Nymphoides peltata as a target for classical biological control

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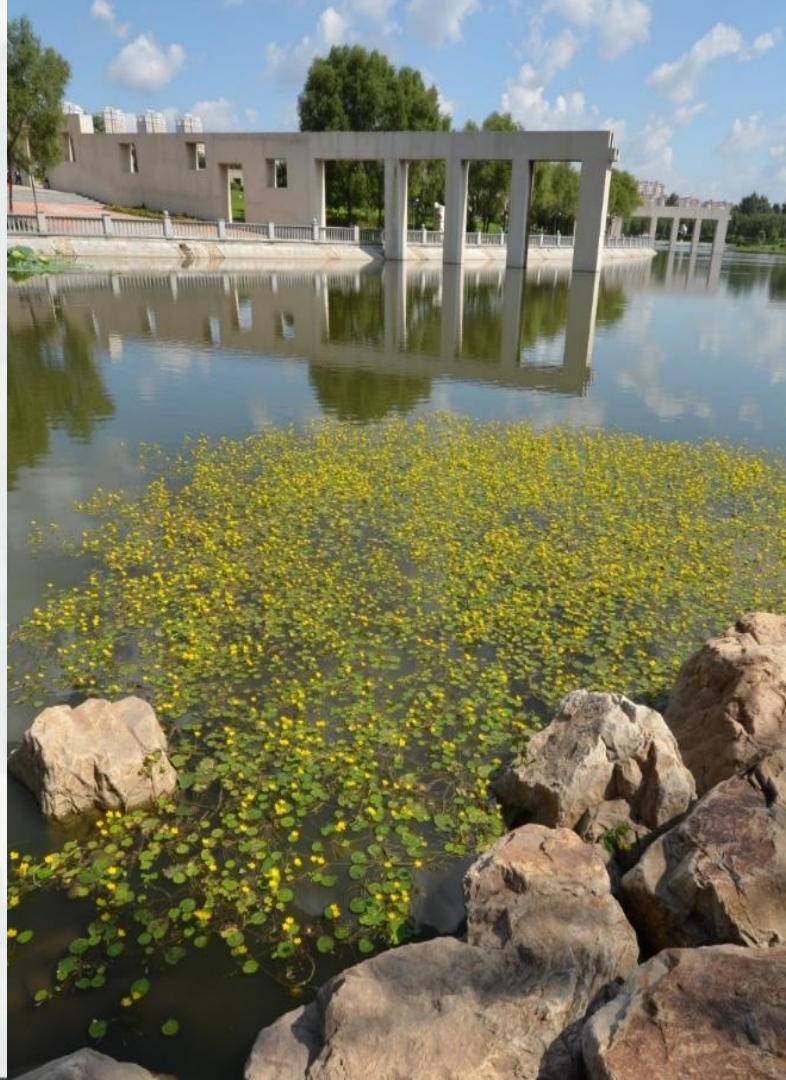Oregon Department of Agriculture
Noxious Weed Summit, March 2018

US Army Corps of Engineers
BUILDING STRONG®

Overview

►Role of USACE
►Biological control
►*N. peltata* review
►Future directions

WHERE WE ARE — U.S. ARMY CORPS OF ENGINEERS

Role of USACE in aquatic plant management

Water hyacinth in LA

- USACE research on ecology, chemical and biological management since 1959

- **In 1965, Aquatic Plant Control Research Program (APCRP) created**

- Leverage research with collaborators around the world

- Began to explore potential biological control of floating hearts in 2017

Aquatic plant management in the US **costs millions** to districts and states, primarily through herbicide application
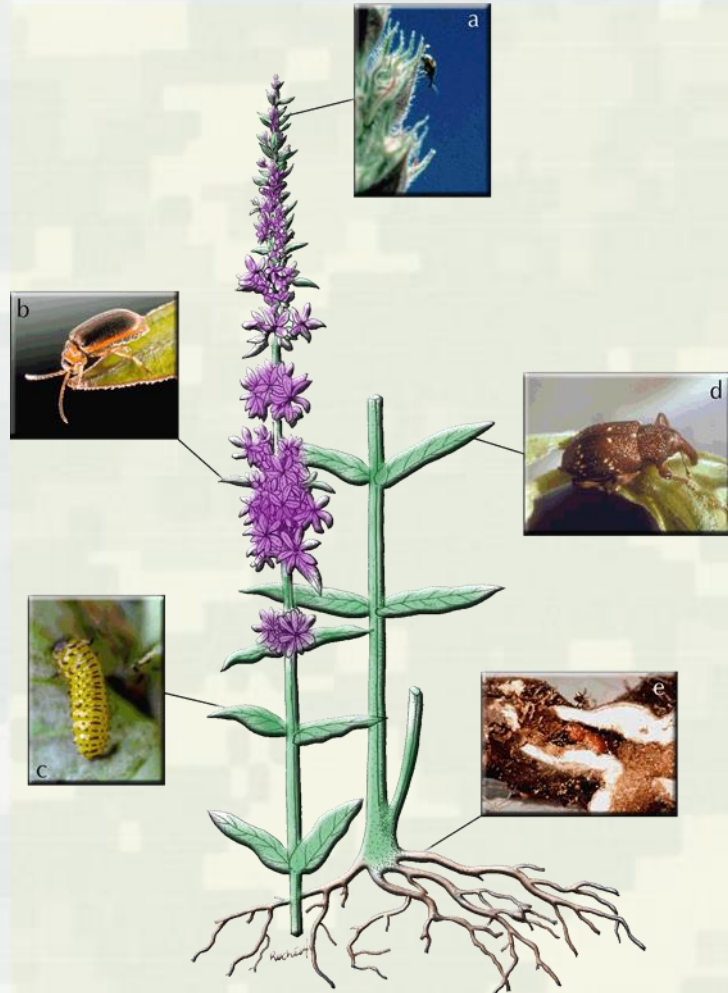
Biological control can be a **sustainable, cost-effective** alternative to herbicides or mechanical harvesting

What is biological control?

