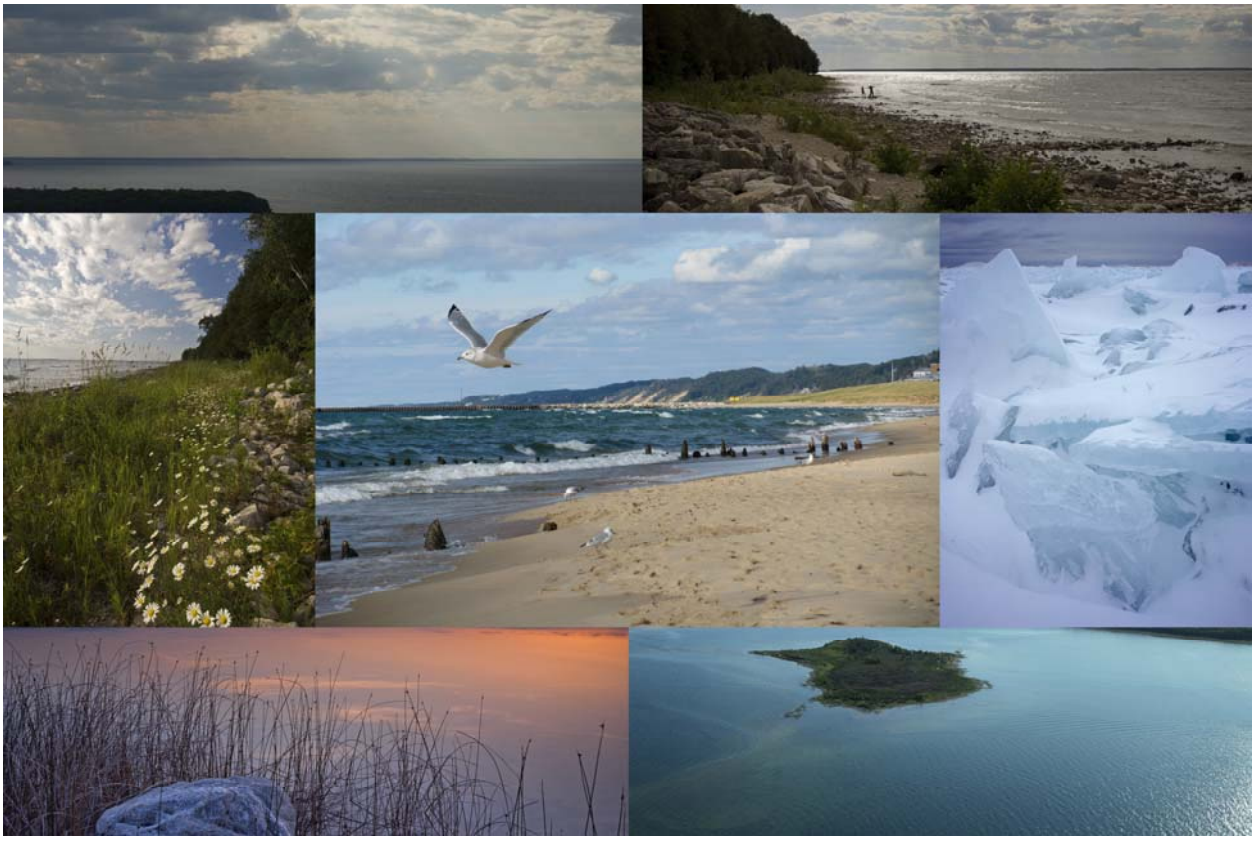
MICHIGAMI: GREAT WATER

Strategies to Conserve the Biodiversity of Lake Michigan



Technical Report

The Nature Conservancy

Michigan Natural Features Inventory

Prepared by the Lake Michigan Biodiversity Conservation Strategy Core Team

Cover photo credits

From upper left – going around clockwise: Green Bay (Mark Godfrey, TNC); Green Bay (Mark Godfrey, TNC), Ice Shoves, Lake Michigan (TNC); Rocky Island (Chris Cantway); Wilderness State Park (Ron Leonetti); Green Bay shore (Mark Godfrey, TNC). Center: Saugatuck Dunes (Melissa Soule).

