Aquatic Invasive Species (AIS) Research Updates

Wisconsin Lakes Partnership Convention
Stevens Point, WI
April 10-12, 2019

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OUTLINE

- AIS Research & Development Grants
- AIS Research Check-off Program
- Overview of Selected AIS Research Projects
  - AIS Management
    - Herbicide toxicity studies
    - Herbicide degradation studies
    - Eurasian/hybrid watermilfoil
    - Non-native Phragmites
  - Prevention
    - Starry stonewort
    - AIS Decontamination
  - Ecological Impacts
    - Zebra mussels
    - Spiny waterflea

AIS Research and Demonstration Grants

- NR 198.60
- AIS Research & Development grants are intended as a cooperative research or demonstration activity between applicants and the DNR.
- Eligible projects shall be designed to increase scientific understanding of the ecological and economic implications of aquatic invasive species and their management.
- Projects will assess experimental and innovative techniques for their prevention, containment and control of AIS.

AIS Research and Demonstration Grants

- Pre-proposals for research or demonstration projects must be submitted to the DNR by July 1 to be considered for funding for the next biennium.
- Pre-proposals shall include the goals and objectives of the project, a brief description of the methods, estimated costs and a timeline for completion.
- Only high priority research topics that are included in the biennial research agenda may be funded by the DNR.
- An AIS R&D Grants sub-team prioritizes the AIS research projects on the Department's Research Agenda.

AIS Research and Demonstration Grants

- A budget for AIS R&D projects is established (no more than $500,000 awarded annually) and highest ranked pre-proposals that fit within the budget are identified by December 1.
- The highest ranked pre-proposal are invited to submit a full grant application by February 1.
- If no researcher is identified the staff may solicit requests for proposals (RFP) due by the grant deadline.
- At the final grant ranking meeting of the year, AIS R&D applications are given final review and approved for funding that cycle.

List of AIS R&D Grants (Closed)

- Crystal Lake (Vilas Co.) whole-lake mixing
- Effectiveness of SWF & NZMS decontamination procedures
- Effects of 2,4-D of reproduction and development of fathead minnows
- Efficacy of milfoil weevils for controlling EWM in Northern WI lakes
- Evaluation of a novel slow release herbicide formulation
- Effects of 2,4-D treatments on fish and zooplankton in Northern WI lakes
- Carbon dioxide as a deterrent to round goby movement
- Early detection, vectors and impact of invasive spiny water flea in Wisconsin Lakes

List of AIS R&D Grants (Open)