Intentional introduction of parasitoids, predators, and/or pathogenic microorganisms to

SUPPRESS

populations of plant or animal pests.

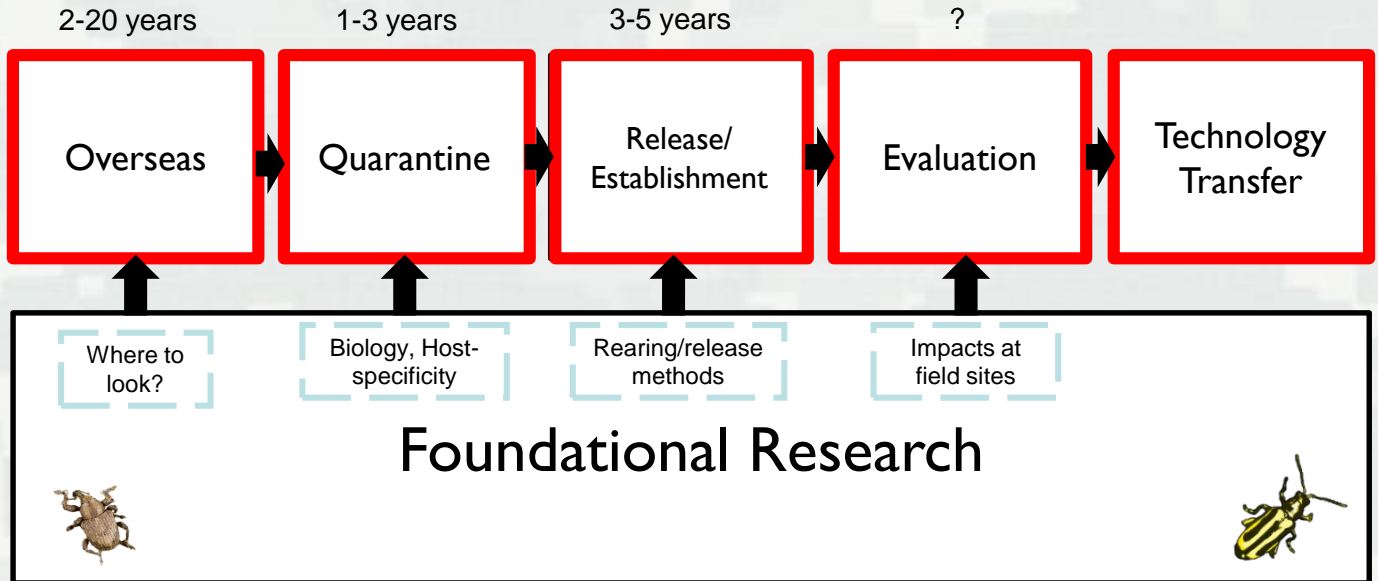# USACE history of aquatic weed biological control

- 1960's- alligatorweed in SE United States
- Current- overseas exploration for agents of monoecious hydrilla, floating hearts
  - Funding *Phragmites*, *Butomus* agent development

Before introducing biological control agents, it is important to document baseline damage and associated agents

Biological control development "pipeline"

2-20 years	1-3 years	3-5 years	?	
Overseas	Quarantine	Release/ Establishment	Evaluation	Technology Transfer

Where to look?

Biology, Host-specificity

Rearing/release methods

Impacts at field sites

Foundational Research

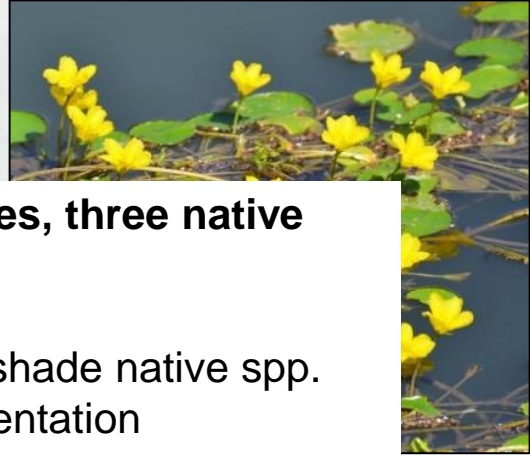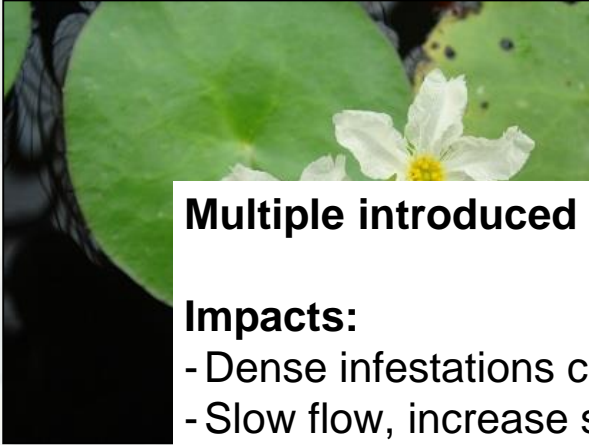Development and implementation of a new biological control program is costly

10-12 million dollars per agent!