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Disclaimer

This report reflects the best efforts of the preparers to accurately represent the expertise and views expressed by project participants. The Conservation Action Planning process is iterative in nature and the Lake Michigan Biodiversity Conservation Strategy should be revisited and updated periodically as conditions and available information change

PREFACE: 2012 GREAT LAKES WATER QUALITY AGREEMENT

The Great Lakes Water Quality Agreement (GLWQA) is a formal agreement between the governments of the United States and Canada established under the authority of the 1909 Boundary Waters Treaty. It was first signed in 1972 under the administrations of President Nixon and Prime Minister Trudeau. The agreement established basinwide water quality objectives and binational commitment on the design, implementation and monitoring of associated programs. The GLWQA was revised in 1978 and 1987.

The 1978 GLWQA included a new purpose statement to reflect a broadened goal, "to restore and maintain the chemical, physical and biological integrity of the waters of the Great Lakes Basin Ecosystem." The ecosystem approach concept introduced in the Revised 1978 Agreement recognized the interconnectedness of all components of the environment and the need for an integrated perspective in addressing human health and environmental quality issues. The 1978 Agreement also called for the virtual elimination of persistent toxic substances in the Great Lakes ecosystem by adopting a philosophy of "zero discharge" of inputs and established a list of toxic chemicals for priority action.

The GLWQA was amended again by protocol in 1987. New concepts of ecosystem-based management were incorporated including the development and adoption of ecosystem objectives for the lakes. The Protocol also included two new annexes focusing on provisions to develop and implement Remedial Action Plans (RAPs) to restore impaired water uses for significantly degrades areas around the Great Lakes (known as Areas of Concern) and Lakewide Management Plans (LaMPs) to address whole lake contamination by persistent toxic substances. Several other new annexes were also introduced, further broadening the scope of the Agreement: non-point contaminant sources; contaminated sediment; airborne toxic substances; contaminated groundwater; and associated research and development.

In June of 2010, the governments of Canada and the United States initiated renegotiation of the Agreement to meet current challenges. On September 7, 2012, Canada and the United States officially amended the Agreement. The 2012 GLWQA facilitates United States and Canadian action on threats to Great Lakes water quality and includes measures to prevent ecological harm. New provisions address the nearshore environment, aquatic invasive species, habitat degradation, and the effects of climate change. It also supports continued work on existing threats to people's health and the environment in the Great Lakes basin such as harmful algae, toxic chemicals, and discharges from vessels.

The Lake Michigan Biodiversity Conservation Strategy (LMBCS) was initiated to provide a more in-depth assessment of the lake's biodiversity status and threats, as well as develop a comprehensive set of strategies to maintain and increase the viability of Lake Michigan's biodiversity and abate the threats to biodiversity. The Strategy was developed by The Nature Conservancy and Michigan Natural Features Inventory, and is the product of a two-year planning process involving roughly 170 individuals from 79 agencies and organizations from around the lake. The project builds on and supports similar biodiversity conservation strategies that have been completed for Lakes Ontario and Huron. The Strategy aims to facilitate coordination of actions among diverse and widespread partners, providing a common vision for conservation of Lake Michigan, and help to put local actions and priorities into a basin-wide context.

The results of this Strategy support several of the new and updated Annexes of the 2012 GLWQA. This includes establishing baseline and assessment information that will inform future monitoring and the setting of ecosystem objectives, identifying areas of high ecological value, providing tools to assess the impacts of climate change, and the development of strategies that will support the Lakewide Action and Management Plan for Lake Michigan.

EXECUTIVE SUMMARY

We envision a healthy Lake Michigan that sustains the full array of natural ecosystems and the services they provide. A resilient Lake Michigan is sustained by collaborative, ecosystem-based management, now and into the future.

