BIOLOGICAL CONTROL: WHAT'S UNDERWAY, WHAT'S POSSIBLE, AND WHAT'S IMPOSSIBLE

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USDA UNITED STATES DEPARTMENT OF AGRICULTURE ars

Red water fern (*Azolla filiculoides*) in South Africa

- Native to the Americas
- Imported about 1948
- Recorded in 152 sites by 1999
- Problems
  - Increased siltation
  - Lowered water quality
  - Clogged irrigation canals & pumps
  - Implicated in livestock drownings
- Control options limited

Summary of *Azolla filiculoides* control in South Africa

Area of infestation	215.5 ha
No. weevils released	24,700
No. sites controlled	91 of 112
% sites controlled	81.3
Area cleared (ha)	203.5
Time (mos.± SD)	6.9 ± 4.3
Program Cost	US $46,962
Annual Benefit	$450/ha

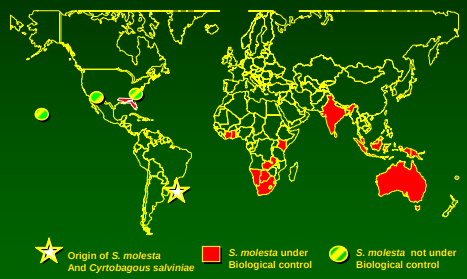
Silver bullets do exist!

But you may have to reload and adjust your aim.

Giant Salvinia, *Salvinia molesta*

- Origin: SE Brazil
- Reproduction: asexual, infestations in the U.S., South Africa, Australia genetically identical.
- Biology: Floating fern, colonizes stagnant, fresh water; doubles in size every 5-7 days in field.
- Pest Status: World-wide.
- Impact: Thick mats impede or eliminate water based activities, oxygen levels reduced in water, leading to declines or extinctions of aquatic fauna.

Salvinia molesta: Worldwide Distribution and Status



Salvinia molesta: United States.

- 1995: South Carolina.
- 1998: Texas & Louisiana
- 1999: Alabama, Arizona, California, Florida, Georgia, Hawaii, Mississippi, Oklahoma.
- 2000: New site in Florida, North Carolina.
- 2001: Maryland, new sites in Texas
- 2002: New sites or expansion in Texas, Louisiana, North Carolina. Persisting in Florida site despite eradication efforts.
- 2003: Expansion in Hawaii, Louisiana, and Florida sites. Infestation in Lake Conroe, TX rebounds.

Salvinia molesta: Biological Control

- Small weevil, *Cyrtobagous singularis*, found attacking *Salvinia auriculata* in Guyana and Trinidad in the 1960's.
- First attempts failed: Botswana (1971), Fiji (1979) and Zambia (1971).
- Weed taxonomy revised in 1972 and *S. molesta* differentiated from *S. auriculata*.
- Native range of *S. molesta* found in southern Brazil in 1978.
- Surveys on *S. molesta* in Brazil found same group of insect herbivores.
- Small weevil, thought to be *Cyrtobagous singularis*, released at Lake Moondarra, Australia in 1980 and destroyed 30,000 tons of *S. molesta* in less than one year.
- Closer examination of the weevil revealed a new species, *Cyrtobagous salviniae*

Salvinia molesta: Biological Control

- Subsequent releases with *C. salviniae* led to successful control of *S. molesta* in other areas of Australia (1980's), Papua New Guinea (1982), India & Namibia (1983), Botswana (1984), South Africa (1985), Sri Lanka (1987), Malaysia (1989), Kenya & Zambia (1990).
- Level of control in tropical areas was more than 99% after a year.

The Salvinia weevil *Cyrtobagous salviniae* (ex Brazil via Australia)

Chronology of Biological Control Efforts in the United States

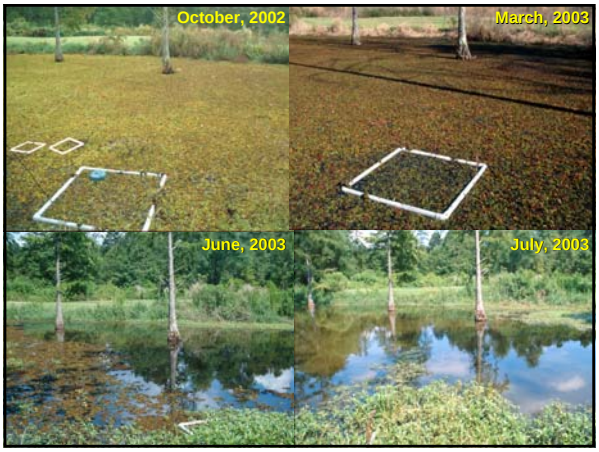
- Sept. 2001 - TAG petition approved for *C. salviniae* from Australia.
- Oct. 2001 - Awarded permit. First field release in Texas and Louisiana.
- Dec. 2001 - Weevils recovered from plots.
- March 2002 - Weevils overwintered.
- May 2002 – Newly emerged weevils found. Significant damage evident.

