Nonnative Invasive Species

Impacts and Control in Southern Wetland Ecosystems

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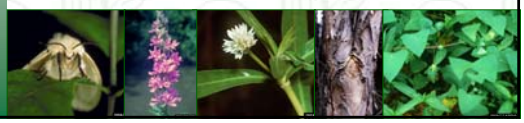
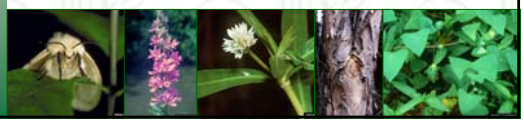
Outline

- Impacts
- Spread
- Morphology
- Environment
- Common Invasive Species in Southern Wetlands
- Control Options
- Problems with Control Options
- Case Studies
- Discussion



Impacts of nonnative invasive plants to wetland systems

- Displaces native plants:
  - By forming mats (e.g. water hyacinth)
  - By crowding / out competing (e.g. purple loosestrife)
  - By smothering (e.g. Japanese honeysuckle, kudzu)
  - By shading regeneration (e.g. Melaleuca, Chinese tallow tree, privet, bamboo)



Water hyacinth infestation in Southern Florida

Photo by Ted D. Center, USDA-ARS

Purple loosestrife infestation

Photo by Randy Westbrooks, USGS

Kudzu infestation in Mississippi

Photo by John D. Byrd, MSU

Melaleuca infestation in the Florida Everglades

Photo by Min B. Rayamajhi, University of Florida

Impacts, displacement cont'd

- Continuing on the theme of nonnatives displacing natives…
  - What IS native? What is a weed?
  - Nonnative Invasive vs. Nonnative non-invasive vs. Native invasive…What's the difference? Do we always agree? (Example—Sawtooth oak)
  - Why are native plants important??
  - Who cares if native plants disappear?
  - Do alien plants increase or reduce biodiversity? Why?

- Are invasive species eradication programs a form of environmental genocide? What do you say to people who argue such?
  - *Invasion Biology: Critique of a Pseudoscience* by David Theodoropoulos
    - "Purple loosestrife, the poster child of invasion biologists, harbors slightly *more* native insects and birds than nearby native plants. It also is an excellent nutrient accumulator, thriving primarily in–and cleaning up–polluted waters."
  - Businessweek Online:
    - "One distinguished environmental historian wonders whether a campaign to eradicate invasive plants in the Everglades might not be Nazi in spirit."

DO YOU BUY IT?

Impacts, cont'd

- Changes Environmental Characteristics
  - Alters nutrient dynamics in the soil
    - Is this good or bad? What about nonnative legumes adding nitrogen to the soil? Conversely, what about toxicity?
  - Alters hydrology
    - How?
  - Depletes oxygen in the water column
  - Alters habitat structure

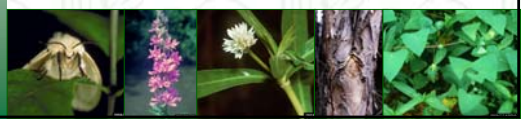
Impacts, cont'd

- Impedes navigation, recreation, commercial fishing
  - And this translates to MONEY!!

Photo: USDA APHIS Archives

Impacts, cont'd

- Financial Loss
  - Losses due to changes in ecosystem functions and values
    - Recreation, commercial fishing, navigation, water quality, aesthetics
  - Property value decline
  - Money spent in efforts to control the spread
  - Restoration of native species



Spread of Nonnative Species in Wetlands

- Intentional Dissemination
  - Ornamental Plant Industry
    - Water Gardens
    - Aquarium Enthusiasts
    - Religious / Cultural Uses
  - Environmental
    - Remediation (e.g. Kudzu!)
    - Food for wild game (e.g. Japanese honeysuckle, Russian olive)

From a different point of view…

- Imagine you are a horticulturist…
  - What types of characteristics would you look for in a "perfect" garden species?
    - Easy to grow
    - Tolerant of a wide range of soil conditions
    - Reproduces quickly to fill in garden space
    - Luxurious growth and pretty flowers
    - Disease and pest resistant
    - Flood and Drought tolerant

Sound Familiar?

Current Examples

- Seattle Chinese Garden Society
  - 4.6 acre garden to be completed by 2006
  - Plans include the introduction of "*hundreds of Chinese species,*" including Chinese Wisteria, and tout "*hillsides covered in bamboo,*" and "*water loving plants*".

