

A method for quantifying habitat indication and expansion of invasive species

J. Stephen Brewer
Department of Biology
University of Mississippi



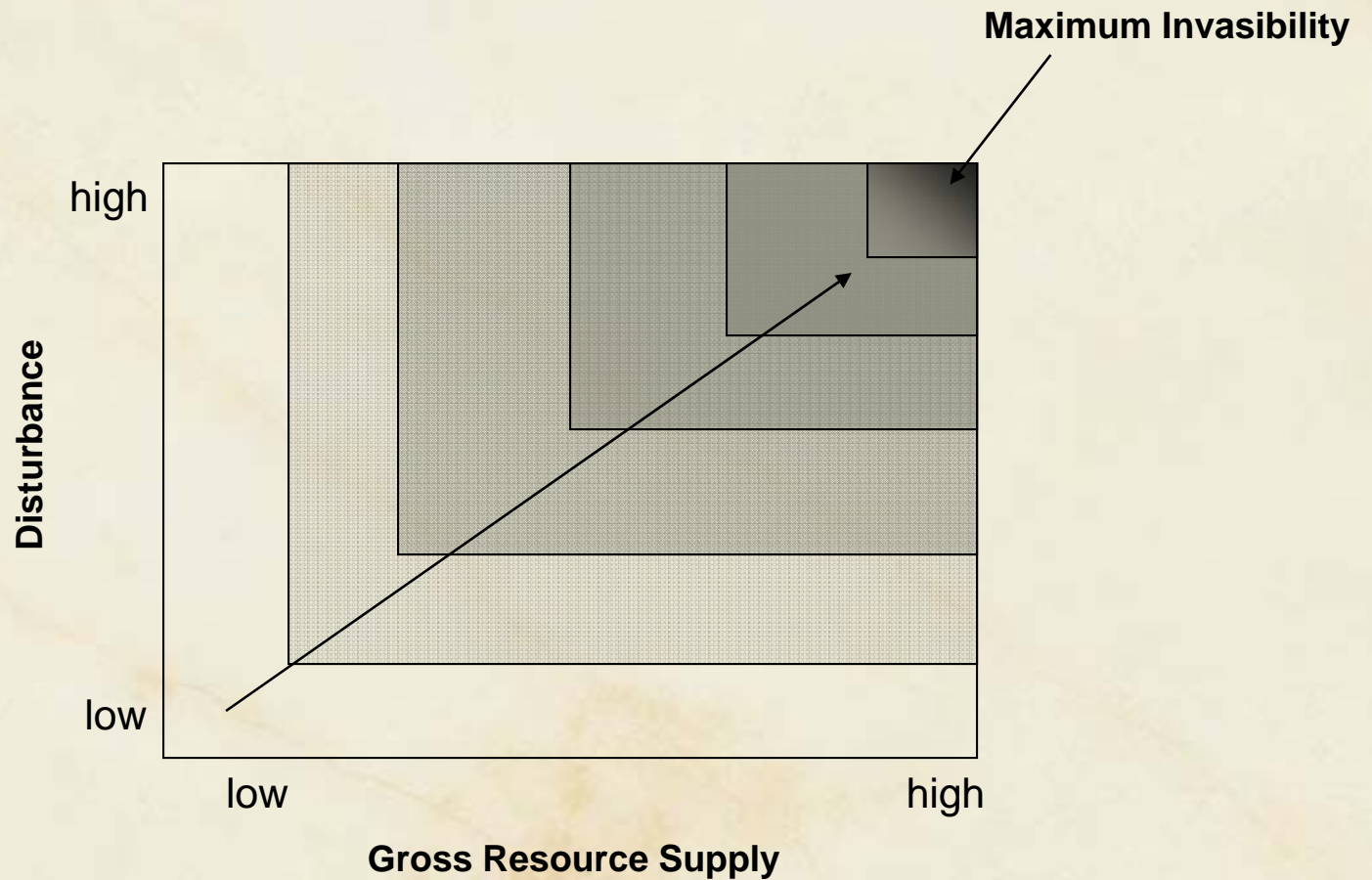


Two Important Ecological Questions about Invasive Species

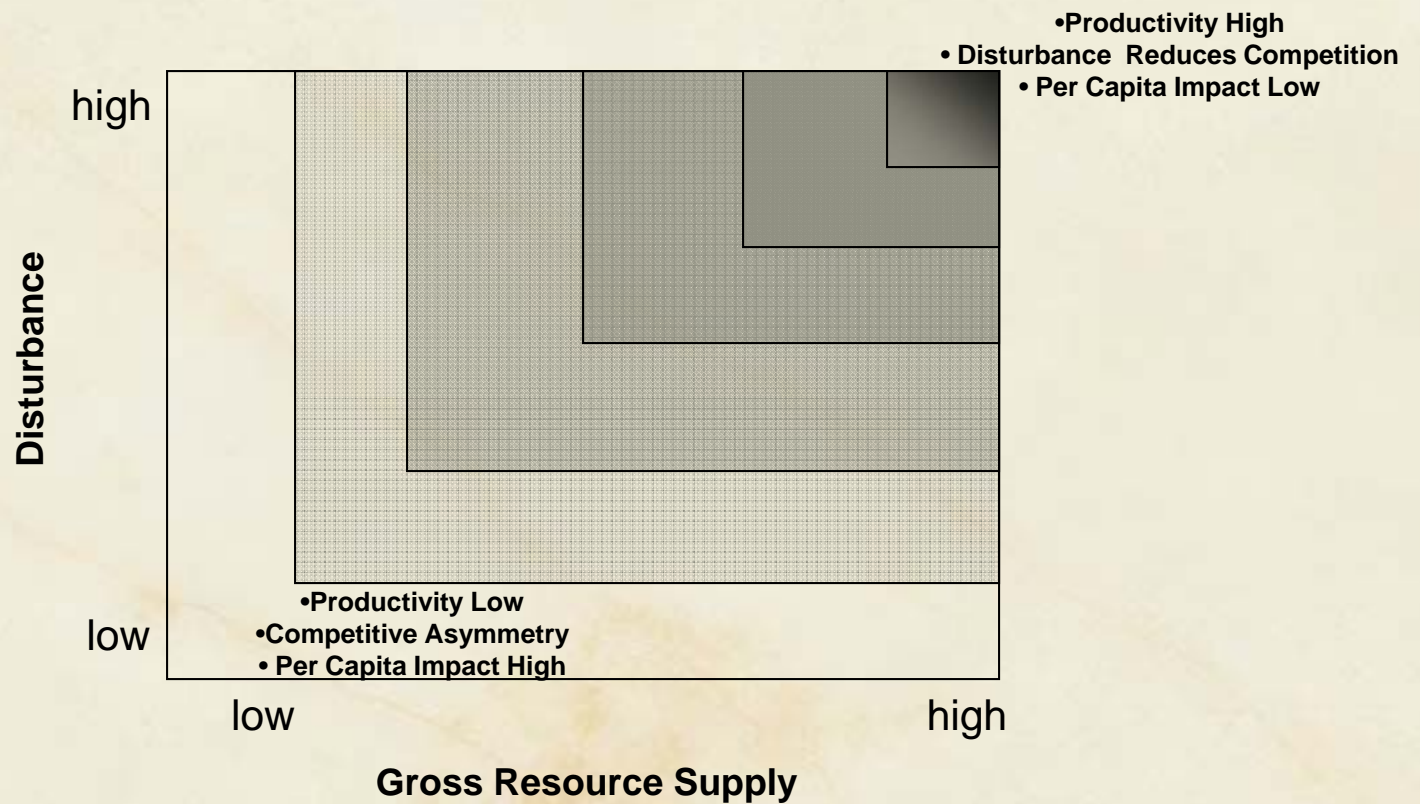
- Which ecological communities are most vulnerable to invasion? *Invasibility*
- In which ecological communities do invasive species have the greatest impact? *Impact*

A General Hypothesis of Invasibility

(Davis, Grime, and Thompson, 2000; J. Ecol.)



