Invasive Plants

Stephen F. Enloe and
Nancy J. Loewenstein

Department of Agronomy and Soils and
School of Forestry and Wildlife Sciences
Auburn University
Invasion Biology as a Scientific Discipline

- Relatively young discipline
  - 1999 White House Executive Order 13112 on Invasive Species
  - 2000 to 2010 has produced a vast array of studies and understanding, but there are still many knowledge gaps
Questions we will answer today

- How do you define “invasive plants”? 
- How did they get here?
- What makes a plant invasive?
- What are the impacts of invasive plants?
- What are some of the key invasive plants in the Southeast?
- Can they be controlled or eradicated with IPM techniques?
Relevant words commonly used regarding troublesome plants

**Weed:** A plant growing where it is not desired

**Alien plants:** Plant species introduced by human activity

**Exotic/Non-native:** of foreign origin or character; not native; introduced from abroad, but not fully naturalized or acclimatized

**Naturalized:** Alien plants that sustain populations over many generations without help, reproduce freely, but do not necessarily invade natural, semi-natural, or human made ecosystems

**Noxious**

**Invasive**
"Noxious" weeds

- "Designated noxious weeds" means the weeds, seeds or other plant parts that are considered detrimental, destructive, injurious or poisonous, either by virtue of their direct effect or as carriers of diseases or parasites that exist within this state, and are on the designated list;

- Weed and Pest Control Laws
  - W.S. 11-5-101 to 11-5-406

- Nursery Stock Laws
  - W.S. 11-9-101 to 11-9-108

- Seed Laws
  - W.S. 11-12-101 to 11-12-123
  - Wyo Rules and Regs, Dept of Ag, Doc. 2675
What is an invasive plant?

- A non-native species whose introduction does or is likely to cause economic or environmental harm or harm to human, animal, or plant health.

Invasive Species Advisory Council 2006
http://www.invasivespeciesinfo.gov/docs/council/isacdef.pdf
More specifically...

- **Definition 1:**
  - Non-native plants that can *spread* into wildland ecosystems, *displace* or *hybridize* with native species, *alter* biological communities, or *alter* ecosystem processes.
    - Alter fire cycles, hydrology, nutrient cycles, food webs
    - Facilitate other invaders

- **Definition 2:** Def. 1 expanded to include agricultural, turf, and horticultural ecosystems
Definition 1:
Non-native plants that can spread into wildland ecosystems, displace or hybridize with native species, alter biological communities, or alter ecosystem processes.
- Alter fire cycles, hydrology, nutrient cycles, food webs
- Facilitate other invaders

Definition 2: Def. 1 expanded to include agricultural, turf, and horticultural ecosystems
Common chickweed (*Stellaria media*)
Tall morningglory (*Ipomoea purpurea*)
Over 500 nonnative invasive species in the Southeast

- 384 plants
- 72 vertebrates
- 92 invertebrates
- 16 pathogens
How did they get here?

- Introduced through human activity
- Unintentionally
  - Contaminated seeds
  - Packing material
  - Ship ballast
  - Livestock and feed
- Intentionally
50% of the species on Alabama’s invasive plant list are escaped ornamentals.
“Between the hedges” refers to Chinese Privet!
planted for wildlife ...
forage and soil stabilization ...
Not all exotic plants become invasive!

- The “Tens Rule” for introduced plants
  - Developed in the United Kingdom
  - 1 of 10 imported species “escapes” to the wild
  - 1 of 10 of these introduced species becomes established in the wild
  - 1 of 10 established species spreads and becomes a pest
- Does not work well for other invasives

Why are some species invasive?
Characteristics of invasive plants

- Rapid growth rates
- Short juvenile phase
- Strong reproductive pressure
- Efficient propagule dispersal
- Tolerant and adaptive
- Hybrid vigor
- High degree of interference
- Competition and/or allelopathy
The disturbance component

- Many of these inherent factors result in rapid positive responses to disturbance
- Natural
  - Hurricanes, drought, flooding, fire, herbivory
- Anthropogenic
  - The very things that have facilitated modern human civilization
Plentiful supply of non-native plant seeds and fragments

