An Ecological Approach to *Submersed* Aquatic Plant Management

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Ponds, greenhouses, mesocosms, labs

Why do non-native, invasive aquatic plants cause problems in the US?

Held in check in their native waters by:

- Biological controls (predators, pathogens)
- Environmental conditions
  - Nutrient limitation
  - Seasonality
  - Hydrological cycles/events (floods and droughts)
- Competition with other aquatic plant species

When non-native, invasive aquatic plants arrive in the USA they find …

Man-made systems

- Altered hydrology
- Dampened water level fluctuations
- High nutrient loads

When non-native, invasive aquatic plants arrive in the USA they find …

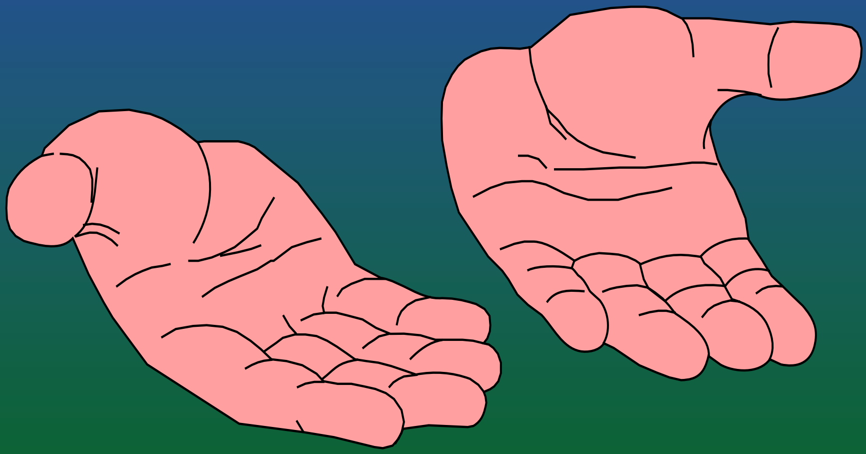
Man-made systems often lack aquatic vegetation

Natural systems have often been so disturbed that they too have lost their vegetation

Unlike terrestrial systems, these empty niches can be persistent

So when non-native, invasive aquatic plants arrive in the USA …

not only have they escaped their coevolved biocontrols, but they also find an inviting environment …



Why do non-native, invasive aquatic plants cause problems?

but there is still more …

The non-native aquatic plants that cause problems are invasive because of their *biological and ecological characteristics!*

Non-native, invasive aquatic plants are *disturbance specialists*

- **Ruderal, pioneer, or weedy species**
  - **Rapid growth rates**
  - **Broad tolerance ranges**
  - **Early maturation and reproduction (fragmentation)**
  - **Adapted for dispersal (fragmentation)**
- **The species that cause widespread problems are simply the *best adapted weeds in the world* for colonizing empty niches!**

"World-class" weeds in the US

Giant salvinia *(Salvinia molesta)*	Brazil
Waterhyacinth *(Eichhornia crassipes)*	South America
Hydrilla *(Hydrilla verticillata)*	Southeast Asia
Eurasian watermilfoil *(Myriophyllum spicatum)*	Europe/Asia

We have done it to ourselves!

We have created near ideal conditions for aquatic weeds!

- The empty niche is exploited by nonindigenous, weedy species
- Eutrophic conditions contribute to rapid growth and spread
- A lack of biological controls ensures rapid growth