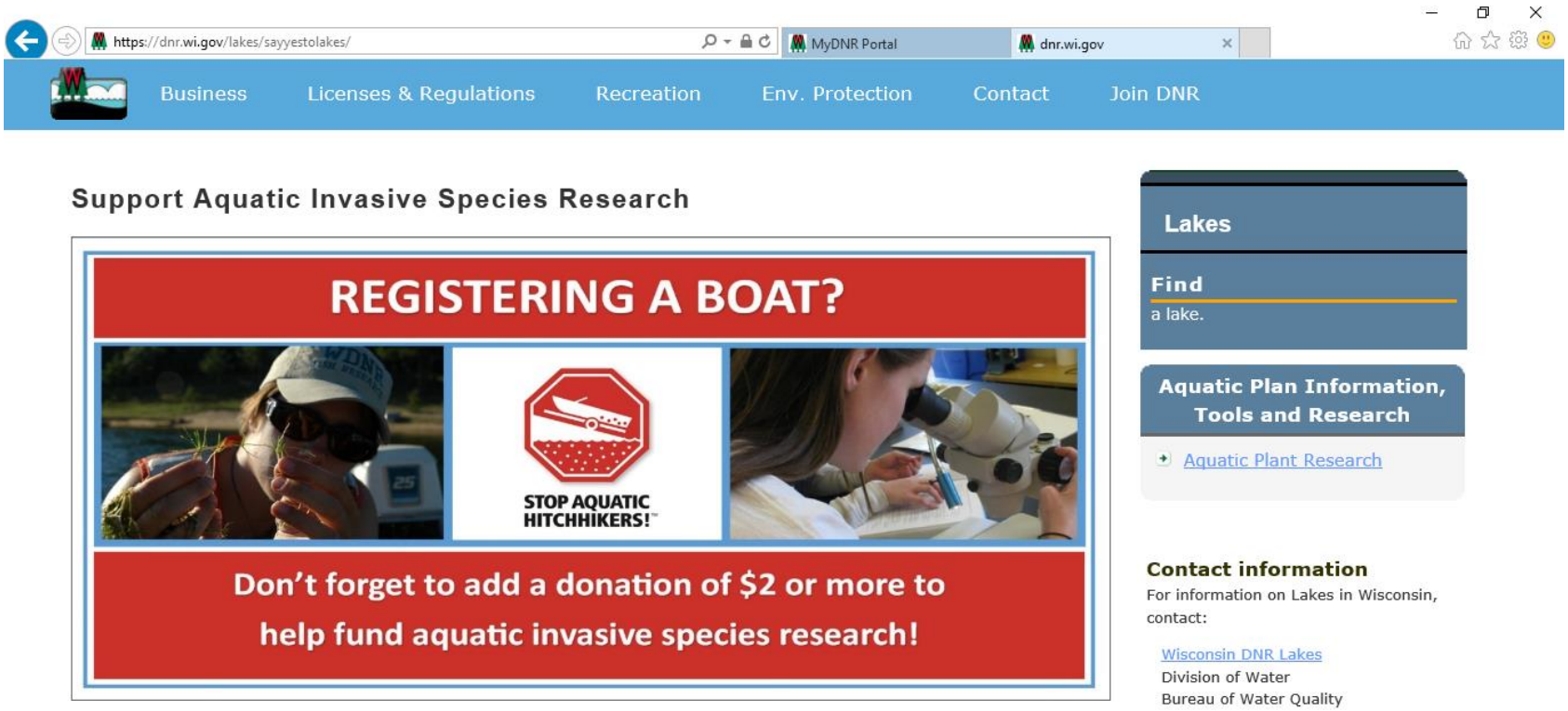
- Temporal genetic monitoring of watermilfoil resistance
- Desiccation, freezing, and dispersal of starry stonewort
- Zebra mussel invasion in Lake Mendota (Dane Co.)
- Effects of 2,4-D herbicides on early life stages of native WI fish
- Facilitating adaptive Phragmites management
- Impacts of zebra mussels on phosphorus uptake in Lake Winnebago
- Control, management, and prevention of spiny waterflea
- Role of microbes and light in the fate of 2,4-D during large-scale treatments

Research Needs and Opportunities

- Evaluating ‘new’ herbicides
  - Pelletized Fluridone, ProcellaCOR, Aquastrike, Triclopyr, etc.
- Evaluating ‘new’ management techniques
  - DASH, Limno-barriers, Drawdown, Mechanical Harvesting, etc.
- Evaluating integrated plant management (IPM) techniques
  - Herbicides + DASH, Harvesting + Herbicides, etc.
- Evaluating ‘new’ species
  - Starry stonewort, yellow floating heart, flowering rush, etc.
- Conducting statewide analysis of PI and APM data
  - Trends over time, trends over space, etc.

AIS Research Check-Off

- https://dnr.wi.gov/lakes/sayyestolakes/



AIS Research Check-Off

- Your donations support important work!
- Your contribution pays for staff, supplies, and other costs of coordinating and carrying out invasive species research and control projects across the state.
- You're also supporting grants to scientists outside DNR who are working to better understand aquatic invasive species and the tools used to manage them.
- Even when projects don't take place on your local waterbody, what we learn will be applied to benefit all Wisconsin waters!

AIS Research Check-Off

- The results of these research studies have helped DNR:
  - Identify best practices for when and how to control species that impact the environment and lake users
  - Better prevent the spread of invasive plants and animals
  - Improve methods used to monitor existing populations of aquatic invasive species
  - Find ways to better predict what waterbodies may be vulnerable to new invasions.

Effects of 2,4-D Herbicide Treatments Used to Control EWM on Fish and Zooplankton in Northern Wisconsin Lakes

Dr. Dan Isermann and Nick Rydell
UW-Stevens Point

- Do large-scale 2,4-D herbicide treatments used to control EWM affect:
  - abundance, diversity, and size structure of fishes at different life history stages?
  - feeding, survival, and growth of larval fishes?
  - diversity, abundance, and size of zooplankton?
- Pre (2015) and post treatment (2016, 2017) data collected on 3 treated and 3 control lakes in northern WI.

