

THE GREAT LAKES AND LAKE CHAMPLAIN INVASIVE SPECIES PROGRAM

2019 Report to Congress



A summary of existing federal, state, and tribal invasive species activities aligned with the listed purposes of Great Lakes and Lake Champlain Invasive Species Program as set forth under the Vessel Incidental Discharge Act of 2018 and currently supported through the Great Lakes Restoration Initiative, the Lake Champlain Basin Program, state, and other appropriations.



U.S. Environmental Protection Agency
Great Lakes National Program Office

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Executive Summary

The Great Lakes and Lake Champlain Invasive Species Program (GLLCISP or Program) was authorized by Section 903(g) of the Vessel Incidental and Discharge Act (VIDA) which was enacted in December of 2018. VIDA Section 903(g) required the U.S. Environmental Protection Agency (EPA) Administrator to establish the GLLCISP within the Great Lakes National Program Office (GLNPO), in collaboration with other federal, state, tribal, and local agencies. VIDA also set forth the desired purposes and methodologies of the Program. While section 903(g)(7) authorized the appropriation of \$50 million annually to fund the Program in Fiscal Years (FY) 2019 through 2023, funding was not appropriated for FY 2019.

VIDA Section 903(g)(6) requires the GLNPO Director to provide a Report to Congress summarizing the outcomes of activities carried out under the Program, as well as recommendations for both achieving the purposes of the Program and for improving it.

Invasive species activities underway in the Great Lakes and Lake Champlain basins already support, to some extent, the stated purposes of the GLLCISP. In the Great Lakes basin, the Great Lakes Restoration Initiative (GLRI) annual planning and budgeting process provides an important forum to review major Great Lakes basin monitoring activities currently underway, emerging Aquatic Nuisance Species (ANS) issues, and needed changes. Consultations with states and tribes occur twice a year, informing consensus-based GLRI decisions to maintain, enhance, or reduce monitoring efforts. This GLRI process also relies on species-specific collaboratives and focused monitoring efforts on individual lakes that depend on technical experts to design effective and informative monitoring strategies. Active participation of federal, state, tribal, and other institutions on the Great Lakes ANS Panel further provides opportunities to address the latest trends from monitoring, updates to watch lists, and common ANS activities.

GLNPO used FY 2019 GLRI-funded resources (i.e., staff time and travel) to prepare this report required by VIDA. GLNPO collected and synthesized readily-available information from many partners, including federal, state, and tribal entities, to “inventory” the degree to which the eight stated purposes of the GLLCISP are currently being met, even in the absence of specific GLLCISP funding. This inventory of existing activities was done in collaboration with Great Lakes states and tribes, EPA Regions 1 and 2, and the Lake Champlain Basin Program (LCBP).

This Report fulfills the requirement detailed in VIDA Section 903(g)(6) by providing brief descriptions of selected existing activities in the Great Lakes and Lake Champlain basins that align with the eight GLLCISP purposes identified by Congress. This inventory does not capture all possible activities in existence that align with the GLLCISP, but rather provide a brief and informative assessment of the most relevant activities. This Report also offers recommendations that would (in conjunction with any GLRI and Lake Champlain Geographic Program funding used for the purpose of implementing the GLLCISP) further support the intended purposes of the GLLCISP as called for by VIDA Section 903(g)(6).

Lake managers in both the Great Lakes and Lake Champlain basins have relied on long-term, existing monitoring and science activities to track the presence and spread of ANS for many

decades. Over the last ten years, the Great Lakes basin has benefited from GLRI appropriations that have accelerated prevention, control, and technology development efforts targeting ANS.

In both the Great Lakes and Lake Champlain basins, support for State ANS management plan development and implementation has been critical. In the Lake Champlain basin, it will be particularly important that future state management plans developed by New York and Vermont, the two states bordering Lake Champlain, be harmonized. In both basins, enhanced support for state implementation of prevention and control activities across a variety of species and vectors has made state ANS control and prevention efforts more effective and allowed states to address existing gaps in such efforts.

Continued research is needed in the Great Lakes basin to enhance ballast water monitoring and technology development to meet the provisions of the GLLCISP. Little to no commercial shipping is currently occurring in Lake Champlain, and therefore the ballast water vector is not a significant concern.

Subject to the availability of future appropriations, recommendations include:

1. Research on both shipboard and land-based ballast water management systems for vessels operating primarily on the Great Lakes could be increased. The unique shipping patterns and environmental conditions within the Great Lakes pose significant technical challenges to developing and piloting suitable ballast water management technology.
2. EPA will consider the potential need for additional full time employee(s) (FTE) in GLNPO to effectively administer the GLLCISP. Proper oversight and administration of any potential future GLLCISP funds from year-to-year will be critical to ensuring efficient, effective, and responsive efforts to emerging ANS issues in both the Great Lakes and Lake Champlain basins.
3. Great Lakes and Lake Champlain state and tribal aquatic nuisance species programs, emphasizing prevention and management could be enhanced.
4. A Lake Champlain ANS Program could be established. ANS activities already being implemented in the Great Lakes basin that could readily be mirrored and incorporated into an enhanced Lake Champlain ANS Program include:
 - the Great Lakes Aquatic Nuisance Species Information System (GLANSIS), a comprehensive ANS tracking and reporting system;
 - monitoring of benthic, nearshore, and high-risk sites, in addition to open-water locations, for ANS;
 - a basin-wide ANS “watch list”;
 - risk assessments for ANS not currently present but which could become established if introduced;

- development and application of genomic tools to aid early detection of ANS and vector-specific control and management; and/or
 - expansion of ANS monitoring activities into canals and waterways; and robust boat inspections for ANS at high-risk locations.
5. Research that provides the technical basis for surveillance of aquatic nuisance species could be expanded beyond current efforts in the GLRI to address monitoring associated with response actions into broader surveillance techniques that combine traditional and emerging technologies to further improve prevention activities.

Both basins already have robust and inclusive multi-agency planning and budgeting processes to make funding decisions, including allocating resources to ANS issues. These existing planning and budgeting mechanisms could remain in place to manage any potential future additional appropriations and to support the eight purposes of the GLLCISP.

I. Introduction

Aquatic nuisance species (ANS) are significant and immediate threats to the ecosystems and economies of the Great Lakes and Lake Champlain basins. There are multiple vectors (pathways) for continued ANS introduction into these large basins due to a robust regional and global economy including canals and waterways, commercial ships, organisms in trade, and recreational boats. In the Great Lakes basin, there are 188 established non-native or invasive species. Of these 188 species, 64 have been determined to have moderate to severe environmental and/or socioeconomic harm. In the Lake Champlain basin, there are 51 established non-native or invasive species. Of these 51 species, about a dozen have been determined to cause harm to the local economy, the ecosystem, or human health.



Figure 1: Map showing the major connections between the Lake Champlain and Great Lakes basins and the Atlantic Ocean. Numbers in the red bars indicate the numbers of ANS currently present within the identified waterbody.

ANS are not only a threat to the basins' ecosystems due to their ability to outcompete native species, alter the food web and threaten the diversity or abundance of native species, but they also present a threat to the basins' economic health. By decreasing the populations of native fish and other species, and decreasing the ecosystem's aesthetic value, ANS can adversely impact basin-wide or local economies that depend on a healthy and diverse ecosystem for recreation, sport and commercial fishing, and tourism.

Asian carp are an obvious example of such threats. Asian carp refers to several species of related fish that originated from Asia, including Bighead carp, Silver carp, Black carp and Grass carp. Though all are fast growing and prolific feeders that out-compete native fish and can leave a trail

Examples of Aquatic Invasive Species in the Great Lakes and Lake Champlain

	Present		Not Present (Focus of Prevention)
The Great Lakes	Grass Carp Sea Lamprey <i>Thermocyclops crassus</i> <i>Hydrilla</i> Round goby Quagga mussels		European water chestnut Killer shrimp Northern snakehead Golden mussel
The Great Lakes & Lake Champlain	Spiny water flea Fishhook water flea Zebra mussel		Bighead carp Silver carp Black Carp <i>Hydrilla</i> (prevent further spread in Great Lakes)
Lake Champlain	Alewife Water chestnut Eurasian watermilfoil		<i>Hydrilla</i> Quagga mussel Round goby

DATA SOURCES: GLANSIS (<https://www.glerl.noaa.gov/glansis/nisListGen.php>), Governors and Premiers "Least Wanted" List (<https://www.blueaccounting.org/print/pdf/node/5099>) and Lake Champlain Basin Program 2018 State of the Lake and Ecosystem Indicators Report (<https://sol.lcbp.org/en/>).

