



Strategic Vision of the Great Lakes Fishery Commission

2021-2025



Table of Contents

- Introduction** [1](#)
- Role of the Commission [2](#)
- Statement of Purpose [2](#)
- Approach and Organization [2](#)
- Strategic Vision Statement [2](#)
- Background** [4](#)
- Pillar One: Healthy Great Lakes Ecosystems & Sustainable Fisheries** [12](#)
- Pillar Two: Integrated Sea Lamprey Control** [22](#)
- Pillar Three: Strategic Alliances & Partnerships** [28](#)
- Glossary** [36](#)
- Photography Credits** [Inside Back Cover](#)

The Great Lakes Fishery Commission (commission) has published three strategic visions to explain and clarify its role in fishery management, research, and sea lamprey control.

The first vision, A Strategic Vision of the Great Lakes Fishery Commission for the Decade of the 1990s, 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.

A second vision, the Strategic Vision of the First Decade of the New Millennium, was published in 2001 and revised in 2008. 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.

A third vision, the Strategic Vision of the Great Lakes Fishery Commission 2011-2020, formalized three areas of work (pillars) consistent with the commission's duties, involving healthy Great Lakes ecosystems and sustainable fisheries, integrated sea lamprey control, and strategic alliances and partnerships. Herein, we extend commission focus on these three pillars through 2025, while addressing a need to periodically reassess priorities to ensure that commission programs remain responsive to change.



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 by administering a science-driven binational program delivered through contracted federal agents and academic researchers. The commission also serves as a forum and coordinating body to support fisheries research and working arrangements for fishery management agencies 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 working arrangements for inter-jurisdictional management to produce sustainable fisheries to benefit society.

Approach and Organization

Nearly 30 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 three decades, and this revised vision is intended to continue this framework for decision-making during 2021-2025. 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.

1

Pillar One Healthy Great Lakes Ecosystems & Sustainable Fisheries

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

2

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.

3

Pillar Three Strategic Alliances & Partnerships

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

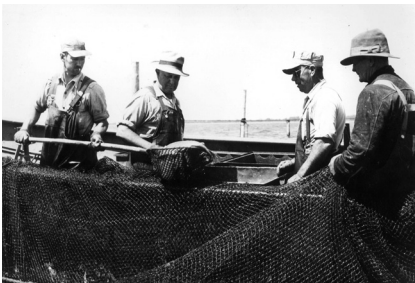
Each pillar consists of a pillar statement, one or more goals, and related strategies and outcomes. These terms are defined below:

- **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 2025.

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. Settlers 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 and led to over-exploited fish stocks, including lake sturgeon, lake trout, and Atlantic salmon, which reduced the diversity of native fishes.

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 river-spawning species 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 critical habitats, threatening many local fish populations and leading to public health concerns and advisories on consumption of certain fish species.



(Left) Dipping fish from a pound net



(Right) Great Lakes Fishery Commission, 1964. Left to right: C. Ver Duin, L. Voight (standing), A. Pritchard, D. McKernan (standing), J. Dymond, A. Blackhurst



(Top) Herring fillets are loaded onto rail cars for distribution

(Bottom) Lake Superior Fisheries Plant, 1945



Inspection of lake herring fillets, 1945

Non-native species began to appear in the Great Lakes in the 1800s. Completion of the Erie Canal in 1825 opened a southerly connection from the Atlantic Ocean to the Great Lakes. The alewife and the sea lamprey were among the first invaders to use this connection, gaining a foothold in Lake Ontario, then expanding 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, the cisco was extirpated in Lake Erie, 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, lake whitefish, and cisco.



(Top) Dipping smelt, Escanaba, Michigan, 1941

(Bottom) Mackinaw boats were the workhorses of 19th century commercial fishing on the Great Lakes



(Top) Kolbe Fish Company in Ashtabula, Ohio

(Bottom) Outside of Bell's Fishery in Cheboygan, Michigan

The catastrophic loss of native fish stocks prompted actions on various fronts by federal, provincial, and state fishery management agencies. Researchers developed lampricides that selectively killed the stream-living larvae of the sea lamprey and reduced sea lamprey predation on native fishes. Managers improved fish restoration programs and strengthened fishery regulations. 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 created new recreational fisheries by stocking salmonid predators (rainbow trout, brown trout, and Pacific salmon) that suppressed burgeoning alewife and rainbow smelt populations and lessened their impacts on native fishes. Implementation of the binational Great Lakes Water Quality Agreement of 1973 brought stricter regulation of nutrients and pollutants that led to improved fish habitats and fish better suited for human consumption.

Improved environmental conditions during the 1980s and 1990s also created challenges for fisheries managers. A new wave of invaders emerged from the ballast waters of intercontinental ocean-going ships. Exploding populations of invasive quagga and zebra mussels disrupted energy flow from the bottom of the food web up to fish and affected production of lake whitefish and other priority fish species. Other invertebrate and fish invaders altered food webs in the lower lakes and spread to the upper lakes. Double-crested cormorants developed extensive nesting colonies in the Great Lakes basin, adding a new predator on nearshore fish communities.

