Binational Great Lakes Aquatic Invasive Species Forum Summary

November 9, 2017

Ann Arbor, Michigan

Additional information, including a final agenda, presentations, and an attendee list, is available online.

Updates from Binational AIS Programs

Great Lakes Water Quality Agreement Annex 6 Subcommittee

Gavin Christie, Fisheries and Oceans Canada (DFO)
Mike Weimer, U.S. Fish and Wildlife Service (U.S. FWS)

- Annex 6 priorities for 2016-2019 are to refine and enhance the early detection and rapid response (EDRR) initiative, as well as assist the Great Lakes ANS Panel in development of a risk assessment clearinghouse
- Research priorities for 2016-2019:
    - Improve tools for eradication and containment methods
    - Improve tools for early detection
    - Design passage around dams that block invasive species but pass wanted fish
- Annex 6 will be involved in Asian carp EDRR planning with DFO and U.S. FWS
- Annex 6 is also working with the Great Lakes Interstate EDRR Coordination team to develop an EDRR framework that is complimentary to the work being done in the U.S. by this team
- A group has been formed to evaluate the AIS indicators used in the State of the Great Lakes report in order to ensure that the indicators accurately reflect progress in the region and provide a better reflection of the region's work
- A federal mutual aid agreement is also being developed, reflecting the structure of the mutual aid agreement developed under the Conference of Great Lakes and St. Lawrence Governors and Premiers
    - The mutual aid agreement will originate between DFO and U.S. FWS, and will eventually expand to include USGS, NOAA, and other Canadian federal agencies

Great Lakes ANS Panel

Bob Wakeman, Wisconsin Department of Natural Resources (DNR)

- The U.S. Department of the Interior (U.S. DOI) "strategic pause" and review of the "charter and charge" of advisory panels to the U.S. DOI is still ongoing, and the Great Lakes ANS Panel (GLANSP) will not be able to convene until this process is complete
- All six regional panel chairs are working together to develop a letter to the Aquatic Nuisance Species Task Force co-chairs documenting what is lost by the Panels' inability to meet
- In the meantime, GLANSP committees are still conducting work
- The GLANSP Executive Committee will be meeting soon to discuss the status of operations moving forward under the "strategic pause" including GLANSP elections
- GLANSP has also formally decided not to initially engage with Blue Accounting initiative
    - A work group has been convened to guide progress of the Blue Accounting aquatic invasive species (AIS) pilot project outside of GLANSP activities

Conference of Great Lakes and St. Lawrence Governors and Premiers' AIS Task Force

Sarah LeSage, Michigan Department of Environmental Quality (DEQ)

- The Conference of Great Lakes and St. Lawrence Governors and Premiers (CGLSLGP) Leadership Summit was held in Detroit on October 20-22
- Over 40 separate listing actions related to the AIS Least Wanted List have occurred since 2013
- Ohio implemented the Mutual Aid Agreement to conduct a response activity for grass carp in Lake Erie in August 2017
    - The response represented a successful implementation of the formal agreement set up through the CGLSLGP
- A new AIS resolution was presented at the October summit that included strengthening the risk harmonization pilot project between Michigan, Ontario, and Ohio
- A new memorandum was also announced to assess cooperation and coordination between existing law enforcement agencies in AIS investigations and collaboration
    - Current signatories: Michigan, Minnesota, New York, Ohio, Ontario, Environment Canada, and U.S. FWS
    - Efforts are underway to include other jurisdictions
    - DFO will be implementing more AIS enforcement activity in the future and will discuss engaging with the memorandum
- The workplan for 2018 will include:
    - Improving risk harmonization pilot project between Michigan, Ontario, and Ohio
    - Developing a list of additions to the AIS Least Wanted List
        - Work on the additions will begin in March 2018 and will be finalized and announced in June 2018, according to the current workplan

Species Update: Grass Carp

Patrick Kočovksý, U.S. Geological Survey (USGS)