Figure 2: Selected examples of ANS *present* and a focus of management and monitoring as well as *not present* and a focus of prevention, outreach, and surveillance for the Great Lakes, Lake Champlain, and both basins

Chicago Area Waterways System. Biologists believe that if these species were to enter the Great Lakes via Lake Michigan, they could have a catastrophic impact on the existing fish populations through disruption of the existing food chain.

Grass carp present significantly different risks to the ecosystem. Grass carp primarily feed on aquatic plants. This feeding pattern can significantly alter the composition of habitat by reducing food sources, shelter and spawning areas for native fish. While a small population of reproducing Grass carp have been detected in Lake Erie, continued monitoring and control activities will be needed to prevent a potential population increase, which could threaten the Lake Erie fishing and boating-based economies by altering the existing fish population and altering the structure of coastal wetlands.

In general, approaches to managing invasive species can be viewed and evaluated relative to stages along an "invasion curve" from initial introduction to establishment (Figure 3). The first stage is monitoring and prevention. Broad monitoring across lakes and targeted monitoring at high-risk locations help first detect, then allow for possible interception of ANS before populations are established.

of environmental destruction, the four species of Asian carp do not impact the underwater environment in the exact same ways.

Bighead and Silver carp are voracious eaters of zooplankton and phytoplankton. Adult Black carp feed primarily on mollusks, such as mussels and snails. These three species have been moving up the Mississippi River watershed, including the Illinois River and Ohio River. Silver and Bighead carp are the most immediate threat to the Great Lakes due to their proximity to Lake Michigan. Silver, Bighead, and Black carp are not yet present in the Great Lakes themselves, but have required the expenditure of hundreds of millions of dollars to keep them from entering Lake Michigan via the

After an invasive species is detected, the relevant jurisdictional authority (e.g., federal agency, states, tribes, or local governments, depending on where the infestation occurs) may implement rapid response actions to control the spread of the invasion by managing, treating, and controlling populations. Examples of rapid response actions include chemical treatments or physical removal, limiting access to neighboring high-risk locations, and/or targeted education and outreach efforts. Signage, and increased numbers of watercraft inspections and decontaminations in high-risk locations are also often used. Other approaches to reduce risk of ANS establishment include educating the public (e.g., via press releases and other media approaches) and local stewardship groups, thereby mobilizing a larger number of individuals to undertake surveillance, prevention, and eradication activities. If a particular ANS successfully reproduces and becomes established in abundance within an ecosystem, the final (and most cost-inefficient and time-consuming) option is controlling the existing populations and managing the ecosystem dynamics as much as possible.

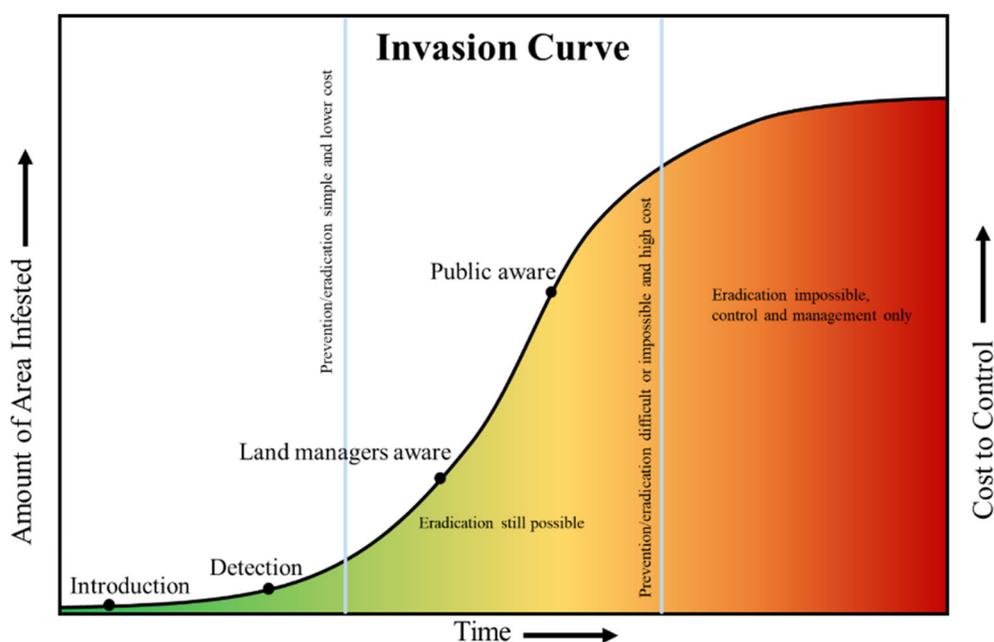


Figure 3: Rising costs of actions required to prevent or control invasive species establishment from the moment of introduction to establishment and abundance within a system (<https://www.nps.gov/subjects/invasive/prevention.htm>)

Purpose of the Report:

This Report examines existing invasive species activities in both the Great Lakes and Lake Champlain basins in relation to the eight stated purposes of the Great Lakes and Lake Champlain Invasive Species Program (GLLCISP):

- 1) to monitor for the introduction and spread of ANS species into or within the Great Lakes and Lake Champlain Systems;
- 2) to detect newly introduced ANS prior to the establishment of the ANS in the Great Lakes and Lake Champlain Systems;

- 3) to inform, and assist with, management and response actions to prevent or stop the establishment or spread of an ANS;
- 4) to establish a watch list of candidate ANS that may be introduced or spread, and that may survive and establish, within the Great Lakes and Lake Champlain Systems;
- 5) to monitor vectors likely to be contributing to the introduction or spread of ANS, including ballast water operations;
- 6) to work collaboratively with the Federal, State, local, and Tribal agencies to develop criteria for prioritizing and distributing monitoring efforts;
- 7) to develop, achieve type approval for, and pilot shipboard or land-based ballast water management systems installed on, or available for use by, commercial vessels operating solely within the Great Lakes and Lake Champlain Systems to prevent the spread of ANS populations within the Great Lakes and Lake Champlain Systems; and
- 8) to facilitate meaningful Federal and State implementation of the regulatory framework in this subsection, including monitoring, shipboard education, inspection, and compliance conducted by States.

For each of the eight GLLCISP Purposes, the Report describes selected existing activities in the Great Lakes and/or Lake Champlain basins that align with the GLLCISP purpose. A summary comparison of key activities that support and align with GLLCISP Purposes is presented in a tabular format. As specified by VIDA 903(g)(6)(B)(iii and iv), each Report section ends with recommendations relating to activities that would contribute to achievement of the purposes and recommendations to improve the efficiency and effectiveness of the GLLCISP, respectively.

Although the Vessel Incidental and Discharge Act (VIDA) specifically mentions Lake Champlain and the Great Lakes in Purpose 7, the lack of commercial navigation by ballasted vessels on Lake Champlain currently makes Purpose 7 relevant only to the Great Lakes. Additionally, it was not possible to identify existing activities that align with implementation of a regulatory framework for ballasted vessels operating within the Great Lakes (Purpose 8) because the regulatory framework has not been finalized. VIDA requires EPA to develop national standards of performance for commercial vessel ballast water by December of 2020. Additionally, two years after EPA publishes the standards of performance, VIDA requires the U.S. Coast Guard (USCG) to develop corresponding implementation, compliance, and enforcement regulations including monitoring, education, and inspection activities. These regulations may include requirements governing the design, construction, testing, approval, installation, and use of devices to achieve EPA's standards of performance.

II. Summary of Existing Activities that Align with the GLLCISP

Purpose 1: “Monitor the introduction and spread of aquatic nuisance species”

In this section, we highlight up-to-date information systems or “clearinghouses” that report current ANS introduction, status, and spread based on various monitoring efforts present in the Great Lakes or Lake Champlain basin. The comprehensive nature of information on current ANS introduction and spread is further discussed based on the diversity of monitoring activities that are currently in operation.

A. Existing Activities:

Great Lakes:

In the Great Lakes basin, one comprehensive tracking system, known as the *Great Lakes Aquatic Nonindigenous Species Information System* (GLANSIS), provides updated information on the presence and spread of ANS. GLANSIS is managed by the National Oceanic and Atmospheric Administration (NOAA). It reports the cumulative results of all Great Lakes monitoring activities, supported and updated with fact sheets, threat assessments, and maps designed to educate stakeholders and inform ANS prevention, management and control activities. It provides up-to-date information on the current status of non-native species and the further spread of ANS throughout the Great Lakes basin. GLANSIS ANS updates and related information are a product of a national tracking database (U.S. Geological Survey Nonindigenous Aquatic Species Program) which contains a diversity of habitats currently sampled by monitoring activities in the Great Lakes.

