined
Primary Factors Determining Status and Trend	Data by individual lake basin was not available for the U.S. at this time.

Purpose

•To describe the extent, composition and structure of Great Lakes basin forests; and
•To address the capacity of forests to perform the hydrologic functions and host the organisms and essential processes that are essential to protecting the biological diversity, physical integrity and water quality of the watershed.

Ecosystem Objective

To have a forest composition and structure that most efficiently conserves the natural biological diversity of the region

State of the Ecosystem

Component (1):

Forests cover over half (61%), of the land in the Great Lakes basin. The U.S. portion of the basin has forest coverage on 54% of its land, while the Canadian portion has coverage on 73% of its land.

In the U.S. portion of the basin, maple-beech-birch is the most extensive forest type, representing 7.8 million hectares, or 39% of total forest area in the basin. Aspen-birch forests constitute the second-largest forest type, covering 19% of the total. Complete data are available in Table 1 and are visually represented in Figure 1.

The entire Canadian portion of the basin is dominated by mixed forest, representing 39% of the total forest area, followed by hardwoods, covering 23% of the total forest area analyzed from satellite data, (see Table 2A). The most extensive provincial forest type is the upland mixed conifer, representing 23% of the forested area available for analysis, followed by the mixedwoods, tolerant hardwoods, white birch, and poplars, (see Figure 2 and Table 2B).

Implications for the health of Great Lakes forests and the basin ecosystem are difficult to establish. There is no consensus on how much land in the basin should be forested; much less on how much land should be covered by each forest type. Generally speaking, maintenance of the variety of forest types is important in species preservation, and long-term changes in forest type proportions are indicative of changes in forest biodiversity patterns, (OMNR 2002).

Comparisons to historical forest cover, although of limited utility in developing landscape goals, can illustrate the range of variation experienced within the basin since the time of European settlement. (See supplemental section entitled "Historical Range of Variation in the Great Lakes Forests of Minnesota, Wisconsin and Michigan" in the State of the Great Lakes 2005 version of this indicator report, #8500, for more information). Analysis of similar historical forest cover data for the entire Great Lakes Basin over the past several years would be useful in establishing current trends to help assess potential changes to ecosystem function and community diversity.

Component (2):
In the U.S. portion of the basin, the 41-60 and 61-80 year age-classes are dominant and together represent about 41% of total forest area. Forests 40 years of age and under make up a further 30%, while those in the 100+ year age-classes constitute 7% of total forest area. Table 3 contains complete U.S. data for age-class distribution as a percentage of forested area within each forest type.

Because forests are dynamic and different tree species have different growth patterns, age distribution varies by forest type. In the U.S. portion of the basin, aspen-birch forests tend to be younger, being more concentrated than other forest types in age classes under 40 years, while the Oak-Pine forests are more concentrated in the 41-60 and 61-80 year age classes, comparatively. Spruce-fir and Oak-Hickory forests have a general distribution centered around 41-80 years, but also have the highest amount of oldest trees, representing about 10% each of total forest area in the 100+ year age class, (see Figure 3).

This age-class data can serve as a coarse surrogate for the vegetative structure (height and diameter) of a forest, and can be combined with data from other indicators to provide insight on forest sustainability.

U.S data on the extent of forest area by successional or seral stage is not available. Although certain tree species can be associated with the various successional stages, a standard and quantifiable protocol for identifying successional stage has not yet been developed. It is expected, however, that in the absence of disturbance, the area covered by early-successional forest types, such as aspen-birch, is likely to decline as forests convert to late-successional types, such as maple-beech-birch.

Canadian forest data for this component is available by seral stage. Ontario's forests have a distribution leaning towards mature stages, representing about 50% of the total forest area analyzed. Forests in the immature stage make up the next largest group with 20% of the total, followed by those in late successional with 14%. Every Canadian forest type distribution follows this general trend except for jack pine. Complete available data for Ontario can be viewed in Table 4 and is visually represented in Figure 4.