Prior to starting a new program, suitability of the target should be determined
- Literature review and Peschkin-McClay scoring
  - Scored 148 out of 179

Nymphoides spp. (Family Menyanthaceae)

Multiple introduced species, three native

Impacts:
- Dense infestations crowd/shade native spp.
- Slow flow, increase sedimentation
- Reduce air exchange
- Block waterways

Difficult to manage- fragments easily establish

Native to Asia and Eurasia

Economic losses

- Poorly understood in US
- Large infestations limit recreational opportunities, depress property values (DCR 2011)

Biology/ reproduction

- Sexual/vegetative reproduction
- Vegetative
  - ▶ Propagates from rhizomes, stolons, leaves, daughter plants (Nault and Mikulyuk 2013)
- Prolific seed production
  - ▶ 3000-9000 / m^2 (Van der Velde and Van der Heijden 1981)
  - ▶ Distylous

- Most literature from native range
  - ▶ Dire need for ecological studies in the introduced range

(photo by Julie Nachtrieb)

(photo by Jen Parsons)

(photo by Laurie Baldwin)

Native range
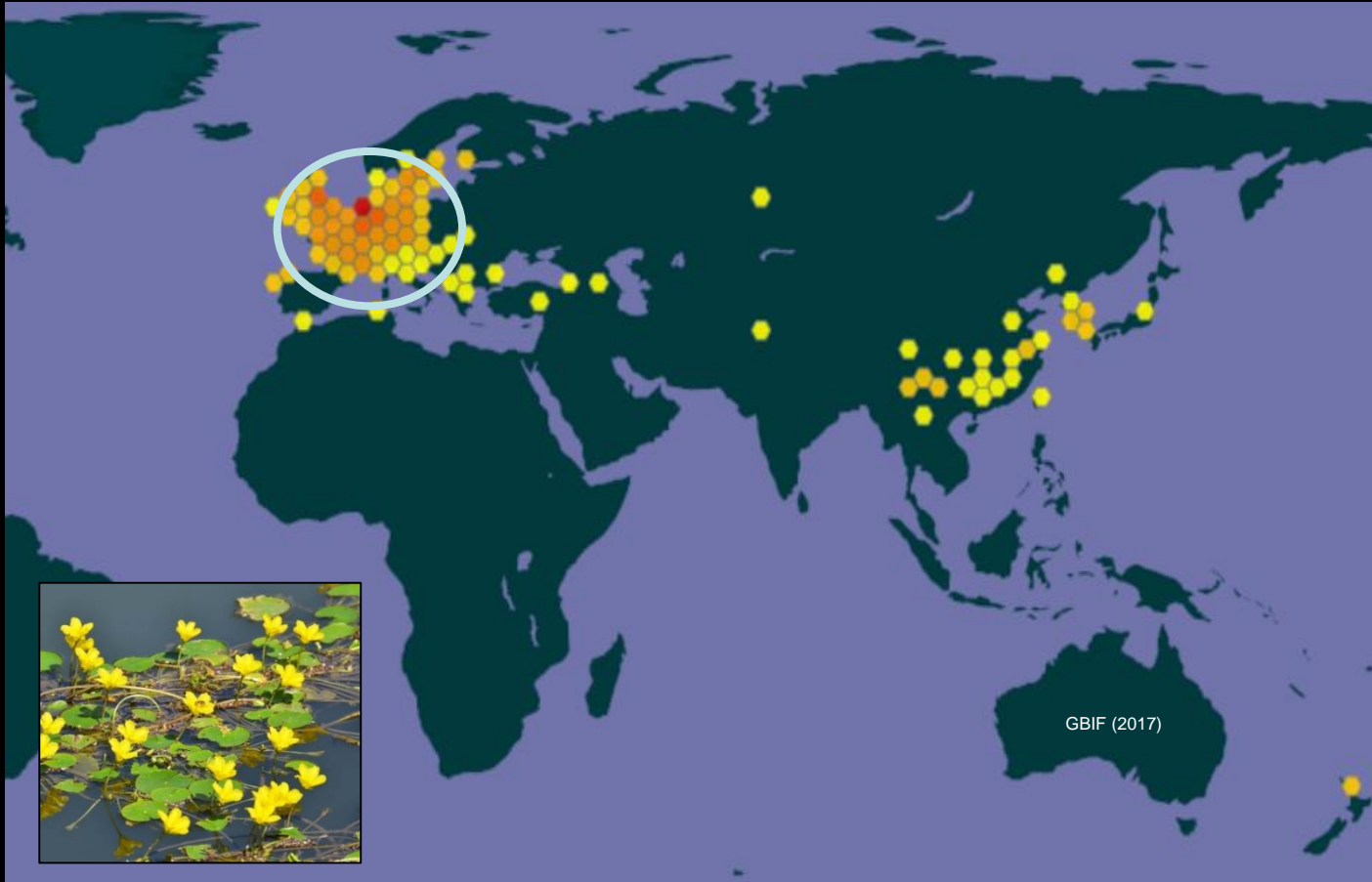
GBIF (2017)

Current and expected distribution

- Reported in 27 states in all regions
- To predict spread, Climex ecological modeling software
  - ► Regional climate-match feature
  - ► Used known Asian occurrences (GBIF.org) to match with USA

