

Biological Control of Aquatic Invasive Species:

U.S. Army Corps of Engineers

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Current Biocontrol Projects

- Hydrilla
- Giant salvinia
- Water hyacinth
- Alligatorweed



Hydrilla

(Hydrilla verticillata)



Hydrilla

- Two leaf-mining flies

- *Hydrellia pakistanae*

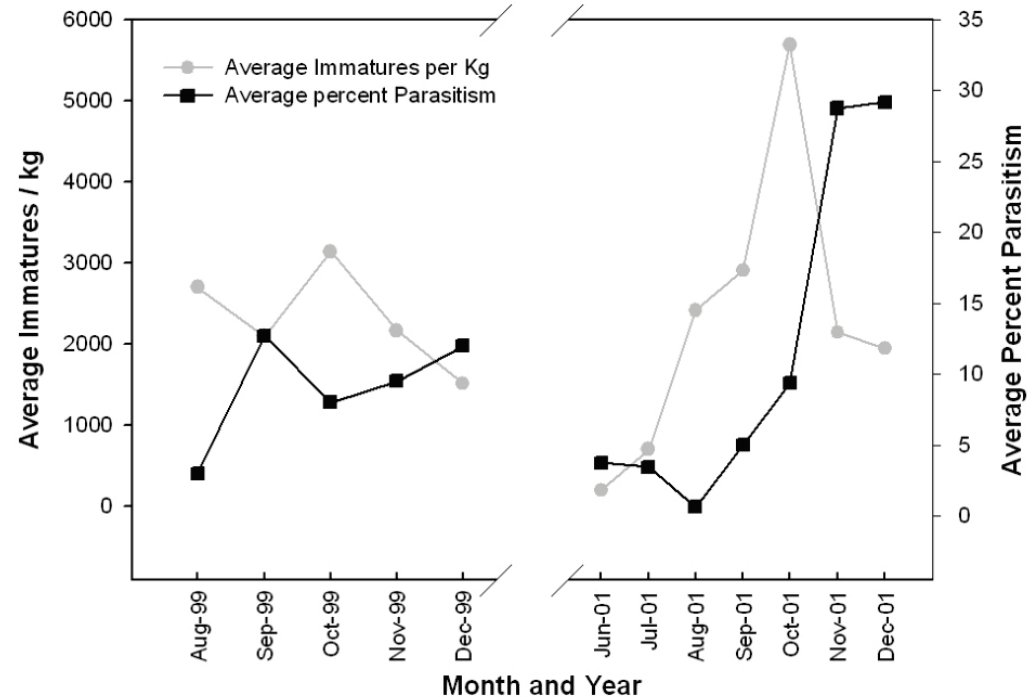
- *Hydrellia balciunasi*

- > 28 million flies released at 30 sites in 6 states

- Established in 80% of sites

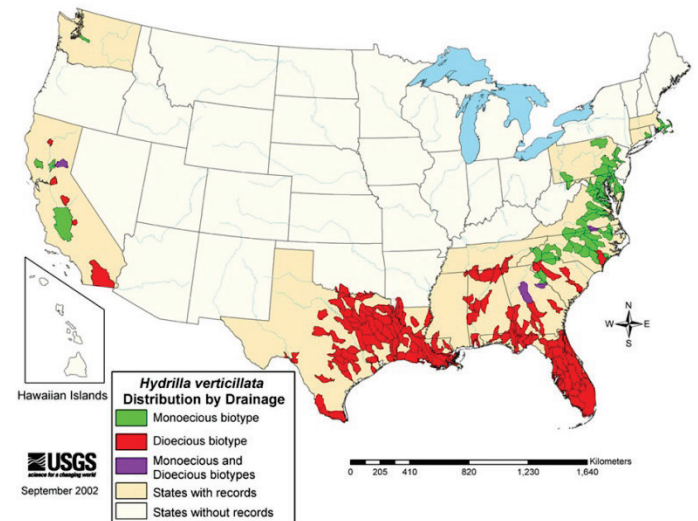
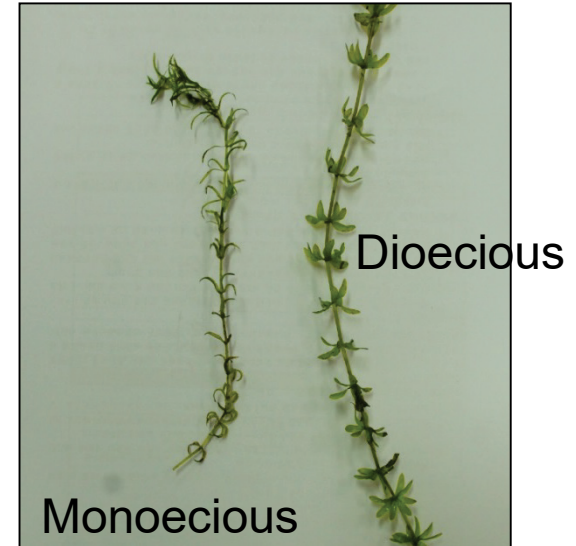
- Impacts highly variable

