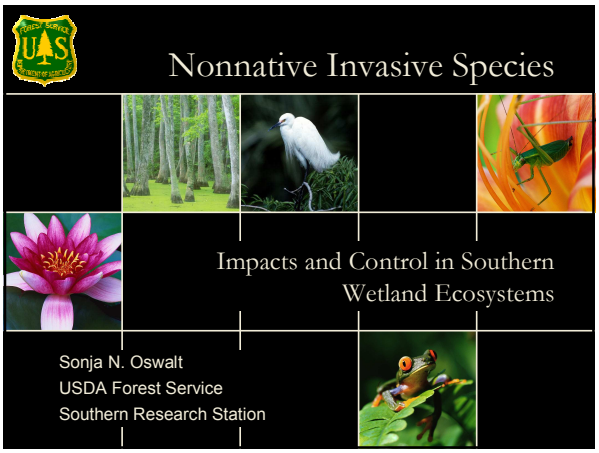
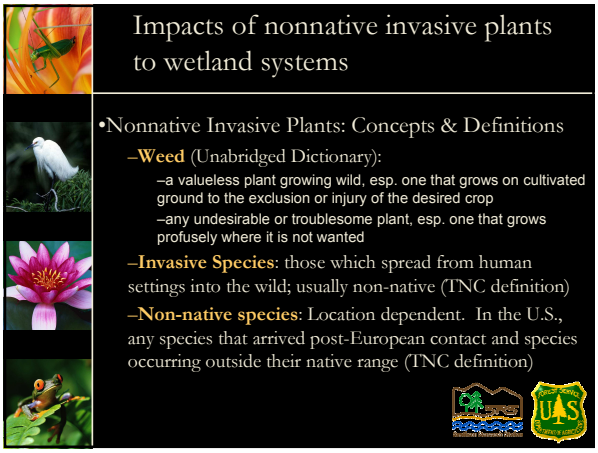

Nonnative Invasive Species
Impacts and Control in Southern Wetland Ecosystems
Sonja N. Oswalt
USDA Forest Service
Southern Research Station


Outline
• Concepts
• Impacts
• Environment
• Spread
• Morphology
• Common Invasive Species in Southern Wetlands
• Control of Wetland Invasive Species
• Case Studies
• Discussion


Impacts of nonnative invasive plants to wetland systems
•Nonnative Invasive Plants: Concepts & Definitions
–Weed (Unabridged Dictionary):
–a valueless plant growing wild, esp. one that grows on cultivated ground to the exclusion or injury of the desired crop
–any undesirable or troublesome plant, esp. one that grows profusely where it is not wanted
–Invasive Species: those which spread from human settings into the wild; usually non-native (TNC definition)
–Non-native species: Location dependent. In the U.S., any species that arrived post-European contact and species occurring outside their native range (TNC definition)

## Impacts of nonnative invasive plants to wetland systems

- Nonnative Invasive Plants: Concepts & Definitions
  - Nonnative Invasive vs. Nonnative non-invasive vs. Native invasive…What's the difference? Do we always agree?
  - Why are native plants important?
  - Who cares if native plants disappear?
  - Do alien plants increase or reduce biodiversity? Why?
    - How does scale play a role in this question?
    - Local vs. Global biodiversity

## 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 (mat-forming)


Photo by Ted D. Center, USDA-ARS

## Purple loosestrife (competition)


Photo by Randy Westbrooks, USGS

## Kudzu (mat-forming, smothering)


Photo by John D. Byrd, MSU

## Melaleuca (competition, shading)


Photo by Min B. Rayamajhi, University of Florida

## Impacts of nonnative invasive plants to wetland systems

- Changes to the Environment
  - Altered Soil Nutrient Dynamics
    - Can be beneficial or detrimental
    - Beneficial example: Nitrogen fixation
    - Detrimental example: Toxicity
  - Altered Hydrology
    - How?
  - Depleted $O_2$ in the Water Column
  - Altered Habitat Structure

## Impacts of nonnative invasive plants to wetland systems

- Financial Losses
  - 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

## Impacts of nonnative invasive plants to wetland systems

Examples Of $$ Down the Drain…

Eurasian Watermilfoil (*M. spicatum*)
Control efforts and research
Photo by Stephen Ausmus, USDA.

