GLANSIS - Report on the FY 2018 Pilot Projects

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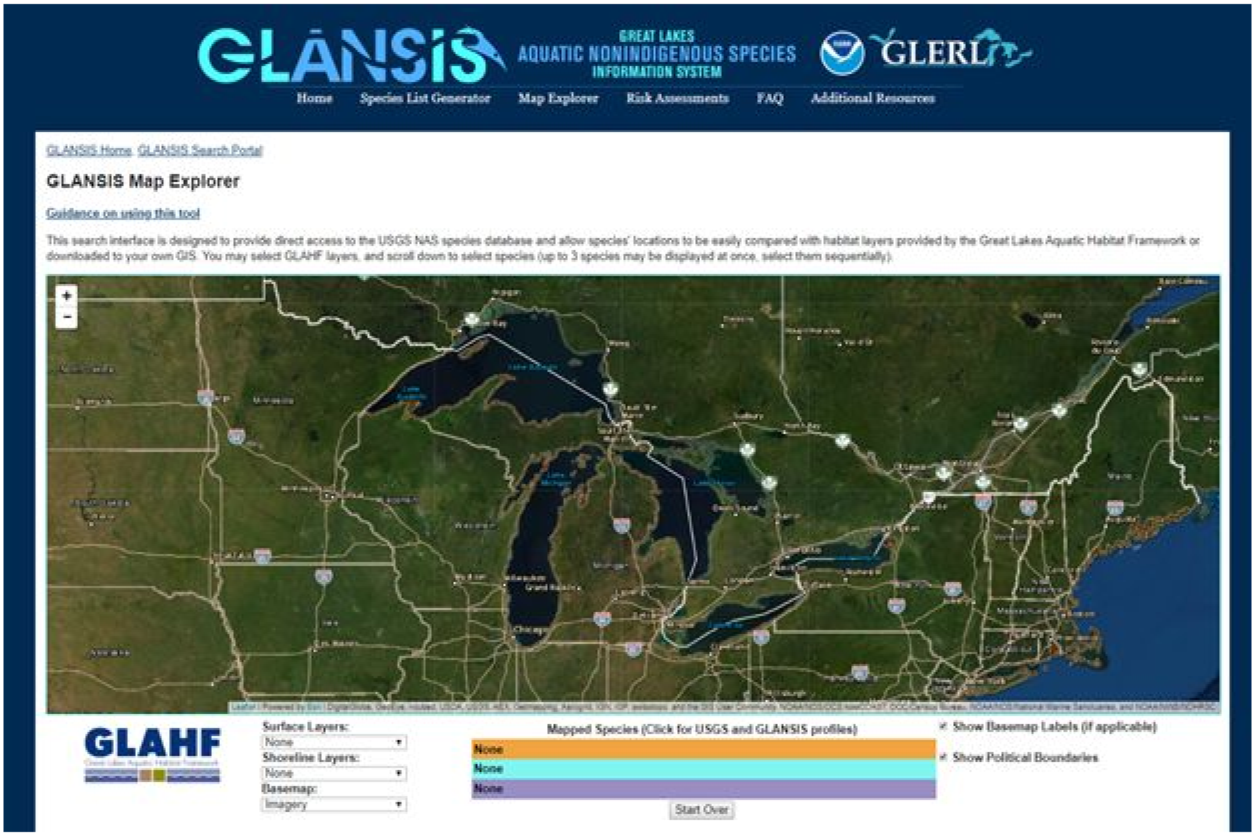
Background

Aquatic invasive species are perhaps the greatest stressor currently facing the Great Lakes aquatic ecosystem, altering energy pathways, lowering food web and fisheries productivity, and costing millions of dollars annually in control and mitigation. NOAAs Great Lakes Aquatic Nonindigenous Species Information System (GLANSIS) is a searchable database with fact sheets, threat assessments, and maps designed to improve stakeholder education, and inform prevention, management and control of aquatic nonindigenous species (AIS). With 2018 funding from the Great Lakes Restoration Initiative (GLRI) we proposed to conduct 3 specific pilot projects exploring potential new ‘value-added’ components of the database. Each of these 3 pilots were initially suggested by natural resource managers in the Great Lakes region. A 4th pilot was added at the request of the Risk Assessment Committee of the Great Lakes Panel on Aquatic Nuisance Species.