Regional climate-matching: U.S. distribution

0 - 0.59
0.59 - 0.69
0.69 - 0.79
>0.80

Used known Asian occurrences (GBIF. org) to match with USA

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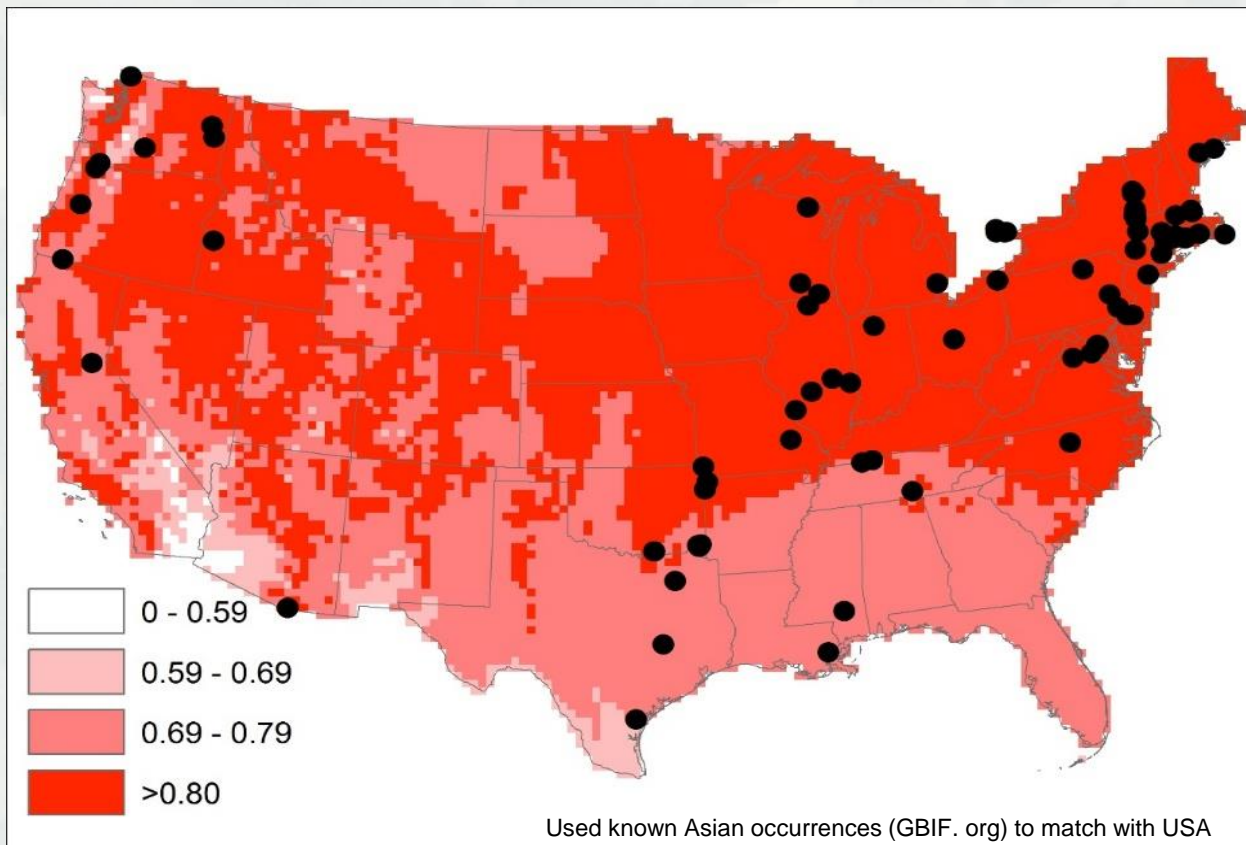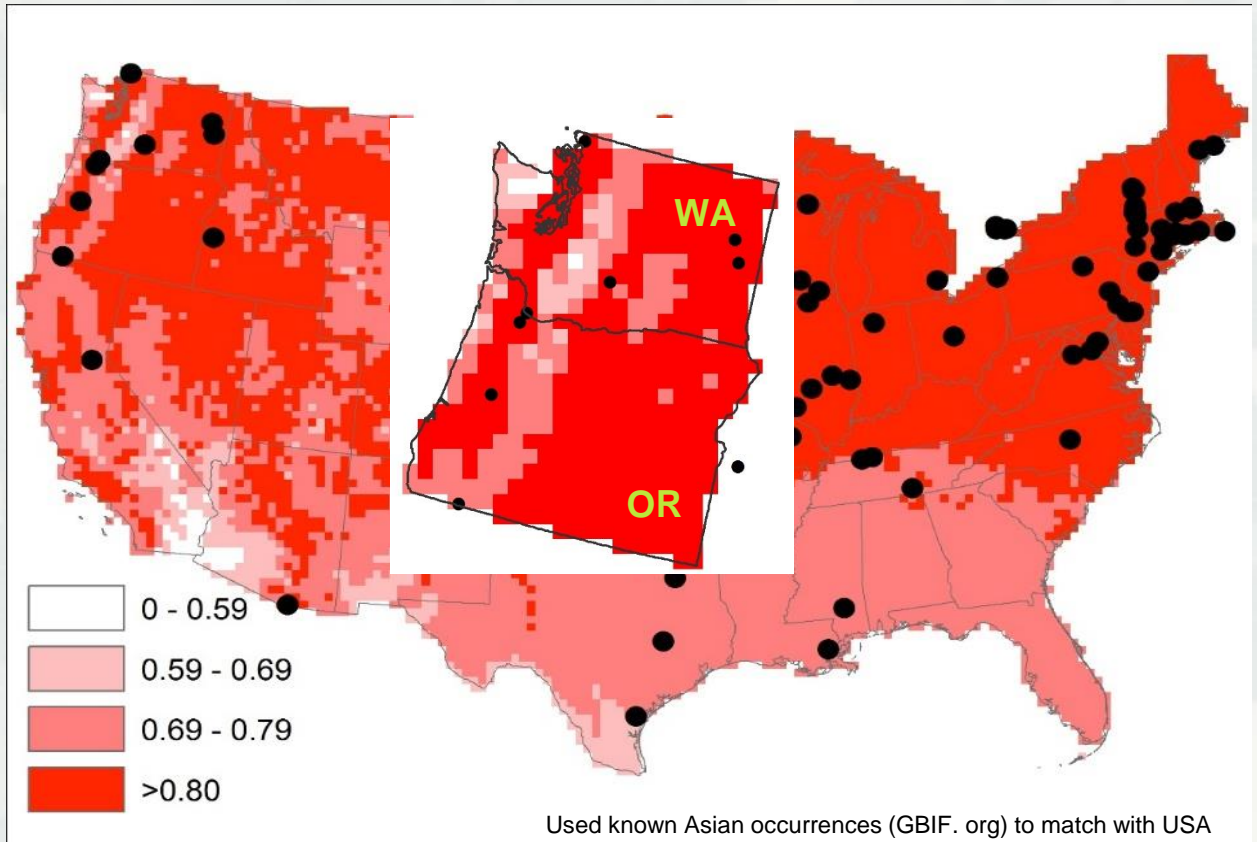
Available management

