AQUATIC INVASIVE SPECIES GREAT LAKES ANS PANEL UPDATE

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Michael Greer, Program Manager
Jennifer Seiter-Moser, Technical Director
Christine Vanzomeren, Associate TD
USACE, Engineer Research and Development Center, Environmental Lab

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AQUATIC PLANT CONTROL & RESEARCH PROGRAM

The Aquatic Plant Control Program (APC) was authorized by Rivers and Harbors Act of 1958 to support cost shared control of invasive species. The 1965 Rivers and Harbors Act expanded the scope of the APC Program to research to support cost effective solutions to invasive species problems.

Cost-Share Activities: cost-shared (50/50) with non-Federal sponsors; control programs; washdown and inspection stations; and monitoring

Research: 100% federally funded; field driven through the Statement of Need process; biology and ecology of invasive aquatic plants species; technologies to manage invasive aquatic plants

Water hyacinth biocontrol (1974-2016)

- Aggregate R&D investment $124M
- Estimated aggregate benefits $4.2B
- B/C Ratio 34:1

AQUATIC PLANT CONTROL RESEARCH PROGRAM

Impact: cost effective management methods of aquatic invasive plants that reduce O&M costs and maximize ecosystem benefits

Research Topics: 25 ongoing research work units in the following categories

- Biological Control
- Chemical Control
- Ecological Assessments
- Applications and Management Strategies

BIOLOGICAL CONTROL OF FLOWERING RUSH

Bagous nodulosus

- Petition for field release submitted in April 2022
  - In July 2022, release approved by the Canadian Food Inspection Agency
  - In July 2022, release recommended by the USDA-APHIS Technical Advisory Group (TAG)
- In April 2022, 30 weevils sent to the USDA-ARS Lab in Sidney, Montana, to establish a rearing colony in quarantine
  → reared 12 weevils in 2022
  → nearly 100% overwintering survival

BIOLOGICAL CONTROL OF FLOWERING RUSH

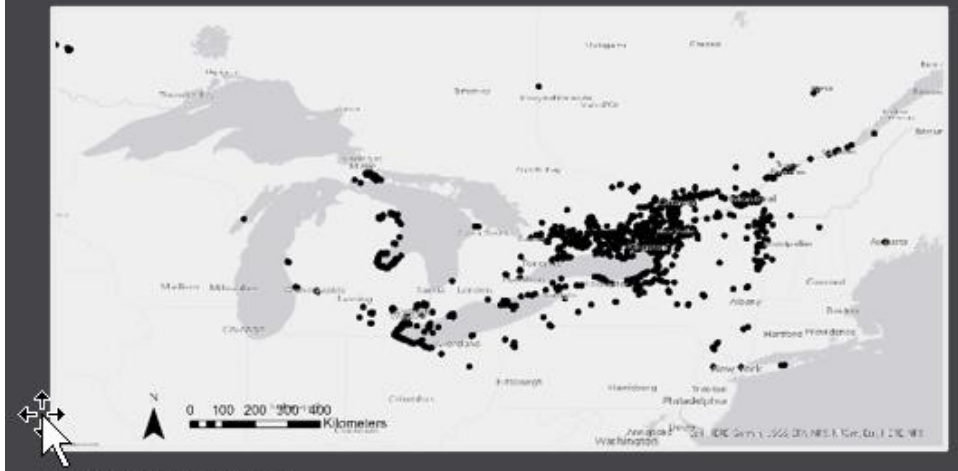
Phytoliriomyza ornata

- Larvae mine in leaves and flowering stems and have the potential to cause leaf wilting after a few weeks.
- In 2023, 1400 flies emerged from overwintering puparia.
- Host-specificity tests nearly completed (37 species tested with 5 remaining). Development only found on flowering rush.
- Additional impact experiment showed up to 69% total biomass reduction (only for diploid plants).