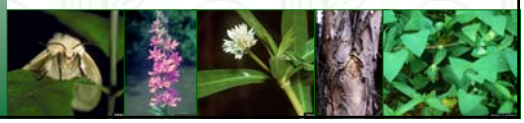
http://www.seattle-chinesegarden.org/frameset.htm

More Fun Examples:

- **Found on the "Plant Delights Nursery, Inc." website:**
  - **Lythrum alatum (Winged Loosestrife) Sun to Part Sun Zone: 3-9 42" tall Origin: USA**
    Web-Only! It's back! Yes, you can once again grow loosestrife and not be hounded by the **eco-nazis.** In fact, *Lythrum alatum* is native to all but 12 US states. Okay, it's not as pretty as the hybrids and when grown in a swamp, it's slightly more aggressive, but **if you're out to clog up a waterway, it might as well be with a native plant**.
  - In reality, Winged Loosestrife is not considered invasive, is considered rare or endangered in some states, and provides food for waterfowl…
- **Found on the "Wallis Creek Gardens" website: 4 varieties of NONNATIVE loosestrife for sale.**
- **And at "Springtime Nurseries": water hyacinth, nonnative invasive yellow iris, flowering rush, invasive parrot's feather, invasive anacharis,**

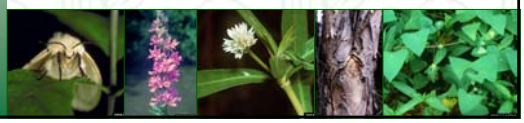
Spread, cont'd

- Unintentional dissemination
  - Trade Dispersal
    - Ship Ballasts
    - Packing Materials
  - Transfer through luggage, on Clothing
  - Biological



Morphology of an Alien
What makes a successful "invader"?

- High reproductive rates / Early reproduction
- "Pioneer" species
- Rapid germination and Rapid Growth
- Multiple means of propagation
  - Vegetative and Sexual Reproduction
- Multiple, rapid dispersal methods
- Genetic variability / phenotypic plasticity
- Resistance to pests
- Habitat generalist
  - Wide range of tolerances (e.g. water quality, hydroperiod, nutrient dynamics, temperatures)

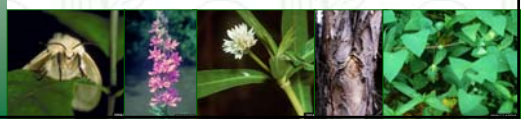


Environment
What makes a wetland susceptible?

- Climatic similarities to location of species' origin
- Disturbance (or, conversely, Stability!)
- Absence of native predators or competition
- Location
- Size

Common nonnative invasives in Southern wetlands (SEVERE threat only)

- Aquatic Forbs:
  - Alligatorweed (*Alternanthera philoxeroides*)
  - Waterhyacinth (*Eichhornia crassipes*)
  - Hydrilla (*Hydrilla verticillata*)
  - Parrot feather watermilfoil (*Myriophyllum aquaticum*)
  - Eurasian watermilfoil (*Myriophyllum spicatum*)
  - Waterlettuce (*Pistia stratiotes*)
  - Giant salvinia (*Salvinia molesta*)
  - Water chestnut (*Trapa natans*)



Aquatic Forbs

Alligator Weed

Water hyacinth

Hydrilla

Parrot's feather

Photos: UGA bugwood network

Aquatic Forbs

Eurasian watermilfoil

Water lettuce

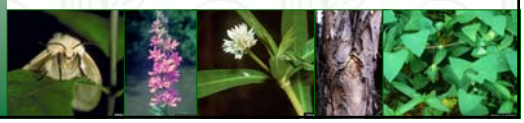
Giant Salvinia

Water chestnut

Photos: UGA bugwood network

Common species, cont'd…

- Emergent and Floodplain herbs
  - Purple loosestrife (*Lythrum salicaria*)
  - Pale yellow iris (*Iris pseudacorus*)
  - Marsh dewflower (*Murdannia keisak*)
  - Japanese knotweed (*Polygonum cuspidatum*)
  - Leafy spurge (*Euphorbia escula*)
- Emergent and Floodplain grasses, sedges and rushes
  - Tall fescue (*Lolium arundinaceum*)
  - Nepalese browntop, Japangrass (*Microstegium vimineum*)
  - Common reed (*Phragmites australis*)