- Mechanical harvesting-cost prohibitive on large-scale, may disperse propagules
  - ▶ Up to $9,000 / ha

- Herbicide options limited
  - ▶ Little literature available
  - ▶ 2,4-D (Countryman 1970)

- Bottom barriers to shade out new growth in spring

- Biological controls not available

Known biological control agents?

- Can reduce exploration time/costs

- A few generalists known from floating hearts in US

- No known specialists, some natural enemies in literature

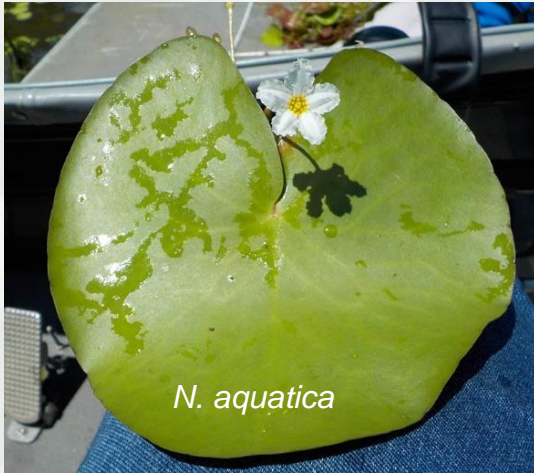- Fungal pathogen that causes leaf spot disease

Elophila nymphaeata

Septoria villarsiae

from Park et al. 2010

Relatives in the US

N. aquatica

N. indica

N. cordata
Little floating heart
Nymphoides cordata
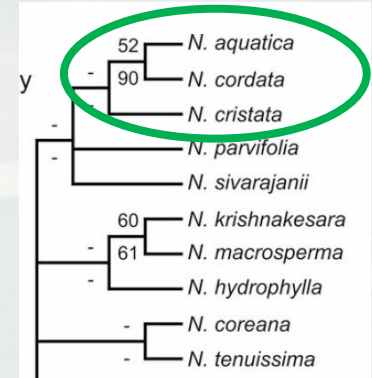Photo by Nia Wellendorf
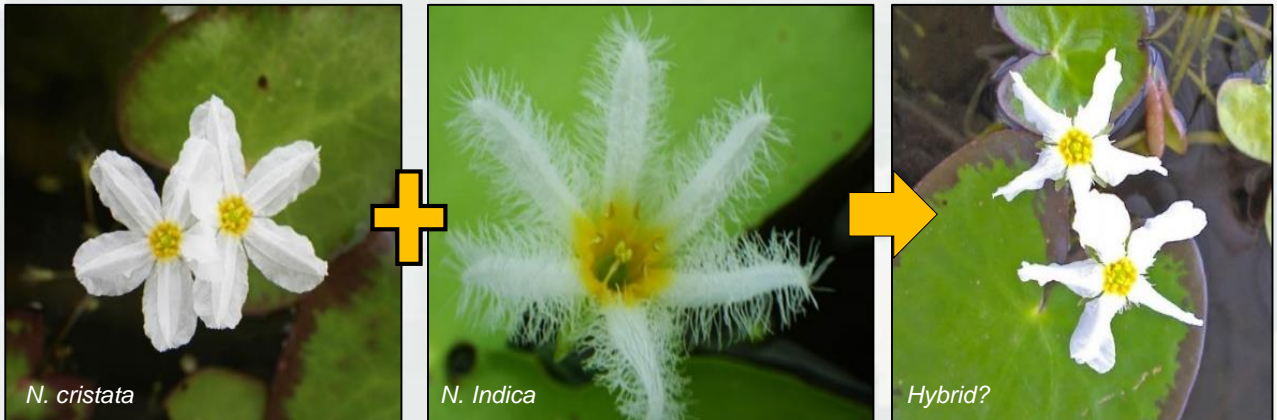Univ. of South Florida

2-3 native, several introduced *Nymphoides* spp.