Although the implications of this age-class and seral stage data for forest and basin health overall are unclear, some conclusions can be made. In general, water quality is most affected during the early successional stages after a disturbance to forest habitats. Nutrient levels in streams can increase during these times until the surrounding forest is able to mature, (Swank *et. al* 2000). The trend towards mature forests in Canada would therefore mean that area of the Great Lakes basin has improved water quality. Alternately, forests with balanced forest type distributions and diverse successional stages are generally considered more sustainable, (USDA Forest Service *et. al* 2003). The combined effect on ecosystem health resulting from the balance of these opposing forces would need to be determined.

Component (3):
In the U.S. basin, 7.8% of forested land is in a protected area category. Among major forest types, 8.9% of maple-beech-birch, 6.6% of aspen-birch and 9.2% of spruce-fir forests are considered to have protected status. The oak-gum-cypress category has the highest protection rate, with 19.2% of its forest area protected from harvest. Please refer to Table 1 for complete U.S. data.

In the entire Canadian portion of the basin, 10.6% of forest area, or 1.6 million hectares, are protected, (see Table 2A). For the region of Ontario that has available forest type data, protection rates range from 15.4% for red and white pine and 11% for white birch, to 6.4% for poplar and 5.7% for mixed conifer lowland forests, (see Table 2B).

It is difficult to assess the implications of the extent of protected forest area, since there is no consensus on what the actual proportion should be. National forest protection rates are estimated to be 8.4% in Canada (WWF 1999) and 14% in the U.S. (USDA Forest Service 2004). Despite the fact that updated trend data for protected status is not available at this time for the Great Lakes basin, earlier analyses have shown a recent general increase in protected areas, (see 2005 version of this report).

As for the range of variation in protection rates by forest types, protected areas should be representative of the diversity in forest composition within a larger area. However, defining what constitutes this "larger area" is problematic. Policymakers often have a different jurisdiction than the Great Lakes basin in mind when deciding where to locate protected areas. Also, the tree species and forest types found on an individual plot of protected land can change over time due to successional processes.

Differences among the U.S., Canadian and International Union for the Conservation of Nature (IUCN) definitions of protected areas should also be noted. The IUCN standard contains six categories of protected areas – strict nature reserves/wilderness areas, national parks, natural monuments, habitat/species management areas, protected landscapes/seascapes, and managed resource protection areas. The U.S. defines protected areas as forests "reserved from harvest by law or administrative regulation," including designated Federal Wilderness areas, National Parks and Lakeshores, and state designated areas (Smith 2004). Ontario defines protected areas as national parks, conservation reserves, and its six classes of provincial parks – wilderness, natural environment, waterway, nature reserve, historical and recreational (OMNR 2002). There is substantial overlap among the specific U.S., Ontario and IUCN definitions, and a more consistent classification system would ensure proper accounting of protected areas.

Common to the U.S., Ontario and IUCN definitions is that they only include forests in the public domain. However, there are privately-owned forests similarly reserved from harvest by land trusts, conservation easements and other initiatives. Inclusion of these forests under this indicator would provide a more complete definition of protected forest areas.

Moreover, there is debate on how protected status relates to forest sustainability, water quality, and ecosystem health. In many cases, protected status was conferred onto forests for their scenic or recreational value, which may not contribute significantly to conservation or watershed management goals. On the other hand, forests available for harvest, whether controlled by the national forest system, state or local governments, tribal governments, industry or private landowners, can be managed with the stated purpose of conserving forest and basin health through the implementation of Best Management Practices and certification under sustainable forestry programs. (For more information, refer to Indicator #8503, Forest Lands – Conservation and Maintenance of Soil and Water Resources).

Component (4):
This component is still under development, as consensus still has not been reached on definitions of forest fragmentation metrics and which ones are therefore suitable for SOLEC reporting. The proposed structure is split into the forces that drive fragmentation, (land conversion and parcelization,) and a series of forest spatial pattern descriptions based off of (as yet to be agreed upon) fragmentation metrics.

