

AIS Workgroup Draft Report

Great Lakes Advisory Board

Theme 4: Seek Advice and Recommendation on Invasive Species Background Information:

Charge Question to GLAB:

Balancing the need for continued commercial, recreational, and other activities on the Great Lakes, what innovative actions could reasonably be taken to accelerate the control of existing invasive species, and what methods or strategies can be deployed to prevent the establishment of future infestations?

I. Introduction

The great lakes ecosystem has been impacted by the introduction of over 180 non-native aquatic invasive species that have caused tremendous ecological and economic damage. A cost-effective approach to accelerate control and prevent establishment of future infestations is to consider the pathways (or Vectors) through which past invasions occurred and future invasions may occur, rather than focus on individual species. The Great Lakes Advisory Board (GLAB) was careful not to “recreate the wheel”, but rather considered opportunities to build on, or combine existing programs and to close loop-holes, if found with existing efforts. The report includes what regulatory programs are in place and the recommendations on each section.

Invasive species means an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health.
<https://www.invasivespeciesinfo.gov/executive-order-13112-section-1-definitions>

Aquatic (water-dwelling) invasive species (AIS) are non-native plants, animals, and other organisms that have evolved to live primarily in water (aquatic habitats) rather than on land (terrestrial habitats). Aquatic habitats are habitats that are covered with water all or part of every year. From oceans to bogs, many types of aquatic habitats exist.

II. Vectors

Numerous vectors have led to the introduction of the established AIS in the Great Lakes. These include vessel discharge, hydrologic connection with canals and waterways, recreational activities, aquaculture, and trade. Furthermore, there are miscellaneous vectors that present a risk for introductions and should be monitored, including avian pathways, setting “pets” free (e.g., release of goldfish into waterways), and cultural/religious practices. The GLAB examined the array of regulations that are in place and made recommendations to increase their effectiveness in avoiding future introduction of AIS into the Great Lakes.

1. Vessel Discharge

The GLAB considered all the vessel discharges that could occur from oceangoing vessels (commonly referred to as salties), lakers (including tug-barges operating exclusively on the Great Lakes); and river barges (excluding lakers).

Signed into US federal law in December 2018, the Vessel Incidental Discharge Act (VIDA) resolved debate concerning state and federal government regulatory roles in maritime vessel discharges. VIDA required the U.S. Environmental Protection Agency (USEPA) to set vessel discharge standards based on technology determinations. The USEPA consulted the states and issued proposed standards in October 2020. The U.S. Coast Guard (USCG) is responsible for implementing enforcement regulations that reflect USEPA standards. USCG must consult the states and issue regulations by December 2022.

Until USEPA publishes final vessel discharge standards and the USCG publishes corresponding implementing regulations under VIDA, the existing vessel discharge requirements established through the USEPA 2013 Vessel General Permit (VGP) and the USCG ballast water regulations, and any applicable state and local government requirements, remain in effect. The status of the regulations for specific vessel categories is described below.

For oceangoing vessels, under VIDA, the USEPA proposes to continue many of the existing best management practices and imposes numeric discharge standards that represent best available technology and largely align with International Maritime Organization's International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention). The USCG will establish compliance in the December 2022 regulations.

For lakers, under VIDA, the USEPA proposes an exemption from meeting numeric ballast water discharge standards for vessels operating exclusively on the Laurentian Great Lakes west of Anticosti Island in the Gulf of St. Lawrence. To date, no technologies or management practices beyond those identified previously in the VGP and USCG regulations have been demonstrated to be available and implementable solutions to address ballast water discharges from these vessels. Transport Canada has imposed numeric ballast water discharge standards for all vessels entering Canadian ports beginning in September 2024. Vessels constructed prior to 2009 and operating exclusively on the Great Lakes have an extended schedule to September 2030. The Transport Canada regulations and proposed VIDA standards acknowledge the lack of availability of BWMS (Ballast water and Management System) for Great Lakes vessels. However, inconsistencies between the regulatory approaches reduces the efficacy of the regulatory controls as vessel owners are left with the task of adjusting to differing regulations on the same body of water. USEPA should strive for consistent international regulations that facilitate efficient implementation.

