# Assessment of the Biodiversity and Conservation Status of Great Lakes Islands: A Progress Report

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## Abstract

*The more than thirty thousand islands of the Great Lakes form the world's largest collection of freshwater islands and their ecological significance is of provincial and global importance. They make a unique contribution to the biodiversity of North America and include a high proportion of Ontario's endemic species, rare communities, specialized biological functions and unique ecological phenomena. Many islands are under threat from incompatible development, invasive species and intensive recreation. Conservation of Great Lakes islands is important for maintaining the biodiversity of Ontario. Over 3100 large islands and island complexes in the Ontario portion of the Great Lakes have been organized by coastal environment and scored for 20 biodiversity criteria that include: rare species and communities, physical diversity, shape complexity, isolation and distinctiveness. Large islands and island complexes were also assigned scores based on threats and existing land protection and conservation policy. Results from this work can be used to better identify islands and island complexes that have exceptional biodiversity values and may require a more urgent conservation focus. This work is being integrated with a similar study in the U.S., and will enhance our understanding of the biodiversity and conservation needs of islands within the entire Great Lakes basin.*

## Introduction

Islands of the Great Lakes present an important opportunity for the conservation of freshwater coastal ecosystems. The more than thirty thousand islands of the Great Lakes, most of which occur in Ontario, form the world's largest collection of freshwater islands. Some of the recognized outstanding features of Great Lakes islands include the alvars of Manitoulin Island; the dune communities of

Lake Huron, Lake Ontario and Lake Erie; the tallgrass prairies and savannahs of the Walpole Island complex; and the harsh Precambrian coastline environments of Lake Superior. Islands also provide key nesting areas for colonial waterbirds, stop-over sites for migratory landbirds and habitat for Great Lakes fishes. In many areas of the Great Lakes, most of the coastal habitats occur on islands. They make a unique contribution to global biodiversity and include a high proportion of Ontario's endemic and disjunct species, rare communities, specialized biological functions and unique ecological phenomena. There are 459 different occurrences of provincially rare or tracked species and plant communities from the Natural Heritage Information Centre (NHIC) database that occur on Great Lakes islands.

The biodiversity on many larger islands has been well documented - Pelee Island and Manitoulin Island for example - but we know less about the more remote and less settled islands. Information is needed on the characteristics of the full spectrum of islands across the Great Lakes basin to inform and focus conservation. This information will benefit both governmental and non-governmental organizations working to conserve biodiversity on private and public lands.

A methodology was developed to take advantage of the availability of digital spatial data on the biological and physical features of islands and potential stressors. This is the first time that a comprehensive analysis of the biodiversity of Great Lakes islands has been completed and it is coordinated with complementary efforts in the United States.

This paper is a progress report on the analysis and preliminary results. A comprehensive report of our findings in Ontario will be released in 2007, in addition to the bi-national assessment.

## Methodology

### Coastal Environments

In order to create manageable units for the analysis, we grouped islands according to their Great Lakes coastal environment (Owens, 1979). Coastal environments are based on relief, geology, fetch, wave exposure, ice conditions, and availability and transport of sediment. This report splits some larger islands (e.g. Manitoulin) into different zones to reflect distinctive coastal characteristics. The Great Lakes shoreline on the Canadian side was divided into 33 coastal environments (Figure 1).

### Large Islands and Island Complexes

Portions of the Great Lakes (e.g. eastern Georgian Bay) contain thousands of islands, many of which are very small and have similar characteristics. These complexes of small islands function as a landscape unit. Within each coastal environment large islands and island complexes were identified. Large islands

were extracted based on the range of sizes and maintained as a single unit of analysis. Clusters of small islands were grouped into island complexes based on proximity (within 200 m of each other and without any intervening land) and similar geology. The analysis was then done on the island complex, rather than small individual islands.

