Strategic Vision of the Great Lakes Fishery Commission 2011–2020

The Great Lakes Fishery Commission was established by the Convention on Great Lakes Fisheries between Canada and the United States, which was ratified on October 11, 1955. It was organized in April 1956 and assumed its duties as set forth in the Convention on July 1, 1956. The commission has two major responsibilities: first, to develop coordinated programs of research in the Great Lakes, and, on the basis of the findings, to recommend measures which will permit the maximum sustained productivity of stocks of fish of common concern; and second, to formulate and implement a program to eradicate or minimize sea lamprey populations in the Great Lakes. The commission is also required to publish or authorize the publication of scientific or other information obtained in the performance of its duties.

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ACKNOWLEDGMENTS

The commission acknowledges the valuable contributions to this document from former commissioner Gerry Barnhart. We are also indebted to those who provided comments on earlier drafts.

December, 2011

The front cover photo shows a lake trout *Salvelinus namaycush*. Historically, lake trout was the dominant predator in the Laurentian Great Lakes. By the mid-1900s, sea lamprey predation, over-fishing, and the loss of spawning habitat had decimated lake trout populations. A major milestone in Great Lakes fishery management was the re-establishment of lake trout populations in Lake Superior. The lake trout cover photo reflects the commitment to protect the health of the Great Lakes ecosystem through managing non-native invasions and re-establishment of native fishes.

FRONT COVER PHOTOS: Lake trout, PAUL VECSEI; Kids fishing on dock, TED LAWRENCE

BACK COVER PHOTOS: J. GALAMBOS, SHADOW PERCH FISHING CHARTER; LESTER PUBLIC LIBRARY, TWO RIVERS, WI; T. LAWRENCE, GLFC

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Juvenile whitefish.
PHOTO: A. MUIR, GLFC

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Introduction

The Great Lakes Fishery Commission (commission) has published two strategic visions to explain and clarify its role in fishery management and research. The first vision, A Strategic Vision of the Great Lakes Fishery Commission for the Decade of the 1990s, consisted of a statement of purpose, a fundamental concept, and three vision statements, each with milestones and supporting rationales. This vision reflected the ecological challenges of the time and a desire to move forward on objectives commonly held by the commission and various government and non-government stakeholders. The commission's role, beyond sea lamprey control, was to be supportive, informative, and collaborative with regard to other regional management authorities. A second vision, the Strategic Vision of the First Decade of the New Millennium, was published in 2001. Both visions reflected the duties described in the Convention on Great Lakes Fisheries, signed by the governments of Canada and the United States in 1954, and confirmed the role of the commission's support for A Joint Strategic Plan for Management of Great Lakes Fisheries as revised in 1997. This third strategic vision, composed in like manner to the first two, was necessitated by the need to reassess priorities after each ten-year interval so that commission programs remain responsive to change.

PHOTO: M. SIEFKES, GLFC

Role of the Commission

The commission strives to control sea lamprey populations in the Great Lakes to levels commensurate with lake-specific fish community objectives. To better accomplish this key duty, the commission administers a program of research aimed at advancing the efficacy of control and the sustainability of fisheries. The commission also serves as a forum and coordinating body for fishery management and research on the Great Lakes.

Statement of Purpose

The commission controls sea lamprey populations to enhance survival and reproduction of desirable fishes, coordinates fishery research, and informs and facilitates inter-jurisdictional management to produce sustainable fisheries to benefit society.

Approach and Organization

More than 20 years ago, the commission committed itself to maintaining a strategic approach in the conduct of its day-to-day affairs by documenting and communicating in a publication its goals and strategies for the ensuing decade. This approach has served it well for the previous two decades, and this new vision is intended to continue this framework for decision making for the decade of 2011-2020. These commitments begin with a Strategic Vision Statement that provides an overarching concept:

Strategic Vision Statement

Fishery managers will cooperatively and collaboratively make sound decisions based on the best available knowledge to sustain fisheries, and sea lamprey populations will be suppressed to levels that enable achievement of the fish community objectives for each Great Lake.

PILLAR ONE:
Healthy Great Lakes Ecosystems and Sustainable Fisheries

Pillar statement: *The commission will encourage the conservation and rehabilitation of healthy Great Lakes ecosystems that sustain fisheries and benefit society.*

PILLAR TWO:
Integrated Sea Lamprey Control

Pillar statement: *The commission will suppress sea lamprey populations to levels that permit achievement of fish community objectives for each Great Lake.*

PILLAR THREE:
Strategic Alliances and Partnerships

Pillar statement: *The commission will build and maintain effective strategic alliances that promote sustainable fisheries and a healthy Great Lakes ecosystem.*

Each pillar consists of a statement, one or more goals, and related strategies and outcomes. These terms are defined below:

Pillar – A representation of an area of work that supports the statement of purpose and the Strategic Vision Statement. Each of the three pillars represents a commitment by the commission to achieve defined objectives for its major responsibilities and activities.

Pillar Statement – A strategic formulation in the broadest terms of what is to be accomplished under each pillar.

Goal – An essential accomplishment, to be achieved within each pillar.

Strategy – A specified approach for achieving a goal.

Outcome – A measure of progress towards achievement of goals that are to be accomplished by 2020.

Pound net boat (far left) and trap net boats, Caseville, Michigan, 1920s.
PHOTO: BURTON HISTORICAL COLLECTION, DETROIT PUBLIC LIBRARY

Background

European settlement of the Great Lakes basin, beginning in the mid-1700s, caused fundamental changes in the Great Lakes ecosystem, its fish populations, and fisheries. As settlers pushed west, they altered the basin's physical landscape through deforestation; construction of water-powered mills; and development of canals that broached the ecological separation between the Lake Ontario drainage and other Atlantic drainages, between the four upper Great Lakes and Lake Ontario, and between the Great Lakes and Mississippi River drainages. The increasing human population drove demand for food fishes that resulted in overdeveloped fisheries, including those for lake sturgeon, lake trout, and Atlantic salmon, which reduced the diversity of native fishes. For instance, the last native Atlantic salmon from Lake Ontario was seen in 1898. By the early 1900s two species of deepwater ciscoes were near extinction in Lakes Michigan and Huron, and fishes that used large rivers for spawning were greatly diminished in all of the Great Lakes. These changes were also accompanied and exacerbated by water-quality changes, including eutrophication and contamination of some critical habitats, which threatened many local fish populations leading to public health concerns and advisories on consumption of certain fish species. Recent outbreaks of fish pathogens have resulted in localized die-offs.