Effects of 2,4-D Herbicide Treatments Used to Control EWM on Fish and Zooplankton in Northern Wisconsin Lakes

- Large-scale 2,4-D treatments did not have any statistically significant effect on any of the metrics measured
- However, lack of significant responses to 2,4-D observed in this evaluation does not necessarily mean that herbicide application has no effects on these or other metrics
- Potential effects may not be detectable in a lake setting given the inherent variation in many of the metrics measured and the number of lakes included in my study
- Non-significant trends observed may be related to changes in the plant community structure and not direct effects of the herbicide

Effects on Wisconsin larval fish and parental exposure to 2,4-D formulations

Dr. William Karasov and Gavin Dehnert
UW-Madison

- Is reduced survival of fathead minnow larvae independent of parental exposure to 2,4-D herbicide formulations?

- Are there similar effects of reduced survival observed on fathead minnows for both DMA IV and Weedestroy AM40 herbicide formulations?

- Are there similar effects observed on native WI fish?

Effects on Wisconsin larval fish and parental exposure to 2,4-D formulations

- Larval survival (30 d post hatch [dph]) was significantly decreased following exposure of eggs and larvae to pure 2,4-D (0.50 ppm), as well as to WAM40 (0.50 and 2.00 ppm) and DMA IV (0.50 and 2.00 ppm).
- The results also narrowed the critical window of exposure for effects on survival to the period between fertilization and 14 dph.
- Development was not negatively altered by any of the compounds tested, although the commercial formulations increased larval total length and mass at the highest rate tested (2.00 ppm).
- *Dehnert et al. 2018. Eniviro. Tox. and Chem.*

Effects on Wisconsin larval fish and parental exposure to 2,4-D formulations

- Embryo (fertilization to hatch)
  - 4 out of the 9 native fish spp. showed sig. decreases in % of healthy embryos
- Larval (hatch to 30 days post survival [no parental exposure]
  - 4 out of 7 spp. showed sig. decreases at 0.5 ppm
- Juvenile exposure
  - No impacts observed – 90 day exposure
- Similar results of pure 2,4-D and DMA IV and WAM40 on % larval survival

Effects on Wisconsin larval fish and parental exposure to 2,4-D formulations

- Sublethal impacts
  - Larval behaviors of zebra fish (prey capture and predator evasion)
  - Larval exposure from fertilization to 6 days post fertilization
  - Observed dose dependent response; 2,4-D seems to be impacting larval fish ability to capture prey
- Predator evasion
  - Motor function aspect and visual function aspect
  - Neuron activity does not increase in 2,4-D exposed fish vs. control fish
- Fluridone studies
  - Cost-amendment provided to begin this final phase

Role of Microbes and Light in the Fate of 2,4-D During Whole-Lake Treatments

Amber White, Chrissy Remucal, Trina McMahon
UW-Madison

- The goal of the proposed research is to determine which factors contribute to the variable half-lives of 2,4-D in whole-lake treatments.
- This will be accomplished using both laboratory and field studies to test the hypothesis that both biodegradation and photodegradation contribute to the fate of 2,4-D.
- Preliminary water quality and microbial community analysis underway in 2 northern and 2 southern lakes

Role of Microbes and Light in the Fate of 2,4-D During Whole-Lake Treatments

- Preliminary results indicate that 2,4-D degradation occurs within the sediments
- Lakes with previous exposure to 2,4-D had faster and more complete degradation compared to lakes that had not previously been treated
- We need your help choosing 2019 study lakes that plan to treat at a large-scale with 2,4-D!

Spatial and temporal patterns of genetic variation in Eurasian and hybrid watermilfoil

Dr. Ryan Thum and Paula Guastello
Montana State University

- Map distribution of EWM, NWM, and hybrids before/after whole lake herbicide treatment to determine:
  - whether relative distribution of parental and hybrid milfoil change following treatment?
  - whether parental and hybrids grow together or in separate patches?

- Collect DNA fingerprints for hybrid genotypes after whole lake treatment to determine:
  - whether distribution of different hybrid genotypes change following treatment?
  - whether lakes are dominated by a single hybrid genotype?
  - whether there is spatial patterning of different hybrid genotypes?

Spatial and temporal patterns of genetic variation in Eurasian and hybrid watermilfoil

- Collected milfoil plants during PI survey and identified genetic biotype in four lakes (Berry, Moshawquit, Hancock and Silver – Kenosha) in 2014.
  - Repeated surveys in Berry and Moshawquit in 2015 without herbicide treatments.
  - Silver Lake treated with fluridone in 2015.
  - Hancock Lake treated with 2,4-D in 2016.
  - Moshawquit Lake treated with 2,4-D in 2017.