Productivity of Invaders and Per Capita Impact





Objectives

- Quantify habitat indication of native and non-native species found at several disturbed and undisturbed sites in Mississippi.
- Evaluate the hypothesis that disturbed habitats and resource-rich natural habitats are the most readily invaded by non-native species.
- Evaluate the hypothesis that the invaders with the greatest competitive effects are those that occur in resource-poor and undisturbed habitats.
- Review impacts of *Imperata cylindrica* and *Microstegium vimineum* on longleaf pine savanna and shady mesic forest vegetation, respectively.

Study Sites





Procedures - Relating to Invasibility to Habitat Productivity

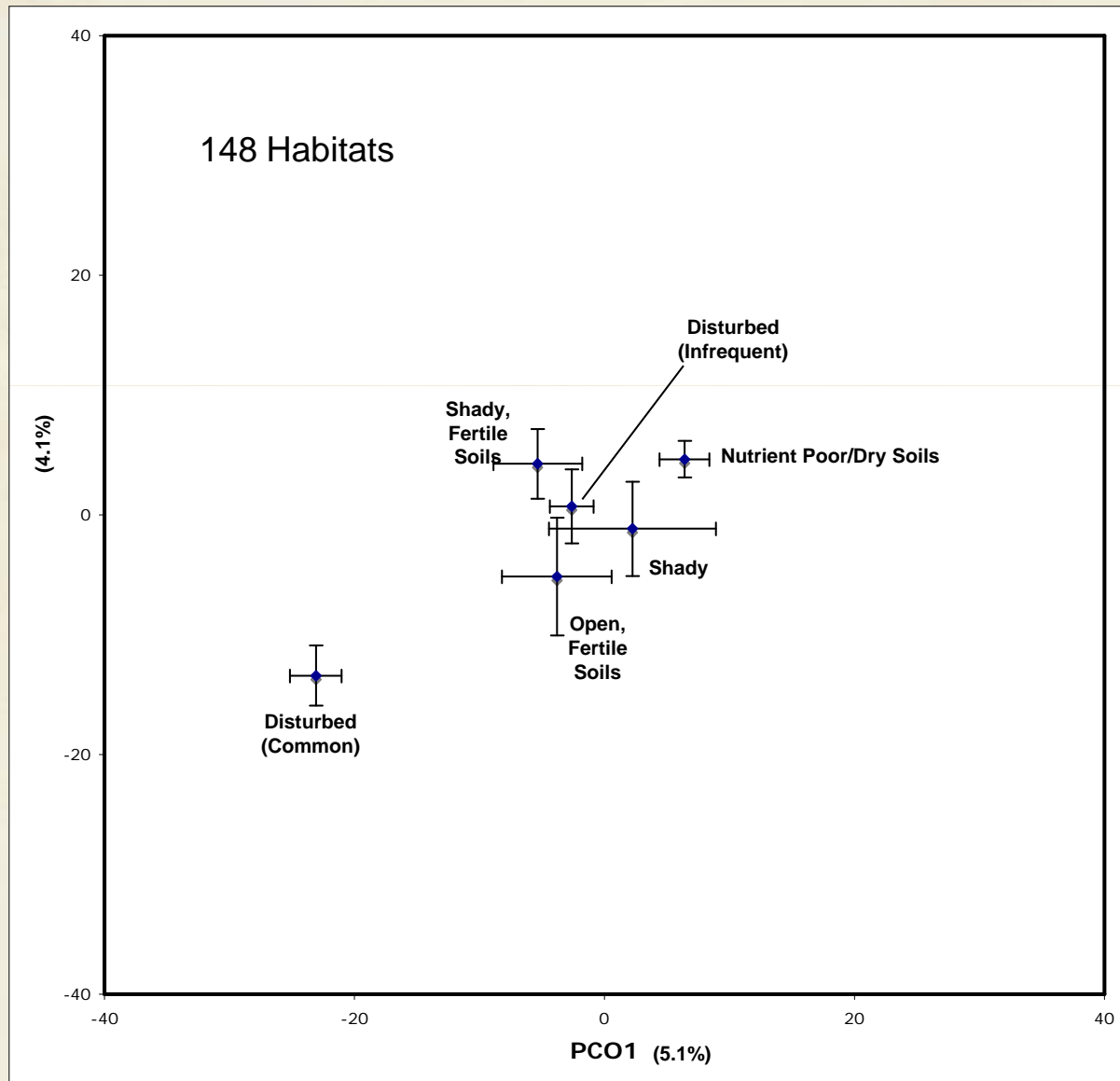
- Construct habitat by species matrix for all native and non-native species encountered using regional flora manuals
- Conduct principal coordinates analysis ordination of all identified habitats
- Overlay the associations of native and non-native (exotic) species with habitats using weighted averages of habitat scores
- Look for trends of association of natives and non-natives with variation in productivity among natural habitats