Parrot Watermilfoil (*M. aquaticum*)
Invading a canal
Photo by Steve Dewey, Utah State University

## Spread of nonnative invasives in wetlands

- Intentional Dissemination
  - Ornamental Plant Industry
    - Water Gardens
    - Aquarium Enthusiasts
    - Religious / Cultural Uses
  - Environmental
    - Remediation (e.g. *Iris pseudacorus*)
      - Erosion control
      - Sewage Treatment
      - Heavy metal sequestration
    - Food for people and/or wild game
      - e.g. *Colocasia esculenta* (Wild Taro)
        - » *Brought over from Africa as food for slaves*

Nancy Loewenstein, Auburn University

## Spread of nonnative invasives in wetlands

- Unintentional dissemination
  - Trade Dispersal
    - Ship Ballasts
    - Packing Materials
  - Transfer through luggage, on Clothing
  - Transfer on Field Equipment
    - Shoes, truck tires, boats & paddles, etc…
    - Logging equipment during dry season
  - Biological
    - Animals, wind, water

*Hydrilla* on a boat trailer
Ken A. Langeland, University of Florida

## Morphology of an Alien

- 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)

## Simply Irresistible…

- Imagine you are a horticulturist…
  - What types of characteristics would you look for in a "perfect" plant?
    - 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

Purple loosestrife
Linda Wilson, University of Idaho

**Sound Familiar?**

## 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
- Wetlands are Ecotones so are susceptible to upland AND lowland species!

## Common Southern Wetland Invasive Plants - Identification

- 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*)

## Alligatorweed (*Alternanthera philoxeroides*)

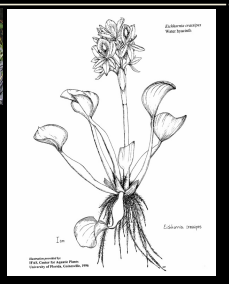
*On the TN invasive weeds list

Buckingham, Mohlenbrock, & Evans—Invasive.Org

- Identification
  - Opposite Leaves
  - Multiple white flowers in a spike that looks like 1 flower
  - Roots from nodes along the stem
  - Mat-forming
  - Reproduces vegetatively from small pieces of the stem

## Water Hyacinth (*Eichhornia crassipes*)

Buckingham, Mohlenbrock, & Evans—Invasive.Org



- Identification
  - Monocot
  - Spreads vegetatively by stolon
  - Leaves in basal rosette, rounded with bulbous petioles
  - Purple flowers (8-15) in a spike
  - Submersed, feathery roots hang below the basal rosette

## Parrot Feather (*Myriophyllum aquaticum*)

*On the TN invasive weeds list

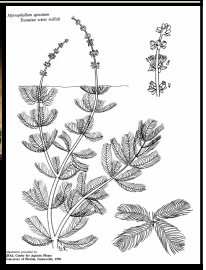
Mehrhoff, Invasive.Org


- Identification
  - Submerged/emergent
  - Whorled leaves, pinnately compound, finely dissected
  - Vegetative reproduction from stems that can reach 5 feet
  - Mat-forming

## Eurasian watermilfoil (*Myriophyllum spicatum*)

*On the TN invasive weeds list



Mehrhoff, Invasive.Org


- Identification
  - Dense mats, stems from 3 to 30 feet in length
  - Whorls of 3-6 leaves, finely dissected
  - Small red flowers in a whorled spike
  - Sexual and vegetative reproduction, though vegetative is most common

## Water lettuce (*Pistia stratiodes*)

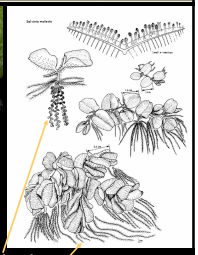


Mehrhoff and Langeland—Invasive.Org


- Identification
  - Monocot, perennial
  - Dull-green, thick, stalkless, hairy leaves
  - Free-floating
  - Inconspicuous flowers near stalk
  - Vegetative reproduction most common

