US Fish and Wildlife Service

Great Lakes Aquatic Invasive Species Early Detection and Monitoring Framework, 2024

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Vision

The US Fish and Wildlife Service (USFWS) Great Lakes Aquatic Invasive Species (AIS) Early Detection Monitoring (GLEDM) Program will deliver a comprehensive, consistent, and transparent program for detecting new populations of AIS, while localized or rare, across the Great Lakes Basin to inform the possible implementation of early response actions in coordination with partners.

Mission

In collaboration with partners, the GLEDM Program will optimize and implement a sampling strategy to detect new AIS before they become established or expand to new locations within the Great Lakes Basin.

Objectives

1. Target high-priority species identified through agency risk assessments, state and tribal input, and published watchlists.
2. Maximize the probability of detection.
3. Communicate outcomes to stakeholders and decision makers.
4. Review program implementation annually.
5. Adapt program implementation on a three-year cycle.

GLEDM Program Framework

The GLEDM Framework (Framework) is a broad-spectrum surveillance program intended to provide decision makers with timely information regarding new AIS so that rapid risk assessments and rapid response planning can be completed while populations are small and localized. This Framework (Figure 1) describes a process to optimize and implement sampling strategies in selected high-priority locations (HPLs) across the Great Lakes Basin to maximize the probability of detecting newly introduced AIS and expansions of currently present AIS. The process described in this Framework was conceived with the goal of detecting non-native fishes, however many facets of this Framework will be incorporated into a future sampling strategy for benthic macroinvertebrates. The Framework begins with an initial research and development stage occurring in an area newly identified as being at high risk of AIS invasion or expansion (Phase 1). This phase lasts for at least three sampling years to establish baseline information to understand the fish community, measure potential spatial trends, and determine optimal gear allocation. Rare-species encounters tend to accumulate over years because of population fluctuations or in- and out-migration patterns (Trebitz et al. 2017), thus multiple years of sampling are necessary to evaluate the efficacy of the sampling strategy.

Insights from Phase 1 will be used to adapt sampling protocols for the next three years, or Phase 2. Cycles of data collection, evaluation, and program adaption continue in subsequent phases. Consistent sampling protocols during each phase are critical to providing datasets that can be used to evaluate program efficiency. Inconsistent sampling protocols make it difficult to disentangle the effects of sampling changes from annual variation.

Accurate and accessible data allow for timely annual reporting, programmatic evaluation, and measuring of success, which ultimately guide programmatic improvements. Thus, data will be stored in a centralized database with appropriate quality assurance to maintain data integrity (Great Lakes

Aquatic Invasive Species Early Detection Monitoring Data Workflow Plan, in prep). A data management plan has been created that outlines how data will be managed, described, and stored (Great Lakes Aquatic Invasive Species Early Detection and Monitoring Program: Juvenile/Adult Fish, Ichthyoplankton and Invertebrates). Following the quality control process, data will be made accessible through USFWS supported repositories. From these data, annual evaluations and reports will share our work and results with partners and managers.

This Framework guides the development of regionally specific implementation plans at each USFWS Fish and Wildlife Conservation Office (FWCO). Consistency among FWCOs in implementation, data collection, and reporting will increase the effectiveness and impact of GLEDM work. Sections 1 through 4 of this Framework primarily describe Phase 1 for 1) identifying and selecting locations at highest risk of AIS introductions or expansions (i.e. HPLs), 2) allocating effort among HPLs, 3) selecting specific sampling sites within an HPL, and 4) allocating collection gears among sampling locations. Although these sections are presented sequentially, the considerations and decisions are interrelated and must be addressed as an ensemble. Future versions of this document will include more detail on data collection and quality control, program evaluation and reporting, measures of success, range expansion monitoring, and Phase 2 implementation. FWCOs will provide annual implementation plans describing the work they plan to conduct each year, including their considerations of the concepts described in this document.

The Framework describes facets of a *broad-spectrum sampling* approach designed to detect a wide range of potentially invasive species (informed by watchlists) before they become established and widely distributed. *Targeted sampling* to document either an expansion of known AIS or detect a single species might share some of the characteristics of a broad-spectrum approach, but sampling methodology related to site selection and gear allocation would likely be less exploratory than traditional GLEDM efforts. Single-species targeted efforts would utilize existing data sets (likely collected as part of broad-spectrum efforts) to determine the most effective gears to deploy and habitats to sample. Certainly, targeted efforts would be regularly evaluated using similar measures of success to improve and refine implementation protocols. Ultimately, a targeted effort would resemble the process depicted in Figure 1 but with different approaches to determining the “Sampling Implementation.”