Conversion of forest land to other land-use classes is considered to be a major cause of fragmentation. Proposed metrics to describe this include the percent of forest lands converted to and from developed, agricultural, and pasture land uses. Both Canadian and U.S. data are available and can be obtained from the Ontario Ministry of Natural Resources and the USDA Natural Resources Conservation Service, Natural Resources Inventory, respectively.

Parcelization of forest lands into smaller privately owned tracks of land can lead to a disruption of continuous ecosystems and habitats and therefore increased fragmentation. A proposed metric is the average size of land holdings. Canada does not have available data for this metric, while the U.S. data should be available through the USDA Forest Service, Forest Inventory and Analysis Program and the National Woodland Owner Survey.

Data for various fragmentation metrics exists for both Canada and the U.S, but the way these metrics are viewed is drastically different. According to sources that have compiled U.S. data, fragmentation, "is viewed as a property of the landscape that contains forest… [as opposed to] a property of the forest itself," (Riitters *et. al* 2002). That inconsistency aside, data exists for Ontario for the following metrics: area, patch density and size, edge, shape, diversity and interspersion, and core area. U.S. data exists for patchiness, perforation, connectivity, edge, and interior or core forest, and is available from the USDA Forest Service and is also being compiled by the U.S. EPA. Substantial discussion is still required to refine these metrics before reporting and analysis of this component can continue.

Pressures
Urbanization, seasonal home construction and increased recreational use, (driven in part by the desire of an aging and more affluent population to spend time near natural settings,) are among the general demands being placed on forest resources nationwide.

Additional disturbances caused by lumber removal and forest fires can also alter the structure of Great Lakes basin forests.

Management Implications
Increased communication and agreement regarding the definitions and reporting methods for forest type, successional stage, protected area category and fragmentation metrics between the United States and Canada would facilitate more effective basin-wide analyses.

Reporting of U.S. forest data according to watershed as opposed to county would enable analysis by individual lake basin, therefore increasing the data's value in relation to specific water quality and biodiversity objectives.

Canadian data by forest type and seral stage for the entire Great Lakes basin in Ontario as opposed to just the Area of the Undertaking (AOU), (see definition below in *Comments* section,) would allow for a more complete analysis. This can only be accomplished if managers decide to extent forest planning inventories into the private lands in the southern regions of the province.

Managing forest lands in ways that protect the continuity of forest cover can allow for habitat protection and wildlife species mobility, therefore maintaining natural biodiversity.

Comments from the author(s)
Stakeholder discussion will be critical in identifying pressures and management implications, particularly those on a localized basis, that are specific to Great Lakes basin forests. These discussions will add to longstanding debates on strategies for sustainable forest management.

There are significant discrepancies within and between Canadian and U.S. data that made it difficult to analyze the data across the Great Lakes basin as a whole. The most pervasive problems are related to the time frame, frequency and location of forest inventories and differences in metric definitions.

Canadian Great Lakes data for provincial forest type and seral stage is only available in areas of Ontario where Forest Resources Planning Inventories occur. This region is commonly referred to as the Area of the Undertaking (AOU) and only represents about 72% of Ontario's total Great Lakes basin land area. The remainder of Ontario's forests (and therefore Ontario as a whole) can only be analyzed using satellite data, which is meant for general land use/land cover analysis and does not have a fine enough resolution to allow for more detailed investigation.

Forest inventory time frames for the U.S. also have an effect on data consistency. Although the 2002 RPA assessment was used as the data source for the U.S. portion of this report, it actually draws data from a compilation of numerous state inventory years as follows: Illinois (1998), Indiana (1998), Michigan (1993), Minnesota (1990), New York (1993), Ohio (1993), Pennsylvania (1989), and Wisconsin (1996). A re-analysis of U.S. Great Lakes basin forests with data from the same time frame would be useful.

Also, the U.S. data provided for this report was compiled by county and not by watershed, so the area of land analyzed is not necessarily completely within the Great Lakes basin and all related values are therefore skewed. This factor also made it impossible to represent the data by individual lake basin. Additional GIS analysis of the raw inventory data would be required to provide forest data by watershed.