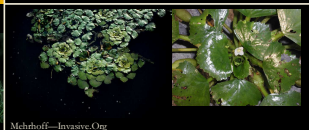
## Giant salvinia (*Salvinia molesta*)



Mehrhoff and Langeland—Invasive.Org


- Identification
  - Floating-leaved aquatic true fern
  - ½ to 1 ½ inch leaves, hairy – eggbeater papillae (see photo) – these hairs repel water & protect the plant!
  - Sporocarps hang under the plant, but the plant is actually sterile
  - Rootless (these are modified leaves & stems!)
  - Reproduction is vegetative

## Water chestnut (*Trapa natans*)



Mehrhoff—Invasive.Org

- Identification
  - Floating plant with triangular, toothed leaves
  - Rosette of leaves with inflated petiole (for buoyancy)
  - 4-petalled white flowers
  - Spiny, nut-like fruit
  - Sexual reproduction

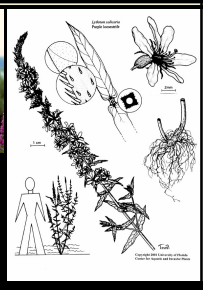
## Common species, cont'd…

- Emergent and Floodplain herbs
  - Purple loosestrife (*Lythrum salicaria*)
  - Pale yellow iris (*Iris pseudacorus*)
  - Japanese knotweed (*Polygonum cuspidatum*)
- Emergent and Floodplain grasses, sedges and rushes
  - Cogon Grass (*Imperata cylindrica*)
  - Nepalese browntop, Japangrass (*Microstegium vimineum*)
  - Common reed (*Phragmites australis*)

## Purple loosestrife (*Lythrum salicaria*)

*On the TN invasive weeds list

Wilson & Dewey—Invasive.Org



- Identification
  - Perennial forb up to 10 ft tall
  - Square, woody, pubescent stem
  - Abundant purple flowers on spikes
  - Opposite or whorled dark green, lanceolate leaves
  - Can produce 2-3 million seeds/year/plant

## Yellow flag iris (*Iris pseudacorus*)

*On the TN invasive weeds list

Loewenstein- Invasive.Org

- Identification
  - Monocot perennial, spreading by rhizome and seed
  - Grows in water and is also drought tolerant
  - Flat, arching leaves
  - Large pale-deep yellow flowers (only yellow iris in the U.S)
  - Brown to purple markings on large petal-like sepals

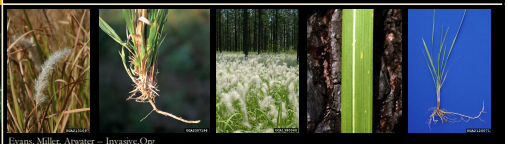
## Japanese knotweed (*Polygonum cuspidatum*)

*On the TN invasive weeds list

Invasive.Org

- Identification
  - Shrub-like forb, reaching heights of 10 feet
  - Dicot perennial
  - Large, alternate, dark-green leaves
  - Small white flowers in panicles
  - Sexual and vegetative reproduction

## Cogon Grass (*Imperata cylindrica*)



Evans, Miller, Atwater – Invasive.Org

- Identification
  - Perennial, colony-forming grass, up to 6 feet tall
  - Off-center, white midrib on leaves, rough edges
  - Large, fuzzy, white seed/flower paniele with a silky look
  - Densely mat-forming
  - Flood tolerant and drought-tolerant (upland & lowland plant)
  - Vegetative and sexual reproduction
  - Flowers spring/early summer

## Japangrass (*Microstegium vimineum*)

*On the TN invasive weeds list


Invasive.Org


Chris Oswalt

- Identification
  - Delicate, annual grass
  - Alternate, lance-shaped leaves
  - Offset mid-vein on leaves
  - Invades forest floodplains
  - Produces copious seed
  - Shade tolerant
  - First introduced in Knoxville!