- Parasitism by native wasp



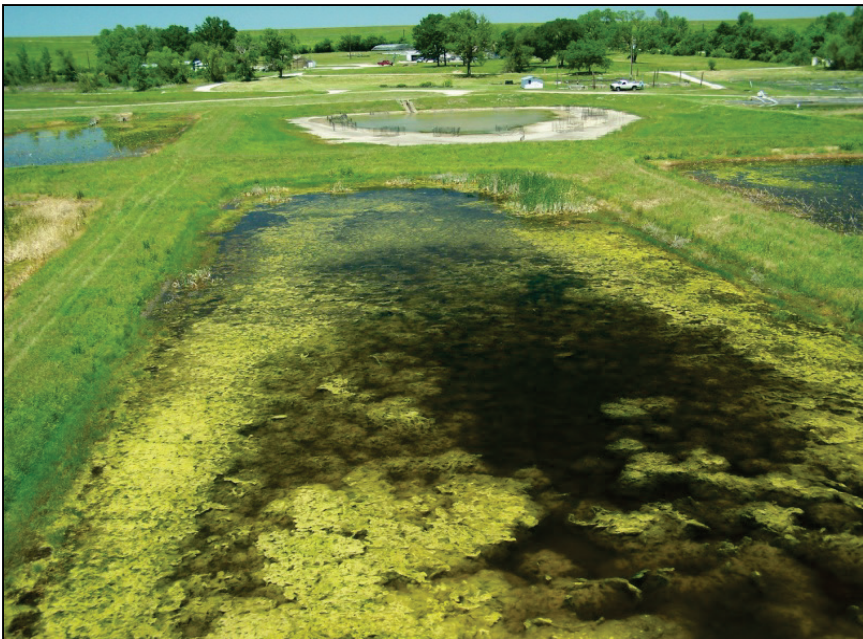
Hydrilla Biotypes

- **Dioecious & monoecious**
 - Differences in biology
- **Contrasting studies**
 - Reported success on monoecious biotype with caveat
 - Year round presence of hydrilla
- **Problem with overwintering?**



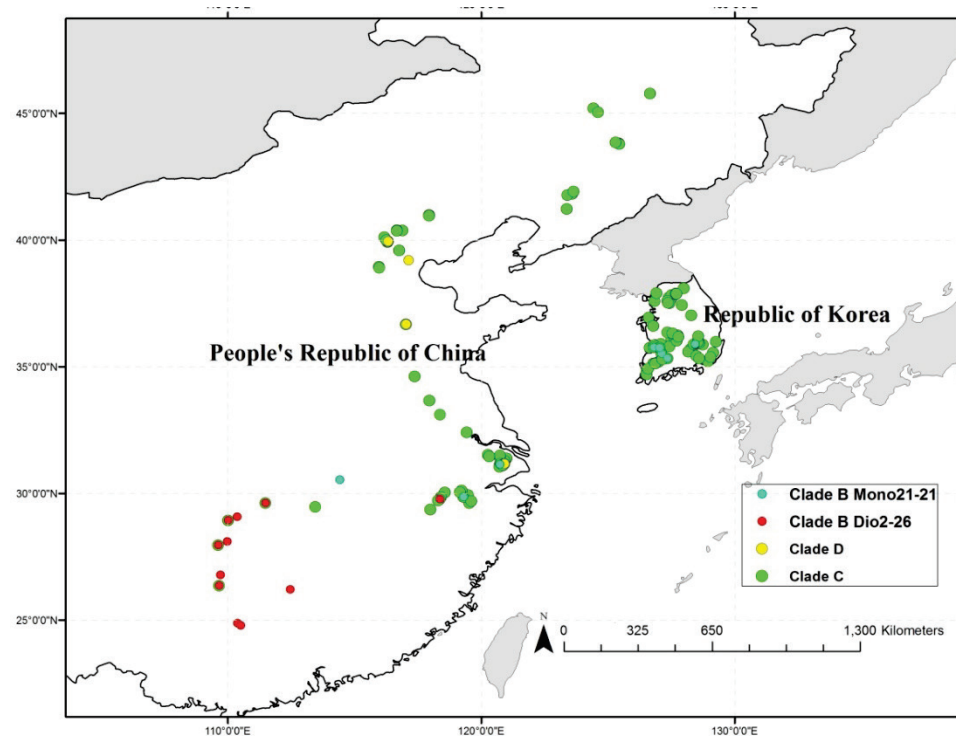
Overwintering of *H. pakistanae*

- 1st and 2nd instar
- Upper 20cm of plant
- Monoecious genotype senesces to root crown!
 - Not suitable as agent



Hydrilla

- Multiple hydrilla genotypes in US
- Surveys in 2013-2016 identified matching genotypes in S. Korea and China
- Current work
 - Prioritizing agents
 - Seasonal phenology & herbivory studies
 - Working with CSIRO to determine identity of specimens & initiate cultures