Definition of forest type differs between the U.S. and Canada as well. In the U.S., forest cover type is done according to the predominant tree species and is divided into the nine major groups represented in this report. The Canadian provincial forest type classifications, (for which data was available for this report,) however, are based on a combination of ecological factors including dominant tree species, understory vegetation, soil, and associated tree species, (OMNR 2002). The definitions of each provincial forest type are available in Table 5. Standardization of forest type definitions between the U.S. and Ontario would be necessary for analysis across the entire Great Lakes basin.

As previously mentioned earlier in this report, the forest fragmentation component of this indicator needs additional refining before it can be included for analysis.

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Authors: This report was updated by Chiara Zuccarino-Crowe, Environmental Careers Organization, on appointment to U.S. Environmental Protection Agency (US EPA), Great Lakes National Program Office (GLNPO), zuccarino-crowe.chiara@epa.gov from the State of the Great Lakes 2005 Indicator report #8500 written and prepared by associate Mervyn Han, Environmental Careers Organization, on appointment to US EPA, GLNPO. (Available online at, http://binational.net/solec/sogl2005_e.html)

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Support in the preparation of this report was given by the members of the SOLEC Forest Land Criteria and Indicators Working Group. The following members aided in the development of SOLEC Forest Lands indicators, collection, reporting and analysis of data, and the review and editing of the text of this report:

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Figure 3. Age-class distribution as a percentage of forested area within forest type for U.S. Great Lakes basin counties
Source: USDA Forest Service, Forest Inventory and Analysis National Program, 2002 Resource Planning Act (RPA) Assessment Database

Figure 4. Seral stage distribution as a percentage of forested area within provincial forest type in AOU* portion of Canadian Great Lakes Basin
Caption: * The Area of the Undertaking (AOU) land area represents 72% of total land area analyzed in Ontario's portion of the Great Lakes basin.
Source: Ontario Ministry of Natural Resources, Forest Standards and Evaluation Section. Landsat Data based on Landcover 2002 (Landsat 7) classified imagery, Inventory data based on Forest Resources Planning Inventories, and NRVIS coverages

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Forest Type	Area (ha)	% of Total Forest Area	Protected Area (ha)	% Protected
White-Red-Jack Pine	1,791,671	8.87%	168,737	9.42%
Spruce-Fir	2,866,777	14.19%	263,216	9.18%
Loblolly-Shortleaf Pine	4,305	0.02%	0	0.00%
Oak-Pine	72,675	0.36%	4,178	5.75%
Oak-Hickory	1,988,126	9.84%	129,431	6.51%
Oak-Gum-Cypress	50,589	0.25%	9,730	19.23%
Elm-Ash-Cottonwood	1,692,069	8.37%	45,564	2.69%
Maple-Beech-Birch	7,828,700	38.75%	692,600	8.85%
Aspen-Birch	3,821,272	18.91%	252,443	6.61%
Nonstocked	88,443	0.44%	4,677	5.29%
Totals	**20,204,626**		**1,570,576**	**7.77%**

Table 1. Total forest area and protected area by forest type in U.S. Great Lakes basin counties
Caption: Non-stocked =
timberland less than 10% stocked with live trees
Source: USDA Forest Service, Forest Inventory and Analysis National Program, 2002 Resource Planning Act (RPA) Assessment Database

A) Canadian Great Lakes Basin				
Satellite Classes	**Area (ha)**	**% of Total Forest Area**	**Protected Area (ha)**	**% Protected**
Forest - Sparse	2,053,869	13.78%	245,118	11.93%
Forest - Hardwood	3,468,513	23.27%	361,147	10.41%
Forest - Mixed	5,750,313	38.57%	649,342	11.29%
Forest - Softwood	2,407,729	16.15%	268,753	11.16%
Swamp - Treed	49,933	0.33%	1,413	2.83%
Fen - Treed	30,197	0.20%	3,726	12.34%
Bog - Treed	436,083	2.93%	28,128	6.45%
Disturbed Forest - cuts	578,450	3.88%	8,973	1.55%
Disturbed Forest - burns	97,545	0.65%	18,628	19.10%
Disturbed Forest - regenerating	35,987	0.24%	381	1.06%
Totals	**14,908,617**		**1,585,608**	**10.64%**