Several additional challenges to fish communities and fisheries have occurred since the 1990s. A unique strain of viral hemorrhagic septicemia virus (VHSV) and other pathogens surfaced in several Great Lakes, resulting in fish kills and affecting bait fish use in the basin. Thiamine deficiency from non-native prey fishes affected restoration of lake trout. Several species of Asian carps were introduced into the Mississippi River basin, meriting extensive efforts to keep them out of the Great Lakes via connected waterways or through other pathways. Offshore wind power projects have been proposed in areas of the Great Lakes, bringing uncertainty about potential impacts on fish communities and fisheries in the first-time application of this technology in large freshwater environments. Additionally, many dams in the Great Lakes are old and need to be repaired or removed, creating new opportunities for fish passage and population restoration but with enormous implications for sea lamprey control.

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.

The commission was also charged with establishing working arrangements among the various Great Lakes fishery management and science agencies in the basin. Lake committees, composed initially of representatives from United States and Canadian fishery management agencies, were established in 1964 with assistance from the commission. Tribal agencies were added to the lake committees after the development of A Joint Strategic Plan for Management of Great Lakes Fisheries, which prescribed a formal structure for engaging federal, provincial, state, and tribal authorities in the basin. Drafted in 1981 and revised in 1997, this plan has proven to be a time-tested, effective means for fishery managers and scientists of all signatory agencies to collectively and proactively address emerging challenges and opportunities for beneficial fisheries in the Great Lakes basin. Accordingly, the commission's continued support for implementation of this plan is in concert with, and fundamental to, the accomplishment of its five duties.

Accomplishment of these duties also requires recognition and attention to factors that affect environmental conditions of profound influence on fish populations and fisheries in the Great Lakes. Sea lamprey and other invasive species, diseases, water pollutants, and habitat alteration remain as threats to sustainable fisheries in the Great Lakes. Mitigation of these threats, in concert with protection or improvement of key fish habitats, requires continued collaboration between invasive species, environmental, and fisheries managers. The commission's continued recognition and facilitation of coordinated, collaborative, and proactive efforts among these managers is important to the fulfillment of its duties.



(Top) The commercial fishing vessel, R.C. Anderson, returns to the Hammond Bay State Refuge Harbor on Lake Huron after collecting the day's catch of lake trout and whitefish

(Bottom) Success! A prized walleye

Given an unpredictable future, the duties of the Great Lakes Fishery Commission remain relevant and vital for sustaining beneficial fisheries in the Great Lakes basin. A strong and adaptive strategic vision that focuses on three core pillars, e.g., healthy ecosystems and sustainable fisheries, integrated sea lamprey control, and strategic alliances and partnerships, supports effective fulfillment of these duties. To ensure accountability, the commission will conduct a review on the achievement of goals and pillar statements and report to its partners by June 15, 2026.

1

Pillar One Healthy Great Lakes Ecosystems & Sustainable Fisheries

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

Great Lakes fisheries depend upon lake-specific ecosystems that support production from naturally-reproducing populations of native and naturalized fishes, supplemented where appropriate with hatchery-plantings of various fishes to provide societal benefits. These fish populations include a variety of priority predator and prey species, whose production varies with dynamic environmental conditions and food webs within each lake, ultimately supporting fisheries of societal importance. Conservation and rehabilitation successes in the Great Lakes have resulted from science-driven collaborative efforts to protect or improve aquatic habitats in the basin, restore fish passage, manage fishing mortality, propagate and stock fish, and minimize impacts from sea lampreys and other invasive species. While rehabilitation has been successful for some priority fish populations (e.g., lake trout in areas of the upper lakes), it has remained elusive for others (e.g., lake trout and ciscoes in the lower lakes). Subsequently, fish community objectives of fishery managers have remained mostly unfulfilled across the basin, with the exception of Lake Superior. The commission's pillar statement about healthy ecosystems and its supporting goals and strategies implicitly recognizes the continued importance of coordinated science-driven management efforts to conserve and rehabilitate priority fish populations, particularly for species that contribute to functional food webs, as integral components of fish communities that sustain valuable fisheries to all societies in the Great Lakes.

Goal 1: Maintain or improve production of fish populations of common concern that benefit from, and support, healthy ecosystems and sustainable fisheries

Sustainable and beneficial fisheries in the Great Lakes derive from healthy fish communities with productive populations of species desired by societies in the basin. Healthy fish communities require environmental conditions that support fish production through functional food webs composed of key predator and prey species. In turn, healthy predator and prey populations help stabilize the fish community through their food web interactions.

Therefore, improving the productivity of fish populations that support valued fisheries and contribute to fish community health through their roles in the food web is important throughout the basin. Important populations include top predators (lake trout, walleye, Pacific salmon), other predators (lake whitefish, white bass, yellow perch), and prey species (alewife, gizzard shad, ciscoes, shiners, sculpins). Additionally, fish behavior affects their distribution and seasonal availability to fisheries within a lake and, for some populations, between lakes. Fish community objectives of agency fisheries managers describe desired species composition and stock structure in each lake. The commission views understanding the condition of health for defined priority fish populations, as well as impediments to their production, as important considerations for developing collaborative management actions that are effective at population and stock scales in each lake.