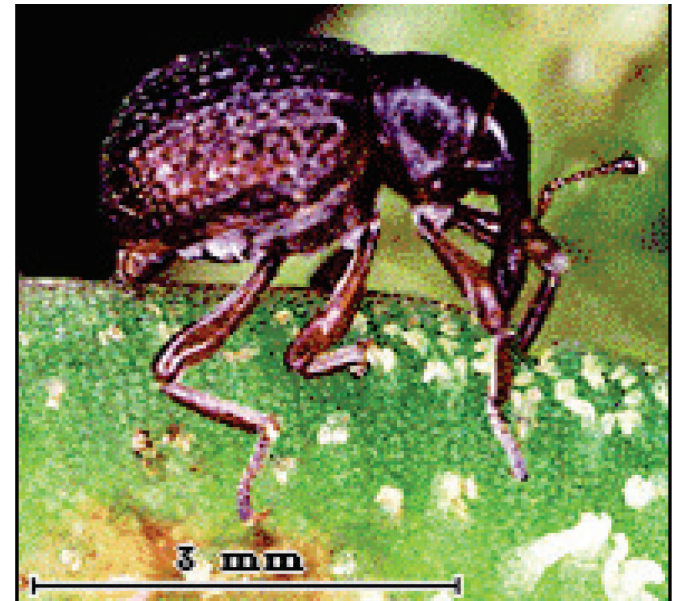
Giant Salvinia

(*Salvinia molesta*)



Giant salvinia

- Present in at least 12 states
- **Salvinia weevils (*Cyrtobagous salviniae*)**
 - Successful at controlling giant salvinia in 15 countries
 - Success remains low in the US



Salvinia Weevil

Control by *Cyrtobagous salviniae*

July 2005

July 2006



Can be spectacular!

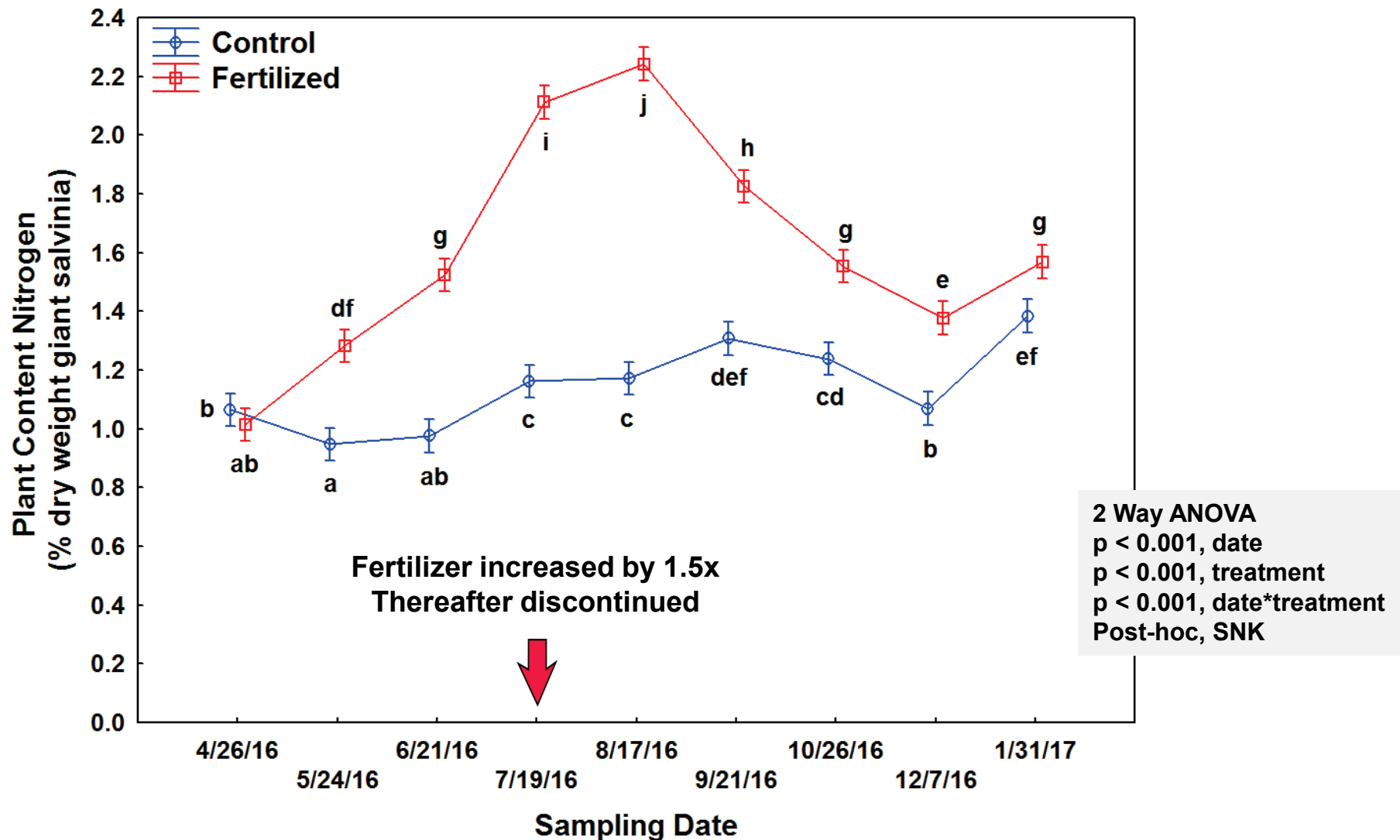
Giant salvinia

- Reared by USACE since 2003
 - 716K released in 2016
- Variable success within regions
- What is the limiting factor?
 - Plant quality
 - Overwintering success