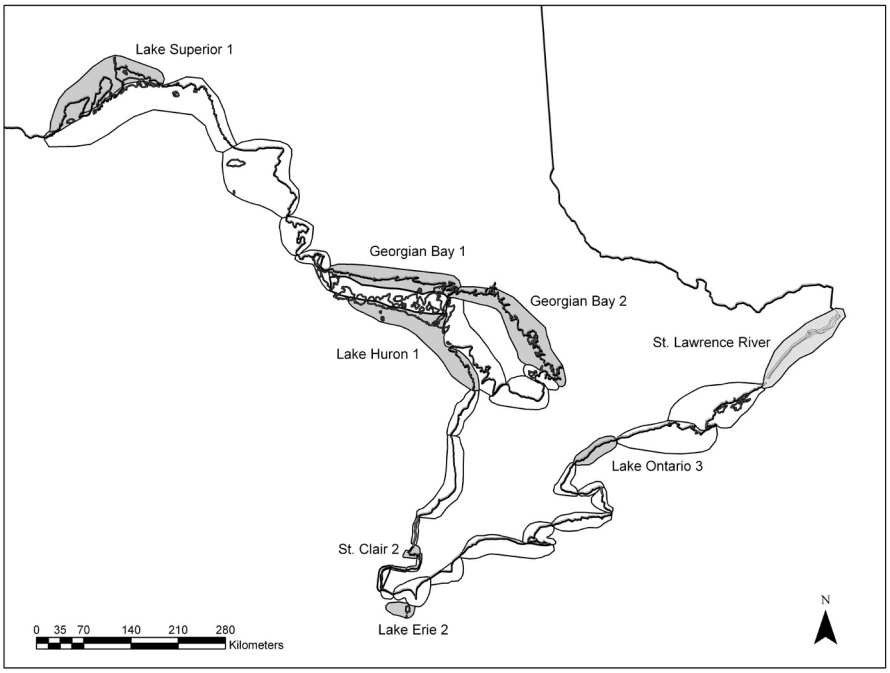
### Scoring Criteria

Islands and island complexes were assigned scores based on three categories: 1) biodiversity values, 2) potential threats, and 3) existing conservation progress.

A bi-national working group established the following biological criteria to rank the relative importance of islands for conservation (Ewert *et al*. 2004):

- Presence of Nesting Colonial Waterbirds
- Presence of Roosting or Foraging Shorebirds
- Presence of Roosting or Foraging Waterfowl
- Stopover Sites for Landbirds
- Occurrence of Nursery/Spawning Areas for Native Inter-jurisdictional Fishes
- Number of State/Provincial Endangered and Threatened Species
- Number of Federally Endangered and Threatened Species

**Figure 1. Coastal environments of the Great Lakes (Owens 1979) identified in this paper.**



- Species and Communities Identified in the Conservation Blueprint for the Great Lakes
- High Quality Sites for a Species or a Community

The criteria from Ewert *et al*. (2004) were modified and used as a basis to build an enhanced scoring method that could use an automatic approach to assess the biodiversity of islands in the Ontario portion of the Great Lakes. Biodiversity criteria used included criteria for biological diversity, physical diversity, size and distinctiveness (Table 1). Data sources included Environmental Sensitivity atlases (e.g. Environment Canada 1993), shoreline data from Environment Canada, colonial nesting waterbird data from Canadian Wildlife Service, data on rare species and community occurrences from the Ontario Natural Heritage Information Centre and vegetation data from the Great Lakes Conservation Blueprint for Biodiversity.

**Table 1. Biodiversity Scoring Criteria for Great Lakes Islands**

**Biological Diversity**

Species
- Diversity of Tracked Species (extant element occurrences)
- Colonial Nesting Waterbirds (known breeding sites)
- Global Biodiversity Values (G1-G3 species and Great Lakes endemic/ disjunct/declining species)
- Species at Risk (Endangered, Threatened, Special Concern)

Vegetation Communities
- Extant community element occurrences and G1-G3 communities

Ecological Systems
- Diversity of natural terrestrial ecological system types
- Presence of key aquatic and terrestrial ecological systems
- Presence of key shoreline combination types
- Presence of rivers/streams, wetlands, inland lakes

Ecological Functions
- Degree of isolation from other islands, island complexes or the mainland
- Presence of roosting and foraging shorebirds, waterfowl and landbirds
- Known occurrences and suitable habitat of interjurisdictional fish

**Physical Diversity**

Shape complexity
- Area weighted mean path fractal dimension

Geological diversity
- Presence of key geology types and diversity of types

Shoreline diversity

Size
- Based on 10 natural breaks within a coastal environment (thresholds will vary)

Distinctiveness

Similarity Index
- Compares ecological complexity, geology and shorelines of each island or island complex to the average for the coastal environment
- Measures which islands are representative and which are unique within their coastal environment

The analysis of threats considered direct potential threats, such as boat launches, anchorages, residences, cottages, building density, invasive species, pits, quarries and lighthouses. Indirect potential threats considered included distance to mining claims, road density and percent of the island occupied by cropland.