Challenges: hybridization

Could impact management because of differential responses

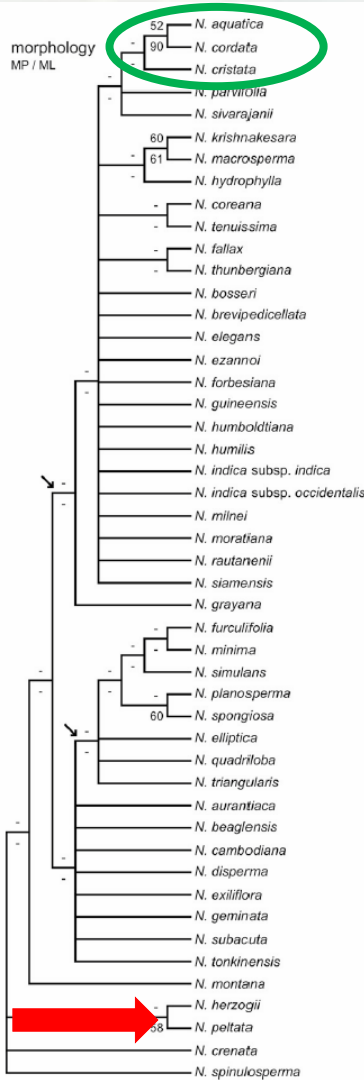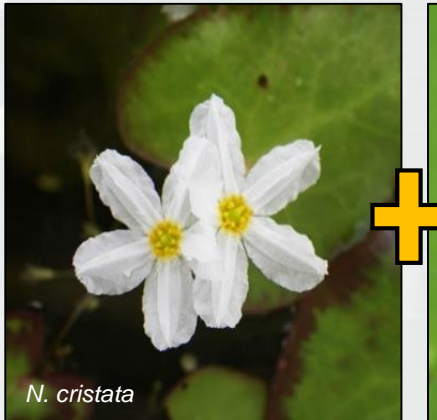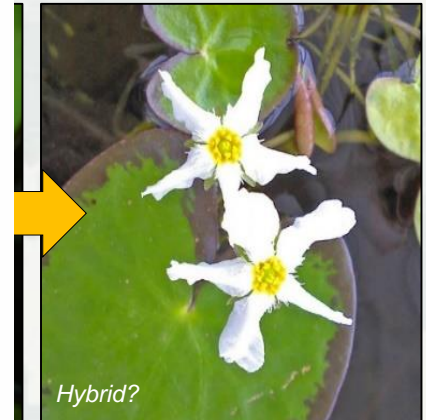May limit biological control opportunities

52 — *N. aquatica*
90 — *N. cordata*
— *N. cristata*
— *N. parvifolia*
— *N. sivarajanii*
60 — *N. krishnakesara*
61 — *N. macrosperma*
— *N. hydrophylla*
— *N. coreana*
— *N. tenuissima*

Tippery and Les (2011)

N. cristata

N. Indica

Hybrid?

Lyn Gettys (2017)

Challenges of Hybridization

Could impact management by differential response

May limit biological control
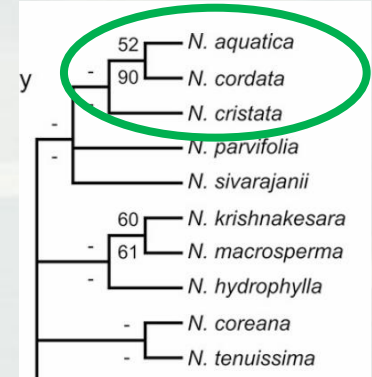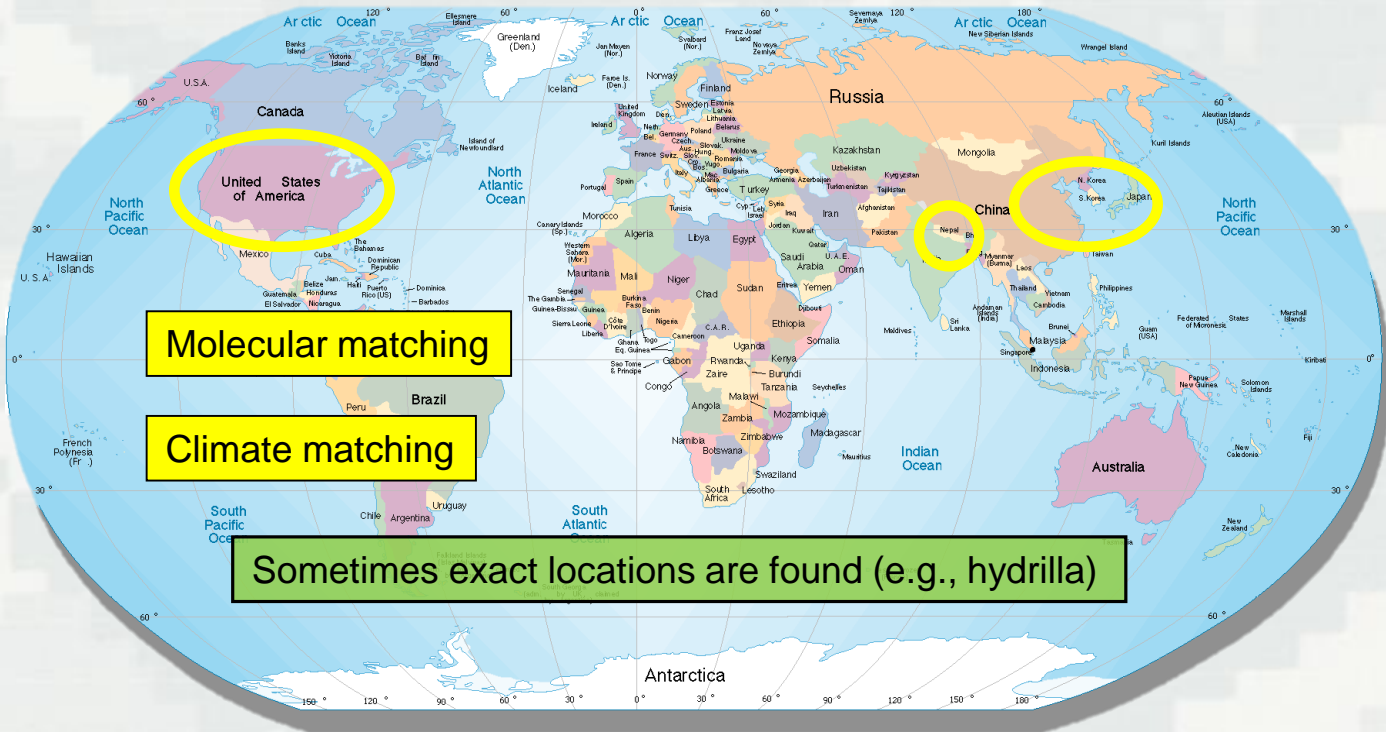

