Effectiveness of management techniques for *Microstegium vimineum* (Japanese stiltgrass) invasions and their impacts on native species diversity and abundance

Luke Flory
Indiana University
Goals of invasive plant management
Goals of invasive plant management

1. Effectively remove invasive plant
Goals of invasive plant management

1. Effectively remove invasive plant
2. Minimize impacts on native plant community
Goals of invasive plant management

1. Effectively remove invasive plant
2. Minimize impacts on native plant community
3. Restore native plant community to prevent future invasions
Microstegium vimineum (Japanese stiltgrass)

- C₄ shade tolerant annual grass
- produces > 1000 seeds/plant
- native to southeast Asia
  (Fairbrothers and Gray 1972)
- persistent 3+ year seed bank
  (Barden 1987)
- not eaten by mammals or insects, not attacked by pathogens
*Microstegium vimineum* (Japanese stiltgrass)

• Introduced in early 1900s, now spreading very rapidly
  (Fairbrothers and Gray 1972)

• currently invasive in > 20 states

• considered the most problematic invasive species in many eastern states
**Microstegium vimineum** (Japanese stiltgrass)

- most commonly found in disturbed riparian areas  
  (Redman 1995)

- invades sites full sun to <5% ambient light  (Winter et al. 1982)

- can tolerate a wide range of soil moisture conditions
*Microstegium vimineum* (Japanese stiltgrass)

Reduces the productivity and richness of native herbaceous species and may reduce native tree seedling emergence

*(see poster #16)*
Research Questions

1. What is the optimum management technique for eradicating *Microstegium* invasions?
Research Questions

1. What is the optimum management technique for eradicating *Microstegium* invasions?
2. How do different management techniques impact native plant productivity and diversity?
Research Questions

1. What is the optimum management technique for eradicating *Microstegium* invasions?
2. How do different management techniques impact native plant productivity and diversity?
3. Do additions of native seeds inhibit future *Microstegium* invasions or increase native plant diversity and productivity?
Experimental Design

No restoration

- Control
- Hand-weeding
- POST herbicide
- POST + PRE herbicide

2m
No restoration

Control

Hand-weeding

POST herbicide

POST + PRE herbicide

2m
No restoration

- Control
- Hand-weeding
- POST herbicide
- POST + PRE herbicide

2m

2m
Control

Hand-weeding

POST herbicide

POST + PRE herbicide

No restoration

Grass specific
Post-emergent herbicide

Fusilade DX
0.75 oz./gal
(Fluazifop-P-butyl)
No restoration

Control

Hand-weeding

POST herbicide

POST + PRE herbicide

Grass specific Post-emergent herbicide plus Pre-emergent herbicide

Pendulum AquaCap
3.2 oz./1,000 sq ft (pendimethalin)
No restoration

Control

Hand-weeding

POST herbicide

POST + PRE herbicide

2m

Restoration: 10 native forb species added

Control

Hand-weeding

POST herbicide

POST + PRE herbicide
Restoration: 10 native forb species added

X 5 reps X 8 sites
= 320 plots
Research Sites

Light availability

Soil moisture
Apply POST and HW

Add seed to restoration plots

Apply PRE

Apply POST and HW

Apply PRE

Destructive harvest

Collect cover data

Destructive harvest

Collect cover data
Fall 2005 Harvest

*Microstegium* biomass

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Microstegium biomass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>40</td>
</tr>
<tr>
<td>Hand weeding</td>
<td>1 (a) 98% reduction</td>
</tr>
<tr>
<td>POST</td>
<td>1 (b) 99% reduction</td>
</tr>
</tbody>
</table>

Treatment: $P < 0.0001$
Spring 2006

Microstegium cover

Treatment: $P < 0.0001$

Percent Microstegium cover

- Control
- Hand weeding
- POST
- POST + PRE

Treatment: a > b > c (d is significantly different from other treatments)
*No difference in Microstegium biomass with seed addition treatment ($P = 0.432$)
Summary: Removal of *Microstegium*

<table>
<thead>
<tr>
<th>Method</th>
<th>Microstegium End of season</th>
<th>Microstegium Spring cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand weeding</td>
<td>86.9% reduction</td>
<td></td>
</tr>
<tr>
<td>POST</td>
<td></td>
<td>99.8% reduction</td>
</tr>
<tr>
<td>POST + PRE</td>
<td></td>
<td>99.9% reduction</td>
</tr>
</tbody>
</table>
Summary: Removal of *Microstegium*

<table>
<thead>
<tr>
<th>Method</th>
<th><em>Microstegium</em></th>
<th><em>Microstegium</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>End of season</td>
<td>Spring cover</td>
</tr>
<tr>
<td>Hand weeding</td>
<td>↓ 86.9% reduction</td>
<td>70%</td>
</tr>
<tr>
<td>POST</td>
<td>↓ 99.8% reduction</td>
<td>25%</td>
</tr>
<tr>
<td>POST + PRE</td>
<td>↓ 99.9% reduction</td>
<td>&lt; 1%</td>
</tr>
</tbody>
</table>
Spring 2006
Native plant cover

*No difference in native cover with seed addition treatment ($P = 0.097$)
Fall 2006 Harvest
Native species productivity

*Decrease in native species productivity with seed addition treatment ($P = 0.051$)
Fall 2006 Harvest
Native species diversity

*No difference in native species diversity with seed addition treatment (P = 0.228)
## Summary: Impact on native species