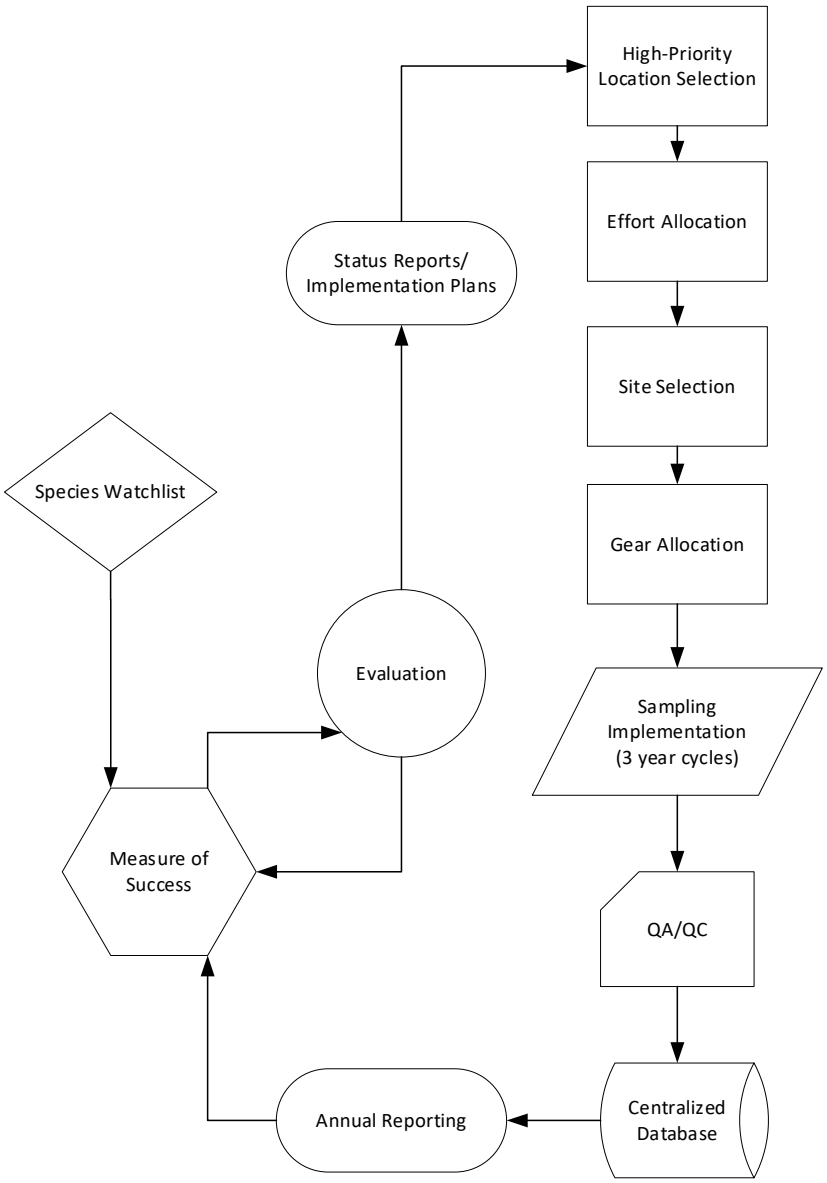

Figure 1. Diagram of the Great Lakes Early Detection Monitoring Program Process.

Section 1. High-Priority Location Selection

The first step in developing an EDM program is to evaluate the entire Great Lakes Basin and identify areas at high risk of new AIS introductions or range expansions (i.e., HPLs). Recent analysis conducted by The Nature Conservancy provides the best available ranked list of the top 25 HPLs across the Great Lakes Basin based on several factors, including propagule pressure and invasion history (Tucker et al. 2020).

From the ranked list of 25 HPLs, each FWCO will select a subset of locations for sampling based on resources such as Ecological Risk Screen Summaries (https://www.fws.gov/story/ecological-risk-screening-summaries), species watchlists (USFWS internal documents), the USGS Nonindigenous Aquatic Species database (https://nas.er.usgs.gov/), recent literature, and partner input. The selection of HPLs

will also reflect constraints of travel time, sampling time, and staff capacity. These criteria and resources will be reevaluated on a three-year cycle. FWCOs will work toward reaching at least the targeted amount of effort (see Section 2. Effort Allocation) at the greatest number of HPLs.