N. cristata

Hybrid?

Where to search?

- Use a combination of literature review, climate and genetic matching

Molecular matching

Where to search?
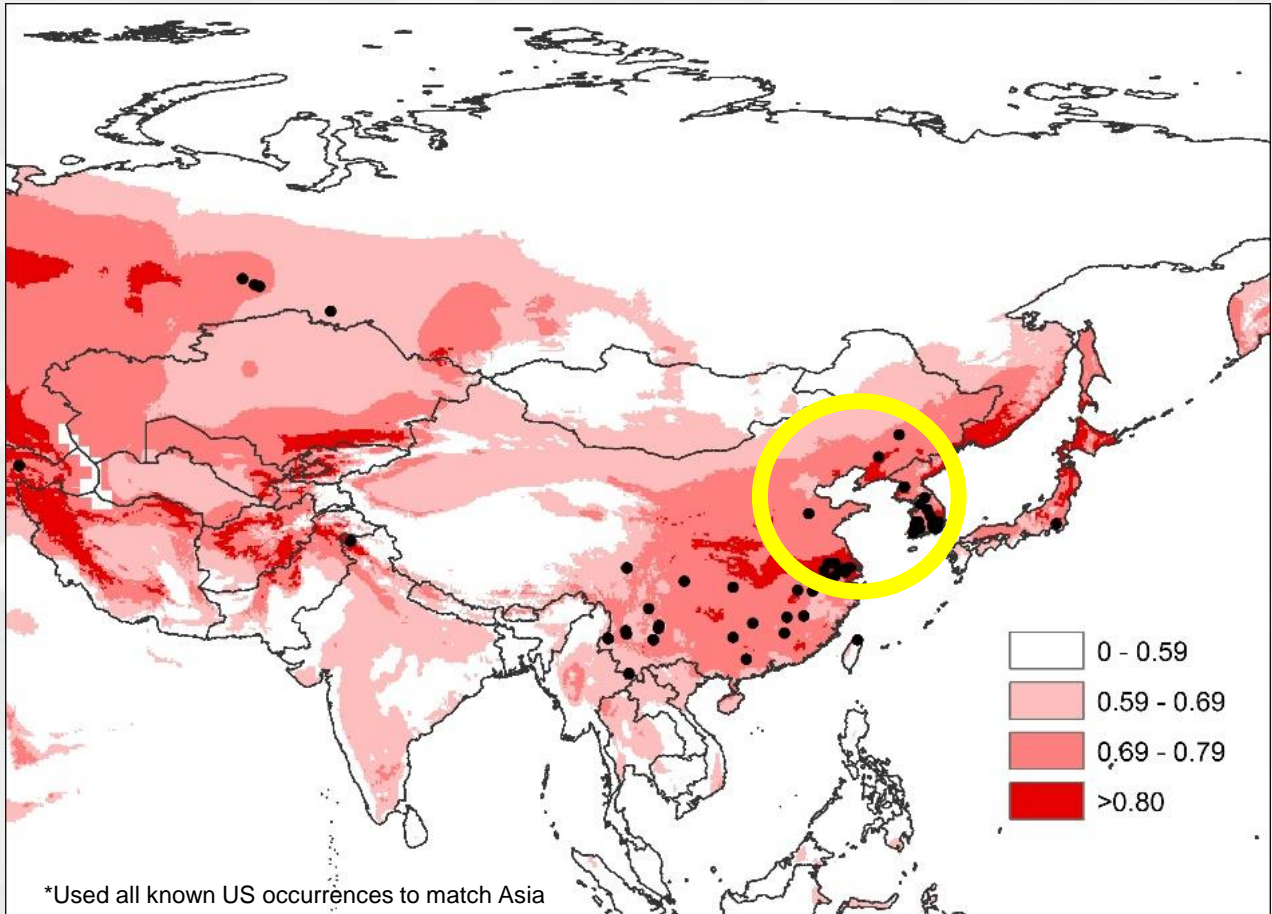
- Use a combination of literature review, climate and genetic matching

Molecular matching

Where to search?