- It is clear that different parent taxa (EWM, NWM, HWM) can grow together in local areas of lakes.
- There is very little spatial patterning of individual genotypes.
- Genotype richness ranges from 4-9 across the four lakes.
- Three lakes have 1-2 dominant genotypes and the other is diverse.

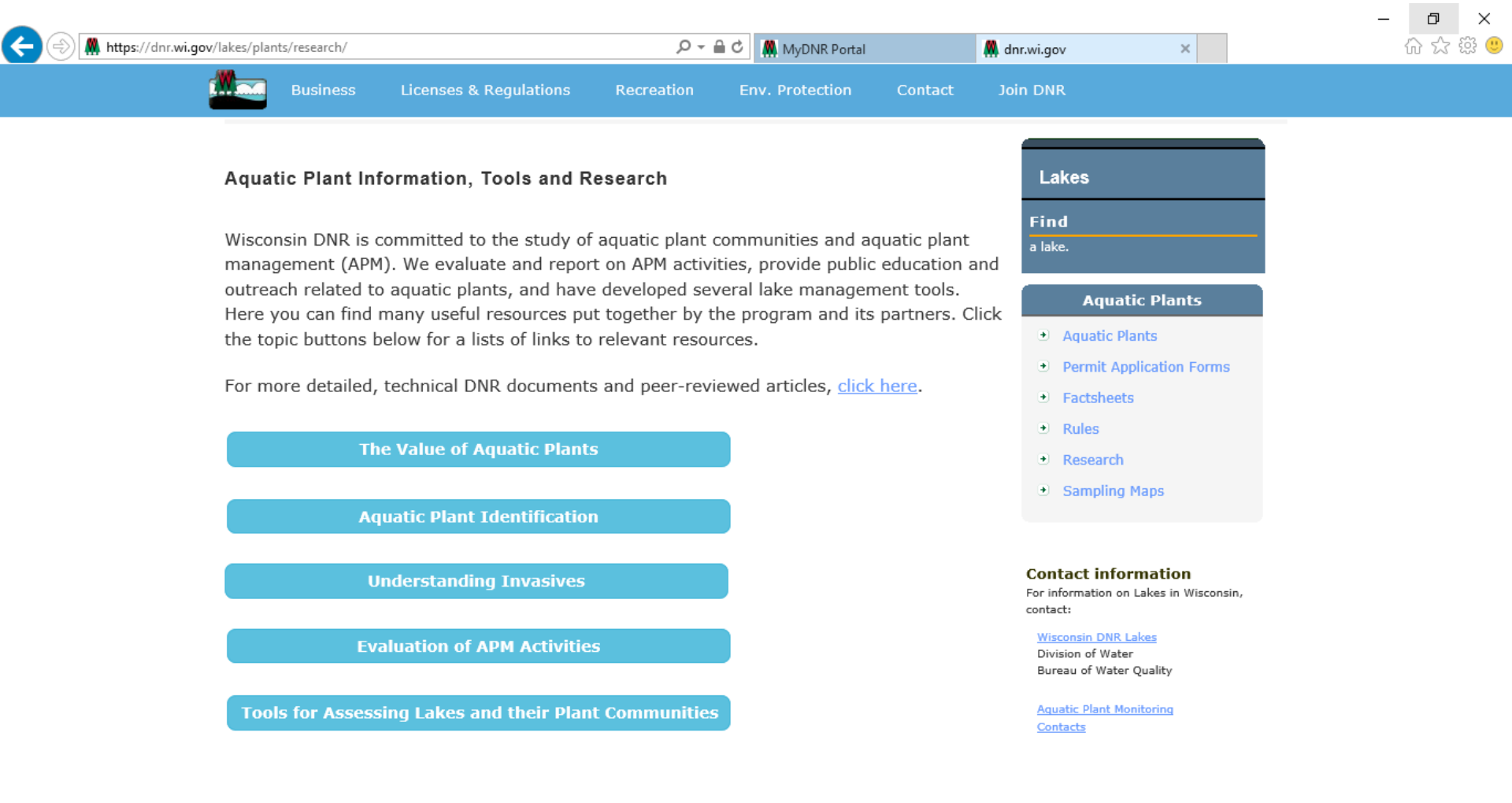
Spatial and temporal patterns of genetic variation in Eurasian and hybrid watermilfoil

Next Steps

- Develop and refine methods for genetic monitoring of lakes.
  - Perform resampling simulation to determine how many points need to be samples to understand milfoil genetics and genetic changes within a lake.
  - Current recommendation is to collect samples from every site with EWM/HWM, and then randomly select 20 sites to process.
  - Based on genetic results of these 20 sites, additional sample processing may or may not be warranted.
- Genetic surveys of additional lakes may be completed.