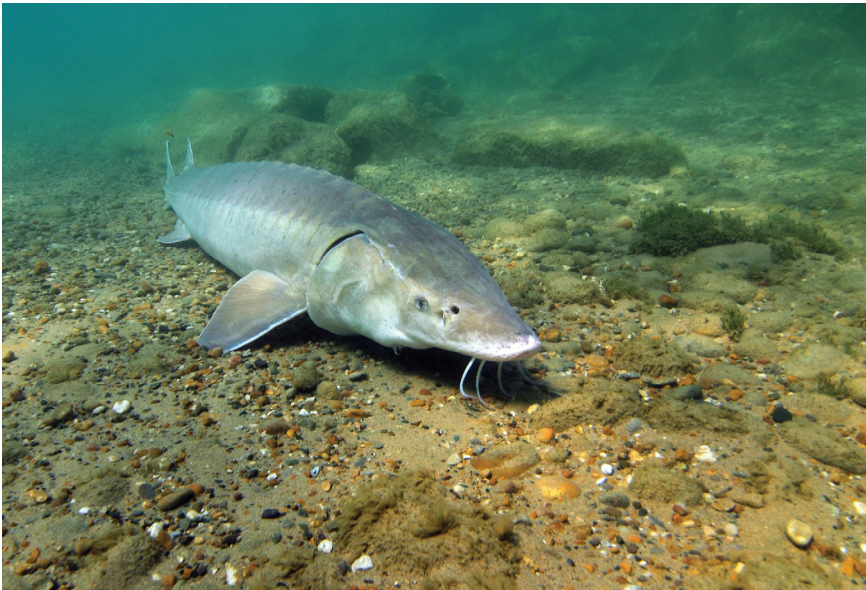
The near extirpation of lake trout from all lakes was a major stimulus for the commission's formation. Lake trout formerly occupied all lakes from shore-to-shore and to the greatest depths. No other species has assumed its ecological role as a deep-water predator. After a six-decade-long effort, promising results are emerging across much of the basin. Lake trout abundance has been restored in Lake Superior, although several forms remain absent. Lake trout have been reproducing in Lake Huron since the early 2000s and wild fish now represent more than 50% of that population. Naturally reproduced lake trout are increasing in abundance in Lake Michigan and wild juvenile lake trout have been increasing in recent years off the Niagara Bar in Lake Ontario. Unfortunately, evidence of natural recruitment has not yet appeared in Lake Erie. 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. The commission has supported research aimed at identifying impediments to lake trout rehabilitation and will continue to do so.



Lake Trout spawning in Lake Huron

To advance rehabilitation of lake trout, the commission also encourages continued rehabilitation of historically-important native prey fishes (ciscoes, sculpins). Four of eight historically recognized cisco species (forms) in the Great Lakes are likely extinct. Considering those four forms, and another four that persist in at least one lake, six have been lost from Lake Michigan; seven from Lake Huron; two from Lake Erie; and three from Lake Ontario. Although extinct ciscoes cannot be rehabilitated, the remaining forms can be re-established in lakes where they are missing. Collectively, rehabilitated populations of lake trout, ciscoes, and sculpins would fill missing links in deep-water food webs that are now only marginally occupied by other species and would provide an enriched community capable of supporting stable fisheries.

The commission's emphasis on deep-water fishes is not intended to minimize the importance of other species noted in the fish community objectives of fisheries managers, including lake whitefish, Pacific salmon, and imperiled shallow-water species, such as coaster brook trout, lake sturgeon, Atlantic salmon, and American eel. Continued development of action plans for these and other species will help to fulfill the fish community objectives for each lake.



Spawning lake sturgeon, St. Clair River, Michigan

Strategy 1: Identify priority fish populations and monitor their condition

- **Outcome:** Researchers and managers will have collaborated to identify priority native and naturalized fish populations throughout the basin
- **Outcome:** Researchers and managers will have collaborated to track the status of priority fish populations

Strategy 2: Prevent the loss of native fish species from any Great Lake

- **Outcome:** No native fishes will have been lost from any Great Lake
- **Outcome:** Researchers and managers will have collaborated to identify sub-populations or forms of native fishes and understand their contributions to the ecology and fisheries within each lake

Strategy 3: Identify impediments to improving productivity of priority fish populations

- **Outcome:** Constraints on productivity of priority fish populations will have been identified
- **Outcome:** Actions that address constraints and improve productivity of priority fish populations will have been identified

Strategy 4: Support cooperative development and implementation of action plans to address impediments

- **Outcome:** Natural resource managers will have undertaken efforts to improve and maintain productivity of priority fish populations

Goal 2: Stop introductions of aquatic invasive species

Aquatic invasive species have entered the Great Lakes through different pathways since the 1800s and have impacted native fishes. Construction of canals and intentional introductions allowed the first wave of invasive species (common carp, sea lamprey, alewife, rainbow smelt, white perch) into the lakes. A second wave of invasive species (quagga and zebra mussels, predacious zooplankton, ruffe, gobies) entered in the ballast water discharges from ocean-going vessels. Other aquatic invasive species have been introduced by humans via the private culture of food and sport fishes, and the aquarium and bait industries. Many of these invaders have profoundly altered Great Lakes food webs, as predators, competitors, and prey of native fishes. Alewife, rainbow smelt, round goby, and white perch have negatively affected the reproductive success of important native fishes, such as lake trout, walleye, ciscoes, smallmouth bass, and yellow perch. Movement of Asian carps from the Mississippi River drainage and through other pathways into the Great Lakes continues to pose a current threat to the health of Great Lakes ecosystems.