Emergent and Floodplain Herbs

Purple loosestrife

Marsh dewflower

Pale yellow iris

Japanese knotweed

Photos: UGA bugwood network and USDA Plants network

Emergent and Floodplain Grasses and Sedges

Tall fescue

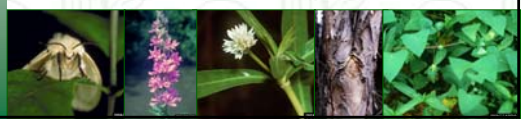
Nepalese browntop

Common reed

Photos: UGA bugwood network and USDA Plants network

Common species, cont'd…

- Nonnative Shrubs
  - Chinese privet (*Ligustrum sinense*)
  - Nonnative roses (*Rosa spp.*)
- Nonnative Trees
  - Melaleuca (*Melaleuca quinquenervia*)
  - Chinese tallowtree (*Triadica sebifera*)
  - Saltcedar (*Tamarix ramosissima*)



Nonnative Shrubs occurring in wetlands and riparian areas

Chinese privet

Nonnative Rose

Photos: UGA bugwood network and USDA Plants network

Nonnative Trees occurring in wetlands and riparian areas

Melaleuca

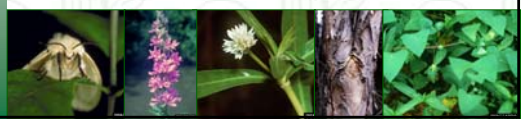
Chinese tallowtree

Saltcedar

Photos: UGA bugwood network and USDA Plants network

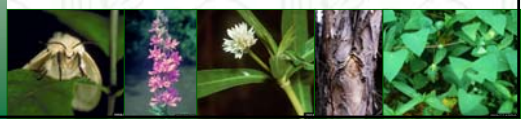
Methods of Control

- Mechanical
- Biological
- Chemical
- Integrated Pest Management (all 3)



Mechanical Control

- Mowing
- Chopping
- Disking
- Rototiller
- Fire
- Water Level Manipulation
- Hand Pulling
- Sediment removal

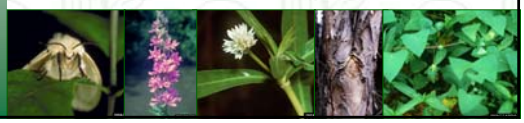


Biological Control

- Herbivores
  - Grass Carp
  - Grazing
- Insects
- Pathogens

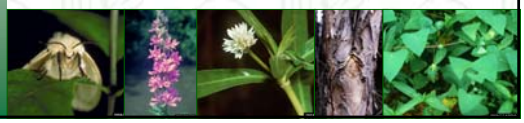
Chemical Control

- Herbicides
  - Broadcast herbicides
  - Cut and Coat
  - Hack and Spray
  - Stem Injection Method



Integrated Pest Management

- Combines Methods
  - Cut or burn then herbicide
  - Cut or burn then flood
  - Graze then remove sediments
- Focuses on managing the invasive to a tolerable level, not eradication

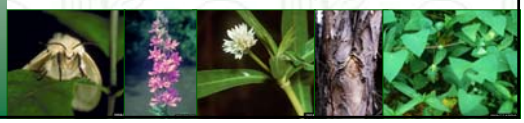


Problems with Control Methods

- Cost and Time Intensive
- Low success rates
- Impacts to the ecosystem
- Controversy: Introducing non-natives to control non-natives….

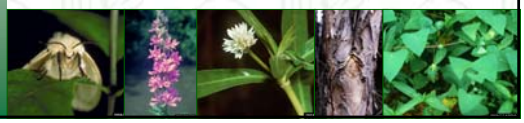
Case Studies

- Chinese Tallow and the Chenier Plain
- Melaleuca in the Everglades
- Hydrilla in Louisiana
- Purple Loosestrife (the "Poster Child")



Chinese Tallow

- **Introduction Year:** 1772
- **Where**: Gulf Coast
- **Why:** Soapmaking
- **Native range**: China
- **Historic use**: candles, soap, fuel, and to create charcoal, ethanol, methanol, petroleum substitute

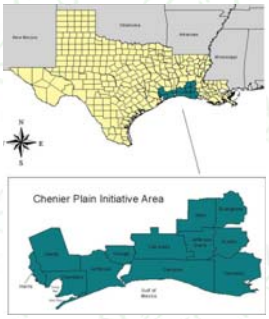


Chinese Tallow, continued

- Characteristics:
  - Attractive fall foliage
  - Grows quickly
  - Reproductive at age 3 and produces for 60 years
  - Pest resistant
  - Tolerant of range of soils
  - Flood, drought, shade, sun, fire tolerant
  - Tolerant of fresh and saline water
  - Toxic berries and sap
  - Thought to be allelopathic