-Vision statement adopted by The Steering Committee

Lake Michigan, the second largest Great Lake (by volume) and fifth largest lake in the world, is an ecologically rich and globally significant ecosystem. Stretching over 300 miles north to south, its coastline harbors boreal forests and coastal fens in the north and dry sand prairies and oak savannas in the south. In fact, Indiana Dunes National Lakeshore is among the most biologically rich of all U.S. National Parks, on a per-area basis, due to the co-occurrence of southern and northern species. The dunes along the eastern shore of the lake are the largest system of freshwater dunes in the world, and the shorelines provide food and shelter for millions of migrating birds every year. In the water, the variety of nearshore habitats provide spawning or nursery grounds for many fish species, supporting important fisheries; migratory fish connect the lake to its tributaries; and in the offshore, a window of opportunity exists to restore the historic communities once found here and nowhere else in the world.

Lake Michigan and its associated biodiversity, however, are at great risk. Invasive species, climate change, water pollution, rapid and poorly planned residential and industrial growth, altered hydrology, and incompatible agriculture, forestry, and fishery practices are taking a toll on this national treasure and critical resource. With more than 10 million people living near, depending on and benefiting from a healthy Lake Michigan, there is an increased sense of urgency to address these threats.

The Lake Michigan Biodiversity Conservation Strategy (LMBCS) is a multi-agency initiative designed to identify specific strategies and actions to protect and conserve the native biodiversity of Lake Michigan. It is the product of a two-year planning process involving roughly 170 individuals from 79 agencies and organizations from around the lake. The goals of this planning process include:

- Assemble available biodiversity information for Lake Michigan.
- Define a multi-agency vision of biodiversity conservation for Lake Michigan.
- Develop shared strategies for protecting and restoring critical biodiversity areas.
- Describe the ways in which conservation strategies can benefit people by protecting and restoring important ecosystem services.
- Promote coordination of biodiversity conservation in the basin.

Designing a biodiversity strategy: Approach, scope and stratification

The Nature Conservancy's Conservation Action Planning (CAP) process – a proven adaptive management approach for planning, implementation, and measuring success for conservation projects – guided the development of the strategy. This effort was managed by staff of The Nature Conservancy and Michigan Natural Features Inventory, working closely with the Great Lakes National Program Office of the USEPA—funders of the project through the Great Lakes Restoration Initiative. At each step of the way, a

Steering Committee of over 40 representatives from Federal, State, County, and local agencies and organizations advised the plan authors. Involvement of these key individuals, several of whom are part of the Lakewide Management Plan (LaMP) or associated stakeholder groups (the LaMP Forum and Watershed Academy), as well as the Great Lakes Fishery Commission, tribal organizations, and other experts and stakeholders throughout the watershed is critical to the long-term success of this effort.

The first step in the planning process was to establish the scope for the plan. The biodiversity encompassed by Lake Michigan Biodiversity Conservation Strategy includes those conservation targets within the lake itself and in the immediate coastal area (roughly 2 km inland from the shoreline). The assessment and strategy design, however, considered the influence of the whole Lake Michigan watershed on this focal biodiversity.

Assessing information and planning at broad scales, such as an entire Great Lakes basin, can present challenges for developing and tracking a set of successful strategies. Lake Michigan has considerable regional variation in climate, ecology, economics, and dominant land use, with the most striking variation found along the north-south gradient. To address the differences within the lake and along the coastal zone, we divided the lake into five generally recognized basins for reporting units: Northern Basin, Central Basin, Green Bay, Mid-Lake Plateau, and Southern Basin. To facilitate viability and threats assessments we further divided these reporting units into offshore and coastal-nearshore units (assessment units). In the main body of the report and appendices, we present our findings for both levels of stratification.

Describing Lake Michigan biodiversity and assessing its health

The project Core Team, Steering Committee, and other partners identified seven focal targets to describe the biodiversity of Lake Michigan and its immediate coastal area:

1. **Open Water Benthic and Pelagic Ecosystem** (i.e., offshore; waters deeper than 30 m)
2. **Nearshore Zone** (waters shallower than 30 m)
3. **Native Migratory Fish** (Lake Michigan fish with populations that require tributaries for a portion of their life cycle, including lake sturgeon (*Acipenser fulvescens*), walleye (*Perca flavescens)*, and suckers (*Catostomus commersonii*).
4. **Coastal Wetlands** (wetlands with historic and current hydrologic connectivity to, and directly influenced by Lake Michigan)
5. **Islands** (including both naturally formed and artificial islands)
6. **Coastal Terrestrial Systems** (upland and wetland systems within ~2 km of the shoreline)
7. **Aerial Migrants** (all types of migrating birds, insects, and bats dependent on Lake Michigan)