Preventing the entry and establishment of new invasive species is the only practical solution to protect extant fish communities and fisheries from impacts. As invasive species become established, management options to minimize their impacts become increasingly limited and eradication becomes impractical if not impossible. Therefore, the commission will continue its work with partners to eliminate the entry of aquatic invasive species by blocking key pathways and by facilitating interagency efforts to share resources via an existing mutual aid agreement of the Conference of Great Lakes-St. Lawrence Governors and Premiers.



Invasive grass carp are removed from Lake Erie tributaries in an on-going effort to prevent their expansion beyond western Lake Erie and the Maumee and Sandusky rivers

Strategy 1: Support establishment of statutory and regulatory authority to prevent aquatic invasive species from entering any Great Lake or spreading within the Great Lakes through all vectors

- **Outcome:** Jurisdictions will have promulgated and enforced laws, administrative rules, and regulations to prevent the entry and spread of aquatic invasive species into the Great Lakes basin

Strategy 2: Encourage science solutions and management actions that prevent the movement of aquatic invasive species through man-made connections among the Great Lakes or between historically separated drainages

- **Outcome:** New populations of aquatic invasive species will not have been established in any Great Lake or have spread among the Great Lakes
- **Outcome:** Techniques and technologies will have been developed and implemented for selective passage of desirable fishes and removal of undesirable fishes at barriers
- **Outcome:** The Great Lakes states and provinces will have maintained and executed a mutual aid agreement to share staff, expertise, and resources in response to new threats from aquatic invasive species



Research technician jumps into the water to begin a SCUBA dive as part of a study on lake trout spawning behavior near Drummond Island, Lake Huron

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

The commission will continue to 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 physical processes and their effects on fish recruitment, energy and nutrient dynamics of Great Lakes food webs, human dimensions of fisheries, the impediments to re-establish native fishes and their fisheries, and emerging priorities identified by the Council of Lake Committees. The study of other large-lake systems is useful to advance an understanding of Great Lakes ecosystems. The challenge in using new information to achieve healthy Great Lakes ecosystems is substantial, requiring 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 the communication of research findings to managers so that new information and tools can help inform 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.



(Top) Sterilized male sea lampreys are released into the Pigeon River in northern Michigan

(Left) USGS biologist checks the experimental "robotfish" during a test on Higgins Lake in central Michigan

(Right) An experimental screw trap to collect recently metamorphosed sea lampreys is evaluated



GLFC science director and FishPass computational engineer answer questions during one of several FishPass public open houses

Strategy 1: Conduct and coordinate research that addresses biological, economic, and social knowledge gaps identified by fishery managers

- **Outcome:** The effects of physical processes on recruitment of fishes will have been quantified
- **Outcome:** Energy dynamics of Great Lakes food webs and the role of food web members in structuring resilient communities and ecosystems will have been determined
- **Outcome:** Historical natural diversity and dynamics of deep- and shallow-water communities and impediments to inform re-establishment of ecosystem function will have been described and quantified
- **Outcome:** Human dimensions of fisheries and fishery management will have been qualified and quantified
- **Outcome:** Networks for data collection, storage, and sharing to quantify fish movement, habitat use, and dynamics and environmental processes driving those dynamics across the Great Lakes basin will have been maintained and expanded
- **Outcome:** Methods for selective passage of desirable species where connectivity is required for fishery re-establishment will have been developed and implemented
- **Outcome:** The sources, effects, and ecological conditions that foster disease outbreaks within fish populations will have been determined
- **Outcome:** Managers will have used new information to engage stakeholders, support management decisions, and update future research needs and priorities

Strategy 2: Promote the exchange of information on issues affecting the large lakes of the world through sponsorship of and participation in workshops, conferences, symposia, research, and scientific publications

- **Outcome:** Managers and scientists will have developed a better understanding of Great Lakes ecosystems



Great Lakes Fishery Commission 2016 annual meeting, Ottawa, Ontario

Strategy 3: Facilitate sharing of research results to better inform fishery managers

- **Outcome:** Knowledge and information about Great Lakes ecosystems will be accessible to fishery managers and other stakeholders for making informed and effective decisions
- **Outcome:** Fishery managers and researchers will have continued to strengthen collaborative relationships that support informed decision-making through the Science Transfer Program
- **Outcome:** The commission will have been effective in using a variety of media to share research results



(Top) Experts in biology, fishery management, hydrology, engineering, and communications meet at the FishPass project scoping workshop, Traverse City, Michigan