A diverse spectrum of partners perform both specialized and routine monitoring across the Great Lakes that has contributed to years of historical data on non-native species presence and

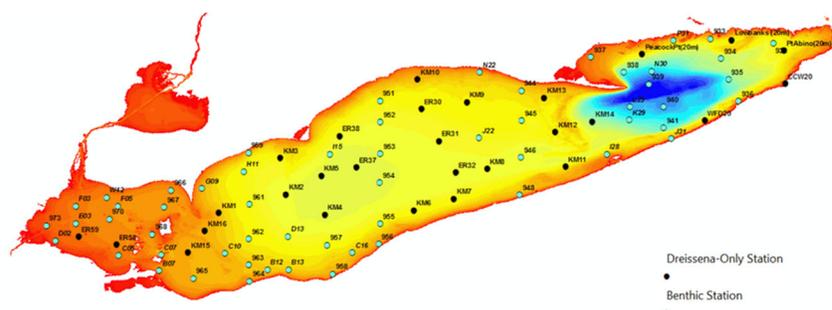


Figure 4. Example of intensive open water and nearshore monitoring of Lake Erie in 2019. Sampled sites in 2019 were chosen to assess benthic (bottom-dwelling) communities, with an emphasis on invasive quagga mussel distribution and spread.

abundance. Targeted, geographic monitoring is conducted to specifically investigate individual ANS issues within Great Lakes (Figure 4). This type of concentrated monitoring occurs in addition to annual monitoring and sampling operations in open water, lake sediments, wetlands, and nearshore areas throughout the Great Lakes. Different techniques used to

characterize Great Lakes habitats include trawling surveys, nearshore electrofishing surveys, and monitoring of the commercial fishing industry by states and other partners. As an example, *The Great Lakes Biology Monitoring Program* (<https://www.epa.gov/great-lakes-monitoring/great->

lakes-biology-monitoring-program-technical-report) is an important annual monitoring effort that documents long-term trends in plankton and benthos communities. The last three new non-native species detections in the Great Lakes have occurred through this program. Many other annual monitoring efforts exist in the Great Lakes, providing a robust dataset that allows GLANSIS to summarize current ANS status.

Lake Champlain:

While there are several collaborative monitoring efforts in the Lake Champlain system to detect and document the spread of ANS, no single system similar to GLANSIS exists to comprehensively report the current introduction and spread of ANS in Lake Champlain. Entities in the Lake Champlain basin must currently use multiple reporting mechanisms to gain an understanding of ANS status and distribution. However, that understanding is limited by the nature of existing monitoring efforts.



Figure 5. Researcher deploys a plankton net to monitor for invasive zooplankton as part of the Lake Champlain Long-Term Water Quality and Biological Monitoring Program in August 2018.

The *Lake Champlain Long-Term Water Quality and Biological Monitoring Program*, in operation since 1990, is a collaborative activity between the Lake Champlain Basin Program (LCBP), the States of New York and Vermont, and Lake Champlain Research Institute at the State University of New York (SUNY) Plattsburgh (<https://www.lcbp.org/water-environment/data-monitoring/monitoring-programs/>). Organisms collected and identified by this monitoring activity provide insight into the open water portion of Lake Champlain. While it was not designed to be a comprehensive ANS monitoring activity, the spiny and fishhook water fleas – two recent invaders of Lake Champlain – have been detected through this activity.

Opportunistic, species- and habitat-specific sampling and tracking is conducted to document occurrence and abundance of important non-native species (e.g., zebra mussel, spiny and fishhook water flea). Lake Champlain partners rely largely on available grant funding to conduct this specialized monitoring, thereby limiting the ability to develop long-term data-sets. As an example, The Nature Conservancy's (TNC) *Adirondack*

Park Invasive Plant Program has conducted monitoring for prioritized high-risk ANS such as Eurasian and variable-leaved milfoil, Asian clam, fishhook and spiny water flea, and *Hydrilla* in select lakes and wetlands in the Lake Champlain basin.

B. Analysis:

Partners in both the Great Lakes and Lake Champlain basins use multidisciplinary approaches to generate data to track ANS occurrence and spread. In the Great Lakes, limnologists, fisheries biologists, wetland ecologists, and other experts provide knowledge and actively advise federal, state, and local activities that broadly monitor the introduction and spread of ANS. Similar diverse expertise is used within the Lake Champlain basin to guide long-term monitoring and

targeted monitoring approaches. Both geographies are pursuing the latest technologies and tools to optimize efforts necessary to characterize ANS presence and absence across these large geographies. However, no systematic sampling of habitats other than open water currently occurs in Lake Champlain.

Analysis of Key Activities Important to Meeting Purpose 1 of the GLLCISP

Key Activity	Great Lakes	Lake Champlain
1. Tracking and reporting ANS introductions and spread	GLANSIS – one system that cumulatively tracks monitoring results across States and agencies	Multiple agency tracking systems; no single comprehensive system
2. Long-term monitoring of important habitats	Open-water, benthic, coastal wetland, and nearshore habitats sampled annually in the Great Lakes	Open-water sampled annually, other habitats opportunistically sampled

C. Potential Recommendations by Key Activity:

Key Activity 1. Develop a single tracking system, similar to GLANSIS, in the Lake Champlain basin to allow for efficient reporting of ANS occurrence and spread. Without a single system, Lake Champlain partners may not be notified in a timely manner of new non-native species occurrence.

Key Activity 2. Promote more frequent and comprehensive monitoring activities that document ANS in a more diverse collection of Lake Champlain basin habitats. Benthic and nearshore monitoring that detects ANS would more fully achieve the goals of Purpose 1 for the Lake Champlain basin. Additional lab capacity for these monitoring efforts, whether part of a new monitoring activity or as part of adding monitoring efforts to an existing activity, would improve monitoring efforts.

D. Other Potential Recommendations:

To more fully achieve the purpose of monitoring the introduction and spread of aquatic nuisance species, the following activities could be considered:

- Great Lakes and Lake Champlain basin managers could share monitoring activity details and examples of successful cooperative in-basin monitoring networks in order to enhance and improve monitoring efforts in one or both basins (e.g., benthic and nearshore monitoring in Lake Champlain);
- As appropriate and feasible, Great Lakes and Lake Champlain basin managers could collaborate on the development of new monitoring technologies so that newly developed methodologies have broad applicability and can benefit multiple freshwater systems.

Purpose 2: Programs that “detect newly introduced aquatic nuisance species prior to the establishment”

Surveillance activities that are designed to track ANS introduction, distribution, and establishment are documented in this section along with the technologies that have been developed and deployed in parallel to find organisms in low numbers across large areas (broader existing monitoring programs providing information on ANS populations are highlighted under Purpose 1, above).

A. Existing Activities:

Great Lakes:

Great Lakes early detection activities focus on “hotspot” locations where there is a known and elevated ANS risk. The *Great Lakes Early Detection and Surveillance Program*, funded through the Great Lakes Restoration Initiative (GLRI) and implemented by the U.S. Fish and Wildlife Service (USFWS) in collaboration with states, conducts targeted monitoring at 26 “hotspot” locations in the basin that represent high-risk pathways and potential suitable habitat for ANS. These sites are sampled annually using techniques necessary to capture potential ANS identified in USFWS Ecological Risk Screening Summaries (ERSSs), focusing on fish and invertebrates. Additionally, the *Aquatic Invasive Species (AIS) Interstate Surveillance and Response Framework for the U.S. Waters of the Great Lakes*, developed under the leadership of TNC with support and input from all eight Great Lakes states, compliments existing USFWS “hot spot” surveillance. It also establishes a comprehensive, basin-wide strategy for detecting new introductions of ANS, identifies priority locations for monitoring, and currently prioritizes sample efforts to detect new non-native plants.



Figure 6. “Hot spot” sampling locations for the Great Lakes Early Detection and Surveillance Program, supported by the GLRI and implemented by the U.S. Fish and Wildlife Service in collaboration with states, tribes, and other partners.

Local partnerships have also been relied on for the early detection of ANS. For example, the *Minnesota AIS Research Center and University of Minnesota-Extension AIS Detectors Program* (Detectors Program) is a statewide surveillance network of trained volunteers that participate in citizen science, outreach and education, and stewardship in support of

aquatic invasive species activities. Minnesota Department of Natural Resources (DNR) and Minnesota Sea Grant utilize the Detectors Program to undertake outreach to the public to increase awareness of invasive species and encourage people to report potential new populations.



Figure 7. The four species of Asian carp that are closely monitored for introduction and spread by the ACRCC due to their threat to the Great Lakes basin. From top left, clockwise: Grass carp, Silver carp, Black carp, and Bighead carp.

facilitated by work groups and collaboratives existing in the Great Lakes. USFWS implements an Asian carp environmental DNA (eDNA) early detection activity and exchanges information with Canadian partners. Federal and state agencies are continually piloting and improving eDNA technology, such as Michigan DNR's effort to evaluate the detection probabilities for eDNA sampling and traditional surveillance methods in order to recommend how best to detect new aquatic invaders with higher accuracy. App-based technologies, including the *Midwest Invasive Species Information Network (MISIN)*, exist and allow lake managers to view maps that show high-risk areas, so they can prioritize surveillance actions. Additional technologies that are in use or development for early detection of select species in the Great Lakes include remote sensing and aerial drones.

