The Beautiful Lake

A Bi-national Biodiversity Conservation Strategy for

Lake Ontario



Prepared by the Lake Ontario Bi-national Biodiversity Conservation Strategy Working Group
In cooperation with the U.S. – Canada Lake Ontario Lakewide Management Plan

April 2009

May 1, 2009

To our biodiversity conservation partners:

The attached report, ***The Beautiful Lake: A Binational Biodiversity Conservation Strategy for Lake Ontario, April 2009*** was prepared by The Nature Conservancy (TNC) and Nature Conservancy Canada (NCC) for the Canada -U.S. Lake Ontario Lakewide Management Plan (LaMP). The report describes key threats to biodiversity, potential strategies to abate these threats, recommended priority action sites and indicators to assess the health of Lake Ontario's biodiversity.

Developed through a two-year process that involved more than 150 Canadian and U.S. government, academic and non-government organization biodiversity experts, this report marks an important step toward conserving Lake Ontario's biodiversity. The LaMP will consider the recommendations developed through this broad, consensus-based process, together with binational and individual agency program priorities, in the development of a final LaMP biodiversity strategy.

Given the enormous amount of work needed to restore and protect Lake Ontario's biodiversity, the LaMP recognizes that the key to success lies in our ability to build and foster cooperative partnerships throughout the basin. To that end, we ask that you consider the strategies and key steps outlined in this report as you plan and undertake collaborative activities to restore and protect Lake Ontario's biodiversity.

Sincerely,

John Marsden
Management Committee Co-Chair
Lake Ontario Lakewide Management Plan
Environment Canada

Mario Del Vicario
Management Committee Co-Chair
Lake Ontario Lakewide Management Plan
U.S. EPA Region 2

The name "Ontario" comes from a native word, possibly "Onitariio" or "Kanadario", loosely translated as "beautiful" or "sparkling" water or lake.
(Government of Ontario 2008)

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Special thanks go to Michele DePhilip of The Nature Conservancy (Pennsylvania chapter) who led the bi-national team that assembled the maps presented in this report.

Disclaimer
This report reflects the best efforts of the preparers (Dan Kraus and David Klein) to represent, as accurately as possible, the views and opinions of project participants. Every effort to ensure the accuracy of the information contained in this study has been taken. We welcome suggestions for improvements.

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[1] Now with Ontario Ministry of Environment

Executive Summary

Lake Ontario and the Upper St. Lawrence River constitute an ecosystem of international importance that provides significant ecological services to over 10 million people. Past and current neglect of this ecosystem have led to drastic changes in nutrient dynamics, altered hydrologic rhythms, loss of coastal habitats, and the introduction of invasive species, with serious consequences to native species, food webs and quality of life. Many of these changes have occurred rapidly, and the lake and river continue to respond to these changes in unpredictable ways.

This report presents the recommendations of a bi-national strategy to protect and restore, to the full extent possible, the native biodiversity and critical natural processes of Lake Ontario (including the Upper St. Lawrence River). Experts from both Canada and the U.S., representing over 50 agencies and organizations, developed this strategy through workshops, small-group meetings, conference calls, and review of earlier drafts of this report. The Lake Ontario Biodiversity Conservation Strategy focuses on key ecosystem components (referred to as "biodiversity targets" in this report), identifies the threats to the viability of these seven biodiversity targets, and recommends a framework for action to protect and restore our *Beautiful Lake*. While many of the actions require significant and long term commitments, the benefits of restoring a healthy, vibrant Lake Ontario ecosystem will support the well-being and prosperity of the basin's residents for many generations.

The viability of these biodiversity targets (and, by extension, the health of the Lake Ontario/St. Lawrence River ecosystem) is imperiled by five critical threats:

1. Incompatible Development
2. Invasive Species
3. Dams and Barriers
4. Non-point Source Pollution
5. Climate Change

This list of threats is quite similar to the ecosystem stresses noted in previous planning efforts, at various geographic scales. While these plans may not have explicitly identified biodiversity targets, or defined the threats to these targets in the approach taken in this report, there is great commonality between this biodiversity conservation strategy and, for example, the Great Lakes Regional Collaboration and New York State's Comprehensive Wildlife Conservation Strategy (two recent large-scale planning efforts). Appendix C links this strategy with other planning initiatives.

Summary of Lake Ontario Biodiversity Targets and Threats

1. Benthic and pelagic offshore system	This target represents the bottom and open waters of the lake in permanently cold water greater than 20 m in depth. The benthos of the lake harbours the twin pillars of the native food web: *Diporeia* and *Mysis*, in addition to other important benthic invertebrates, and prey fish such as the deep-water sculpin. Lake trout and burbot are the native top predators. A diverse array of native Coregonid fishes previously dominated pelagic waters, with the Atlantic salmon as the top predator, but these species have been almost entirely eliminated from the system. The impacts of invasive species, particularly Dreissenid mussels, pose the most serious threat to the viability and restoration of this system.

2. Native migratory fish	This target is defined as fish that depend on migration to satisfy their life cycle. Examples of native migratory fish include lake sturgeon (lake to tributaries), American eel (lake to ocean), lake trout (deep lake to reefs), white sucker (lake to tributaries), walleye (lake to tributaries), and northern pike (lake to shallow wetlands). Several threats endanger these native fishes: invasive species feed on larval young and replace native macroinvertebrates (food source); dams and barriers on tributaries and on the St. Lawrence interrupt migratory processes; non-point source pollution alters water chemistry and decreases oxygen levels in tributaries and nearshore waters; and incompatible development fragments coastal wetlands and raises water temperatures through removal of vegetation along tributaries. Climate change, an emerging threat, is projected to increase water temperatures with unknown impacts on coldwater species such as lake trout.
3. Coastal wetlands	This target includes wetlands that have, or historically had, a hydrologic link to Lake Ontario and the Upper St. Lawrence River. An array of different natural communities, shaped by the long-term hydrologic periodicity of the lake and river, provides breeding, nursery, and migratory habitat for many species of native fish, birds, amphibians and reptiles. Coastal wetlands – the "lungs of the lake" – are imperilled by dams and barriers, which have altered natural hydrologic rhythms; invasive species, which reduce wetland diversity and resilience; incompatible development, which fragments adjacent uplands and interferes with longshore sediment transport; and climate change, which is forecast to lower lake levels and increase the severity of storms.
4. Nearshore zone	This target represents the open waters of the lake from the 20 m depth contour to the mean high water mark along the coast. These shallow, productive waters provide the link between the land and open lake, and support submerged aquatic vegetation critical for waterfowl and many fishes such as smallmouth bass and yellow perch. Primary threats to the viability of the native diversity in this zone include invasive animals and plants, particularly Dreissenid mussels, round goby, and submerged and floating plants such as Eurasian milfoil and water chestnut; non-point source pollution, which changes water chemistry and lowers dissolved oxygen; and incompatible development, particularly shoreline armoring that alters longshore movement of sediments.
5. Coastal terrestrial systems	This target includes natural cover from the line of wave action to two kilometers inland. These systems include the dunes and beaches that protect inshore lagoons and major wetlands in the Prince Edward peninsula and eastern shore of the lake in Jefferson and Oswego Counties, New York. Remnant barrier beaches and cobble bars still shelter embayments and ponds along the southern shore of the lake. Coastal systems are under threat from incompatible residential and recreational development that alters habitats and nearshore functions.
6. Rivers, estuaries & connecting channels	This target includes tributaries to the lake and their associated riparian zones and estuaries. There are hundreds of streams and rivers that flow into Lake Ontario. These systems and their associated riparian areas provide habitat for many fishes and other aquatic species, and have a significant influence on the diversity and health of nearshore waters. The highest threats to tributaries are dams and barriers that restrict the movement of fish and alter natural stream processes. Tributaries are also impacted by invasive species and non-point source pollution.
7. Islands	This target includes both natural and artificial islands. Lake Ontario and the Upper St. Lawrence River have almost 2000 islands, primarily in the eastern basin. The islands of Lake Ontario are important for colonial nesting waterbirds, migratory birds and support many rare species. Islands in the eastern basin and the upper St. Lawrence River provide "stepping stones" in the linkage between Ontario's Algonquin Park and the Adirondacks in New York. Islands are threatened by incompatible development, invasive species and some types of recreational uses.

To abate the threats to biodiversity targets, and conserve the native biodiversity of Lake Ontario, participants in the expert workshops of this planning process proposed the following six recommendations and 18 strategies. These strategies are presented in outline form here, with recommended "best bet" actions for immediate attention.

Recommendation #1: CONSERVE CRITICAL LANDS AND WATERS

Strategy 1.1: By 2015, secure 50% of unprotected and vulnerable coastal wetlands, tributary floodplains, and terrestrial systems as identified in watershed and other conservation plans.
Strategy 1.2: Complete watershed planning in both countries encouraging development and conservation in appropriate areas.
Strategy 1.3: Ensure that all public lands in priority areas are managed for the benefit of the native species and natural habitats.
Strategy 1.4: Encourage coastal and riparian stewardship on private lands.

BEST BET ACTIONS:
***** *Fund and initiate community-based watershed planning in New York.*
** Complete watersheds plans in Ontario; update new plans for coastal watersheds to include nearshore areas.*
** Establish a dedicated Lake Ontario coastal conservation fund to support land protection and management in priority areas.*

Recommendation #2: REDUCE THE IMPACT OF AQUATIC INVASIVE SPECIES

Strategy 2.1: Halt introductions of aquatic invasive species via shipping through coastal and oceanic shipping pathways (ballast water, hull fouling, anchors) by 2015.
Strategy 2.2: Re-establish biological separation at strategic points currently connected by canals.
Strategy 2.3: Halt new introductions of AIS due to recreational boating activities by 2015.
Strategy 2.4: Halt new introductions of AIS via live trade in animals and plants by 2015.
Strategy 2.5: Pool resources to develop and implement a rapid-response plan for newly discovered aquatic invasive species.
Strategy 2.6: Reduce the dominance and impact of existing aquatic invasive species to permit increased spawning by lake trout and other native species.

BEST BET ACTIONS:
***** *NGOs support the effort by New York State to regulate shipping traffic through locks in the St. Lawrence River.*
** Support the effort by U.S. Army Corps of Engineers (USACOE) to assess feasibility of a barrier to AIS movement in the Champlain Canal, and consider extending this analysis to the NYS Barge Canal.*
** Assemble a geospatial database of all boat landings, following a template developed by MNR and DFO, to identify high-risk boat landings for monitoring and rapid response.*
** Support efforts by DFO and Notre Dame University to develop a standardized risk assessment protocol for live trades in the Great Lakes.*
** Support formation of an expert technical working group to consider techniques for controlling current AIS. The NYS Partnerships for Regional Invasive Species Management (PRISM) network may provide a mechanism for assembling such a group of experts.*

Recommendation #3: RESTORE CONNECTIONS AND NATURAL HYDROLOGY

Strategy 3.1: Remove or mitigate the impacts of priority dams and barriers to restore fish passage and natural processes.
Strategy 3.2: Enhance environmental guidelines for siting and operations of all new hydropower facilities.
Strategy 3.3: Restore more natural hydrologic periodicity to Lake Ontario through a new regulation plan, and monitor impacts on coastal habitats.

BEST BET ACTIONS:
***** Work with International Joint Commission to establish a bi-national working group to finalize a regulation plan for Lake Ontario/St. Lawrence (LOSL) that "moves toward natural flows, while respecting other interests."*
** Provincial and state agencies join with federal partners to implement monitoring of key indicators of the impacts of a new regulation plan on coastal wetlands and species. These indicators, and the models that predict their responses, have already been developed by the IJC's (International Joint Commission) LOSL study, and therefore the elements necessary for adaptive management of the lake ecosystem are already in place.*
** Establish a barrier mitigation task force to prioritize barriers for near-term mitigation, and to define best practices for operation and siting of hydropower facilities.*

Recommendation #4: RESTORE NATIVE FISH COMMUNITIES, NATIVE SPECIES & AQUATIC ECOSYSTEMS

Strategy 4.1: By 2020, restore and maintain elements of the native fish community, including top and middle level predators that can act as biological control agents for key invasive species.

BEST BET ACTIONS:
** Pursue restoration of selected native Coregonid species, with monitoring to assess the effectiveness of juvenile stocking compared to egg releases. The Great Lakes Regional Collaboration, the CWCS, and the OGLECC report all recommend these steps.*
** Implement restoration plans for the American eel and lake sturgeon.*
** Engage sportfishing stakeholders in restoration of native species.*

Recommendation #5: RESTORE THE QUALITY OF NEARSHORE WATERS

Strategy 5.1: Target best management practice efforts in rural areas of priority watersheds to restore natural sediment and phosphorus cycles in nearshore waters.
Strategy 5.2: Within urban areas of targeted watersheds, reduce sediment and phosphorus from urban non-point sources through three-prong approach – controls at source, conveyance, and end-of-pipe levels.

BEST BET ACTIONS:
** Prioritize watersheds for action [Figure 6.3 (included in executive summary below) represents a proposed completion of this step].*
** Increase funding for agricultural best management practices, and target funding in priority watersheds.*
** Purchase or lease sensitive floodplain lands in priority watersheds.*
** Develop and implement urban stormwater standards for water balance to be applied in all new developments.*

Recommendation #6: PLAN & ADAPT FOR CLIMATE CHANGE

Strategy 6.1: Through watershed planning and management, provide corridors and linkages to facilitate species migrations and shifts in ecological communities.

Strategy 6.2: Adapt the regulation of Lake Ontario and watershed management regulations to accommodate the impacts of climate change.

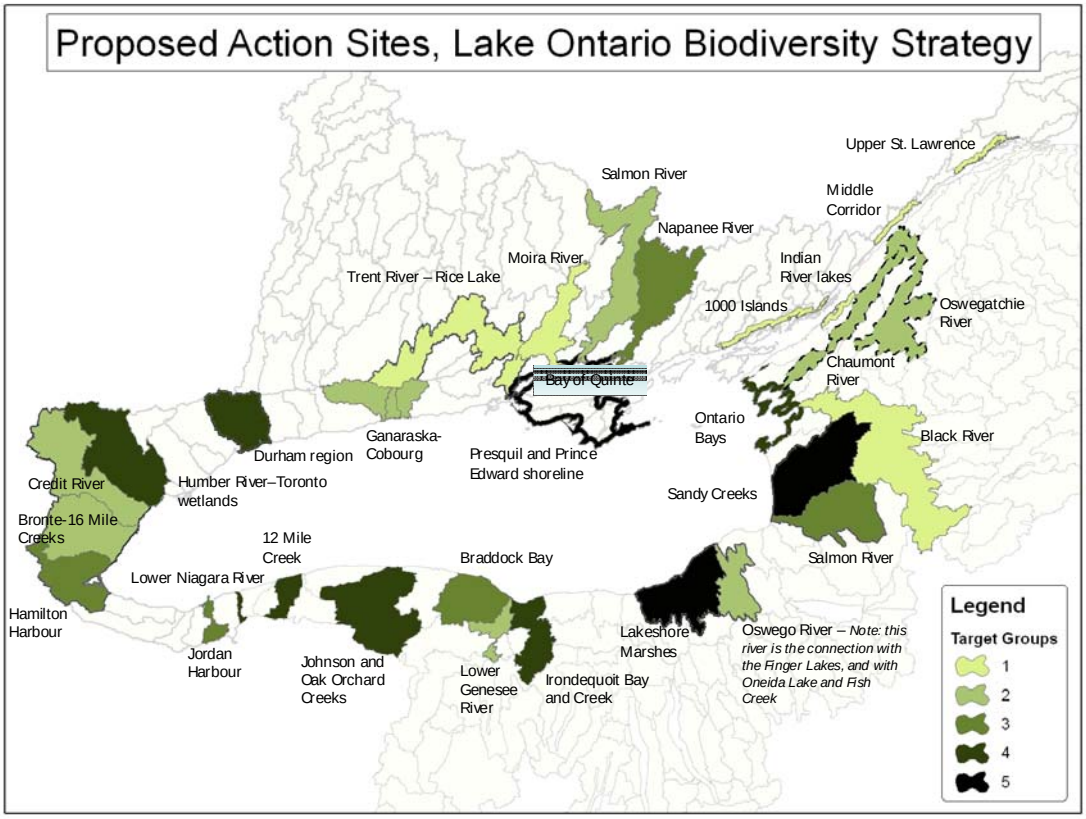
BEST BET ACTIONS:

** Assemble a detailed bathymetry of nearshore waters linked seamlessly to coastal topography to permit mapping of critical nearshore habitats and modeling of the potential impact of lower lake levels. (Note: this topo-bathymetry database is already being assembled for New York waters by NOAA Coastal Science Center, in partnership with The Nature Conservancy. This process needs to be matched with a similar effort in Ontario.)*

** Take steps to manage streams as natural systems – use the natural range of hydrologic variation as the baseline for assessing the impact of proposed withdrawals and climate change. The anticipated legislation in New York and Ontario to implement the Great Lakes Compact provides an excellent opportunity for progress toward this objective.*

** As a step toward re-establishing natural flows in the St. Lawrence River, assemble the bi-national adaptive management working group described under Recommendation #3.*

Several of the biodiversity targets are found in particular places within Lake Ontario, and can directly benefit from place-based action. Coastal wetlands, for example, are limited in distribution to distinct embayments, estuaries, and coastal areas; different species of migratory fish depend on particular tributaries and areas of the shoreline; and coastal terrestrial habitats such as beaches and dunes are limited in distribution. Several of the strategies presented above are most effective when implemented in distinct places. A final step in this biodiversity conservation planning process was to identify, through analysis of biological data and expert judgment, the watersheds and coastal reaches of the Lake Ontario ecosystem that most urgently require conservation action, and the actions needed in each priority action site. The figure below presents a map of these priority sites (discussed in greater detail in Table 6.4 of this report).