VIDA authorizes USEPA within its Great Lakes National Program Office to establish the Great Lakes and Lake Champlain Invasive Species Program (see VIDA Section 903(g)). One of that program's purposes is to develop, achieve type-approval for, and pilot shipboard or land-based

ballast water management systems installed on, or available for use by, vessels operating solely within the Great Lakes to prevent the spread of AIS within the Great Lakes System. This program is to be developed in collaboration and consultation with several other federal agencies. As acknowledged by Congress in its inclusion of this provision in the VIDA, this program is expected to play a vital role to advance the development of a type-approved ballast water management system for Great Lakes vessels and inform future regulations. To date, USEPA has chosen to not request the VIDA-authorized funds, and to fund the Great Lakes and Lake Champlain Invasive Species Program through GLRI. While the GLRI process is well established, USEPA's decision leaves \$50M annually unused, and takes GLRI funds away from other worthy projects.

Currently, the priority focus for inland river barges has been the guidance documents.

Numerous initiatives are underway to study tools for implementation to minimize the risk of AIS transfer towards the Great Lakes. The federal and state agencies engaged in this research are working with representatives of the navigation/river barge industry to determine feasibility, navigational safety impacts, navigational security impacts and general operational impacts. Continued adequate funding for these research projects is needed.

Other key points:

- Great Lakes States can propose new standards, if necessary, to be approved by unanimous consent; (the process to do this is enormous – let's leave this out for now)
- Ballast Water Exchange, a successful management practice, is required in Great Lakes; (Let's set aside for now)
- Citizen lawsuits preserved; (Let's set aside for now)
- Funding authorized for monitoring and technology development (\$50M/yr for 5 years beginning FFY2019)

Recommendations

USEPA SHOULD:

- Work with Canada to align ballast regulations that provide consistent regulatory controls across the Great Lakes.
- Include \$50M/yr in USEPA-Great Lakes National Program Office (GLNPO) budget request to fund the Great Lakes and Lake Champlain Invasive Species Program authorized by Section 903(g) of the Vessel Incidental and Discharge Act with priority to monitoring and technology development related to vessels.
- USEPA and USCG should develop a guidance document and training that provides a flow chart/timeline/fiscal impacts/international status/ summary for general public to explain what is and is not the law re: AIS.
- We should discuss under innovative strategies the use of the AIS-specific molluscicide, Zequanox®. Zequanox® is a registered biopesticide (EPA registration number 84059-15) derived from a strain of the naturally occurring soil bacterium,

Pseudomonas fluorescens. A recent study showed effectiveness on a localized basis (i.e., a rocky reef in Good Harbor Bay in Lake Michigan near the Sleeping Bear Dunes National Lakeshore: https://invasivemusselcollaborative.net/wp-content/uploads/2020/12/Final_Report_Good_Harbor_Zequanox.pdf). (

2) Canal and Waterways

The GLAB relied heavily on the Great Lakes and Mississippi River Interbasin Study (GLMRIS) of 2013. The U.S. Army Corps of Engineers (USACE), and partner agencies, identified 36 areas of concern of transfer of AIS between basins. The majority of the USACE study was the movement of invasive carp from the Mississippi River basin into the Great Lakes; however, other AIS were looked at for potential transfer. [Appendix N; Focus Area 2, GLMRIS]

The challenge will be for USEPA coordination with other federal agencies and states to ensure the sharing of lessons learned as it relates to AIS.

3) Recreational Activities (Recreational Boating/Jet Skis)

The Great Lakes' states have their own regulations regarding recreational activities. The workgroup did not document each state's regulations; however, we did note several of the regulations that would impact the recreational community and attempt to prohibit the transfer of AIS.

States' regulations:

- Michigan's Natural Resources and Environmental Protection Act ([Act 451 of 1994](#)) [Part 413](#) has been amended with changes for boaters and anglers that are in effect as of March 21, 2019. The changes are intended to strengthen protection for Michigan waterways against the introduction and spread of aquatic invasive species¹.
- Minnesota has several state laws intended to minimize the introduction and spread of invasive species of wild animal and aquatic plants in the state. Using a four-tiered system, invasive species are classified as prohibited, regulated, unregulated nonnative species, or are unclassified and remain as unlisted nonnative species.