B) AOU* Portion of Ontario				
Provincial Forest Type	**Area (ha)**	**% of Total Forest Area**	**Protected Area (ha)**	**% Protected**
White Birch	1,593,114	13.73%	175,261	11.00%
Mixed Conifer Lowland	1,048,126	9.03%	60,192	5.74%
Mixed Conifer Upland	2,657,086	22.90%	239,194	9.00%
Mixedwood	2,099,760	18.10%	194,682	9.27%
Jack Pine	714,165	6.15%	54,991	7.70%
Poplar	1,189,573	10.25%	75,538	6.35%
Red & White Pine	685,124	5.90%	105,682	15.43%
Tolerant Hardwoods	1,616,502	13.93%	108,993	6.74%
Totals	**11,603,450**		**1,014,533**	**8.74%**

Table 2. Total forest area and protected area by forest type in, A) Canadian Great Lakes basin, B) AOU* portion of Ontario

Caption: * The Area of the Undertaking (AOU) land area represents 72% of the total land area analyzed in Ontario's portion of the Great Lakes basin.

Source: Ontario Ministry of Natural Resources, Forest Standards and Evaluation Section. Landsat Data based on Landcover 2002 (Landsat 7) classified imagery, Inventory data based on Forest Resources Planning Inventories, and NRVIS coverages

Forest Type	Age Class (in years)							
	0-20	21-40	41-60	61-80	81-100	100+	Mixed	not measured
White-Red-Jack Pine	13.86%	27.04%	25.41%	11.63%	7.47%	4.32%	2.40%	7.87%
Spruce-Fir	8.84%	18.55%	21.84%	17.96%	9.57%	10.23%	0.33%	12.69%
Loblolly-Shortleaf Pine	0.00%	47.96%	0.00%	52.04%	0.00%	0.00%	0.00%	0.00%
Oak-Pine	7.08%	14.58%	47.30%	18.29%	3.02%	6.49%	3.18%	0.07%
Oak-Hickory	9.43%	10.13%	18.14%	21.49%	14.14%	10.06%	11.38%	5.22%
Oak-Gum-Cypress	4.47%	36.37%	19.84%	8.75%	4.08%	0.00%	5.73%	20.76%
Elm-Ash-Cottonwood	14.03%	24.29%	23.21%	15.95%	8.58%	6.17%	5.21%	2.56%
Maple-Beech-Birch	9.25%	12.38%	21.96%	20.87%	12.31%	8.75%	6.21%	8.27%
Aspen-Birch	25.40%	19.91%	26.15%	16.64%	3.85%	1.36%	0.45%	6.25%
Nonstocked	63.98%	16.73%	2.97%	1.71%	0.00%	1.14%	0.00%	13.47%
Total	**13.29%**	**16.85%**	**22.77%**	**18.37%**	**9.65%**	**7.02%**	**4.33%**	**7.72%**

Table 3. Age-class distribution as a percentage of area within forest type for U.S. Great Lakes basin counties
Caption: Non-stocked = timberland less than 10% stocked with live trees
Source: USDA Forest Service, Forest Inventory and Analysis National Program, 2002 Resource Planning Act (RPA) Assessment Database

Provincial Forest Type	Seral Stage				
	Presapling	Sapling	Immature	Mature	Late Successional
White Birch	3.49%	4.52%	15.55%	63.58%	12.87%
Mixed Conifer Lowland	13.81%	9.31%	13.38%	47.00%	16.50%
Mixed Conifer Upland	5.91%	13.12%	22.51%	42.11%	16.36%
Mixedwood	4.60%	7.92%	26.06%	51.03%	10.39%
Jack Pine	8.60%	31.96%	29.24%	27.51%	2.69%
Poplar	6.60%	10.45%	18.97%	52.55%	11.43%
Red & White Pine	4.94%	3.77%	23.28%	62.95%	5.06%
Tolerant Hardwoods	1.23%	0.87%	6.40%	60.13%	31.37%
Totals	**6.00%**	**10.14%**	**20.12%**	**49.84%**	**13.91%**

Table 4. Seral stage distribution as a percentage of area within provincial forest type in AOU* portion of Canadian Great Lakes Basin
Caption: * The Area of the Undertaking (AOU) land area represents 72% of the total land area analyzed in Ontario's portion of the Great Lakes basin.