- Ornamental plants
- Wildlife plantings
- Roadside stabilization
- Globalization & world trade

- Mulch, pine straw, soil
- Runoff and flood water
- Vehicles, equipment
- Pets and people
Invasive tendencies + abundant propagules + disturbance
Invasive Plant Increase Over Time

- **Acres Infested**
  - Initial introduction
  - Few locales
  - Many locales
  - Approaching biological potential

- **Lag Phase**
- **Rapid expansion phase**
- **Biological potential**

**Time**
Impacts of invasive plants

- Reduce Native biodiversity
  - plants, insects, animals
- Alter Ecosystem structure and function
  - Productivity, fire cycles, hydrology, nutrient cycles, and food webs
  - facilitate other invaders
- Forestry and Rangeland Productivity
- Hinder management
- Decrease recreational value
- Alter aesthetics
- Increase costs
Alabama’s Invasive Plant List
A “Who’s-who” in the Southeast

<table>
<thead>
<tr>
<th>Species</th>
<th>Category</th>
<th>Urban and Interface</th>
<th>Managed</th>
<th>Natural Areas and Parks</th>
<th>Wildlife Habitat / Food Plots</th>
<th>Rights-of-Way</th>
<th>Aquatic-Wetland / Riparian</th>
<th>Pasture / Orchards</th>
<th>Rowcrops / Nurseries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japanese honeysuckle</td>
<td>Vinca</td>
<td>2.0 2 2 2.0 2.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese honeysuckle</td>
<td>Lonicera maackii</td>
<td>0.0 0.0 2 1 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese mulberry</td>
<td>Morus rubra</td>
<td>0.0 2 1 1 2 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese rhubarb</td>
<td>Rheum palmatum</td>
<td>0.0 2 1 1 2 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese bananas</td>
<td>Musa paradisiaca</td>
<td>0.0 2 1 1 2 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese quince</td>
<td>Cydonia oblonga</td>
<td>0.0 2 1 1 2 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese blackberry</td>
<td>Rubus fruticosus</td>
<td>0.0 2 1 1 2 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese elderberry</td>
<td>Sambucus chinensis</td>
<td>0.0 2 1 1 2 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese persimmon</td>
<td>Diospyros kaki</td>
<td>0.0 2 1 1 2 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese plum</td>
<td>Prunus salicina</td>
<td>0.0 2 1 1 2 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese persimmon</td>
<td>Diospyros kaki</td>
<td>0.0 2 1 1 2 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese plum</td>
<td>Prunus salicina</td>
<td>0.0 2 1 1 2 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese persimmon</td>
<td>Diospyros kaki</td>
<td>0.0 2 1 1 2 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese plum</td>
<td>Prunus salicina</td>
<td>0.0 2 1 1 2 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Plants are ranked within eight different land use categories
- Indicate if species is currently used as an ornamental or as a crop
- Available at: http://www.se-eppc.org/alabama/
**KEY INVADERS: Occupation of Alabama’s Forests by Invasive Plants 2001-2006**

James H. Miller and Erwin Chambliss, US Forest Service R&D Auburn

Preliminary Estimate of Actual Acres Covered (SRS FIA)

<table>
<thead>
<tr>
<th>Invasive Plant</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japanese Honeysuckle</td>
<td>2,922,547</td>
</tr>
<tr>
<td>Privet</td>
<td>902,215</td>
</tr>
<tr>
<td>Kudzu</td>
<td>61,295</td>
</tr>
<tr>
<td>Japanese Climbing Fern</td>
<td>43,709</td>
</tr>
<tr>
<td>Cogongrass</td>
<td>43,889</td>
</tr>
<tr>
<td>Mimosa / Silktree</td>
<td>34,945</td>
</tr>
<tr>
<td>Tallowtree</td>
<td>22,505</td>
</tr>
<tr>
<td>Nonnative Roses</td>
<td>20,837</td>
</tr>
<tr>
<td>Chinaberry</td>
<td>13,496</td>
</tr>
<tr>
<td>Asian Wisterias</td>
<td>12,380</td>
</tr>
<tr>
<td>Princesstree</td>
<td>2,284</td>
</tr>
<tr>
<td>Tropical soda apple</td>
<td>1,710</td>
</tr>
</tbody>
</table>