This classification system establishes the level of regulation and allowable uses for each species. The Minnesota Department of Natural Resources (MN DNR) has regulatory authority over aquatic plants and animals, and terrestrial vertebrates².

¹ https://www.michigan.gov/invasives/0,5664,7-324-68071_91899---,00.html?utm_campaign=news+digest+sept2019+week5&utm_medium=pr&utm_source=govdelivery

² <https://www.dnr.state.mn.us/invasives/laws.html>

- Illinois
- Indiana
- Wisconsin
- Ohio
- Pennsylvania
- New York

USFWS Guidance Document: Preventing the Spread of Aquatic Invasive Species by Recreational Boats (<https://laws-lois.justice.gc.ca/eng/regulations/SOR-2015-121/FullText.html>)

4) Aquaculture (Combine these two)

- A) Iowa Selling Live Asian (Grass) Carp
- Regulatory
 - Development of federal regulations related to the sale of AIS species needs to be finalized.
 - Recommendation:
- B) Net Pens
- The three Michigan Agencies dealing with Quality of Life conducted a thorough study evaluating the environmental, ecological, social, and economics aspects of commercial net pen aquaculture in Michigan’s open waters of the Great Lakes³. The report concluded that the Agencies “do not recommend pursuing of commercial net-pen aquaculture in the Great Lakes at this time” because of significant risks to fishery management and other forms of recreation and tourism; the absence of a funding source to monitor potential impacts from the industry; and lack of regulatory authority.

5) Organisms in Trade: zebra mussels & sponges – unsure as to how to define a category to cover “and all other objectionable things” to capture sponges etc.?

- a) Bait Trade
- b) Aquarium and Water Gardening Trade

³ (summary report: https://www.michigan.gov/documents/mdard/Synth-Paper-NetPENS-09Mar2016_516439_7.pdf)

6) Other Pathways (Cultural Practices; Religious Practices; Indigenous Practices; Naturally Occurring Movements)

Several miscellaneous pathways were considered. Pet stores/pet trade (not professional, licensed establishments), releasing “pets” into the environment; and cultural/religious practices. These pathways are more “behaviors” and cannot be regulated in a traditional sense. This is an area where education and community outreach are going to get the best results. Given the federal priority on Environmental Justice, could the teams expand their role to include cultural/religious practices in their outreach? It is possible that no formalized outreach has occurred with the cultural/religious entities that may be engaged in AIS releases. If communication link is well established, it may be possible an understanding and behavior/practices can be altered.

Animal transfer of AIS is an area that has no way of being controlled. One example looked at was the transfer of an invasive fish species being picked up by a bird of prey for a food source and potentially “lost” while transferring basins.

III. Early Warning System (IJC and USEPA) (Under Recommendations – needs to be cleaned up a little in the move)

The IJC is in the process of developing a scientifically based framework for detecting and identifying emerging stressors and threats using available data. The workgroup recommends that EPA should coordinate with the IJC regarding the findings from this study⁴.

- 1) Methods or strategies currently being deployed to prevent the establishment of future infestations given that prevention is a primary management focus.
 - a) Live trade is one success story we could highlight: Progress being made at state, provincial and federal levels. Focus is on complementary policies (prohibiting species list, least wanted lists) and sharing of risk assessment across jurisdictions so everyone singing off the same song sheet and avoid duplication of effort via a Risk Assessment Clearing house (being managed by GLANSIS).
 - b) Similar regional assessments exist for recreational boating (see white paper in Blue Accounting library) but resources at state levels are resulting in different rates of adoption of best practice. Just not a priority for poorly resourced states and seems to be a politically charged issue.
 - c) Prevention: Is still primary management focus.

⁴ (<https://ijc.org/en/sab/towards-great-lakes-early-warning-system>)

- d) Early detection and response (the end of prevention process). Lots of progress here, USFWS really leading the way with their monitoring efforts and states around development of regional priorities and communication⁵. And the improvement in genomic based detection methods (including next gen) has made concept of early detection a far more realistic proposition.