<table>
<thead>
<tr>
<th></th>
<th>Spring native cover</th>
<th>Native species productivity</th>
<th>Native species diversity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand weeding</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POST</td>
<td>![up arrow]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>POST + PRE</td>
<td></td>
<td></td>
<td>No difference</td>
</tr>
</tbody>
</table>
## Summary: Impact on native species

<table>
<thead>
<tr>
<th></th>
<th>Spring native cover</th>
<th>Native species productivity</th>
<th>Native species diversity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hand weeding</strong></td>
<td><img src="https://via.placeholder.com/15" alt="Increase" /></td>
<td><img src="https://via.placeholder.com/15" alt="Increase" /></td>
<td><img src="https://via.placeholder.com/15" alt="Increase" /></td>
</tr>
<tr>
<td><strong>POST</strong></td>
<td><img src="https://via.placeholder.com/15" alt="Increase" /></td>
<td><img src="https://via.placeholder.com/15" alt="No difference" /></td>
<td><img src="https://via.placeholder.com/15" alt="No difference" /></td>
</tr>
<tr>
<td><strong>POST + PRE</strong></td>
<td><img src="https://via.placeholder.com/15" alt="No difference" /></td>
<td><img src="https://via.placeholder.com/15" alt="No difference" /></td>
<td><img src="https://via.placeholder.com/15" alt="Increase" /></td>
</tr>
</tbody>
</table>
### Summary: Impact on native species

<table>
<thead>
<tr>
<th></th>
<th>Spring native cover</th>
<th>Native species productivity</th>
<th>Native species diversity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hand weeding</strong></td>
<td>![up arrow]</td>
<td>![up arrow]</td>
<td>No difference</td>
</tr>
<tr>
<td><strong>POST</strong></td>
<td>![up arrow]</td>
<td>No difference</td>
<td>No difference</td>
</tr>
<tr>
<td><strong>POST + PRE</strong></td>
<td>No difference</td>
<td>![up arrow]</td>
<td>![down arrow]</td>
</tr>
</tbody>
</table>
Conclusions

- Invasions of *Microstegium* can be eliminated using post-emergent grass specific herbicide followed by a spring application of pre-emergent herbicide.
- Control of *Microstegium* by this method results in decreased native species diversity but may not affect productivity.
- Further study will determine if repeat applications can eliminate populations over the long term.
- Further data analysis will reveal the influence of environmental conditions on *Microstegium* abundance and the effectiveness of management and restoration techniques.
Conclusions

• Invasions of *Microstegium* can be eliminated using post-emergent grass specific herbicide followed by a spring application of pre-emergent herbicide

• Control of *Microstegium* by this method results in decreased native species diversity but may not affect productivity

• Further study will determine if repeat applications can eliminate populations over the long term

• Further data analysis will reveal the influence of environmental conditions on *Microstegium* abundance and the effectiveness of management and restoration techniques
Conclusions

• Invasions of Microstegium can be eliminated using post-emergent grass specific herbicide followed by a spring application of pre-emergent herbicide
• Control of Microstegium by this method results in decreased native species diversity but may not affect productivity
• Further study will determine if repeat applications can eliminate populations over the long term
• Further data analysis will reveal the influence of environmental conditions on Microstegium abundance and the effectiveness of management and restoration techniques
Conclusions

- Invasions of *Microstegium* can be eliminated using post-emergent grass specific herbicide followed by a spring application of pre-emergent herbicide.
- Control of *Microstegium* by this method results in decreased native species diversity but may not affect productivity.
- Further study will determine if repeat applications can eliminate populations over the long term.
- Further data analysis will reveal the influence of environmental conditions on *Microstegium* abundance and the effectiveness of management and restoration techniques.
Management Recommendations
for *Microstegium*

1. Monitor natural areas for *Microstegium* invasions
Management Recommendations for *Microstegium*

1. Monitor natural areas for *Microstegium* invasions
2. Remove new, isolated *Microstegium* populations with hand weeding – monitor throughout growing season
Management Recommendations for *Microstegium*

1. Monitor natural areas for *Microstegium* invasions
2. Remove new, isolated *Microstegium* populations with hand weeding – monitor throughout growing season
3. Eradicate large, dense *Microstegium* invasions with a grass specific post-emergent herbicide
Management Recommendations for *Microstegium*

1. Monitor natural areas for *Microstegium* invasions
2. Remove new, isolated *Microstegium* populations with hand weeding – monitor throughout growing season
3. Eradicate large, dense *Microstegium* invasions with a grass specific post-emergent herbicide
4. Apply a pre-emergent herbicide the following spring to well established (large seed bank) *Microstegium* invasions
Acknowledgments

Funding
- USDA, Hoosier National Forest
- The Nature Conservancy
- National Wild Turkey Federation
- Townsend Chemical Division
- B.F. Floyd Summer Fellowship

Research Sites
- Hoosier National Forest
- Big Oaks National Wildlife Refuge
- Morgan-Monroe State Forest
- Jackson-Washington State Forest

Field Assistants
Rachel Soukup, Margie Smith, Patrick McGinley, Neena Thomas, Colleen Krga, Melinda Kaelin, Kyle Schneider, Nathan Hyde, Eric Hancock, Laura Stebbins, Rachel Bennett, Simon Flory, Jesse Goode, Tyler Droste, Brandon Hall, Susan Cook, Maria Gaetani, Justin Miller, Wes Abplanab, Rachel Maranto, Julie Rubly, Lindsay Klaunig