- Direct spawning was observed in 2015 in the Sandusky River when eight eggs were discovered over five dates during three separate high-flow events
- Grass carp spawn in riverine environments; eggs need to remain suspended in order to hatch
- Since 2015, USGS has focused on improving sampling methods in the Sandusky River, increasing to five sites and sampling at surface waters and 1.5 meters below the surface
- Compared to 2015, many more eggs were captured in 2017
- Sampling an early high flow event in 2017 yielded 530 eggs captured during the flow's peak
- Comparing 2015 results to 2017 results, there was a much higher density of eggs captured in 2017 surface nets with equal effort; 90 times more eggs captured
- Four sites were also sampled in the Maumee River at the surface, and five eggs were captured at one site roughly 26 hours after being spawned
- The HEC-RAS model for the Maumee River is being evaluated to determine if it is suitable for use with the FluEgg model
    - The HEC-RAS model software allows the user to perform one-dimensional steady flow calculations, one and two-dimensional unsteady flow calculations, sediment transport/mobile bed computations, and water temperature/water quality modeling
- As observed, spawning in 2017 occurred three weeks earlier than 2015; however, the early high flow event of 2015 was not sampled so spawning could have occurred earlier than detected
- Fish are spawning in warmer than average waters, indicating that the current thermal thresholds are incorrect
    - Thermal threshold testing and re-evaluation is ongoing
- Eggs were captured at a lower peak flow in 2017 than in 2015

- Larval fish processing is underway to separate and evaluate cyprinids in order to identify the presence/density of juvenile grass carp
- USGS is continuing to sample tributaries that were identified as potentially suitable for spawning and partnering with U.S. FWS to conduct eDNA surveillance, as well as sampling for larvae
- Currently, there is little evidence to indicate if all spawning events result in recruitment, and identifying spawning areas/events that do will allow for targeted control

John Navarro, Ohio DNR

- Ohio DNR is working to address knowledge gaps surrounding grass carp:
    - Conducting ploidy analysis of specimens captured (fertile vs. sterile)
    - Working with commercial fishermen for removal of grass carp individuals
    - Conducting egg and larvae sampling to determine early life history in Ohio waters
    - Telemetry surveillance to record seasonal movements
    - Modeling of spawning and hatching locations
    - Vegetation mapping of food available and macrophyte community impact
- Telemetry surveillance has revealed useful information on seasonal movement, with 50 grass carp caught and released with telemetry tags
- A multi-agency sampling approach in 2017 evaluated various gear and methodologies to improve sampling efforts and prepare for a large-scale effort in 2018
- The Mutual Aid Agreement allows a state or province to call for assistance and expertise to deal with an AIS issue, and was appropriate to use for grass carp in Lake Erie
    - Ohio will likely make another request under the agreement for assistance in 2018
- The Incident Command Structure (ISC) for the response was “light” to keep the process simple and out of the central office of Ohio DNR so decisions were made in-person out on Lake Erie
    - Combining ISC responsibilities worked well to streamline the decision-making process
- Eight fish were caught during the response activity; all by Fisheries and Oceans Canada staff using electrofishing and trammel nets
- Lessons learned:
    - ICS structure worked well
    - Methodology and information was shared between agencies, resulting in training on the most effective sampling methods
- Future actions: The Lake Erie Committee (LEC) will assume control in the future when dealing with grass carp in Lake Erie
    - LEC is informed by appropriate federal, state, provincial, and university research and will determine priorities for both action and research

Seth Herbst, Michigan DNR

- The LEC is working to develop a control and eradication strategy for grass carp based on science, but there are many uncertainties that need to be addressed in order to develop a sound strategy, such as:
    - Current abundance, spatial distributions, spawning locations, reproductive capacity (diploid vs. triploid), age and size composition, and management efficiency/cost
- Substantial effort in the 2014 Invasive Carp Response Exercise resulted in two captures
- With improved life history information, the 2017 response activity decreased effort by more than half and resulted in eight captures