New colonies can expand rapidly

Management can contribute to the problem

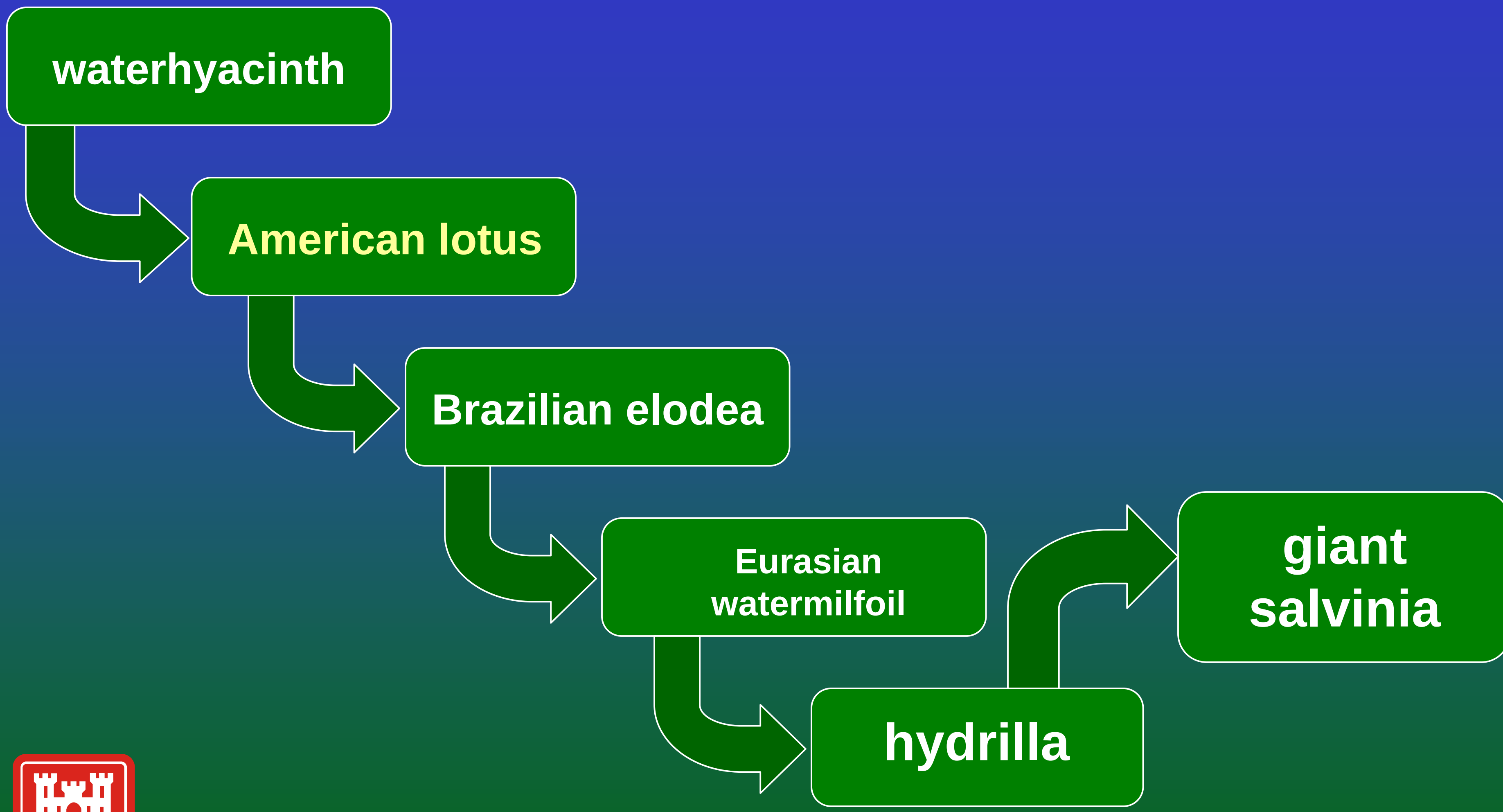
Waterhyacinth problem in Florida

“Successful” elimination of waterhyacinth?

Management or Mismanagement?

- **Large-scale management actions (herbicides, grass carp, drawdown) are major disturbances and they serve to set the system back to the empty niche condition**
- **Empty niches invite colonization by weedy species**
- **Repetitive action of this type results in "*survival of the weediest*". Our management actions are often exerting strong selection pressure for the worst weed!**

Example: ‘Successional’ history of Caddo Lake, Texas



Whole-lake treatments need to be conducted with great caution

- Stable water levels
- Abundant shallow water
  (Light limits depth distribution)
- High nutrient loads and a lack of filtering wetlands
  (watershed activities, STPs, septic fields, excess lawn fertilization)

= plants!

- Lack of biological controls
  (predators, pathogens)
- Lack of competing aquatic plant species

= weedy plants!

There's got to be a better way!

Under the Corps of Engineers' Aquatic Plant Control Research Program we have been developing *holistic, ecological approaches to aquatic weed problems*

Integrated Plant Management (IPM)?

What is Integrated Plant Management?