Non-native species began to appear in the Great Lakes in the 1800s. Completion of the Erie Canal in 1825 opened the way west for settlement, but also opened a more southerly connection from the Atlantic Ocean to the Great Lakes. The alewife and the sea lamprey were among the first and most successful invaders to use this connection. They gained a foothold in Lake Ontario and expanded into Lakes Erie, Huron, Michigan, and Superior, after the Welland Canal opened

in 1829. Rainbow smelt were introduced into Crystal Lake, Michigan, in 1912 and quickly spread into Lake Michigan and the other Great Lakes. By the middle of the 20th century, rainbow smelt and alewife dominated fish communities across the basin and largely replaced the native ciscoes, which had been key forage species. Lake trout, the native top predator, was extirpated in three of the lakes by the combined effects of over-fishing and sea lamprey predation. By 1960, Lake Erie's signature fish, the blue pike, was nearly extinct, and the walleye was headed towards a population collapse. As fish communities changed, so did Great Lakes fisheries. Much of the commercial fishing industry disappeared because the non-native species could not replace the higher valued native lake trout and lake whitefish.

Lake cisco haul at a commercial platform illustrates the large catches in the Great Lakes in the early 1900s.
PHOTO: UNITED STATES GEOLOGICAL SURVEY, JOHN VAN OOSTEN LIBRARY

The sea lamprey invasion and its effects on lake trout and lake whitefish populations prompted action in the 1950s by federal, provincial, and state fishery management agencies. Meanwhile, the science of fishery management was advancing rapidly, thereby allowing fishery managers to make improvements in fish stocking and fishery regulation. Researchers also had developed lampricides that selectively killed the stream-living larvae of the sea lamprey, and lampricide use reduced sea lamprey predation on lake trout and other valued fishes. These actions, combined with ongoing improvements in water quality, resulted in rejuvenated fisheries. For example, self-sustaining lake trout populations in Lake Superior were rebuilt with hatchery-reared fish. The results of stocking and sea lamprey control in Lake Superior were encouraging and these efforts were expanded to the other four lakes. In the late 1960s, fishery managers initiated wide-scale stocking of rainbow trout, brown trout, and Pacific salmon to suppress the burgeoning alewife and rainbow smelt populations. This approach allowed managers to create valuable recreational fisheries, while improving opportunities for recovery of those native fishes incompatible with large populations of rainbow smelt and alewife. Implementation of the Great Lakes Water Quality Agreement brought stricter regulation of nutrients and pollutants that led to improved fish habitats and fish better suited for human consumption.

The fishery rehabilitation gains made from the 1950s to the mid-1980s were vulnerable to setbacks. In the 1980s, new species, introduced via ballast water from ocean-going ships, proliferated and disrupted important food webs. Exploding populations of invasive quagga and zebra mussels disrupted energy flow from the bottom of the food web up to fish. Other new invertebrate and fish invaders distorted food webs in the lower lakes and began to spread to the upper lakes. Asian carps, introduced into the Mississippi River basin from aquaculture operations in the south, spread north and now are perilously close to colonizing the Great Lakes via multiple pathways. The most likely entry point now is the Chicago Area Waterway System, where an electrical barrier is all that keeps Asian carps and other opportunistic species from Lake Michigan.

To address fishery losses in the Great Lakes, the governments of Canada and the United States signed the Convention on Great Lakes Fisheries in 1954. The convention established the Great Lakes Fishery Commission and gave it five duties:

a) To formulate a research program or programs designed to determine the need for measures to make possible the maximum sustained productivity of any stock of fish in the Convention Area which, in the opinion of the Commission, is of common concern to the fisheries of the United States of America and Canada and to determine what measures are best adapted for such purpose;

b) To coordinate research made pursuant to such programs and, if necessary, to undertake such research itself;

c) To recommend appropriate measures to the Contracting Parties on the basis of the findings of such research programs;

d) To formulate and implement a comprehensive program for the purpose of eradicating or minimizing the sea lamprey populations in the Convention Area; and

e) To publish or authorize the publication of scientific and other information obtained by the Commission in the performance of its duties.

Angler caught coho salmon on Lake Michigan.
PHOTO: UNITED STATES GEOLOGICAL SURVEY, JOHN VAN OOSTEN LIBRARY

Tribal fishers, Great Lakes, 1938.
PHOTO: UNITED STATES GEOLOGICAL SURVEY, JOHN VAN OOSTEN LIBRARY

With assistance from the commission, lake committees, composed of representatives from United States and Canadian fishery management agencies, were established in 1964. A more formal collaborative structure for engaging federal, provincial, state, and tribal authorities emerged in 1981 with the adoption of A Joint Strategic Plan for Management of Great Lakes Fisheries. The commission's support for implementation of this plan and its subsequent 1997 revision is in concert with, and fundamental to, the accomplishment of its five duties. Nevertheless, ongoing changes to the Great Lakes ecosystem continue to challenge fishery managers.

The future for Great Lakes fish and fisheries cannot be accurately predicted, but an effective Great Lakes Fishery Commission is clearly needed now more than ever. To this end, the commission must be accountable for implementing a strong and adaptive strategic vision. To ensure accountability, the secretariat of the commission will provide annual reports to the commission describing progress towards achieving this strategic vision. The commission will also conduct a review and provide reports to its partners on the achievement of goals and pillar statements by June 15, 2016, and June 15, 2021.