WDNR Aquatic Plant Research

- https://dnr.wi.gov/lakes/plants/research/



Facilitating Adaptive Management of Non-native *Phragmites australis* in Wisconsin

Dr. Robert Howe and Bobbie Webster
UW-Green Bay

- Create online clearinghouse of *Phragmites* treatment and monitoring data.
- Establish a coordinated experimental approach to *Phragmites* control by enlisting partners to strategically apply different treatment methods.
- Develop and test a quantitative evaluation protocol for *Phragmites* treatments, including field methods for monitoring plant species.
- Monitor soil microbial communities at selected treatment sites.
- Conduct a multi-spectral imagery assessment of long-term treatment success and native vegetation response at Wisconsin sites in northeastern Wisconsin.

Facilitating Adaptive Management of Non-native *Phragmites australis* in Wisconsin

- A webpage story map has been designed to illustrate treatments in this project
- Vegetation and soil monitoring protocols employed and slightly improved
- Data entry and analysis currently underway
- Prepared aerial orthophoto imagery so that the infrared views can easily be turned on or off
- Remained in contact with partners in the region conducting Phragmites treatments; hope to still used data from these treatments as part of this project
- Soil samples are ready for DNA sequencing
- Leaf samples indicate that native haplotype E and exotic haplotypes M and O were found in the project areas

Desiccation, Freezing, and Dispersal of *Nitellopsis obtusa*

Dr. Ken Karol and Stephen Gottschalk
New York Botanical Garden

- Determine the effects of desiccation and freezing on SSW bulbils. When is germination 0%?

- Describe the population structure of SSW across its known North American range in the Great Lakes region and the Northeast U.S.

Desiccation, Freezing, and Dispersal of *Nitellopsis obtusa*

- Initial genetic analyses indicate a complex pattern of spread, but more samples are needed to fully understand.
  - Older herbarium specimens didn't work well for genetic sequencing.
- Preliminary results show that any freezing or drying from 1-6 hours eliminates bulbil germination relative to controls.
- However, tetrazolium tests suggest that 24 hours may be needed.
- No bulbil has yet germinated after 24 hours of freezing at either -20 °C or -6 °C, nor after 24 hours of desiccation under high and low humidity.
- Bulbils exposed to boiling water for one hour do not germinate.

Desiccation, Freezing, and Dispersal of *Nitellopsis obtusa*

- Storing gear dry for 5 consecutive days appears to be effective treatment for decontamination of SSW bulbils.
- Steaming bulbils at 140°F between 10 s and 30 s eliminated any positive signal from tetrazolium tests
- Though there was a negative trend between bulbil viability and increasing contact duration with 500 ppm Chlorine bleach solution, the longest contact interval of 10 minutes did not appear to completely kill bulbils as measured by the tetrazolium assay

Effectiveness of Decontamination Procedures for Reducing the Spread of Small-bodied Aquatic Invertebrates

Dr. Bart DeStasio
Lawrence University

- Test high priority AIS for tolerance to decontamination procedures:
  - Top priority: spiny water flea and New Zealand mud snail
  - Secondary priority: faucet snail and bloody red shrimp
- Test both spray and total immersion application procedures of decontamination (Virkon, bleach, freezing) of various materials on which AIS may attach (polyester line, nylon mesh, neoprene, canvas, rubber).

Effectiveness of Decontamination Procedures for Reducing the Spread of Small-bodied Aquatic Invertebrates

- NZMS
  - Virkon was highly effective at killing individuals during total immersion
  - Bleach and formula 409 were less effective
  - Method of application (i.e. immersion vs. spray) also affected rate of survival, with spray application generally resulting in higher survivorship.
- Faucet snails
  - Virkon Aquatic was effective at killing 100% of the faucet snails in all treatment combinations and exposure times when fully immersed
  - Minimum exposure time was 5 min; for spray exposure some animals survived after 20 min exposure
- Desiccation will not work on snail species.
- Freezing or hot water immersion will control all species.