- A structured decision-making exercise brought LEC, federal agencies, and universities together to establish goals and objectives for a grass carp management strategy and collaboratively carry out those management actions
- The structured decision-making exercise incorporates information and stakeholder values to provide a formal structure for making decisions in a transparent and collaborative process
- The primary objectives of the formal decision-making structure are to fulfill public trust responsibility, minimize management associated costs, and minimize collateral damage
- A population model for grass carp in Lake Erie was developed to inform the decision-making structure and predicts abundance at various ages
- Several management actions were identified through the structured decision-making process:
    - Removal – Direct capture, harvest incentives, or chemical controls
    - Barriers – Behavioral or physical
    - Flow modifications – Control structures or channel modifications
- Once management actions are identified, trade-offs must be evaluated and an action selected to move forward with
    - Targeted removal may be effective if used in combination with seasonal and location information derived telemetry data and hydrological information
    - Barriers may be effective, but cost/benefit must be evaluated
- The partnership with commercial fishermen will be continued to move forward with a dedicated removal effort.
    - The removal target to stop population growth is 390 fish/year based on assumptions of population size and annual survival derived from best available data
    - Removing more uncertainty from the assumptions on which the removal target is based is key to achieving this goal

Questions and Discussion

- Grass carp eggs and adults have been captured in Lake Erie tributaries but no juveniles have been confirmed
- USGS is conducting a study to confirm the age of grass carp caught in the Sandusky River, and two or three juvenile fish, each approximately one year old, have been captured
- The stock recruitment relationship is very challenging to estimate

U.S. Army Corps of Engineers – Brandon Road Feasibility Study and Tentatively Selected Plan

Mark Cornish, U.S. Army Corps of Engineers (USACE)

- The goal of the Brandon Road feasibility study is to develop a plan to reduce risk of one-way transfer of AIS to the Great Lakes basin, with a focus on the movement bighead carp, silver carp, and *Apocorophium lacustre*, a marine crustacean currently living in freshwater in Dresden Pool
- Brandon Road was selected as the study site because it is an effective means to block upstream movement through the lock, avoids flooding bypass via the Upper Des Plaines, was identified in 3 of 6 structural alternatives listed in the 2014 Great Lakes and Mississippi River Interbasin Study (GLMRIS) Report, and minimizes impacts to current waterway uses
- The ability to quantify the value and benefits of the Great Lakes basin is vital to communicate why the project should be completed at Brandon Road now, particularly to those who may not support the project at this time
- Concern about the impact of AIS on the Great Lakes watershed, not just within Great Lakes waters, is a primary driving factor for this project
- Several AIS control options were considered for use in the waterway:

    - Water jets to remove fish from the underside of barges
    - Complex noise/using sound to direct fish movement
    - Electric barriers to deter passage
    - Flushing lock to create negative pressure, pulling floating particles downstream
- The study identified six alternatives for implementation at Brandon Road:
    - No new action
    - Nonstructural alternative
    - Electric barrier
    - Complex noise
    - Electric barrier + complex noise
    - Lock closure
- Of the six alternatives, lock closure is the only guaranteed solution to preventing biological spread through the waterway, but there are more than $300 million worth of commodities that are currently moved through the lock, and the selected plan must consider existing users
- Each management alternative was evaluated with the same criteria:
    - Effectiveness
    - Relative life safety
    - Impacts to navigation
    - Life span costs, including construction, operation, maintenance, repair and replacement, and mitigation
    - Ability to cycle in the new controls
    - Number of structural control points in the Chicago Area Waterway System
    - Modes of transport that can be used in the waterway in conjunction with the management alternative
- The USACE tentatively selected plan (TSP) is to build an engineered channel that includes an electric barrier downstream of the lock, and utilizing a complex sound system within the channel
    - The electric barrier would be powered off and complex noise used during the times that barges are moving and locking
    - The electric barrier is most efficient when run continuously, so USACE is working to ensure the most effective design is selected
- Non-structural measures don't have to go through a feasibility study and simply require approval and appropriations from Congress
- The Brandon Road Feasibility Study is currently in the third phase the review process, a public comment period. The comment period ends December 8, 2017, and the projected agency decision milestone on a management alternative is June 2018
- One planning constraint in the process is that a control mechanism must be feasible and available for implementation immediately
    - Carbon dioxide as a deterrent is still in the research and development phase with USGS and therefore was not considered as a management alternative for this feasibility study
- An engineered channel would have conditions similar to a controlled lab environment, allowing for studies and test of new technologies and potential implementation in the future
- Adding long-term control options in the channel would require Congressional approval

Pathway Update: Ballast Water

Testing BWMS and Monitoring Laker Ships' Ballast Water/Harbors
Allegra Cangelosi, Great Waters Research Collaborative