2) Innovative actions that could reasonably be taken to accelerate the control of existing invasive species

- a) Monetary allocation of AIS – Division among the vectors/pathways

The research committee of the Great Lakes panel is beginning to grapple with, especially in terms of funding, how EPA and GLRI could be more strategic about what species and tools development is supported. Current funding is focused on a small number of high-profile species. A better balance is needed of how and what research is funded and whether the current funding model(s) is working to minimize AIS.

- b) At a species level there are some interesting developments:

- o Mussels – open water treatment at Good Harbor reef was a useful proof of concept - challenge is how to scale up for these critical habitats and need to answer whether suppression is sustained and results in improved spawning habitat⁶
- o Phragmites – the work Kurt Kowalski is leading from USGS on microbial control and gene silencing are looking promising⁷
- o Grass carp response program. Unlike the ACRC silver and big head carp work – this program has clear objectives based on science, including fisheries population models and by combining judas carp with targeting fishing my sense is they are making real progress and adaptive research by management approach⁸.

- c) Gene Drive Technologies:

- o The big innovation on the horizon is the advances in gene drive technologies and this is an area we as a region probably need to start to get our head around and determine if it is something we want to embrace (and under what circumstances). Methods seem to have the potential. And Bureau of Reclamation is already funding the development of a Dreissenid mussel gene drive and there is plenty of talk in sea lamprey community about

⁵https://www.reabic.net/journals/mbi/2021/Accepted/MBI_2021_Davidson_etal_correctedproof.pdf

⁶<https://invasivemusselcollaborative.net/research-and-projects/imc-pilot-project-draft/>

⁷<https://www.greatlakesphragmites.net/research/control-options/>

⁸<https://www.sciencedirect.com/science/article/pii/S0380133020300770>

this as well. Still very much in early phases but it has the potential (assuming stable and safe) to provide a species-specific method to suppress some of these key species. But from a stakeholder engagement perspective, the priority is to start the consultation and education process in combination effort to assess the risk etc.

I. Recommendations

Traditional Approaches

- 1. Prevention:** Preventing the introduction of AIS is the most cost-effective management strategy (see Vander Zanden et al. 2010). It is critical that prevention continues to be a primary management focus and that we optimize its implementation (see Supplement #1). Prevention is geared toward stopping future impacts and does not, in itself, restore ecosystems impacted with AIS, which requires different management options.

An excellent resource for additional information on AIS in the Great Lakes is available at: <https://www.blueaccounting.org/issue/aquatic-invasive-species>.

- (a) Management of the live trade pathways is one example where progress is being made at the state, provincial and federal levels; the focus is on complementary policies (prohibiting species list, least wanted lists) and sharing of risk assessment across jurisdictions to avoid duplication of effort via a Risk Assessment Clearing house (managed by GLANSIS).
- (b) While similar regional assessments exist for recreational boating⁹, resources at state levels are resulting in different rates of adoption of best practice.

Recommendation #1: We recommend better coordination, information exchange, and database sharing at the federal, state, and local levels. This is absolutely essential given that it takes only one weak link in the prevention network for AIS to invade and potentially spread.

- 2. Early detection and response (EDR):** EDR takes place at the end of prevention process. Trebitz et al. (2017) identified a set of science-related recommendations involving early detection monitoring. These include:
 - a. Better data to support risk assessments that guide choice of taxa and locations to monitor.
 - b. Improved understanding of spatiotemporal scales for sample collection.
 - c. Further development of DNA target markers, reference barcodes, genomic presented a set of workflows, and synergies between DNA-based and morphology-based taxonomy.
 - d. Tools and information management systems for better evaluating and communicating survey outcomes and uncertainty.

⁹ <https://www.blueaccounting.org/link/assessment-watercraft-inspection-and-decontamination-legislative-provisions-management>

The USFWS' monitoring programs provide a template for expansion of regional surveillance programs and the interstate surveillance working group has developed regional site and species priorities (Tucker et al. 2020, Davidson et al. 2021) and along with others, communication protocols. There remains limited coordination with ancillary fisheries and ecosystem monitoring that also has the potential to add to surveillance network. The improvement in genomic-based detection methods (including next generation sequencing) is making the concept of early detection a far more realistic proposition.