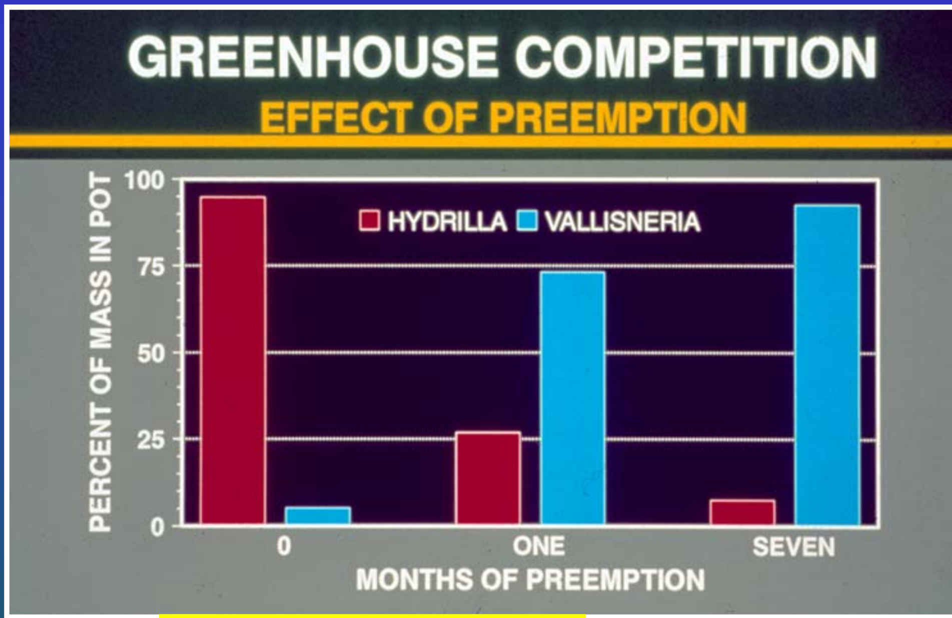
Integration of approaches into a pest (plant) management system that uses an array of complementary methods and takes into account the *ecology* and all relevant interactions that management practices may have on the environment

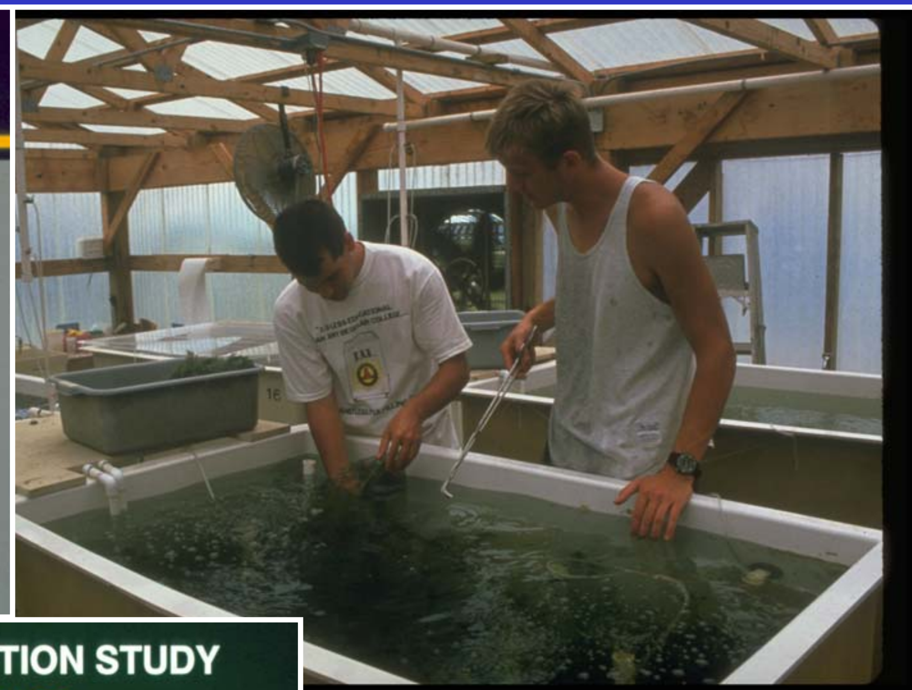
- **Chemical Controls**
- **Natural predators and parasites – host-specific Biological Controls**
- **Physical techniques (drawdown, harvesting)**
- **Grass carp (*Ctenopharyngodon idella*)**
- **Native plant restoration**