Sea lamprey assessment in the Ocqueoc River, northern Michigan.
PHOTO: UNITED STATES GEOLOGICAL SURVEY, JOHN VAN OOSTEN LIBRARY

Vernon C. Applegate studying sea lamprey caught in the Ocqueoc River, northern Michigan, 1947.
PHOTO: UNITED STATES GEOLOGICAL SURVEY, JOHN VAN OOSTEN LIBRARY

In 1997, representatives from state, provincial, tribal, and federal management agencies gathered to sign a revised Joint Strategic Plan for Management of Great Lakes Fisheries.

PHOTO: M. GADEN, GLFC

PILLAR ONE:
Healthy Great Lakes Ecosystems and Sustainable Fisheries

PHOTO: PAUL VECSEI

PILLAR STATEMENT:

The commission will encourage the conservation and rehabilitation of healthy Great Lakes ecosystems that sustain fisheries and benefit society.

GOAL 1: Eliminate further losses of native species and rehabilitate depleted populations.

Strategy 1: Prevent the loss of native fish species from any Great Lake.

Outcome: No native species will have been lost from any Great Lake.

Strategy 2: Encourage management actions to increase natural reproduction of lake trout.

Outcome: Rehabilitation of lake trout will be achieved and maintained throughout Lake Superior.

Outcome: Rehabilitation of the shallow-water form of lake trout will be achieved in Lake Huron's main basin.

Outcome: Progress towards lake trout rehabilitation in Lakes Erie, Michigan, and Ontario will be demonstrated by an increase in the population of naturally reproduced juvenile lake trout.

Strategy 3: Promote development and implementation of rehabilitation plans for depleted native fishes.

Outcome: Rehabilitation plans for deep-water ciscoes will be developed and implemented.

Outcome: Naturally produced populations of deepwater ciscoes will increase in Lake Ontario.

Outcome: Natural recruitment of lake sturgeon will increase in Great Lakes tributaries.

Asian carps have significantly altered the Mississippi and Illinois River systems. They are voracious eaters and compete with native fish species for food. If Asian carps enter the Great Lakes, there is a high likelihood they will become established and spread. *PHOTOS: T. LAWRENCE, GLFC*

GOAL 2: Stop invasions of aquatic species.

Strategy 1: Support establishment of statutory and regulatory authority to prevent non-native aquatic species from entering the Great Lakes through all vectors.

Outcome: Laws and regulations that seek to prevent the entry of aquatic invasive species into the Great Lakes basin will be promulgated.

Strategy 2: Prevent the movement of non-native species through man-made connections between the Great Lakes and historically separate drainages.

Outcome: Species not already established in the Great Lakes will be denied entry from historically separated drainages.

Strategy 3: Encourage management actions that prevent Asian carps from establishing populations in the Great Lakes.

Outcome: Asian carps will not establish populations in the Great Lakes.

GOAL 3: Conduct, coordinate, and communicate research to facilitate informed fishery management decision-making.

Strategy 1: Quantify the effects of physical processes on recruitment of fishes.

Strategy 2: Identify the causes of nutrient changes and their effects on fisheries.

Strategy 3: Describe the natural diversity present historically in deep-water communities, identify impediments to its restoration, and propose actions for rehabilitation.

Strategy 4: Determine the effects of changing human demographics on fisheries and fishery management.

Strategy 5: Determine the sources, effects, and ecological conditions that foster disease outbreaks within fish populations.

Strategy 6: Promote the exchange of information on issues affecting the large lakes of the world through sponsorship of and participation in workshops and symposia, research, and scientific publication.

Strategy 7: Facilitate information sharing and communicate the results of research to better inform fishery managers.

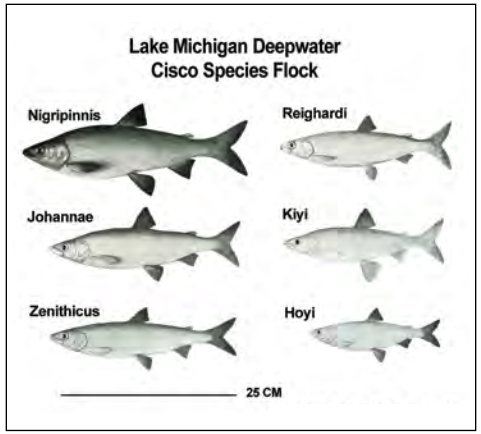
Outcome: Fishery managers and other stakeholders will have access to knowledge and information about Great Lakes ecosystems sufficient to make informed and effective decisions.

Rationale for Pillar Statement and Strategies

Great Lakes fishery management remained complex during the first decade of the 2000s. The trout and salmon fishery continued to depend largely on hatcheries, invasive species rapidly altered many Great Lakes food webs, and new species with the potential to be invasive threatened establishment. Nevertheless, improvements in some important fish populations were realized. The numbers of naturally produced lake trout increased substantially in Lake Huron after alewife stocks collapsed. This trend was especially notable in the population spawning on the shoals in the middle of the lake's main basin and at the northern end of the lake and represents the first recovery of lake trout from a lake where it was essentially extirpated. Naturally produced walleye increased in Saginaw Bay and yellow perch populations were strong in Lake Erie. The commission's pillar statement about healthy ecosystems and its supporting goals and strategies emerges from, and responds to, this milieu of uncertainty and change.

GOAL 1: Eliminate further losses of native species and rehabilitate depleted populations.

The near extirpation of the lake trout was a major stimulus for the formation of the commission. This species has been almost fully restored in Lake Superior after a five-decade-long effort. Success in the other lakes, however, remains elusive except in Lake Huron. The commission believes that the Great Lakes cannot be considered rehabilitated until this species and its former diversity of forms become self-sustaining in each lake. Lake trout formerly occupied all lakes from shore-to-shore and to the greatest depths, and no other species has assumed this ecological role.