Lake Champlain:

Instead of stand-alone early detection and surveillance activities, the Lake Champlain basin relies on existing monitoring programs including the *Biological Long-Term Water Quality Monitoring Program* to detect new ANS in open water habitats.

This monitoring activity was expanded to include early detection of zebra mussels in inland lakes in Vermont, and the dispersion and establishment of Asian clams and plankton (including non-

Species-specific early detection efforts and collaboratives monitor high-risk vectors to increase their chances of early detection for a species or group of related species. The Asian Carp Regional Coordinating Committee (ACRCC), made up of federal, state, provincial, and other entities in the Great Lakes basin implements the *Asian Carp Action Plan*, which outlines annual surveillance activities for Bighead, Silver, Black, and Grass carp in the Great Lakes and connecting waterways. Other species-specific early detection and surveillance efforts exist in the Great lakes for aquatic plants, invasive crayfish, and common reed.

The deployment and optimization of innovative sampling technologies is

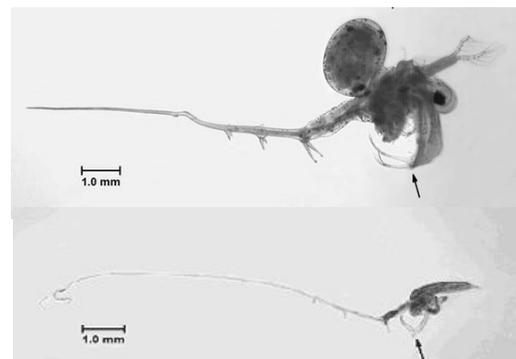


Figure 8. From top to bottom: The spiny water flea (*Bythotrephes longimanus*) and fishhook water flea (*Cercopagis pengoi*) are species whose abundance and distributions is determined by existing monitoring efforts in Lake Champlain.

native fishhook and spiny water flea) in Lake Champlain. USFWS and state routine monitoring activities such as creel surveys, seining, plankton tows, and electrofishing are serving to detect new ANS in lieu of a dedicated surveillance system.

Partnerships and citizen efforts are similarly relied on in the Lake Champlain basin to assist in early detection of ANS. The *Vermont Invasive Patroller* is a network of trained citizens that can identify high priority ANS and report them to the state for early detection. The LCBP and its member states rely on partners in Quebec for updates on detection of species such as quagga mussel and round goby and whether those ANS are moving closer to Lake Champlain from connecting waterways. Lake Champlain partners also collaborate with researchers across New York and New England to better understand where quagga mussel, round goby, and *Hydrilla* are relative to the Lake Champlain system.

Lake Champlain partners are building capacity and knowledge necessary to pilot innovative sampling techniques for ANS LCBP staff participate in regional efforts seeking to advance innovative eDNA sampling techniques for zebra and quagga mussels as well as Asian clam throughout the northeast United States. The New York Department of Environmental Conservation is in the process of setting up an eDNA lab to be used for ANS detection analysis.



Figure 9. Asian clam (*Corbicula fluminea*) is a species of high concern for which there are some targeted monitoring efforts in the Lake Champlain basin.

B. Analysis:

Through dedicated early detection and surveillance, piloting and use of new technologies, and existing monitoring activities, the Great Lakes basin has a significant level of effort in place to detect new occurrences of non-native species. Traditional aquatic sampling techniques have been integrated with genetics, characterization of invasion “fronts” and pressures, and spatial prioritization to sample multiple habitats and species groups. Species such as Asian carp (4 species), *Hydrilla*, and Red swamp crayfish have dedicated collaboratives in place in the Great Lakes to closely track occurrences of these species in or near the Great Lakes. ANS groups such as larval fish, invertebrates, and aquatic plants are spatially prioritized for early detection efforts using a combination of sampling techniques. This implementation of multidisciplinary techniques in the Great Lakes basin is still relatively recent (*i.e.*, last 10 years) but is significantly more advanced than the implementation of similar approaches in Lake Champlain.

Analysis of Key Activities Important to Meeting Purpose 2 of the GLLCISP

Key Activity	Great Lakes	Lake Champlain
3. “Hotspot” early detection activities	Basin-wide program in place to monitor “hotspot” locations along with supplementary activities by partners	No established early detection monitoring efforts present at boat launches and marinas and other opportunistic areas

4. Species-specific activities or collaboratives (<i>i.e.</i> , focus efforts on critical species)	Collaboratives exist for Asian carp, crayfish, <i>Hydrilla</i> , invasive mussels, <i>Phragmites</i> , New Zealand mud snail	Collaboratives exist for water chestnut and Asian clam, but directed efforts for other high concern species are lacking
5. Innovative technology development and deployment	Monitoring and intercepting vectors of bighead and silver carp using eDNA tools while building genomic libraries and techniques for additional species	Piloted development of genomic tools for early detection of quagga mussel, Asian clam, and Zebra mussel

C. Potential Recommendations by Key Activity:

Key Activity 3. Implement a Lake Champlain “hotspot” early detection and surveillance program targeting high-risk locations such as boat launch sites and marinas. Targeted surveys at these sites would also highlight decontamination of boats using Lake Champlain (which are currently viewed as a critical pathway for new non-native species).

Key Activity 4. Encourage Lake Champlain partners to develop and sustain species-specific collaboratives for priority species including quagga mussels, *Hydrilla*, spiny water flea, and fishhook water flea. These species-specific collaboratives will inform monitoring and deployment of innovative technologies to track species occurrence in and adjacent to the Lake Champlain basin.

Key Activity 5. Further develop and implement genomic early detection tools, such as eDNA, in Lake Champlain for the early detection of quagga mussels, Asian clams, and Zebra mussels. The expansion of existing lab capacity in Lake Champlain should include the addition of new and emerging eDNA sample analysis technology.

D. Other Potential Recommendations:

- Lessons learned from implementation of the Great Lakes “hotspot” early detection and surveillance program, including sampling techniques, frequency and optimal conditions, level of effort, can be used to inform the development of parallel activities in the Lake Champlain basin.
- If Lake Champlain managers establish a “hotspot” early detection and surveillance program, managers in the Great Lakes and Lake Champlain basins can collaborate on protocol development and prioritization of hotspot locations.
- Great Lakes and Lake Champlain managers may benefit from sharing eDNA monitoring details to identify method improvement and needs for standardization, where appropriate.
- For both new and existing species-specific collaboratives, managers in the two basins could collaborate and share information on applicable non-native species.

Purpose 3: Programs that “inform and assist with management and response actions to prevent or stop the establishment or spread of an aquatic nuisance species”

Selected elements of State ANS management plans developed and periodically updated by states that prioritize ANS prevention, response, management, and outreach to the public are summarized in this section. Examples of partnerships and species collaboratives that help jointly prioritize use of federal and state funds for key ANS are also highlighted.

A. Existing Activities:

Great Lakes:

State ANS management plans, developed by individual states and approved by the National ANS Task Force (<https://www.anstaskforce.gov/stateplans.php>) are critical in guiding management and response actions in the Great Lakes. State ANS management plans identify agency roles, necessary cross-agency coordination, and outline the multi-disciplinary approach that will best address the ANS issues a state has prioritized. State ANS management plans typically include guidance for preventing species introduction via vectors, early detection/rapid response (EDRR) actions, management and control of established species, and outreach and education. For example, Michigan agencies implement early detection and response activities to prevent the establishment and spread of aquatic invasive plants identified on a state-developed “watch list,” including local eradication when possible and practical.



Figure 10. Invasive Hydrilla (left) and Phragmites (right) are both present in the Great Lakes basin and have species-specific collaboratives for controlling current populations and preventing their spread.

Interstate and regional ANS management plans also guide management and response across jurisdictions and entities. As mentioned above, the *AIS Interstate Surveillance and Response Framework* for the U.S. Waters of the Great Lakes is an interstate ANS management plan for Great Lakes states. This plan has resulted in states undertaking table-top, rapid response exercises focusing on response actions for different species including invasive crayfish, plants, and fish. Based on these response exercises, Great Lakes states have begun to optimize communication and

rapid response plans and actions across jurisdictions with benefits for the entire Great Lakes basin.

Partnerships between states and federal agencies are critical in ensuring that federal resources are prioritized and focused on development of technologies that have the greatest interest and chance of deployment. These federal-state partnerships and joint prioritization efforts often occur within the context of species-specific collaboratives established in the Great Lakes. Examples of technologies pursued in the Great Lakes through GLRI support and of interest to states include sound and physical deterrents for Asian Carp, biocides for invasive mussels, chemical

attractants/deterrents for sea lamprey, bioherbicides for *Phragmites*, pesticides for invasive crayfish, and real-time tracking of Grass carp to inform response and removal actions.