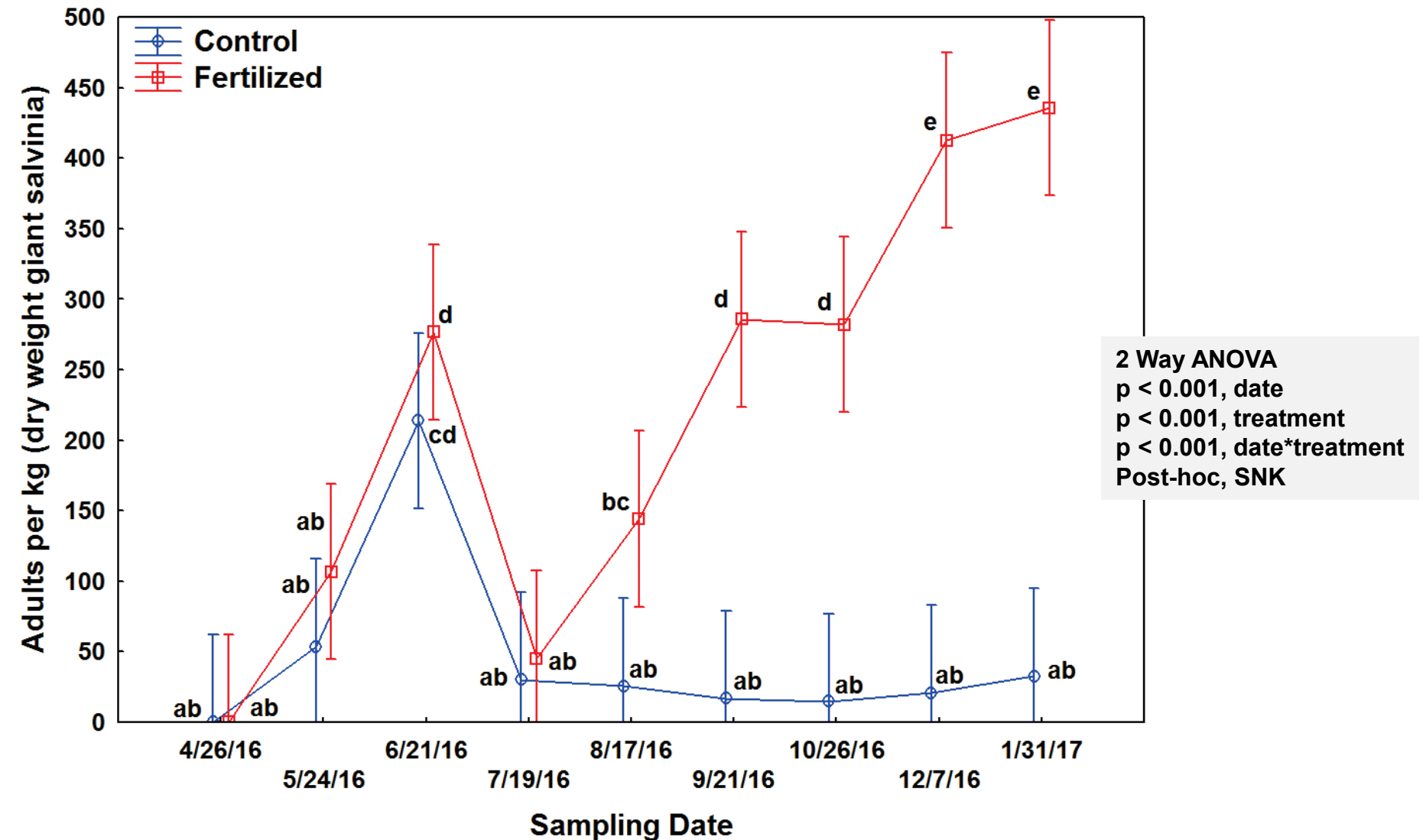


***Cyrtobagous salviniae*-
“Salvinia Weevil” (1999)**

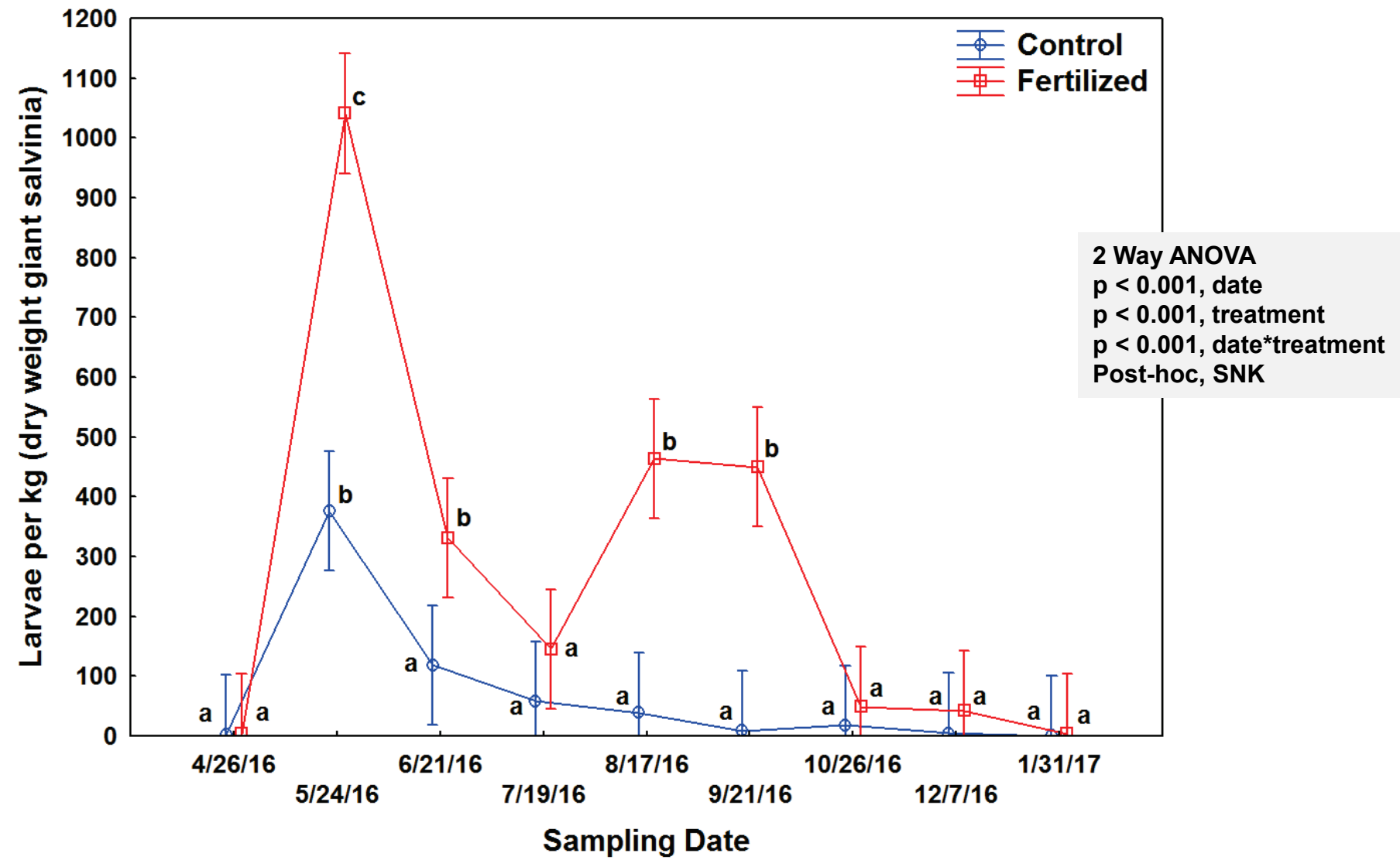
Plant Nitrogen Content