Recommendation #2: Two areas, in particular, where we recommend greater resource investment are: 1) coordinated information management on AIS (and ancillary monitoring efforts) among the relevant jurisdictions in the Great Lakes Basin; and 2) next generation sequencing and genomics environmental DNA analysis screening for AIS.

B. Innovative Approaches

1. Early Warning Systems: The IJC is developing a scientifically-based framework for detecting and identifying emerging stressors and threats using available data¹⁰. This proactive approach, as opposed to the more commonly used reactive approach, would allow agencies charged with AIS prevention and eradication to mobilize resources in advance of an invasion, protecting the Great Lakes ecosystem and making more efficient use of limited human and monetary resources.

Recommendation #3: We recommend that federal, provincial, and state agencies coordinate with the IJC regarding the implementation of recommendations from this study.

2. Monetary allocation toward AIS: Much of the financial allocation in the AIS field is based on a small number of high-profile species, such as silver carp, Phragmites and sea lamprey. (Create a metric system to monitor progress and accountability – blue accounting website (TNC)). While the rationale for these allocations is obvious, it may not be the most effective approach to dealing with the problem of AIS, as it tends to be reactive instead of proactive. We believe focused funding on control or eradication of these problematic taxa should be continued, as several projects are showing some success at least as proofs of concept (e.g., control of Phragmites¹¹). But there is a need for a more holistic and strategic approach that consider which suite of AIS need to be controlled to facilitate restoration of critical sites and habitats across the Great Lakes. An example of this approach would be the experimental control of dreissenids on native fish spawning reefs at Good Harbor reef:

<https://invasivemusselcollaborative.net/research-and-projects/imc-pilot-project-draft/>.

Recommendation #4: We recommend that financial allocations involving AIS have a two-fold strategy: 1) focus on the development of management tools for a broader suite of high impact,

¹⁰ <https://ijc.org/en/sab/towards-great-lakes-early-warning-system>

¹¹ <https://www.greatlakesphragmites.net/research/control-options/>

established AIS that pose the greatest impediment to restoration of key sites and habitats across the Great Lakes, such as coastal wetlands and coastal spawning reefs; and 2) continue efforts at the vector and pathway levels, to maintain a coordinated prevention approach.

- Innovations:** One area that deserves increased attention is the advances in gene drive technologies. Briefly, gene drive is a process that increases the chance of inheriting a certain gene variant to something greater than the 50% inheritance that is present in their parents. If you have a gene variant that provides some type of advantage, gene drive technology can allow it to spread relatively quickly through a given population. The advantage of this technology is that you can manipulate certain populations to carry some particularly advantageous traits. Hence, it may be possible to manipulate invasive populations to limit reproduction. The main disadvantage is the fear and uncertainty associated with manipulating genes; what happens if individuals with these drive genes spread to their native range and breed with native populations? How will this potentially impact the species as a whole, or other organisms that depend on those species? This might be particularly problematic for invasive species in the Great Lakes that are native to other parts of North America (e.g. alewife and sea lamprey). So, the unforeseen/unintended consequences of releasing these individuals into the wild is the main concern. In addition, many of the drive techniques are now using CRISPR-Cas9 to target gene regions. One of the known issues with CRISPR is that it can also affect non-target regions (i.e., parts of the genome that you don't want to modify). Given these uncertainties will be critical that research and development of gene drive tools are complemented by a regionally coordinated community education and engagement process to ensure stakeholder concerns are understood and community support for these tools isn't lost through promulgation of misinformation.

To be included here: Bubble barrier; acoustics, strobe lights, mussels for waste ponds, chlorine chamber, CO₂

Recommendation #5: Initiate a coordinated research and stakeholder engagement program, involving aquatic and molecular ecologists, ethicists, social scientists, biotech specialists, and venture capitalists to explore the feasibility, desirability, and legality of gene drive technology as a control mechanism for AIS.

4. Commodification of commercially viable AIS

While many, if not most, AIS have limited or no commercial value, there are some species whose market value may make them attractive as commodities. For example, numerous companies are harvesting Asian Carp and bringing them to market in various ways: Colgan Carp Solutions is working with fishers in Maine to use Asian carp as lobster bait; Sorce Freshwater is identifying bait, fertilizer, and pet food markets for Asian Carp; and Wilder Harrier has introduced an Asian Carp-based dog food.