Source: Ontario Ministry of Natural Resources, Forest Standards and Evaluation Section. Landsat Data based on Landcover 2002 (Landsat 7) classified imagery, Inventory data based on Forest Resources Planning Inventories, and NRVIS coverages

Provicial Forest Type	Description
White Birch	predominantly white birch stands
Upland Conifers	predominantly spruce and mixed jack pine/spruce stands on upland sites
Lowland Conifers	predominantly black spruce stands on low, poorly drained sites
Mixedwood	mixed stands made up mostly of spruce, jack pine, fir, poplar and white birch
Jack Pine	predominantly jack pine stands
Poplar	predominantly poplar stands
White and Red Pine	all red and white pine mixedwood stands
Tolerant Hardwoods	predominantly hardwoods such as maple and oak, found mostly in the Great Lakes forest region

Table 5. Description of Canadian provincial forest types
Source: Descriptions taken from, *Forest Resources of Ontario 2001: State of the Forest Report, Appendix 1*, p. 41, (OMNR 2002).

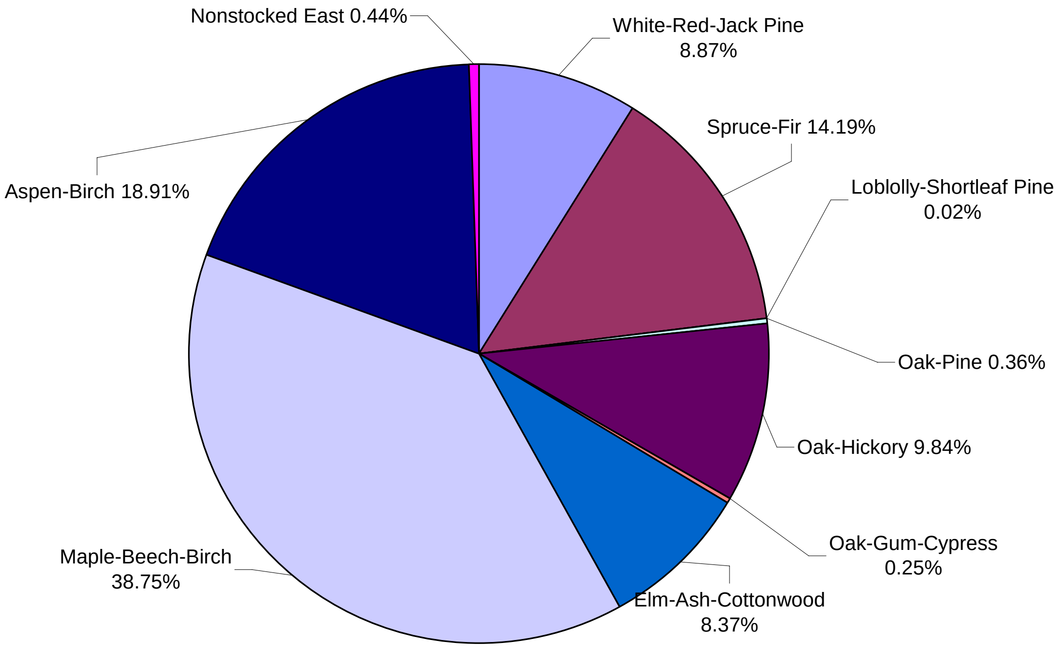
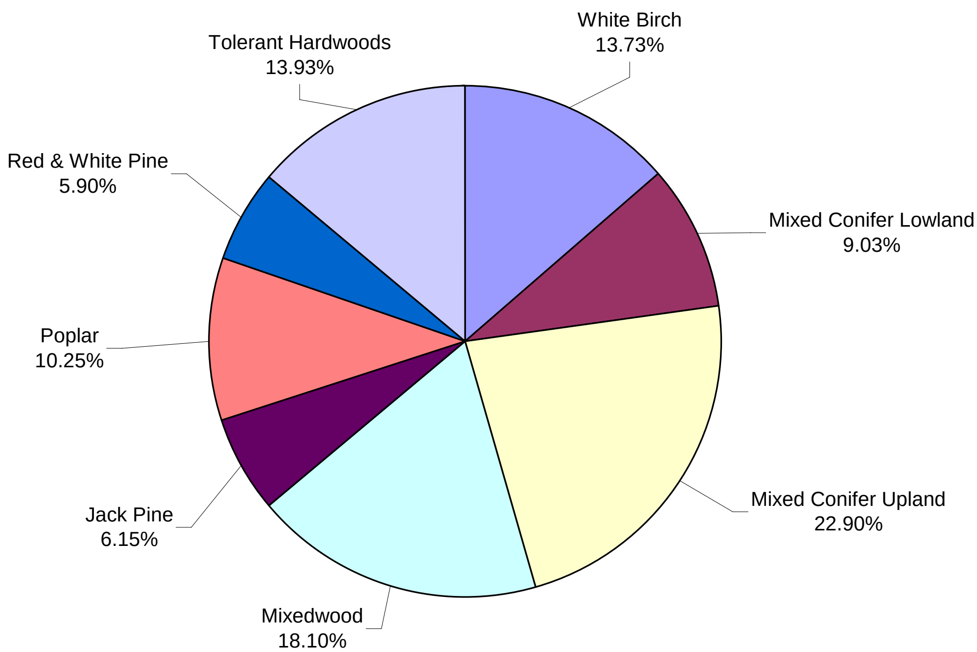