(Bottom) Sea lamprey control agents and researchers convene at the 2020 Sea Lamprey Annual Workshop

2

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

Since 1958, sea lamprey impacts on Great Lakes fish communities have been reduced primarily with lampricides, barriers, and trapping through a binational control program guided by comprehensive assessments of sea lamprey adult and larval abundance in each lake and by research results. Continuous improvements to lampricide application, barrier development and maintenance, and trapping techniques have facilitated a science-driven tactical and efficient approach to direct control efforts where most needed. However, lampricides and barriers (primary control methods) also have affected non-target organisms that are sensitive to the toxicants or to habitat loss in formerly free-flowing waterways. Consequently, the development and application of supplementary control methods were initiated in the 1990s to augment primary methods under an integrated control program. Supplemental methods have included the development and implementation of lampricide application protocols for sensitive species, seasonal barrier technologies, new trapping techniques, and sterilized male introductions to reduce reproductive capacity of the sea lamprey population. Lampricide application protocols have reduced lethal impacts on non-target species. Trapping of adult sea lampreys has provided abundance assessments and potentially could enhance suppression efforts. The experimental use of sterilized male sea lampreys has provided mixed results in selected areas of the Great Lakes, but remains



(Left) Sea lamprey mouths



(Right) Angler holds a freshwater drum with a fresh sea lamprey wound, Lake Erie

constrained by the supply of trapped adult sea lampreys. Another promising, but not yet operational technology involves the use of naturally occurring pheromones and alarm cues released by sea lampreys to enhance trapping or deter them from optimal spawning habitats.

A high degree of integration involving the newest technologies will require estimates of their effectiveness and efficiency (marginal cost), whereas this requirement is less stringent for the existing primary methods. 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 and reduces non-target effects.



(Top) USGS laboratory technician records data during a TFM bioassay

(Bottom) USFWS sea lamprey control agent assesses a TFM concentration during a lampricide treatment

Goal 1: Suppress sea lamprey populations to target levels

The performance measures for control of sea lampreys in each lake are expressed three ways: abundance of adult sea lampreys, wounding rates on lake trout, and changes in lake trout abundance. Research is being done to understand disparities among the three metrics to better assess control program efficacy. Performance target levels have not been consistently met in any of the five Great Lakes.

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. Improvements in lampricide application will depend on identifying sources of larval lampreys and factors that affect variation in treatment effectiveness. Maintenance of an effective barrier network will deny access of spawning sea lampreys to considerable amounts of spawning and larval habitat. The barrier network includes dams built specifically to block sea lamprey spawning runs and dams built for other purposes, but that also block spawning runs. Although more sea lamprey barriers will be built, maintaining the integrity of existing dams is crucial – many of them are in poor condition and no longer block sea lampreys, thereby causing a need for additional treatments or establishment of difficult-to-detect populations. Additionally, the need for improved aquatic habitat connectivity, including fish passage, must be balanced with the need for sea lamprey control. Improvements in these areas will minimize the number of parasitic sea lampreys and reduce the impacts of sea lamprey control on non-target species.



Dead sea lamprey larvae indicate a successful lampricide treatment

While the need to further suppress sea lamprey populations is indisputable, the performance measures that drive control decisions need to be better quantified. 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, adult 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, to optimize the allocation of control effort among lakes, and to reduce the impacts of lampricides on non-target species.

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 have been maintained at, or below, target levels in each Great Lake

Strategy 2: Conduct surveys to identify all sources of larval sea lampreys

- **Outcome:** Control efforts will have been more effectively prioritized among streams

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

- **Outcome:** New treatment protocols that result in more effective application of lampricides will have been developed and implemented

Strategy 4: Evaluate the success of sea lamprey control program efforts

- **Outcome:** Increased consistency between estimates of sea lamprey abundance and lake trout wounding rates will have been achieved
- **Outcome:** Quantification of impacts from sea lampreys on other species will have been improved

Strategy 5: Construct, monitor, and maintain a network of barriers

- **Outcome:** An inventory of sea lamprey blocking barriers will have been completed
- **Outcome:** A prioritized list of barriers with maintenance needs will have been developed
- **Outcome:** The commission's infrastructure plan will have been funded to complete highest priority maintenance
- **Outcome:** All proposals to remove sea lamprey barriers will have been reviewed
- **Outcome:** Sea lamprey access to spawning and larval habitats will have been contained or reduced
- **Outcome:** Application of lampricides upstream of effective barriers will have been reduced

Goal 2: Continue investment in research and development of supplemental methods to augment the traditional sea lamprey control program

Achieving targets for sea lamprey control in each Great Lake with current methods and funding is challenging. The probability of reaching control targets can be improved if new supplemental control technologies can be implemented to increase suppression beyond that achieved by the application of lampricides and the existing barrier network. Development of supplemental control technologies aimed at reducing reproductive capacity or trapping of recently metamorphosed sea lamprey before they harm fish provide potential avenues for improved control. New supplemental control technologies are expected to be less cost-effective than lampricide application; nevertheless, these new technologies hold promise for addressing other needs such as further diminishing the effects of lampricides on non-target organisms or addressing difficult-to-treat systems. Additionally, the development of less costly methods for accurately assessing larval sea lamprey populations 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 supplemental control techniques, 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.