Various states have provided small grants and loans to incentivize business development around Asian Carp. However, vigilance is also required to ensure commercialization does not

unintentionally lead to the spread or maintenance of AIS populations (as has occurred with various non-native marine aquaculture and freshwater sport fish, as well as other terrestrial pests like rabbits in Australia and New Zealand).

Recommendation #6: We recommend that a regional grant program be developed, using both private and public funds that addresses all AIS and has funding of sufficient size to attract a large pool of applicants.

5. AIS Prize?

Companies and philanthropy could join to fund an annual competition for the most creative and effective AIS management idea. This could be funded by a private-public partnership and/or with support from family and community foundations. Such an AIS prize could catalyze and reward a range of AIS research and development, information management and exchange, and/or innovative business and community practices.

Recommendation #7: Start an annual or biennial AIS Prize, with a monetary award, which is open to both the private and public sectors, to help develop new and creative ideas to control or prevent AIS.

C. Literature Cited:

Davidson, A.D., Tucker, A.J., Chadderton, W.L., Jensen, E., Weibert, C. and R. Death. 2021. Assessing progress in regulation of aquatic nonindigenous species across the multijurisdictional waters of the Laurentian Great Lakes, with emphasis on the live trade pathways. *Management of Biological Invasions* 12 (in press).

Trebitz, A.S., J.C. Hoffman, J.A. Darling, E.M. Pilgrim, J.R. Kelly, E.A. Brown, W.L. Chadderton, et al. 2017. Early detection monitoring for aquatic non-indigenous species: Optimizing surveillance, incorporating advanced technologies, and identifying research needs. *Journal of Environmental Management* 202: 299-310.

Tucker A., Chadderton W.L., Annis G., Davidson A., Hoffman J., Bossenbroek J., Hensler S., Hoff M., Jensen E., Kashian D. 2020. A framework for aquatic invasive species surveillance site selection and prioritization in the us waters of the Laurentian Great Lakes. *Management of Biological Invasions* 11, Issue 3: 607–632.

Vander Zanden, M.J., Hansen, G.J., Higgins, S.N. and M.S. Kornis. 2010. A pound of prevention, plus a pound of cure: early detection and eradication of invasive species in the Laurentian Great Lakes. *Journal of Great Lakes Research* 36: 199-205.

Appendix A: Other resources

Below are links to existing legislation, publications and reports that are relevant to Invasive Aquatic Species in the Great Lakes.

SOR/2015-121 Fisheries Act; Registration 2015-05-29; Aquatic Invasive Species Regulations (<https://laws-lois.justice.gc.ca/eng/regulations/SOR-2015-121/FullText.html>)

https://www.icaais.org/pdf/2016abstracts/ICAIS%20Thursday%20AM%20Session%20B/0830_Kerluke.pdf

The [Nonindigenous Aquatic Nuisance Prevention And Control Act Of 1990](#) (As Amended Through P.L. 106–580, Dec. 29, 2000.) is the Act under which the USFWS Branch of Invasive Species manages the Aquatic Nuisance Species Task Force and its Aquatic Nuisance Species Program.

The [Lacey Act](#) is the Act under which the Branch of Invasive Species conducts its activities pertaining to listing an organism as [Injurious Wildlife](#).

The [Executive Order 13112](#), signed by President Clinton on February 3, 1999, requires that a Council of Departments dealing with invasive species be created to prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause.

The [Alien Species Prevention and Enforcement Act](#) of 1992 makes it illegal to ship plants or animals that are covered under the Lacey Act or the Plant Protection Act through the U.S. mail.

The [Plant Protection Act](#) of 2000 consolidates and modernizes all major statutes pertaining to plant protection and quarantine (Federal Noxious Weed Act, Plant Quarantine Act) and permits APHIS to address all types of weed issues. It also authorized APHIS to take both emergency and extraordinary emergency actions to address incursions of noxious weeds.

Invasive species control and prevention continues to be a challenge for the Great Lakes. Perhaps the most visible example are the efforts to prevent Asian Carp from entering Lake Michigan.