Figure 1. Proportion of forested area by forest type in U.S. Great Lakes basin
Source: USDA Forest Service, Forest Inventory and Analysis National Program, 2002 Resource Planning Act (RPA) Assessment Database



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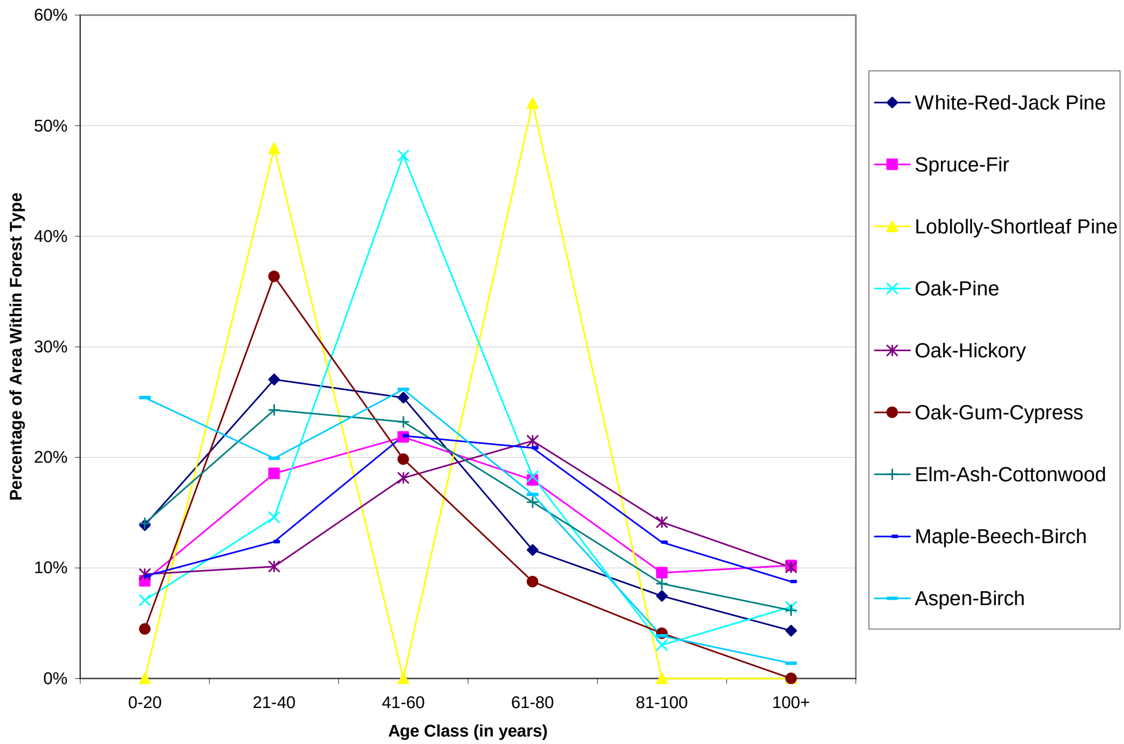