The numerical scores assigned to each island and island complex according to the criteria above is described in another paper (Henson *et al*. 2006).

Conservation progress was also assessed for each island and island complex. Spatial data on parks and protected areas, Areas of Natural and Scientific Interest, OMNR evaluated wetlands, lands owned by NCC and other organizations for conservation purposes agencies, and islands recognized as top-scoring aquatic and terrestrial sites from the Great Lakes Conservation Blueprint for Biodiversity were compiled as part of this project. Parks, protected areas, conservation lands and existing recognition of biodiversity values were assigned into four categories to reflect the general type of associated conservation. Existing conservation progress scores did not directly contribute to the biodiversity or threat scores, but the proportion of these conservation lands on each island and island complex were assessed to provide further insight into island values and identify potential conservation gaps and needs.

Highest scoring islands for biodiversity and threats within each coastal environment were identified based on the natural breaks, (Jenks) method provided in ArcGIS software (ESRI 2002). Along with the protection gap analysis, potential priority islands and island complexes for conservation can be identified.

## Preliminary Results

Ontario's Great Lakes islands contain an abundance of provincially and globally significant biodiversity values that vary across the basin. There is also a wide range in threat scores across the islands within and among the coastal environments (Table 2). The highest mean biodiversity score was found in the Georgian Bay 2 coastal environment followed by Lake Erie 2.

This analysis confirms the importance of several islands that are already well known for their biodiversity. For example, the southern portion of Manitoulin Island had the highest overall score for biodiversity (Table 3) (Note: Manitoulin Island occurs in three different coastal environments and has an associated score for each portion). Manitoulin Island is known as the largest freshwater island in the world. Larger islands, like Manitoulin, tended to score higher for biodiversity because of their size and because they typically support a greater range of habitats than do smaller islands. Manitoulin Island was separated into subsections that fell within different coastal environments (Figure 1) and would have scored higher if included in one coastal environment. It scored high for species at risk, the diversity of globally rare vegetation communities,

the presence of wetlands, lakes and rivers, and fish habitat, as well as, size. Manitoulin supports habitat for many globally rare species including itcher's thistle (*Cirsium pitcheri*), lakeside daisy (*Tetraneuris herbacea*) and dwarf lake iris (*Iris lacustris*). The large and globally rare alvar communities are also particularly significant.

**Table 2. Total biodiversity score and threat scores for eight of the 33 coastal environments on the Canadian side of the Great Lakes.**

| Coastal Environment | No. Individual Islands | No. Islands/ Complexes | Biodiversity Score | | Threats 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 |
| Lake Erie 2 | 15 | 15 | 151.7 | 87-385 | 11.2 | 1-88 |
| Lake Huron 1 | 887 | 173 | 103.4 | 39-490 | 8.2 | 1-179 |
| Lake Ontario 3 | 34 | 13 | 127.0 | 86-190 | 7.0 | 1-27 |
| Lake Superior 1 | 167 | 117 | 84.6 | 39-290 | 2.2 | 1-25 |
| St. Clair 2 | 234 | 25 | 162.2 | 92-336 | 9.2 | 1-68 |
| St. Lawrence 1 | 337 | 111 | 92.4 | 44-211 | 19.5 | 1-81 |

**Table 3. Islands in top-scoring biodiversity class from eight coastal environments in the Great Lakes in Ontario.**

| Coastal Environment | Islands in Top-Scoring Class (total biodiversity score) |
|---|---|
| Georgian Bay 1 | Great La Cloche Island (345); Clapperton Island (259) |
| Georgian Bay 2 | Parry Island (290); Philip Edward Island (271); Beausoleil Island (270) |
| Lake Erie 2 | Pelee Island (388) |
| Lake Huron 1 | Manitoulin Island (490); Cockburn Island (318); Fitzwilliam Island (240) |
| Lake Ontario 3 | Toronto Island (190), Algonquin Island (186), LO3-13 (157) |
| Lake Superior 1 | Pie Island (290); St. Ignace Island (259) |
| St. Clair 2 | Squirrel Island (Portion of Walpole Island) (336) |
| St. Lawrence River | Ault Island (211); Grenadier Island (196); Tar Island (174); Cornwall Island (168) |