Habitat Suitability Mapping Pilot

For selected high profile AIS we proposed to include links to recently completed assessments of suitable habitat with an initial focus on the habitat suitability assessments that were funded by NOAA. Maps of AIS habitat suitability are intended to help focus efforts by managers and the public to search for and respond rapidly to AIS introductions as well as to predict the potential behavior of newly introduced species.

We created a system in which the habitat suitability maps and relevant environmental data layers are stored in the Great Lakes Aquatic Habitat Framework (http://ifr.snre.umich.edu/projects/glahf/), an online spatial database and map warehouse managed by Michigan Dept. Natural Resources Institute for Fisheries Research and Dr. Catherine Riseng at University of Michigan to support management, protection, and policy development for Great Lakes aquatic resources. Selected maps are accessed through a custom portal – the Map Explorer – constructed by GLANSIS and residing on the NOAA servers. The Map Explorer portal simultaneously provides access to the entire suite of species map data which resides on USGS servers (accessed through our dedicated API interface). In addition to allowing the user to build custom maps and explore data within the interface, the Map Explorer adds a greatly simplified capacity to download GLANSIS species map data, allowing the user to transfer data to their own platform for further exploration or support of their own research.



Details of the Map Explorer interface can be found in: Smith, JP, EK Lower, FA Martinez, CM Riseng, LA Mason, ES Rutherford, M Neilson, P Fuller, KW Wehrly, and RA Sturtevant. 2019. Interactive mapping of nonindigenous species in the Laurentian Great Lakes. *Management of Biological Invasions 10(1): 192-199.*

The Habitat Suitability pilot test included a total of 12 habitat suitability maps for 5 species from 2 sources:

- Kramer et al 2017
  - Killer Shrimp
  - Golden Mussel
  - Golden Mussel with Restricted Benthic Temperature
  - Snakehead
  - Snakehead with Restricted Benthic Temperature
  - Snakehead Restricted SAV and Wetlands
- Wittman et al 2017

- Hydrilla
- Hydrilla Restricted GDD
- Hydrilla Restricted GDD and Photic Zone
- Grass Carp
- Grass carp Restricted SAV and Wetlands
- Grass Carp Restricted SAV, Wetlands & Hydrilla

The following environmental layers are also available through the portal from the GLAHF:

- Surface Layers
  - Geomorphology Depth
  - Geomorphology Substrate
  - Spring Surface Temperature
  - Summer Surface Temperature
  - Cumulative Degree Days
  - Ice Duration
  - Upwelling
  - Aquatic Ecological Units (AEU)
  - Depth
  - Thermal Regime
  - Mechanical Energy
  - Tributary Influence
- Shoreline Layers
  - Classification
  - Sinuosity
- Basemap
  - Topographic

- National Geographic
- Oceans
- Gray
- Dark Gray
- Shaded Relief
- USA Topographic

We have not received much feedback from general users regarding the utility of the core set of habitat suitability maps (the initial pilot goal). Initial responses from a core beta test group indicate that the Habitat Suitability Maps are 'buried' in the interface (under surface layer tab) which may be causing general users to fail to discover these maps. We propose pulling these maps out separately in the next iteration of the interface. Nonetheless, as a 'proof of concept' we consider the pilot to be a success in demonstrating the capacity of the system to provide access to additional types of AIS-related map layers from disparate sources. We propose working with the Great Lakes Panel on Aquatic Nuisance Species to determine which types of additional map data should be highest priority for adding to the system.

Users generally like the direct access to map data afforded by the Map Explorer. Frequency of contacts asking for assistance with data access has fallen significantly since the Map Explorer came online. In stakeholder usability interviews conducted for the GLANSIS site's redesign, several of the environmental managers who participated said that the Map Explorer was the tool they used most frequently on GLANSIS. Interview participants noted that this map data was especially useful for generating visuals for presentations and reports by using screenshots generated through the Map Explorer. However, a few interviewees noted that the addition of so many new GLAHF layers in the current drop-down menu setup was difficult to navigate in its present form, and requested a more user-friendly and streamlined revision to this part of the Map Explorer in future updates.