Outreach to the general public and specific stakeholder groups continues to be an important component of State ANS prevention and control strategies. Multiple States continue to support efforts and projects to better understand social motivations and barriers related to ANS prevention. Results from these social science studies and evaluation of outreach efforts allow individual States to recommend informed prevention practices to the general public and to address important pathways for new non-natives introductions.



Figure 11. Aerial view of electric barriers for Asian carp, located in the Illinois River near Romeoville, Illinois. Testing of the efficiency of these electric barriers as well as complex sound, carbon dioxide, and bubble curtains has been prioritized by federal and state fishery agencies participating in the Asian Carp Regional Coordinating Committee.

Lake Champlain:

State and interstate ANS plans are the cornerstone for management and response actions to address ANS introduction and spread in the Lake Champlain basin. The Lake Champlain Basin ANS Management Plan covers Vermont, New York, and Quebec guidance for preventing species introduction, key vectors, EDRR actions, management, and outreach and education. This interstate plan is further reinforced by the New York State plan, which covers the Great Lakes and Lake Champlain basins. Vermont and New York provide grant programs to support ANS prevention and management efforts.

In the Lake Champlain Basin, there are additional regional plans that guide projects to monitor vectors, EDRR, manage and control ANS spread, and for outreach and education. Looking at the feasibility of a barrier on the Champlain Canal to prevent the spread of ANS between the Hudson and Champlain drainages is currently a focus of prevention efforts in Lake Champlain. Additional focus and multi-partner efforts are underway between United States and Canadian entities to control lamprey populations with lampricide treatments, barriers, and traps. The binational, multi-jurisdictional *Lake Champlain Basin AIS Rapid Response Task Force*, formed in 2009, was developed to evaluate new invasions and determine appropriate management action.

Finally, collaborative education and outreach also help prevent ANS spread in Lake Champlain. New York Sea Grant administers invasive species trainings to volunteers. The Adirondak Partnerships for Regional Invasive Species Management is a notable example of regional stewardship network that specializes on prevention and control of ANS.

B. Analysis:

Through the State and interstate ANS plan development process, Great Lakes and Lake Champlain states have outlined and planned cross-agency, multi-disciplinary approaches to comprehensively address ANS. Expertise from aquatic scientists, terrestrial scientists, law enforcement, state universities and outreach organizations have been used for development of plans. As new information on risks of non-native species not found in either system is made available and innovative prevention and control technologies are developed, states in both the Great Lakes and Lake Champlain basins benefit from existing federal-state partnerships and ANS panels to share information and lessons learned from the emerging issue areas. Additionally, States may adapt their current approved ANS plans or revise these plans to reflect the latest science and threats. The full implementation of the multi-disciplinary approaches outlined by state-approved ANS plans continues to be heavily dependent on sufficient support from both internal state funding sources as well as federal programs.



Figure 12. Volunteer from the Nature Conservancy hand removes water chestnuts from the Ticonderoga area of Lake Champlain. Control of water chestnut is consistent with and guided by New York and Vermont state ANS plans.

Analysis of Key Activities Important to Meeting Purpose 3 of the GLLCISP

Key Activities	Great Lakes	Lake Champlain
6. Development and approval of State ANS management plans	All 8 Great Lakes States have approved ANS management plans	New York and Lake Champlain have approved ANS management plans. Vermont does not have an approved ANS management plan.
7. Funding for implementation of State ANS management plans	Funding for implementation of State ANS management plans in Great Lakes via GLRI and state appropriations	Limited funding for implementation of ANS management plans in New York and Lake Champlain
8. Supporting testing and advancement of innovative technologies to control species of importance and address vectors	Annual GLRI planning process allows GLRI to assess opportunities and provide funding for species control technologies	Pilot work on eDNA markers and exploring alternatives for the Champlain Canal barrier
9. Education and outreach to support management and control	State ANS management plan activities, species-specific collaboratives, and other general Great Lakes educational campaigns target key stakeholder	Stewardship programs are the primary education and outreach approach, with limited outreach also occurring at marinas and fishing tournaments

	groups associated with ANS pathways	
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C. Potential Recommendations by Key Activity:

Key Activity 6. Support the development and approval of a Vermont State ANS management plan.

Key Activity 7. Continue implementation of State ANS management plans in the Great Lakes basin and work with partners to encourage implementation of and state support for ANS plans in the Lake Champlain basin.

Key Activities 8. Enhance species- and vector- specific innovative control and management technologies where they show promise in Lake Champlain.

Key Activity 9. Work with states to implement education and outreach as needed, across all vectors and species, for both the Great Lakes and Lake Champlain basins. In both basins, activities focused on educating the public on preventing the spread of ANS in the pet and aquarium trade should be encouraged.

D. Other Potential Recommendations:

- Innovative control technologies developed through Great Lakes species collaboratives can be shared with Lake Champlain managers for evaluation and possible use.
- Great Lakes and Lake Champlain basin managers can share successful education and outreach approaches.
- Regulatory actions that are implemented to stop important ANS pathways, such as illegal pet and aquarium trade, can be adapted and improved to increase cross-jurisdictional coordination and actions.

Purpose 4: Programs that “establish a watch list of candidate aquatic nuisance species that may be introduced or spread, and that may survive and establish”

In this section, we first describe state activities to develop watch lists and tools to identify watch list species and their associated risks, and then describe federal and basin-wide efforts to do the same.

A. Existing Activities:

Great Lakes:

Great Lakes states have established regulations to identify prohibited, injurious, and restricted species and to regulate their possession, import, transport, or sale. These state-by-state lists identify species that could cause significant economic and ecological harm and can guide law enforcement and compliance activities. In selected State ANS management plans, non-native species lists are listed with additional details on each species such as risk of introduction, spread, survival, and establishment. These various forms of state “watch lists” also focus the prevention activities of local stakeholder groups.

Federal agencies in the Great Lakes use the best available science and tools to predict ability of new ANS to establish or spread. These efforts serve to assist states in evaluating and adapting state watch lists and prevention activities. The USFWS development of ERSSs for species posing high risk to the Great Lakes is one such information source for states. The U.S. Geological Survey (USGS) Nonindigenous Aquatic Species Program developed the Alert Risk Mapper, which produces maps showing waterbodies potentially at risk of invasion. It also developed the Flood and Storm Tracker, which uses current ANS distribution data combined with precipitation forecasts and storm surge models to identify watersheds at risk of invasion in times of flooding, allowing natural resource managers to rapidly assess and design post-storm ANS monitoring surveys and species watch lists.

Basin-wide watch lists have been developed to promote an interjurisdictional approach to regulation, prevent new occurrences of ANS, and guide surveillance activities. The Great Lakes and St. Lawrence Governors and Premiers has identified a prioritized “Least Wanted” list, documenting 21 injurious fish, plants, and invertebrates. Since release and updating of this list (in 2013 and 2018, respectively) the proportion of states regulating these species has increased. The NOAA GLANSIS watch list uses a comprehensive approach to document aquatic species not yet established in the Great Lakes but likely to become so, and living in an area with matching climate conditions. A subset of these species, including all species listed by federal agencies and Great Lakes states, form the GLANSIS watch list.

Lake Champlain:

No single agreed-upon “watch list” of ANS exists for Lake Champlain. Instead, a combination of state regulations and ANS reports/documents are combined to generate an informal preliminary list of priority ANS species that could be considered for a future state or basin-wide “watch list.” New York and Vermont have lists of prohibited and regulated species list, such as the Vermont Agency of Food and Markets Invasive and Noxious species list

(<https://agriculture.vermont.gov/public-health-agricultural-resource-management-division/plant-health-and-pest-management/plant-2>). New York and Vermont each have enacted legislation addressing transportation and distribution of certain species. The *Lake Champlain Basin AIS Identification Guide* has been developed to help partners identify existing ANS in the basin and those not present but likely to invade. An informal list of species of high priority concern have been identified by the LCBP and called out in examples in the *AIS Rapid Response Management Plan*, which provides a system that develops risk assessments and ranking criteria for ANS in Lake Champlain. This activity may be a useful precursor for development of a basin-wide “watch list.”

B. Analysis:

The Great Lakes basin has both an agreed-upon basin-wide “watch list” (*i.e.*, the Great Lakes and St. Lawrence Governors and Premiers “Least Wanted” list) supplemented by individual state regulations while the Lake Champlain basin has only state regulations and ANS guidance documents that inform prevention and management actions. “Watch list” development is based on various disciplines and information sources including natural resource professionals, predicted likelihood of invasion based on a species “donor” region and matching climates present in the Great Lakes basin, status of sale and trade of organisms in the pet and nursery industries, and others. While the Great Lakes basin has regional, comprehensive watch lists that inform actions across disciplines and jurisdictions across the entire basin, Lake Champlain has begun activities that could lead to the development and agreement on a basin-wide “watch list.”