Effectiveness of Decontamination Procedures for Reducing the Spread of Small-bodied Aquatic Invertebrates

- Spiny water flea
  - Virkon was more effective than bleach for killing spiny water fleas, yielding 100% mortality on every fabric for every duration of exposure
  - Freezing was also 100% effective when applied for $\geq$ 2 hours
  - Bleach immersion/spray – 100% control if $\geq$ 15 minutes of spray contact time
    - Live embryos found in some adults killed with bleach.
- Bloody red shrimp
  - Virkon or bleach immersion/spray both very effective

The zebra mussel invasion of Lake Mendota: New insights into invasive species eruptions and impact

Dr. Jake Vander Zanden and Michael Spear
UW-Madison

- To evaluate population trends and changing abundance and size structure of zebra mussels from their current exceptionally low population densities in Lake Mendota.

- To gain insights into the factors limiting zebra mussel population abundance and eruptions.

- If the zebra mussel population does 'erupt', to evaluate zebra mussel impacts through a pre-post comparison of a broad range of benthic and pelagic variables.

The zebra mussel invasion of Lake Mendota: New insights into invasive species eruptions and impact

- 2016 - 2018 monitoring (spring through fall)
  - Adult ZM sampling via Scuba
  - Sampling veligers with net tows – analysis in progress
  - Sampling young of year with plate samplers
  - Benthic periphyton (with Bowling Green State)
  - Benthic macroinvertebrates (with SUNY-Buffalo)
- Benthic and pelagic biological and chemical variables will be compared to previous (pre-ZM invasion) LTER data.
- Benthic metabolism and macrophyte data in 2017
- Track impacts on native unionid mussels.
- Benthic substrate mapping of Lake Mendota.

The zebra mussel invasion of Lake Mendota: New insights into invasive species eruptions and impact

Results

- Zebra mussel population (adults) increased from 2016 to 2018.
- Has created a website/app that illustrates the population changes over time at different sites.
- In shallow rocky sites, zebra mussel density growth has begun to slow, and in some sites appears to have reached local saturation between 10,000-50,000 individuals / m2
- Mean and peak veliger densities in the water column have grown each year

The zebra mussel invasion of Lake Mendota: New insights into invasive species eruptions and impact

Results

- Data still indicate no obvious limiting factors to population growth
- Hypothesize that zebra mussels came to Mendota well before their 2015 discovery, and that a large population of large-bodied *Daphnia pulicaria* could have kept a low-density zebra mussel population in check through the 2000's until invasion of spiny-water flea
- Spiny water flea's decimation of the *Daphnia* population may have released top-down control of the zebra mussels, and could explain the delayed 2015 discovery and 2016-2018 explosion of Mendota's zebra mussels.
- Currently running laboratory feeding trials with *Daphnia* and ZM veligers

Opportunities for control, management, and prevention of spiny water flea in Wisconsin

Dr. Jake Vander Zanden and Jake Walsh
UW-Madison

- To understand the potential role of fish predation in reducing spiny water flea abundance and impact in the Madison lakes.
- To understand the factors influencing the spread and distribution of spiny water flea in Wisconsin.

Opportunities for control, management, and prevention of spiny water flea in Wisconsin

- Have analyzed stable isotope data from surveys of the food webs of Lake Mendota and Lake Monona from 2002, 2003, 2016, and 2017.
- Progress made in developing an ecological niche model to predict lake vulnerability to spiny water flea invasion
  - Models are based primarily on lake temperatures as Wisconsin lies at the southern edge of spiny water flea's geographical distribution, where its range is expected to contract northward with climate change
  - Incorporating this into the UW-CFL's online AIS 'smart prevention' support tool
  - Begun collaboration to use Penn State's random utility model of boater movement in the NHLD to model spiny water flea movement through recreational boating in Northern Wisconsin.

We want your feedback!

- What *closed* AIS R&D grant are you most interested in getting more information on?

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- Facilitating adaptive Phragmites management
- Impacts of zebra mussels of phosphorus uptake in Lake Winnebago
- Control, management, and prevention of spiny waterflea
- Role of microbes and light in the fate of 2,4-D during large-scale treatments
- Invasive crayfish pathogen screening

We want your feedback!

- How can we *best* communicate new AIS research findings to partners?

- Creation of summary factsheets
- Peer-reviewed journal articles
- Blog/social media
- Email Listserv
- Quarterly/annual newsletter
- Reoccurring Skype meetings
- DNR Research website
- Oral presentations at regional/statewide meetings
- Pre-recorded YouTube video presentations
- One-on-one conservations with lake associations
- “Science on Tap” public events
- Choreographed song and dance
- Others??

We want your feedback!

- What AIS research topics should we *prioritize* in the upcoming FY?

  - Specific species to focus on?
  - Specific management technique(s)?
  - Integrated management technique(s)?
  - New innovative technique(s)?

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