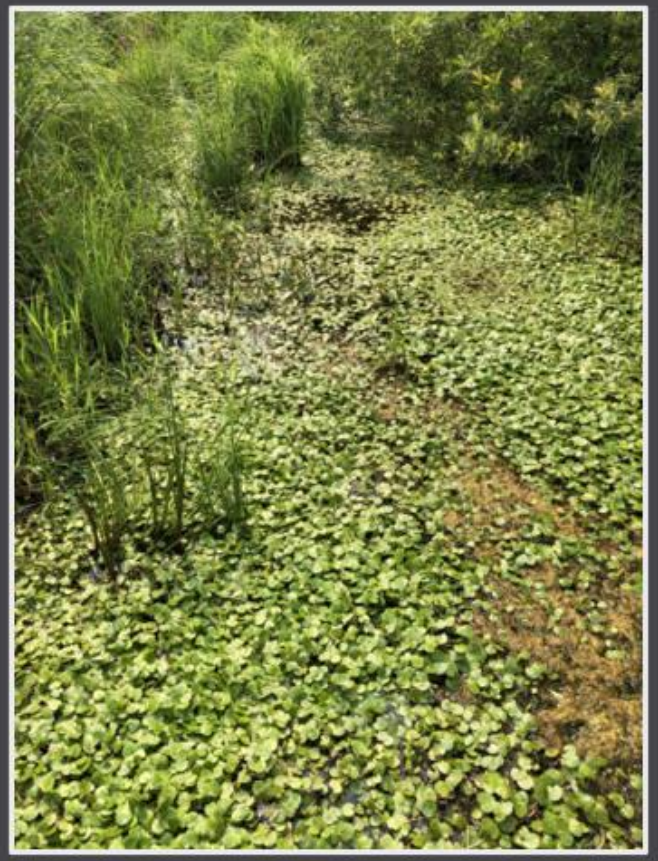
INTEGRATED PEST MANAGEMENT – EUROPEAN FROG-BIT

European Frogbit (*Hydrocharis morsus-ranae*)

- Hydrocharitaceae (Hydrocharis, Limnobium, Elodea, Egeria, Stratiotes)
- 1932: Introduced as ornamental, Ontario Canada
- 1939: Observed outside cultivation
- 1974: First observed in US near St. Lawrence River
- Shade out/ displace native vegetation, restrict water flow, reduce DO concentration, impede boat traffic and recreation