Analysis of Key Activities Important to Meeting Purpose 4 of the GLLCISP

Analysis of Key Activities Between Systems		
Key Activities	Great Lakes	Lake Champlain
10. Basin-wide “Watch List”	The Great Lakes and St. Lawrence Governors and Premiers “Least Wanted” list and the GLANSIS watch list	No agreed-upon basin-wide watch list currently exists
11. Updating “Watch Lists” Based on Risk Assessments	States and federal agencies utilize USFWS ERSSs and other risk assessments in updates to watch lists	There may be significant opportunity for inclusion of the latest science and predictions of ANS establishment into existing watch lists

C. Potential Recommendations by Key Activity:

Key Activity 10. Develop a Lake Champlain basin-wide watch list or “Least Wanted” list, similar to the Great Lakes and St. Lawrence Governors and Premiers effort, to be used universally by states and agencies in the basin.

Key Activity 11. Key agencies from the Lake Champlain Basin assess the usefulness of the USFWS ERSS in developing a watch list of species for the Lake Champlain system. If the ERSS

is determined to be useful, future efforts can take an approach to maximize efficiency and applicability to both the Great Lakes and Lake Champlain.

D. Other Potential Recommendations:

- Great Lakes and Lake Champlain basin managers can share risk assessment information and rationales for updating state or regional watch lists due to ERSSs. Risk assessments will often be applicable for both basins based on their geographic similarities (climate, water quality, usage, etc.).
- The Governor and Premiers “Least Wanted” list should be referenced for all state and federal watch lists in the Great Lakes to ensure consistency.

Purpose 5: Programs that “monitor vectors likely to be contributing to the introduction or spread of aquatic nuisance species, including ballast water operations”

There are seven major vectors through which the spread of ANS occurs. These are: 1) canals and waterways; 2) recreational boating; 3) commercial shipping and ballast water operations; 4) the trade of illegal or banned species; 5) release of pet and aquarium species; 6) live bait; and 7) water garden and nursery trade. Each of these vectors are recognized and monitored to varying degrees by activities across the federal, state, and local jurisdictions.

In this section, we focus on the seven major vectors and how ANS are monitored and controlled in each of them. Please note that commercial shipping and ballast water operations are also addressed in more detail in Purposes 7 and 8.

A. Existing Activities:

Great Lakes:

The Chicago Area Waterway System (CAWS) and portions of the Illinois River are a singular focus for surveillance and monitoring of canals and waterways to prevent the spread of Bighead and Silver carp into the Great Lakes. This waterway focus is based on the “invasion front” of these Asian Carp species and is guided by results of the *Great Lakes and Mississippi River Interbasin Study* (GLMRIS), a U.S. Army Corps of Engineers (USACE) study evaluating a range

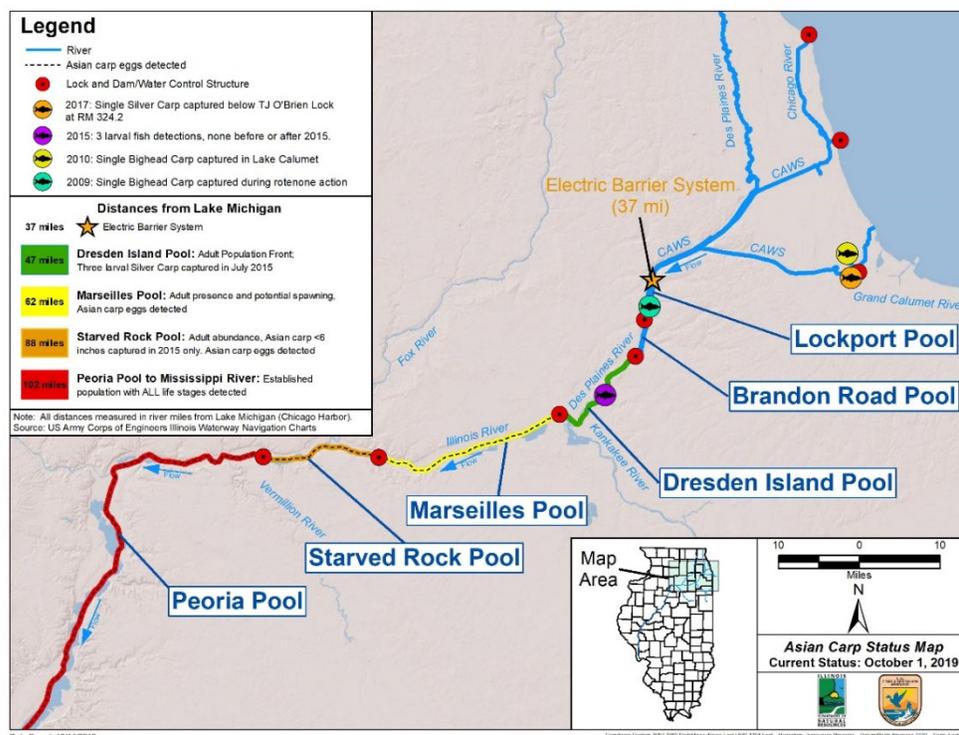


Figure 13. The current leading edge of Silver and Bighead carp in the Upper Illinois River.

of technologies and controls, known as “ANS controls,” to prevent ANS from entering the Great Lakes from the Mississippi River. GLMRIS highlights permanent or potential hydrologic connections, such as CAWS, between the Great Lakes and the larger Mississippi River basin that may serve as routes for introduction of Asian carp species to the Great Lakes basin.

Watercraft inspection is a widespread activity conducted by states and tribes. Watercraft inspection activities across the Great Lakes enforce applicable ANS prevention regulations and use boat wash stations to encourage the decontamination of equipment. Education of the public on proper prevention behavior is also an important aspect of boat washing stations. Inspectors can be the first to detect species in a new area of the watershed and collect critical information from boaters to understand potential sources of non-native species. Some states apply permitting and training requirements to businesses that move equipment like docks and boat lifts.

Ballast water from ocean-going vessels is a primary vector for introduction of ANS into the Great Lakes from regions throughout the world. U.S. and Canadian vessels operating primarily on the Great Lakes uptake ballast water at ports which receive ballast water from overseas and, therefore, serve as possible stepping stones for ANS spread throughout the Great Lakes.

Commercial vessels carrying ballast water entering the Great Lakes Seaway are subject to ballast water monitoring overseen by the binational Great Lakes Seaway Ballast Working Group, which includes the USCG. During 2016-18, this effort monitored the salinity in 100 percent of the ballast water tanks of vessels bound for the Great Lakes Seaway from outside the United States (known as “salties”) to confirm that they had conducted a ballast water exchange. “Salties” are required to either exchange ballast water mid-ocean prior to entering the Great Lakes Seaway or retain ballast water the entire transit through the Seaway and while in the Great Lakes.

To prevent the spread of ANS through release of live bait, some states have implemented a comprehensive bait inspection program, including enforcement of bait harvest and sale restrictions. Watercraft inspection activities often include the inspection of live bait.

Lake Champlain:

There are no sustained monitoring systems in place for the Lake Champlain basin dedicated to surveillance of major ANS vectors. Short-term monitoring activities are occasionally developed for specific species on an *ad hoc* basis as threats occur.

Lake Champlain is hydrologically connected to the Hudson and Saint Lawrence River systems through the Champlain Canal (connecting Lake Champlain to the Hudson River) and the Chambly Canal (connecting Lake Champlain to the Richelieu River, which connects to Saint Lawrence River). These canals and waterways serve as vectors of species that exist in the Hudson and Saint Lawrence systems. USACE is working with the New England Interstate Water Pollution Control Commission to identify an appropriate solution to reducing the impact of the Champlain Canal as an invasive species vector between the Champlain and Hudson systems. In addition, New York State recently initiated their “Reimagine the Canals” effort to develop a new approach to operating and maintaining the New York State Canal System that will enhance their economic viability while improving ecosystem integrity.

Recreational boating is considered a major vector for ANS spread in Lake Champlain. Activities to prevent this ANS introduction are carried out by many entities at decontamination stations. Trained boat launch stewards are stationed at key public launching and landing points to offer voluntary inspections and to aid in decontamination. There is a mandatory boat inspection program in place for Lake George, a large lake located within the Lake Champlain basin. Both Vermont and New York have overland transport regulations that target precautionary measures before boat launching. Lake Champlain partners deliver ANS spread prevention information to marinas in the basin.



Figure 14. Lake Champlain boater uses high water pressure at a decontamination station to remove invasive species from a recreational boat prior to movement to a new waterbody.