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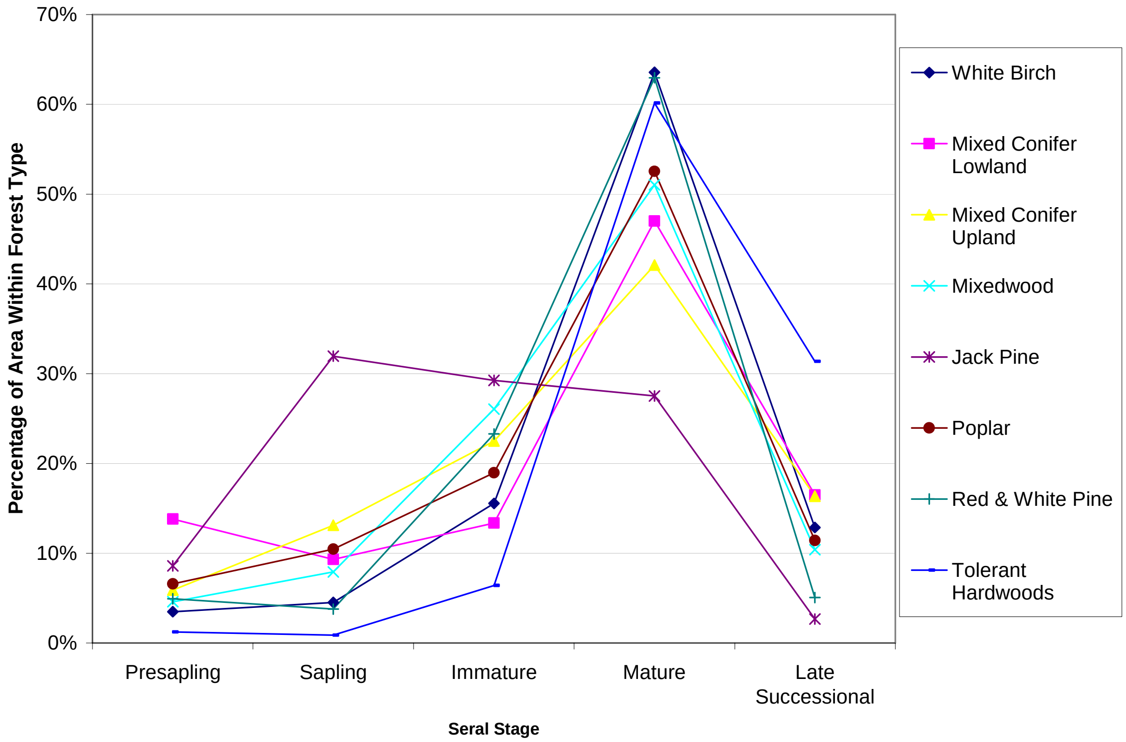

Figure 4. Seral stage distribution as a percentage of forested area within provincial forest type in AOU* portion of Canadian Great Lakes Basin
Caption: * The Area of the Undertaking (AOU) land area represents 72% of total land area analyzed in Ontario's portion of the Great Lakes basin.
Source: Ontario Ministry of Natural Resources, Forest Standards and Evaluation Section. Landsat Data based on Landcover 2002 (Landsat 7) classified imagery, Inventory data based on Forest Resources Planning Inventories, and NRVIS coverages