**Figure 2. A provincially rare plant found in a globally rare community type. Nodding onion *(Allium cernuum,* S2) in Stone Road Alvar. Photo by G.M. Allen, NHIC Archives.**

Pelee Island was the second highest scoring individual island and the highest within its coastal environment (Lake Erie 2) (Table 3). Pelee Island also supports a high diversity of globally rare, endemic and disjunct species and species at risk as well as rare plant communities. It had high scores for key ecological systems and wetland, stopover sites for land birds, colonial nesting birds, fish habitat and size. Per unit area, it is one of the richest sites in the entire province, supporting dozens of rare species such as blue racer (*Coluber constrictor foxii*), Lake Erie watersnake (*Nerodia sipedon insularum*), Eastern foxsnake (*Elaphe gloydi*), yellow-breasted chat (*Icteria virens*) and Miami mist (*Phacelia purshii)*.

Patterson Island, the largest of the Slate Islands in Lake Superior at 2,776 hectares, was notable for its disjunct species, key ecological systems, streams, shoreline diversity, fish habitat, isolation and size. As well as arctic-alpine vegetation communities, this island supports woodland caribou (*Rangifer tarandus*), yellow dryas (*Dryas drummondii*), smooth woodsia (*Woodsia glabella*), northern woodsia (*Woodsia alpina*), mountain bladder fern (*Cystopteris montana*) and large-leaved sandwort (*Moehringia macrophylla*). It is adjacent to spawning shoals of lake trout (*Salvelinus namaycush*) and lake herring (*Coregonus artedi*).

Lesser known islands in other coastal environments that scored highly include: Great La Cloche Island in Georgian Bay 1, Parry Island and Philip Edward Island in Georgian Bay 2 and Pie Island and St. Ignace Island in Lake Superior 1. Squirrel Island, a part of the Walpole Island complex in St. Clair 2

scored highly and would score even higher if the entire complex were within the study area (a portion is on the U.S. side).

In addition to assigning priority to islands based on the total biodiversity score, islands were also assessed based on key attributes that are unique to island systems. The diversity of ecological systems and physical environments were also assessed separately as surrogates for biodiversity.

Key island attributes include habitat for colonial nesting waterbirds. Islands with a relatively low total biodiversity score can nevertheless be critical for nesting waterbirds. Wallis Rocks, a complex of 12 small islands contains nesting habitat for colonial nesting birds: herring gull (*Larus argentatus*), Caspian tern (*Sterna caspia*), ring-billed gull (*Larus delawarensis*) and great black-backed gull (*Larus marinus*). Despite the abundance of these species, there are relatively few nesting sites on the Great Lakes.

Priority islands were also identified based on the score for the diversity of ecological systems and physical environments. These measures can be less biased than some of the species and community measures, which are based on field data. Often, sites with high scores for their diversity of ecological systems and physical environments also had the highest overall biodiversity scores.

**Figure 3. Northern anemone (*Anemone parviflora*, S5), an Arctic disjunct plant found on Lake Superior islands. Photo by M.J. Oldham, NHIC Archives.**

## Potential Threats

There are many potential threats to the biodiversity of Great Lakes islands. Extensive residential and cottage development occurs on the islands of the lower Great Lakes as well as development related to tourism and recreation,

such as marinas, resorts and roads. Large aggregate operations are located on some islands. Larger islands support permanent residential development, roads and agriculture. The aquatic ecosystems adjacent to islands can be impacted by over-harvesting (not scored) and by the array of non-native species.

Many islands scoring high in biodiversity also scored high for threats (Table 4), partly because the larger islands that support greater biodiversity also support more human activities. There is a significant but low positive correlation between total biodiversity score and threat score (Pearson correlation coefficient=0.343, $P \leq 0.01$).