Engaging numerous experts and employing recognized Key Ecological Attributes (KEAs) and indicators of viability, the Core Team assessed the current viability status of each of the seven targets both by assessment unit, reporting unit and lakewide. These assessments provide a snapshot of the status of biodiversity in Lake Michigan and their desired status. Overall, the viability for the biodiversity in Lake Michigan is *Fair*, which indicates that human intervention is required to restore its biodiversity to a self-sustaining condition and prevent irrecoverable declines (Table a). The viability is also presented in

Table a by the five reporting units and by targets. With the exception of Islands and coastal wetlands, most targets ware rated as *Fair*. While this summary gives us an overall picture of Lake Michigan, we also recognize that important differences exist at finer scales and provide a more detailed assessment in maps of each target in Chapter 4, and tables for each attribute assessed in Appendix E. In considering the work needed to be done to rehabilitate these targets to reach the goals presented in Table b, it will be important to consult the finer-scale assessment, as well as focusing on those attributes most impaired.

Table a. Lakewide viability assessment summary.

Target	Northern Basin	Central Basin	Green Bay	Mid-Lake Plateau	Southern Basin	Lakewide
Nearshore Zone	Fair	Fair	Fair	Fair	Fair	Fair
Aerial Migrants	Fair	Fair	Fair	Fair	Fair	Fair
Coastal Terrestrial Systems	Fair	Fair	Fair	Fair	Fair	Fair
Coastal Wetlands	Good	Good	Good	Fair	Fair	Good
Islands	Good	Good	Good	Good	Good	Good
Native Migratory Fish	Fair	Fair	Fair	Fair	Poor	Fair
Offshore Benthic and Pelagic Ecosystem	Fair	Fair	Fair	Fair	Fair	Fair
Overall Biodiversity Health	**Fair**	**Fair**	**Fair**	**Fair**	**Fair**	Fair

Table b. Goals for 2030 to assure long-term viability.

Target	Goal
Open Water Benthic and Pelagic Ecosystem	By 2030, to assure that the offshore benthic and pelagic zone of Lake Michigan is characterized by a more stable food web that supports a diverse fishery and is resilient to invasive species: • Native fish will comprise 50% of the prey biomass, with substantial representation by multiple coregonid species (e.g., cisco or lake herring (*Coregonus artedi*), bloater (*Coregonus hoyi*), kiyi (*Coregnus kiyi*)); • Lake trout (*Salvelinus namaycush*) will maintain self-sustaining populations in each major area of the offshore; • Self-sustaining populations of native predators (such as lake whitefish (*Coregonus clupeaformis*) and lake trout) maintain relatively stable populations consistent with Fish Community Objectives.

Target	Goal
Nearshore Zone	By 2030, as evidence that the nearshore is improving as habitat for native fish and invertebrates: • Greater than 75% of native nearshore fishes are represented within each area of the lake; • Late summer cladaphora standing crop is below 30 gDW/m^2 on hard substrates; • The 5-year average chlorophyll-a concentrations are between 0.5-3.0 µg/L; • The average shoreline hardening index is less than 20%; • Average annual sediment loadings are less than 0.075 tons/ac.
Migratory Fish	By 2030, to provide adequate access to spawning habitat: • At least 50% of the total length of each type of stream is connected to the lake; • Each river-spawning Lake Michigan fish species is represented by at least two viable populations in each applicable region (i.e. assessment unit) of the lake; • Tributary connectivity is maximized for Lake Michigan migratory fish, while increased risk of aquatic invasive species spread and proliferation is minimized.
Coastal Wetlands	By 2030, so that coastal wetlands provide adequate ecological functions and habitat for native plants and animals: • The average wetland macrophyte index for coastal wetlands around the lake will reflect good condition; • Coastal wetland area around the lake will have increased by 10% compared to the 2011 wetland area.
Islands	By 2030, to ensure that islands remain as intact and sustainable ecological systems: • A minimum of 60% of Lake Michigan islands are owned and managed for conservation; • A minimum of 80% of the total area of Lake Michigan islands are in natural land cover; • The abundance and richness of colonial nesting waterbirds is maintained within 1990-2010 range of variation; • All islands are protected by quarantine from known vectors of invasive species; • Maintain island habitat in an undeveloped condition to support colonial nesting waterbirds, including cormorants, on the islands that have been historically used by nesting colonial nesting waterbirds.