4,081,812 Acres
Invasive trees and shrubs

- Seeds often dispersed by birds and other mammals
- Initially invade forest edges and gaps
- Very rapid growth rates
- Strong crown/root resprouters
Invasive trees

- tree-of-heaven (**Ailanthus altissima**)
- silk tree (**Albizia julibrissin**)
- camphor tree (**Cinnamomum camphora**)
- Chinaberry (**Melia azedarach**)
- princess tree (**Paulownia tomentosa**)
- trifoliate orange (**Poncirus trifoliata**)
- ‘Bradford’ pear (**Pyrus calleryana**)
- sawtooth oak (**Quercus acutissima**)
- Chinese tallow tree (**Triadica sebifera**)
- tungoil tree (**Vernicia fordii**)

![Tree of Heaven](image)
Tallowtree, Popcorntree

*Triadica sebifera*

**Forest Acres in a County Occupied**

- Not Detected
- < 1,000
- 1,000 - 10,000
- 10,000 - 25,000
- 25,000 - 50,000
- 50,000 - 75,000

USDA Forest Service
SRS FIA database March 2008 Miller and Chambliss, Auburn
Chinese tallow tree, popcorn tree

*(Triadica sebifera)*

- Ornamental deciduous tree, originally introduced for seed oil
- Alternate, diamond-shaped leaves, nice fall color
- Tolerant of shade, flooding and saline water
- Fire suppressant
- Allelopathic properties and dense growth make this a severe threat
- Spreads through prolific seed production and root sprouts
- Invades riparian and upland forests, wetlands, pastures, urban...
- Converting grasslands and coastal prairie into tallowtree forest
Callery pear
*(Pyrus calleryana)*
tree-of-heaven
(Ailanthus altissima)

- Deciduous tree used as an ornamental.
- Large compound leaves with circular gland on underside of lobes at base of leaflets
- Shade intolerant
- Allelopathic
- Spreads by root sprouts, abundant wind- and water-dispersed seeds
- Invades urban areas, rights-of-ways (ROWs), disturbed areas ...
tungoil tree
(Vernicia fordii)
Invasive shrubs

- thorny olive (*Elaeagnus pungens*)
- autumn olive (*Elaeagnus umbellata*)
- bicolor lespedeza (*Lespedeza bicolor*)
- Chinese privet (*Ligustrum sinense*)
- glossy and Japanese privet (*L. lucidum, L. japonicum*)
- bush honeysuckles (*Lonicera maackii*, etc.)
- leatherleaf mahonia (*Mahonia bealei*)
- nandina (*Nandina domestica*)
- coralberry (*Ardesia crenata*)
- multiflora rose (*Rosa multiflora*)
- tropical soda apple (*Solanum viarum*)
thorny olive
*(Elaeagnus pungens)*
leatherleaf mahonia
*(Mahonia bealei)*
Tropical soda apple
Chinese and European Privets
*Ligustrum sinense* and *L. vulgare*

Forest Acres in a County Occupied

- Not Detected
- < 1,000
- 1,000 - 10,000
- 10,000 - 25,000
- 25,000 - 50,000
- 50,000 - 75,000
- 75,000 - 100,000

USDA Forest Service
SRS FIA database March 2008 Miller and Chambliss, Auburn
Invasive vines

- Respond faster to disturbance and new forest gaps than many natives
- Have faster growth rates (make leaves not wood)
- Strongly suppress growth of tree and understory species (smothering)
- Often have “positive reinforcement” with disturbance
Invasive vines

- chocolate vine (*Akebia quinata*)
- porcelain berry (*Ampelopsis brevipedunculata*)
- Oriental bittersweet (*Celastrus orbiculatus*)
- Chinese yam (*Dioscorea oppositifolia*)
- English ivy (*Hedera helix*)
- Japanese climbing fern (*Lygodium japonicum*)
- wisteria (*Wisteria sinensis, W. floribunda*)
Kudzu: The classic Southeastern invasive plant
Kudzu impacts on native biodiversity