Adult Weevil Density



Larval Weevil Density



Overwintering / Cold Tolerance

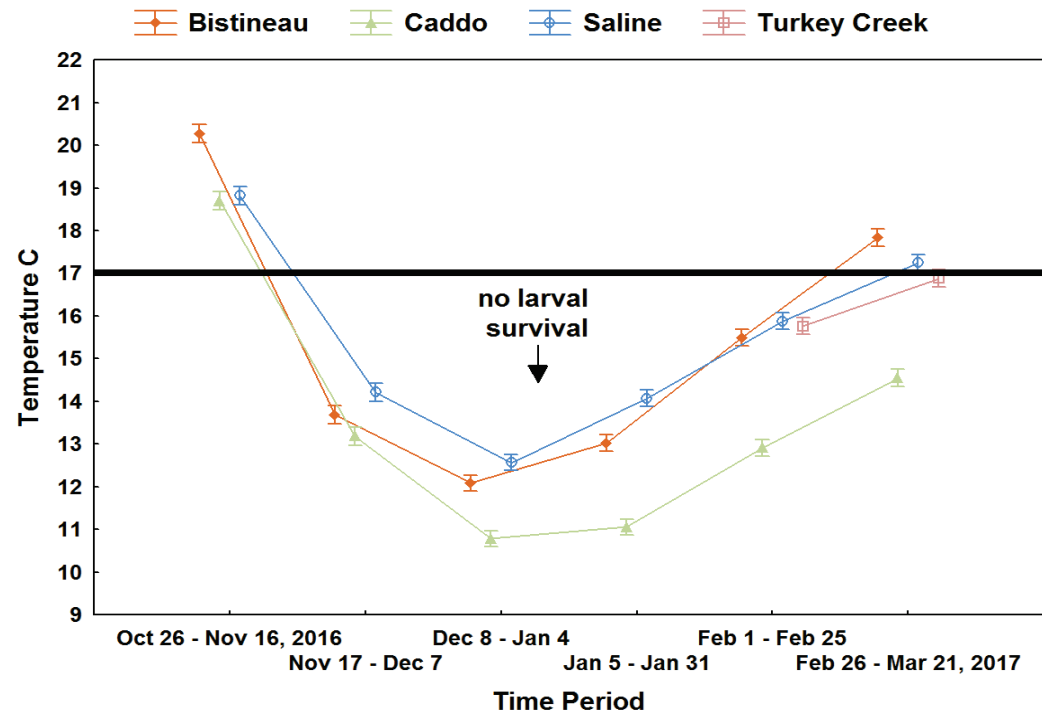
- **Adult survival at 0°C**
(Mukherjee et al. 2014)