- The Great Waters Research Collaborative (GWRC) has been sampling "laker" ballast uptake and discharge to fill knowledge gaps about the movement of water within the Great Lakes
- This project is a partnership with ship owners to provide information about ballast water and harbor water compositions to state agencies
- Sampling is focused on looking for a target AIS: *Hemimysis anomala*
- Two sampling procedures were designed: one that samples only discharged water, and one that samples linked uptake and discharge
- For linked uptake and discharge:
    - Only ships moving from lower Lake Superior to western Lake Superior were sampled
    - Port water was sampled around the ship during uptake and a research team followed the ship to its discharge port, where the team samples discharged water and surrounding harbor water
    - Uptake sampling was coordinated with ships in ports known to have populations of *Hemimysis anomala*
- For discharge only sampling:
    - Any laker from a partner shipping company discharging water at a western Lake Superior port could be sampled
- The GWRC provided engineering support to ship owners to determine the most appropriate place in the internal pipe system for a sampling port. As a result, many U.S. and Canadian lakers now have valid sampling ports for taking representative uptake samples
    - Ships generally do not have locations perfectly conducive for placement of a sampling port, so GWRC staff identify the best location within the system and note what, if any, detractors are associated with that location
- To sample, research technicians board vessels with cooperation from the vessel's crew to conduct the sampling activity
    - A vessel crew member connects the sampling system to the port, and GWRC staff are connected directly to the sample port without needing to access other sections of pipe
    - Vessels are able to discharge several tanks at once during sampling
    - Accurate sampling requires a specific mass of water at the sampling port, not necessarily from a single tank
- Surveillance for the target organism (*Hemimysis anomala)* is the only component of project sampling that is not a component of compliance monitoring
- An eDNA probe is applied to the sampling port to test for a *Hemimysis* genetic marker
- Data analysis of the water samples is conducted in a way as to provide information without implicating culpability of a single ship
- As treatment isn't currently occurring in lakers, GWRC is able to assess community composition, death rates, survival statistics, etc., for untreated Great Lakes ballast water
- The data analysis seeks to develop a propagule pressure model for voyage routes if possible
- A report on the sampling results is planned for release in February 2018, with data represented categorically and not attributed to specific vessels or dates

Transfer of ANS into the Great Lakes from U.S. and Canadian Coastal and Inland Ports

Patricia Engel, Eastern Research Group, Inc. and Elizabeth Eddy, Environmental Protection Agency (*EPA)*

- This project studies the risk of vessel mediated transfer of AIS via ballast water in the Great Lakes for three scenarios – overseas, inter-lake, and between coastal and inland areas
- The study period is previous 10 years (2007-2016)
- The project examines risk of introduction, survival, and consequences of movement of AIS

- Ports on the St. Lawrence Seaway within the boundary of the river mouth are considered inland ports for purposes of this study
- Volume of ballast water moved and environmental similarity were analyzed to determine risk
    - Data is U.S. biased, but Canadian information is available if a Canadian vessel is docked in a U.S. port
    - Ballast water volume is derived from the National Ballast Information Clearinghouse
    - Environmental similarity is based on water temperature and salinity and is sourced from Keller's Global Port Database
- Port pairs, determined by voyage data and ballast water volume, linked uptake and discharge locations
    - Nine source ports and ten discharge ports in various combinations comprise the top 25 port pairs in terms of volume of ballast water moved
    - Source ports are located primarily in the St. Lawrence Seaway, while discharge ports are located primarily in Lake Superior and Lake Ontario
    - Quebec City to Duluth-Superior is responsible for 38% of the transport of ballast water within the Great Lakes
    - Quebec City has contributed 4.2 million metric tons in ballast water uptake over the past 10 years
- In this study, the lowest risk ballast water tends to originate in marine ports, where species are less likely to survive transport/introduction due to environmental constraints
    - This project yielded 19 high risk port pairs, four medium risk pairs, and two low risk pairs
    - Quebec City port pairs are categorized as low risk due to its salinity characteristics
- 91% of ballast water transported during the 10-year timeframe is reported as managed, with a 74% ballast water exchange rate
- Regulations changed during the study time frame, so reports of non-management do not necessarily imply non-compliance, as there may have been no regulations at the time