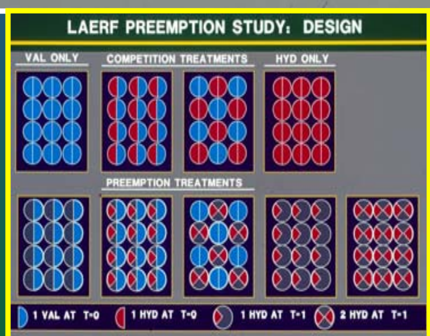
An Ecological Approach to invasive aquatic plant problems

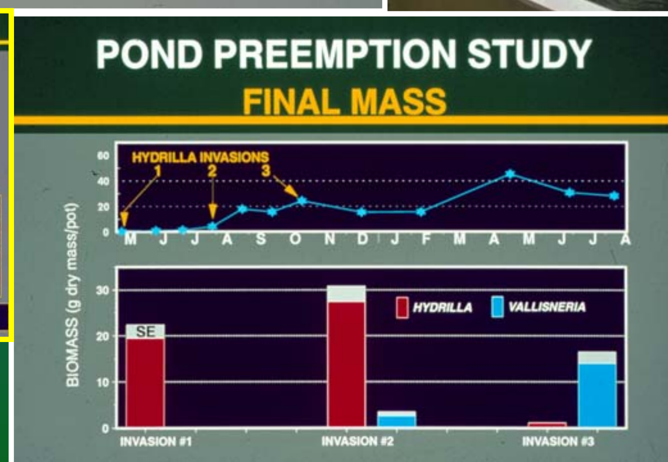
- Control invasive species
- Introduce host-specific biological controls
- Introduce a variety of native plant species
- Reduce disturbances and excess nutrient loading
- Monitor plant community
- Take prompt remedial action