The American eel (left) and ciscoes (above) have been the focus of rehabilitation efforts in the Great Lakes (see page 9). Both groups of fish are native, but their populations have suffered from overfishing, pollution, and habitat loss.

PHOTOS: AMERICAN EEL COURTESY OMNR-2007 COA; CISCO DIAGRAM ADAPTED FROM W. KOELZ (1929) BY J. WINGFIELD AND M. GADEN, GLFC

The commission has supported research aimed at identifying impediments to lake trout rehabilitation and will continue to do so in the next decade.

To advance rehabilitation of lake trout, the commission will also promote rehabilitation of other native deep-water fishes such as sculpins and ciscoes, which were historically important prey species. Of six species of deep-water ciscoes indigenous to the Great Lakes, two were last seen in the 1960s and another was last seen in the 1970s. Although these three extinct species cannot be rehabilitated, the remaining three can be re-established in those lakes where they are missing.

These deep-water fishes−lake trout, ciscoes, and sculpins−are specialized for large, deep lakes and can fill missing links in deep-water food webs that are now only marginally occupied by other species. Their re-establishment would provide an enriched community capable of supporting more-stable fisheries. Rehabilitation plans for many species need to be developed and implemented aggressively. The commission's emphasis on deep-water fishes is not intended to minimize the importance of rehabilitating shallow-water species such as the coaster brook trout, lake sturgeon, Atlantic salmon, and American eel.

GOAL 2: Stop invasions of aquatic species.

More than 180 non-native species have become established in the Great Lakes, many accidentally. Several pathways—such as canals, the trade of live organisms, and global shipping—have served as vectors for invasive species. Ocean-going vessels that enter the lakes, like the one pictured, often carry ballast, which can be a source of invasive species.

PHOTO: M. GADEN, GLFC

Aquatic invasive species have negatively impacted the native fish fauna of the Great Lakes for more than a century. Construction of canals and intentional introductions allowed the first wave of invaders into the lakes. A second wave of invading species is associated with ballast-water discharges from ocean-going vessels. Many of these invaders—quagga and zebra mussels, predacious zooplankton species, and round gobies—have profoundly altered Great Lakes food webs. Aquatic invasive species also can gain entry via the private culture of food and sport fishes and via the aquarium and bait industries.

Most invaders, once established, are impossible to control. Even when their populations are curtailed, non-native species, such as the alewife, can disrupt food webs. For example, alewives negatively affect the reproductive success of important native fishes including lake trout, emerald shiner, and yellow perch. Zebra and quagga mussels likely caused recent food-web shifts in Lake Huron, and could cause similar changes in Lakes Michigan and Ontario. Movement of Asian carps from the Illinois River into Lake Michigan through the Chicago Area Waterway System, if not prevented, risks the future health of Great Lakes ecosystems. The reverse is also true: species from the Great Lakes now have a pathway to the Mississippi River system through this waterway. For example, round gobies and zebra mussels have spread into the Mississippi River basin from the Great Lakes, and zebra mussels are now found throughout the south and in parts of the west, even in Nevada's Lake Mead. Clearly, invasive species in one ecosystem have the potential to spread throughout North America. Preventing entry, rather than controlling afterwards, is the only practical solution to the invasive-species problem. The commission, therefore, will intensify its work with its partners to generate governmental action to eliminate the entry of aquatic invasive species by blocking key pathways.

GOAL 3: Conduct, coordinate, and communicate research.

The commission, during the next decade, will encourage its partners to collaborate on the establishment, review, and revision of research priorities essential for fishery management decision-making. Information about interactions among species and between species and their environment is needed if managers are to anticipate and respond to changes. Therefore, important areas of commission research will focus on large-scale disturbances such as climate change and how they influence fish communities; the causes for rapid ecological change in Lakes Huron, Michigan, and Ontario; and the impediments to re-establish native fishes and their fisheries. The study of other large-lake systems will be a key strategy to advance an understanding of Great Lakes ecosystems.

The USGS research vessel *Kiyi* collects new scientific information on ecosystem functions and fish behavior, all of which supports fishery management and sea lamprey control.

PHOTOS: G. CHOLWEK, USGS; USGS

The challenge in using new information to achieve healthy Great Lakes ecosystems is large and will require coordination and cooperation among many federal, provincial, state, and tribal agencies and non-governmental partners. The commission will encourage the exploration and application of new technologies, as well as adoption of data standards to ensure data sharing among agencies and timely access for the management community. In particular the commission's Science Transfer Program will assist with transfer of research findings to managers so that new information can provide for informed decision-making. Agencies will need to be proactive and flexible when implementing programs to attain or maintain sustainable fisheries and a healthy Great Lakes ecosystem. The commission's program of sea lamprey control is an essential element in the suite of management actions required to achieve healthy Great Lakes ecosystems. Accordingly, it will coordinate, conduct, and communicate research in support of sea lamprey control consistent with the goals and strategies under Pillar Two.

Fishery research is a collaborative endeavor and is essential to achieving and maintaining healthy Great Lakes ecosystems. Clockwise from top left, scientists work in the lab, dissecting a sea lamprey, walleye tagging, zooplankton sampling, and sturgeon assessment.

PHOTOS, CLOCKWISE FROM TOP LEFT: G. CHOLWEK, T. LAWRENCE, MI DNR, B. GUNTHER, GLFC.

PILLAR TWO:
Integrated Sea Lamprey Control

PHOTO: T. LAWRENCE, GLFC

PILLAR STATEMENT: *The commission will suppress sea lamprey populations to levels that permit achievement of fish community objectives for each Great Lake.*

GOAL 1: Suppress sea lamprey populations to target levels.

Strategy 1: Implement lampricide treatment strategies to suppress sea lamprey populations to target levels in each Great Lake.