Within our own group, we have started to use the environmental data layers – particularly the GLAHF Aquatic Ecological Units and Shoreline Classification – along with our GLANSIS species distribution data to generate new combined maps and to build understanding of the drivers of distribution for established species (see demographics pilot below). We are also recognizing 'less obvious' potential uses of the Map Explorer such as exploring relationships between the distributions of pairs of invasive species and creating time series maps. As we explore these capacities, we plan to build 'help memos' to better direct users of the system.

Tabular Access to Cross-Taxa Information

Based on requests from scientists and managers, we proposed to pilot a system providing a more tabular access to cross-taxa information (e.g., fecundity data for all fishes). We selected a set of 10 species to use in piloting this feature. These 10 species were not chosen randomly, but were selected to represent both diverse taxa (to ensure the selected information categories would work for the entire diversity of species in the database) as well as species within each taxa that were highly studied and thus would have the greatest probability of success in finding the desired information. The 10 species selected are:

- *Procambarus clarkii* (Red swamp crayfish)
- *Petromyzon marinus* (Sea lamprey)
- *Ctenopharyngodon idella* (Grass carp)
- *Neogobius melanostomus* (Round goby)
- *Phragmites australis australis* (Common reed)
- *Lythrum salicaria* (Purple loosestrife)
- *Hydrilla verticillata* (Hydrilla)
- *Nitellopsis obtusa* (Starry stonewort)
- *Dreissena polymorpha* (Zebra mussel)
- *Bythotrephes longimanus* (Spiny waterflea)

Categories of information went through several iterations as the pilot progressed based on relative success/difficulty in accessing information across species. The final categories are as follows

- Habitat
    - Depth Range
    - Thermal Tolerance
    - pH
    - Other Critical Factors (collapsed from a longer list)
    - GLAHF AEU and/or Shoreline Classification
- Life History
    - Size
    - Age at maturity
    - Maximum Lifespan
    - Fecundity
- Food Web
    - Trophic Level
    - Diet
    - Predators
- Impact
    - GLANSIS RA Impact Factors (Environmental, Socioeconomic and Beneficial)

- Vector (primary vector of introduction to the Great Lakes)

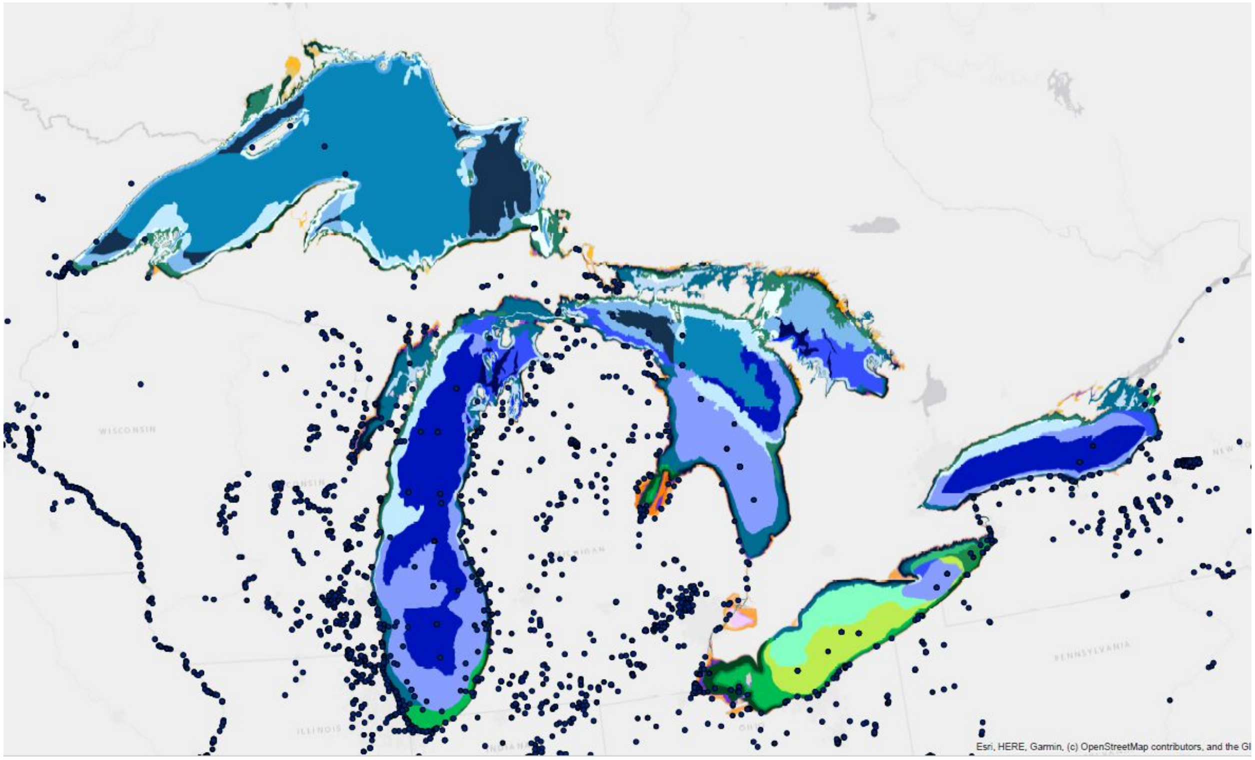
This created a matrix of information which we collated for all 10 pilot species, beginning with extraction of the information in our current profiles and turning to the literature only when that information was not in our profiles.