Native plants can resist invasion





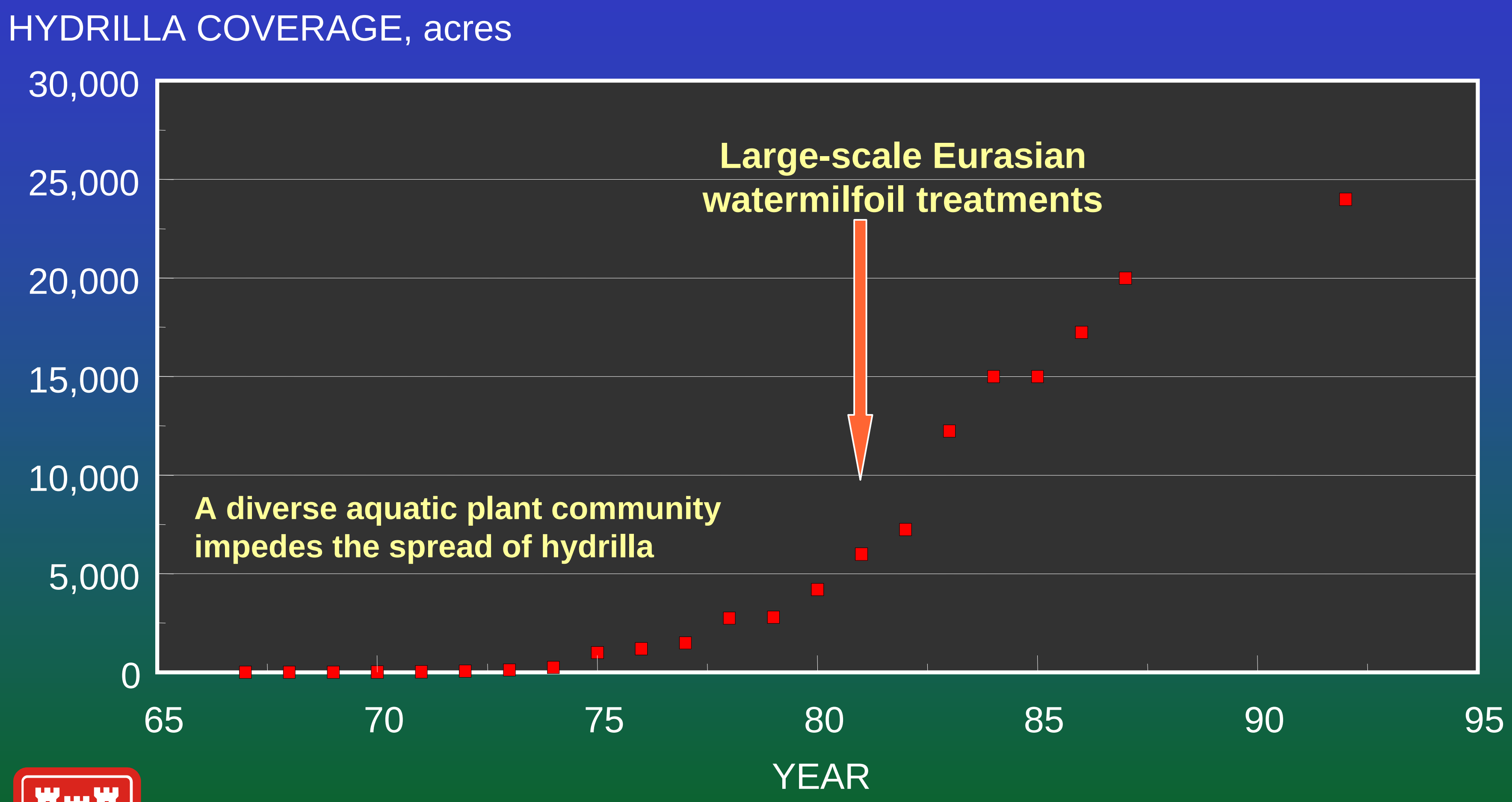




Preemption is the key to resistance!

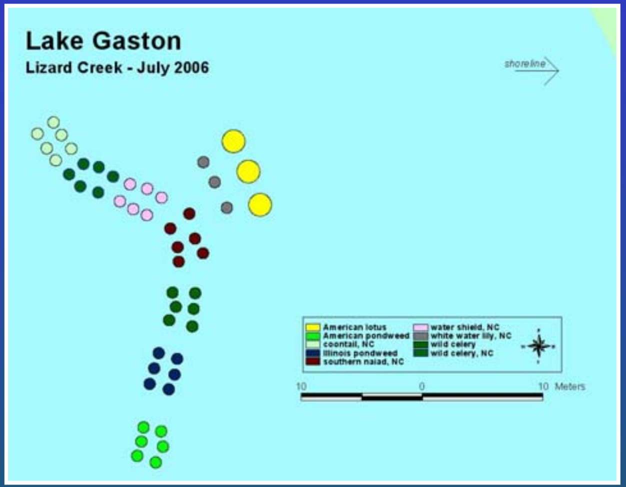
Lake Seminole, Florida

Hydrilla first observed 1967



The best defense (against nonindigenous invasive aquatic plants) is a good offense!

"Founder Colony" plantings ensure native plant propagules are available to fill the empty niche



Hydrilla verticillata

Interfere with:

- **Navigation**
- **Flood protection**
- **Recreation**
- **Water supply**
- **Hydropower production**
- **Fish and wildlife habitat**

3 – 3.5 M water depth

"tubers"