Outcome: Sea lamprey abundance and wounding rates on lake trout will be at, or below, target levels in each Great Lake.

Niagara Falls served as a natural barrier to the sea lamprey. The falls were bypassed by the Welland Canal. *PHOTO: T. LAWRENCE, GLFC*

Strategy 2: Conduct detection and distribution surveys to identify all sources of larval sea lampreys.

Outcome: Sources of sea lamprey will be delineated and control efforts will be more effectively prioritized among streams.

Strategy 3: Measure the effectiveness of lampricide applications and account for its variation among streams.

Outcome: New treatment protocols that result in more effective application of lampricides will be developed and implemented.

Strategy 4: Quantify the relationship between the abundance of spawning-phase sea lampreys, lake trout abundance, and wounding rates on lake trout.

Outcome: Inconsistencies between estimates of sea lamprey abundance and observed changes in lake trout wounding rates will be accounted for.

Strategy 5: Construct and maintain a network of barriers to limit sea lamprey access to spawning habitats.

Outcome: Sea lampreys will have reduced access to spawning habitats.

Strategy 6: Deploy trapping methods to increase capture of spawning-phase and recently metamorphosed sea lampreys.

Outcome: Effective and efficient trapping techniques will be developed and implemented.

DRAWING: COURTESY OF NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

GOAL 2: Increase the effectiveness and efficiency of sea lamprey control to further reduce sea lamprey populations in each Great Lake.

Strategy 1: Increase the capture of sea lampreys by developing cost-effective trapping methods including those based on release of pheromones.

Outcome: One new cost-effective trapping method will be deployed.

Strategy 2: Evaluate a repellent-based control method to deter sea lampreys from reaching spawning areas.

Outcome: The efficacy of a repellent-based control method will be assessed in field trials.

Strategy 3: Improve existing and develop new rapid assessment methods to determine the distribution and relative abundance of larval sea lamprey populations.

Outcome: The effectiveness of assessing the distribution and abundance of larval sea lampreys will be increased.

Strategy 4: Implement integrated sea lamprey control strategies for each lake and evaluate their effectiveness.

Outcome: Existing and newly developed methods of sea lamprey control will be used in concert and sea lamprey abundance will be further reduced in each Great Lake.

Rationale for Pillar Statement and Strategies

Although still strongly reliant on the application of lampricides, a control method first deployed in 1958, the effort to control sea lamprey populations in the Great Lakes has become more diverse, especially during the past decade. Consequently, the integration of existing and emerging technologies has become increasingly important. Application of lampricides in streams inhabited by larval sea lampreys continues to be the key control strategy, and is being improved continuously. Likewise, the existing network of barriers, which denies spawning-phase sea lampreys upstream access to favorable spawning habits, is highly effective, but not likely to be greatly expanded owing to the limited availability of suitable sites. Although the trapping of spawning-phase sea lampreys actually preceded the use of lampricides, it continues mainly as a method of assessment, but with further research could become more of a suppression tool.

A promising, but not operational, technology involves the use of pheromones (natural substances released by sea lampreys), especially in conjunction with new approaches to trapping. A high degree of integration among the newest technologies will require estimates of their effectiveness and efficiency (marginal cost), whereas this requirement is less stringent for the existing, long-used technologies. In recognition of this difference, the control strategies are organized under two broad goals. The first focuses on the use of existing technologies to achieve the suppression targets for each lake, and the second focuses on determining the effectiveness and efficiency of emerging technologies to allow for an overall program that better meets performance measures.

A brown trout with a sea lamprey wound

PHOTO: V. DZSURDZSA

Research on sea lamprey behavior, particularly the role of pheromones and repellents during spawning, will guide trap design, placement, and operation to increase trapping effectiveness.

PHOTO: GLFC

GOAL 1: Suppress sea lamprey populations to target levels.

The performance measures for control of sea lampreys in each lake are now expressed three ways: abundance of spawning-phase sea lampreys, wounding rates on lake trout, and an appraisal of these based on changes in lake trout abundance. As of 2011, populations of spawning-phase sea lampreys in four of the five Great Lakes—Michigan, Huron, Erie, and Ontario—were above target levels and wounding rates on lake trout were above target levels in all but Lake Ontario.

Suppressing sea lamprey populations to target levels in each lake remains the top priority for the commission. In the near term, relief will depend mostly on improving the delivery of its mainstream methods – application of lampricides and maintenance of a barrier network. Near-term improvements in lampricide application will depend on determining better the sources of larval lampreys and factors that affect variation in treatment effectiveness. At the same time, maintaining effectiveness of the barrier network will deny spawning sea lampreys access to considerable amounts of spawning habitat. The barrier network includes low-head dams built specifically to block sea lamprey spawning runs and conventional dams built for other purposes, but that also block spawning runs. More low-head dams will be built, but maintaining the integrity of other dams is more important, because many of them are in such poor condition that they may no longer block sea lampreys, thereby causing a need for additional treatments or establishment of difficult-to-detect populations. Improvements in these two areas will minimize the number of parasitic sea lampreys that originate from either untreated sources or from stream treatments that allowed too much escapement.

While the need to achieve better suppression of sea lamprey populations is indisputable, the performance measures used to determine whether more control is necessary need to be better quantified. For instance, in Lake Superior while one performance measure, the number of spawning sea lampreys, was reduced to the target level, the other performance measure, the wounding rate on lake trout, increased and is well above its target. The Great Lakes-wide database on lake trout wounding has been improved recently to allow for a closer examination of the relationship between lampricide applications, spawning-phase sea lamprey abundance, lake trout wounding, and lake trout abundance. Targets for each lake need to be estimated as accurately as possible to prevent over or under treatment and to optimize the allocation of control effort among lakes.

An innovative granular baylucide sprayer boat employs a high pressure spray system and GPS to effectively target lentic areas on the St. Marys River system.