Chinese Tallow, continued

- Chenier Plain
  - Series of sandy, prairie-like ridges of marsh vegetation interspersed with small patches of forest
  - Significant wintering waterfowl populations
  - Significant migratory passerine fallout
  - Small forest patches historically important to neotropical migrants

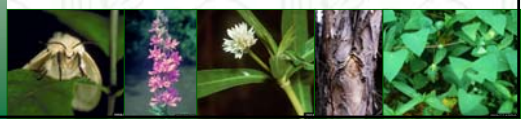


Map from the Gulf Coast Joint Venture

Chinese Tallow, continued

- Chinese Tallow effects on the Chenier Plain*:
  - Displacing marsh vegetation (less habitat for waterfowl)
  - Forming monoculture forests
  - Toxicity of berries to insects = fewer insects
  - Fewer insects = less food for neotropical migrants
  - Result: Tired birds crossing the Gulf of Mexico fallout onto Chenier Plain "Tallow Forests" and find no food source
  - Tallow forests on the Chenier Plain have become ecological traps (sinks)

*Wylie Barrow, personal communication, 2001

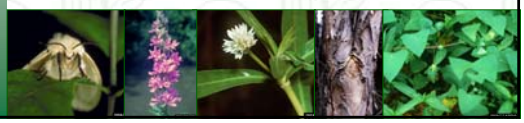


Potential Chinese Tallow Control

- Mechanical
  - Individual tree removal in low density areas
  - Prescribed burning can slow spread, but is ineffective against high-density stands
- Chemical
  - Stem-injection Herbicides
    - Arsenal AC, Garlon 4, Pathfinder II

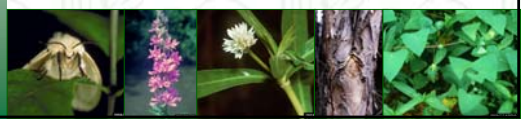
Melaleuca in the Everglades

- **Introduction Year:** late 1800s, early 1900s
- **Where:** Florida (primarily Everglades)
- **Why:** Drainage / erosion control / landscaping
- **Native Range:** Australia (endangered)
- **Historic Use:** Tea Tree Oil (natural antiseptic and insect repellent), Insulation (bark), Cabinetry, Boats, other structural uses

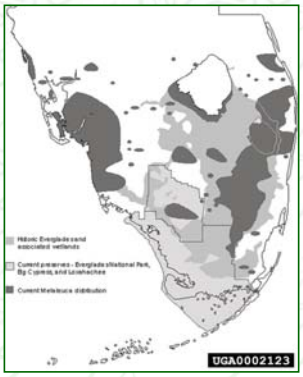


Melaleuca, continued

- Characteristics:
  - Evergreen, 60-70 feet tall
  - Tolerant of fluctuating water levels
  - Produces adventitious roots
  - Reproductive at age 1
  - Produces millions of seeds per year per plant
  - Seeds remain viable for 6 months under water
  - Stump sprouts when cut
  - Tolerant of most soils
  - Somewhat Fire-tolerant



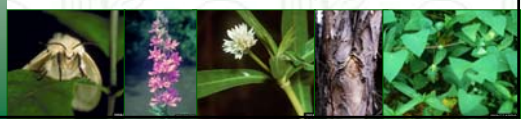
Melaleuca, continued



Melaleuca, continued

- Melaleuca effects on the Everglades**:
  - Altered Hydrology (Possible—more research needed)
  - Poor wildlife habitat (birds rarely nest in Melaleuca—one exception is the snail kite, seeds edible to few, if any, native wildlife)
  - Displaces native plants that ARE useful to wildlife
  - Allelopathic—so further impacts native plant communities
  - Leaf litter buildup changes micro-topography of the marsh systems, altering plant communities

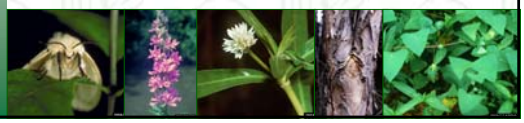
**Source: Dr. Jim Miller, USDA Forest Service Southern Research Station



Melaleuca control efforts

- Biological control (insects)
- Prescribed fire
- Herbicide application

Effectiveness? University of Florida describes the methods as “somewhat effective”

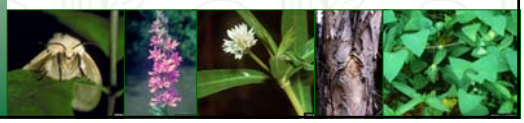


Purple Loosestrife
"Poster Child" or Unsupported Hysteria?