Biological Control Options
Hydrilla leaf-mining flies

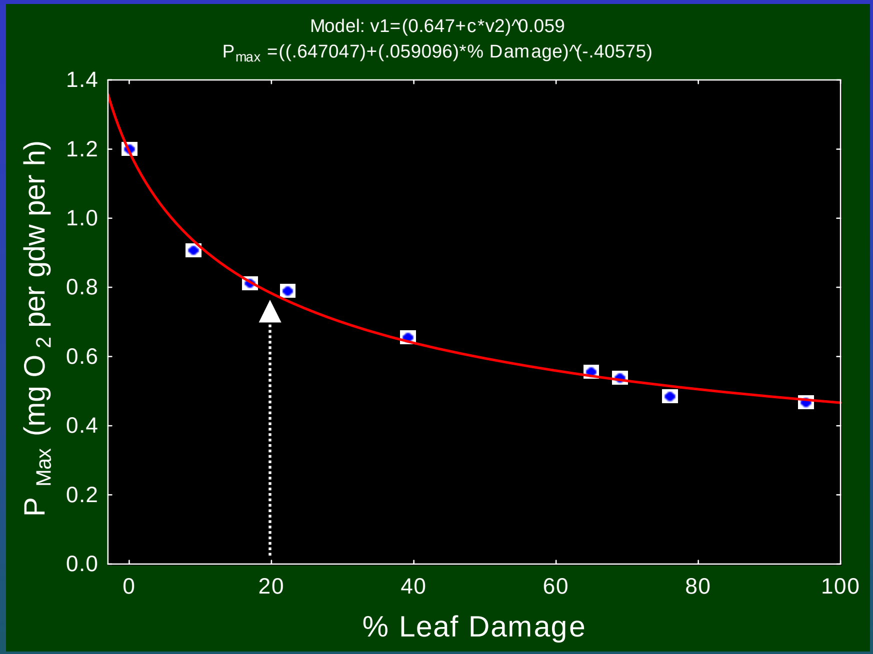
Adult

Larva feeding

Impacts of *Hydrellia* feeding

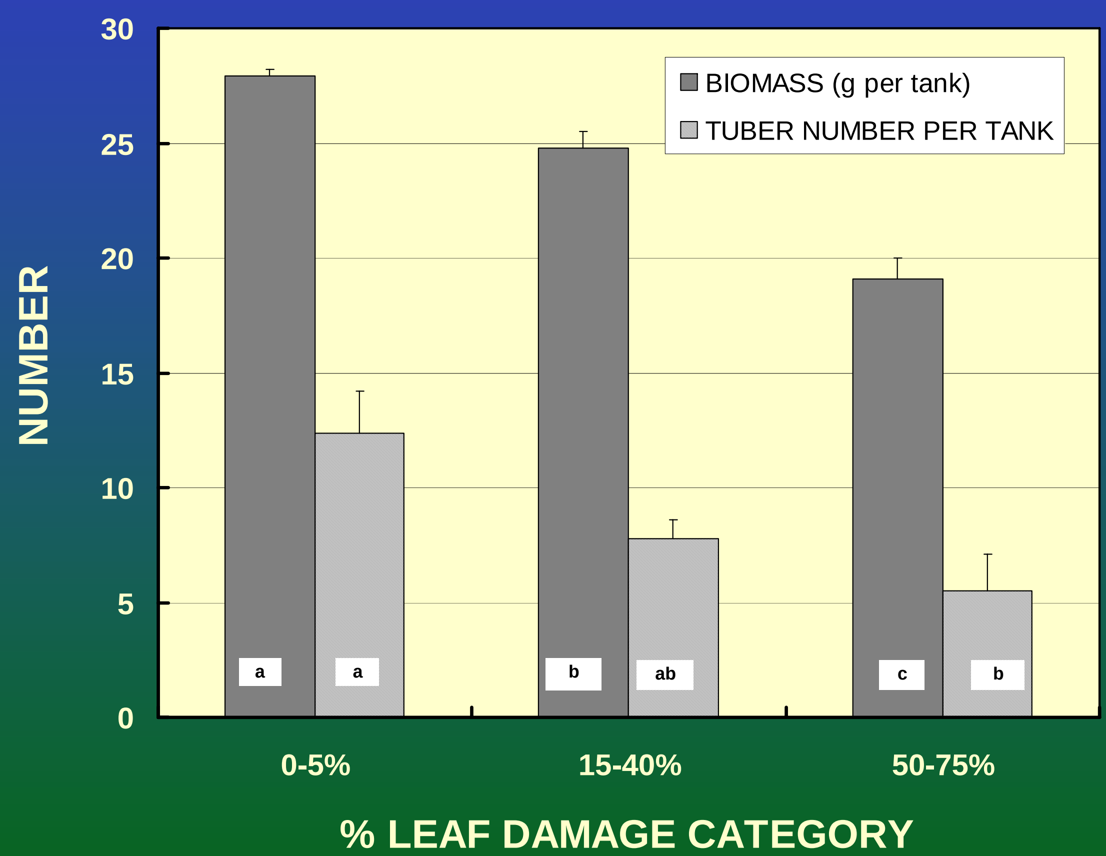
Decreased photosynthetic rates

As little as 20% damaged leaves can send the plant into negative carbon balance (24 hrs)



Impacts of *Hydrellia* feeding

- Decreased photosynthetic rates
- Decreased shoot biomass
- Decreased tuber production