- Very poorly studied and almost completely observational
- “The aggressive, climbing nature of *P. montana* causes shading and death of native vegetation, resulting in a monoculture…”
  - Forsyth and Innis, 2004 *Critical Reviews in Plant Sciences*
- Appears to completely arrest successional processes
  - Possibly strong local impacts on wildlife
Kudzu and Nitrogen Fixation

- May be as high as 235 kg/ha/year
  - (~210 pounds/Acre/year)
- Actual nitrogen cycling not well studied
  - Large stands could be contributing significant N-loading into watersheds
Japanese honeysuckle 
(*Lonicera japonica*)
Honeysuckle impacts (+ and -)

- Aggressively displaces young trees and understory species
- Reduces native plant diversity and slows or inhibits succession
- Estimated to comprise 50% of white tail deer diets!
  - Strong compensatory response to herbivory
- Used by many nocturnal and diurnal pollinating insects
Japanese Climbing Fern

*Lygodium japonicum*

**Forest Acres in a County Occupied**

- Not Detected
- < 1,000
- 1,000 - 10,000
- 10,000 - 25,000

**USDA Forest Service**
**SRS FIA database March 2008 Miller and Chambliss, Auburn**
Chocolate vine
(Akebia quinata)
Oriental bittersweet
(Celastrus orbiculatus)
Porcelain berry
(Ampelopsis brevipedunculata)
Air yam
*(Dioscorea bulbifera)*
Invasive grasses

- Often poor food source for wildlife
- Often form dense thatch layers
- Faster growth than comparable natives
- Tolerant to broader range of conditions
- FIRE cycle changes
  - Pyrogenic
  - positive feedback mechanisms
Cheatgrass (*Bromus tectorum*) in the Western USA
Cogongrass
For more information ... http://www.cogongrass.org
Japanese stiltgrass, Nepalese browntop

*Microstegium vimineum*

- Annual grass, shade-tolerant
- Favors moist soils in understory
- Forms very dense stands
- Prolific seed production – spread by flood waters and soil disturbance
- Seed produced late summer/early fall
- Seed bank lasts 3-5 years
- Invades riparian forests, trail and roadsides, damp fields, lawns ...
- Class C noxious weed
Aquatic invasive plants

- Water hyacinth
- Parrot feather
- Water lettuce
- Giant salvinia
A Field Guide for the Identification of Nonnative Invasive Plants in Southern Forests
Miller, Chamblis and Loewenstein

A Management Guide for Nonnative Invasive Plants of Southern Forests
Miller, Manning and Enloe
IPM for Invasive Plants in Natural Areas

- Overlooked for decades in regards to invasive plants
- A value shift has occurred:
  - From utilization to conservation of biodiversity
  - Single species protection to entire ecosystem protection
- President Clinton’s 1999 Executive Order on invasive species provided momentum for natural areas
Invasive plant issues in natural areas

- Management very difficult in many natural systems
- Selectivity in control strategies frequently lacking
  - Minimize non-target damage to everything surrounding the weed
- T+E species concerns
Additional Issues in natural areas

- Strong lack of awareness among general public
  - Horticultural roots of many invasive plants
- Insufficient infrastructure on the state/national level
- Lack of direct economic incentive to do anything about them
- Mixed or sometimes limited data on invasive plant impacts
Invasive Plant Increase Over Time

- **Public awareness begins**
- **Initial detection**
- **Lag Phase**
- **Rapid expansion phase**
- **Approaching biological potential**

- **Initial introduction**
- **Few locales**
- **Many locales**
- **Biological potential**

Dimensions: 720.0x540.0
Weed Increase Over Time

- **Initial introduction**: Prevention or eradication highly probable
- **Few locales**: Eradication feasible
- **Many locales**: Eradication unlikely, intense effort required
- **Approaching biological potential**: Local control and management only
Wildfire Paradigm of Invasive Plant Management

- Maintain the Clear Zone
- Eradicate the Outliers
- Stop the Advancing Front
- Protect Special Habitats
To report cogongrass infestation contact your local Alabama Forestry Commission Office.