Update on Canadian Ballast Water Research Activities

Sarah Bailey, Fisheries and Oceans Canada

- One new established species has been identified in the Great Lakes since 2006, the lowest rate of introduction recorded for the Great Lakes
- Approximately 66 ballast water management systems (BWMS), based on eleven treatment processes, are undergoing the IMO approval process, and most have multiple treatment steps (rather than relying on a single treatment technology)
- Concerns have been expressed about the capacity to test treatment systems under the type approval process in extreme water conditions, but revisions to the Convention have expanded the testing requirements to demonstrate that the technology can work across a variety of temperatures, salinities, and lengths of voyages
- The Convention is currently in an experience building phase, where member jurisdictions are focused on data gathering and data analysis of treatment systems and implementation, followed by a review of the Convention
    - The goal is to identify what components of the Convention work well in practice, and where issues of implementation and compliance may arise
    - This phase is designed to encourage vessels to install treatment systems and cooperate with scientists who are gathering data on how well the system(s) is/are working

- During this experience building phase, DFO is trialing sampling and analysis methods for compliance testing, and taking advantage of the opportunity to learn about new BWMS and how well they are working
    - Conducting both indicative and detailed analysis of sampling methodology
- Of the 12 systems tested by DFO to date, most have multiple treatment methods for uptake and additional treatment on discharge
    - All samples met the Convention D-2 limit for the ≥10µm, <50 µm organism size class, and indicative analysis, designed to identify "gross" non-compliance rather than exact counts, yielded similar results to the more exact organism counts of epifluorescent microscopy
    - Operational constraints prohibited DFO sampling of the ≥50 µm size class from two of 12 vessels tested. Of the remaining 10, seven samples met the Convention D-2 limit, and the three that failed were far above the limit (thousands of individuals)
        - One of the failed samples came from a BWMS that worked properly on uptake but failed on discharge and raised an alarm, alerting crew that ballast water wasn't being treated properly. The other two vessels had BWMS that were operating normally and an alarm was not initiated, despite the size class treatment failure
    - Three vessels that met the Convention D-2 limit were unable to ballast safely, so testing was conducted under sea-to-sea conditions, where water is run through the system and not held for any period of time; this process is considered partial treatment, but all results from the sea-to-sea testing were successful
    - One additional ship was unable to provide a 3 m^3 water sample due to a clogged filter, so a smaller sample was provided (1 m^3) for testing, which passed
- Only "gross" failures have been observed by DFO in this experience building phase, not small exceedances that may raise difficult compliance/enforcement decisions
- Many vessels have voluntarily used their BWMS in combination with ballast water exchange (exchange + treatment) as there is concern that treatment of ballast water on uptake while at port may clog treatment system filters with sediment leading to significant operational and maintenance issues

Questions and Discussion

- Usage of chlorine as a treatment method may present issues with corrosion of laker ballast tanks (which are typically uncoated) and confirmation that any discharge meets water quality standards

New Non-Native Species: *Brachionus leydigii*

Joe Connolly, Cornell University

- The native range of *Brachionus leydigii* is not well understood
- *Brachionus leydigii* is a rotifer that was discovered in April 2016 in the Western Lake Erie Basin (WLEB), north of the Lake Erie islands
    - A female individual was captured, but there is no evidence of reproduction
- The detection was made through the EPA Great Lakes National Program Office long term biological monitoring program, and underscores the need for regular monitoring
    - The detection was made using a 153µm vertically towed plankton net

- The EPA website has an information page on the species, GLANSIS and USGS-NAS have published fact sheets, U.S FWS has published an Ecological Risk Screening Summary, and the Rotifer World Catalogue has general information
- The theory of introduction is transference by ballast water
- Ballast water has been identified as a possible movement mechanism based on work by Sarah Bailey et al. in 2005, who successfully hatched *B. leydigii* from resting eggs collected from the ballast sediment of 4 transoceanic NOBOB vessels, and collected a single specimen of *B. leydigii* from the upper wing ballast tanks of a ship in Hamilton Harbor
- Most native *Brachionus* species in the Great Lakes inhabit the WLEB and most rotifers reproduce asexually. If there was an established population of *B*. *leydigii*, more specimens would likely be found in the favorable environment the discovered specimen was identified in
- *Brachionus* community composition in Lake Erie changes from year to year, so intercommunity fluctuation and competition could potentially account for the lack of other *B*. *leydigii* specimens
- Potential impacts are unknown
    - This rotifer is so small that it may replace other rotifers, and there is the potential for cascading effects; impacts will be difficult to predict until more is understood about the species/variation
- Additionally, USGS sampling in nearshore areas in northwestern Ohio in 2017 found a number of *Thermocyclops crassus* specimens