Impacts of *Hydrellia* feeding

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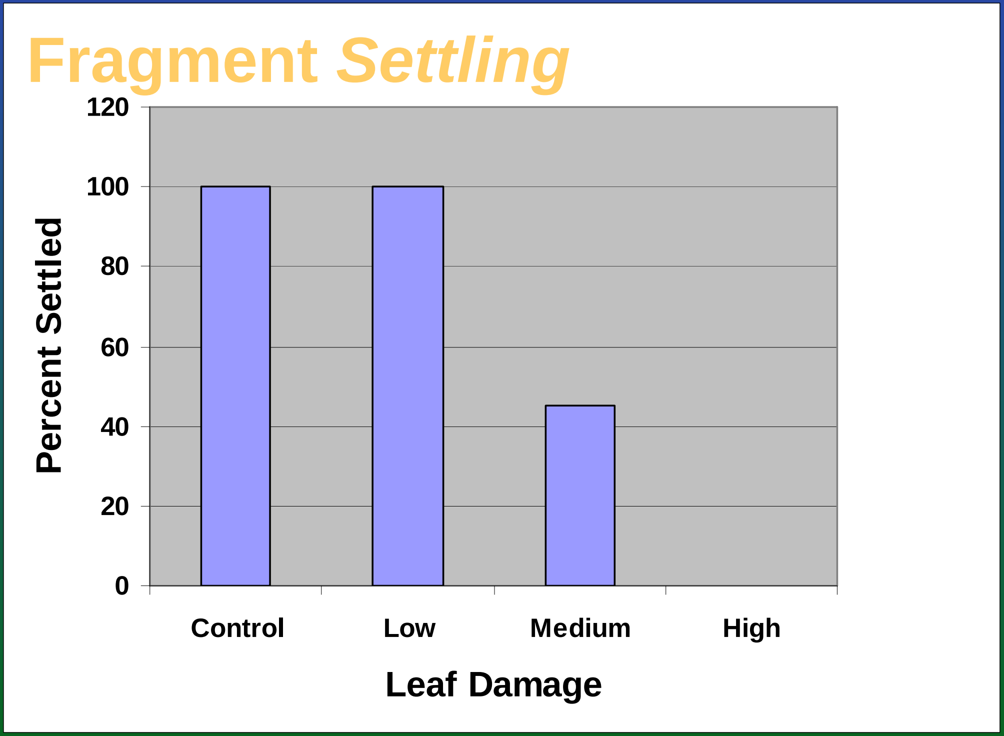
- Decreased shoot biomass
- Decreased tuber production
- **Decreased fragment viability**



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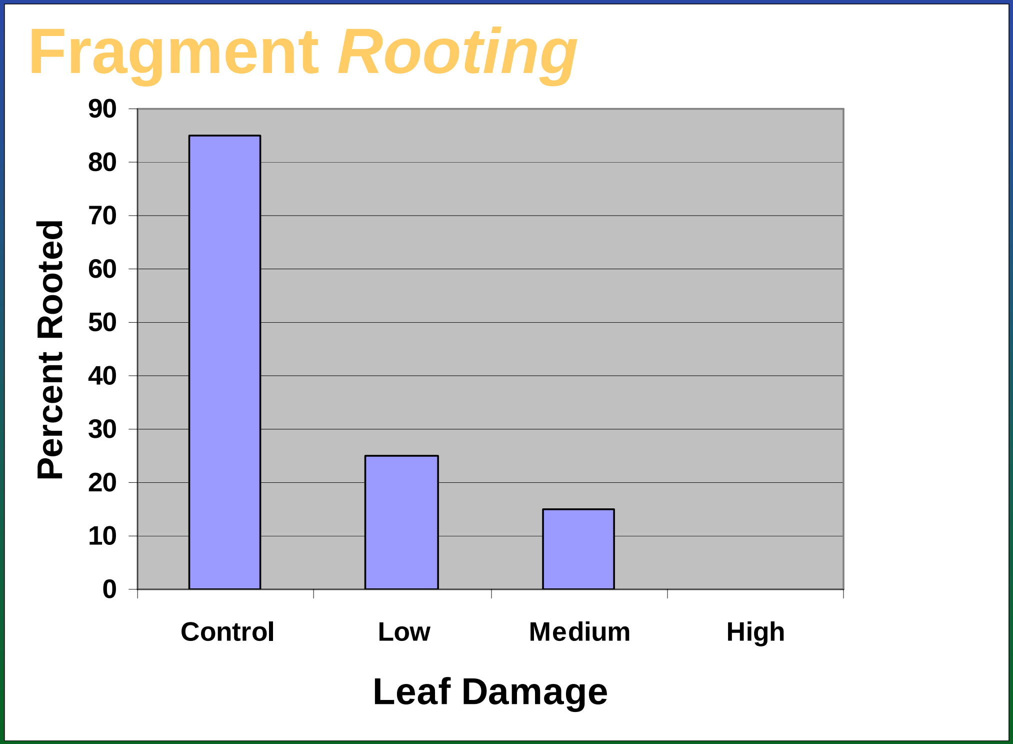
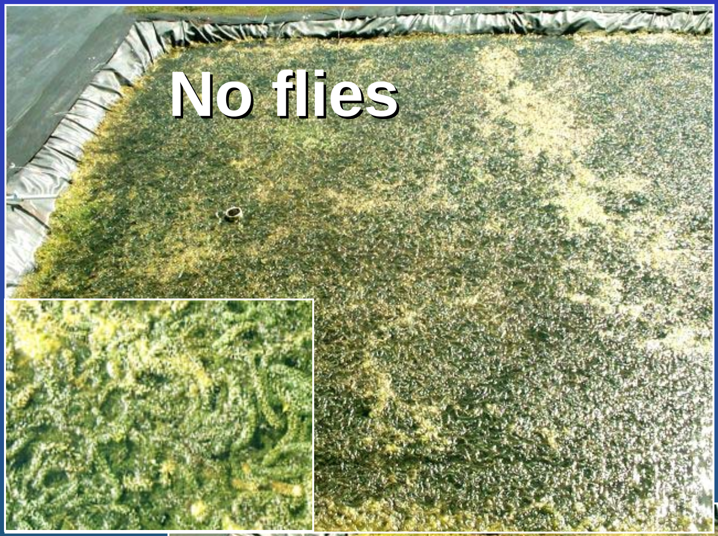
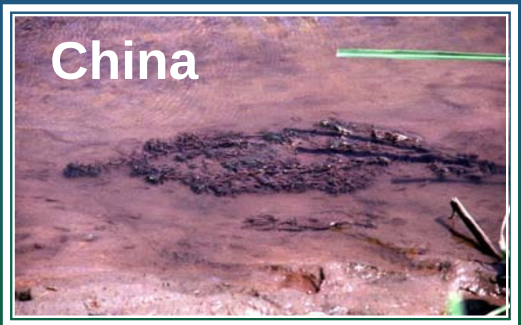