Data as of 9/10/2009 3:07:41 PM

Data updated daily by the Alabama Forestry Commission

5419

Number of Spots

Disclaimer

The information presented on the maps have been compiled from many sources and are considered reliable. The Alabama Forestry Commission (AFC) makes no warranties either expressed or implied, concerning the location, accuracy, completeness, reliability, or suitability of this data for any use other than display. The maps and information contained on the maps may periodically change and may or may not be incorporated in any new version. AFC assumes no liability for the use or misuse of the information contained in these maps. Please contact the AFC GIS Manager if you discover any discrepancies with the online maps.
What does eradication really mean?

- The complete elimination of ALL living propagules, including sexual and asexual...
Eradication definition (Part 2)

- The complete elimination of ALL living propagules, including sexual and asexual...
- ...within a defined boundary
  - Single patch
  - County
  - State
  - National
  - Continental
Integrated Tools for Invasive Plants

Cultural
Chemical
Prescribed fire
Mechanical
Biological
Grazing
Revegetation

Desirable plant community increases
Target weed(s) decrease(s) or is (are) eradicated

Land management objectives met
Natural areas herbicides

- Glyphosate
- Triclopyr
- Imazapyr
- Imazamox
- Aminopyralid
- Metsulfuron
Cut stump
(Cut-treat) herbicide
treatments
Cut / treat is generally very effective
Basal treatments
Herbicide issues

Natural areas

- Sensitivity of on site non-target species
- Potential for non-target injury
- Water frequently comes into play
  - Aquatic labeled formulations typically used
- Herbicide resistance?
Grazing Issues

- Cattle grazing not typically used
  - Public perception often negative towards cattle in “natural areas”
- Sheep or goats increasingly used
- Wild ungulate / invasive plant interactions rarely studied
In 2006, the City of Chattanooga began an experiment to see if grazing goats would provide a better solution to ridding the Missionary Ridge area of the insidious kudzu vines choking the banks above the Missionary Ridge Tunnels. The surprising results were that the goats could and did clear the area in a much quicker and efficient manner than herbicides and manpower. As a result, the goats have been making an annual appearance in more areas of Missionary Ridge. A Goat Browsing Academy was held in May of 2007 and people from as far away as North Carolina attended. The use of the goats may be continued in other areas of the City in the future.

GOAT BROWSING
Chattanooga City Code Sec. 7-74
Mowing with goats

5/01/2009 09:32:00 AM
At our Mountain View headquarters, we have some fields that we need to mow occasionally to clear weeds and brush to reduce fire hazard. This spring we decided to take a low-carbon approach: instead of using noisy mowers that run on gasoline and pollute the air, we've rented some goats from California Grazing to do the job for us (we're not "kidding"). A herder brings about 200 goats and they spend roughly a week with us at Google, eating the grass and fertilizing at the same time. The goats are herded with the help of Jen, a border collie. It costs us about the same as mowing, and goats are a lot cuter to watch than lawn mowers.
Biological control

- Few agents available for many invasive plants in natural areas
- Some resistance to the use of available biologicals has come from interactions with native species
  - *Rhinocyllus* damage on native thistles
  - Deer mice harvest of *Urophora* galls on spotted knapweed
Fire and invasive plants

Fire does **not** help with the control of most invasive species

- Fire hazard
- Re-sprouting/ rapid re-growth
- Promote flowering
- Promote seed germination
- Fire disturbance may increase establishment potential

Fire may aid with the control of a few species

- May reduce stand and allow for easier access and/or better herbicide contact
- Tallow tree – dormant season fire may help, although may re-sprout
- Chinese privet – repeated fires can sometimes help with control
Restoration / Revegetation Issues

- A lack of historic records of composition of many native ecosystems
- A lack of available propagules of many native plants
  - “Local ecotype” controversy
- A lack of effective establishment techniques for many native plants
- Changing climate may not make restoring historic conditions possible
Chinese tallowtree
Japanese honeysuckle
Japanese climbing fern
Chinese privet
Cogongrass
Mimosa
Helpful Websites

- Cogongrass information:
  - www.cogongrass.org

- Southeast Exotic Plant Plant Council
  - www.se-eppc.org

- Alabama Invasive Plant Council
  - http://www.se-eppc.org/alabama/

- Invasive Plant Info
  - www.invasive.org
Questions?