Defining the Boundary of an HPL

Tucker et al. (2020) identified locations at risk of AIS introductions but did not describe the specific areas or habitats within those locations. Each FWCO will define the boundary of an HPL to encompass likely invasion pathways, including a range of habitats suitable for watchlist species (Morisette et al. 2020). Additionally, factors such as geomorphology, barriers, shipping channels, habitat distributions, and access points will be considered when defining HPL boundaries. These boundaries will constrain the locations of specific sampling sites as described in Section 3. Site Selection.

Although increasing the size of a sampling area may increase the number of species encountered (Hill et al. 1994), it is important to weigh the time spent traveling between sampling sites within an HPL with the time spent sampling (Reaser et al. 2020). Long travel time between sites will reduce the total number of sites that can be sampled in a day and may jeopardize efforts to meet the target amount of effort at an HPL (see Section 2. Effort Allocation).

Section 2. Effort Allocation

Once HPLs have been selected, the next step is to allocate sampling effort among locations. Implementation plans will balance the number of HPLs that can be visited with the time to adequately sample each HPL. This balance is complicated by the fact that different HPLs represent different habitat combinations, which are most effectively sampled by different gears, which in turn have different staff, time, and resource requirements.

The GLEDM Program quantifies one 'unit of effort' (UOE), as one gear set or transect; for example, one fyke net set or electrofishing transect. Logistically, some gears pair well together (e.g., fyke nets and electrofishing), while other gears do not (e.g., electrofishing and trawling). While it is difficult to capture these considerations into a single measure of effort, our UOE allows us to provide a generalized description of the amount of effort a crew can accomplish in a day. A single crew can generally conduct six UOE per day, regardless of the gear types. Newly developed gears or technologies, like environmental DNA sampling (eDNA), require further discussion about how to similarly describe effort.

The amount of effort deployed at an HPL should 1) effectively sample for new AIS, and 2) gather enough data to guide implementation adaptations. Recognizing both inter- and intra-annual variation in fish behavior and distribution suggests that sampling over multiple years will improve sampling efficiency. Hoffman et al. (2016) suggest that a minimum of three years' sampling is necessary to generally capture 95% of species richness. They also suggest that sampling in at least two seasons may improve efficiency. Trebitz et al. (2009) and Hoffman et al. (2016) suggest that a minimum of 40-50 UOE is necessary to adequately sample an area. We adopt this recommendation and set our minimum annual target level of effort for an HPL at 40 UOE. More effort spread across seasons is encouraged, especially for the highest ranked HPLs. The more effort invested early in the GLEDM process, the more successful GLEDM will be over time.

The level of effort for each gear type should remain consistent across seasonal sampling events and years during each phase to strengthen evaluation of the sampling protocol. For example, if 12 units of

electrofishing are completed during a first sampling event, subsequent sampling events should complete at least 12 units of electrofishing. Furthermore, if 40 UOE are completed over three sampling events the first year, then subsequent years should at least sustain the same level of effort. As much as possible, the timing, number of sites sampled, and gear allocation will also remain consistent.

Section 3. Site Selection

Once HPLs have been selected and effort allocated, the next step is to choose sampling sites within an HPL. The GLEDM Program is intended to detect a broad range of species with uncertain life histories and habitat preferences. For any species, habitat preferences may be defined by many factors, for example substrate type, bathymetry, water clarity, flow, temperature, oxygen levels, even vessel traffic. Without prior knowledge of habitat preferences, site selection should be distributed across as many habitats as possible (Trebitz et al. 2017) using a stratified random sampling design. When beginning work in a new area, little may be known about fish communities and distributions. However, knowledge about physical parameters, partner knowledge or other data may be available to guide stratification. Bathymetry and substrate are most likely to have quality available data.

Once strata have been defined, specific sampling sites will be randomly chosen within each stratum. With each sampling event, across different seasons and years, new sites will be randomly selected within each stratum. For each sampling event, an abundance of sites should be identified, allowing field crews the flexibility to adjust daily sampling plans for inclement weather, environmental changes, and other unforeseen circumstances. Familiarity with an HPL, improved physical data and knowledge of fish communities will guide stratification decisions in Phase 2.