Strategy 1: Deploy a suite of supplemental control methods

- **Outcome:** Tactics will have been developed and implemented to reduce sea lamprey reproductive capacity
- **Outcome:** Removal of recently metamorphosed sea lampreys will have been improved

Strategy 2: Improve existing and develop new rapid assessment methods to determine the distribution and relative abundance of larval sea lamprey populations

- **Outcome:** A more accurate and efficient method for assessing the distribution and abundance of larval sea lampreys will have been adopted

Strategy 3: Implement integrated sea lamprey control strategies for each lake and evaluate their effectiveness

- **Outcome:** Existing and newly-developed methods of sea lamprey control will have been used in concert to reduce sea lamprey abundance in each Great Lake

Strategy 4: Research and develop methods for selective passage of desirable species and removal of sea lamprey and other undesirable species

- **Outcome:** At least one new method for selectively passing desirable fish and trapping sea lamprey will have been identified
- **Outcome:** Adverse impacts on non-target native species from sea lamprey control will have been reduced

Strategy 5: Investigate new lampricides with a different mode of action than traditional lampricides

- **Outcome:** At least one candidate compound for potential development as a lampricide will have been preliminarily identified

Strategy 6: Investigate genetic control of sea lamprey

- **Outcome:** At least one viable means of genetic control will have been identified
- **Outcome:** Biological, ecological, ethical, and social impacts of at least one genetic sea lamprey control technique will have been explored and articulated

3

Pillar Three Strategic Alliances & Partnerships

Pillar Statement: The commission will build and maintain effective strategic alliances to promote sustainable fisheries and a healthy Great Lakes ecosystem

The goals and strategies within this pillar cannot be fulfilled without strong, durable partnerships. Research and sea lamprey control programs require consultation, coordination, and cooperation among many agencies and stakeholders to operate throughout the Great Lakes basin. The benefits of these programs are greatly enhanced when commission actions complement the fishery management activities and objectives of its partners. Forged over many decades, working arrangements are solid among fisheries agencies in the basin, tested by emerging issues and opportunities to protect or improve fisheries in concert with dynamic socio-economic conditions within jurisdictions. Partnerships between fisheries and environmental managers remain essential for developing and implementing adaptive ecosystem management that accommodates both fish community and ecosystem objectives. Additionally, the commission continues to recognize the immense value of incorporating stakeholder support and advice into the implementation of its programs.

Goal 1: Strengthen inter-jurisdictional fishery management

Eight states, the Province of Ontario, and three U.S. intertribal agencies share responsibility for managing Great Lakes fisheries, and the two federal governments contribute to the 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. Similarly, a Council of Lake Committees was later created to facilitate interactions among lake committees on items of common interest in the basin.

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 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 by 15 signatory agencies. The 1854 Treaty Authority became the 16th signatory agency in 2014. Today, more than fifty years after formation of the lake committees and thirty years after the first signing of the Joint Strategic Plan, all signatory agencies have remained committed to the collaborative approach prescribed under the Joint Strategic Plan.

The revised Joint Strategic Plan also enhanced the strategic functions of lake committees, the Council of Lake Committees, and a newly-formed Council of Great Lakes Fishery Agencies. Comprising fisheries managers from signatory provincial, state, and tribal agencies, lake committees articulate their shared vision and strategies for action through the publication of fish community objectives and fishery management and restoration plans. Fish community objectives outline a specific vision for a healthy, vibrant, and sustainable fishery for each of the five Great Lakes. Fishery management and restoration plans provide detailed steps that 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 Council of Lake Committees, comprising all lake committees, provides a forum for fisheries management communications involving issues affecting multiple lakes with additional attention to law enforcement and fish health. All signatory agencies are represented by senior administrators on the Council of Great Lakes Fishery Agencies, which provides oversight and leadership to help keep the Joint Strategic Plan and its participants responsive to challenges and opportunities in the basin. The commission will continue to devote considerable effort toward the coordination of inter-jurisdictional fishery management through the lake committees and the facilitation of efforts by the two councils.

Lake Committee Membership by Lake

- **Lake Superior Committee**
 1854 Treaty Authority
 Chippewa-Ottawa Resource Authority
 Great Lakes Indian Fish & Wildlife Commission
 Michigan Dept. of Natural Resources
 Minnesota Dept. of Natural Resources
 Ontario Ministry of Natural Resources and Forestry
 Wisconsin Dept. of Natural Resources
- **Lake Michigan Committee**
 Chippewa-Ottawa Resource Authority
 Illinois Dept. of Natural Resources
 Indiana Dept. of Natural Resources
 Michigan Dept. of Natural Resources
 Wisconsin Dept. of Natural Resources
- **Lake Huron Committee**
 Chippewa-Ottawa Resource Authority
 Michigan Dept. of Natural Resources
 Ontario Ministry of Natural Resources and Forestry
- **Lake Erie/Lake St. Clair Committee**
 Michigan Dept. of Natural Resources
 New York State Dept. of Environmental Conservation
 Ohio Dept. of Natural Resources
 Ontario Ministry of Natural Resources and Forestry
 Pennsylvania Fish and Boat Commission
- **Lake Ontario Committee**
 New York State Dept. of Environmental Conservation
 Ontario Ministry of Natural Resources and Forestry