Hansen et al. 2022



Michigan Invasive Species Program

INTEGRATED PEST MANAGEMENT – EUROPEAN FROG-BIT

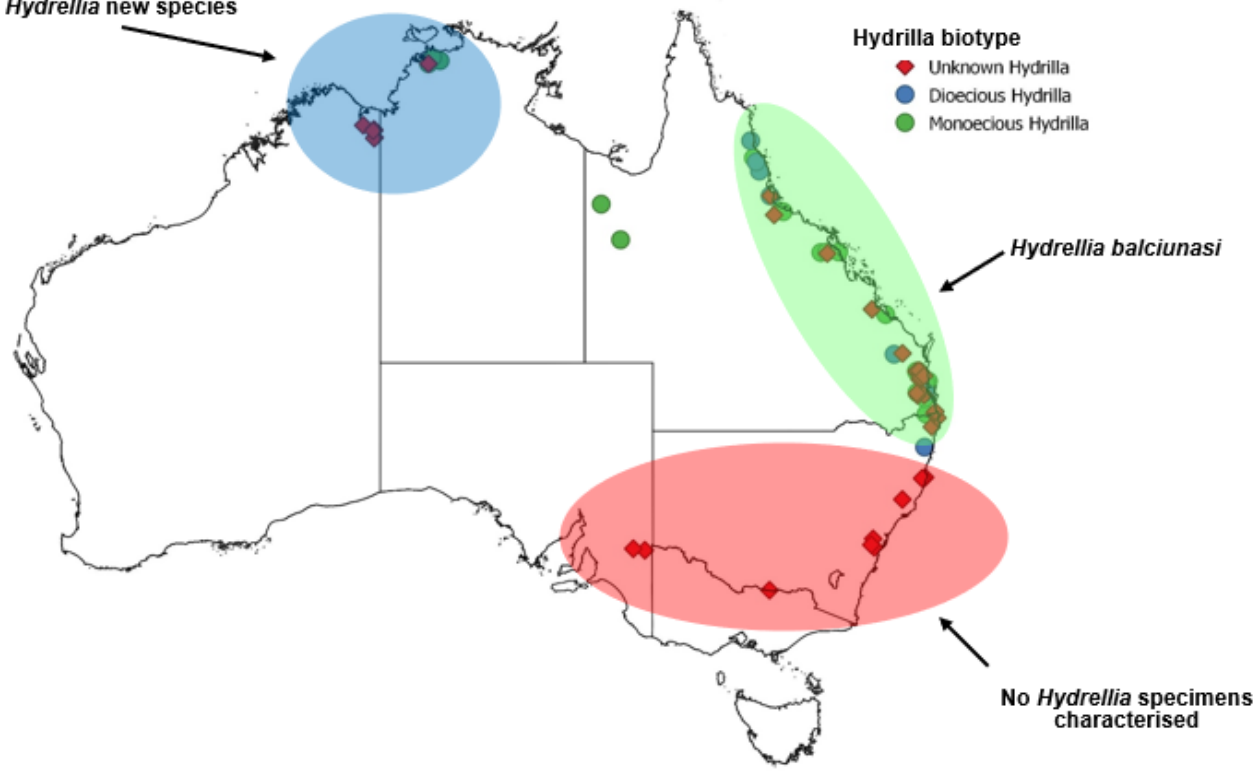
Objectives

- Develop and integrate tools and strategies for managing European Frogbit in North America
  - Limited information on management
  - EFBC providing coordination and tools to connect multiple stakeholders from across invaded range
- Conduct genetic characterization of EFB and WS from their invasive and native ranges
  - Genetic differences within an invasive population may contribute to susceptibility management strategies
  - Can be used to inform and focus foreign exploration efforts
  - FY23 Objective: CESU to perform genotyping
  - FY23 Objective: Collect preliminary genetic samples from invasive range
- Conduct foreign exploration for EFB and WS natural enemies
  - Biocontrol agent development can take ~10 years
  - Create a modern and comprehensive understanding of EFB and WS
  - Develop priority list of candidate biocontrol agents
  - FY23 Objective: BAA to perform foreign exploration

BIOLOGICAL CONTROL
ERDC AQUATIC PLANT MANAGEMENT TEAM

BIOLOGICAL CONTROL OF HYDRILLA IN THE US

Hydrellia flies Australia



- Two separate species occur in Australia, only *Hydrellia balciunasi* from near Brisbane has been tested and released in the US
- Specimens from temperate regions characterised but failed to amplify, few recent collections due to extensive flooding over three years (La Nina)

BIOLOGICAL CONTROL OF HYDRILLA IN THE US

Hydrellia new species specificity

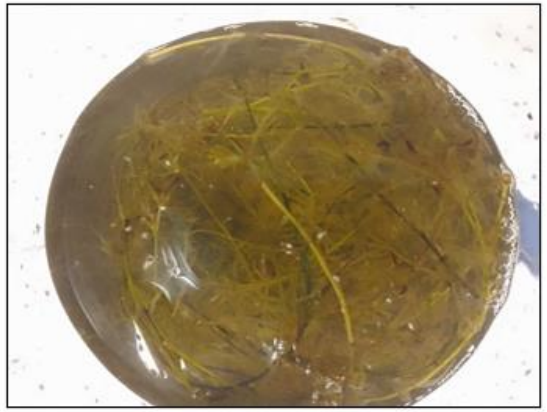
Hydrellia species

Plant species	No. replicates	Avg total adult emergence (13days after first emergence)
Hydrilla verticillata (control, Hydrocharitaceae)	6	49.7
Elodea canadensis (Hydrocharitaceae)	3	0.0
Potamogeton crispus (Potamogetonaceae)	3	4.7

- Host range testing of *Hydrellia* new species from NW Australia was mostly specific to hydrilla.
- *Hydrellia* new species failed to develop on *Elodea canadensis*.
- Adults were reared on *Potamogeton crispus*, but emergence was only 10% of that on hydrilla.
- It's unlikely a population could be sustained on *Potamogeton crispus* as less than 50% of adults developed in tests than were released initially (fivefold increase on hydrilla)