Non-Native Crayfish: New Invasions and Control Methods

Michigan-Red Swamp Crayfish

Seth Herbst, Michigan DNR

- Red swamp crayfish was listed as a prohibited species in Michigan in 2015
- Michigan DNR received two different reports of a red swamp crayfish sighting from Sunset Lake (Vicksburg, MI) on July 14, 2017, and a third report from Novi, MI two days later
- These discoveries led to an increased outreach effort from Michigan DNR to the public encouraging them to send reports and identification photos
    - Most of the reports received were for native species, but there were more credible reports of red swamp crayfish focused primarily in southeast Michigan, but also existent in other areas of the state
- Prior to 2015 red swamp crayfish were common in biological supply, food markets, pet stores, and bait trade, indicating live trade as the most probably vector of introduction
- Michigan DNR developed a response plan with the goals of:
    - Determining extent of infestation,
    - Implementing early detection monitoring strategy in high risk areas,
    - Determining source(s) of infestations,
    - Collecting baseline biological and physical info, and
    - Implementing and evaluating control measures
- Michigan DNR is implementing the response plan with Michigan State University
    - Conducting extensive early detection, continued trapping, and continued outreach
    - The outreach is unique as the crayfish are being found and reported from backyards, pools, etc., rather than completely natural areas
- Currently Michigan DNR has confirmed red swamp crayfish infestations in Sunset Lake, Novi, and Farmington Hills

Minnesota-Rusty Crayfish

Derrick Passe, Lake County Soil and Water Conservation District

- An Initiative Foundation Grant was received in 2010 to implement a four-pronged approach to reducing the spread of rusty and other non-native crayfish within the Lake County Soil and Water Conservation District, including:
    - Public outreach
    - Identifying infestations, replicating a Forest Service 2005 surveillance program
    - Intensive trapping
    - Social trapping
        - Trapping undertaken by lake association members as a citizen science monitoring program
        - Citizen science monitoring from lake association members is very hit or miss on participation
- Public outreach efforts extended to children involved in intensive trapping efforts challenging them to see how many crayfish they could trap with 80 traps every day
    - Management through prevention, focused on taking children on trapping boats to educate them and assist with trapping and sexing the crayfish
- Most confirmed reports on crayfish mirror the route of a major highway, with a few outliers
- Rusty crayfish are not widespread in the rest of the state
- Modified minnow traps were used for intensive trapping on the Kawishiwi River in the summers of 2015 and 2016
    - Native crayfish catches were significantly lower than rusty crayfish
- The average number of crayfish caught per trap in volunteer and staff trapping in the White Iron Chain of Lakes shifted from majority native to majority rusty crayfish between 2007 and 2017
- The largest lesson in rusty crayfish management is spreading awareness to the public and encouraging them to prevent spread and reports observations

Ohio-Red Swamp Crayfish

John Navarro, Ohio DNR

- Red swamp crayfish have been present in Ohio waters for more than 50 years at a private duck hunting club
- The movement of crayfish for crayfish boils is the likely pathway of introduction
- Red swamp crayfish have shown a preference for soils with a high organic content, and are possibly using roadside ditches to move through the state
- In Ohio, red swamp crayfish outcompete other burrowing crayfish

USGS Control Method Research

Kim Fredricks and Ann Allert, U.S. Geological Survey

- It is possible to eradicate invasive crayfish if the population is kept in a localized area, but there is difficulty with eradication if the crayfish is burrowing
    - It is also very expensive to control established populations of crayfish
- The objectives of this study were to identify problematic species and their pathways and impacts, identify feasibly control strategies, and determine management issues associated with those control strategies
- When considering control methods for implementation, the method must be feasible and justifiable, be inexpensive, have limited labor need, cause as little damage to non-target biota and ecosystems as possible, and be conducive to an integrated pest management system