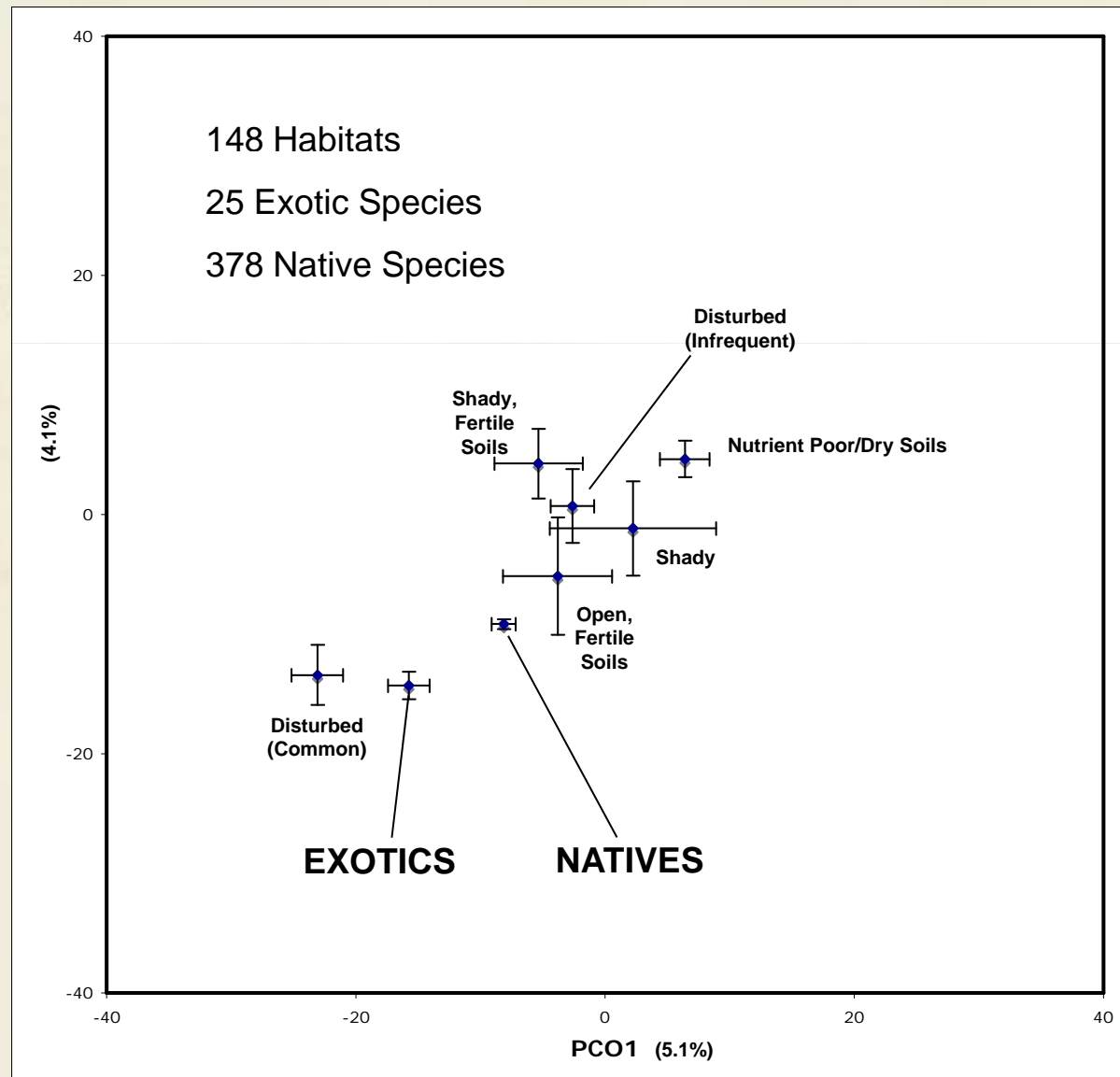
Procedures - Relating Impact to Habitat Productivity and Disturbance