Vermont and New York have existing baitfish regulations. Lake Champlain Sea Grant trained nearly 2,000 bass anglers visiting New York tournaments on ANS identification and spread prevention techniques.

Vermont occasionally has resources to survey pet and aquarium trade and nursery businesses for compliance with the noxious species listings. The State of New York has regulations that apply to species in pet trade, aquarium trade and water garden nurseries.

B. Analysis:

Great Lakes states and other entities because of capacity limitations, rely on multiple disciplines to optimize monitoring of the seven major ANS vectors to identify weak points that may facilitate new introductions and spread. Experts in traditional aquatic species sampling methods, innovative surveillance techniques (e.g., eDNA), spatial prioritization and automated computer algorithms, and law enforcement have been relied on to target vector monitoring in the Great Lakes. Still, significant variability among Great Lakes states exists in their individual implementation and support of enforcement duties for the illegal trade of ANS. The current ANS vector monitoring efforts in Lake Champlain do not include significant collaborations or a multidisciplinary approach as seen in the Great Lakes.

Analysis of Key Activities Important to Meeting Purpose 5 of the GLLCISP

Key Activities	Great Lakes	Lake Champlain
12. Canals and waterways monitoring	Current Great Lakes activities focused on canals and waterways are tracking bighead and silver carp presence and abundance in and around Chicago canals and waterways	No regular monitoring in canals and waterways

13. Recreational boating monitoring	Underway through state and tribal efforts, complimented by education and outreach to boaters on preventing ANS spread	Existing program for boat inspection but inspection in Lake Champlain is not widespread
14. Commercial shipping and ballast water monitoring	Monitoring the salinity of ballast water of “salty” vessels by the Great Lakes Seaway Ballast Water Working Group; Limited examples of monitoring by other states and research institutions	Not applicable – little to no commercial shipping
15. Release of pet and aquarium species	Comprehensive monitoring is challenging. Education and outreach in place for responsible protection of the environment by pet owners	Comprehensive monitoring is challenging. No consistent education and outreach for release of pet and aquarium species.
16. Water garden and nursery trade monitoring	Capacity, education, and training provided to natural resource officers to undertake selective monitoring and increase awareness	No thorough monitoring of the water garden and nursery trade
17. Live bait release monitoring	Bait inspection and monitoring bait trade in place to varying degrees across Great Lakes States	States have permitted processes in place for selling bait, but do not routinely monitor; baitfish regulations are routinely enforced
18. Illegal and banned species sale and trade monitoring	Automated computer algorithms have been developed and used in the Great Lakes to track the sale of banned species	There is no system in Lake Champlain that can track the trade and sale of banned species

C. Potential Recommendations by Key Activity:

Key Activity 12. Expand monitoring activities into canals and waterways through the Lake Champlain basin. Assessments of this vector are currently limited in the basin.

Key Activity 13. Promote activities to inspect boats and determine high-risk boat launch locations in the Great Lakes and Lake Champlain.

Key Activity 14. Assess what additional monitoring data and research would be needed to address the contribution of ballast water to the introduction or spread of aquatic nuisance species.

Key Activity 15. In both the Great Lakes and Lake Champlain basins, states’ compliance monitoring for the trade of pet and aquarium species could be enhanced.

Key Activity 16. In both the Great Lakes and Lake Champlain, states' compliance monitoring of plants in the nursery and water garden trade could be enhanced.

Key Activity 17. In both the Great Lakes and Lake Champlain, maintain and increase states' monitoring of bait shops for compliance with applicable requirements.

Key Activity 18. Maintain and increase the use of automated searching and notification programs to track the sale of banned species in the Great Lakes and Lake Champlain.

D. Other Potential Recommendations:

- Increased coordination between Great Lakes and Lake Champlain states regarding the illegal trade of invasive species would improve efforts to target this vector in both basins.
- States should consider co-managing and co-facilitating collaboratives for each ANS vector, which could improve the effectiveness of vector monitoring. If collaboratives are established, states could collaborate in seeking federal resources for identified priorities, as opposed to competing against each other for limited funds.
- Methodologies for optimizing canal and waterway sampling should be shared between Great Lakes and Lake Champlain lake management agencies to facilitate improvements in both basins.
- A current national inventory of aquatic pet and aquarium species currently in trade does not exist and new species are likely entering trade regularly. A coordinated national inventory would improve the effectiveness of monitoring and regulatory efforts for these ANS species.

Purpose 6: Programs that “work collaboratively with the Federal, State, Local, and Tribal agencies to develop criteria for prioritizing and distributing monitoring efforts”

The active participation of federal, state, tribal, and other institutions in annual planning and budgeting of prevention, monitoring, and management efforts as well as interstate collaborations are highlighted under this purpose. These and other activities allow for broad information exchange, prioritization, and consensus-based decisions on ANS management issues in the Great Lakes and Lake Champlain year-to-year.

A. Existing Activities:

Great Lakes:

Monitoring efforts are prioritized both geographically and among taxa, focusing on the highest risk species and locations based on input from federal, state, local, and tribal partners. Recent interstate collaborations, including *the AIS Interstate Surveillance Framework for the U.S. Waters of the Great Lakes*, has provided states an opportunity to further prioritize monitoring at regional scales within the Great Lakes basin. This framework prioritizes vectors and species, translating these into explicit guidance for detection and monitoring and has provided states with more opportunities to collaborate among themselves and with federal agencies conducting early detection activities. As part of the *Interstate Early Detection and Response Project*, Michigan developed a prioritization map for surveillance of all Great Lakes shorelines to detect newly introduced and watch list fish, invertebrate, and plant species. GLANSIS’ Map Explorer supports monitoring prioritization by identifying invasion fronts and overlaying geospatial habitats.

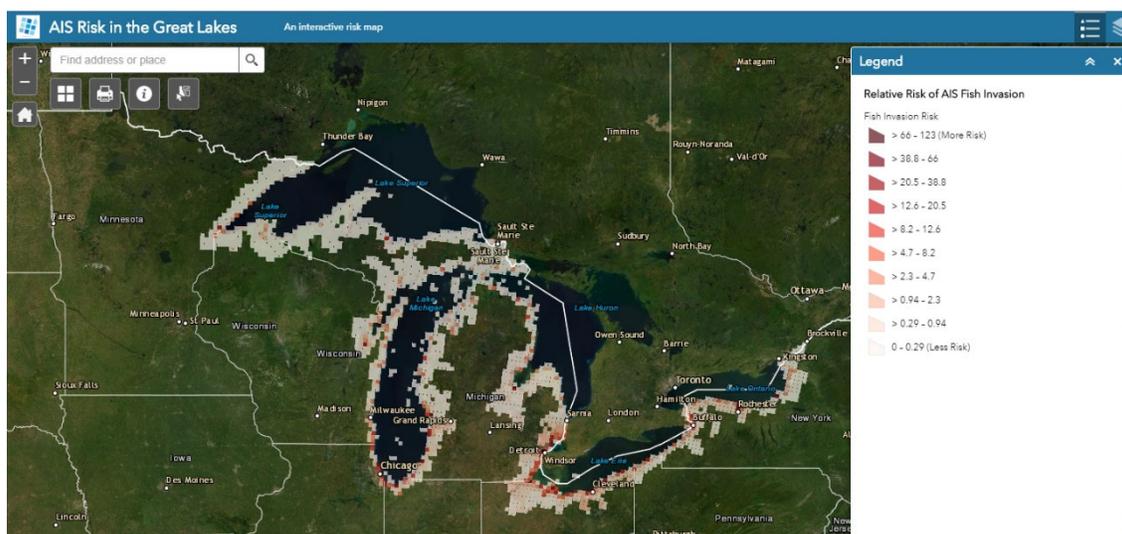


Figure 15. Spatial prioritization of Great Lakes shorelines and watersheds based on risk of invasive fishes. This product of the AIS Interstate Surveillance Framework is used to assist State and other entities in deploying monitoring and rapid responses activities.

Lake Champlain:

The primary channel through which LCBP collaborates with the three jurisdictions in the watershed is the ANS Subcommittee and AIS Rapid Response Task Force. LCBP also leads the collaboration between federal, state, and local partners in the basin to prioritize ANS monitoring efforts. LCBP committees meet regularly throughout the year to discuss prioritization and to provide federal, state, provincial, local, and citizen groups an opportunity for input. LCBP is also a member of the Northeast ANS Panel, and ex-officio member of the National ANS Task Force, and other state and regional ANS associations and societies, to discuss monitoring efforts across the entire region.