- LA and TX weevils

- Approximately 24 hrs
 - 50% mortality at 25 hrs
 - 90% mortality at 30 hrs

- Cold tolerant Australian ecotype

- 50% mortality at 34 hrs



Water hyacinth

(*Eichhornia crassipes*)



Water hyacinth present in LA for >100 yrs



- Widespread in southeastern US
- Biocontrol initiated in 1970's

Eichhornia crassipes (Mart.) Solms (Waterhyacinth)



Nechoetina eichhorniae
"Mottled Waterhyacinth Weevil"
(1972)



Megamelus scutellaris
(2010)



Niphograptia albiguttalis
"Waterhyacinth Moth"
(1977)



Nechoetina bruchi
"Chevroned Waterhyacinth Weevil"
(1974)



- *Acremonium zonatum*
- *Alternaria eichhorniae*
- *Cercospora piaropi*
- *Uredo eichhorniae* (rust)

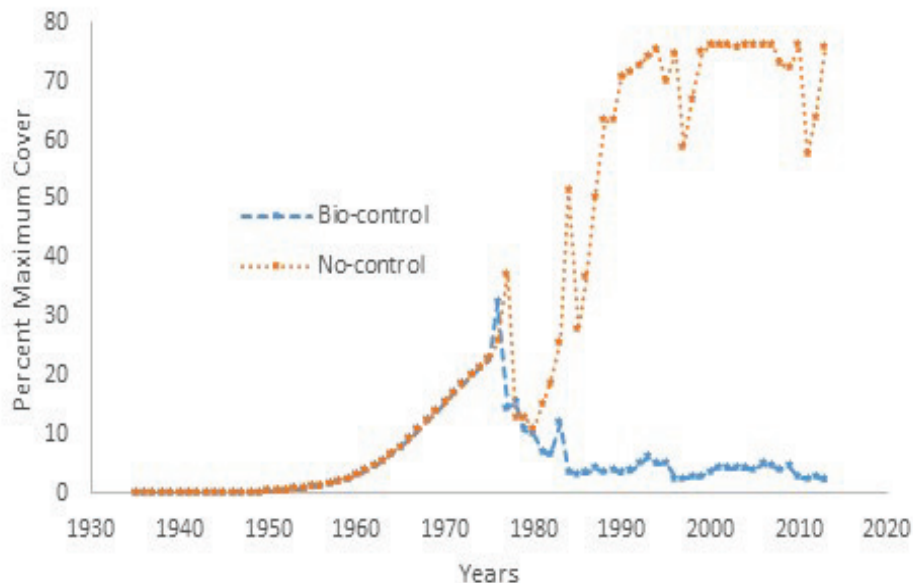
Megamelus scutellaris

- Reared by USACE since 2010
- Heat-sensitive strain
- New lineage from USDA in 2015
- Tentative establishment in LA



Value of water hyacinth control

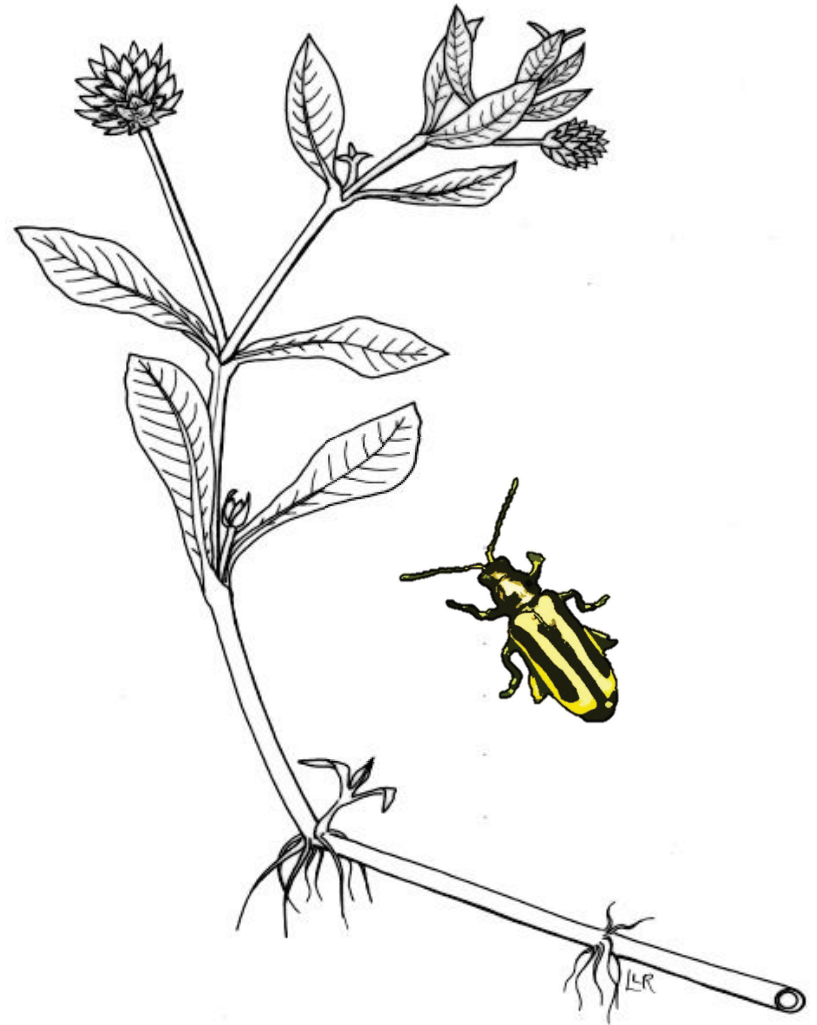
- USACE partnered with U of Maryland economist
- Spending on control/research since 1974- **\$112M**
- Estimated EGS benefits to be **~\$700M** per year