- Calculate the degree of indication of non-native species to anthropogenically disturbed and resource-poor or resource-rich natural habitats (using method of Brewer and Menzel 2009).
- Quantify demonstrated impact of non-natives on plant community composition (i.e., competitive displacement) using NatureServe and literature searches.
- Relate habitat indication of non-natives to their impact using discriminant analysis.

Results - Ordination of Major Habitat Types



Results - Ordination of Major Habitat Types with Habitat Indication of Exotics and Natives Superimposed



Results - Habitat Indication of Non-Native Species

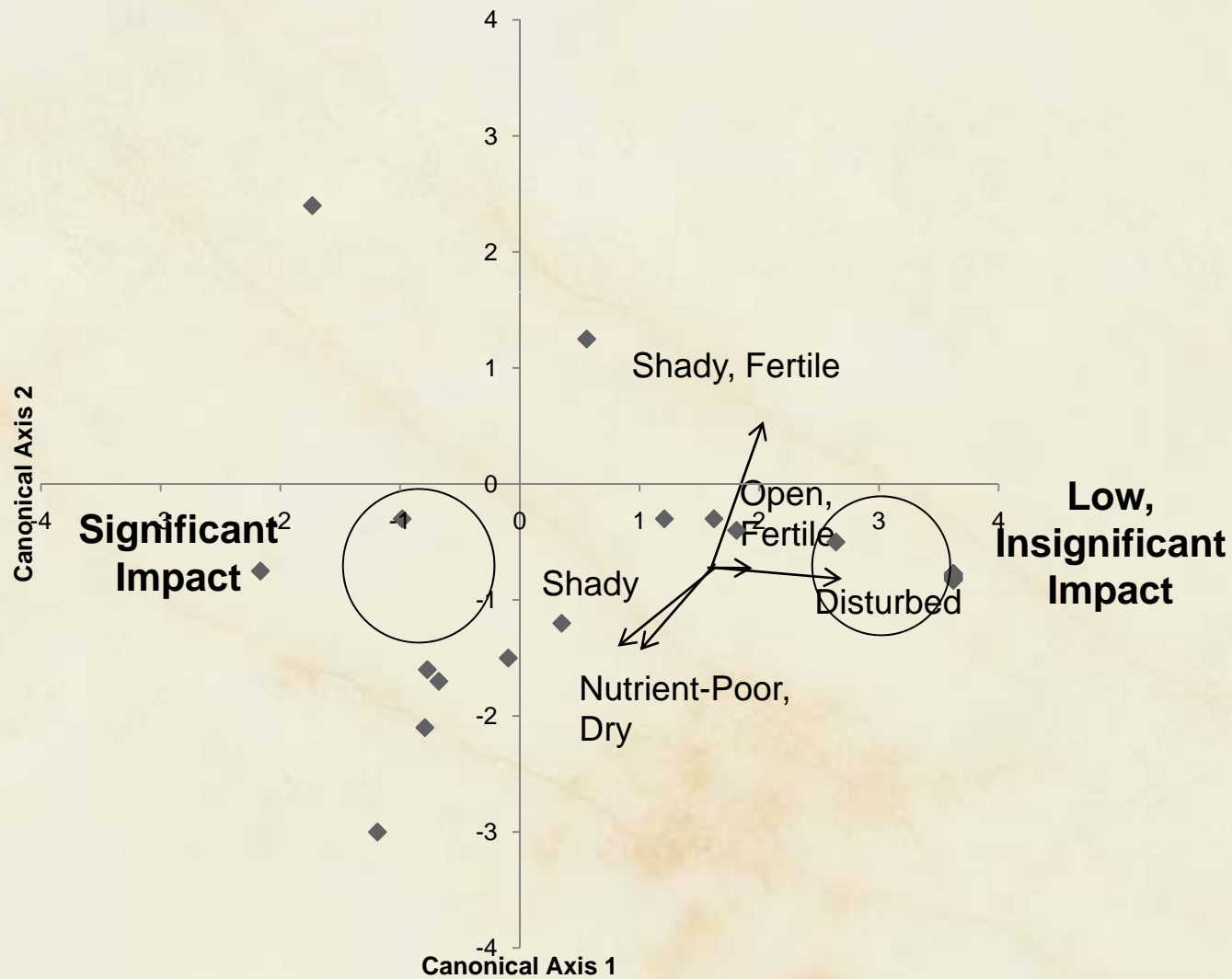
Species	disturbed	open, fertile soils	nutrient-poor/dry soils	shady
<i>Abutilon theophrasti</i>	1.00	0.00	0.00	0.00
<i>Ailanthus altissima</i>	0.50	0.00	0.00	0.50
<i>Albizia julibrissin</i>	0.33	0.00	0.00	0.00
<i>Allium vineale</i>	1.00	0.00	0.00	0.00
<i>Cerastium vulgatum</i>	1.00	0.00	0.00	0.00
<i>Cynodon dactylon</i>	1.00	0.00	0.00	0.00
<i>Cyperus iria</i>	0.50	0.33	0.00	0.00
<i>Digitaria sanguinalis</i>	1.00	0.00	0.00	0.00
<i>Hedera helix</i>	0.33	0.00	0.00	0.33
<i>Imperata cylindrica</i>	0.20	0.00	0.14	0.00
<i>Ipomoea purpurea</i>	1.00	0.00	0.00	0.00
<i>Lespedeza cuneata</i>	0.11	0.09	0.14	0.00
<i>Ligustrum sinense</i>	0.14	0.14	0.00	0.14