## Common reed (*Phragmites australis*)

*On the TN invasive weeds list


Invasive.Org

- Identification
  - Tall perennial, 15 ft tall or more
  - Alternate, broad, strap-like pointed leaves
  - Leaves up to 2 ft long, 1 in. wide
  - Fluffy gray or purple flower heads
  - Clumping habit

## Common species, cont'd…

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

## Chinese privet (*Ligustrum sinense*)

*On the TN invasive weeds list



Invasive.Org

- Identification
  - Thick, evergreen shrub up to 30 ft tall
  - Multiple-stem trunk, opposite oval leaves
  - Fragrant, white, abundant flowers
  - Purple to black fruit
  - Other non-native privet species are very similar

## Nonnative roses (*Rosa spp.*)

*On the TN invasive weeds list



Miller, Evans, Mehrhoff - Invasive.Org

- Identification
  - Multi-stemmed, thorny, perennial shrub up to 15 ft tall
  - Odd pinnately compound leaves with 5 - 9 leaflets
  - Feathery, fringed bract at leaf base
  - Branched clusters of flowers, white to pink, 5 petals, flowers from April to June
  - Fruits from July to December, ripens to a dark red color

## Melaleuca (*Melaleuca quinquenervia*)




Starr, Pernter - Invasive.Org

- Identification
  - Evergreen tree up to 100 ft tall
  - Alternate gray-green leaves, oval, smell like camphor when crushed
  - White flowers in brushy spikes
  - Whitish, spongy, peeling bark
  - Produces huge quantities of seed
  - The object of conservation efforts in its native Australian habitat

## Chinese tallowtree (*Triadica sebifera*)



Evans, Atwater - Invasive.Org

- Identification
  - Deciduous tree growing to 60 ft tall
  - Heart-shaped leaves, alternately whorled, dark green (red in fall)
  - Flowers April to June, thin spikes about 8 inches long with tiny yellow-green flowers (petal-less)
  - Fruits in late fall/early winter, fruits split open to reveal a white waxy seed (hence the common name "popcorn tree"

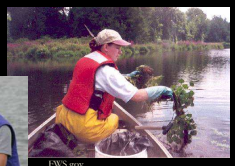
## Methods of Control

- Manual
- Mechanical
- Biological
- Chemical

- Integrated Pest Management (all of the above)

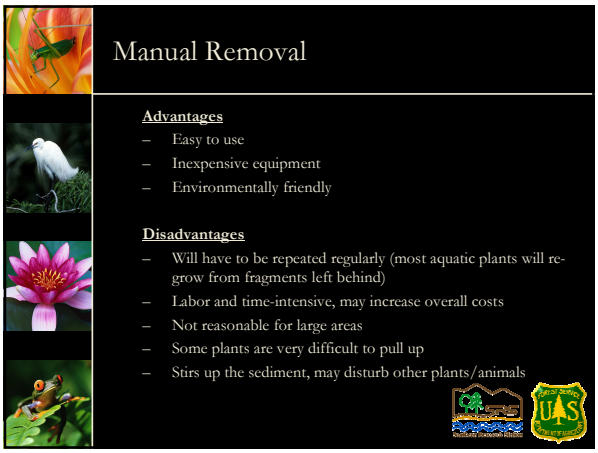
## Manual Removal

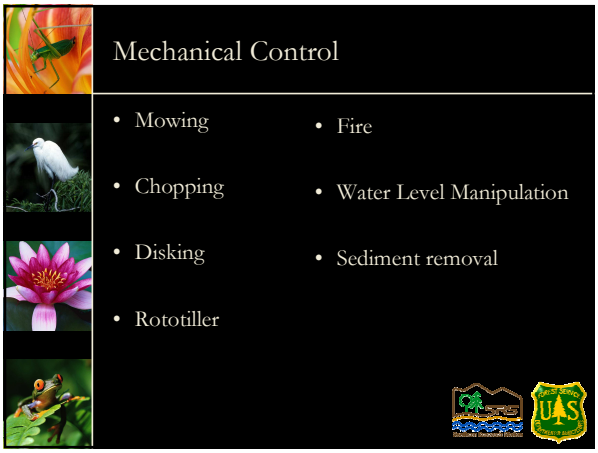
- Raking
- Hand pulling
  - Accomplished with SCUBA gear in deep water scenarios
- Hand cutting