- Use a combination of literature review, climate and genetic matching

Molecular matching

Climate matching

Sometimes exact locations are found (e.g., hydrilla)

Climate-matching: Asia

☐	0 - 0.59
☐	0.59 - 0.69
☐	0.69 - 0.79
☐	>0.80

*Used all known US occurrences to match Asia

Climate-matching: Europe

Legend:
- 0 - 0.59
- 0.59 - 0.69
- 0.69 - 0.79
- > 0.80
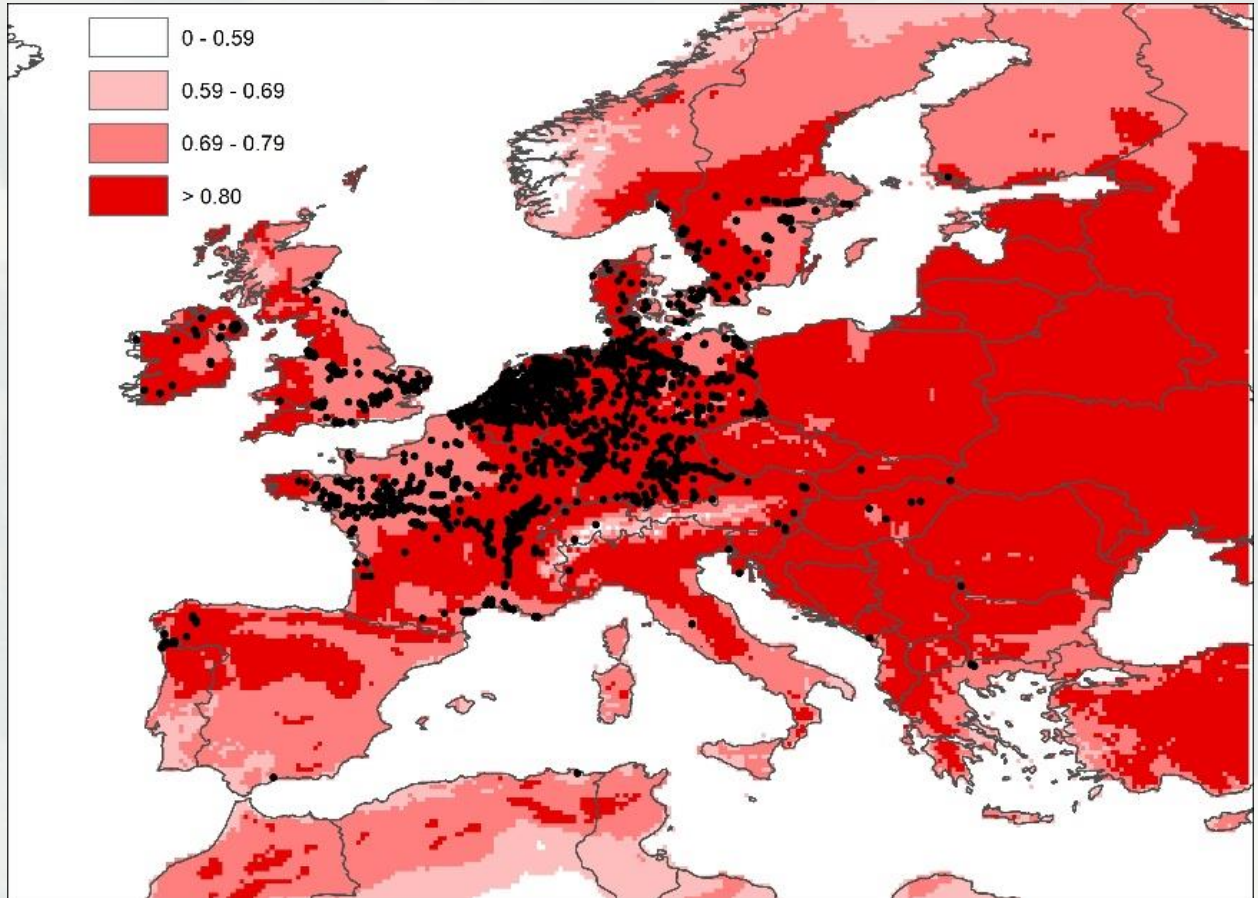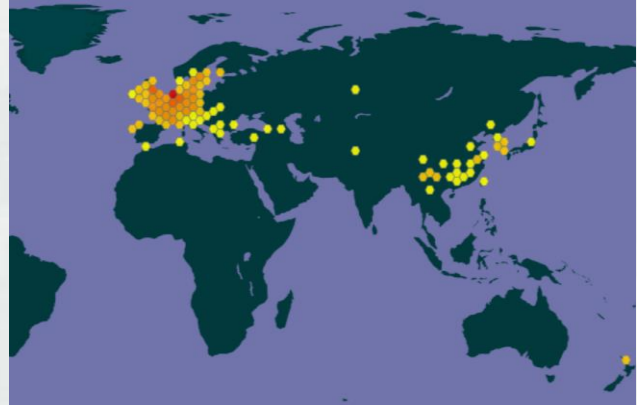
*Used all known US occurrences to match Europe

Next Steps:

1. Determine genetic diversity of *N. peltata* and where source populations are located

    -Ryan Thum (Montana)

2. Conduct foreign exploration for agents

Questions for the audience:

1. How do you manage yellow floating heart?
   - And what are costs?

2. What impacts do you see/anticipate?
   - Why do you manage it?

3. How do you document impacts and evaluate successful management?

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Collaborators: