Phragmites australis

An update on biological control development and ecological impacts

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Timeline I

- 1998: Project initiation
  - Herbivore surveys in NA an Europe
- 2000: Focus on select species in NA and Europe
  - Distribution, impact,life history
- 2002: Existence of endemic NA *P. australis* confirmed
- 2002/3: Diagnostic Service established
- 2004: Native subspecies *P. australis americanus*
- 2005- present: Host specificity with focus on native and introduced genotypes at CABI, Switzerland, URI
- 2007: Hybridization forced in the lab (Meyerson, URI)
- 2007: *Phragmites* workshop at Cornell
    - Importance of seed set for dispersal established

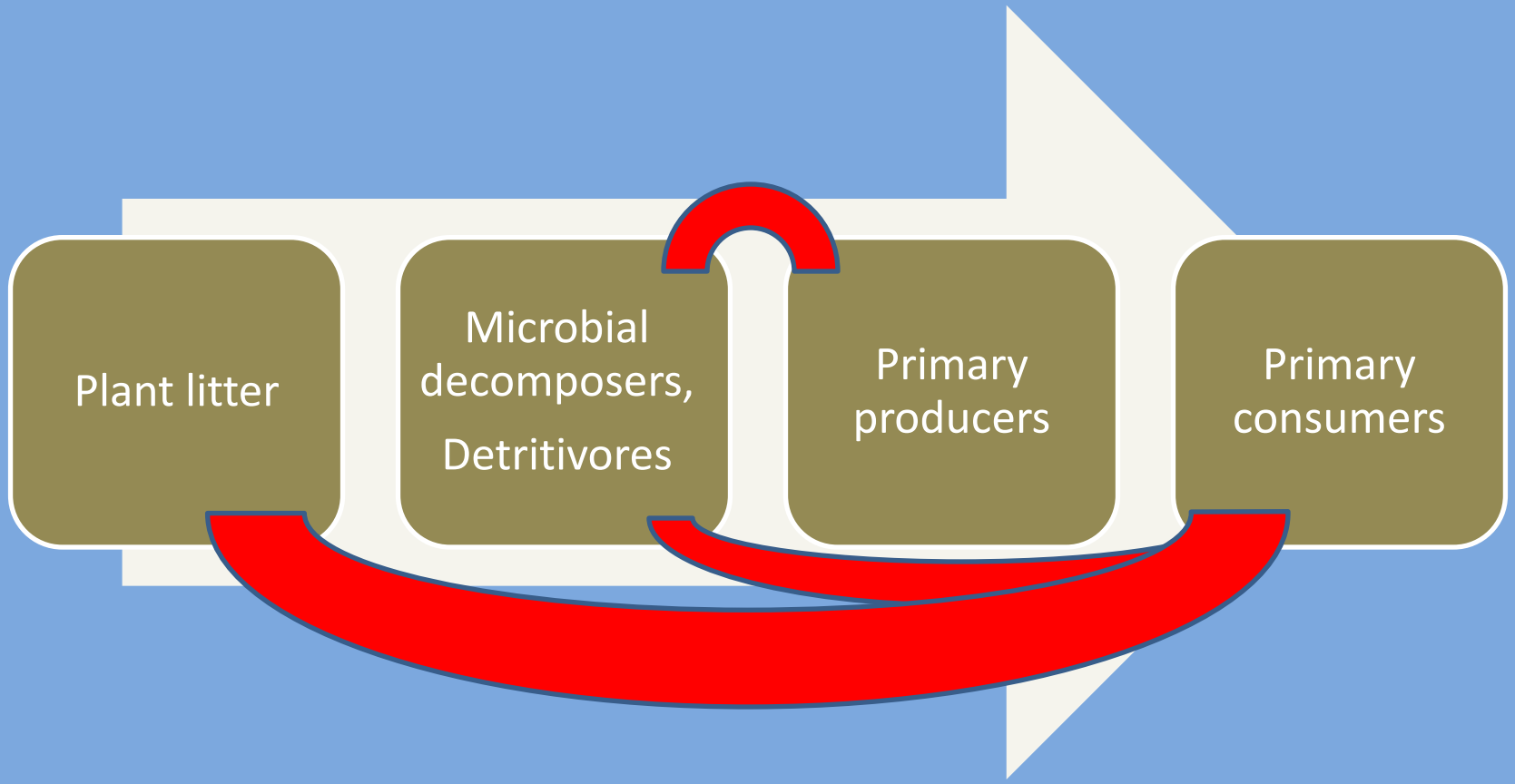
Timeline II

- 2009: Petition to approve host specificity testing to TAG
- 2008/9: Problems with rearing, establishing quarantine colonies
  - High tissue specificity (very early, very soft) of control agents (L_1)
- 2009: What if candidate species are not genotype specific?
  - Nationwide questionnaire launched (ecological/economic)
- 2009: Role of soil microbial communities in structuring wetland plant communities
- 2010: Structured decision making group established (FWS region 5)
  - Develop assessment/performance indicators
- Since 2002: Investigations into ecology, life history, impact of native and introduced genotypes

Effects of plants in aquatic habitats

Amphibians
Invertebrates

“The plant litter pathway”



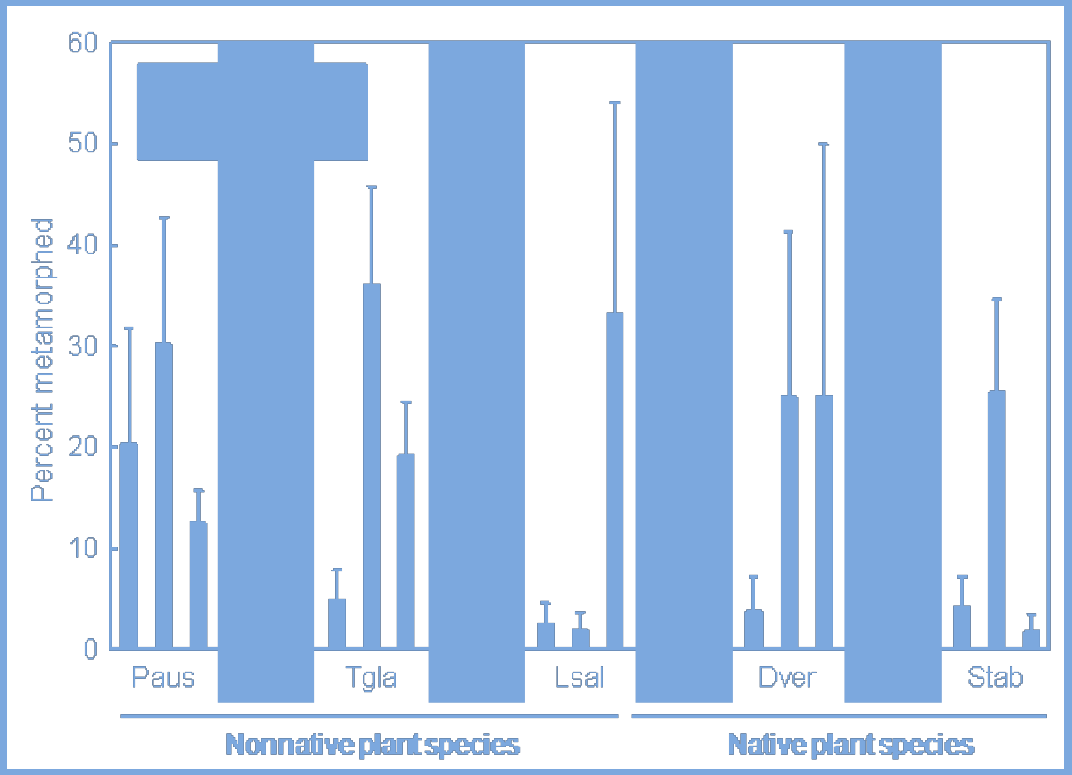
Field study

Nonnative	Native
Purple loosestrife*	Swamp loosestrife*
Narrowleaf cattail*	Broadleaf cattail*
Hybrid “glauca” cattail*	
Reed canarygrass	Softstem bulrush
Common reed	Broadfruit bur-reed

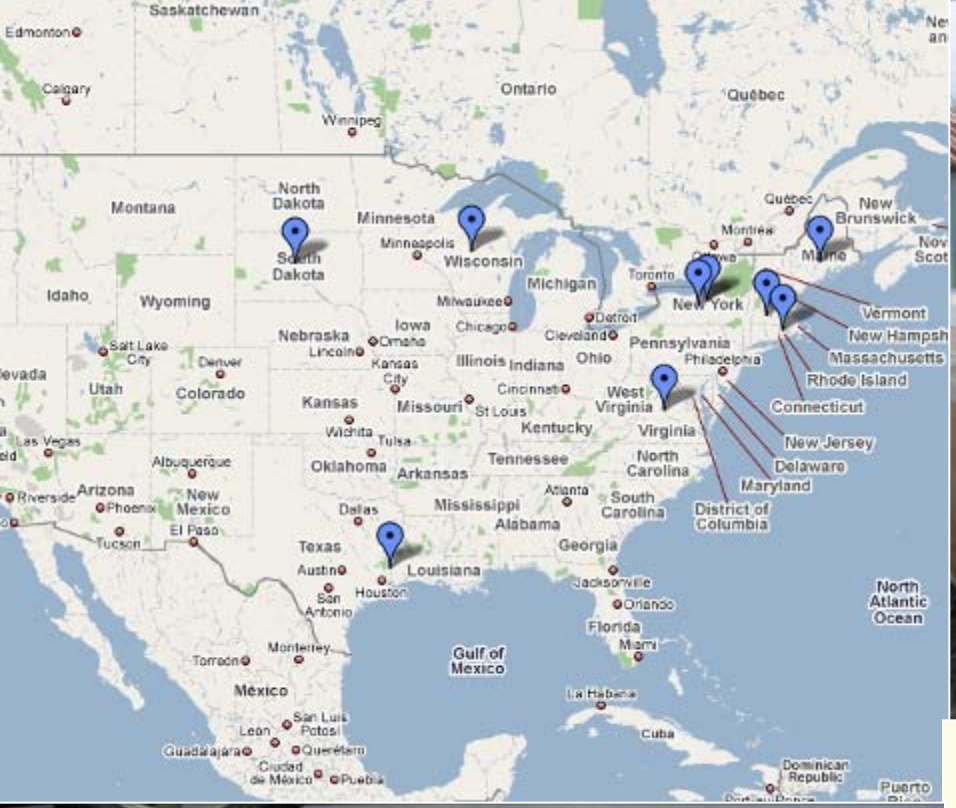
- phylogenetically related pairs

- American toad, wood frog, pickerel frog

Successful tadpole development



Large variation in success of amphibian species
No effect of origin on results (N vs I)
Effect measured in common gardens detectable in the field
Plant traits (C:N, lignin, tannin most important)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Milwaukee
Toronto
New York
Vermont
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Nebraska
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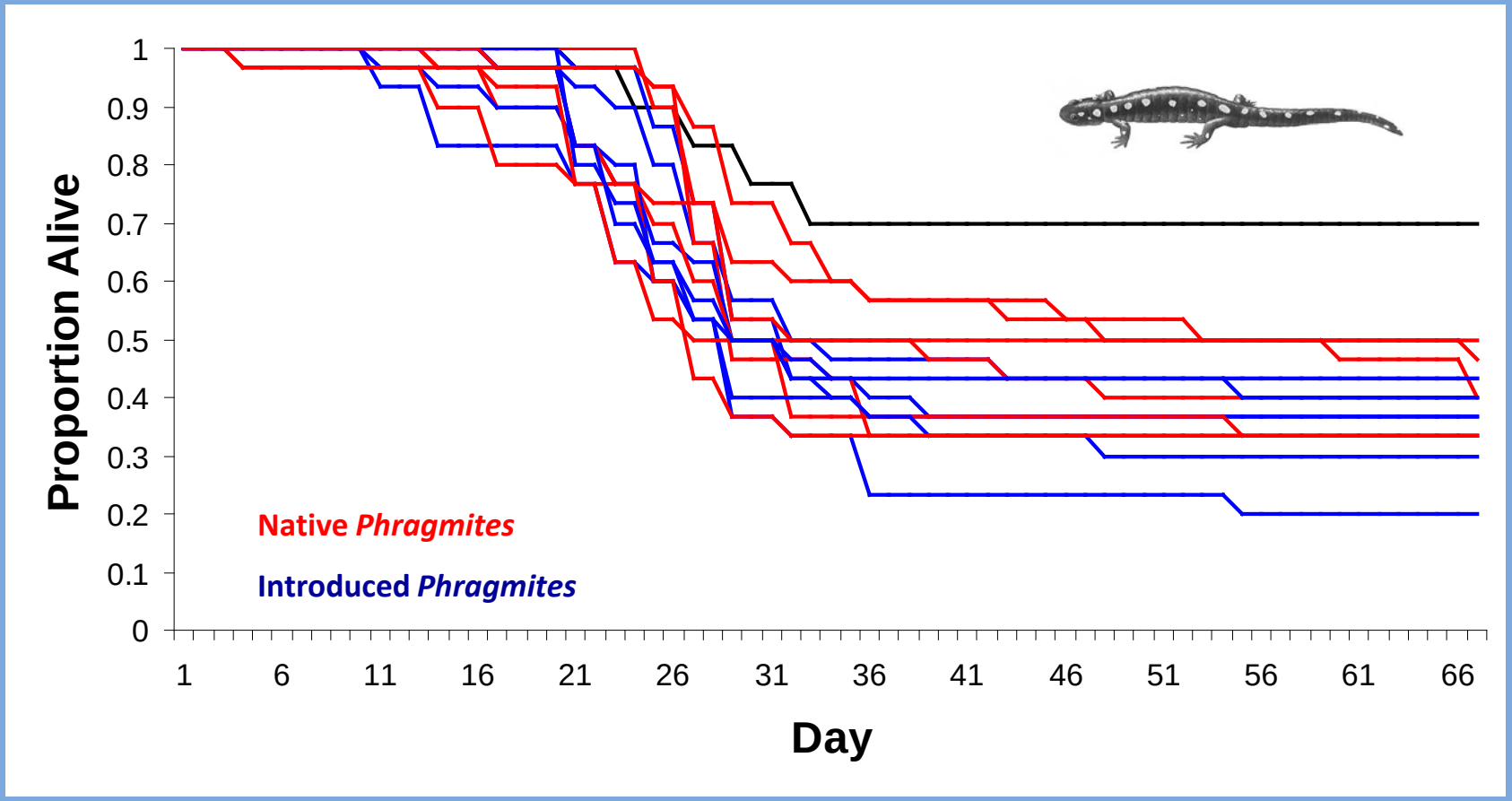
Wichita
Tulsa
Jacksonville
Orlando
Florida
Miami
Gulf of Mexico
North Atlantic Ocean
Monterrey
Torreon
México
San Luis Potosí
Leon
Guadalajara
Querétaro
Ciudad de México
Puebla
La Habana
Cuba
Dominican Republic
Puerto


MA N
MEN
3g
SD

Native/non-native origin does not predict probability of survival

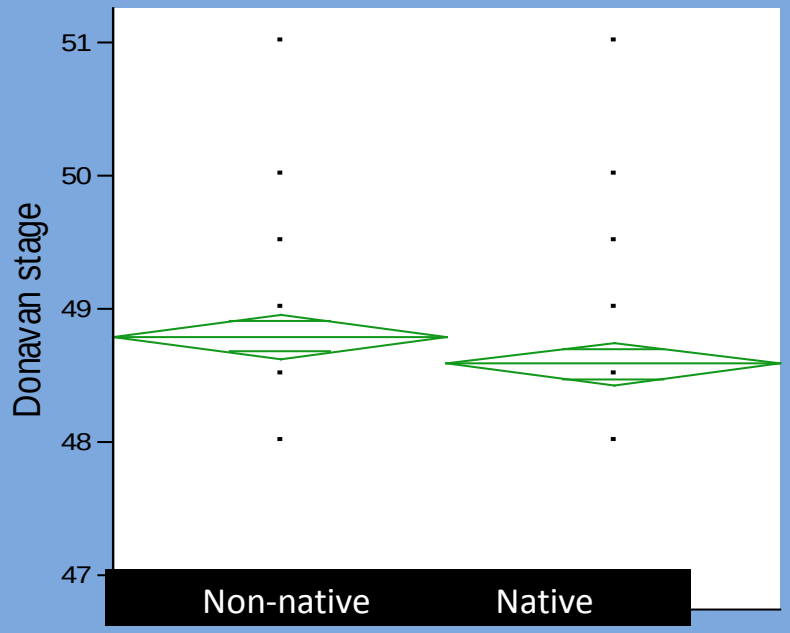
A. maculatum Survival



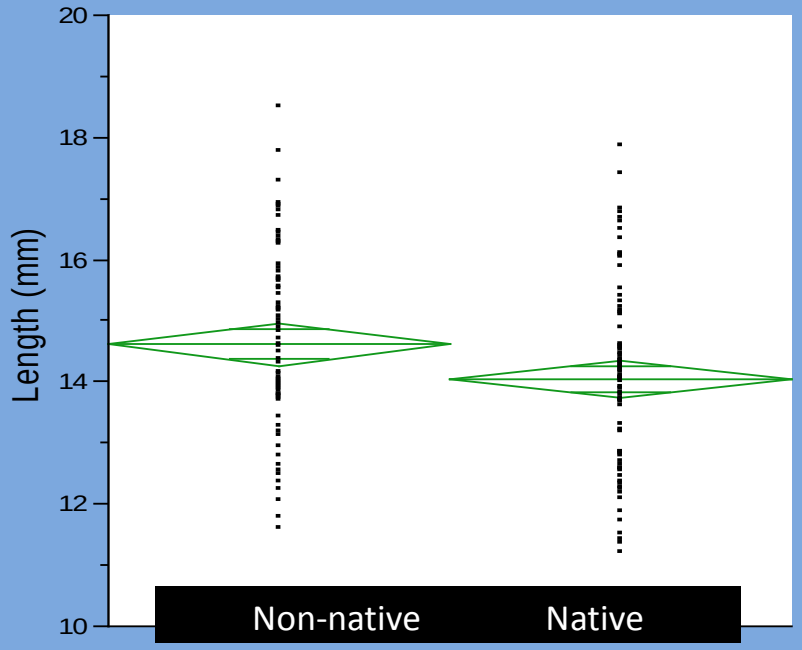
Logistic regression [Treatment, Pond, Clutch], Difference of least square means

Spotted salamander larval development: Native vs. introduced *Phragmites*

ANOVA F=2.24, *P*=0.14



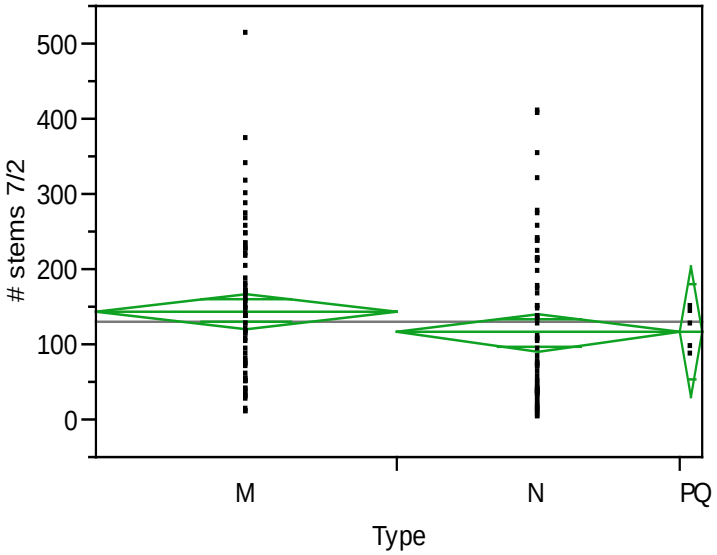
ANOVA F=3.87, *P*=0.06

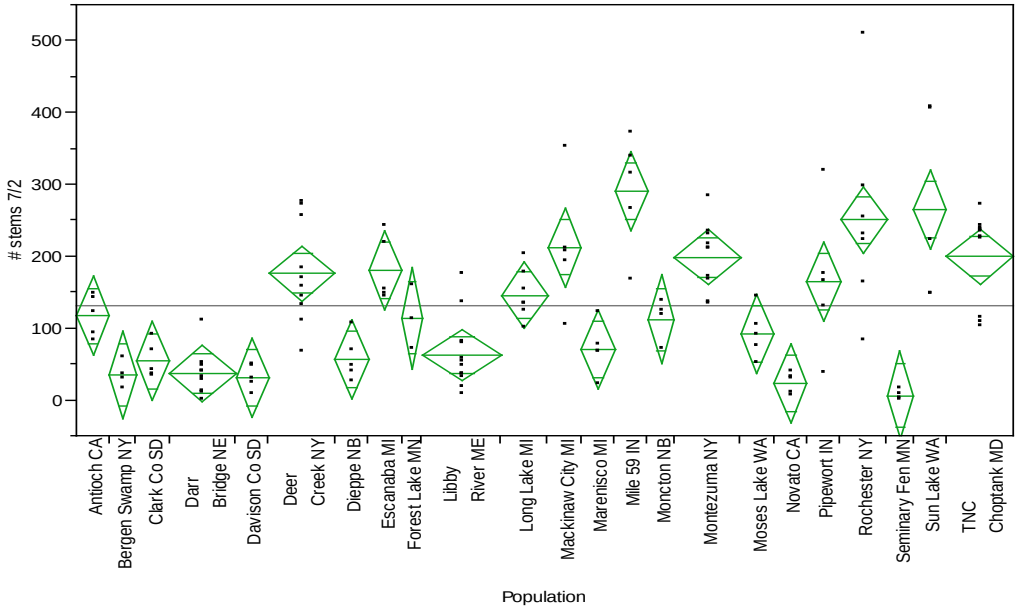


Significant differences in performance among populations

No significant differences observable by origin

Growth habit of native and introduced *Phragmites* (# of stems)



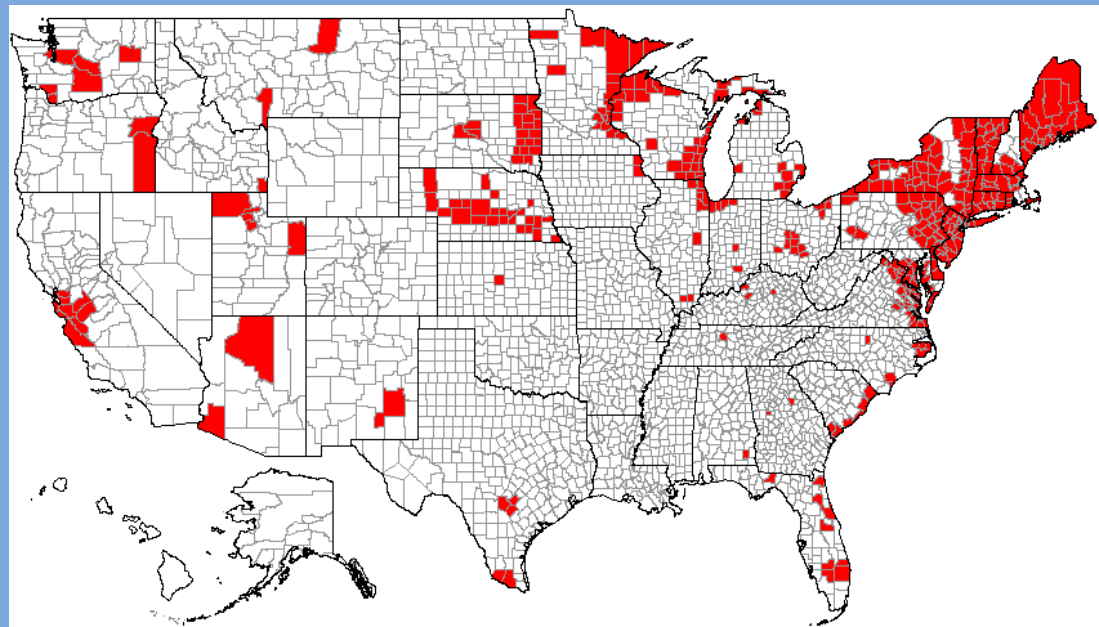


Large variation among populations but not based on origin

What is the importance of ecological impacts?

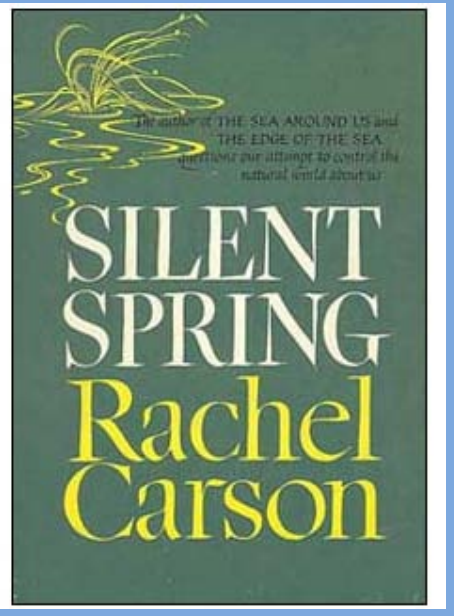
- Nationwide questionnaire (2009)
  - **285 respondents: 40 states, 425 counties**
  - **12.3% of continental US land area**
  - **$22 million / yr (10% of federal IS budget)/ $4million/yr for Phrag**
  - **>90% managers motivated by conservation (species/function) concerns**

- **<u>Goal is to reduce IMPACT not abundance of Phrag to benefit native species</u>**



How did we get to this point?

Invasive plant control: nature.nps.org



Conservationists as major users of herbicides!

No long term assessment of effects

$4million annually for *Phragmites* control

Conservation benefits?

Control success using herbicides?

Short term vs long term

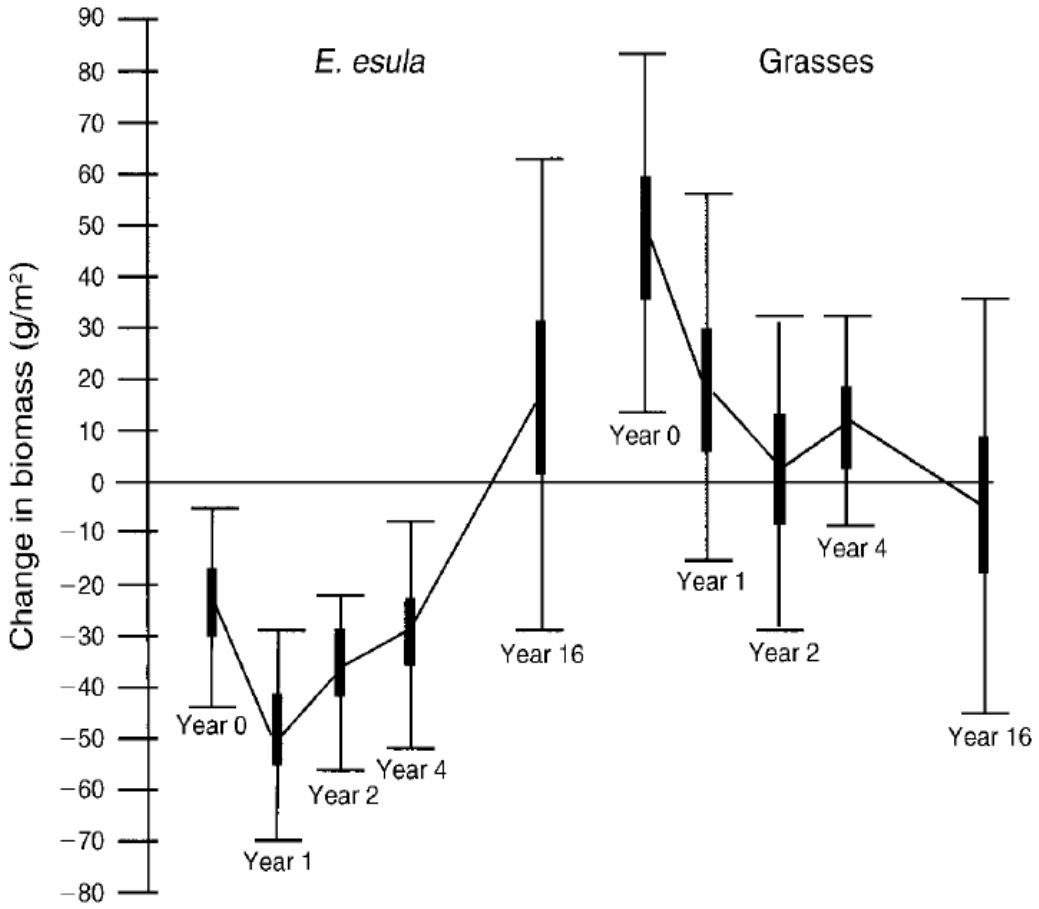


FIG. 2. Change in *Euphorbia esula* and grass biomass due to herbicide use one month (year 0) and 1, 2, 4, and 16 years after herbicide application. Lines connect posterior distribution modes, while "boxes" and "whiskers" denote 75% and 95% Bayesian credibility intervals, respectively.

Control efforts target large populations

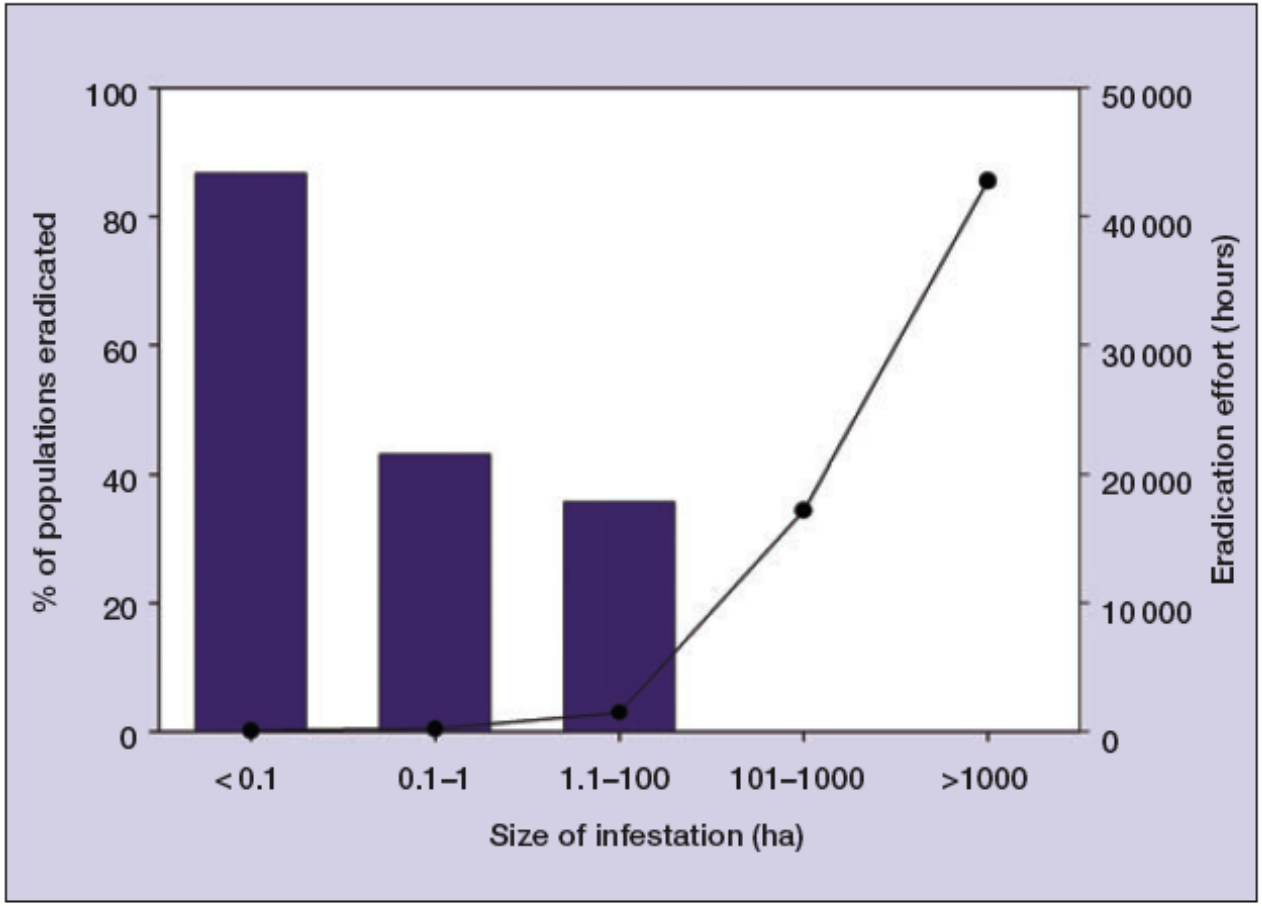
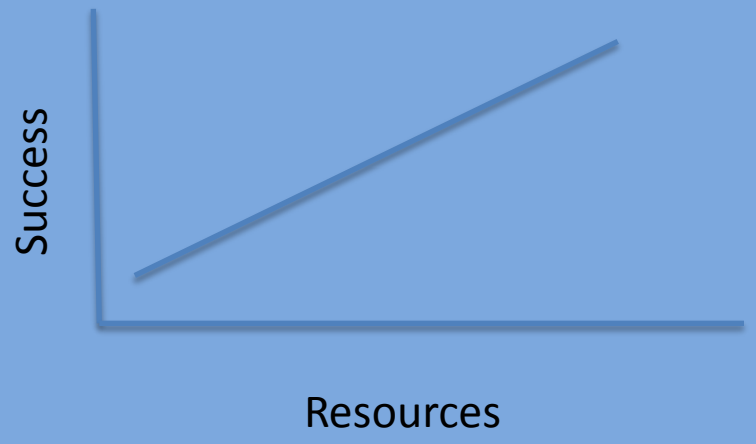


Figure 5. *Percentage of infestations of alien plant species in California that were successfully eradicated (vertical bars) and the amount of effort expended on eradication (black line), as a function of the area of the initial infestation. From data of Rejmánek* et al. *(2005).*

Questionnaire highlights

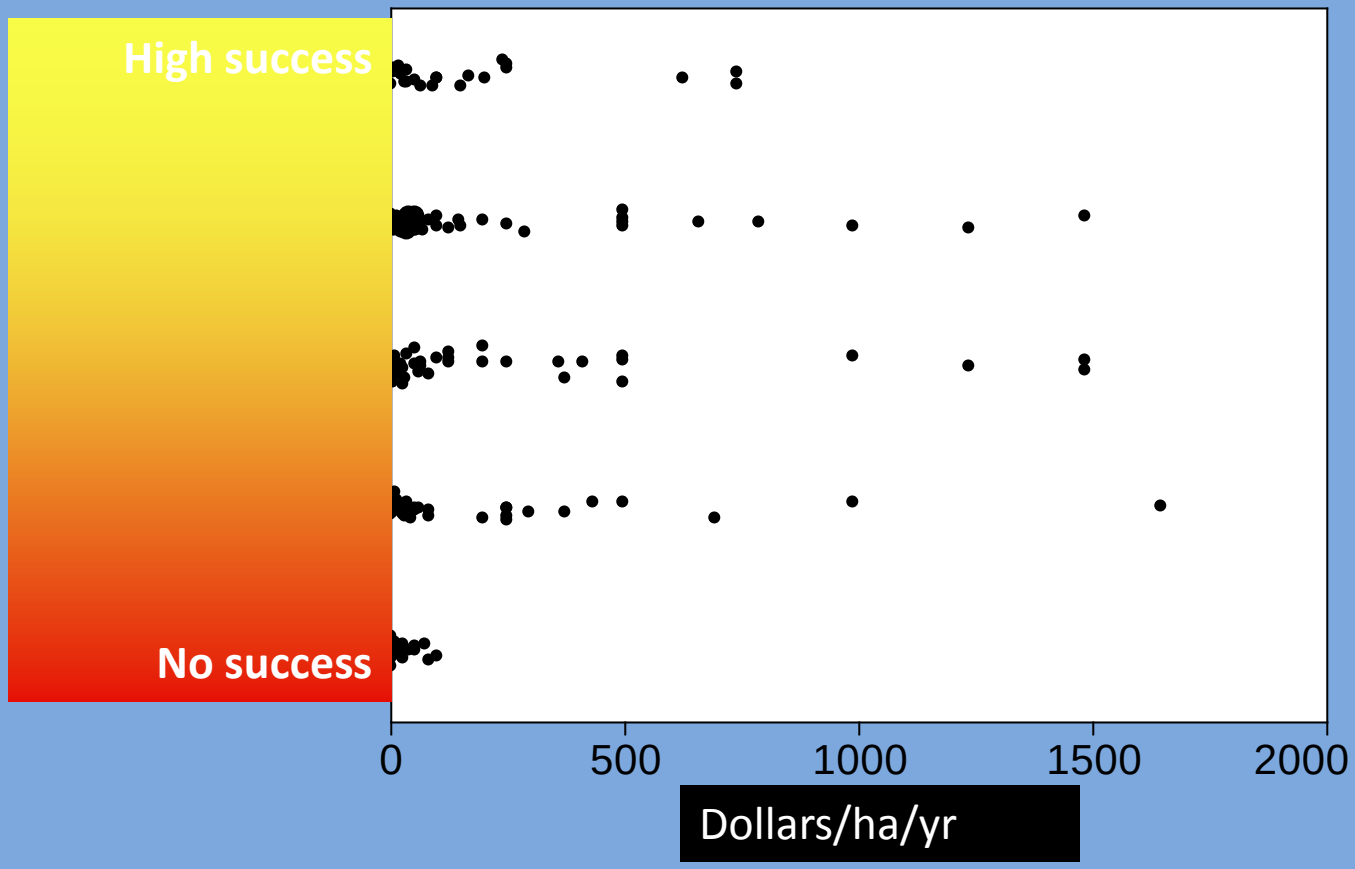
(self evaluation, 1-5 Strongly agree - strongly disagree Likert scale)

- Success
  - 54% Short term control
  - 45% increase in # of native species
  - 38% long-term control (36% disagree)
  - 25% increase in abundance of native species (34% disagree)
- Constraints
  - 62% Lack of $
  - 73% Lack of personnel



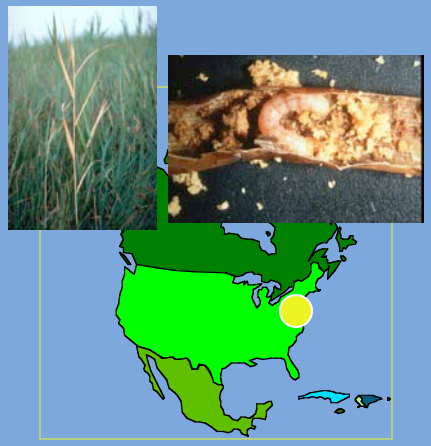
Money and Time ≠ Success

Long-term *Phragmites* control

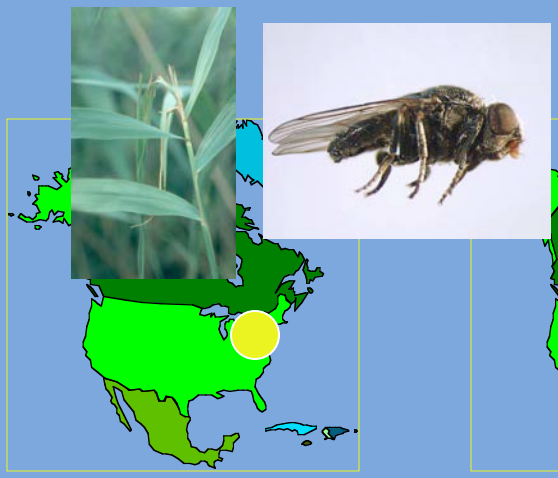


Herbivore distributions in North America

Chaetococcus



Rhizedra lutosa



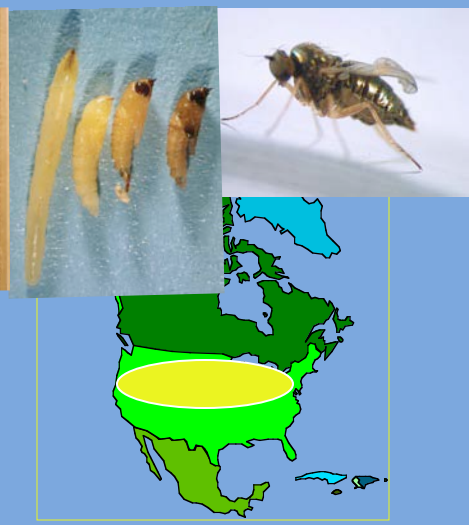
Lipara similis

Lipara rufitarsis

Lasioptera hungarica

Calamomyia

Tetramesa



Thrypticus

Biocontrol candidates

- ***Archanara* spp. (3)** **Noctuidae**
- ***Arenostola phragmitidis*** **Noctuidae**
- *Rhizedra lutosa* Noctuidae
- *Phragmataecia castaneae* Cossidae
- *Chilo phragmitellus* Pyralidae
- *Schoenobius gigantellus* Pyralidae
- ***Platycephala planifrons*** **Chloropidae**

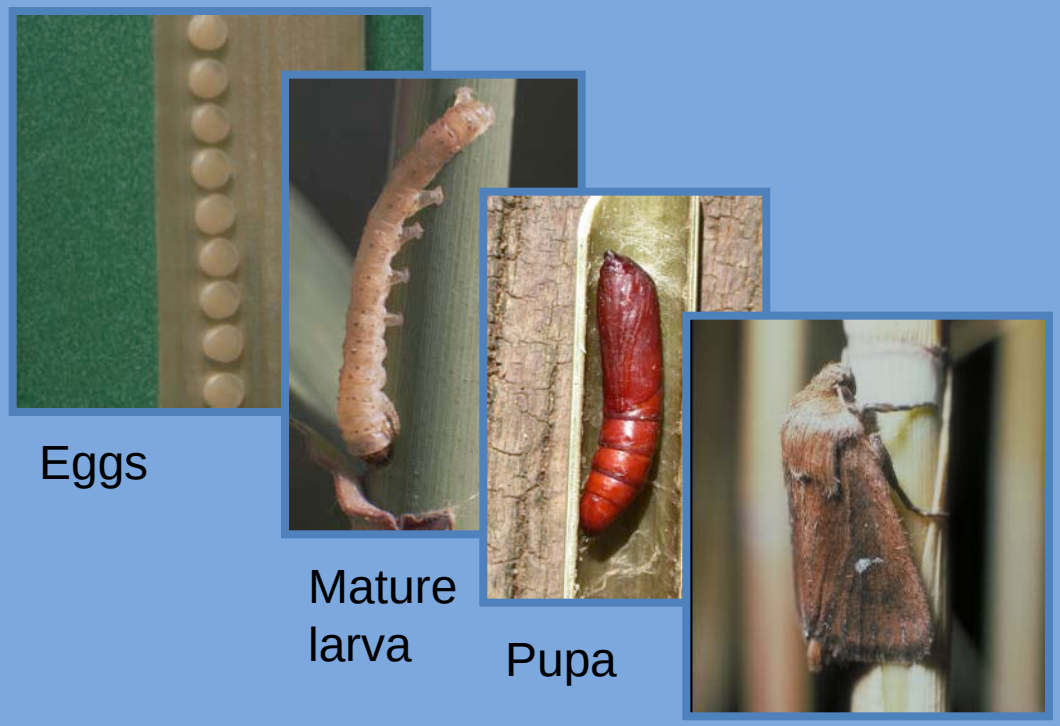
Noctuid moth species

Archanara dissoluta

Archanara neurica

Arenostola phragmitidis

Life cycle of *A. geminipuncta*



Eggs

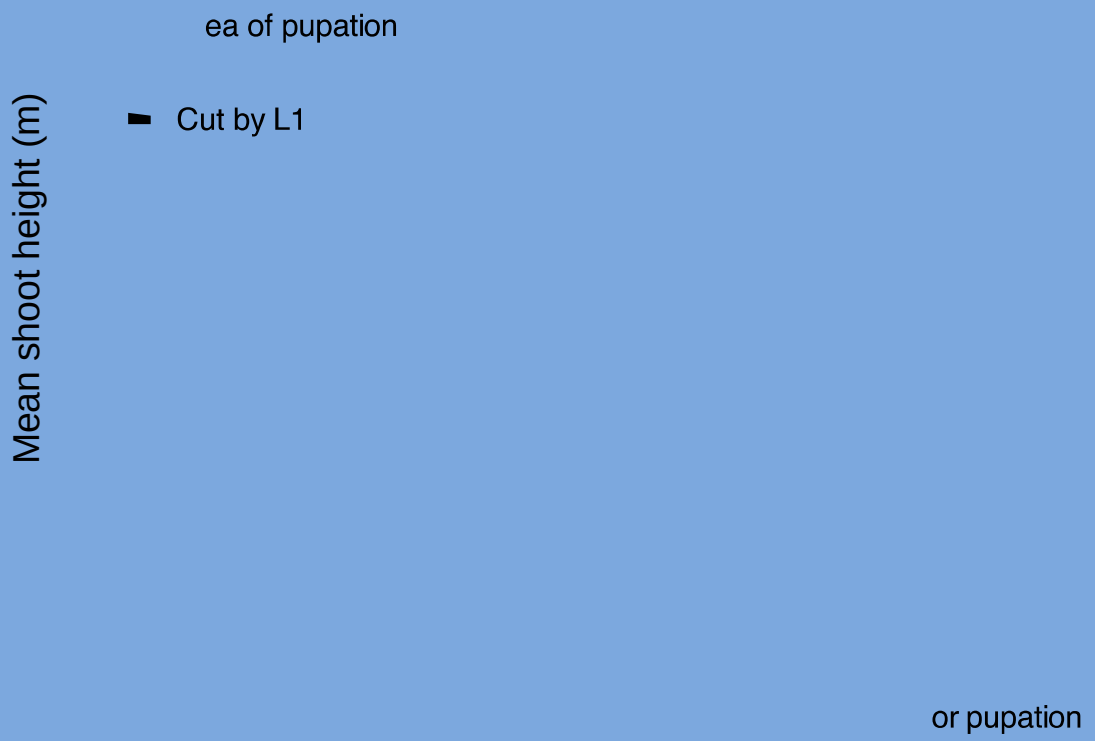
Mature larva

Pupa

Adult

Damage

Life cycle of *Archanara geminipuncta*

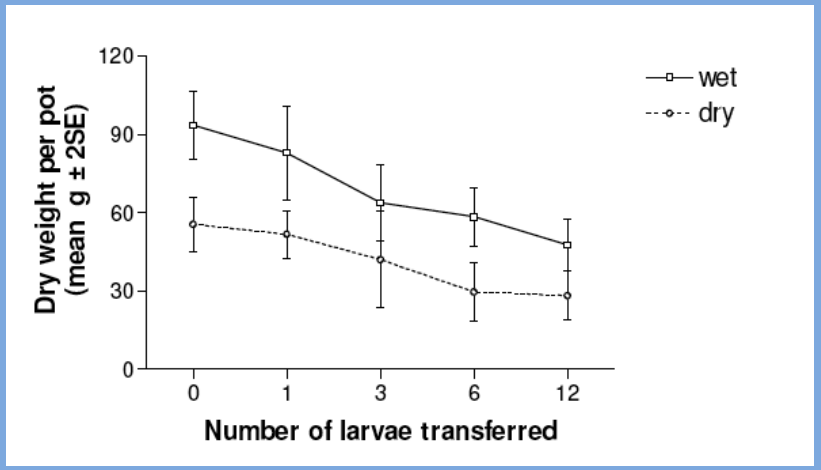


Archanara impact

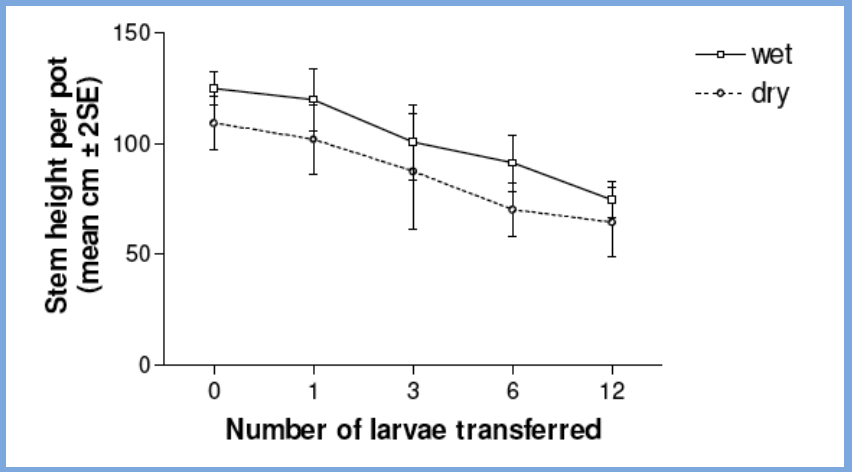
Reduced biomass production under wet and dry conditions

Decreased stem height under wet and dry conditions

Biomass

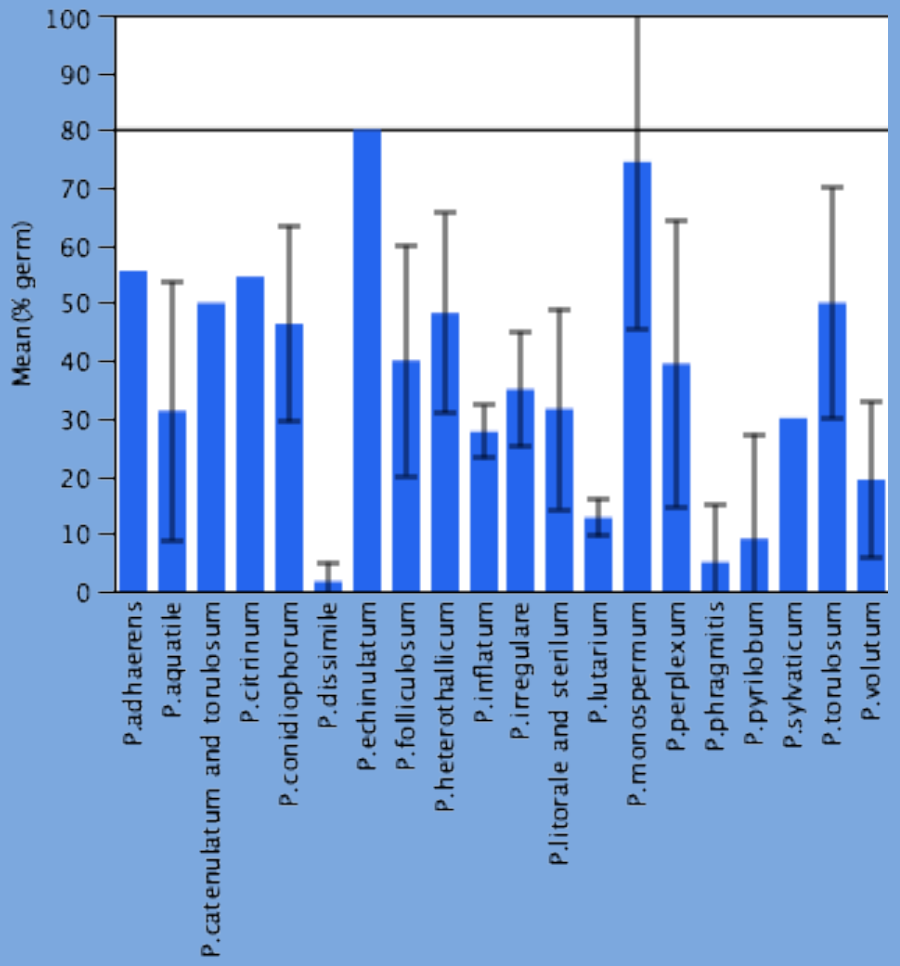


Stem height



Pathogenicity testing of *P. australis* associated oomycetes

- Screened over 260 isolates, BLAST matches to over 20 species of oomycetes, genus *Pythium*
- Looked at seed germination and seedling survival
- Wide range of pathogenicity between and within species



Status of biocontrol development in 2011

Host specificity screening status

- continues in Europe and at URI
- Critical test plants are native subspecies (population variation?)
- Strong preference for introduced but some attack may occur on native

BC questionnaire results

- 91% approve is species are specific (2% never approve)
- 46% approve in native attacked but pops do not decline
- 18 approve even if native decline
- Representative of society at large? (managers were asked)

3-5 years away from completing everything

Regulatory approval uncertain at APHIS under current leadership

Embed biocontrol in conservation

- Different discourse
  - Protection of diversity, not control of single species
  - Conservation/restoration replaces pest control mindset. Know what you want.
  - Form alliances. From assessment of impacts (invader + control options), to implementation and follow-up, including restoration
  - Successful biocontrol only provides short-term “windows of opportunities”

The future of *Phragmites* management: a few proposals

- Know what you want
  - (plant and animal communities / ecosystem function) for specific habitats
- Assess success of different management approaches (mechanical, chemical, etc.) to achieve desired outcome
  - Measure indicators, not just *Phragmites*
  - Monitor long term (not just Phrag)
  - Have controls (untreated areas)
  - Reward protection instead of area treated
  - Target early/small areas
    - (if you think you need aerial treatments it is too late)

- Develop active restoration
  - Propagule pressure of other invaders often higher than desired natives
  - Created “nurseries” (largely for plants) as source materials

The future of *Phragmites* management: why biocontrol?

- Increases “connectivity” of food webs (more loops)
  - From stems to moths to birds to bats to hawks to microbes
  - Not just plants to microbes
- Potential reductions in the size of monocultures
- Potential widespread control
  - Only an ecological success if not replaced by another invade/monoculture

- Revenge effects of widespread herbicide use (Remember Rachel?)
  - Long term impacts of herbicides on amphibians, invertebrates, turtles, crabs, plants, fish, humans