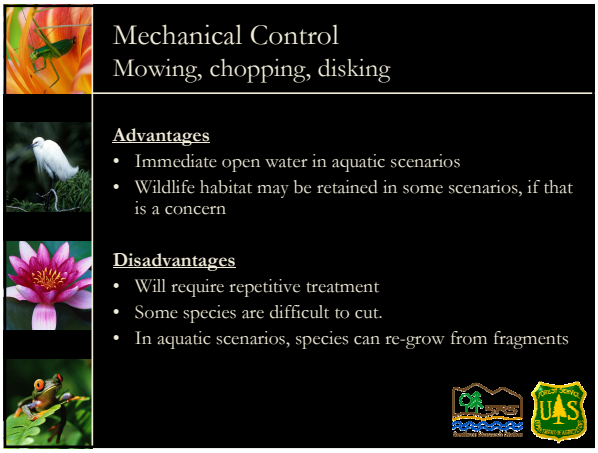


FWS.gov

University of Wisconsin Extension


Manual Removal
Advantages
– Easy to use
– Inexpensive equipment
– Environmentally friendly
Disadvantages
– Will have to be repeated regularly (most aquatic plants will re-grow from fragments left behind)
– Labor and time-intensive, may increase overall costs
– Not reasonable for large areas
– Some plants are very difficult to pull up
– Stirs up the sediment, may disturb other plants/animals


Mechanical Control
• Mowing
• Chopping
• Disking
• Rototiller
• Fire
• Water Level Manipulation
• Sediment removal


Mechanical Control
Mowing, chopping, disking
Advantages
• Immediate open water in aquatic scenarios
• Wildlife habitat may be retained in some scenarios, if that is a concern
Disadvantages
• Will require repetitive treatment
• Some species are difficult to cut.
• In aquatic scenarios, species can re-grow from fragments

## Mechanical Control
### Water level manipulation

**Advantages**

- The expansion of native aquatic plants in areas formerly occupied by exotic species can be enhanced by drawdown.
- May increased dissolved oxygen in the water, improving aquatic wildlife habitat
- May serve additional functions (shorebird habitat, etc…)

**Disadvantages**

- May be expensive if water control structures are not already on-site
- May be affected by weather events
- Public relations issues (potential odors resulting from decomposing plants, hydric soils; aesthetic & recreation issues, etc…)
- May negatively impact some wildlife

## Mechanical Control
### Prescribed burns

**Advantages**

- Cost effective
- Easy to treat relatively large areas at a time

**Disadvantages**

- Understanding the life-history of the plant is crucial
- Many species will re-sprout, so repeat treatments are required
- May also harm native populations, wildlife
- Public Relations issues
- Seasonal timing is important
- May cause some species to spread (e.g. in cogon grass file promotes spread & flowering)

## Biological Control

- Herbivores
  - Grass Carp
  - Grazing
- Insects
- Pathogens

## Biological Control

**Advantages**

- Ongoing control
- Possibility for better establishment of control over the long-term
- Works well with other control methods

**Disadvantages**

- Development takes a long time, substantial money and research
- Introduction of one exotic species to control another
- Usually doesn't eliminate the problem species, but does help to control it

## Chemical Control

- Herbicides
  - Systemic
    - Kills the entire plant through uptake
  - Non-systemic (contact herbicides)
    - Roots remain, plant can re-grow
    - Damages the cellular structure of contact surfaces
  - Selective
    - Only affects some plants (e.g. broad-leaf herbicide)
  - Non-selective
    - Broad-spectrum—affects all plants the chemical comes into contact with