	Habitat					Life History				Food Web			Impact Factors			Vector
	Depth range	Thermal tolerance	pH	Critical Factors	GLAHF Habitat	Max Size	Age at Maturity	Max Lifespan	Fecundity	Trophic Level	Diet	Predators	Environmental	Socio-Economic	Beneficial	
Red Swamp Crayfish	Shallow/littoral, ranging inland	0-35 C (prefers 21-30C)	5.8-10	salt tolerant to 35ppt (needs 2-3 for reproduction)	Shoreline - Sand Beach (97%), Coarse Grain/Flat (3%)	12 cm length	as young as 2 months	5 years in the wild	100-500 eggs per female, 1-2 breeding events per year	Polytrophic	Insects (chironomids), other crayfish, fish, detritus	fish, larger crayfish	5	4	3	Aquaculture/aquarium
Sea Lamprey	1 - 4099 m	1°C - 20°C		Anadromous: can adapt to saltwater.	Found in 56% of AEUs. Most (28%) reports are in coastal margins with moderate thermal energy, low exposure and high tributary influence (1213).	100 cm	3-5 years	11 years	Breed once at the end of their lifespan, but produce between 30,000 and 100,000 offspring, then die shortly after spawning.	Tertiary consumer	Salmon, lake trout, rainbow trout, whitefish, chub, burbot, walleye, and others.	Humans. Few natural predators.	12	18	0	Canal
Grass Carp	1-3 m	0-39 C	6-9.24	1.05 mg/l ammonia (median lethal concentration) Require high flow for successful spawning; in the Great Lakes Basin, the Maumee and Sandusky Rivers of Lake Erie, and the St. Joseph and Milwaukee Rivers of Lake Michigan have suitable hydrology for successful Grass Carp spawning (Murphy and Jackson, 2013)	Found in 18% of AEUs. Most reports (74%) are in coastal margins with high thermal energy, low exposure and high tributary influence (1313).	125 cm	1-11 years (~20-33 inches)	20 years	10^5-10^6 eggs/female	Primary consumer	Aquatic plants, filamentous algae, macrophytes. May consume crayfish, detritus, and zooplankton if vegetation is unavailable (Conover, 2007)	Largemouth bass, osprey, blue herons, otters	20	5	1	Stocking, aquaculture
Round Goby	1-50 m			Can tolerate low oxygen concentrations and poor water quality. Can survive in brackish water up to 20 ppt.	Found in 60% of AEUs. Most reports (34%) are in coastal margins with high thermal energy, low exposure and high tributary influence (1313).	17.8 cm (US max)	1-2 years for females, 3-4 for males	4 years	Related to female body size. 100-4000 eggs per clutch, spawning every 20 days from April to September annually.	Midtrophic	Macroinvertebrates, zebra and quagga mussels, small fishes, and eggs and fry of lake trout, sculpin, log perch, and darters.	Walleye, burbot, smallmouth bass, yellow perch, cormorants	13	13	1	Shipping ballast