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1. Introduction: The Beautiful Lake

Lake Ontario is the last lake in the chain of Laurentian Great Lakes and is shared by Ontario and New York. It is the smallest of the Great Lakes, with a surface area of 18,960 km^2, but has the highest ratio of watershed area to lake surface area. It is a deepwater system, with an average depth of 86 meters and a maximum depth of 244 meters, second only to Lake Superior. Approximately 80% of the water flowing into Lake Ontario comes from Lake Erie through the Niagara River. The remaining flow comes from Lake Ontario basin tributaries (14%) and precipitation (7%). About 93% of the water in Lake Ontario flows into the St. Lawrence River; the remaining 7% is lost via evaporation. Lake Ontario has over 3,900 km of shoreline, dominated by bedrock shores and bluffs. While the western portion of the Lake Ontario coast has been heavily urbanized, most of the basin is dominated by agricultural and rural lands (Figure 1.1).

Lake Ontario and its watershed support a rich diversity of plants and animals. The physical environment supporting this biodiversity is rich and variable - there are island archipelagos, sand and cobble beaches, sand dunes often interspersed with rich wet meadows and fens, productive shallow embayments, numerous and varied tributaries, and a bedrock geology deriving from both Precambrian and Paleozoic periods. Native fish populations of walleye, yellow perch, and other species continue to be an important resource despite numerous threats. American eel is present in Lake Ontario and its tributaries, but has declined to the extent that it is now listed as Endangered in Ontario. Lake Ontario once supported lake trout and Atlantic salmon, and programs have been established to restore these species. Islands provide nesting habitat for colonial nesting bird species like black tern, Caspian tern, ring-billed gull, and the coast and nearshore areas provide migratory stopover habitat for birds, insects and bats. The central and eastern Lake Ontario coastal dunes, marshes and barrier beaches are ecologically very significant. Rare dune ecosystems can be found at Presqu'ile and Sandbanks Provincial Parks and on Wolfe Island. Globally rare alvars can be found along the coast.

The lake's water quality and ecology have undergone major changes in the last two centuries. Today, over 10 million people live in the basin. The Canadian population in Lake Ontario is the most rapidly expanding population in the Great Lakes basin. The population in this region has grown by over 40% in the last two decades and it is projected that the population in the western end of Lake Ontario will grow by an additional 3.7 million people by 2031 (Environment Canada and United States Environmental Protection Agency 2008). Many residents of the basin remain unaware of biology and ecological services provided by Lake Ontario (see Box 1). The lake provides drinking water to almost 8 million people and has supported substantial commercial and recreational fisheries. The character of the fisheries has been radically altered from the effects of historic over-fishing, habitat alterations, invasive species such as alewife, dreissenid mussels and round goby, extensive stocking of non-native trout and salmon, fluctuations in nutrient loading, and contaminants from industrial, agricultural and residential sources around the basin. Since Lake Ontario is the lower-most Great Lake, it is further impacted by human activities occurring throughout the Lake Superior, Michigan, Huron, and Erie basins.

There has been a long-running spirit of cooperation between Canada and the U.S. to protect and manage Lake Ontario. Lake-wide Management Plans (LaMPs) developed out of the 1987 amendments to the Great Lakes Water Quality Agreement signed by the United States and Canada provide a framework to assess, restore, protect and monitor the ecosystem health of the lake. The LaMP is used to coordinate the work of all the government, tribal, and non-government partners working to improve the lake ecosystem. The LaMP process requires public consultation to ensure that the plan adequately addresses the public's concerns. The stated goals of the 2004 update to the Lake Ontario LaMP (LaMP 2004) were:

- The Lake Ontario Ecosystem should be maintained and, as necessary, restored or enhanced to support self-reproducing diverse biological communities.
- The presence of contaminants shall not limit the uses of fish, wildlife, and waters of the Lake Ontario basin by humans and shall not cause adverse health effects in plants and animals.
- We as a society shall recognize our capacity to cause great changes in the ecosystem and we shall conduct our activities with responsible stewardship for the Lake Ontario basin.

It was within this context that in 2006 the LaMP Management Committee initiated a process to create a biodiversity conservation strategy for Lake Ontario that was bi-national in scope (LaMP 2004). The LaMP tasked the Nature Conservancy of Canada and The Nature Conservancy (U.S.) to support the coordination of partners to develop the strategy.

Box 1: Ten Things Every Resident of the Lake Ontario Basin Should Know

1. Lake Ontario is the 14th largest lake in the world; it is a deep, coldwater ecosystem that supports lake trout and whitefish.
2. A critical link in the Lake Ontario food chain is a small freshwater shrimp.
3. American eel lives in Lake Ontario in its tributaries, but spawns in the Atlantic Ocean.
4. There are almost 100 species of native fish in Lake Ontario.
5. It is one of two Great Lakes with water levels that are regulated through dams in outlet rivers (the other one is Lake Superior).
6. Over 8 million people get their drinking water from the lake.
7. Only the western portion of the watershed is highly developed, most of the basin is characterized by rural landscapes.
8. The western part of Lake Ontario is the fastest growing area in the Great Lakes basin.
9. The open lake is significantly cleaner than it was 20 years ago.
10. Improving the health of the lake improves the quality of life for people in the basin.

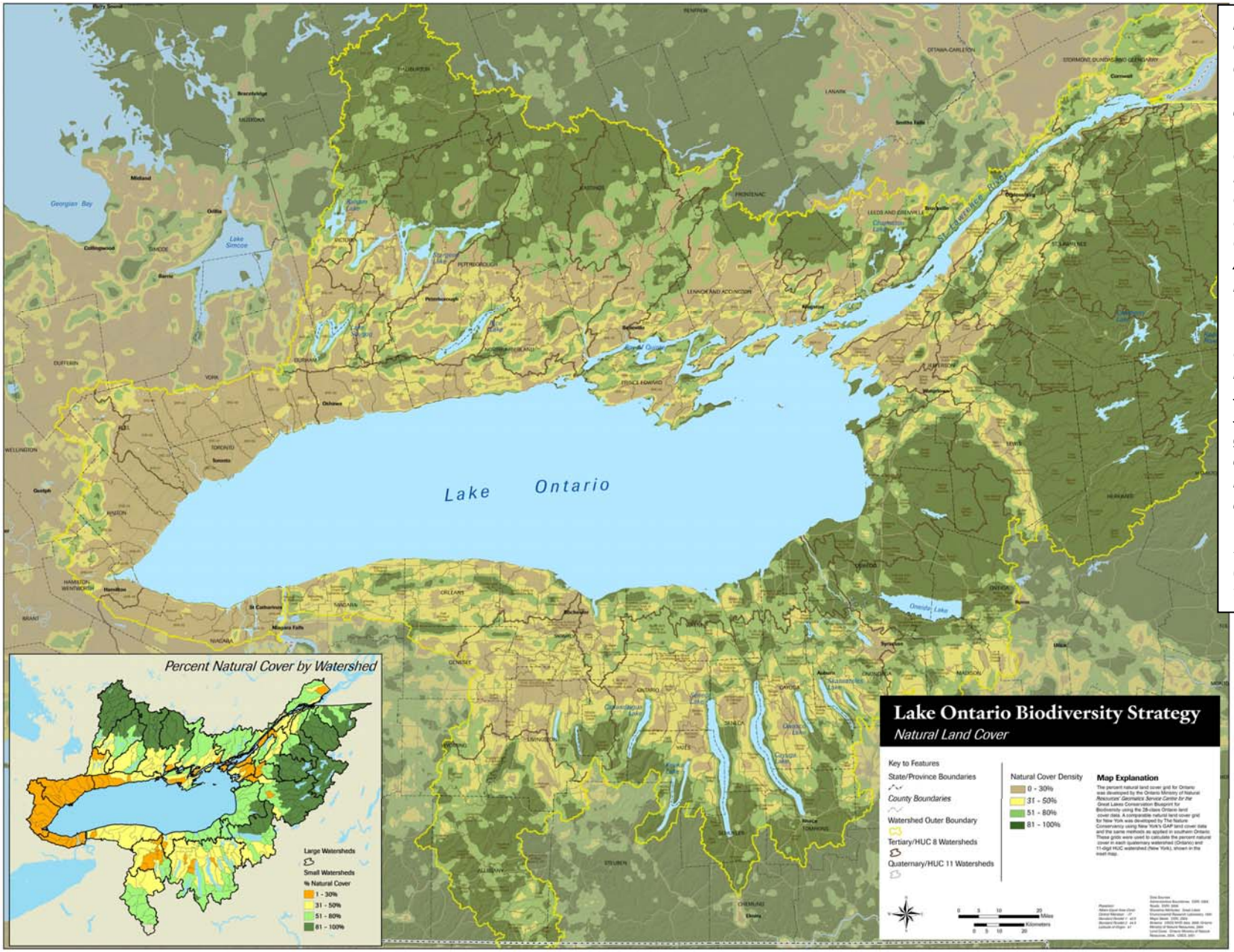


Figure 1.1: Natural Cover in the Lake Ontario Watershed
The percent natural land cover grid for Ontario was developed by the Ontario Ministry of Natural Resources' Geomatics Service Centre using the 28-class Ontario land cover data. A comparable natural land cover grid for New York was developed by The Nature Conservancy using New York's GAP land cover data and the same methods used in southern Ontario. These grids were used to calculate the per cent natural land cover in each quaternary watershed (Ontario) and 11-digit HUC watershed (New York) displayed in the inset map.

2. Developing the Lake Ontario Biodiversity Conservation Strategy

This strategy has been prepared through the participation and input of over 150 experts and 50 agencies, universities, and organizations (see Appendix A.1). These experts participated in four bi-national workshops that focused on developing different sections of this strategy. The purpose of these workshops was to assemble Lake Ontario experts from Canada and the U.S. and develop consensus on the scope and goals of the strategy, identify and assess the health of biodiversity targets, identify and rank threats to biodiversity, and to develop both basin-wide and place-based conservation strategies. The following list describes the objectives which were achieved at each workshop[1].

Workshop 1 (June 21-22, 2006): define project scope and identify biodiversity targets and health
Workshop 2 (October 5-6, 2006): identify and describe threats to the biodiversity targets
Workshop 3 (February 28-March 1, 2007): identify strategies
Workshop 4 (December 5-6, 2007): refine place-based strategies and implementation steps

Project Scope and Goals
The project scope identified by workshop participants was "to develop bi-national strategies for conserving and restoring the biological diversity of Lake Ontario, including its coastal habitats, pelagic and benthic zones, tributaries, and connecting channels[2]". Since the focus of this project is to foster bi-national action to address the biota of Lake Ontario, the scope for recommended actions included the watersheds of tributaries to the extent that they affect the biodiversity of the lake.

Goals identified for this project were:

- To reach a consensus on the key threats to biodiversity
- To develop a bi-national action agenda of strategies to abate these threats
- To identify priority action sites for implementation of strategies
- To identify a suite of indicators of the health of biodiversity targets
- To achieve greater integration of efforts toward common goals.

The Conservation Action Planning (CAP) process was used to help develop this strategy. The CAP process has been used successfully by The Nature Conservancy (TNC) and other organizations for identifying appropriate and effective actions through which successful conservation can be achieved (The Nature Conservancy 2006). CAP is intended to systematically link conservation actions with the health of a region's biodiversity targets and threats to those targets

[1] Additional workshops were also held in Ontario with Conservation Authorities to review the strategies.
[2] Connecting channels include Niagara River and upper St. Lawrence River.

3. The Biodiversity of Lake Ontario

Lake Ontario contains a rich and diverse array of species, communities and ecosystems that include aquatic, terrestrial and wetland biomes. This project identified seven biodiversity targets with Lake Ontario. These biodiversity targets represent and encompass the full array of biodiversity found in Lake Ontario. Each biodiversity target includes a suite of nested species and communities with linked conservation needs. For example, by conserving islands in Lake Ontario, the needs of colonial nesting waterbirds will be met. Additional detail and maps of the biodiversity targets is provided in Appendix B.

1. Benthic and pelagic offshore system: This target represents the deepwater ecosystem in Lake Ontario, including the open waters and bottom of the lake in permanently cold water greater than 20 m in depth. This zone once supported an abundant and diverse fish community dominated by lake trout, lake whitefish and deepwater sculpin. The Atlantic salmon was once the top predator in this system.

2. Native migratory fish: Many of Lake Ontario's fishes depend on migration for part of their life cycle. This includes species that migrate to rivers (e.g. walleye), coastal wetlands (e.g. yellow perch and northern pike) and even the Atlantic Ocean (American eel). Protecting these migratory species requires protecting all of the habitats they utilize during their life cycle.
3. Coastal wetlands: Lake Ontario has over 35,000 ha/86,450 ac of coastal wetlands. These wetlands have a hydrologic link to Lake Ontario as their water levels are directly related to the water level in the lake. Wetlands also provide a critical link between land and water, and they support a high diversity of species.
4. Nearshore zone: This zone occurs from the 20 m depth contour to the high water mark along the coast. These shallow waters are the most productive zone of the lake and often include rich beds of aquatic vegetation that support fishes and waterfowl. Dynamic sand and cobble beaches also occur in this zone.
5. Coastal terrestrial systems: This biodiversity target includes a wide diversity of natural habitats that occur from the line of wave action to 2 km inland. This zone is over 3,900 km in length, and supports sand dunes, alvars and coastal forests and provides important stop-over habitat for migrating birds.
6. Rivers, estuaries & connecting channels: There are hundreds of streams and rivers that flow into Lake Ontario. These systems and their associated riparian areas provide habitat for many fishes and other aquatic species, and have a significant influence on the diversity and health of nearshore waters.
7. Islands: Lake Ontario has almost 2,000 islands. These islands provide nesting habitat for colonial waterbirds and often contain unique assemblages of plants and animals due to their degree of isolation from other terrestrial systems. Islands in the eastern basin and the upper St. Lawrence River provide "stepping stones" in the linkage between Ontario's Algonquin Park and the Adirondacks in New York.

Many of the biodiversity targets identified from Lake Ontario were assigned a general viability (or health) rank of "C" or "Fair". This rank reflects the fact that most occurrences of the targets have been negatively impacted by land and water uses in the basin. The scope and scale of degradation is highly variable. Some biodiversity targets, such as the offshore pelagic and benthic systems, have a similar condition throughout the Lake. Coastal wetlands share some common factors that are impacting their health (e.g. lack of long-term water level fluctuations), but other factors such as surrounding land use are very different between the eastern and western parts of the Lake. The maps in Appendix B provide a representation on the values and condition of Lake Ontario's biodiversity targets in different parts of the basin.

4. Threats to the Heath of Lake Ontario

Threats to the health of Lake Ontario negatively impact the biodiversity targets. The workshop process required the project team to link threats to the key ecological attributes of targets and to rank individual threats based on their scope, severity and irreversibility. This expert input was supplemented with threats information from the literature and GIS analysis (e.g. mapping of dams and barriers). The overall conclusion from this analysis is that the threats to each ecological system are very high and the Lake Ontario ecosystem as a whole is under a very high level of threat. The biodiversity of Lake Ontario is imperiled by five critical threats, outlined below and further expanded upon in Appendix B:

1. Incompatible Development: Some forms of development can degrade coastal habitats and disrupt natural processes such as nearshore currents. Shoreline armoring can reduce flushing of coastal areas and interferes with natural sediment movement and deposition. Development along Lake Ontario's shores has already resulted in a loss of over 50% of its original coastal wetlands.

2. Invasive Species: Non-native invasive species such as zebra and quagga mussel, round goby and alewife have had a significant impact on the ecology of Lake Ontario including the food web and nutrient cycles. These species displace native species, and may be linked to increased nearshore algal blooms and the death of waterfowl by botulism. The number of invasive species in Lake Ontario has been increasing in the last decade.

3. Dams and Barriers: There are thousands of dams within the Lake Ontario watershed. These dams alter the natural flows of rivers and creeks that sustain coastal wetlands, and restrict fish migration to spawning and nursery areas. The Moses-Saunders dam has stabilized lake levels and natural decadal cycles of high and low levels have been eliminated through this regulation. As a result the distribution and diversity of wetland communities and species has been reduced, which may be linked in part to the growing dominance by certain invasive species. This dam also impedes the migration of the American eel to its spawning areas in the Sargasso Sea in the Atlantic Ocean.

4. Non-point Source Pollution: The runoff of nutrients and sediments into Lake Ontario contributes to the algal blooms in nearshore waters that decrease oxygen levels and alter water chemistry and, subsequently, species composition. This pollution also results in beach closings and can cause the growth of dense mats of algae along the shore, reducing the health of nearshore areas. Non-point source pollution and its impacts are most acute in the western, more urbanized portion of the basin, but can also occur in nearshore waters of rural areas.

5. Climate Change: Climate change is predicted to lead to decreased winter ice cover resulting in increased evaporation and lower lake levels. This will result in shifts in coastal ecosystem such as wetlands. Other impacts include increased water temperatures of tributaries and nearshore waters and an increase in the severity of storms along the coast. A greater number of severe summer storms may then in turn increase nutrient and sediment runoffs, exacerbating this already problematic issue.

5. Six Recommendations to Protect & Restore the Health of Lake Ontario

Development of the Lake Ontario Biodiversity Conservation Strategy included a detailed review of past studies and plans so that past strategies and recommendations that are still relevant could be brought forward in this project (see Appendix C). For example, in 1992, New York's Department of Environmental Conservation presented a 25-year plan for the state's Great Lakes shorelines and waters. The plan called for conservation of wetlands and vulnerable coastal habitats, ecosystem-based watershed planning to foster closer cooperation between local towns and higher levels of government, restoration of native species like the lake trout, control of invasive species (the sea lamprey was the focus of this discussion), ecologically-sensitive management of water levels and flows in the St. Lawrence River and tributaries, and public outreach to engage private citizens and local governments in environmental protection. Many of the short- and long-term actions recommended by this plan are quite pertinent today. However, much has also changed with regard to the current state of the lake. For example, the sea lamprey and alewife have been joined by numerous additional invasive species which have altered the ecosystem's food web and energy flow; the open waters of the lake have become increasingly oligotrophic, while nearshore reaches are subject to high nutrient levels (possibly caused by Dreissenid mussels) which leads to harmful algal blooms; and climate change has become an even more relevant threat to the integrity of coastal habitats.

The questions that dominated discussions during the third and fourth workshops of this planning process were:

- *What actions should be taken today to preserve and restore the biodiversity of Lake Ontario? and,*
- *Where should these actions be focused?*

The diverse threats to the native biodiversity of Lake Ontario affect the ecosystem at both the local scale (e.g. dams or incompatible development which impair specific streams), and at lake-wide or regional scales (e.g. new introductions of aquatic invasive species). In this section, we present recommendations for action at a lake-wide scale to lessen the impact of the top threats discussed in section 4. These recommendations are the products of the third workshop (see section 2 for a breakdown of workshop objectives), during which groups of experts discussed how to abate each of the critical threats.

Between the third and fourth workshops, project participants from several agencies helped design a process for targeting high priority watersheds and coastal units for implementation of place-specific strategies. The goal of the fourth workshop was to provide a geographic context to the strategies, and identify the watersheds and coastal areas where land conservation, best management, barrier mitigation, and other place-specific strategies would have the biggest impact on the lake ecosystem.

The following presents a summary of strategies and key action steps designed to achieve the six broad recommendations for Lake Ontario and the upper St. Lawrence River:

1. Conserve critical lands and waters
2. Reduce the impact of aquatic invasive species
3. Restore connections and natural hydrology
4. Restore native fish communities and native species
5. Restore the quality of nearshore waters
6. Plan for, and adapt to, climate change.

Results of the fourth workshop (identification of priority areas for conservation work) can be found in Section 6 – *Priority Areas for Conservation Action – A Recommended Framework*.

Recommendation #1: CONSERVE CRITICAL LANDS AND WATERS

The watershed of Lake Ontario reflects the impacts from the demands of large urban centers, suburban residential development, second home development, industry, and agriculture. These land uses have had the typical effects of removing, altering, and fragmenting the landscape's original natural cover, with accompanying changes to freshwater and coastal environments. In particular, shoreline development has had an array of effects including the inhibition of longshore sediment transport from shoreline armoring (e.g. nearly 40% of the western lakeshore has been hardened); the loss of wetlands (e.g. 60-90% of the original wetlands have been lost from the Greater Toronto Area); isolation of remaining wetlands and limitations in their ability to migrate up- and down-slope in response to long-term changes in lake levels. According to the IJC, development of shoreline tracts in Lake Ontario and the upper St. Lawrence River increased at a decadal rate of 6% from 1990 to 2000, a rate of growth which is projected to continue.

The need to abate the effects of changing land use is universally recognized in previous and current plans addressing biodiversity conservation in the Great Lakes. The key challenges include how to mitigate the causes and impacts of habitat degradation, and where to focus efforts so they may have the greatest benefit to native biodiversity.

Participants in this project proposed a bi-national approach to conserving critical lands and waters in the Lake Ontario watershed. This approach includes land protection in priority areas, aided by targeted conservation funding, watershed planning, and management of public and private lands for the benefit of biodiversity. Section 6 of this report suggests a focus of these strategies in priority tributary watersheds and coastal reaches and makes recommendations for action in these priority areas.

BEST BET ACTIONS:
** Fund and initiate community-based watershed planning in New York.*
** Complete watersheds plans in Ontario; update new plans for coastal watersheds to include nearshore areas.*
** Establish a dedicated Lake Ontario coastal conservation fund to support land protection and management in priority areas.*

Strategy 1.1: By 2015, secure 50% of unprotected and vulnerable coastal wetlands, tributary floodplains, and terrestrial systems as identified in watershed conservation plans.

Priority areas for implementation: In New York, the Comprehensive Wildlife Conservation Strategy (CWCS) has identified three action zones for the watershed of Lake Ontario, encompassing the southwestern shoreline west of Rochester; the southeastern zone including the watersheds of Oswego, Salmon, and Black Rivers, and Sandy Creek; and the upper St. Lawrence River. During this project's fourth workshop, participants identified specific watersheds within these action zones for conservation action.

This strategy is most effective in the priority watersheds in which aquatic resources are most threatened. Relevant examples include watersheds in the northwestern and southwestern portions of the lake ecosystem, such as Durham region, Credit River, Humber River, Bronte - 16 Mile Creek, and Jordan Harbour in Ontario, and Johnson-Oak Orchard Creeks and Braddock Bay in New York. This strategy also should focus on maintaining the least-altered areas, such as Sandy Creek, Salmon River, and Lakeshore Marshes in New York, and the Napanee watershed, Bay of Quinte, and Thousand Islands and Prince Edward County shoreline in Ontario.

Within each watershed it must be determined which lands should be the highest priority for protection. Decisions on these priorities need to emerge from specific watershed plans, but workshop participants highlighted the need to specifically protect coastal wetlands, floodplains along tributaries, and unique coastal features such as beaches and dunes.

Key Steps for the Next Five Years
By 2010, prioritize conservation efforts on public and private lands based on biodiversity values and threats to natural resources. • *A first iteration of this priority-setting was completed during this project's fourth workshop with identification of recommended action sites (watersheds and coastal reaches) for implementation of place-based strategies. Section 6 illustrates and describes the results of this discussion.*
By 2010, develop procedures for identifying key lands within priority watersheds or coastal reaches. Coastal wetlands, tributary floodplains, and vulnerable terrestrial habitats such as beaches and dunes have been proposed as priorities for protection. • *Consistent, scientifically valid procedure will be used in both countries to highlight lands within a watershed that have high impact on Lake Ontario. This procedure will inform watershed planning.*
Link land protection priorities to existing land conservation strategies at the province/state level. • *In NY, focus funds through the state's Open Space Plan to protect undeveloped shorelines and 5,000 acres (2,024 ha) of lands buffering aquatic systems in priority watersheds and coastal reaches. In Ontario, priority lands will be reflected in ongoing watershed and conservation planning. For example, Credit Valley Conservation Authority seeks to protect 12% of the land area of Mississauga in natural areas, with 6% protected to date.*
Allocate more funding for land securement – by 2012, work in both countries to secure $10 million per year in a dedicated Lake Ontario fund for conservation of riparian and coastal areas. • *See Strategy 1.4: public relations key step.*

Strategy 1.2: Complete watershed planning in both countries encouraging development and conservation in appropriate areas.

In Ontario, watershed planning is primarily carried out by the regional Conservation Authorities at the watershed and subwatershed level (see Appendix D). In New York, the recent Ocean and Great Lakes Ecosystem Conservation Act is introducing ecosystem-based management at the watershed level, pilot-tested through a community planning process for the Sandy Creek watershed. Completion of watershed planning, particularly in the priority watersheds proposed in this report, is an important step toward the protection of critical lands and waters.

Key Steps for the Next Five Years
Secure funding for completion of watershed plans in Ontario and New York, incorporating protection of sensitive lands. • *Fund and initiate community-based watershed planning in New York, resulting in watershed plans for all priority watersheds by 2015. The new emphasis on Ecosystem-based Management provides a mechanism to assist this process*.
By 2012, Complete watershed planning in Ontario. • *Comments from Conservation Authorities on an earlier draft of this report point out that sourcewater protection plans are scheduled for completion in 2012, but that more comprehensive biodiversity conservation planning will require additional funding.*
Link watershed plans to nearshore ecosystem health. By 2012, develop a pilot study in the western basin that links watershed planning to nearshore ecosystems. • *Opportunity for Conservation Authorities to add actions to restore nearshore water quality and natural processes (sediment transport) to all new and updated watershed plans.*
Update the Lake Ontario Greenway Strategy (Ontario). • *Greenway Strategy will incorporate priority land protection and steps to restore nearshore areas, as reflected in Conservation Authority watershed plans*.

Strategy 1.3: Ensure that public lands in priority areas are managed for the benefit of the native species and natural habitats.

Only 5.7% of the Lake Ontario coastline is protected through public ownership in New York, and 1.7% of the Ontario shore is conserved in regulated provincial parks, national parks or federal wildlife areas (does not include Conservation Authority lands; see Figure 5.1 for a map of publicly-owned lands in Ontario and New York). These public lands contain important segments of the coastal zone, and need to be managed for the benefit of the biodiversity of Lake Ontario.

Key Steps for the Next Five Years
By 2011, appropriate agencies identify public lands in priority watersheds that are most in need of management plans.
Appropriate agencies identify and share "best example" management plans.
NGO partners seek Lake Ontario coastal conservation funds to support land conservation and management. • *This action is part of the effort to assemble $10 million per year for land conservation (see Strategy 1.1).*

Strategy 1.4: Encourage coastal and riparian stewardship on private lands.

Since the great majority of land in the Lake Ontario watershed is in private hands, most conservation actions at the ecosystem scale should engage private landowners. In addition, since land-use decisions, particularly in New York, are made at the local level, it will be necessary to work with local town governments in priority action sites to encourage stewardship to preserve aquatic natural resources. The need to foster closer cooperation in New York between state and local governments and private citizens was prominently noted in the Department of Environmental Conservation's (DEC) 25-year plan and, more recently, in the Comprehensive Wildlife Conservation Strategy.

An essential vehicle that could enlist the support of local governments and landowners is an outreach program that describes the Lake Ontario ecosystem, its key natural resources, threats to their viability, and the necessary steps needed to preserve biodiversity. Many appropriate materials have already been developed by LaMP partner agencies, but it is difficult to reach the public on a meaningful scale. This strategy will require a public relations effort that describes how the ecosystem of the lake works, and the role of people at the local level to preserve its natural processes.

Key Steps for the Next Five Years
Project partners identify coastal areas adjacent to biodiversity targets (coastal wetlands, key coastal terrestrial habitats, priority tributaries) with little natural cover that are in private ownership, to highlight areas where targeted public outreach is most needed. Initial focus will be on priority watersheds. • *Data-bases assembled for this LaMP-based process provide the information necessary to complete this step. NCC, Conservation Authorities, MNR, DEC, and TNC can combine efforts to complete this step.*
Update Province of Ontario Wetland Evaluation System and Provincial Policy Statement to provide additional protection for all Lake Ontario coastal wetlands and coastal systems, by 2010.
By 2011, employ diverse methods (e.g. electronic, print, mass media) to increase understanding of the lake ecosystem so that New York watershed plans incorporate actions to preserve aquatic biodiversity. This action step mirrors a similar near-term recommendation in *Our Waters, Our Communities, Our Future* – the report of NY's Ocean and Great Lakes Ecosystem Conservation Council (OGLECC). • *Develop a compelling publication and presentation on the biodiversity of Lake Ontario.* • *Share information with coastal municipalities and NGOs to inform watershed actions.* • *Credit Valley Conservation Authority's Save the Leopard Frog campaign provides an example of a successful campaign to increase understanding of ecosystem needs.*

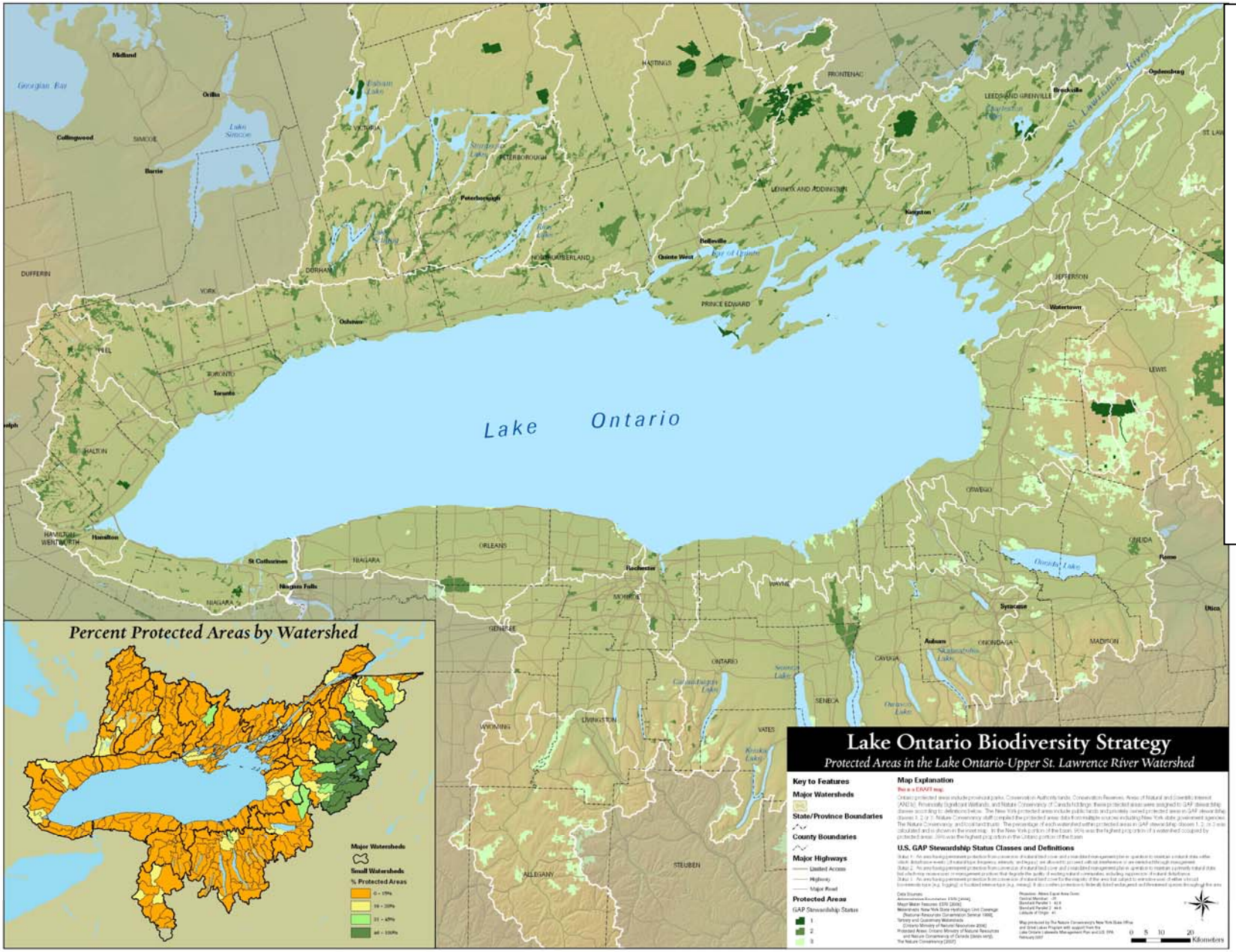


Figure 5.1: Protected Areas and Conservation Lands in the Lake Ontario Watershed

This map displays protected areas in GAP classes 1, 2, and 3. The percentage of land area in each watershed in these three GAP classes was also calculated, and is shown on the inset map. In the New York portion of the basin, 96% was the highest proportion of a watershed occupied by protected areas; 39% was the highest proportion in the Ontario portion of the basin.

Recommendation #2: REDUCE THE IMPACT OF AQUATIC INVASIVE SPECIES

Aquatic invasive species (AIS) have altered the native food web in fundamental ways, from re-routing energy flow in food webs and the exclusion of native macroinvertebrates by Dreissenid mussels; to predation on larval native fish by exotic planktivores such as alewife, rainbow smelt, and round goby; to parasitism on top predators by sea lamprey (possibly native to Lakes Ontario and Champlain, although its population explosions through the late 19th and 20th centuries have given it invasive status).

While international shipping through the St. Lawrence Seaway remains the primary vector for new invasive species (over 180 non-native species have been identified in the Great Lakes, and a new species is discovered every 28 weeks), discussions during project workshops also focused on additional vectors – canals, trade in live animals and plants, and recreational boating. Several Conservation Authorities, including Credit Valley Conservation, noted that stocking of stormwater management ponds represents an increasingly significant vector of introduction, and recommended guidance documents to educate local residents on the negative impacts of such stocking.

BEST BET ACTIONS:
***** NGOs support the effort by New York State to regulate shipping traffic through locks in the St. Lawrence River.*
** Support the effort by U.S. Army Corps of Engineers (USACOE) to assess feasibility of a barrier to AIS movement in the Champlain Canal, and consider extending this analysis to the NYS Barge Canal.*
** Assemble a geospatial database of all boat landings, following a template developed by MNR and DFO, to identify high-risk boat landings for monitoring and rapid response.*
** Support efforts by DFO and Notre Dame University to develop a standardized risk assessment protocol for live trades in the Great Lakes.*
** Support formation of an expert technical working group to consider techniques for controlling current AIS. The NYS Partnerships for Regional Invasive Species Management (PRISM) network may provide a mechanism for assembling such a group of experts.*

Strategy 2.1: Halt introductions of aquatic invasive species via shipping through coastal and oceanic shipping pathways (ballast water, hull fouling, anchors) by 2015.

Key Steps for the Next Five Years
State/provincial/federal governments adopt a consistent set of standards for management of AIS in the ballast tanks of all saltwater vessels. These standards should encompass ballast water exchange and sediment management, achieving environmentally protective standards for ballast treatment by 2011.
By 2011, support a study to quantify risks of AIS introduction posed by hull fouling and other ship-borne vectors and current ballast water mitigation measures. Support investigations to quantify these issues, and identify hull management solutions.
LaMP agencies consider support to update a cost-benefit analysis considering all transportation alternatives to meet the objective of halting saltwater introductions of AIS.

Strategy 2.2: Re-establish biological separation at strategic points currently connected by canals.

Artificial connections linking Lake Ontario with other catchments have been a vector for introduction of non-native invasive species since the 19th century. Most recently, the blue-back herring was introduced to Lake Ontario and the Great Lakes basin via the New York Barge Canal, which connects the Lake Ontario drainage with the Hudson River. Workshop discussions identified the Hudson – Barge Canal connection and the Rideau Canal – Ottawa River connection as candidates for biological separation.

Key Steps for the Next Five Years
By 2011, the LaMP agencies support an objective assessment of the risks of different management options (including the status quo) for biological separation of major catchments currently connected by canals to Lake Ontario. • *This strategy is consistent with the Great Lakes Regional Collaboration's aquatic invasive species milestones 2.2, 2.3, 2.4.*
By 2009, LaMP agencies establish a working group, including all stakeholders, for a consultative process to identify issues and consider options for biological separation between Lakes Ontario and Champlain and the Hudson River.
By 2015, begin implementation of the steps recommended by the working group for permanent barriers (cargo transfer stations, small watercraft lifts, cleaning stations) with the goal of halting AIS introductions without interrupting transport of goods or recreation.

Strategy 2.3: Halt new introductions of AIS due to recreational boating activities by 2015.

Recreational boating is globally recognized as a vector for the spread of invasive species. Viral hemorrhagic septicemia (VHS) and Hydrilla (an invasive aquatic plant) may have been introduced to Lake Ontario by recreational boats.

Key Steps for the Next Five Years
By 2010, assemble an inventory of all boat landings and major water access points that may provide access to Lake Ontario for AIS. As part of this inventory process, identify the boat landings with the highest probability of new invasions. • *This inventory will require development by a contractor of a geospatial database of all boat landings, and an existing program of DFO (Fisheries and Oceans Canada) and MNR (Ministry of Natural Resources) can serve as a model. Quantification of use patterns through active monitoring at boat landings will be necessary to identify the landings that present the highest risk for new introductions. DFO will be conducting a pilot study during the next two years.*
By 2011, design and implement surveillance monitoring and rapid-response techniques at the highest-risk boat landings and access points. • *DFO has a draft AIS monitoring plan for the Great Lakes that, when implemented, will focus on highest-risk sites.*
By 2012, establish a comprehensive public awareness program, focused on the highest-risk sites.
By 2015, complete the steps to halt introductions via the boating pathway by finding support for boat washing stations and inspection stations on major transportation routes and water access points.

Strategy 2.4: Halt new introductions of AIS via live trade in animals and plants by 2015.

Invasive species from the horticultural, pet, bait, and food trades constitute another critical vector for introduction that must be addressed to protect the Lake Ontario ecosystem from new introductions of AIS. Species that have had significant impacts in other regions include silver carp (in the Mississippi River) and snakehead (eastern US). Key steps for the next five years include:

Key Steps for the Next Five Years
By 2011, LaMP agencies and partners develop and implement risk assessment procedures to assess the full range of species in live trades. • *DFO's Centre of Expertise for Aquatic Risk Assessment (CEARA) is currently developing risk assessment and screening protocols for all of the major freshwater AIS pathways and several specific AIS, with emphasis on the Great Lakes. David Lodge, Notre Dame University, is proposing similar assessments, as well as the development of a standardized RA framework for the GL basin. The Great Lakes Commission has a program on AIS pathways.*
By 2012, agencies and partners complete an inventory of species involved in live trades and apply the risk assessment procedures to identify live-trade species that pose the highest risk of ecosystem damage. • *DFO CEARA has nearly completed such an inventory.*
LaMP agencies and partners form a working group, including stakeholders and industry representatives, to build public support for regulating trade in live species. • *As a preparatory step, the agencies link with other agencies in the Great Lakes basin and the Great Lakes Commission to coordinate efforts to identify stakeholders and recruit their participation in determining the scope and goals of a regulatory process.*
By 2015, legislation is introduced in both countries with a comprehensive list of prohibited species. • *An NGO or other partner will need to be found to propose legislation, which could be supported by the working group mentioned above.*
By 2015, an agency/NGO team will design and implement a consistent public information program, including workshops for stakeholders such as bait harvesters, to educate the public and the industry on species that can be safely and legally traded. • *Ontario is already conducting workshops.*

Strategy 2.5: Pool resources to develop an early detection – rapid response plan for aquatic invasive species.

Develop a rapid response capability for major ports and canals, through enhanced monitoring, dedicated staff resources, and revolving funds for response.

Key Steps for the Next Five Years
Form interagency, bi-national early detection-rapid response (ED-RR) team to develop protocols for monitoring, identify places of high vulnerability (ports, canal connections, major recreational boating locations), and cooperate with agencies throughout Great Lakes region on eradication techniques. • *Form a bi-national early detection team, with participation by DFO, MNR, DEC, USFWS (U.S. Fish and Wildlife Service), USGS (U.S. Geological Survey), and Conservation Authorities.* • *Develop a basin-wide rapid response framework to coordinate interjurisdictional response to early detection of aquatic invasive species, pooling the resources of the aforementioned partners.* • *Nick Mandrak of DFO has proposed this strategy, which reflects a similar recommendation by the Great Lakes Regional Collaboration. The actions of this bi-national team might initially focus on the Welland Canal, New York Barge Canal, and Hamilton Harbour. In NY, the PRISM network and the Invasive Species Task Force provide mechanisms for forming and implementing this team.*
Explore funding mechanisms for the ED-RR team, including the State Clean Water Revolving Fund (NY), the Canada-Ontario Agreement, and federal invasive species legislation.

Strategy 2.6: Reduce the dominance and impact of existing aquatic invasive species to permit increased spawning by lake trout and other native species.

This strategy builds on the experience of controlling sea lamprey, and the introduction of Pacific salmonids to control the alewife. The recommendation is to develop a program to integrate the control efforts on several invasive species into a lake-wide effort to restore native ecosystems using techniques of integrated pest management. Unlike the strategies discussed in preceding sections, this strategy focuses on integrated management of existing AIS.

Key Steps for the Next Five Years
LaMP agencies support development of a technical working group (TWG) to identify priority AIS for management, and identify national and international partners working on aquatic pest management. • *This step repeats a recommendation by the Great Lakes Regional Collaboration (GLRC), which highlights the need for an Integrated Management Program for rapid response, control, and management.*
EPA's Targeted Watershed Grants program designs an international conference to assess feasibility of integrated pest management on the Lake Ontario scale, and define a long-term research agenda for development of control or eradication tools for priority species. • *Agreement on priority steps to develop control tools, and identification of target species. The need for coordinated research on control methods "for uncontrolled species of concern" is also a Great Lakes Regional Collaboration action step.*

Recommendation #3: RESTORE CONNECTIONS AND NATURAL HYDROLOGY

Hydrologic alteration due to dams in tributaries, dams in the St. Lawrence River, and unsustainable withdrawals from aquifers emerged as a serious threat to biodiversity during this project's expert workshops. In particular, the regulation of flows in the St. Lawrence River, which alters the natural decadal cycles of high and low lake levels in Lake Ontario, has had serious impacts on coastal wetlands, habitats and species (Environment Canada and Ontario Ministry of Natural Resources 2003).

Dams and barriers (such as culverts at road-stream crossings) alter hydrologic rhythms that sustain riparian and coastal habitats, restrict access by fish to spawning and nursery habitats, alter the thermal regime of streams, and interrupt movement of sediments. Several thousand dams have been installed in the tributaries to Lake Ontario (See Figure 5.2 which displays the extent of tributaries with uninterrupted access to the lake); for example, over 110 instream barriers such as dams and weirs have been identified in the Humber River watershed alone.

Several recent developments provide opportunities to address some of the threats to biodiversity posed by dams and barriers:

- The recent recommendation by the IJC, to consult with federal and provincial/state governments about a new regulation approach restoring more natural flows in the St. Lawrence River, represents an important opportunity to address a major threat to the viability of coastal habitats and species.
- Methods for reducing the impacts of dams and barriers are being developed in both New York and Ontario. Several Conservation Authorities have inventoried and categorized barriers in specific watersheds, and are developing decision support tools to prioritize dams for mitigation. Priority dams have been identified in New York by New York Rivers United. A province-wide project to inventory dams in Ontario will include a registration program by 2012.
- Many dams in Ontario are being retrofitted for hydropower, and the licensing procedures provide an opportunity to improve connectivity between tributaries and the lake.
- A comprehensive bi-national database of the dams in the watershed, describing current use and ownership, does not exist, but efforts in both countries may combine to produce this important source of information.

Several participants have cautioned that aquatic invasive species like the sea lamprey and VHS complicate the issues of connectivity, fish passage, and dam removal. Conservation Ontario notes: "*Not all dams and barriers are a problem. Many are needed to help separate native and non-native species – being able to partition streams may be a key management tool for programs like the Atlantic salmon recovery project*" (written comments on an earlier draft of this report, Jan. 18, 2009) Clearly, decisions about fish passage or dam removal need to be assessed on the basis of local conditions.

BEST BET ACTIONS:
***** *Work with International Joint Commission to establish a bi-national working group to finalize a regulation plan for Lake Ontario/St. Lawrence (LOSL) that "moves toward natural flows, while respecting other interests."*
* *Provincial and state agencies join with federal partners to implement monitoring of key indicators of the impacts of a new regulation plan on coastal wetlands and species. These indicators, and the models that predict their responses, have already been developed by the IJC's (International Joint Commission) LOSL study, and therefore the elements necessary for adaptive management of the lake ecosystem are already in place.*
* *Establish a barrier mitigation task force to prioritize barriers for near-term mitigation, and to define best practices for operation and siting of hydropower facilities.*

Strategy 3.1: Remove or mitigate the impacts of priority dams and barriers to restore fish passage and natural processes.

While a more detailed, basin-wide inventory is required to prioritize dams for action, many key sites which provide opportunities for mitigation in the near-term are known. However, a key challenge to this strategy is the possibility of increased access to upstream areas for invasive species like the sea lamprey or pathogens like VHS once a dam has been removed.

Priority areas for implementation: Sandy Creek, Oswego River, Hamilton Harbour watershed, Credit River, and Durham Region are all target areas for dam removal; fish passage is a priority strategy in Braddock Bay, Oak Orchard-Johnson Creek, and Trent River-Rice Lake.

Key Steps for the Next Five Years
LaMP agencies form a bi-national barrier mitigation task force to define criteria for prioritization, and develop a bi-national consensus on priority barriers for near-term mitigation action, by 2011. • *Update the current database and map of barriers to lake-to-tributary connectivity to achieve a bi-national inventory of dams, identifying the status, ownership, and use of each dam.* • *Define criteria for prioritizing dams for action: possible criteria include first barrier; relative habitat gain for fish; Species at Risk benefits; diadromous fish habitats; ownership; community support, and renewable energy needs.* • *Among all non-functional dams, prioritize dams for removal or mitigation (this process is complete in NY, and will be completed in Ontario – many Conservation Authorities have this information).*
By 2015, remove and/or mitigate a minimum of 10 high priority dams and barriers to restore fish passage and riverine processes. • *Project leads must be identified for each project, to seek necessary approvals and funding.* • *In each case, assessment will be necessary to determine how to prevent spread of invasive species or pathogens.*
By 2015, assemble existing education materials and create a standard education package for dams on private lands. • Hundreds of small dams in the bi-national watershed are on private land. • Increasing the awareness of landowners about the impact and liabilities of private dams may encourage mitigation. • The goal is to reach 75% of private owners, and receive feedback from 30% of those reached.

Strategy 3.2: Enhance environmental guidelines for siting and operations of all new hydropower facilities.

Demand for hydropower is increasing, and several tributaries in the Lake Ontario watershed have been identified as potential sites for new facilities, or for retrofitting existing dams. New hydropower facilities in the basin need to maintain riverine fish habitats and improve conditions where possible. This strategy has particular relevance in Ontario, where new hydropower facilities are being considered on numerous streams throughout the province.

Key Steps for the Next Five Years
By 2011, the bi-national barrier mitigation task force will develop guidelines/criteria on how all new facilities should be sited and operated to maintain and enhance habitats for fish.
Meet with Ontario Waterpower Association (OWPA) to present guidelines and ensure conservation-based input into new projects.

Strategy 3.3: Restore more natural hydrologic periodicity to Lake Ontario through a new regulation plan, and monitor impacts on coastal habitats.

In September, 2008, the IJC announced its intention to withdraw the previously-recommended regulation plan, Plan 2007, and develop a new "regulation package, in combination with mitigation and adaptive management measures" that will "move towards more natural flows to benefit the environment, while respecting other interests" (Letter from the Commission to Secretary of State Condoleezza Rice and Minister of Foreign Affairs, September 4, 2008).

This recent step requires a revision of previous strategies to restore more natural flows in the St. Lawrence River. The steps recommended below reflect the results of recent discussions with agency personnel, but do not necessarily represent a consensus on the part of project participants.

Key Steps for the Next Five Years
In 2009, bi-national partners work with the IJC to assemble working group to build on existing information and models in proposing a regulation plan for LOSL.
By 2010, New York agencies develop shoreline restoration plan, with comprehensive approaches to shoreline property and infrastructure. • *LaMP agencies organize a bi-national group to consider best management practices for shoreline hardening. Consider organizing a symposium engaging representatives from other lakes and shoreline property interests.*
By 2010, LaMP agencies work with IJC staff to refine adaptive management program to complement a new regulation plan.

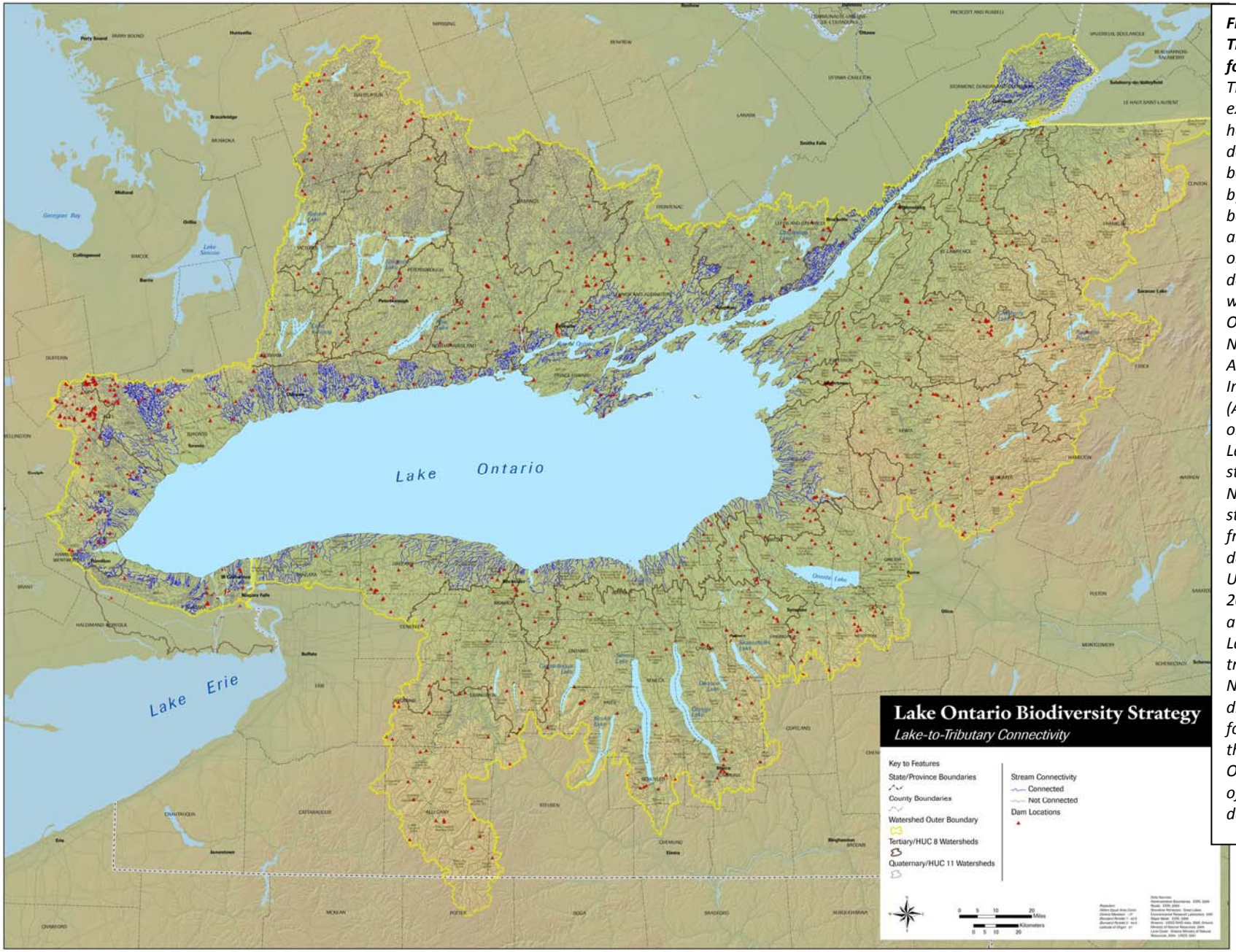


Figure 5.2: Lake to Tributary Connectivity for Lake Ontario
This map shows the extent of tributary habitat that is downstream of the first barrier and is accessible by fishes that migrate between Lake Ontario and its tributaries. Data on tributary habitat downstream of barriers were available from Ontario Ministry of Natural Resources in the Aquatic Landscape Information System (ALIS). Comparable data on migration barriers for Lake Ontario tributary streams and rivers in New York were part of a stream habitat fragmentation model developed by Cornell University (Meixler et. al. 2003) Data were not available for the St. Lawrence River tributaries in Ontario or New York. In addition, discrepancies were noted for three tributaries in the Niagara region of Ontario. Future versions of this map will add new data and corrections.

Recommendation #4: RESTORE NATIVE FISH COMMUNITIES, NATIVE SPECIES & AQUATIC ECOSYSTEMS

Like all the Great Lakes, the food web of Lake Ontario has been highly altered by over-fishing, damming of tributaries, pollution of nearshore waters, and the impacts of invasive species. A former top predator, the Atlantic salmon, which ascended high into the tributaries to spawn, is now extirpated from the lake, likely from degradation of spawning areas (including dams), the introduction of alewife, over-harvest and the sea lamprey. An active restoration program for Atlantic salmon, supported by private funds, is progressing in three tributaries in Ontario. Another top predator, the lake trout, is only present in the lake today because of stocking, although some natural reproduction has apparently resumed at low levels. Lake sturgeon reproduction is occurring in several areas, and active restoration efforts are underway in both Ontario and New York. Many of the native coldwater prey fish species are gone from the lake, although the lake whitefish still persists in low levels in the Kingston Basin, and small lake herring populations remain along the southern and eastern shores.

Opportunities exist to restore portions of this food web, and restoration of native species and communities is both a LaMP priority and a goal of the Great Lakes Fishery Commission's Lake Ontario Committee

Today, several challenges impede efforts to restore portions of the native food web:

- invasive species such as the round goby, alewife, sea lamprey, water fleas, and Dreissenid mussels interfere biochemically with reproduction of top predators (alewife), depress fry survival through predation (alewife and goby); parasitize the adult fish (lamprey); replace and put predation pressure on native food resources (water fleas); and alter energy flows through the lower levels of the web (mussels).
- stocking of non-native Pacific salmonids and rainbow trout has been used effectively as a technique to control alewife populations and develop a presence of top predators in the ecosystem. Several reviewers of earlier drafts of this report have noted that the interplay between alewife populations, Pacific salmonids, and native species is very complex and the challenges of restoring native species, particularly top predators, should not be underestimated. For example, the resurgence of native species in Lake Huron may be the result of the collapse of alewife due to increased natural reproduction by Chinook salmon. Participants in this project emphasized restoration of native prey fish, such as the lake herring, whitefish, and bloater, to set the stage for increased natural recruitment of native predators like the lake trout.
- public demand for stocked sport-fish could limit efforts by agencies to restore native species.

BEST BET ACTIONS:

** Pursue restoration of selected native Coregonid species, with monitoring to assess the effectiveness of juvenile stocking compared to egg releases. The Great Lakes Regional Collaboration, the CWCS, and the OGLECC report all recommend these steps.*

** Implement restoration plans for the American eel and lake sturgeon.*

** Engage sportfishing stakeholders in restoration of native species.*

Strategy 4.1: By 2020, restore and maintain elements of the native fish community, including top and middle level predators that can act as biological control agents for key invasive species.
(Key native fishes for restoration: lake sturgeon, American eel, lake trout, Atlantic salmon, bloater, lake herring, lake whitefish)

Priority areas for implementation: Most of the priority watersheds were identified as sites at which restoration of one or more of the focal native fish was feasible. Watersheds of particular note (three or more species) are Sandy Creek and embayments (NY), the Ontario bays (NY), Jordan Harbour (ON), Hamilton Harbour (ON), Credit River (ON), and Bay of Quinte/Trent River (ON).

Key Steps for the Next Five Years
By 2010, make LaMP ecosystem indicators consistent with the measures of the lake trout, sturgeon, American eel, cisco, and Atlantic salmon Great Lakes Fisheries Commission management plans.
By 2012, work with sport-fishing interests to develop support for the restoration of native species. • *DFO is conducting an inventory, evaluation and gap analysis of aquatic protected areas in a study for GLFC.*
By 2012, establish fish habitat partnerships, including partnership with sport-fishing groups, to raise funds to assist in native fish species restoration.

Recommendation #5: RESTORE THE QUALITY OF NEARSHORE WATERS

Non-point source pollution of tributaries and nearshore waters from urban, suburban, and agricultural sources can lead to algal blooms in nearshore waters that alter water chemistry, decrease oxygen levels, and may combine with actions of invasive mussels to alter chemical and species composition in the littoral zone. This is an issue of particular importance in the urban settings of the western basin, but research in New York has revealed high nutrient levels in nearshore waters adjacent to rural settings as well. The proposed bi-national target for phosphorus concentration in nearshore waters is 15ug/litre.

The population of the western basin of Lake Ontario is projected to grow by 3.7 million by 2031. In anticipation of the environmental issues, including increased non-point and stormwater runoff, which are likely to occur as a result of this rapid population growth, provincial policies in Ontario are emphasizing low impact development and accelerated natural heritage system planning, among other initiatives. The proposed strategies and action steps reflect these initiatives.

BEST BET ACTIONS:
** Prioritize watersheds for action (Figure 6.3 represents a proposed completion of this step.)*
** Increase funding for agricultural best management, and target funding in priority watersheds.*
** Purchase or lease sensitive floodplain lands in priority watersheds.*
** Develop and implement urban stormwater standards for water balance to be applied in all new developments.*

Strategy 5.1: Target best management practice efforts in rural areas of priority watersheds to restore natural sediment and phosphorus cycles in nearshore waters.

Priority areas for implementation of this strategy: During the third workshop, the project team identified 18-Mile Creek, Salmon Creek, Oak Orchard Creek in NY; and Humber River, Credit River, and 16-Mile Creek in Ontario as the watersheds requiring the greatest amount of restoration effort.

Key Steps for the Next Five Years
Prioritize watersheds: by 2010, complete prioritization of Lake Ontario quaternary/11-digit watersheds for restoration or conservation action. • *An initial version of this prioritization was an outcome of the fourth workshop and subsequent discussion, and is presented in Figure 6.3.*
Allocate more funds for stream restoration. Target resources for BMP assistance to priority watersheds – increase BMP funding by 25% by 2010 in both countries. • *Conservation Authorities question whether a percentage increase is a useful measure of progress, and recommend basing this goal on the costs of the Healthy Watersheds/Healthy Great Lakes programs.* • *Conservation Ontario notes: Watershed plans, rural water quality improvement programs, and stewardship programs led by Conservation Ontario and local Conservation Authorities and municipalities are examples of positive efforts to reduce rural and urban water quality impacts. However, a lack of funding for non-Area of Concern (AOC) watersheds has limited opportunities for progress in implementing best management practices (Written comments, January 18, 2009).*
By 2015 reduce phosphorus loading from 5-6 priority tributaries to achieve nearshore concentrations of 15 ug/L. • *Conservation Authorities point out that the goal of 15 ug/L has already been achieved for many areas in the Durham region, and propose that the nearshore goal be revised to 10ug/L.* • *Complete watershed plans by 2012, targeting specific priority areas through stressed stream analysis.* • *Provide soil testing and nutrient management services to priority farms.* • *Purchase or lease sensitive lands, with emphasis on stream buffers – buffer active river areas identified through floodplain analysis.*

Strategy 5.2: Within urban areas of targeted watersheds, reduce sediment and phosphorus from urban non-point sources through three-prong approach – controls at source, conveyance, and end-of-pipe levels.

Priority areas for implementation: Project participants identified western and northern watersheds as the primary areas where this strategy is needed. Jordan Harbour, Hamilton Harbour, Bronte/16 Mile Creeks, Durham Region, Ganaraska/Cobourg, and Trent River/ Rice Lake (all located in Ontario) led the list of action sites for implementation of urban non-point controls.

Key Steps for the Next Five Years
By 2010, prioritize watersheds for action (see Strategy 5.1 above)
Complete watershed plans in 5-6 priority watersheds by 2012 (see Strategy 5.1 above)
Develop urban stormwater standards for water balances that will be used in all new developments in target watersheds, by 2015. • *Appropriate partners develop standards, using widely accepted LEEDS standards, and propose these standards through LaMP and agency channels.* • *Partners present and discuss standards with municipal governments – standards ideally adopted by 80% of municipalities in targeted watersheds.* • *Partners conduct outreach to developers, seeking 80% agreement and use.* • *MOE updates Ontario stormwater objectives – opportunity to introduce and adopt Low Impact Development (LID) stormwater techniques.* • *Partners in targeted watershed promote concepts and methods of low impact development (LID).*
Outreach programs to municipal governments and homeowners adjacent to high-risk stream reaches reduce peak flows by 10% by 2015 • *Conservation Authorities propose that these outreach programs should emphasize the effects of shoreline hardening, and provide alternatives to this practice, as a step toward a lake-wide goal of less than 20% hardened shorelines in priority watersheds by 2020.* • *Shoreline conservation could be promoted through Official Plans in Ontario.*
Increase riparian and coastal natural cover – by 2015, restore stream and coastal buffers and wetlands to reduce peak flows in 20% of stream miles • *Watershed plans identify high-risk stream reaches.* • *Conservation Authorities incorporate fisheries management objectives into CA watershed planning.* • *Project partners secure funding for protection and restoration from federal and provincial/state sources.*

Recommendation #6: Plan Adaptations to Climate Change

Recent models of the impacts of climate change on Great Lakes ecosystems predict increased severity of storms, leading to increases in peak flows of tributaries accompanied by increased runoff of sediment and nutrients; increasing temperatures leading to decreased winter ice cover, increased evaporation resulting in declining lake levels; and increasing tributary water temperatures, accompanied by decreasing reproductive success in fish species, among other effects. Average lake levels may decline by several meters, with unknown impacts to coastal wetlands and the littoral zones of the lakes.

Our discussions on adaptation strategies focused on detailed bathymetry of the nearshore area, to identify vulnerable coastal areas; watershed planning leading to basin-wide efforts for land-use policies encouraging coastal and riverine buffer zones; and watershed management focused on maintaining the natural range of variation in hydrologic regimes.

BEST BET ACTIONS:
***** *Assemble a detailed bathymetry of nearshore waters linked seamlessly to coastal topography to permit mapping of critical nearshore habitats and modeling of the potential impact of lower lake levels. (Note: this topo-bathymetry database is already being assembled for New York waters by NOAA Coastal Science Center, in partnership with The Nature Conservancy. This process needs to be matched with a similar effort in Ontario.)*
** Take steps to manage streams as natural systems – use the natural range of hydrologic variation as the baseline for assessing the impact of proposed withdrawals and climate change. The anticipated legislation in New York and Ontario to implement the Great Lakes Compact provides an excellent opportunity for progress toward this objective.*
** As a step toward re-establishing natural flows in the St. Lawrence River, assemble the bi-national adaptive management working group described under Recommendation #3.*

Strategy 6.1: Through watershed planning and management, provide corridors and linkages to facilitate species migrations and shifts in ecological communities.

Connectivity must be a key component of an adaptation strategy to allow species and ecological systems to migrate in response to shifting habitat conditions. This connectivity must include both terrestrial linkages and maintenance of a flexible land-water interface to allow shifts in coastal wetlands, beaches, and other natural communities.

Key Steps for the Next Five Years

Develop linked reserves: By 2011, plan and begin to implement a single, basin-wide natural heritage system to accommodate habitat shifts.

- *By 2011, assemble and employ GIS tools to identify key habitats and corridors connecting zones of natural cover, both terrestrial and aquatic.*
- *Complete LIDAR bathymetry of nearshore zone, and model how declining lake levels may affect coastal wetlands and fish spawning areas, by 2012.*
- *Develop land use policies to support a natural heritage system that will protect coastal areas most impacted by hydrologic change.*
- *Share results with municipalities, to increase understanding and influence on local land-use decisions.*
- *As part of IJC process, develop basin-wide monitoring of coastal wetlands and other nearshore habitats.*

Buffer streams and coasts - by 2020, protect and restore an additional 10,000 ha (24,700 acres) and 100 stream kilometers (62 miles) of critical habitats identified in the bi-national natural heritage system.

- *Refine goals for protection based on the analysis described above.*
- *As a component in watershed plans, complete scenarios to determine feasibility of habitat corridors.*

Strategy 6.2: Adapt the regulation of Lake Ontario and watershed management regulations to accommodate the impacts of climate change.

Climate change is projected to decrease the water levels of Lake Ontario and increase the frequency and severity of storm events. Impacts to existing infrastructure as a result of these storms could affect coastal habitats and water quality.

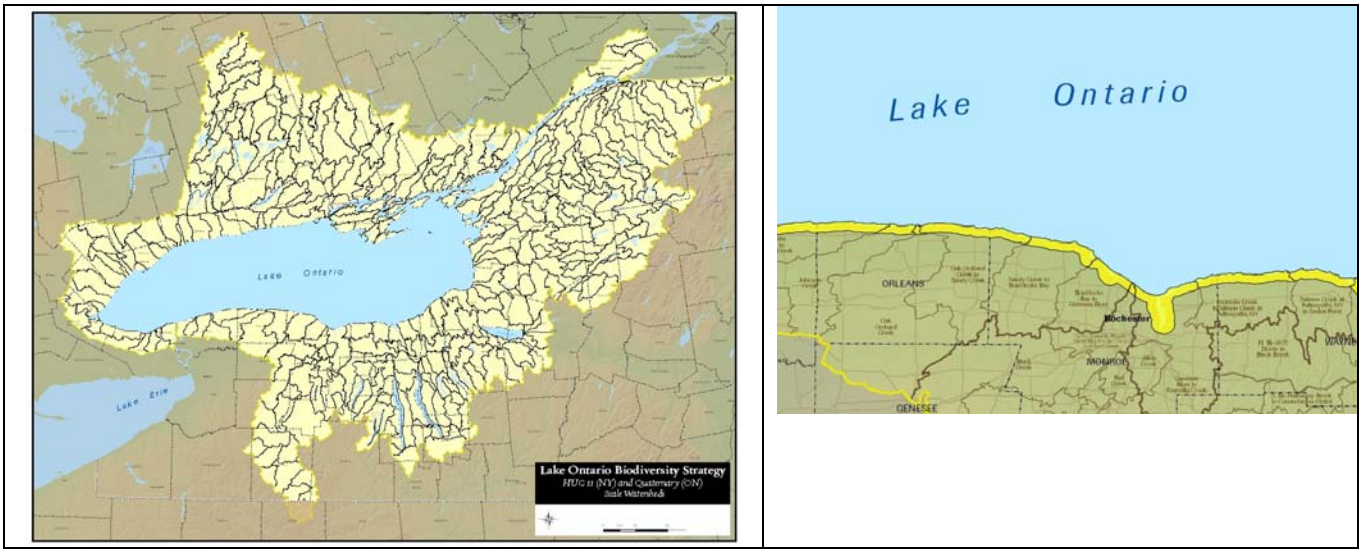
Key Steps for the Next Five Years
IJC adaptive management of Lake Ontario regulation incorporates climate change into 5-year reviews. • *In 2009, ensure adoption of regular adaptive management review as part of a new regulation plan.* • *Key partners develop monitoring program for regular reporting to the IJC of water management impacts on coastal habitats.* • *Shoreline management agencies in both countries develop policy to protect and maintain "new" shoreline that may emerge if water levels decline, including restrictions on moving existing shoreline protection structures.*
By 2009, create Lake Ontario LaMP environmental adaptive management working group to assess impacts of climate change on biodiversity and inform water management policies and actions. • *Organize multi-stakeholder working group.* • *Create impact assessment process and establish baseline, using scientific research from IJC study.*
By 2012, New York and Ontario take steps to manage streams as natural systems – watershed-based base flow monitoring programs that incorporate natural range of variability (NRV) and expected impacts under climate change scenarios. • *Develop funding sources and support services for watershed approaches to water management.* • *Generate watershed-based baseline information and guidelines for responses to low water conditions.* • *In Ontario, review outcomes of instream flow requirement studies and water budgets (major partners in these efforts include Conservation Ontario, Ministry of Environment, MNR, Conservation Authorities, and DFO).* • *Develop report on "How much water is enough" to support stream flow management.*
By 2012, Ontario and New York revise stormwater regulations to accommodate NRV and climate change impacts. • *In Ontario, establish a working group to develop stormwater and instream flow regulations to address both flood and drought conditions in a coordinated manner.* • *In NY, re-assess regional rule curves to incorporate climate change, assess frequency of water events, and inform municipalities.* • *In NY, develop an instream flow numerical standard incorporating NRV.*

6. Priority Areas for Conservation Action – A Recommended Framework

The strategies presented in the preceding section must be implemented at both lake-wide and local scales. Workshop participants and LaMP agencies recognized a need to pursue strategies that will benefit the lake ecosystem as a whole, and also to work in biological "hot spots" in the Lake Ontario/Upper St. Lawrence River basin where actions to benefit coastal wetlands; nearshore waters; tributaries and estuaries; coastal terrestrial habitats such as beaches, dunes, and bedrock shores; islands; and migratory fishes will have the largest beneficial impacts on the lake ecosystem.

To identify these "hot spots", we examined the entire watershed of the lake in HUC-11/quaternary watershed units (see Appendix A.2 for a list of Lake Ontario watersheds included in the analysis). We also organized data on the nearshore zone in coastal units, defined as encompassing the nearshore waters to 20 m depth, the coastal terrestrial zone to 2 km inshore, and bounded by the HUC-11/quaternary watershed boundaries. Figure 6.1 illustrates the HUC-11/quaternary watersheds, and the coastal units.

Figure 6.1: HUC-11/Quaternary Watersheds and Example of Coastal Units



We then used the bi-national GIS database assembled for this project to rate the relative biological significance and condition of each watershed or coastal unit. The criteria for these ratings were developed in consultation with expert project participants through a series of conference calls prior to the fourth workshop. Table 6.1 below presents the criteria used to evaluate each watershed and coastal reach for five of the biodiversity targets.

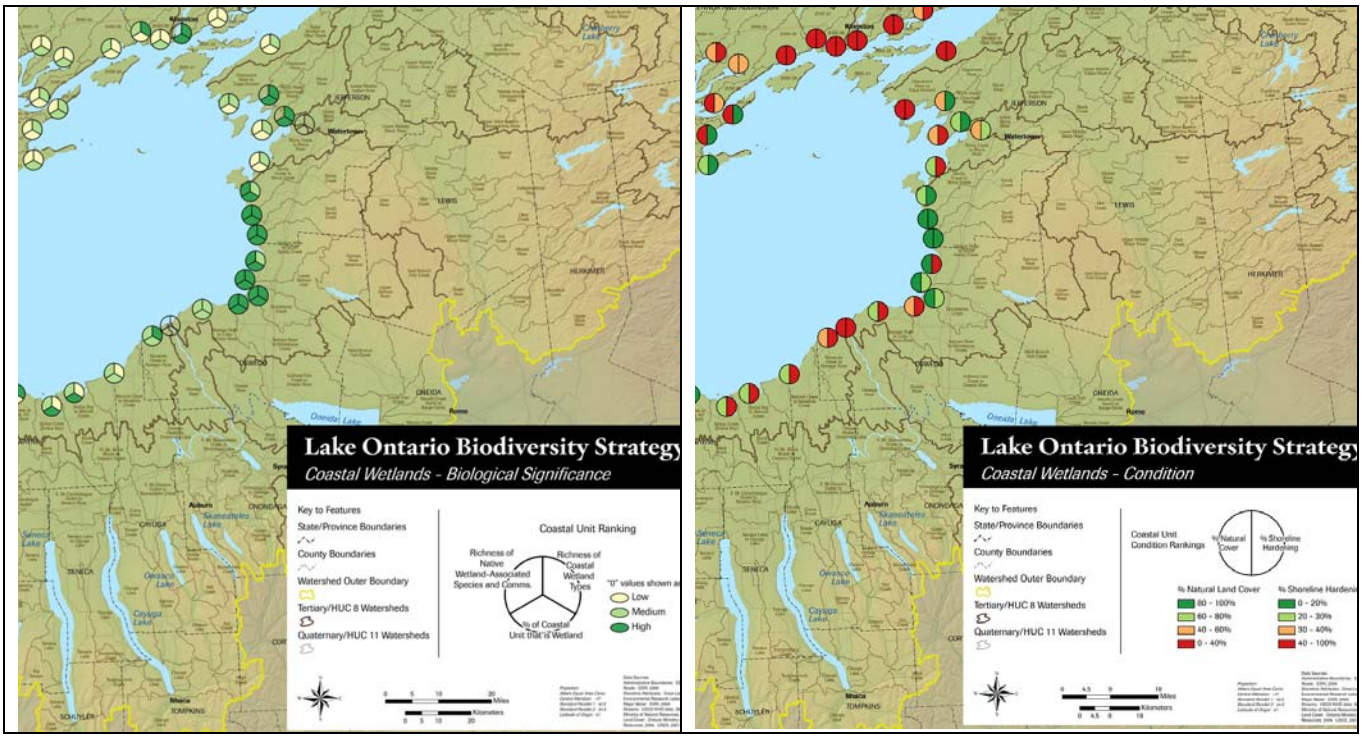
Table 6.1: Evaluation Criteria for Watersheds and Coastal Reaches for Five Selected Biodiversity Targets

	Biological Significance	Condition
Coastal Wetlands	- Number of native wetland-associated species and natural communities - Number of coastal wetland types - Percent of coastal unit that is wetland	- Percent natural land cover within coastal unit - Percent of shoreline with manmade structures
Nearshore Zone	- Number of native nearshore zone-associated species and communities - Number of nearshore subaqueous types (e.g. resistant / non-resistant bedrock, clay, sand)	- Percent of shoreline with manmade structures - Watershed land disturbance index - Contributing area of watershed
Coastal terrestrial	- Number of native terrestrial-associated species and communities - Number of shoreline geomorphic types (e.g. cohesive bluffs, low banks, coarse beach)	- Percent of shoreline with manmade structures - Watershed land disturbance index - Contributing area of watershed
Migratory Fish	- N/A	- Percent of total stream length within the watershed connected to Lake Ontario - Percent natural cover within watershed
Tributaries	- Total number of native fish species - Fish and mussel rarity - Fish irreplaceability	- Natural cover - Agricultural land cover - Tributary connectivity

The detailed maps resulting from this ranking process are included in Appendix B. Included below are two examples of maps that rank the biological significance and condition of the coastal wetlands in representative coastal units. The “pie” symbols provide rankings for richness of native wetland-dependent species and communities; richness of coastal wetland types; and percent of the coastal unit that is wetland – the biological significance rankings. Wetland condition is evaluated by two measures – percent natural land cover within the surrounding coastal unit (the left half-circle in Figure 6.2 below), and percent of shoreline within the coastal unit that has been altered by shoreline hardening or jetties (the right half-circle).

These criteria are not represented as exhaustive, but we have complete and comparable data for these criteria throughout the bi-national watershed. At a minimum, use of these criteria provides a starting point for expert discussion to identify top priority coastal units and watersheds where conservation action will most clearly benefit the lake ecosystem.

Figure 6.2: Example of Rankings of Biological Significance and Condition – Coastal Wetlands



These maps guided discussion in this project's fourth workshop, when project participants were organized in discussion groups focused on biodiversity targets (i.e. nearshore zone, coastal wetlands, coastal terrestrial habitats, tributaries, and migratory fish) that can directly benefit from place-based action. Each discussion group of experts in the fourth workshop was asked to identify the HUC-11/quaternary watersheds or coastal units where conservation action was most needed and would have greatest benefit to a conservation target or targets. Groups were also asked to be as specific as possible about the strategic actions needed for each place.