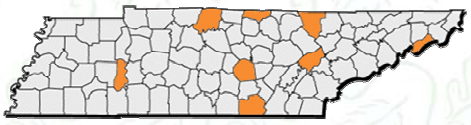
- **Introduction Year:** Early 1800s
- **Where: Northeastern U.S. and Canada**
- **Why: Unintentionally by ship ballasts, intentionally by horticultural trade and for medicinal use**
- **Native Range: Eurasia**
- **Historic Use: Medicinal for upset stomach, bleeding, wounds; Honeybees**

Purple loosestrife, continued

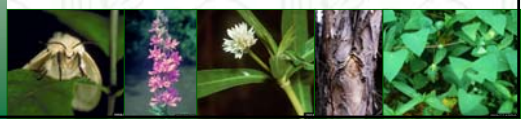
- Characteristics:
  - Perennial, 1-3m tall
  - Blooms June-September, up to 3,000 flowers per plant
  - Sexual reproduction, vegetative by cuttings or plant fragments
  - Each plant contains up to 900 seed capsules
  - Each seed capsule contains an average of 120 seeds
  - Seeds are wind and water-dispersed
  - Seeds remain viable up to 20 months, submerged
  - Thrive in any moist, freshwater soil—tolerant of flooding, low nutrient level, variable pH
  - Full sun to 50% shade



Purple loosestrife occurs in every continental US state with the possible exception of Florida



Range map from the University of Tennessee Herbarium

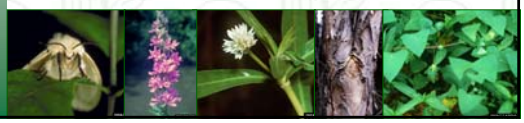


Effects of Purple loosestrife

- Conflicting evidence
- Current accepted theory is that purple loosestrife:
  - Establishes monocultures
  - Lowers overall community diversity
  - Is of little value to wildlife
  - Out competes native plants, endangering rare species
  - Alters hydrology and nutrient dynamics

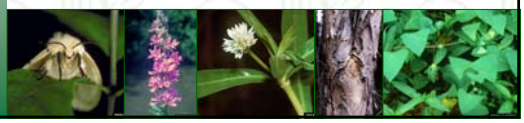
Effects of Purple loosestrife

- Why the Conflict?
  - Correlative studies
    - People have inferred cause-effect relationships
      - Hager and McCoy 1998, Farnsworth & Ellis 2001
  - Limited studies over wide temporal scales
  - Differing results in studies using different metrics = hard to make comparisons
  - Conclusions are rarely, if ever, really conclusive



Examples

- Farnsworth and Ellis 2001. Wetlands 21(2):199-209
  - Hypothesis: Purple loosestrife density and biomass are not significantly correlated with density, diversity & biomass of other plant species
  - Methods: various linear and non-linear metrics
  - Results: varied depending on metrics used, though overall findings indicated that purple loosestrife did "not appear to threaten the diversity or density of other wet meadow species…"
  - Conclusion: need more controlled experimental studies to conclusively determine the potential threat, if any

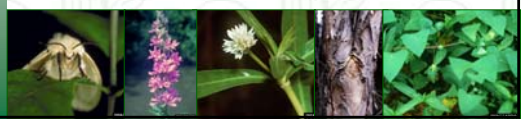


Examples

- Morrison 2002. Wetlands 22(1):159-169
  - Objective: Determine effect of loosestrife on native plant colonization
  - Methods: ANOVA on cover/density/diversity
  - Results: No correlation between loosestrife and species richness; low cover values of native species suggests competition from loosestrife, but confounding factors exist that preclude those conclusions; no evidence to support that loosestrife forms monocultures
  - Conclusion: need more controlled studies across larger temporal and spatial scales

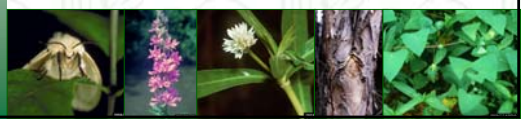
Examples

- Gardner et al. 2001. Wetlands 21(4):593-601
  - Objective: Determine if purple loosestrife infestation alters aquatic invertebrate communities
  - Methods: two-factor ANOVA
  - Results: No significant differences in invertebrate abundance between vegetation types; invertebrates in purple loosestrife communities were significantly smaller than invertebrates in cattail communities
  - Conclusion: smaller invertebrate sizes might negatively impact fish, but more research on a broader temporal and spatial scale is needed