Phragmites	Emergent, wetland/upland interface	>10C for germination	3.9-8.6	Water depths > 5cm prevent germination of seeds.	No current GLANSIS records intersect with GLAHF layers	6 m tall	2-4 years	6 years (colonies survive for much longer)	Mature plants produce as many as 2,000 seeds annually	Primary producer	Autotroph	most grazers (insects to mammals) will eat phragmites, but it tends not to be a preferred food source	18	5	2	Shipping ballast/packing
Purple loosestrife	Emergent, wetland				Shoreline - Coastal wetland (37%), Sand Beach (27%), Coarse Grain/Flat (18%), Rocky Cliffs/Bluffs (16%), Sediment Scarp (2%), NA -- Mixed Beach (<1%)	2.5 m tall	8-10 weeks	seeds retain 80% viability for 2-3 years	2.7 million seeds annually	Primary producer	Autotroph	5 species of beetles approved for biocontrol as well as grazing by sheep	9	0	1	Shipping ballast
Hydrilla	Submerged littoral			0-7ppt salinity	Inland Lakes Only - not in Great Lakes Yet	9 mm long	Perennial		Reproduces mainly through vegetative fragmentation	Primary producer	Autotroph	herbivorous fish (e.g., grass carp)	19	30	5	Aquarium/hitchhiker
Starry Stonewort	1-30 m (prefers 3-8m)	growth supressed if water temperatures exceed 30C		water velocity 3-11cm/s	Shoreline - Artificial (46%), Coastal Wetland/Riparian (28%), Sand Beach (9), Coarse Grain/Flat Coast (11%), Sediment Scarp (4%), Rocky Cliffs/Bluffs (2%)	2m				Primary producer	Autotroph		4	7	1	Shipping ballast
Zebra Mussel	All, higher densities Nearshore	6°C - 30°C	6.6-8.5	10mg/L Calcium for shell growth	Found in 73% of AEUs. Fairly evenly distributed with most reports (10%) in deep nearshore areas with moderate thermal energy, directional currents and high tributary influence (3243).	5 cm	2 years		1 million eggs per spawning season	Primary consumer	Seston	Planktivorous fish will consume veligers. Round goby, pumpkinseed, common carp, and freshwater drum have been documented to consume attached zebra mussels in North America	30	25	1	Shipping ballast
Bythotrephes longimanus	Upper water column	4-30°C		0.4-0.04 ppt salinity	Found in 45% of AEUs. Most reports are in deep/profundal offshore water (70%) or in areas of cyclonic currents (69%) most often with both (5250 + 6150 + 6250 = 54%) .	15 mm				Secondary consumer	Cladocerans, copepods, and rotifers	rainbow smelt, lake herring, lake whitefish, yellow perch, white perch, white bass, walleye, alewife, bloater chub, emerald shiner, spottail shiner, deepwater sculpin, chinook salmon, and less frequently *Mysis relicta*	7	1	0	Shipping ballast

Our intent was to have all values in this table be numerical or limited in the number of options, but we quickly found that for some species only qualitative descriptions of the key factors were available. For example, the ‘depth range’ for purple loosestrife is described only as ‘emergent wetland’ rather than a specific depth range. For other cases, more refined information needed to be added to properly interpret the numbers -- for example, red swamp crayfish has a survivable temperature range of 0-35C, but prefers 21-30C.

Our original table included numerous categories for environmental tolerances such as salinity, calcium, ammonia, oxygen, etc; however none of these could be gathered for all the species in the pilot. Thus we opted to collapse this category to a single text-based column with the flexibility to include whatever types of information were available.

GLAHF Habitat was added following the successful deployment of the Map Explorer (described above). For species limited to the nearshore environment, this category includes the Shoreline Classification Layers (text descriptions) with the percentage of records available for each category (at the time the table was completed) in parentheses. Inclusion of the number of records in each habitat type greatly aids interpretation of the data (dominant habitats versus outliers) but is likely to quickly become dated. For species found throughout the lake, this column includes a summary of the GLAHF Aquatic Ecological Units (4 digit codes corresponding to a combination of depth, thermal regime, REI and tributary influence) with the percentage of records available for the dominant category (at the time the table was completed) in parentheses. These pilot species typically were found in >10 AEUs, with what appears to be relatively complex patterns of influence in most cases. We look forward to analyzing this data in greater depth to determine the nature of these patterns as well as adding additional species beyond the pilot group that may be less ubiquitous. These descriptions of the habitats in which the species are actually found in the Great Lakes represents a unique GLANSIS product not available elsewhere, and one which we believe will be particularly useful for early detection efforts relating to species spread.



Sample graphic used for analysis of habitat drivers of distribution: zebra mussel distribution overlaid on GLAHF Aquatic Ecological Units

Complete life history information was not available for all species, however we opted to retain these categories in the table as they reflect critical information and we are hopeful that the explicit gaps provide incentive for researchers to fill these gaps in the knowledge base.

Food web information remains at a fairly coarse grain for most species, and unfortunately could not easily be limited to simple categories.

Our GLANSIS impact factors were a 'last minute' addition to the table as feedback from users included an interest in eventually being able to search for species based on impact. All species included in the pilot project meet our definition of invasive (environmental and/or socioeconomic impact factor greater than or equal to 2) but not all of the species included in the larger database of nonindigenous species will meet this criteria. Inclusion of these columns 'up front' in the design will support expansion of this tool.

The overall vector assigned to each species was added to the table in anticipation of improving capacity of the database to properly search by vector (current selector in the list generator uses the vectors assigned to each individual report - so both spread and introduction vectors - which is causing some misinterpretations).

Within the GLANSIS project team, we found this pilot to be enlightening. We plan to use the table moving forward as a core guideline for gathering information in the early stages of developing our profiles to improve consistency and quality of our core products. We are also hopeful that when we re-design the layout of the GLANSIS profiles, we will be able to move to this more easily updated tabular format for a subset of the information currently embedded in the text of the profiles.

Currently, GLANSIS is providing access to this cross-taxa tabular information only as a static table. Our original intent was to make this a searchable interface interoperable with the original GLANSIS List Generator. However, this interoperability cannot be accomplished at a pilot scale as it would require a complete table be available which includes all species in the database as well as a complex interface with the USGS NAS system. We currently plan to build a separate interface accessing this table when it grows to >20 species. Only fields that have strictly limited options will be searchable by the new interface. We are currently working with our Steering and Advisory committees to determine the best way to proceed on design of such an interface.

Enhance Information Support to AIS Control

GLANSIS provides a basic summary of available information on control within each species profile, and includes a handful of case studies of control for particular species. The GLANSIS maps currently categorize each sighting as “Collected/Other,” “Established,” or “Extirpated”. We proposed to better clarify which ‘established’ populations are subject to active control efforts as well as to provide better access to information on control methods being used at that site. We proposed to deliver enhanced information and case studies on control beginning with a subset of 10 high-priority species (identical to the species list for the tabular access pilot) for which this type of information is readily available.

‘Readily available’ information on control proved to be much more difficult to locate than anticipated, even for the pilot species which were deliberately chosen as most likely to have readily available control information. The total control information (pre-existing plus added by this pilot) available for the 10 pilot species is summarized in the table below.

Control Information Summary Table

Species	**Collaborative or Lead Agency**	**Control Papers in GLANSIS Bibliographies**	**Map points with Control Info in Comments**
Red Swamp Crayfish	Invasive Crayfish Collaborative	22	3

Sea Lamprey	Great Lakes Fishery Commission	31	2
Grass Carp	Asian Carp Regional Coordinating Committee	8	0
Round Goby	Round Goby Club (email list serve, no website yet)	9	2
Phragmites australis	Great Lakes Phragmites Collaborative	21	6
Purple Loosestrife	NA	53	127
Hydrilla	Great Lakes Hydrilla Collaborative	105	5
Starry Stonewort	Starry Stonewort Collaborative	2	15
Zebra mussel	Invasive Mussel Collaborative	111	10
Bythotrephes longimanus	NA	10	0

Of the 10 species on our pilot list, 2 species fall directly under the jurisdiction of other federal/binational coordinative bodies: coordination of Grass carp control falls under the jurisdiction of the Asian Carp Regional Coordinating Committee (ACRCC) and Sea lamprey control falls under the jurisdiction of the Great Lakes Fishery Commission (GLFC). An additional 5 currently have active collaboratives with a strong web presence and staff already dedicated to providing the best available information on management of these species. Links to these entities were added to the management section of the GLANSIS profiles in lieu of 'recreating the wheel' and summarizing that information within GLANSIS itself (which would likely become dated more quickly than the original source). GLANSIS staff have also joined as members of all of these regional AIS collaboratives to ensure that critical changes in management information can be incorporated into GLANSIS more quickly. The Round Goby Collaborative coordinated by WI and PA Sea Grant does not (yet) have a web presence, though it does have an active list-serve that members can use to share information - this group has to-date focused primarily on the spread of round gobies to inland lakes in the Great Lakes region. No active control programs exist for spiny waterflea that we were able to find and no current collaborative body focuses on information sharing for purple loosestrife control.

Beyond the resources provided by these groups, we scoured the scientific literature for additional case studies for control of these 10 species as well as appealing to the membership of the Great Lakes Panel on ANS for additional ‘grey literature’ case studies that might be included in agency reports. Only a handful of additional such studies were found. These are now included in the ‘full bibliographies’ for these species but were insufficient to warrant development of a new section of the profile to house such limited information. Control-related information in the current bibliographies (counted in the table above) include both research publications on the development of new control technologies (most of the total) as well as case studies of the use of particular methods in actual field settings (only a small fraction of the sources). News reports (a small fraction) were generally excluded from this count unless focused specifically on control efforts.

GLANSIS has always had an instruction in our base protocols to include information on control efforts in the comments field associated with each report if such is available. However, this information has not been systematically sought if the original report did not include it. Only very rarely have we added control information to a report substantially after the original report for a location (typically only if control efforts result in a status change to ‘eradicated’). Given control decisions are often made after a significant time-lag from the initial report, it has overall been quite rare for the database to include even anecdotal information on whether control has taken place for particular sites. When the reports come through bulk data-sharing with other systems via USGS NAS (e.g., data-sharing between iMAPInvasives and NAS) any control information is typically lost. As part of this pilot, we explored the feasibility of attempting to gather this information more systematically. We quickly found that the manpower needed to systematically go back through the thousands of older records in an attempt to determine which locations may have had control programs was beyond the capacity of our staff. Examining the subset of data that already existed in the system as record comments, we also encountered difficulties in defining a ‘control program’ - for example, in some cases a report of a new infestation might note that ‘all visible plants were handpulled’ with no information on subsequent follow-up. The numbers reported in the table above include even such simple notes as a form of ‘control info in comments’. Only in one case - purple loosestrife biocontrol via *Galerucella* beetles in the initial phase of that program - was there substantial control information readily available in existing reports and documents. Even in that case, absence of control information in GLANSIS and NAS cannot be taken as evidence of the population not being controlled. Overall, our efforts to expand this portion of our control tracking fell far short of our original vision of a potential for a map-based product identifying controlled and uncontrolled populations of nonindigenous species. While we will continue to enhance our systematic efforts to ensure that control information is included in GLANSIS distribution report comments moving forward, we have neither the capacity nor the available information base to be able to offer new map-based control products in the foreseeable future. Should external partners, such as the collaboratives, take on such a task for particular species, we remain willing to partner in the development and/or hosting of such products.

Risk Assessment Clearinghouse

At the request of the Risk Assessment Committee of the Great Lakes Panel on Aquatic Nuisance Species (RA Committee), we added a fourth pilot project, focused on creating a clearinghouse for risk assessment information. This committee identified a regional need for a 'one-stop' clearinghouse to access information currently in the hands of multiple state and federal agencies and scattered throughout the peer-reviewed and grey literature. The RA Committee was involved in the design of this clearinghouse from its inception. The committee identified a need for a multi-tiered system that would allow managers to (1) access the full scope of AIS Risk Assessment Literature, (2) clarify which risk assessment methods were most suitable for particular purposes, and (3) provide direct access and side-by-side comparison to risk assessments conducted by different agencies/methods on the same species.