Figure 6.3 presents the results of these discussions, with watersheds color-coded based on the number of the discussion groups that highlighted each place as important for a particular biodiversity target. This figure is supplemented with a table that summarizes the significance of each watershed and coastal unit, and the conservation actions that experts deemed most needed in each site.

Since it was not possible to staff each discussion group with experts familiar with each watershed, the workshop discussions have been augmented with information from relevant Conservation Authorities, and existing watershed plans (where available). Assessments of needs for some watersheds are more complete than for others, and it is intended that future drafts of this plan will reflect additional information.

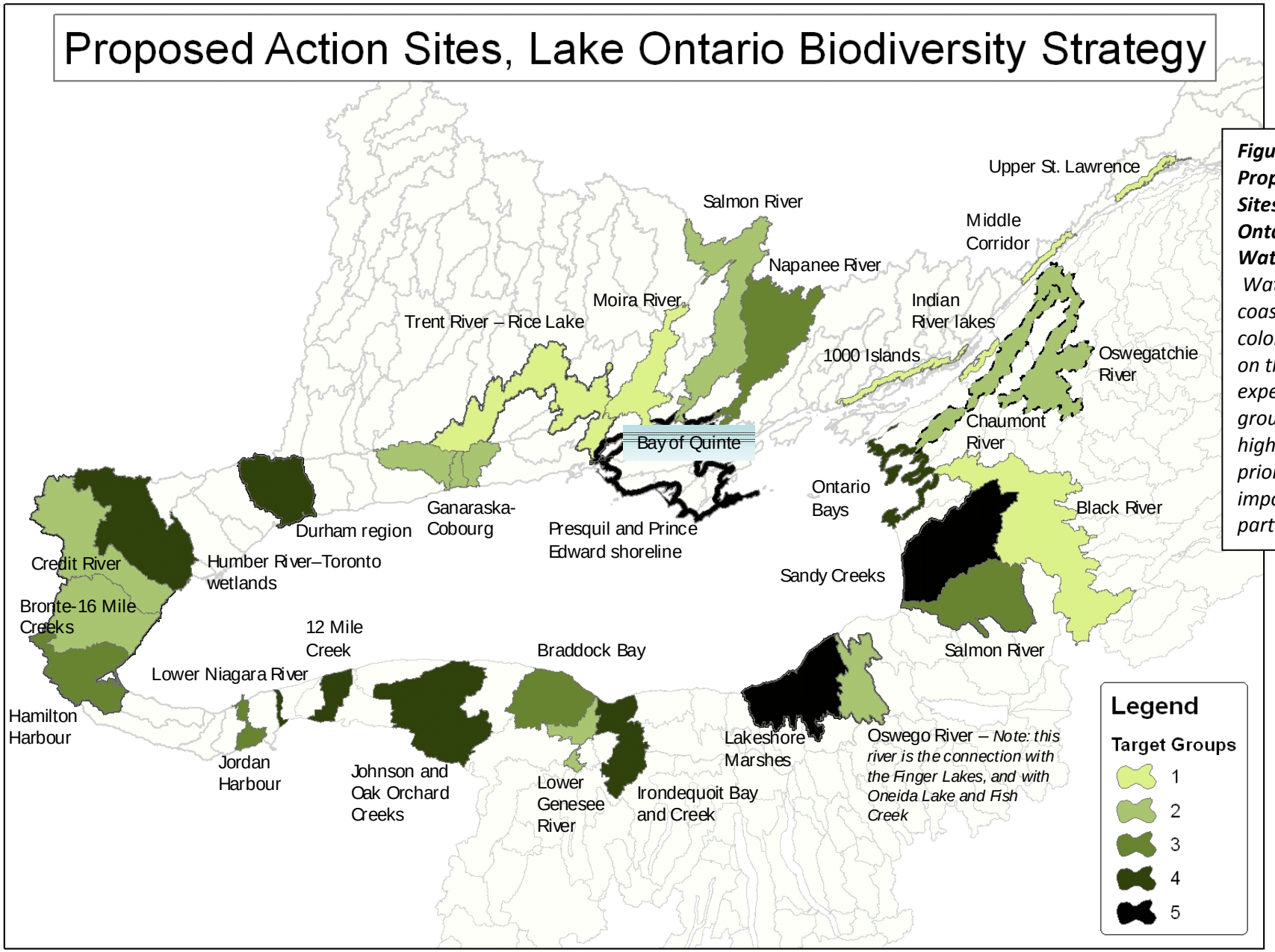


Figure 6.3: Proposed Action Sites Across Lake Ontario Watersheds *Watersheds and coastal units are color-coded based on the number of expert discussion groups that highlighted each priority site as important for a particular*

Table 6.2: Priority Action Sites for Implementation of Strategies – Importance and Recommended Actions

Site	Biological Importance	Recommended Actions/ Comments
Ontario Bays	• both Chaumont River and Black River empty into this series of bedrock shoreline embayments in New York • extensive marshes are degraded with invasive plants, but Blanding's turtle and black tern are found here • embayments and river mouths, and the shoals offshore (Johnson shoals) are important for lake whitefish and lake herring • both historical and active bald eagle nests can be found along the shoreline, and the site is a priority for the LaMP Bald Eagle Recovery Plan	• buffer wetlands and river mouths with protected land in natural cover • reduce sediment runoff into river mouths – rocky shoals are important for herring/whitefish spawning • restore natural hydrologic periodicity to Lake Ontario – wetlands are shaped by natural fluctuations in water levels • restore populations of lake whitefish and lake herring
Black River	• large river system with historic importance for Atlantic salmon, lake sturgeon and American eel	• enhance fish passage at dams
Sandy Creeks and Embayments	• 17-mile barrier beach/dune ecosystem with sheltered lagoons, coastal fens, globally-rare species • nesting black terns • 3 historic bald eagle nest locations, and the site is a priority for the LaMP recovery plan • Sandy Creek has historic importance for Atlantic salmon, American eel, whitefish and lake herring	• restore natural hydrologic periodicity of Lake Ontario – wetlands and beaches shaped by natural fluctuations (this strategy applies to all sites with wetlands, embayments, or beaches) • dam mitigation/removal, but VHS is complicating factor (This may be a long-term strategy once VHS issue is resolved - dams for mitigation have already been identified) • complete watershed planning for Sandy Creeks • complete management plans on public lands • land protection in active river areas and to buffer wetlands • reach out to private landowners • reduce non-point loading from septic systems and upstream agriculture • respond to early infestations of several invasive plants (including water chestnut) in the wetlands, and address established invasives such as purple loosestrife with biocontrol • restore coastal marshes through control of dense cattail stands and floating mats

Site	Biological Importance	Recommended Actions/ Comments
Salmon River	• river system goes deep into Tug Hill forest, and rich estuary was source of sediment to eastern shore beaches • historic importance for Atlantic salmon • major spawning system for stocked and naturalizing Pacific salmonids	• complete watershed planning
Oswego River	• keystone river system that connects the Seneca River, Finger Lakes, and Oneida Lake and tributaries, to Lake Ontario • provided access to spawning grounds for Atlantic salmon and feeding areas for American eel • the mouth of the river also was important for lake sturgeon spawning, although the population appears extirpated (lake sturgeon restoration plan in draft)	• fish passage around dams, with trap-and-transfer techniques to exclude lamprey • determine whether river mouth is currently suitable for stocking lake sturgeon
Lakeshore Marshes	• a series of small creeks and embayments, with diverse coastal wetlands • extensive submerged aquatic beds • embayments are possible restoration sites for lake herring • this area has 3 historic bald eagle nesting locations, and is a priority recovery site	• protect lands buffering wetlands and riverine corridors • restore lake herring • complete and implement management plans on public lands – harbour management plan for Sodus Bay • reduce dominance of aquatic invasive plants • outreach to local governments – septic/sewer upgrades and BMPs for urban runoff
Irondequoit Bay and Creek	• large embayment (6.4 km/ 4 miles in length) formed by drowned mouth of ancient Genesee River • major streams have uninterrupted connectivity with Lake Ontario • possible restoration site for lake herring	• evaluate restoration potential for lake herring
Lower Genesee River	• active stocking site for lake sturgeon, with evidence of survival	• Rochester Embayment Remedial Action Plan (RAP) is being implemented
Braddock Embayments	• extensive submerged aquatic beds • baymouth barrier beaches and shoreline bluffs with sand nearshore • tributaries to southern Lake Ontario bays: lakeplain wetland- and groundwater-fed streams • coastal ponds and embayments connected to the lake • extensive wetlands with diverse bird community – American bittern, sedge wren, black tern (population appears extirpated)	• reduce phosphorus loading to ponds through riverine buffers and BMPs • municipal sewage upgrades • new building design standards for water balance • screen culverts for mitigation to restore connectivity to the lake • targeted land conservation (wetland and upstream buffers for Salmon Creek) • fish passage for low barriers on Sandy Creek • management plans for public lands • plan and protect corridors for species migration in response to climate change

Site	Biological Importance	Recommended Actions/ Comments
Western New York creeks – Johnson and Oak Orchard	• region is characterized by numerous short lakeplain streams • upper reaches of Oak Orchard watershed contain the Oak Orchard Wildlife Management Area and Iroquois National Wildlife Refuge – important stopover resources for migratory waterfowl and other birds. • the lower reaches of both Oak Orchard Creek and Sandy Creek were previously important feeding grounds for the American eel. • this southwestern portion of Lake Ontario in New York has high fish biodiversity, but needs further biological inventory. • high diversity of native mussels in the upper reaches of these streams.	• biological inventory of streams • floodplain and buffer protection for streams. • complete watershed planning for Oak Orchard and Johnson Creeks. • explore fish passage for Lake Alice Dam, and dam on Johnson Creek. • reduce non-point runoff into nearshore waters with buffer strips for creeks and BMPs (an active effort is underway under auspices of Lake Plain Soil and Water Conservation District).
12-Mile Creek	• High biological significance and species richness	• targeted land securement – stream buffers • influence management of private lands
Lower Niagara River	• Important spawning and nursery area for lake sturgeon.	• Continue efforts to restore lake sturgeon (USGS and USFWS are leading this effort.)
Jordan Harbour	• Harbour historically important feeding area for American eel • Includes one of the largest wetland features in Niagara Peninsula region and provides key habitat for a number of waterfowl species	• floodplain and buffer protection for streams • targeted land securement • restoration of creek mouth
Hamilton Harbour	• Cootes Paradise is an extensive wetland system under restoration • Former resource for American eel, whitefish and lake herring	• explore feasibility of restoring whitefish and lake herring • targeted land securement – stream buffers • reduce loading to nearshore through streamside buffers and BMPs • reduce sediment and phosphorus runoff from urban sources through 3-prong approach • watershed planning for corridors and linkages for species movement in response to climate change • complete management plans for public lands • explore “soft engineering” approaches to shoreline hardening • influence management of private lands
Bronte-16 Mile Creeks	• Bronte Creek – historic importance for Atlantic salmon	• restoration site for Atlantic salmon

Site	Biological Importance	Recommended Actions/ Comments
Credit River	• main constituent of "Golden Horseshoe" region with high fish/mussel diversity • Rattray Marsh is the last remaining baymouth bar coastal wetland between Oshawa and Burlington • source of all Pacific salmon raised for stocking in Ontario • historic importance for Atlantic salmon	• restoration site for Atlantic salmon • targeted land securement • complete management plans for public lands • work with private landowners to restore natural cover • restore stream buffers and wetlands to reduce peak flows • outreach to municipal governments – disconnect cross-connections between storm and sewer • design standards for new developments to restore water balance • watershed planning for corridors for species movement in response to climate change • explore "soft engineering solutions for shoreline hardening • reduce phosphorus loadings through BMPs and stream buffers • nutrient monitoring both watershed and subwatershed scale
Humber River – Toronto wetlands	• historic importance for Atlantic salmon • isolated wetlands in highly urbanized area	• restoration site for Atlantic salmon • targeted land securement • complete management plans for public lands • work with private landowners to restore natural cover • restore stream buffers and wetlands to reduce peak flows • outreach to municipal governments – disconnect cross-connections between storm and sewer • design standards for new developments to restore water balance • watershed planning for corridors for species movement in response to climate change • explore "soft engineering solutions for shoreline hardening
Durham region	• highly diverse coastal wetlands • historic importance for Atlantic salmon	• restore natural periodicity in water levels to Lake Ontario • restoration site for Atlantic salmon • reduce phosphorus loading to wetlands and nearshore through BMPs and stream buffers • restore stream buffers and wetlands to reduce peak flows • reduce dominance of aquatic invasive species – carp

Site	Biological Importance	Recommended Actions/ Comments
Ganaraska-Cobourg Creeks	• historic spawning site for lake sturgeon; judged to be suitable for stocking (Draft Lake Sturgeon Rehabilitation Plan) • historic site for Atlantic salmon	• priority site for restoration of Atlantic salmon • targeted land securement • complete management plans for public lands • work with private landowners to restore natural cover • complete watershed plans • reduce sediment and phosphorus runoff from urban sources • mitigate barriers to sediment transport – soft engineering of shoreline hardening
Trent River – Rice Lake	• major river system • mouth of the river just upstream from Bay of Quinte to Rice Lake has historic importance for American eel • potential spawning and nursery stream for lake sturgeon, with existing remnant population	• inventory and prioritization of barriers (dams and locks) that are barriers to fish passage (locks present 38 barriers to fish movement) • design operational guidelines for dams requiring recertification • retrofit existing dams with screens on turbine intakes • seek restoration of more natural flows through dam management • explore removal of selected dams • Partners for such a project could include appropriate Conservation Authorities, Parks Canada, MNR, DFO, other federal agencies • estimated cost for planning: $500K, with $1 million estimated cost to retrofit each dam
Presqu'ile and Prince Edward shoreline	• extensive barrier beach system with sheltered embayment wetlands; one of two such barrier beach systems remaining in Lake Ontario • area of high waterfowl use and high density of breeding pairs of waterfowl • priority area for restoration of bald eagle, with 7 priority sites identified • designated an Important Bird Area	• targeted land securement – buffers for Sandbanks Provincial Park and Wellers Bay, and protection of additional coastal areas • complete and implement management plans for public lands • work with private landowners to restore natural cover • complete watershed planning • reduce phosphorus loading through BMPs and buffers • manage streams as natural systems, incorporating NRV and expected climate change impacts

Site	Biological Importance	Recommended Actions/ Comments
Bay of Quinte	• lengthy embayment with extensive embayment and river mouth wetlands • important spawning resource for whitefish, herring • historic importance for American eel • Prince Edward Bay important resource for lake sturgeon	• restore natural periodicity in water levels to Lake Ontario • targeted land securement – buffer for wetlands • complete management plans for public lands • work with private landowners to restore natural cover • complete fish habitat management plan • need a specific strategy to combat spread of Common Reed • reduce sediment and phosphorus runoff from urban sources • plan and protect corridors for species migration in response to climate change
Thousand Islands	• bays, fringe wetlands, and diverse tributaries • SAR, including historic bald eagle nesting locations • colonial waterfowl nesting areas • raptor staging and migration areas	• targeted land securement – mature forests and stream buffers • restoration of natural vegetation (made difficult by the shallow overburden on pre-Cambrian rock • watershed planning – designed to address recreational and tourism pressures
Napanee River	• restoration site for lake sturgeon	• priority site for restoration of lake sturgeon