Bathymetry

Water depth can often be used as a surrogate for different habitat types. Hoffman et al. (2016) identify the 2-meter depth is a reasonable demarcation because it often reflects significant decreases in vegetation cover. This depth also separates the typical efficacy of shallow-water (e.g., fyke nets and electrofishing) and deep-water gears (e.g., trawls and gill nets). This cutoff could be adjusted based on local water clarity and substrate conditions.

Substrate

When substrate distribution information is available it can be help refine the definition of strata. There are a growing number of geospatial, substrate distribution resources, for example The Great Lakes Aquatic Habitat Framework (https://www.glahf.org/data/). FWCOs should search for all available data in their areas, recognizing that accurate substrate information is more likely available for shallower sites.

Section 4. Gear Allocation

Once HPLs are selected, effort allocated, and sampling sites selected, the next step is to match sampling gears with the chosen sites. This step happens in close concert with effort allocation and site selection. Traditional fisheries gears include electrofishing, fyke netting, gill netting, seining, and trawling. Developing sampling methods, like eDNA, will be incorporated as appropriate. When allocating gear, it is important to consider the effectiveness of each gear in different habitats. It is also important to consider species' susceptibility to different gears. Common fisheries knowledge, experience, and current site conditions like depth, flow, vegetation cover, or the presence of obstructions, will guide the choice of a gears at specific locations (USFWS 2014).

Hoffman et al. (2016) acknowledge that no sampling method can definitively detect a new or expanding AIS. However, the probability of finding AIS is maximized by allocating effort and a suite of gears across a range of habitats. For example, they found that in three Lake Superior HPLs an allocation of electrofishing, fyke netting, and either bottom trawling or gill netting in a 2:2:1 ratio maximized observed species richness. Assuming little knowledge of the fish community and habitat when beginning sampling in a new location, we recommend an even distribution of effort across three primary gear types: electrofishing, fyke netting, and either bottom trawling or gill netting. Additional knowledge and understanding of a site may lead to deviations from this distribution.

As with effort allocation, regardless of the specific effort and gear allocation selected for an HPL, keeping these consistent throughout Phase 1 will create an appropriate baseline dataset to inform changes in effort and allocation in subsequent phases. As knowledge of and experience in a location grow, gear choice will be revisited in future phases.

Section 5. Phase 1 Sampling Protocol Overview

1) Select HPLs from among those identified by Tucker et al. (2020) and define the boundaries.
2) Allocate effort among selected HPLs, with at least 40 units of effort at each HPL.
3) Select an abundance of sites within an HPL using a stratified random design.
4) Sample HPLs with an equal, or appropriate, proportion of suitable gears.
5) In subsequent visits, randomly select new sites but with consistency in HPL boundaries, effort allocation, sampling strata and season, and gear allocation throughout Phase 1.
6) From quality data, share annual evaluations and reports with partners and managers.

Section 6. Future Directions

As part of the National Early Detection and Rapid Response Framework, the GLEDM Program is developing this Framework to detect new species introductions and range expansions as means of minimizing the impact of AIS. The GLEDM Framework outlines a cyclical process of data gathering, evaluation and adaptation guiding where and how we strategically allocate limited resources. With FWCOs located across the Great Lakes and in our ongoing efforts to detect new AIS, we have already done substantial work that will inform future improvements to the GLEDM Program. As EDM efforts throughout the Great Lakes Basin mature through this Framework, consistency in implementation, data management, and reporting will strengthen the GLEDM Program. This document represents the first steps in developing a full Framework. Next steps include discussions on data collection and quality control, program evaluation and reporting, measures of success, and Phase 2 implementation. Perhaps the most pressing step is to develop measures of how well the EDM Program is adaptively implemented and its success detecting AIS. As this framework develops, the GLEDM Program will continue to comprehensively, consistently, and transparently sample for new aquatic invasive species across the Great Lakes Basin.

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Glossary of Terms

AIS – Aquatic invasive species

EDM – Early Detection Monitoring

eDNA – Environmental DNA

FWCO – USFWS Fish and Wildlife Conservation Office

GLEDM – Great Lakes Early Detection Monitoring

HPL – High-priority Location.

Site – The area where one Unit of Effort occurs, regardless of what that effort is.

UOE – Unit of Effort. One gear set or transect applied at one site.

USFWS – United States Fish and Wildlife Service