The GLANSIS Risk Assessment Clearinghouse was released in beta in 2018 (https://www.glerl.noaa.gov/glansis/riskAssessment.html). The literature search was populated leveraging the USGS NAS Reference list by tagging individual references which were risk assessments. The methods tier was populated with the GLANSIS Risk Assessments (OIA and RA for established and watchlist species) and a handful of additional assessments as 'proof of concept'. The RA Committee identified an additional 7 major bodies of work that should be considered top priority for addition to the Clearinghouse:

- FWS-ERSS
- NYIS.INFO
- WI-DNR
- USDA-APHIS-WRA
- STAIR (Crayfish, Mollusks, Fish)
- AqWRAs (US, Canada, and Great Lakes)
- DFO-CEARA

A select subset of the species data (2-3 records per method) was used to populate the database as proof of concept.

The RA Committee was sufficiently impressed with the pilot that they recommended the Panel fund a project to 'jump start' population of the database with all the data for the above methods. The full Panel approved funding a summer intern through the Great Lakes Commission. The intern, Patrick Canniff, developed a protocol for vetting summaries with the original authors and was able to add more than 3100 species risk assessment results summaries to the Clearinghouse.

In 2020, we plan to continue populating the database beginning with USDA-WRA and DFO-CEARA, followed by developing a way to insert regional species lists (e.g., Governors' Least Wanted) and legislative species lists (e.g., Injurious Species under the Lacey Act) into the database as a different form of risk assessment result. We will also continue to populate the database with updates to RAs from the above sources (including GLANSIS RAs) and with additional methods and assessments from the literature.

Summary

Important lessons were learned from all four of the 2018 pilot projects. The Risk Assessment Clearinghouse was the most successful of the pilots and the one which we were most rapidly able to bring to a full-scale incorporation as a core GLANSIS tool. In large part, the success of this pilot was due to the critical feedback from the dedicated Risk Assessment Committee of the Great Lakes Panel on ANS as well as to the additional support provided by the Panel to accelerate this pilot. True partnership with the user (AIS management) community in the development of this product is what made it so successful. We also consider the Habitat Suitability Mapping pilot to have been a great success. Lesser direct engagement with end-users necessitates our doing additional work in the future to improve the visibility, navigation and useability of this tool, but we were still able to take it fully operational at a pilot scale. More work will be needed in the future to identify additional map layers which should be added to the system and inclusion of key user partners in that decision-making process will clearly be critical to the eventual success. More importantly, the development of the core Map Explorer tool itself (originally designed to just serve the habitat suitability maps as 'proof of concept') was able to simultaneously solve other core GLANSIS issues (data download capacity, navigation, custom mapping, simultaneous data display for multiple species) as well as to spur development of additional products (GLAHF layer analyses added to the 'tabular access' pilot). The tabular access pilot fell short of its goal of piloting a new type of search interface, but did provide a new data-management structure which will improve consistency of GLANSIS information for the species profiles and which will continue to be expanded and more gradually be incorporated into the core GLANSIS products. The path forward for expansion of this pilot is clear, but a fully operational interface with the full suite of species is realistically 5 years out. Meanwhile, the pilot has also brought to light several interesting potential new analysis products that we are eager to explore. The control pilot suffered from our overestimation of readily available control information for even key species and underestimation of the staff-time requirement to collate and enter such information. Despite recognizing the value of sharing geographic-based information on AIS control, given how difficult this information is to gather, verify, and process for even highly visible species, we do not currently intend to expand this pilot unless external partners (such as species collaboratives) request such data and are willing to partner in verifying the data. It is unlikely that such a product could ever be expanded to include the full suite of 188+ nonindigenous species in the Great Lakes.

We will continue to expand our control-related bibliographic inventory for all species and to incorporate summaries of this information into the management section of the GLANSIS species profiles, as well as linking to any collaboratives or other key regional management coordinating entities.