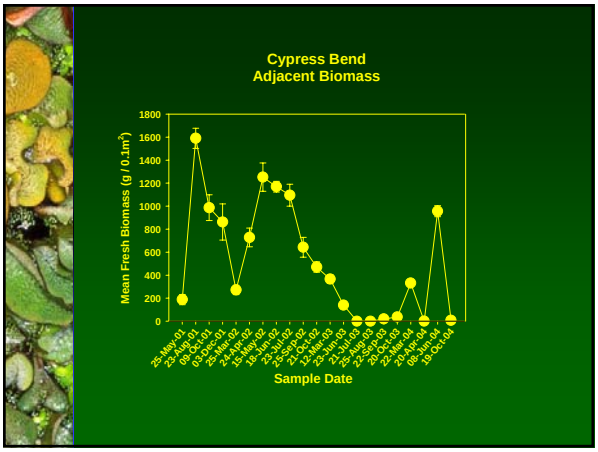
Chronology of Biological Control Efforts in the United States

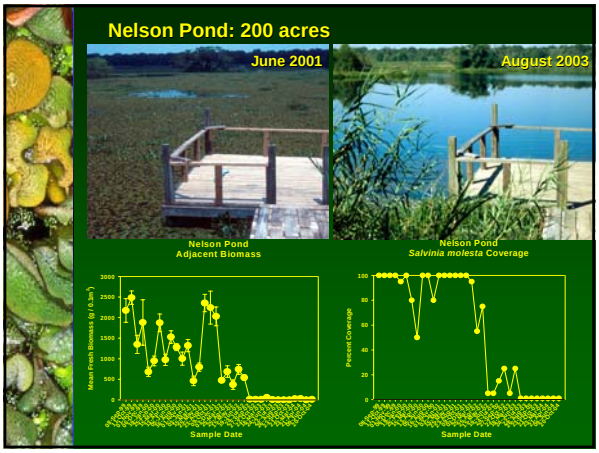
- June 2002 - More newly emerged weevils recovered (30%) so reproducing population present.
- July 2002 - Weevil spread at 5 meters. Two sites flooded and salvinia and weevils flushed out. A total of 2775 weevils released since Oct. 2001.
- Sept. 2002 - More weevils released. Damage increasing at all release sites. Mats showing waterlogged appearance. Open water noted – first time in three years. Loss of long-term release site because of property changing hands.
- Dec. 2002 - Weevils released at Lake Texana site to replace those flushed out by flooding. Although mats brown and waterlogged, no sinking occurs. Cooler weather slows or stops damage.

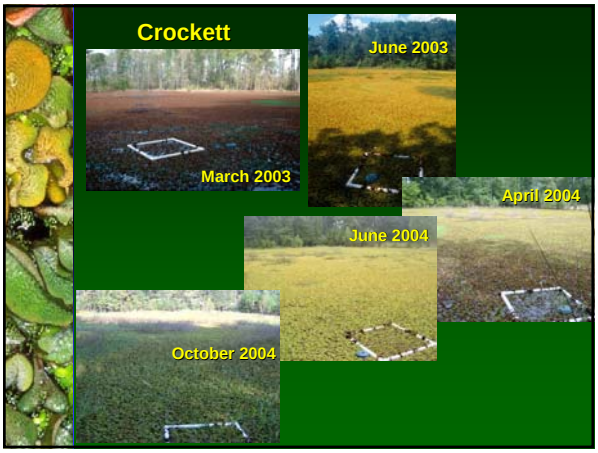
Chronology of Biological Control Efforts in the United States

- March 2003 - Weevils recovered at all release sites.
- June 2003 – Open water at Louisiana site previously covered. Large numbers of adults found in tissue samples (50-69 weevils per 0.1 m^2)
- July 2003 – We have arrived….

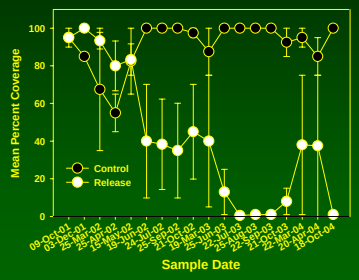








Salvinia molesta Coverage in Study Square Control vs Release Sites



Salvinia molesta: Mathesis….

- You must attend: 34 Texas/ Louisiana trips, 100,000 miles.
- Persistence.
- Good local support, Good local support, Good…
- If there is a weed project out there with a famous heritage based largely on pre- and post-release photographs, scanty field data, uncertain taxonomy, a minute biological control agent, competing and obfuscating agencies, a massively damaging weed, research plots thousands of miles away along a hurricane coast, with a target weed that moves around the landscape: make sure you don't miss any meetings.

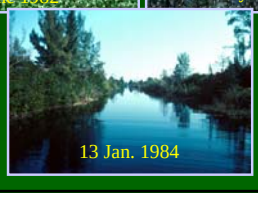
A full bag is heavy to carry, but an empty one is heavier.

- Chinese saying

Next Up …. Water Hyacinth

- Still considered the world's worst aquatic weed despite numerous successes.
- Continues to cause problems in fresh water ecosystems throughout the southeastern U.S.
- Need for new agents that are more mobile, with short life cycles, and high reproductive capacities, that:
  - can survive non-cyclical disruptions of water hyacinth communities induced by herbicide applications,
  - are adapted to temperate climates that can survive seasonal disruptions from cold.