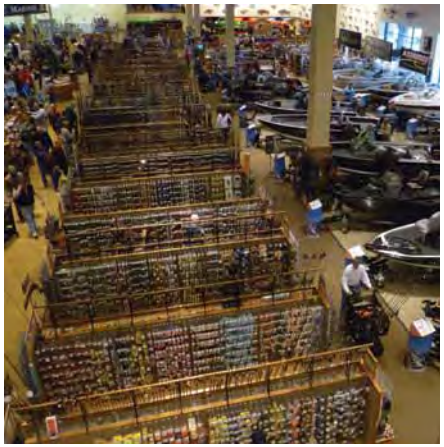
PHOTOS: T. LAWRENCE, GLFC

Pheromone studies are in the field-trial stage. At top right, a dye marks emitted pheromone from a trap on the Ocqueoc River, Northern Michigan. Barriers (bottom right) and trapping are also important components of the sea lamprey control program.

PHOTOS: M. GADEN, GLFC; USGS

GOAL 2: Increase the effectiveness and efficiency of sea lamprey control to further reduce sea lamprey populations in each Great Lake.

Achieving the targets for sea lamprey control in each Great Lake with current methods and funding will be challenging. The commission had hoped to meet these targets by the end of the past decade, but fell short of this goal, in part, owing to an emphasis on reducing the concentration of lampricides and duration of exposure in stream treatments, without an offsetting deployment of effective alternative control methods. Lampricide application rates have since been increased. The probability of reaching control targets can be tipped appreciably more in the commission's favor if new technologies can be implemented to increase suppression beyond that achieved by the application of lampricides and the existing barrier network. Development of alternative technologies was a centerpiece of the commission's vision for the past decade, and the resulting effort has set the stage for a deployment of one or more of them in this decade. These technologies involve chemical communication aimed at either attracting spawning sea lampreys into traps or repelling spawning sea lampreys away from favorable spawning habitats. New technologies are expected initially to be less cost-effective than lampricide application. Reliance on them will increase when their cost-effectiveness approaches that of lampricide application, allowing for anticipated improvements with use. Nevertheless, these new technologies hold promise for addressing other needs such as diminishing the non-target effects of lampricides. Accordingly, a strategy of developing less costly methods of assessing larval sea lamprey populations, if successful, could allow for a diversion of resources from assessment to control and increased experimentation with new technologies. Assuming a demonstration of efficacy in field trials of pheromone attractants, the challenge will be to integrate existing and new methods into a unified approach, where the new methods can replace, if warranted and as much as possible, the existing methods. Only then will the individual elements that comprise sea lamprey control emerge as an integrated program.



The Great Lakes sustain a thriving fishery worth at least $7 billion annually to the people of Canada and the United States. Sea lamprey control is essential for a healthy, vibrant fishery. *PHOTOS: T. LAWRENCE, GLFC*

PILLAR THREE:
Strategic Alliances and Partnerships

PHOTO: T. LAWRENCE, GLFC

PILLAR STATEMENT: *The commission will build and maintain effective strategic alliances to promote sustainable fisheries and a healthy Great Lakes ecosystem.*

GOAL 1: Strengthen inter-jurisdictional fishery management.

Strategy 1: Facilitate the implementation of A Joint Strategic Plan for Management of Great Lakes Fisheries.

Outcome: Agencies signatory to the Joint Strategic Plan will have met regularly to coordinate management.

Outcome: Lake Committees will have developed, revised, and implemented Joint Strategic Plan products – such as fish community objectives, environmental objectives, total allowable catches, annual lake committee reports, and state-of-the-lake reports – to evaluate progress on the achievement of fish community, environmental, and law enforcement objectives.

Strategy 2: Facilitate the marking of all trout and salmon stocked into the Great Lakes to improve lakewide assessment.

Outcome: Mass marking equipment will have been acquired and used throughout the basin.

Outcome: The Council of Lake Committees will have developed and overseen a coordinated process to collect, maintain, and analyze marking data.

Outcome: The extent of natural reproduction will have been determined, and the effectiveness of stocking programs and methods known.

GOAL 2: Integrate environmental and fishery management.

Strategy 1: Assist the lake committees with communicating to environmental management agencies the biological, physical, and chemical requirements necessary to achieve each lake's environmental and fish community objectives.

Outcome: Environmental objectives for all lakes will have been developed and progress in their achievement will have been monitored.

Outcome: Lakewide management plans, remedial action plans, and the Great Lakes Water Quality Agreement will reflect fishery management priorities.

Strategy 2: The commission will facilitate implementation of cooperative fishery and ecosystem restoration based on the Joint Strategic Plan.

Outcome: The U.S. Army Corps of Engineers will have implemented the Great Lakes Fishery and Ecosystem Restoration Program (GLFER) based on input and support from the partner agencies.

Outcome: The federal and provincial governments of Canada will have implemented the Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem so as to support restoration and protection of the Great Lakes basin ecosystem.

Automated and portable mass marking trailers are capable of marking and tagging all trout and salmon stocked into the Great Lakes. Mass marking, when implemented fully, will assist fishery managers in decision-making.

PHOTOS: MARION DANIELS, ONTARIO MINISTRY OF NATURAL RESOURCES

GOAL 3: Strengthen Advisor relationships.

Strategy 1: The commission will support its Canadian and U.S. committees of advisors.

Strategy 2: The commission will actively seek advice on policy matters from its committees of advisors.

Strategy 3: The commission will consult on a regular basis with its committees of advisors to review and amend as necessary their terms of reference.

Outcome: Canadian and U.S. advisors will have attended commission meetings regularly and have provided counsel on topics identified by the commission and the advisors themselves.

GOAL 4: Leverage resources to enhance commission and partner programs.

Strategy 1: Forge and maintain strategic alliances to address priority fishery research and management issues.

Outcome: Strategic alliances among the commission and other agencies will have continued to address effectively priority fishery research and management issues.