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:** Agencies signatory to the Joint Strategic Plan will have committed or acquired resources to fulfill management and research obligations to partner agencies
- **Outcome:** Lake Committees will have developed, revised, and implemented Joint Strategic Plan products – such as fish community objectives, environmental priorities, 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.
- **Outcome:** The Council of Lake Committees will have addressed policy and management issues of importance across lakes
- **Outcome:** The Council of Great Lakes Fishery Agencies will have ensured strong coordination and communication among agencies signatory to the Joint Strategic Plan

Goal 2: Integrate environmental and fishery management

Fisheries management agencies lack the authority and capacity to tackle environmental obstacles that impede the achievement of fish community objectives in the Great Lakes. Actions to address these impediments generally must occur within watersheds or along shorelands under the direction of environmental management agencies that are not signatory to the Joint Strategic Plan. Efforts to achieve the objectives of environmental managers may or may not address impediments to fish community objectives. Therefore, fisheries managers see value in determining the impediments to achieving fish community objectives and communicating their interests and priorities to environmental management agencies for potential implementation of remedial actions. Fisheries agencies, under the Joint Strategic Plan, specifically recognize the implementation of the binational Great Lakes Water Quality Agreement through Lake-wide Management Plans as an important opportunity for integrating fishery and environmental management. The commission continues to view the importance of collaborative partnerships between fisheries and environmental management agencies as essential for adaptive ecosystem management in the basin.

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

- **Outcome:** Environmental priorities for sustained fish production for all lakes will have been developed and progress in their achievement will have been monitored

- **Outcome:** The Council of Great Lakes Fishery Agencies will have assisted lake committees with communicating established environmental priorities to environmental management agencies
- **Outcome:** Lakewide management plans, remedial action plans, and the Great Lakes Water Quality Agreement will have reflected fishery management priorities

Strategy 2: The commission will facilitate implementation of actions associated with environmental priorities identified by lake committees

- **Outcome:** Actions will have been implemented through a variety of mechanisms, including the Great Lakes Water Quality Agreement, the Great Lakes Fishery and Ecosystem Restoration program, the Great Lakes Fishery and Wildlife Restoration Act, deepwater science, mass marking, the Canada-Ontario Agreement, the Great Lakes Restoration Initiative, the Great Lakes and St. Lawrence Collaborative Strategy, and coastal zone management programs, among others
- **Outcome:** Actions to address connectivity between tributaries and their lakes to improve production of priority fish populations will have accommodated the need for effective sea lamprey control



(Left) Great Lakes Fishery Commission 2019 interim meeting, Ann Arbor, Michigan



(Right) 2016 upper lake committee meetings, Milwaukee, Wisconsin

Goal 3: Strengthen Advisor relationships

Pursuant to the Great Lakes Fisheries Act, the commission's U.S. enabling legislation, the commission has supported a U.S. Committee of Advisors since 1956. In 1999, the commission formalized and expanded what had been an unofficial Canadian committee of advisors to provide a more-balanced binational forum. 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 Forestry 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 three 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 the advisors and other stakeholders, are effective by convening regular meetings and workshops.

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

- **Outcome:** Canadian and U.S. advisors will have attended regularly scheduled meetings with reimbursed travel expenses
- **Outcome:** The commission will have instituted a communications protocol to keep advisors better informed between in-person meetings

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

- **Outcome:** Canadian and U.S. advisors will have provided counsel on topics identified by the commission and the advisors themselves

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:** Terms of reference for Canadian and U.S. advisors will have been updated as warranted

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.



The USGS research vessel Grayling is one of the U.S. Geological Survey's eight large vessels that support long-term monitoring and assessment of the Great Lakes ecosystem and the fisheries it supports

Strategy 1: Forge and maintain strategic alliances among the commission, agencies, and other organizations to address priority fishery research and management issues

- **Outcome:** Strategic alliances will have promoted more rapid progress toward cooperative and sound fishery management decisions and effective sea lamprey control in support of fish community objectives

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 management and research programs

Goal 5: Strengthen relationship with engageable publics whose actions and behaviors will support the commission's work

Public support is essential for effective implementation of commission programs. Key audiences include local governments, citizen and environmental groups, tribal groups, news media organizations, and law makers of both countries. The commission places emphasis on having effective and adaptive communication that enhances public understanding of its responsibilities, past accomplishments, and future endeavors.

Strategy 1: Develop and implement a comprehensive communications program that formulates messages for dissemination and proposes methods to reach key audiences

- **Outcome:** The commission's key audiences will have understood the value and importance of the commission's programs and will have amplified the commission's message
- **Outcome:** The commission will have made its key audiences aware of the commission's history and incorporated the historical lessons surrounding sea lamprey control, science, and coordinated fishery management
- **Outcome:** The commission will have developed strategies for disseminating information about special projects such as FishPass, the AHS sea lamprey barrier in Grand Rapids, and science projects



The commission's communication directorate educates thousands of people of all ages about the Great Lakes fishery and the sea lamprey control program

Glossary

Action Plan: A documented set of steps or activities for achieving a defined purpose, such as a management objective or rehabilitation strategy.