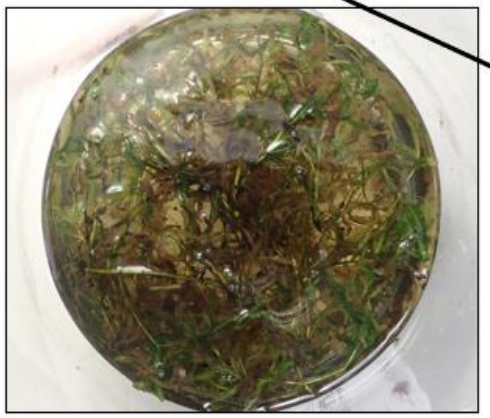
BIOLOGICAL CONTROL OF HYDRILLA IN THE US

Hydrellia new species specificity



Hydrilla verticillata

Hydrellia species



Potamogeton crispus

Elodea canadensis

Objectives

Objective 1. Evaluate the effectiveness of intermittent herbicide applications on biotypes of nuisance hydrilla and desirable species

- 1a: Intermittent herbicide - FPB, endothall, fluridone
- 1b: Endothall pulse followed by diquat pulse
- 1c: Product combinations
- 1d: desirable species
- 1e: Connecticut River Hydrilla*

Objective 2. Propagule establishment by sediment type*

*Data still being collected or project not yet underway

UNDERWATER REMOTELY OPERATED VEHICLE FOR DETECTION & TREATMENT OF SUBMERGED AQUATIC INVASIVE PLANTS

Project Purpose

FY22 SoN #1777 - Underwater ROV to Detect Submerged Aquatic Invasive Plants

To improve, expand, and diversify USACE's current methods for identification of two priority invasive SAV species by developing an AI/ML-based frame-by-frame video analysis program for accurately identifying **hydrilla** and **Eurasian watermilfoil** and integrating this identification program with an underwater ROV.

Desired Final Product: (1) an underwater ROV that will accurately detect two species of invasive SAV and to (2) test spot-treatment using UV-C integration

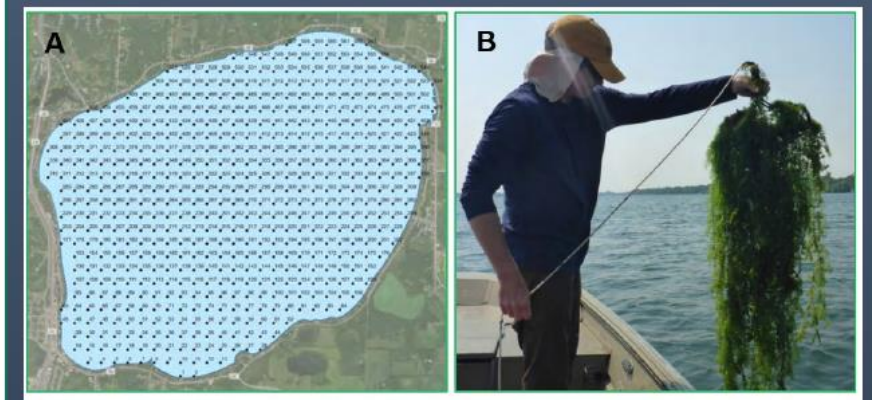
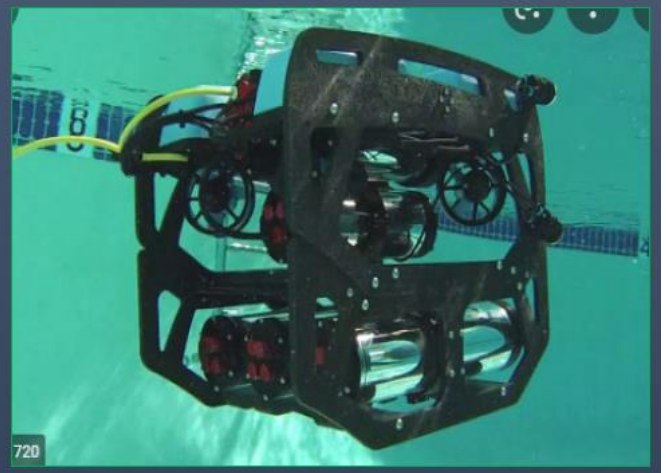


Figure 1. A) PIS sample locations and B) rake sample from Green Lake, MN (Blue Water Science, 2018).