Impacts of *Hydrellia*

Rarely complete elimination but …

- Less competitive
- Slower spread
- Allow native species time to establish





A “research-scale” example

Lake Jacksonville, Texas

- **600 hectare impoundment**
- **Hydrilla invasion early 1990’s**
- **Selected for “test plantings” in 1997**
- **Cooperative agreement for small-scale “demo project” in 1998**

Lake Jacksonville -- Hydrilla management

Hydrellia flies (single releases in 2002, 2005)

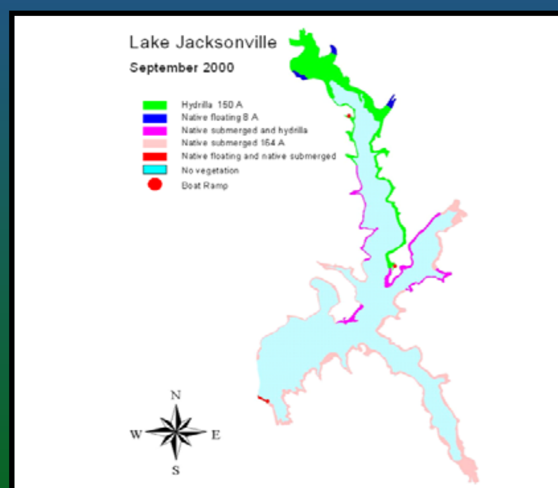
Low-dose Aquathol ("spot" treatments annually)

Low density grass carp (3-5 per vegetated acre)

"Test plantings" of native aquatics (1997, 1998, 1999, 2000)

Good establishment of native vegetation, spreading in traditional hydrilla beds, resisting hydrilla spread

Fly damage to hydrilla



Spreading natives

There is no 'silver bullet', no quick fix, no easy answer

- Holistic, ecological, integrated approach
  - Use all appropriate technologies (especially biocontrols and native plant restoration)
- Develop a lake-specific management plan
  - goal is not elimination of all vegetation
  - goal is not eradication of nonindigenous vegetation
  - goal is the *development of a diverse plant community dominated by native species*

    In this way we derive the benefits that aquatic plants can provide and we seek sustainable solutions to the problem of nonindigenous species

Where do we go from here?

We have "proof of concept"

Laboratory, greenhouse, outdoor mesocosm, pond, and field studies have all produced positive results

We need to conduct a large-scale demonstration project (*with adequate funding for long-term monitoring*) to demonstrate the *reality* of this approach

Unfortunately …