Appendix A.1: List of Participants

Ivette Bolender	Biohabitats, Inc.
Greg Grabas	Canadian Wildlife Service
Carolyn Bonta	Cataraqui Region Conservation Authority
Christine Woods	Cataraqui Region Conservation Authority
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Teresa Labuda	Conservation Halton
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Marci Meixler	Cornell University
Mark Bain	Cornell University
Bob Morris	Credit Valley Conservation
Christine Zimmer	Credit Valley Conservation
Hazel Breton	Credit Valley Conservation
Jon Clayton	Credit Valley Conservation
Scott Sampson	Credit Valley Conservation
James Atkinson	Department of Fisheries and Oceans
Mark Ferguson	Department of Fisheries and Oceans
Nick Mandrak	Department of Fisheries and Oceans
Susan Doka	Department of Fisheries and Oceans
Sheila Hess	Ducks Unlimited
Carolyn O'Neill	Environment Canada
Graham Bryan	Environment Canada
Greg Mayne	Environment Canada
Jennifer Vincent	Environment Canada
Rimi Kalinauskas	Environment Canada
Marcia Brown	Foundations of Success
Nick Salafsky	Foundations of Success
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Pam Lancaster	Ganaraska Region Conservation Authority
David Zorn	Genesee-Finger Lakes Regional Planning
Naureen Rana	Great Lakes Protection Fund
Lisa Jennings	Hamilton Region Conservation Authority
Lisa Riederer	Hamilton Region Conservation Authority
Rob Stavinga	Kawartha Region Conservation Authority
Anne Anderson	Lower Trent Conservation
Jeff Borisko	Lower Trent Conservation
Paul Johanson	Lower Trent Conservation
John Price	Mississippi Valley Conservation Authority
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R. Donald Maracle	Mohawks of the Bay of Quinte
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Gary Bell	Nature Conservancy of Canada
Gary White	Nature Conservancy of Canada
Mark Stabb	Nature Conservancy of Canada
Bruce Carpenter	New York Rivers United
Alison Thomson	Niagara Peninsula Conservation Authority
Deanna Lindblad	Niagara Peninsula Conservation Authority
Kim Frohlich	Niagara Region Conservation Authority
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Gregory Capobianco	NYS Department of State
Sarah Lazazzero	NYS Department of Transportation
Amy Mahar	NYSDEC
David Adams	NYSDEC
Donald Zelazny	NYSDEC
Doug Carlson	NYSDEC
Gary Neuderfer	NYSDEC
Heidi Kennedy	NYSDEC
James Eckler	NYSDEC
Jenny Landry	NYSDEC
Matt Sanderson	NYSDEC
Michael Connerton	NYSDEC
Richard McDonald	NYSDEC
Steven LaPan	NYSDEC
Tracey Tomajer	NYSDEC
Greg Edinger	NYSDEC -- Natural Heritage Program
Peter Roberts	Ontario Ministry of Agriculture, Food & Rural Affairs
Conrad DeBarros	Ontario Ministry of Environment
Alastair Mathers	Ontario Ministry of Natural Resources
Anne Bendig	Ontario Ministry of Natural Resources
Bill Crins	Ontario Ministry of Natural Resources
Bonnie Henson	Ontario Ministry of Natural Resources
Bruce Morrison	Ontario Ministry of Natural Resources
Colin Lake	Ontario Ministry of Natural Resources
Dawn Walsh	Ontario Ministry of Natural Resources
Gavin Christie	Ontario Ministry of Natural Resources
Jim Mackenzie	Ontario Ministry of Natural Resources
Julie Simard	Ontario Ministry of Natural Resources
Kate Maddigan	Ontario Ministry of Natural Resources
Laura Kucey	Ontario Ministry of Natural Resources
Les Stanfield	Ontario Ministry of Natural Resources
Mark Heaton	Ontario Ministry of Natural Resources
Mike McMurtry	Ontario Ministry of Natural Resources
Rob MacGregor	Ontario Ministry of Natural Resources
Todd Howell	Ontario Ministry of Natural Resources
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Sandy Bonanno	Oswego County
John DeHollander	Oswego County SWCD
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Angus McLeod	Parks Canada
Jeff Leggo	Parks Canada
Paul Zorn	Parks Canada
Brad McNevin	Quinte Conservation
Brendan Jacobs	Raisin Region Conservation Authority
Chris Critoph	Raisin Region Conservation Authority
Katherine Beehler	Raisin Region Conservation Authority
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Jennifer Lamoureux	Rideau Valley Conservation Authority
Charles Knauf	Rochester Embayment RAP
Julia Sutton	South Nation Conservation
Pat Pitz	South Nation Conservation
Jim Snyder	St. Regis Mohawk Tribe - Environment Div.
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Joseph Makarewicz	SUNY Brockport
Donald Stewart	SUNY ESF
John Farrell	SUNY ESF
Kim Schulz	SUNY-ESF
Andrew Beers	The Nature Conservancy
Brad Stratton	The Nature Conservancy
Chris Lajewski	The Nature Conservancy
Colin Apse	The Nature Conservancy
Darran Crabtree	The Nature Conservancy
Dave Ewert	The Nature Conservancy
David Klein	The Nature Conservancy
Elizabeth Marr	The Nature Conservancy
George Schuler	The Nature Conservancy
Gregg Sargis	The Nature Conservancy
Gretchen Wainwright	The Nature Conservancy
Jim Howe	The Nature Conservancy
Kristin France	The Nature Conservancy
Lindsay Chadderton	The Nature Conservancy
Lynne Eder	The Nature Conservancy
Mary Harkness	The Nature Conservancy
Michele DePhillip	The Nature Conservancy
Michelle Brown	The Nature Conservancy
Michelle Peach	The Nature Conservancy
Rob van der Stricht	The Nature Conservancy
Zach O'Dell	The Nature Conservancy
Adele Freeman	Toronto and Region Conservation Authority
Christine Tu	Toronto and Region Conservation Authority

Deb Martin-Downs	Toronto and Region Conservation Authority
Gary Bowen	Toronto and Region Conservation Authority
Gord MacPherson	Toronto and Region Conservation Authority
Jason Tam	Toronto and Region Conservation Authority
John Bartow	Tug Hill Commission
Katherine Malinowski	Tug Hill Commission
Robin Davidson-Arnott	University of Guelph
Tom Stewart	University of Toronto
Michael Greer	US Army Corps of Engineers
Anne Secord	US Fish and Wildlife Service
Betsy Trometer	US Fish and Wildlife Service
June DeWeese	US Fish and Wildlife Service
James McKenna	US Geological Survey
Robert O'Gorman	US Geological Survey
Fred Luckey	USEPA
Karen Rodriquez	USEPA
Mario Delvicario	USEPA

Appendix A.2: Lake Ontario Watersheds

MAP ID	QUATERNARY WATERSHED	QUATERNARY NAME	TERTIARY WATERSHED	TERTIARY NAME
67	2HA-01	Thirty Mile Creek	02HA	Niagara
105	2HA-02	Twenty Mile Creek	02HA	Niagara
25	2HA-03	Fifteen Mile Creek	02HA	Niagara
3	2HA-04	Twelve Mile Creek	02HA	Niagara
50	2HA-05	Upper Welland Canal	02HA	Niagara
55	2HA-06	One Mile Creek	02HA	Niagara
14	2HA-07	Welland River	02HA	Niagara
2	2HA-08	Fort Erie Creeks	02HA	Niagara
40	2HB-01	Appleby Creek	02HB	Credit River - 16 Mile Creek
118	2HB-02	Credit River/Rattray Marsh	02HB	Credit River - 16 Mile Creek
73	2HB-03	Sixteen Mile Creek	02HB	Credit River - 16 Mile Creek
79	2HB-04	Bronte Creek	02HB	Credit River - 16 Mile Creek
4	2HB-05	Grindstone Creek	02HB	Credit River - 16 Mile Creek
24	2HB-06	Red Hill Creek	02HB	Credit River - 16 Mile Creek
41	2HB-07	Spencer Creek	02HB	Credit River - 16 Mile Creek
49	2HC-01	Etobicoke Creek	02HC	Humber - Don Rivers
113	2HC-02	Mimico Creek	02HC	Humber - Don Rivers
38	2HC-03	West Humber River	02HC	Humber - Don Rivers
8	2HC-04	Humber River	02HC	Humber - Don Rivers
48	2HC-05	East Humber River	02HC	Humber - Don Rivers
82	2HC-06	Toronto Harbour	02HC	Humber - Don Rivers
80	2HC-07	Don River	02HC	Humber - Don Rivers
97	2HC-08	Highland Creek	02HC	Humber - Don Rivers
61	2HC-09	Rouge River	02HC	Humber - Don Rivers
58	2HC-10	Duffins River	02HC	Humber - Don Rivers
72	2HC-11	Lynde Creek	02HC	Humber - Don Rivers
42	2HC-12	Carruthers Creek	02HC	Humber - Don Rivers
70	2HD-01	Gage Creek	02HD	Ganaraska
108	2HD-02	Shelter Valley Creek	02HD	Ganaraska
62	2HD-03	Black/Harmony/Farewell/Oshawa Creeks	02HD	Ganaraska
31	2HD-04	Bowmanville Creek/Soper Creek	02HD	Ganaraska
119	2HD-05	Wilmot Creek	02HD	Ganaraska
121	2HD-06	Ganaraska River	02HD	Ganaraska
29	2HD-07	Baltimore Creek/Cobourg Brook	02HD	Ganaraska
76	2HE-01	Sawguin Creek North	02HE	Prince Edward Bay
46	2HE-02	Sawguin Creek South	02HE	Prince Edward Bay
12	2HE-03	Demorestville Creek/Smiths Creek	02HE	Prince Edward Bay
123	2HE-04	Melville Creek/Conescon Creek	02HE	Prince Edward Bay
87	2HE-05	Bloomfield Creek	02HE	Prince Edward Bay
96	2HE-06	Marsh Creek	02HE	Prince Edward Bay
34	2HE-07	Black Creek/Wapoos Creek	02HE	Prince Edward Bay
47	2HE-08	Cressy Creek	02HE	Prince Edward Bay
71	2HE-09	Hubbs Creek	02HE	Prince Edward Bay
110	2HE-10	East Lake	02HE	Prince Edward Bay
68	2HE-11	Point Petre - Long Point	02HE	Prince Edward Bay

MAP ID	QUATERNARY WATERSHED	QUATERNARY NAME	TERTIARY WATERSHED	TERTIARY NAME
5	2HF-01	Pearns Creek/Martin Creek	02HF	Gull
28	2HF-02	Staples River	02HF	Gull
112	2HF-03	Corben Creek	02HF	Gull
78	2HF-04	Union Creek	02HF	Gull
89	2HF-05	Irondale River	02HF	Gull
104	2HF-06	Burnt River	02HF	Gull
26	2HF-07	Gull River	02HF	Gull
111	2HF-08	Kennisis River	02HF	Gull
13	2HF-09	Drag River	02HF	Gull
20	2HF-10	East Redstone River	02HF	Gull
18	2HF-11	Redstone River	02HF	Gull
19	2HG-01	Stony Creek	02HG	Scugog
100	2HG-02	Lake Scugog	02HG	Scugog
95	2HG-03	Layton/Nonquon Rivers	02HG	Scugog
65	2HG-04	Scugog River	02HG	Scugog
116	2HG-05	Mariposa Brook	02HG	Scugog
90	2HG-06	East Cross Creek	02HG	Scugog
22	2HH-01	Pigeon River/Fleetwood Creek	02HH	Kawartha Lakes
7	2HH-02	Pigeon Lake	02HH	Kawartha Lakes
109	2HH-03	Sturgeon Lake	02HH	Kawartha Lakes
93	2HH-04	Miller Creek/Deer Bay Creek	02HH	Kawartha Lakes
59	2HH-05	Emily Creek	02HH	Kawartha Lakes
54	2HH-06	Redmond Creek	02HH	Kawartha Lakes
56	2HH-07	Eels Creek	02HH	Kawartha Lakes
120	2HH-08	Camp Creek	02HH	Kawartha Lakes
122	2HH-09	Squaw River	02HH	Kawartha Lakes
57	2HH-10	Nogie's Creek	02HH	Kawartha Lakes
114	2HJ-01	Otonabee River	02HJ	Otonabee
23	2HJ-02	Rice Lake	02HJ	Otonabee
63	2HJ-03	Indian River	02HJ	Otonabee
107	2HJ-04	Ouse River	02HJ	Otonabee
35	2HK-01	Trent River	02HK	Crowe
16	2HK-02	Cold Creek	02HK	Crowe
60	2HK-03	Salt Creek	02HK	Crowe
9	2HK-04	Percy Creek	02HK	Crowe
10	2HK-05	Rawdon Creek	02HK	Crowe
66	2HK-06	Hoards Creek	02HK	Crowe
51	2HK-07	Crowe River	02HK	Crowe
32	2HK-08	North River	02HK	Crowe
77	2HK-09	Beaver Creek	02HK	Crowe
37	2HK-10	Dickey Creek	02HK	Crowe
85	2HK-11	Deer River	02HK	Crowe
30	2HL-01	Meyers Creek/Potter Creek	02HL	Moira
11	2HL-02	Palliser Creek	02HL	Moira
103	2HL-03	Parks Creek	02HL	Moira
88	2HL-04	Clare River	02HL	Moira
74	2HL-05	Partridge Creek	02HL	Moira
84	2HL-06	Black River	02HL	Moira
106	2HL-07	Moira River	02HL	Moira

MAP ID	QUATERNARY WATERSHED	QUATERNARY NAME	TERTIARY WATERSHED	TERTIARY NAME
69	2HM-01	Blessington Creek	02HM	Napanee
21	2HM-02	Salmon River	02HM	Napanee
81	2HM-03	Depot Creek	02HM	Napanee
83	2HM-04	Wilton Creek	02HM	Napanee
115	2HM-05	Loyst Creek/Townline Creek	02HM	Napanee
86	2HM-06	Millhaven Creek	02HM	Napanee
39	2HM-07	Collins Creek	02HM	Napanee
52	2HM-08	Little Cataraqui Creek	02HM	Napanee
45	2HM-09	Amherst Island	02HM	Napanee
64	2HM-10	Sucker Creek	02HM	Napanee
92	2MA-01	Reeds Creek/Shanty Creek	02MA	Cataraqui
6	2MA-03	Wolfe Island North	02MA	Cataraqui
27	2MA-04	Howe Island	02MA	Cataraqui
43	2MA-05	Moores Creek	02MA	Cataraqui
15	2MA-06	Rideau Canal	02MA	Cataraqui
102	2MA-07	Loughborough Lake	02MA	Cataraqui
17	2MA-08	South Branch Plum Hollow Creek	02MA	Cataraqui
36	2MA-09	Fosters Creek	02MA	Cataraqui
33	2MB-01	Beaver Meadow Creek	02MB	Upper St. Lawrence - Thousand Islands
44	2MB-02	LaRue Creek	02MB	Upper St. Lawrence - Thousand Islands
91	2MB-03	Jones Creek	02MB	Upper St. Lawrence - Thousand Islands
1	2MB-04	Buells Creek	02MB	Upper St. Lawrence - Thousand Islands
53	2MB-05	Johnstown Creek	02MB	Upper St. Lawrence - Thousand Islands
124	2MB-06	Doran/Hilliard/Parlow Creeks	02MB	Upper St. Lawrence - Thousand Islands
99	2MC-04	Delisle River	02MC	Upper St. Lawrence - Raisin
75	2MC-06	Beaudette River	02MC	Upper St. Lawrence - Raisin
94	2MC-07	Creeks of South Glengarry	02MC	Upper St. Lawrence - Raisin
98	2MC-09	Raisin River	02MC	Upper St. Lawrence - Raisin
101	2MC-10	Grays Creek/Fraser Creek	02MC	Upper St. Lawrence - Raisin
117	2MC-12	Hoople Creek/Hoasic Creek	02MC	Upper St. Lawrence - Raisin