Hydrilla in Lake Martin (Louisiana)

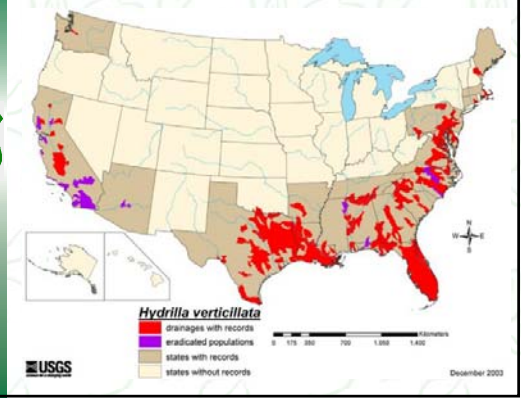
- **Introduction Year: 1950s**
- **Where: Florida**
- **Why: Accidental by water garden enthusiasts, accidental through fragments stuck on boats**
- **Native Range: Asia, Africa, Australia**
- **Historic Use: ? Aquarium industry**



Hydrilla, continued

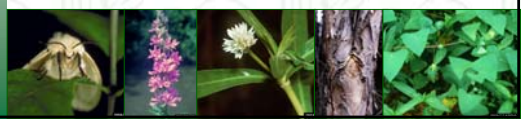
- Characteristics:
  - Free-floating or rooted aquatic plant
  - Dioecious (single-sex plants) and Monoecious (both male and female on one plant) forms
  - Vegetative propagation (stem fragments, turions, tubers) and limited sexual reproduction (monoecious populations)
  - Tubers remain viable 4 years submerged in sediment (Southeast Exotic Pest Plant Council 2003)
  - Shallow water or clear water to 10m deep
  - Tolerant of moderate salinity, poor water quality, low oxygen levels, and light levels from full sun to very low light conditions

Hydrilla range

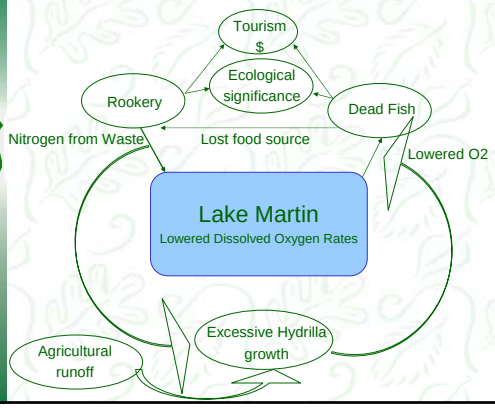


Lake Martin, Louisiana

- Enlarged 800-acre lake owned by The Nature Conservancy
- Home to a large (40,000 pairs) heron, egret, and spoonbill rookery
- Used for hunting, sport fishing, birdwatching(!), boating tourism, wildlife viewing, recreational exercise (walking trail on levee surrounding the lake)

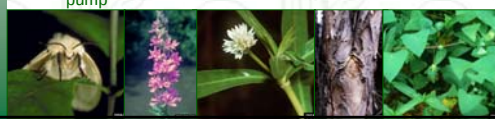


Lake Martin = "Hyperproductive"



Hydrilla control efforts

- Early efforts:
  - Pesticide application
  - Grass Carp introduction (presumed sterile)
- But they were neglecting:
  - Hydrology
  - Nutrient accumulation in sediments (result of agriculture)
  - Nutrient accumulation in water column (result of rookery)
- Corps of Engineers Plan:
  - Integrated approach—seasonal drawdowns from rookery side of lake (to reduce nutrient buildup and control plants)
  - Restoring circulation & increasing DO levels by introducing water from nearby canal and installing a pump



Discussion

- Are native species always a better alternative? Are nonnative species always bad?
- Should we be proactive or reactive in our approach to nonnative species?
- Eradication programs are expensive. Where should the money be directed? Who should decide? Based on what?
- As scientists, what should our role be in invasive species management?
- How should we respond to accusations of "bio-nazi-ism?" Or should we respond at all?
- Should introduced species be used to control introduced species? How about herbicides? What are the potential ramifications, and how do they compare to the impacts of invasive species?
- What makes the study of invasive species so difficult? What limits are there to hypothesis-driven, manipulative studies?