Impact	Affected Users/Entities	Cost of Impact (×1,000 \$2010/year)	
		1987	2010
Recreational freshwater fishing	583,483 anglers	\$412,872	\$675,512
Recreational waterfowl hunting	19,400 waterfowl hunters	\$5,159	\$8,335
Boat-related businesses	400 marinas (Southern Louisiana only)	\$4,550 – \$8,050 ¹	\$5,200 – 9,200 ¹
Drinking Water Supply	77 drinking water intakes	\$59 – \$210	\$83 – \$295
Total		\$424,466	\$691,236

Alligatorweed

(Alternanthera philoxeroides)

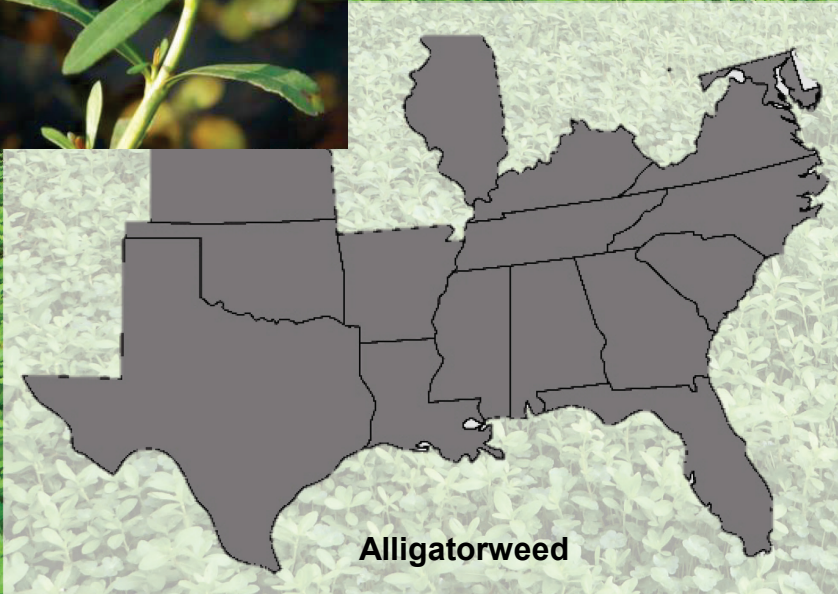


Alligatorweed

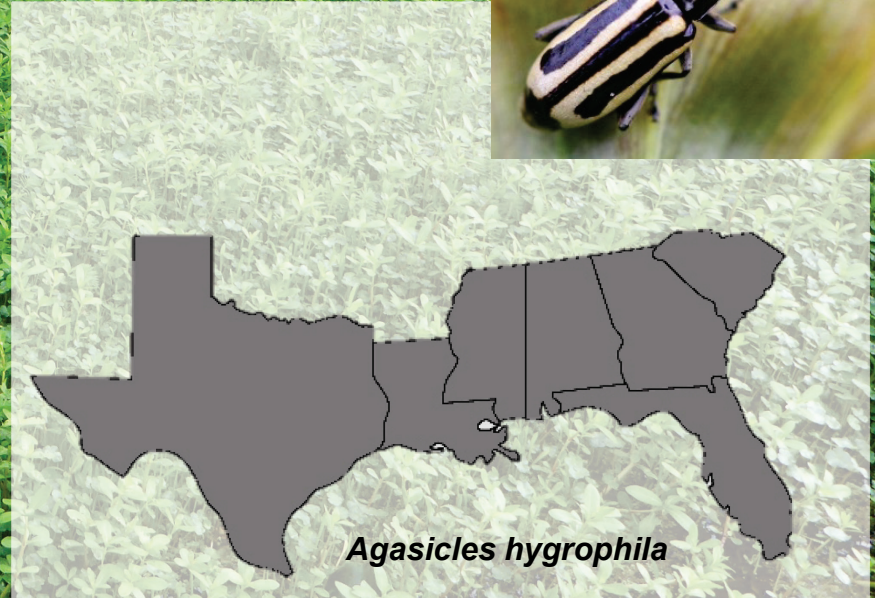
- Present in US for >100 yrs
- Largely limited to southeastern US
- *Agasicles hygrophila* limited by winter severity
 - Disperses annually to colonize northern sites