Strategy 2: The commission will assist its partners in tracking and advocating funding for key Great Lakes programs in Canada and the United States.

Outcome: The commission will have contributed to the success of other agencies in maintaining or enhancing the resources needed to deliver effective fishery programs.

Rationale for Pillar Statement and Strategies

The commission knows that the goals and strategies within this pillar cannot be fulfilled without strong, durable partnerships. Its research and sea lamprey control programs operate within a Great Lakes-wide system and require consultation, coordination, and cooperation among many agencies and stakeholders. The benefits of these programs are significantly enhanced when commission actions complement the fishery management activities and objectives of its partners. The commission's long-standing adherence to an ecosystem approach relies inherently on such partnerships among a wide range of authorities and interests to achieve sustainable fisheries.

Commercial fishing vessels, Wheatley, Ontario.

PHOTO: M. GADEN, GLFC

Pictured is the first documented wild Atlantic salmon from an intensive restoration effort led by the Ontario Federation of Anglers and Hunters and the Province of Ontario, in cooperation with the State of New York and other agencies. Credit River, September 2010.
PHOTO: HEATHER LOTIMER, ONTARIO STREAMS

GOAL 1: Strengthen inter-jurisdictional fishery management.

Eight states, the Province of Ontario, and two U. S. intertribal agencies share responsibility for managing Great Lakes fisheries, and the two federal governments contribute to fulfillment of lakewide fishery management plans. Governmental agencies had a weak record of cooperation until 1964, when the commission, encouraged by the Convention on Great Lakes Fisheries to establish and maintain working arrangements with public or private organizations, formed lake committees as a place for fishery management authorities to share information and coordinate programs.

United States and Canadian Advisors meeting in June, 2011. L-R: Harold Michon, First Nations; Peter Meisenheimer, commercial fishery; John Jackson, environmental interests; Denny Grinold, sport fishing; Jennifer Nalbone, public-at-large; Jim Dexter, state agency.
PHOTO: T. LAWRENCE, GLFC

Cooperation was significantly enhanced in 1981 through adoption of A Joint Strategic Plan for Management of Great Lakes Fisheries, a voluntary, multi-jurisdictional agreement designed to strengthen partnerships, enhance the strategic function of lake committees, and create accountability among the agencies as they sought to achieve their agreed-upon goals. The Joint Strategic Plan was revised and reaffirmed in 1997. Today, nearly fifty years after formation of the lake committees and thirty years after the signing of the Joint Strategic Plan, the agencies are more committed than ever to a collaborative approach. The commission facilitates implementation of the Joint Strategic Plan, devotes considerable effort toward encouraging coordination of fishery management programs, and fosters connections between management and science to develop decision tools.

Lake committees articulate their shared vision and strategies for action through publication of fish community objectives and fishery restoration plans. Fish community objectives outline a specific vision for a healthy, vibrant, and sustainable fishery for each of the five Great Lakes. Fishery restoration plans provide detailed steps agencies agree to take to help achieve their objectives. Lake committee actions, objectives, and plans are rooted in the scientific information generated and analyzed jointly by the agencies and their partners in government and academia, such that fishery managers have the best information available to support their decisions.

The Great Lakes Mass Marking Initiative began operating in 2008 and it is a good example of an integrated, international approach to fishery rehabilitation. State, provincial, federal, and tribal agencies stock millions of fish into the Great Lakes annually to restore, sustain, and enhance fish stocks. The goal of the mass marking initiative is to use automated technology to mark every trout and salmon stocked into the Great Lakes. This program will provide agencies with the data needed to determine the contribution of hatchery-reared fish to spawning populations and fisheries and to make improvements in

stocking programs. For rehabilitation to succeed, agencies must carefully plan their stocking activities, share automated technology, and exchange data. Lake committees have embraced the Great Lakes Mass Marking Initiative as a way to achieve their individual and shared objectives and have devoted considerable resources to coordinating their stocking programs. The efforts of the commission were essential for securing the necessary capital and for coordinating the planning requisite to making the mass marking initiative a reality.

GOAL 2: Integrate environmental and fishery management.

The commission will provide support for achievement of fish community objectives, environmental objectives, species rehabilitation plans, and other lake committee products by encouraging adherence to, and further implementation of, the Joint Strategic Plan. Moreover, the commission will work with fishery agencies in advocating acceptance of their plans and objectives by environmental agencies, linking such plans to research programs and law enforcement, and in nurturing and advancing partnerships. For example, a major goal of the Joint Strategic Plan is to break away from jurisdictional boundaries whenever possible to better link fishery management objectives with the Lakewide Management Plans called for in the Great Lakes Water Quality Agreement. Likewise, the commission and its partner agencies believe that water quality and ecosystem rehabilitation efforts will benefit from greater interactions with fishery managers. Indeed, more collaboration among all individuals involved in Great Lakes management and ecosystem rehabilitation is essential.

GOAL 3: Strengthen Advisor relationships.

Pursuant to the Great Lakes Fisheries Act, the commission's U.S. enabling legislation, the commission since 1956 has supported a U.S. Committee of Advisors. In recognition of the benefits of a more-balanced approach, the commission formalized and expanded in 1999 what had been an unofficial Canadian committee of advisors. The U.S. advisors are nominated by state governors and appointed by the U.S. section of the commission. Canadian advisors are appointed through consultations between the Ontario Ministry of Natural Resources and Fisheries and Oceans Canada. Both committees represent a broad cross section of interests. Their involvement in commission programs has evolved substantially during the past two decades, and their input has become increasingly essential for the formulation of commission policies and for the delivery of its programs. The advisors also provide new perspectives and communicate the rationale for commission programs to other stakeholders. The commission will maintain active advisory committees and will ensure that communications between them and the commission and between them and other stakeholders are effective by convening regular meetings and workshops.

GOAL 4: Leverage resources to enhance commission and partner programs.