Target	Goal
Coastal Terrestrial Systems	By 2030, to assure that Coastal Terrestrial System is of high quality and of sufficient extent to provide habitat for native plant and animal species: • At least 40% of the Coastal Terrestrial System will be in natural land cover; • Viable populations of priority nested targets are adequately represented across the lake; • At least 5% of the Coastal Terrestrial System will be in good to excellent condition; • The average artificial shoreline hardening index will be below 20%; • All high priority biodiversity areas in the Coastal Terrestrial System are minimally affected by shoreline alterations.
Aerial Migrants	By 2030, so that Lake Michigan remains a globally significant stopover area for migrating birds: • At least 30% of the 2 km coastal area comprises high quality stopover habitat for migrating landbirds; • At least 10% of the coastal area comprises high quality stopover habitat for migrating shorebirds; • At least 50% of the 2 km coastal area including coastal wetlands comprises high quality stopover habitat for migrating waterfowl; • At least 80% of the 2 km coastal area that is high quality stopover habitat for all bird groups is in conservation ownership or management.

Identifying critical threats

To assess threats to biodiversity, the Core Team compiled a list of threats from previous lake-wide and regional CAPs, and the Steering Committee provided additional suggestions to complete the initial list. We then developed online surveys, one for each of the five reporting units, inviting experts to rate the threat to each target in that reporting unit, and document their level of confidence with each rating. Threats were ranked according to scope (size of area), severity of impact (intensity of the impact), and irreversibility (length of recovery time). We received 40 responses. Using a weighted-averaging approach that considered the respondent's expertise level, we calculated overall threat-to-target ranks, related threats across all targets and overall threat ratings for each target.

Threats ranked *Very High* or *High* by reporting unit:

- **Northern Basin**: Aquatic Invasive Species; Terrestrial Invasive Species; Dams & Other Barriers; Climate Change; Contaminated Sediments
- **Central Basin**: Aquatic Invasive Species; Terrestrial Invasive Species; Housing & Urban Development; Climate Change
- **Green Bay**: Aquatic Invasive Species; Terrestrial Invasive Species; Housing & Urban Development
- **Mid-Lake Plateau**: Aquatic Invasive Species; Climate Change

- **Southern Basin**: Shoreline Alterations, Pollution (Urban & Household); Pollution (Agriculture & Forestry); Aquatic Invasive Species; Terrestrial Invasive Species; Housing & Urban Development; Climate Change; Pollution (Industrial)

To address the most critical threats to biodiversity and restore badly degraded conservation targets, the Core Team hosted a strategy development workshop in Chicago in December, 2011. In the workshop, participants brainstormed and identified priority strategies and, for the top one to three strategies, developed objectives and measures for five topics; the sixth topic, dams and barriers, was addressed through subsequent webinars and conference calls:

1. Agricultural Non-Point Source Pollutants;
2. Invasive Species (aquatic and terrestrial);
3. Housing & Urban Development and Shoreline Alterations;
4. Urban Non-Point and Point Source Pollutants;
5. Restoration of Offshore Fisheries;
6. Dams and Barriers.

While recognized as a critical threat, climate change was not addressed in isolation at the workshop. Rather, we worked with participants in the groups above to identify key climate-related vulnerabilities of targets, and ways in which factors like increases in temperature or increases in peak storm intensities should influence the framing or relative priority of strategies.

Developing conservation strategies

Developing conservation strategies requires a thorough understanding of how critical threats and their causal factors influence the health of biodiversity features. We created conceptual models to illustrate visually how social, political, economic, and environmental elements act together to perpetuate direct and indirect threats to biodiversity targets of Lake Michigan. Based on these models, workshop participants identified specific strategies to abate these threats, then identified highest priority strategies and developed a detailed set of outcomes at least one. The final set of ten featured biodiversity conservation strategies for Lake Michigan is presented in Table C in the third column.