Distribution in US

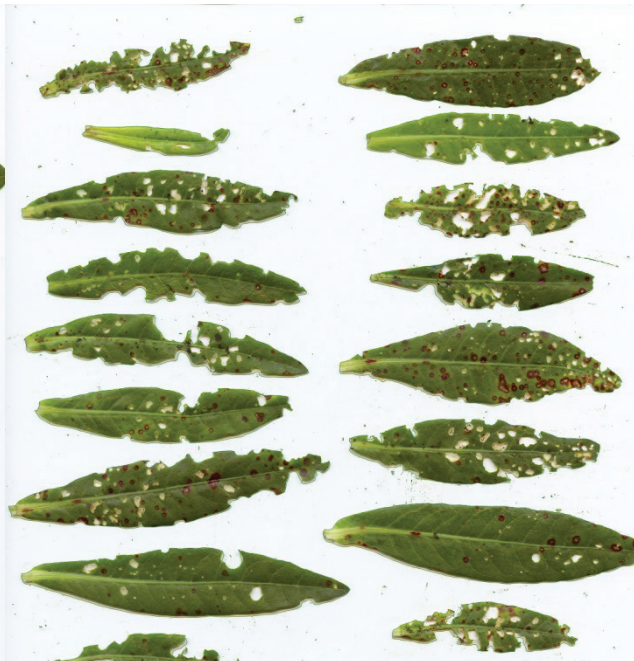


Alligatorweed



Agasicles hygrophila

A. hygrophila limited to mean winter temperature of $>10^{\circ}\text{C}$ (Julien et al. 1995)



4/09/15



5/08/15



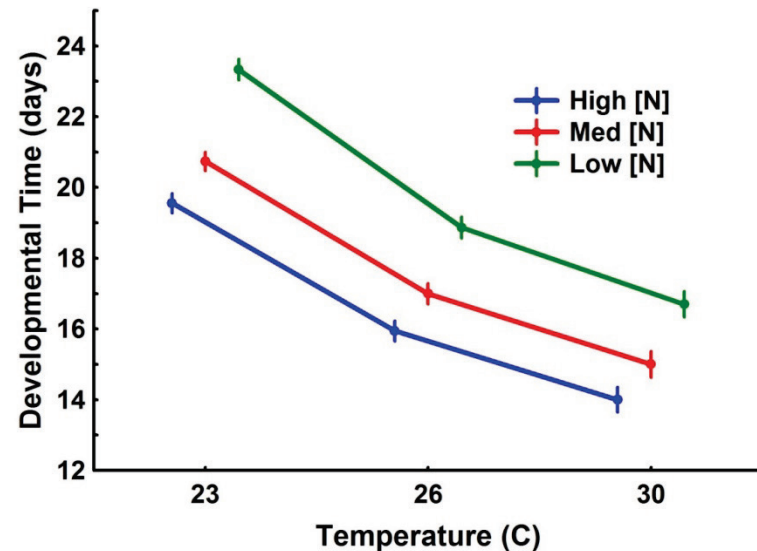
5/19/15

Combined effect of temperature and foliar nitrogen on *A. hygrophila*

Larval development

Nitrogen and temperature effects were additive.

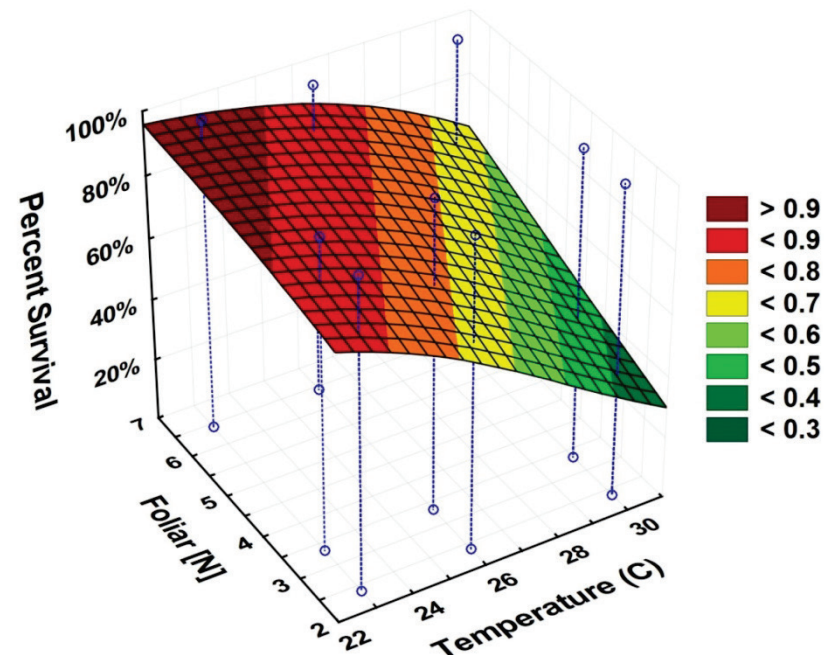
Developmental time was reduced 16% due to N.



Larval survival

High temp: survival increased with higher nitrogen

Low Temp: survival not greatly impacted by nitrogen



Summary

- USACE has an active biocontrol program
 - Foundational and applied research
 - Laboratory and field scale
 - Biocontrol agent field establishment
 - Rearing
 - Release
 - Monitoring



Questions?