    - The margin of safety when treating waters with other organisms are present (e.g. fish shipments or hatcheries), is where the lethal concentration required for 100% crayfish mortality is less than the lethal concentration for 1% fish mortality
- Registration of chemical tools and applicability of state permit procedures are necessary to understand when considering a control method
- Chemical controls considered in this study:
    - Lethal chemicals
        - Pyrethrin (natural pesticide from chrysanthemum)
        - Cypermethrin (synthetic) – effective in water, not in burrows
        - Sodium hypochlorite – spotty effectiveness
    - Poison baits
    - Pheromones and hormones to prevent maturation
    - Deterrents
        - Carbon dioxide
        - Sodium sulfite
- USGS is currently trialing carbon dioxide as a control mechanism; fish tend to avoid areas rich with CO_2, and crayfish may exhibit similar behavior
    - For the trials, a shuttle tank is used to track crayfish movement in response to CO_2
    - CO_2 is a non-selective control method
- Cypromethrin is non-selective to most invertebrates and fish may exhibit some sensitivity
    - Virile crayfish and white river crayfish have shown some range of sensitivity to cypromethrin, but life stage and species make a difference
- Some other pyrethrin chemicals were considered for inclusion in this study, but the margin of safety for fish hatcheries didn't meet expectations as some of the inhibitors were damaging to zooplankton communities and have a high persistence in the water column
- Organisms with a symbiotic relationship with crayfish are being considered for biocontrol, but this control method is currently underdeveloped
- Crayfish can be very susceptible to disease, which may present a biocontrol opportunity

Status and Activities of AIS Collaboratives

Invasive Crayfish Collaborative

Pat Charlebois, Illinois-Indiana Sea Grant

- This is a new collaborative that has been funded through the Great Lakes Restoration Initiative (GLRI) and is a partnership between Illinois-Indiana Sea Grant and Loyola University
- The purpose of the collaborative is to link managers, researchers, and stakeholders and it will be member-driven
- The process for determining goals for the collaborative will be led by a needs assessment of members, followed by defining e short-term goals based on those needs that can be accomplished within the two-year timeframe of the GLRI grant
- Long-term, the collaborative will need to secure funding for continuation after the end of the GLRI grant
- Communication and collaboration between members will likely take place via an email listserv and possibly a Slack workspace
- During the current funding period, the collaborative will meet three times
- Collaborative staff will also develop a website (www.invasivecrayfish.org)

- Collaborative members will also develop resources for an IAGLR workshop focused on identifying research and outreach needs
- Active participation is expected of all members, and membership is open to all interested parties
- To join, email Lisa Kim (lhkim1@illinois.edu) or email Pat Charlebois (charlebo@illinois.edu) for more information

Round Goby

Tim Campbell, University of Wisc. Extension/Wisc. Sea Grant/Wisc. DNR

- The round goby "collaborative" will likely remain an informal group
- Sara Stahlman, Pennsylvania Sea Grant, is working to create an email listserv as a place to share information on round goby
- If needed, the group can meet in-person in conjunction with other Great Lakes basin regional conferences/meetings
- For more information, email Sara Stahlman (sng121@psu.edu)

Invasive Mussel Collaborative

Erika Jensen, Great Lakes Commission (GLC)

- Impetus for the inception of the Invasive Mussel Collaborative (IMC) was the approval of Zequanox for open systems
- USGS, NOAA, Great Lakes Fishery Commission, and GLC convened to establish the collaborative and bring together other partners and stakeholders as members with a common understanding and agenda for developing and implementing mussel management and control
- The IMC is structured around a steering committee, a science team, and a core team
- IMC staff have worked to develop an expansive communications network, including a website, email listserv (invasivemussels@great-lakes.net), and webinar series
- The IMC recently conducted a research questionnaire to further develop the research resource pages of the website and begin development of an expert database
    - More than 75 responses to the questionnaire were received
- A decontamination method quick guide is available on the IMC website here
- The IMC is now working on a developing a long-term adaptive strategy for advancing control and management of dreissenid mussels in Great Lakes basin waters
- The first drafting session for this strategy was held in August 2017
- As currently drafted, the strategy is centered around four management goals, with the understanding that it may not be possible to fully realize each goal
- Activities identified in the strategy should not preclude prevention activities or work in other systems not specifically identified