Climate change was a key consideration in several of strategies. In particular, the likely increases in the intensity of storm events is an important consideration in planning for NPS management (4a), and improving connectivity (6a) helps fish and other aquatic species respond to increasing temperatures.

Priority areas

To complement the lake-wide strategies and better direct conservation action to the local scale, we conducted an analysis of ecological significance analysis to rank smaller coastal units and islands in Lake Michigan. We were able to rank priority areas for four of the seven biodiversity targets. For Coastal Terrestrial and Coastal Wetland targets, we conducted a novel analysis of biodiversity significance and condition. For Aerial Migrants and Islands, we used two recently completed research studies that identified priority areas (Ewert et al. 2012 and Henson et al. 2010 respectively). Priority areas are not relevant to the Open Water Benthic and Pelagic Ecosystems zone, and while relevant to Migratory Fish and the Nearshore Zone, we lack sufficient data to do this type of analysis.

Table c. Summary of featured strategies in the Lake Michigan Biodiversity Conservation Strategy.

Strategy	Key factors in situation analysis	Strategies selected for focus in workshop
1. Reducing the Impact of Agricultural Non-Point Source Pollutants	• Erosion • BMP funding issues • BMP implementation • Cropping trends/prices • Drainage • Altered hydrology • Freshwater pollutants • Nutrient management/Fertilizer application • Climate change – increases in peak storm intensities and run-off	a. Development of a communications network within the agricultural community: i. Use existing agricultural communications networks in new ways to expand/improve implementation of conservation practices to naturalize hydrology and reduce NPS ii. Identify key influencers and create incentives for their delivering the message iii. Prioritize where to focus if possible based on conservation needs b. Market mechanisms: nutrient trading: iv. Enable market mechanisms for changing behavior to increase BMP adoption v. Develop linkages between agricultural landowners/operators and out of compliance point sources vi. Requires viable market, supportive regulatory framework, aggregator, ability to quantify beneficial impacts
2. Preventing and reducing the impact of invasive species	• Vectors: seeds, horticulture and live organism trade, cargo and shipping containers, recreation, waterways and canals • Insufficient capacity • Insufficient knowledge and awareness • Insufficient coordination • Lack of political will	a. Agreements among Great Lakes States for invasive species in Lake Michigan i. One governor takes lead (MI). ii. Discussions leading to an agreement to proceed. iii. Gap analysis of need to take to governors. iv. Bring in risk assessment studies. b. Early detection and rapid response network for invasive species in Lake Michigan v. Raise funds for all aspects of strategy. vi. Train people to provide data. vii. Data collection. viii. Develop shared and unified GIS and information management system. ix. Develop strategic Great Lakes surveillance system. x. Develop rapid response capability.

Strategy	Key factors in situation analysis	Strategies selected for focus in workshop
3. Coastal Conservation: Preventing and reducing the impacts of Incompatible Development and Shoreline Alterations	• Awareness/understanding • Political: lack of will and funding/incentives to protect shoreline, emphasis on growth/tax base • Socio-economic: demand, property values, aesthetic/recreational values, commercial development pressure, ability to participate in decision making, lack of clarity for ownership responsibility • Knowledge: cumulative effects, long term costs, research, monitoring, accessibility of information • Planning: scale of decision making, lack of comprehensive plans, priorities, and professional experience	a. Use coordinated land use planning to align future development in the coastal zone with biodiversity conservation and ecological processes i. Spatial ecological information is easily accessible and priority places and opportunities are identified across the Basin ii. Communities collaborate to develop ecologically based coastal strategies iii. Coastal targets are effectively integrated into a variety of local plans, ordinances, and planning activities – leads to ecological management of public lands, incentives for conservation actions, adoption of protective zoning ordinances, and acquisition of desired lands iv. Future development fully addresses coastal biodiversity and supporting processes v. Low impact development projects and practices are increased and future development is directed to the most appropriate places vi. Ultimately these actions lead to a decrease in shoreline hardening and impervious surfaces particularly in areas where they will have the biggest impact
4. Reducing the Impacts of Urban Non-Point and Point Source Pollutants	• Economy/population pressure • Climate change – increases in peak storm intensities & run-off • Imperviousness • Lack of knowledge/understanding – biodiversity, how to control NPS • Lack of enforcement • Emerging contaminants • Legacy pollutants	b. Expand implementation of green infrastructure and strengthen NPS management i. Develop and promote standards and incentives to increase green infrastructure practices through local codes and ordinances and sharing model codes and ordinances ii. Address regulatory barriers to adoption of green infrastructure iii. Increase in green infrastructure creates increased sewer capacity (reducing CSOs) and increased urban habitat iv. Reducing effective impervious area to increase infiltration, reduce runoff and to moderate impacts of climate change