To further protect and restore the Great Lakes ecosystem, the commission recognizes that key programs throughout the basin, in both Canada and the United States, need strong commitments from governments. The commission will assist its partners in tracking and advocating for key Great Lakes programs that protect fisheries and Great Lakes ecosystems. Discussions among lake managers about emerging issues, such as siting for wind power, failing dams, and impeded fish passage, will be promoted. Efforts such as the Great Lakes Mass Marking Initiative, the U.S. Geological Survey's Deepwater Research Program, and the Great Lakes Fishery and Ecosystem Restoration Program enhance federal, provincial, state, and tribal partnerships. Large regional efforts like the Great Lakes Restoration Initiative, the Canada-Ontario Agreement, and the Great Lakes Water Quality Agreement are equally important. These initiatives require support and advocacy. The commission maintains a strong interest in promoting ways that make its own programs, the programs of its partners, and efforts by others complementary, to maximize what is accomplished in protecting and restoring the Great Lakes fishery.

L-R, Commissioners: Peter Wallace (CAN), David Ullrich (US), William Taylor (US), Robert Lambe (CAN), Michael Hansen (US).
PHOTO: M. GADEN, GLFC

L-R, Commissioners: Robert Hecky (CAN), David Ullrich (US), Virginia West (CAN).
PHOTO: M. GADEN, GLFC

Commissioner Siddika Mithani (CAN) observing sea lamprey operations.
PHOTO: C. KRUEGER, GLFC

Jake Van Effen of the USFWS, left, presenting a sea lamprey to Commissioner William James (US). *PHOTO: T. LAWRENCE, GLFC*

PHOTO: T. LAWRENCE, GLFC

GLOSSARY

Convention on Great Lakes Fisheries An agreement made in 1954 between Canada and the United States to improve and perpetuate the fishery resources of the Great Lakes and to establish the commission.

ecosystem Collectively, all organisms in a community plus the associated physical and chemical environment.

environmental objectives Statements developed and agreed to by lake committees that specify abiotic or environmental characteristics of an ecosystem required for achievement of each lake's fish community objectives.

extirpated Exterminated over a distinct part of an organism's natural range.

fish community An assemblage of fish species that interact with each other in a geographically circumscribed unit such as a lake.

fish community objectives Statements developed by lake committees for each Great Lake that specify desired characteristics of fish. A set of fish community objectives has been established for each Great Lake as required by A Joint Strategic Plan for Management of Great Lakes Fisheries.

fishery The act, process, occupation, or season of taking fish.

food web The organisms in an energy pathway usually depicted as starting with primary producers like algae and higher plants and moving to herbivores and eventually to top predators.

Great Lakes Water Quality Agreement An agreement between Canada and the United States, originally signed in 1972 and subsequently modified, to improve the water quality of the Great Lakes.

indigenous Species occurring naturally in a particular place.

invasive species Animals or plants that are non-native to an ecosystem and whose establishment may cause economic or environmental harm.

A Joint Strategic Plan for Management of Great Lakes Fisheries A plan originally signed in 1981 and adopted by federal, provincial, state, and tribal natural-resources agencies to guide management of fisheries in the Great Lakes.

lakewide management plan Plans specified in the Great Lakes Water Quality Agreement that define remedial measures needed to bring a whole Great Lake into compliance with agreement objectives.

lake committee Committees of fishery managers that address issues of common interest about Great Lakes fisheries. Five lake committees exist, one for each Great Lake, and each is composed of one representative from each fishery management authority.

lampricide Various formulations of chemicals used to kill sea lampreys, usually in stream or near shore habitats.

lower lakes Together, Lakes Erie and Ontario.

native An individual, group, or population of organisms occurring naturally within an ecosystem.

non-native An individual, group, or population of organisms introduced into an ecosystem, for example by stocking or by entry through canals.

remedial action plans Plans specified in the Great Lakes Water Quality Agreement that define remedial measures needed to bring an area into compliance with agreement objectives.

recruitment Fish that are just entering the adult population or are becoming available to a fishery or to a sampling gear.

rehabilitation A process of bringing about a recovery to a state similar to, but perhaps different from, the original.

secretariat The staff of the commission.

state of the lake report A published compilation that describes achievement by a lake committee of its fish community objectives.

upper lakes Together, Lakes Superior, Michigan, and Huron.

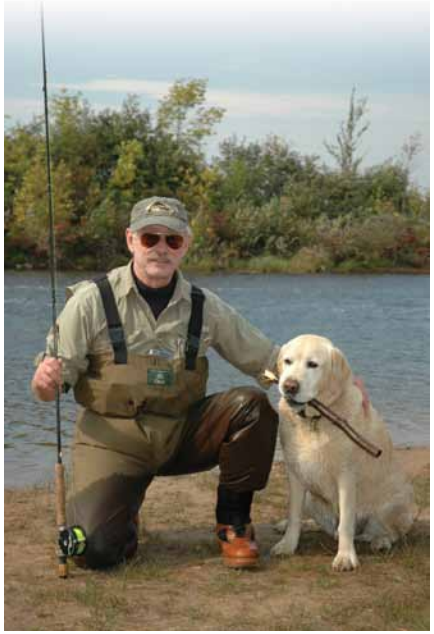
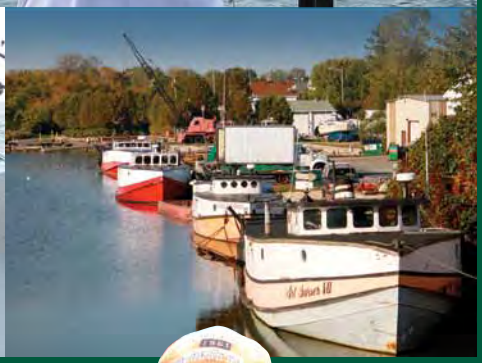


PHOTO: T. LAWRENCE, GLFC



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