UNDERWATER REMOTELY OPERATED VEHICLE FOR DETECTION & TREATMENT OF SUBMERGED AQUATIC INVASIVE PLANTS

FY24 Objectives

1. Establish satisfactory accuracy and speed for object detection of video streaming data
2. Establish library of high resolution labeled images of underwater *H. verticillata* under various conditions, angles, and luminosity; accuracy of AI/ML-based image analysis program for *H. verticillata;* and accuracy and speed for object detection of AI/ML-based live video capture
3. Equip one of ERDC-EL's existing ROVs with the *H. verticillata* AI/ML detection program
4. Complete LAERF pond experimental unit preparation; appropriately vegetated for controlled pond-scale testing
5. Determine efficacy of UV-C treatment on *H. verticillata* at two life stages

PHRAGMITES GENE SILENCING

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Summary and FY24 Work plan

Summary

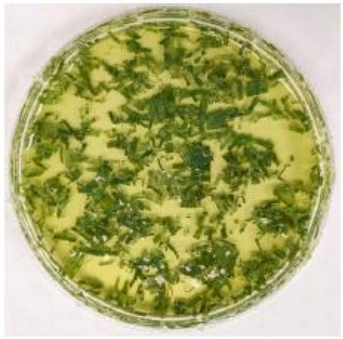
- We have designed and screened dozens of GSAs and identified effective GSAs of different classes and targeting different essential genes in the invasive *Phragmites*.
- The effective GSAs not only silenced their target genes but also induced desired phenotypic effects within 7 days when they were delivered via a nanocarrier, stem infusion, foliar abrasion, or rub inoculation.

Workplan for FY24

- Continue to screen ledRNAs (designed by CSIRO) and other dsRNA/hpRNA using 24-hr protoplast or leaf disk assay.
- Continue to build and screen VIGS constructs
- Design and test cocktails of multiple GSAs targeting multiple genes to get the optimal recipe.

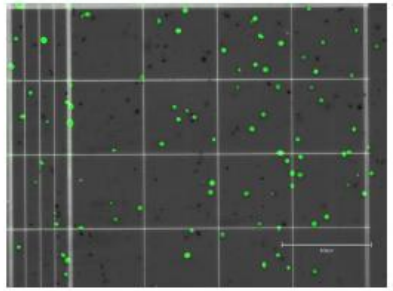
Protoplast preparation

Before digestion

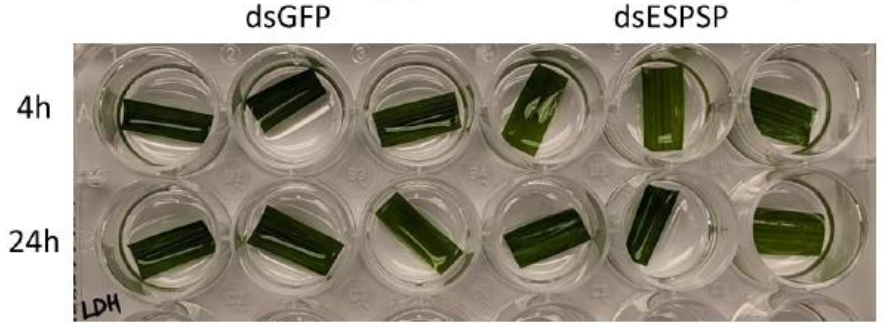


After 6-hr digestion

Cell viability after 24-hr exposure



Leaf disk assay (4-hr vs. 24-hr exposure)