Strategy	Key factors in situation analysis	Strategies selected for focus in workshop
5. Restoration of Offshore Fisheries	• Historic and current impacts of commercial fishing • Sport-fishing • Treaty constraints • Lack of resources and interest in comprehensive restoration • Federal agency native species mandates • State agency funding/constituencies • Aquatic invasive species (especially alewife (*Alosa pseudoharengu)*, sea lamprey (*Petromyzon marinus*)) • Stocking	a. Restore cisco (*Coregonus artedi*) in Lake Michigan i. Restore cisco to a self-sustaining population that can be sufficient forage for lake trout and Pacific salmon (Oncorhynchus spp) ii. Would require a comprehensive restoration plan called for by the Lake Michigan Committee (GLFC), participation by key stakeholders iii. Funding secured for a pilot stocking effort – for a long enough term to achieve success or confirm infeasible (10 years) iv. Expand stocking if needed to reach self-sustaining levels desired lakewide b. Broaden constituency for sea lamprey control v. Partnership among NGO's , state agencies, and GLFC established vi. Public awareness for sea lamprey control need increased vii. State Department maintains sea lamprey control funding
6. Improving Habitat Connectivity by Reducing the Impact of Dams and Other Barriers	• Pressures to keep • Cost • Invasive species control • Human use values • Inadequate BMPs • Legal lake level structures • Sediment control • Pressures to remove • Fisheries/ecosystem restoration • Property values • T/E species conservation • Costs/liabilities • Road safety/permanence	a. Increase connectivity to Lake Michigan through development and use of a comprehensive lowest barrier decision tool i. Tool would answer questions related to costs and benefits, considering value to species, habitat, as well as risks and societal benefits ii. Priorities for critical watersheds and barriers would be set using the tool iii. Watershed plans would be updated to incorporate recommendations iv. The priority barriers would guide spending v. Enough connectivity would be restored to achieve 25% of all habitat types being connected to Lake Michigan and having one viable run of lake sturgeon in each applicable region of Lake Michigan, by 2020 b. Increase connectivity at road-stream crossings at a large scale vi. Seek to leverage existing funds by requiring that grant funds include cost-sharing from road agencies vii. Identify priorities and agreement to focus on these priorities for stream crossing improvements based on connectivity restored, species benefitting, ecosystem

Strategy	Key factors in situation analysis	Strategies selected for focus in workshop
		benefits, cost, feasibility and potential risks (aquatic invasive species) viii. Complete an economic analysis and document ecological justifications such that road managers, resource management agencies, and state lawmakers are convinced of need for either increased funding and/or higher regulatory standard for road-stream crossing. ix. Establish demonstration projects in key watersheds and share results with road managers, resource management agencies, and state lawmakers. x. Increased application of road-stream crossing best practices results in priority watersheds (see strategy 6a) being 80% connected by 2040 and a 20% improvement in connectivity in priority watershed by 2020.

The Door Peninsula east coastal watershed unit (CWU) in Wisconsin received the highest score for coastal terrestrial biodiversity. Three units located in the Upper Peninsula of Michigan, the Calumet River CWU located in Indiana and Illinois, and the Lake Charlevoix CWU encompassing the northwest tip of the Lower Peninsula of Michigan also scored *High*. The top eight highest scoring units for Coastal Terrestrial Systems condition are all located in Michigan with seven of those units located in the Upper Peninsula of Michigan.