Common Concern: High importance to all fishery managers (e.g., lake committee) in a Great Lake.

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.

Council of Lake Committees: A formal group, consisting of all lake committee members, that addresses topics involving two or more lakes.

Council of Great Lakes Fishery Agencies: A formal group, consisting of senior administrators from all signatory agencies to A Joint Strategic Plan for Management of Great Lakes Fisheries, that works to ensure implementation of the plan and its revision as necessary.

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

Ecosystem Objectives: Statements developed by environmental managers that specify characteristics of an ecosystem that are desired by society

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 geographical area, such as a lake.

Fish Population: A group of individuals of the same species or subspecies that are spatially, genetically, or demographically separated from other groups.

Fish Stock: a subpopulation of a particular species of fish

Fish Community Objectives: Statements developed by lake committees for each Great Lake that specify characteristics of the fish community desired by fisheries managers. 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.

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.

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.

Lampicide: 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, prior to European colonization.

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

Priority Fish Populations: Fish populations of high importance among fishery managers in each Great Lake due to their ecological contributions to the ecosystem and/or their fishery benefits to society.

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.

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.

Photography Credits

Cover images

A. Miehl, GLFC (*kid fishing*)
GLFC (*school of whitefish*)
T. Lawrence, GLFC (*lampricide treatment*)
A. Miehl, GLFC (*lampricide bioassay*)

Introduction

B. Buechel, USGS (*Isle Royale*, page 1)
A. Miehl, GLFC (*Pillar One image*, page 3)
GLFC (*Pillar Two image*, page 3)
M. Gaden, GLFC (*Pillar Three image*, page 3)

Background

USGS John Van Oosten Library (*pound net dipping*, page 4)
GLFC (*signers of convention*, page 4)
USGS John Van Oosten Library (*herring loaded onto rail cars*, page 5)
NOAA Central Library Historical Fisheries Collection (*Lk superior fish plant*, page 5)
NOAA Central Library Historical Fisheries Collection (*inspecting herring fillets*, page 6)
USGS John Van Oosten Library (*dipping smelt*, page 7)
GLFC (*early sailboat*, page 7)
USGS John Van Oosten Library (*Kolbe Fish Company*, page 8)
B. Skaggs (*Bells Fishery*, page 8)
A. Miehl, GLFC (*RC Anderson*, page 11)
N. Johnson, USGS (*kids holding walleye*, page 11)

Pillar One: Healthy Great Lakes Ecosystems & Sustainable Fisheries

H. Thompson, USGS (*lake trout*, page 13)
A. Muir, GLFC (*lake sturgeon*, page 14)
University of Toledo (*grass carp removal photos*, page 16)
A. Miehl, GLFC (*scuba diver*, page 17)
A. Miehl, GLFC (*dumping sterile lampreys*, page 18)
MSU (*Robofish*, page 18)
R. Pokorzynski, USGS (*screw trap image*, page 18)
R. Shaw, GLFC (*FishPass poster and crowd*, page 19)
M. Gaden, GLFC (*Ottawa meeting*, page 20)
A. Miehl, GLFC (*FishPass group shot*, page 21)
J. Wingfield, GLFC (*SLAWS crowd*, page 21)

Pillar Two: Integrated Sea Lamprey Control

A. Miehl, GLFC (*lamprey mouths*, page 22)
A. Miehl, GLFC (*wound on drum*, page 22)
A. Miehl, GLFC (*lampricide bioassay*, page 23)
J. Wingfield, GLFC (*lampricide treatment*, page 23)
T. Lawrence, GLFC (*dead larvae in hand*, page 24)

Pillar Three: Strategic Alliances & Partnerships

M. Gaden, GLFC (*interim meeting*, page 31)
T. Lawrence, GLFC (*lake committee crowd*, page 31)
USGS (*research vessel*, page 33)
A. Miehl, GLFC (*little boy handling lamprey*, page 35)
A. Miehl, GLFC (*kids at outreach table*, page 35)
R. Shaw, GLFC (*lamprey presentation*, page 35)

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.

Commissioners

Canada

James McKane, Vice-chair
Jean-Guy Forgeron
Vacant
Vacant

United States

William Taylor, Chair
Ethan Baker
Don Pereira
David Ullrich
Charlie Wooley

Acknowledgments

The commission acknowledges the valuable contributions from former commissioners Robert Hecky, Tom Melius, Tracey Mill, Douglas Stang, and Trevor Swerdfager; the Canadian and U.S. advisors; and Lake Committee members who provided comments on earlier drafts.



**Great Lakes
Fishery Commission**

PROTECTING OUR FISHERY



EST 1955 BY TREATY

Great Lakes Fishery Commission
2200 Commonwealth Blvd, Suite 100
Ann Arbor, MI, 48105

glfc.org