**Table 4. Islands in top-scoring threat class in eight coastal environments of the Great Lakes in Ontario.**

| Coastal Environment | Islands in Top-Scoring Class (total threat score) |
|---|---|
| Georgian Bay 1 | St. Joseph Island (65) |
| Georgian Bay 2 | Island-GB2-278 (52); Island-GB2-681 (52); Island-GB2-1283 (50) Note: there are 21 islands in the top threats class in GB2, none of which have names |
| Lake Erie 2 | Pelee Island (88) |
| Lake Huron 1 | Manitoulin Island (179) |
| Lake Ontario 3 | East Island (Ontario Place) (27) |
| Lake Superior 1 | St. Ignace Island (25) |
| St. Clair 2 | Squirrel Island (68) |
| St. Lawrence River | Cornwall Island (81) |

In general the level of threat is higher in the lower Great Lakes, as a result of the greater human population and its impacts. However, many islands, due to their isolation or small size, have been relatively free of human impacts and represent excellent opportunities for conserving representative or unique ecological systems.

## Applications

The urgency for conservation actions concerning islands, or any natural area, will be a combination of the importance of the biodiversity values, the threats to those values and any existing conservation progress. Our first attention should be towards irreplaceable biodiversity values, especially those under impending threat (*sensu* Margules and Pressey 2000). When assessing priority for conservation, the level of threat can be an incentive to take actions quickly,

but if the threat is too great, it may be more practical to conserve areas with similar values but less immediate threat. However, such choices are not always available to be made. Figure 5 presents an example from the Lake Erie 2 coastal environment of how plotting biodiversity scores against threat scores can be useful for identifying islands that may be a priority for conservation action.

## Next Steps

The work reported here will form part of a binational report on the biodiversity of islands across the entire Great Lakes. Another report in progress (Henson *et al*. 2006) will describe the methodology and present detailed results for coastal environments within Ontario. This information should make a useful contribution towards identifying the most important islands for future conservation initiatives.

**Figure 4. Caspian tern and ring-billed gull nesting colony, South Watcher Island. Photo by D.A. Sutherland, NHIC Archives.**

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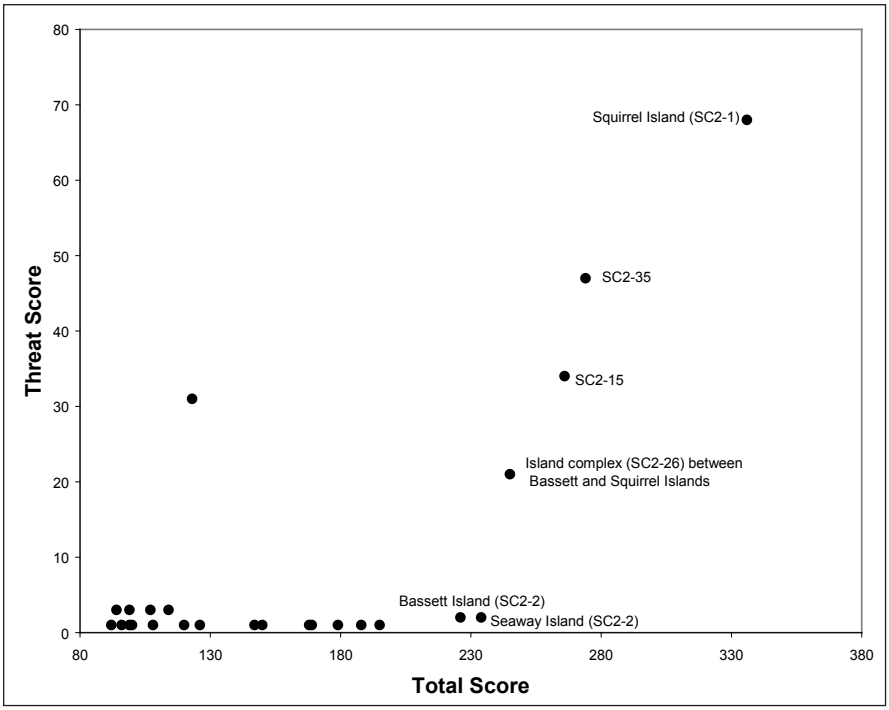
**Figure 5. Total biodiversity score versus threat score for islands in the St. Clair 2 coastal environment. Islands in the upper right quadrant may be a higher priority for conservation (i.e. higher biodiversity and threats scores relative to other islands in the coastal environment).**

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