## Chemical Control

- Regulations on Aquatic Use:
  - "No product can be labeled for aquatic use if it poses more than a one-in-a-million chance of causing significant damage to human health, the environment, or wildlife resources." – Madsen, J.D. LakeLine 20(1):22-34
  - Must be EPA-approved for use in aquatic environments
  - Most states also have restrictions (e.g. may only be applied by a licensed applicator)

## Chemical Control

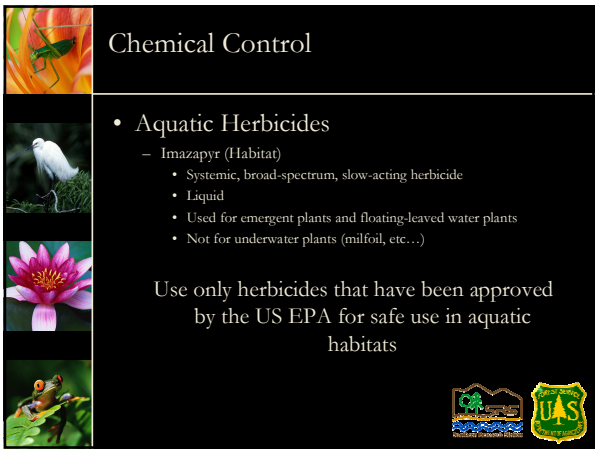
- Other things to consider
  - The success of aquatic herbicide use depends on knowledge of the plant, the system, and the herbicide
  - Important things to know:
    - Plant response
    - Herbicide concentration levels for effectiveness
    - Exposure time necessary for effective action
    - EPA maximum concentration allowance
    - System water exchange rate

## Chemical Control
### Seven EPA-approved Aquatic Herbicides

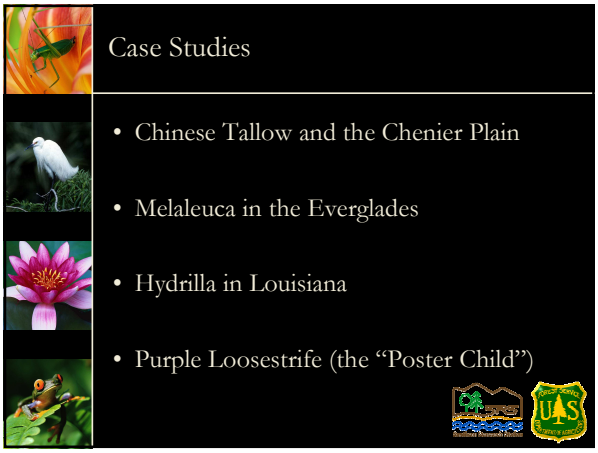
- Aquatic Herbicides
  - Glypohsate (Rodeo, AquaMaster, Aquapro)
    - Broad-spectrum, systemic herbicide for floating-leaved plants or shoreline plants (e.g. purple loosestrife, hyacinth)
    - Applied to leaves, not for underwater plants
  - Fluridone (Sonar, Avast)
    - Systemic, slow-acting pellet or liquid herbicide
    - Used for underwater plants (e.g. watermilfoil)
    - Not effective for spot treatment of small areas—works best in large areas (>5 acres)
  - 2,4-D (AquaKleen, Navigate)
    - Granular or liquid
    - Fast-acting, systemic, selective
    - Used for watermilfoil and other broad-leaved species
    - Restricted use

## Chemical Control

- Aquatic Herbicides
  - Endothall (Aquathol)
    - Non-selective, fast-acting contact herbicide
    - Granular or liquid
    - Does not typically kill roots, used for seasonal control of aquatic plants
    - Useful for small, contained populations
    - Fish sensitivity possible
  - Diquat (Reward)
    - Fast-acting, non-selective contact herbicide
    - Liquid
    - Does not kill roots
    - As in Endothall, useful for small-area, seasonal treatments
  - Triclopyr (Garlon 3A, Renovate3)
    - Liquid
    - Very useful against purple loosestrife
    - 12-hour swimming restriction when applied in aquatic environments
    - Works against watermilfoil & broad leaved aquatics