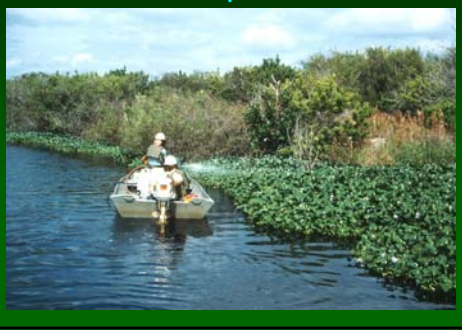
M-Canal: West Palm Beach



Why do we need new agents?

Current Biological Control Agents

System Perturbations: Boom & Bust Dynamics



Why do we need new agents?

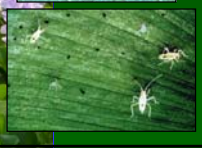
- Need for agents that are more mobile, with short life cycles, and high reproductive capacities, that:
  - can survive non-cyclical disruptions of water hyacinth mats induced by herbicide applications,
  - can quickly re-colonize incipient stands as regrowth occurs
  - are adapted to temperate climates and able to survive seasonal disruptions from cold.

Potential Biological Control Agents

Megamelus scutellaris (Heteroptera: Delphacidae)

Four species of *Megamelus* ex water hyacinth, *M. scutellaris* restricted to water hyacinth

The Waterhyacinth Bug *Eccritotarsus catarinensis* (Heteroptera: Miridae)



Thrypticus spp. (Diptera: Dolichopodidae)

8 to 10 species ex Pontederiaceae

Taosa spp. (Homoptera: Dictyopharidae)

Plant Damage from *Taosa* spp.

Broad-leaved paperbark *Melaleuca quinquenervia*

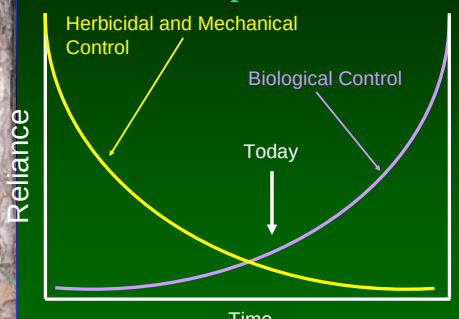
Herbicide treatment

Melaleuca Management Plan

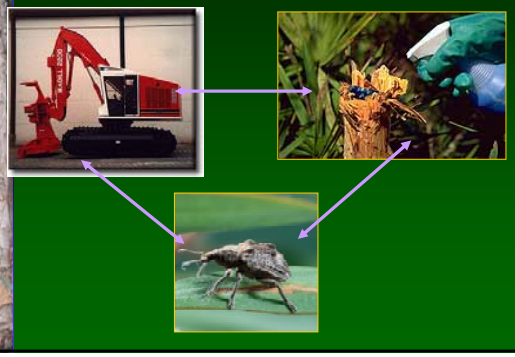
Strategy

Eliminate stands	Prevent Regeneration
Herbicidal Control & Mechanical Removal	Biological Control

Conceptual Model



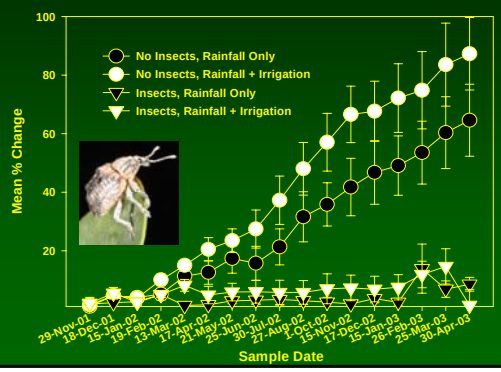
Control Tactics



Oxyops vitiosa – the melaleuca weevil

Weevil Exclusion Study

Impact of *O. vitiosa* on *M. quinquenervia* Tree Height



Psyllid impacts: Seedling mortality

- Feeding caused 40-65% mortality of seedlings

Psyllid impacts: Reduced seed production

Psyllid Impacts: Estero

April '02:
8,000 psyllids released

October '02:
- 75% of coppices infested
- 10 psyllid colonies/coppice
- 23 nymphs/colony
- 160,000 nymphs/acre
- Dispersal up to 7 miles/yr

Accomplishments

- Melaleuca stands removed from public lands
- Biological control implemented
  - Seed production reduced up to 90%
  - Stand densities reduced > 70%
  - Sapling growth strongly curtailed
  - Coppicing reduced
  - Seedling survival reduced by 60%
  - Reduced canopy, increased light penetration
  - Increasing biodiversity
- Melaleuca is now much less invasive

What's ~~Impossible?~~ Challenging

Submersed Aquatic Weeds (e.g., hydrilla)

You've gotta have a plan!

- State expectations
- Define success
- Clarify roles of partners
- Integrate all methods
- Do not marginalize biological control
- Publish and distribute info
- Don't prophesize

Local Partnerships