As in the Great Lakes basin, prioritization decisions for monitoring efforts in the Lake Champlain basin are based on data from current monitoring efforts, informal watch lists, and information gathered from partners across the basin. Many agencies and organizations within the Lake Champlain basin and species-specific collaborations provide data for high-risk areas and species. Rigid criteria for prioritizing monitoring efforts that can be applied continuously, year after year, do not exist. High-risk species and ANS pressures are constantly changing, as is our knowledge about them so prioritization decisions in Lake Champlain, as in the Great Lakes, are flexibly based on species of concern, the 7 main vectors, and ecosystem needs. Lake Champlain uses these data in the budgeting process to inform priorities as considerations for funding distribution.

B. Analysis:

The development of rigid monitoring criteria that can be used year after year for the Great Lakes and Lake Champlain is challenging due to the changing ecosystem conditions, population dynamics, emerging threats, and new knowledge and technologies. The process for distributing resources for monitoring efforts is informed by existing monitoring efforts, discussions with partners, collaborative data and tools, the ability for early detection, species, and vectors.

Analysis of Key Activities Important to Meeting Purpose 6 of the GLLCISP

Key Activities	Great Lakes	Lake Champlain
19. Multi-agency planning process for prioritizing distribution of monitoring efforts	GLRI planning and budgeting process allows adaptive planning year-to-year based on input from multiple agencies and current ANS threats	Lake Champlain process allows adaptive planning based on input from multiple agencies

C. Potential Recommendations by Key Activity:

Key Activity 19. Ensure opportunities for broad representation including state, tribal, and local partners on species-specific collaboratives, interjurisdictional projects, and annual planning committees that recommend monitoring priorities for ANS.

D. Other Potential Recommendation:

- Continue to use the existing processes in the Great Lakes (*i.e.*, GLRI annual planning process) and Lake Champlain (*i.e.*, LCBP annual planning process) that are efficiently incorporating input from multiple jurisdictions and agencies.

Purpose 7: Programs that “develop, achieve type approval for, and pilot shipboard or land-based ballast water management systems installed on, or available for use by, commercial vessels operating solely within the Great Lakes and Lake Champlain Systems”

Purpose 7 describes the three current methods by which ballast water treatment technology is tested and achieves type approval in the Great Lakes: the U.S. Department of Transportation Maritime Administration (MARAD), the *Great Waters Research Collaborative*, and studies in some states.

A. Existing Activities:

Great Lakes:

MARAD works with the maritime community to address issues related to the introduction of ANS through ballast water and hull biofouling. MARAD established its Ballast Water Initiative to assist industry and government agencies in moving treatment technologies from the laboratory to shipboard application as rapidly as possible. MARAD’s ballast water efforts have grown into a multi-state and multi-agency cooperative effort that supports the development of technical and scientific protocols for technology testing and verification, and the operation of independent testing facilities to provide the needed data for ultimate certification of ballast water management systems (BWMS) to International Maritime Organization (IMO) and USCG standards. These facilities also test (typically at the bench scale level) promising equipment or treatment methods to control the spread of non-indigenous aquatic species.

The *Great Waters Research Collaborative* (GWRC) is a project managed by University of Wisconsin-Superior Lake Superior Research Institute and funded primarily through GLRI (via MARAD). It provides a land-based, ballast water treatment system testing facility representing environmental conditions that commercial vessels operating in the Great Lakes may experience. GWRC generates USCG type-approval relevant information that informs private sector, state, federal, and international policy activity. The GWRC, formerly known as the *Great Ships Initiative*, focuses on the testing of existing technologies, rather than the development of new ones, and, from 2010 to date, has validated the performance of over 50 different ballast water treatment systems in controlled bench, land-based, and shipboard tests.

Additional collaborative studies between states and other entities help determine effectiveness of ballast water management technology. Minnesota Pollution Control Agency staff work with U.S. and Canadian shipping organizations to develop a framework for ballast water treatment studies and identify new or modified ballast water management systems that are compatible with fresh water and satisfy USCG type approval requirements.

Lake Champlain:

This purpose currently has limited-to-no application to the Lake Champlain basin.

B. Analysis:

As one of the main purposes of the GLLCISP, VIDA acknowledged the need for the development of BWMS for vessels operating solely within the Great Lakes. Currently, there are no BWMS for vessels operating primarily on the Great Lakes capable of meeting ballast water discharge standards for ANS that are required of other commercial vessels with ballast water. EPA understands that the lack of capable BWMS at this time is due to the unique construction of some of these vessels (e.g., the existing U.S. Laker fleet); the challenging environmental conditions of the Great Lakes, including turbid ports, icing conditions and the short voyage times; and the lack of interest from the BWMS manufacturers to develop systems for such a small and unique set of vessels. In order to protect the Great Lakes from the risk of spread of ANS between the Great Lakes, it is critical that ballast water treatment technologies are developed for vessels operating primarily on the Great Lakes.

The field of development, testing, and refinement of ballast water treatment technologies for large freshwater vessels is relatively new and continually evolving. The GWRC facility in Superior, Wisconsin is the only North American, freshwater ballast water treatment testing facility. Through partnerships with neighboring research institutions, engineering firms, and the Great Lakes shipping industry, the GWRC is well positioned to be responsive to the emerging and future approaches to ballast water regulation in the Great Lakes. It is expected that as more details become available on the regulatory framework proposed and finalized for vessels operating primarily on the Great Lakes, GWRC will be able to assess additional multi-disciplinary approaches to test ballast water management practices.

Analysis of Key Activities Important to Meeting Purpose 7 of the GLLCISP

Key Activities	Great Lakes	Lake Champlain
20. Establish and maintain a facility with appropriate staff and robust testing procedures that evaluate Great Lakes-specific ballast water conditions and organisms that can be transported by commercial shipping activities	MARAD conducts testing on ballast water management systems The Great Waters Research Collaborative facility was established at Superior, Wisconsin and continues to test various ballast water treatment technologies and promising equipment and treatment methods	Not currently applicable

C. Potential Recommendations by Key Activity:

Key Activity 20. Expand research on ballast water management for vessels operating primarily on the Great Lakes to develop, achieve type approval for, and pilot shipboard or land-based ballast water management systems.

D. Other Potential Recommendations:

- Identify and prioritize the best available technologies for vessels in the Great Lakes that address the challenges of preventing ANS introduction via ballast water, to incrementally reduce the risk of ANS transport.
- Identify and prioritize the ports and specific water quality challenges at these ports so future ballast water treatment technologies may take these issues into account.

Purpose 8: Programs that “facilitate meaningful Federal and State implementation of the regulatory framework in this subsection, including monitoring, shipboard education, inspection, and compliance conducted by States”

The status of activities that align with Purpose 8 in the Great Lakes is based on the finalization of national standards of performance for discharges, including ballast water, from commercial vessels, which has not yet occurred.

A. Existing Activities:

Great Lakes:

It was not possible to identify existing activities to control ANS that align with implementation of a regulatory framework for vessels operating within the Great Lakes because a regulatory framework has not been finalized. VIDA requires the EPA to develop national standards of performance for commercial vessel discharges including ballast water by December of 2020.

Lake Champlain:

This purpose currently has limited-to-no application to the Lake Champlain basin due to a lack of commercial shipping activity.

Therefore, no analysis nor development of potential recommendations was possible for GLLCISP Purpose 8 during preparation and submittal of this Report.

III. Major Findings and Conclusions:

The preceding sections show how multi-agency coordination through annual planning and budgeting processes (*i.e.*, GLRI and the LCBP process) can work to leverage existing authorities and resources to address significant ANS challenges in both the Great Lakes and Lake Champlain basins. Both basins have experience in managing ANS activities and adapting these activities year-to-year based on the latest information. Existing GLRI and LCBP planning and budgeting processes could effectively be used to enhance and accelerate ANS activities using potential additional appropriations for GLLCISP-based activities.

In addition to using existing planning processes in each basin for key ANS activities, potential future appropriations made available for GLLCISP-based activities could be used to support:

1. Research on shipboard and land-based ballast water management systems for vessels operating primarily on the Great Lakes.
2. The effective administration of the GLLCISP by GLNPO through the provision of additional FTE.
3. Enhancements to existing Great Lakes and Lake Champlain basin state and tribal ANS programs, emphasizing prevention and management.
4. The establishment of a comprehensive Lake Champlain ANS Program akin to the existing program in the Great Lakes basin.
5. Research that provides the technical basis for surveillance of aquatic nuisance species that combines traditional and emerging technologies and that would improve ANS prevention.

In both the Great Lakes and Lake Champlain basins, support for state and tribal ANS plan development and implementation has been critical. Additional education and outreach activities, which are critical for preventing ANS spread, could be implemented for all species and vectors. States could also benefit from enhanced compliance in monitoring the pet, aquarium, nursery and water garden trades in addition to bait shops. Lake Champlain and the Great Lakes could continue to use innovative tools (e.g., the Great Lakes Detector of Invasive Aquatics in Trade) to inform and target law enforcement and compliance checks.