Chemical Control
• Aquatic Herbicides
– Imazapyr (Habitat)
• Systemic, broad-spectrum, slow-acting herbicide
• Liquid
• Used for emergent plants and floating-leaved water plants
• Not for underwater plants (milfoil, etc…)
Use only herbicides that have been approved by the US EPA for safe use in aquatic habitats


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


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

## Chinese Tallow

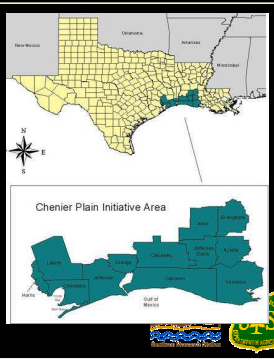
- **Introduction Year:** 1772
- **Where**: Gulf Coast
- **Why:** Soapmaking
- **Native range**: China
- **Historic use**: candles, soap, fuel, and to create charcoal, ethanol, methanol, petroleum substitute

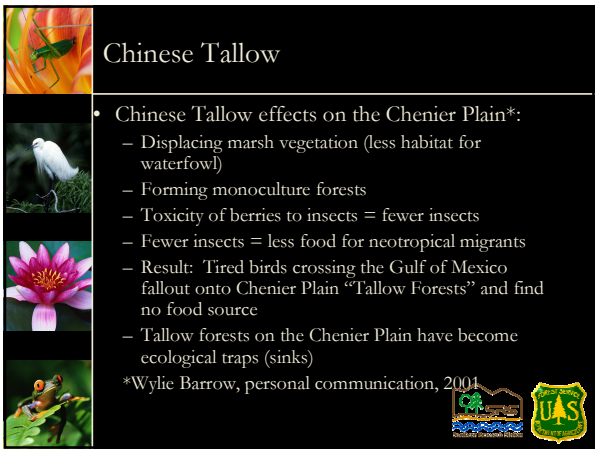
## Chinese Tallow

- 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

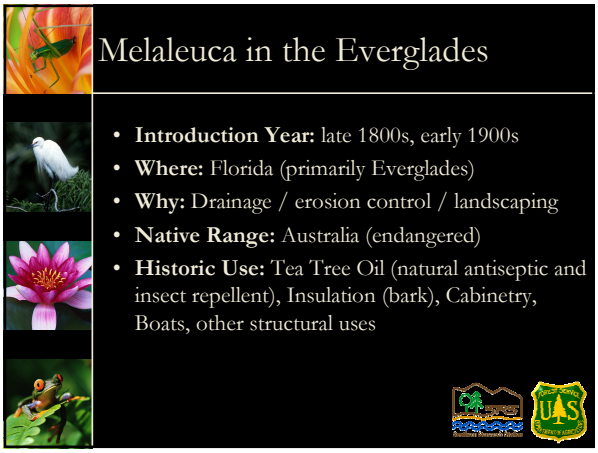
## Chinese Tallow

- 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




Chinese Tallow
• 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, 2004

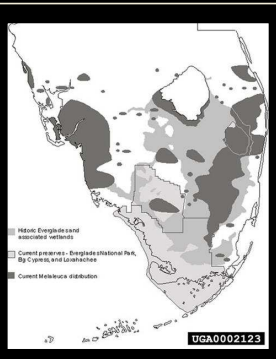

Potential Chinese Tallow Control
• Mechanical
– Individual tree removal in low density areas
– Prescribed burning can slow spread, but is ineffective against high-density stands
• Chemical
– Stem-injection Herbicides
• Arsenal AC, Garlon 4, Pathfinder II