Only three units scored *High* in both terrestrial biodiversity and condition. All three are located in the Upper Peninsula of Michigan. The only unit with a high biodiversity value and very low condition score is the Calumet River CWU located in the Chicago-Gary metropolitan region.

Regarding coastal wetland biodiversity, the only unit to score in the *Very High* category was the Cut River CWU. All of the units that scored *High* for Coastal Wetland condition are located in Michigan. The Garden Peninsula CWU received the highest wetland condition score in the Lake Michigan Basin. It is important to note that although coastal wetlands on islands were not analyzed, Waugachance Point, located in the northwestern most point of the Lower Peninsula of Michigan, is a significant set of islands for wetland biodiversity. Waugachance Point harbors federally listed coastal wetland species as well as three different types of wetland communities. Garden and Hog Islands, both part of the Beaver Island Archipelago, also harbor significant wetland biodiversity values.

The Cut River CWU located in the Upper Peninsula of Michigan is the only unit to score high for both coastal wetland biodiversity value and condition. This unit contains some very significant wetlands, such as the large wetland complex at Pt. Aux Chenes, and a large percentage of its contributing watersheds are under public ownership. Both the Lower Peshtigo and Lake Charlevoix CWUs are the only two units with somewhat high biodiversity scores but relatively low condition scores.

Priority areas for aerial migrants are based on a study developed by Ewert et al. (2012 draft) to model and assess migratory bird stopover sites in the Great Lakes Basin. The preliminary results highlight that the Lake Michigan Basin provides good spring stopover habitat across the lake for waterfowl, with a high concentration of good habitat found along the southeast shoreline and the Michigan portion of Green Bay. There also appears to be good stopover habitat for shorebirds along the southeast shore of the lake.

For the Islands target, we used the results from a recent study (Henson et al. 2010) that assessed the biodiversity value of all Great Lakes islands. Key islands for biodiversity conservation in Lake Michigan are Beaver, Garden, and Hog Islands located in the Northern Basin just east of Petoskey, Michigan, and Washington Island located just north of the Door Peninsula in Wisconsin.

Ecosystem services

While the LMBCS strategies are intended to address threats to and restore biodiversity, experts around the lake clearly agree that the strategies are very likely to have positive effects on human well-being. We conducted two surveys to: 1) identify the ten most important ecosystem services provided by Lake Michigan and its coastal area, and 2) estimate the potential effect (in qualitative terms) of the proposed conservation strategies on those important ecosystem services.

Participants from all four states representing public agencies at all levels of government, as well as private organizations and others, completed the survey. Not surprisingly, supplying fresh water, purifying water, and the water cycle were all among the top ten most important services. Other top ten benefits included recreation, primary productivity, wildlife and fish habitat, aesthetics, climate regulation, “sense of place”, and nutrient cycling.

Among the recommended strategies, respondents estimated that reducing impacts from urban non-point and point source pollution would have the greatest positive effect on these ecosystem services, followed by coastal conservation and reducing agricultural non-point pollution. Services identified as most likely to be improved included wildlife and fish habitat, recreation, and primary productivity. Respondents found no strategies that would negatively affect ecosystem services, nor ecosystem services that would be degraded by the recommended strategies.

Implementation recommendations

The LMBCS presents key components of a common vision for the conservation of Lake Michigan biodiversity. The strategies (with associated goals, objectives and measures) are designed to augment efforts to fulfill obligations of the Great Lakes Water Quality Agreement (GLWQA) as updated in 1987 and 2012, the Great Lakes Restoration Action Plan, and a host of other local and regional priorities (see Appendix K). We conclude this report with several general recommendations to facilitate implementation of the LMBCS. These recommendations include:

1. The Lake Michigan LaMP adopts the LMBCS and affirms a common vision and priorities.
2. Lakewide organizations review and restructure to meet implementation needs.
3. Expand stakeholder engagement to include corporate and industrial sectors, as well as local-regional government.
4. Leader and stakeholders adopt a common vision and agenda and then develop an Implementation Plan.
5. LMBCS is viewed as a living document and is regularly updated using adaptive management as a standard component of the review, analysis, and business planning processes.
6. Align funding streams to achieve LaMP priority outcomes.