Great Lakes *Phragmites* Collaborative

Heather Braun, Great Lakes Commission

- The purpose of the Great Lakes *Phragmites* Collaborative (GLPC) is to facilitate communication and collaboration to inform research and lead to more effective and efficient management of non-native *Phragmites* in the Great Lakes region
- A collaborative approach to the issue of *Phragmites* management is necessary to build a community around the people working on *Phragmites* and habitat restoration
- Prior to establishment of the GLPC, state agencies and other managers were not always working together on management projects and were often starting from ground zero in learning how to manage *Phragmites*

- GLPC employs a collective impact approach in order to sustain interest/engagement with the GLPC and avoid plateaus
- The GLPC hosted a common agenda workshop in February 2017 to establish objectives and workgroups to achieve those objectives (below):
    - GLPC funding that is stable, long-term, and diversified
    - Data collaboration
    - Containment of *Phragmites* spread and promotion of diverse, resilient native plant communities
    - Adaptive management of *Phragmites* integrating ongoing research and evaluation of management programs
    - Integrating management into a watershed-scale approach
- GLPC has experienced a successful and high level of engagement in communication and outreach
- In order to increase effectiveness of management, GLPC is implementing the *Phragmites* Adaptive Management Framework (PAMF), a community science and decision support tool
    - The adaptive management approach learns from individual management activities and integrates that data into a predictive model that is used to advise managers and landowners on strategies that may be most effective for their treatment area
    - For more information or to join the program, please visit: http://www.greatlakesphragmites.net/pamf/

Starry Stonewort Collaborative

Hilary Mosher, Finger Lakes Institute at Hobart and William Smith Colleges

- Starry stonewort population has exploded in the basin since 2005, which has provided managers with case studies in population modeling and growth parameters
- Uncertainties still remain regarding growth and distribution of starry stonewort, and there are many problems trying to grow starry stonewort in lab environments for control studies
- There is a lack of effective and efficient control methods, and trials haven't shown consistent efficacy across the basin
- The objective of the starry stonewort collaborative is to bring together researchers and resource managers to find methods to prevent and control starry stonewort, and its goals are to:
    - Collate existing information
    - Increase collaboration
    - Increase capacity of professional and citizens
- The collaborative also capitalizes on existing tools of member agencies and other regional collaboratives
- The collaborative is targeting expert consultants, lake association members and community members engaged in prevention, outreach, and citizen science monitoring, and students and teachers interested in experiential learning for membership
- One of the first steps is to convene an expert panel to conduct a gap analysis of management information, control methods, and other unknowns about starry stonewort and to assist in developing and refining best management practices for starry stonewort management
    - Meetings will likely be held in conjunction with other regional meetings
- The collaborative retains program staff for administrative support, data collation, and communication
    - Staff will coordinate webinars, social media, email listserv, meetings, and website

- The next steps for the collaborative are to engage experts, collaborators, and resource managers as partners in the collaborative, and to set a schedule for webinars, meetings, and conference engagement

Habitattitude

Doug Jensen, Minnesota Sea Grant

- The Habitattitude campaign is a partnership between U.S. FWS, the Pet Industry Joint Advisory Council, and the Sea Grant network, and aims to reduce the release of pets by owners
- Between 2010-2015, Habitattitude generated >3.5 million public impressions with GLRI funding
- Survey data from Habitattitude events shows that exposure to the campaign raises awareness of pet owner responsibilities regarding invasive species and proper pet disposal
- A Habitattitude curriculum for grade 6-12 is in development to provide AIS education for students as well as prevent the release of live study specimens
- Surrender events are hosted with various local partners to provide pet owners with an opportunity to responsibly rehome a pet
    - Late spring and early fall are good times to host surrender events because the timing corresponds to when students are typically leaving or arriving at college campuses
- Habitattitude also assisted a classroom in returning their live crayfish specimens from grade school studies to the biological supply company and receiving credit toward another order
- The anticipated partnership with big box store pet shops to integrate a “take back” policy has been temporarily suspended as there was little interest from retailers in participating
- Habitattitude will be hosting a second “BIOTIC” symposium to advance understanding of AIS pathway management as part of the 2018 Upper Midwest Invasive Species Conference