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

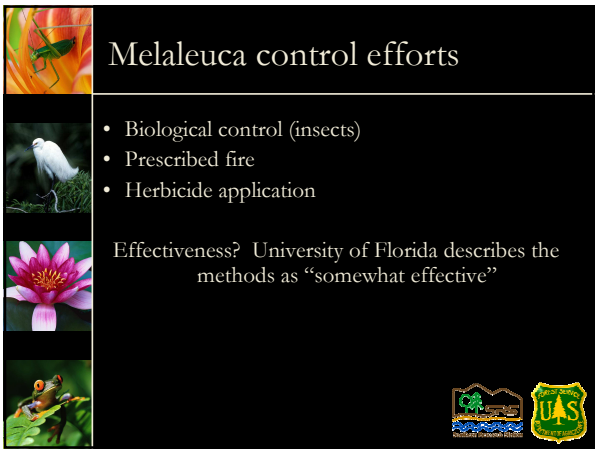
## Melaleuca, continued




## 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



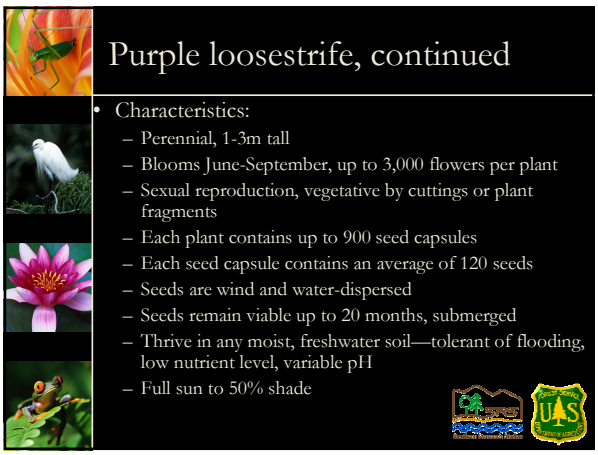
## Melaleuca control efforts

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

Effectiveness? University of Florida describes the methods as "somewhat effective"

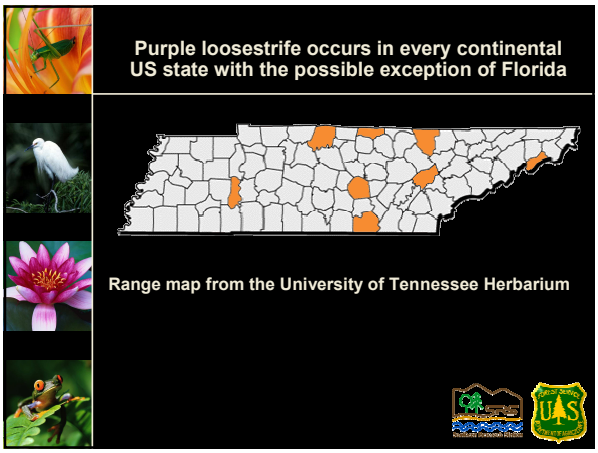
## Purple Loosestrife
## "Poster Child" or Unsupported Hysteria?

- **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




## 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

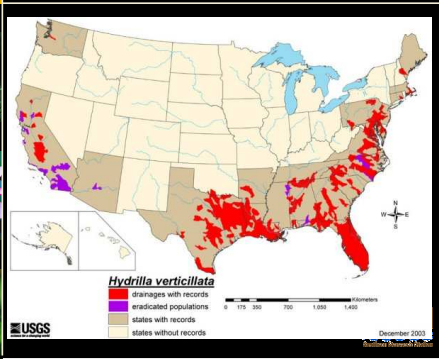
## Hydrilla in Lake Martin (Louisiana)

- **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

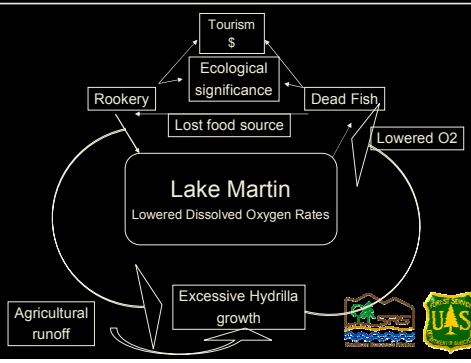
## Hydrilla range



## 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

- 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?
- 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?