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CONNECTICUT RIVER HYDRILLA RESEARCH AND DEMONSTRATION PROJECT

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OBJECTIVES

- 1) Characterize water exchange dynamics and evaluate their effects on traditional herbicide application techniques
- 2) Characterize plant phenological patterns
- 3) Compare Clade C hydrilla biology and ecology characteristics to other US genotypes
- 4) Evaluate potential herbicide CET relationships
- 5) Verify small-scale research findings through operational herbicide treatment demonstrations
- 6) Compile research findings to inform management and containment strategies

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REPRODUCTIVE BIOLOGY OBSERVATIONS

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CONNECTICUT RIVER HYDRILLA RESEARCH AND DEMONSTRATION PROJECT

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OTHER FY23 ACCOMPLISHMENTS

- USACE public messaging and outreach efforts in FY23:
  - Project website: https://www.nae.usace.army.mil/Missions/Projects-Topics/Connecticut-River-Hydrilla/
  - Five hydrilla fact sheets & one USACE demonstration project fact sheet
  - Agency workshop March 2023
  - Public stakeholder project introduction meeting (June 2023).
  - Hydrilla FAQs handout
  - Social media posts on project updates and notifications (cross-posting with CRC and others)
  - Technical and Education & Outreach working groups: USACE, CAES, RiverCOG, CT DEEP, MA DCR, UF-CAIP, CT River Conservancy

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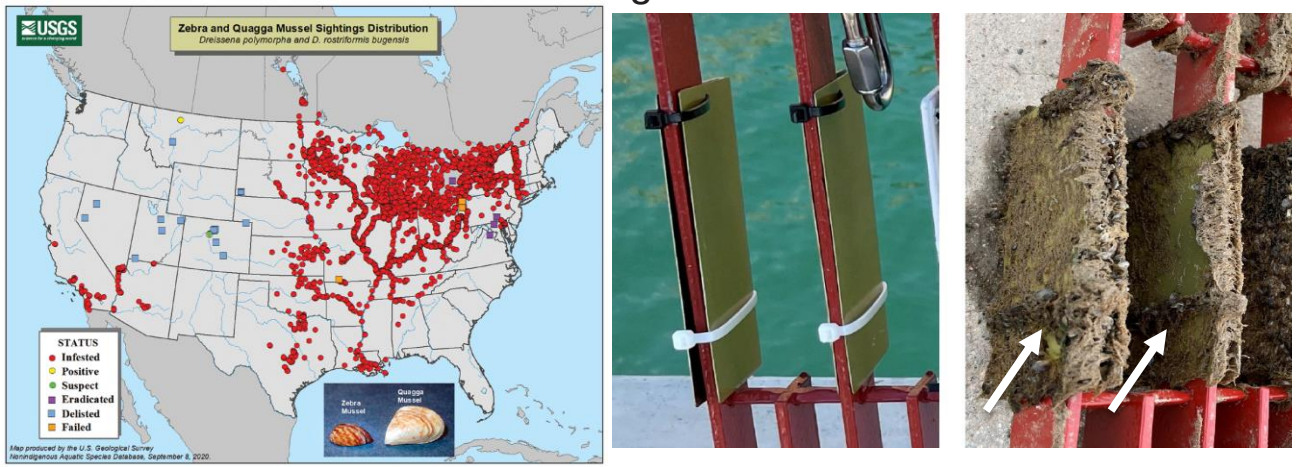
AQUATIC NUISANCE SPECIES RESEARCH PROGRAM

Authorized by the Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA) of 1990; reauthorized in 1996 with the National Invasive Species Act (NISA)

Research: on invasive aquatic animals, as well as harmful algae blooms (HABs), and Next Generation Ecological Models

- Invasive carp, sea lamprey, mussels (zebra/quagga)
- Invasive species costs
- Early detection, prevention, management, and scalable technologies for reducing HABs, including field demonstration projects

Antifouling Research



Invasive Carp Modeling

AQUATIC INVASIVE SPECIES

Challenges

- Early detection and rapid response
- Multijurisdictional projects
- Additive effect of new introductions

Successes

- Utilizing advances in science and technology from other disciplines
- Public awareness