<i>Lonicera japonica</i>	0.33	0.00	0.00	0.14
<i>Lygodium japonicum</i>	0.20	0.00	0.25	0.20
<i>Microstegium vimineum</i>	0.25	0.20	0.00	0.25
<i>Nandina domestica</i>	0.00	0.00	0.00	0.50
<i>Paspalum boscianum</i>	1.00	0.00	0.00	0.00
<i>Paspalum notatum</i>	1.00	0.00	0.00	0.00
<i>Poncirus trifoliata</i>	0.50	0.00	0.00	0.00
<i>Rumex crispus</i>	0.33	0.17	0.00	0.00
<i>Setaria pumila</i>	1.00	0.00	0.00	0.00
<i>Sonchus asper</i>	1.00	0.00	0.00	0.00
<i>Trifolium dubium</i>	1.00	0.00	0.00	0.00
<i>Triadica sebifera</i>	0.17	0.17	0.17	0.17


Results - Impacts of Non-Native Species

Species	Negative Effect on Community Composition Peer Reviewed Research	NatureServe Impact - Community Composition
<i>Abutilon theophrasti</i>	insignificant	medium/insignificant
<i>Ailanthus altissima</i>	significant	high ¹
<i>Albizia julibrissin</i>	inconclusive/no data	high ¹
<i>Allium vineale</i>	low/inconclusive	low
<i>Cerastium vulgatum</i>	not studied	not studied
<i>Cynodon dactylon</i>	mixed	high ¹
<i>Cyperus iria</i>	not studied	not studied
<i>Digitaria sanguinalis</i>	low	low
<i>Hedera helix</i>	significant	moderate ¹
<i>Imperata cylindrica</i>	significant	high
<i>Ipomoea purpurea</i>	insignificant	low
<i>Lespedeza cuneata</i>	significant	high
<i>Ligustrum sinense</i>	significant	high ¹
<i>Lonicera japonica</i>	mixed	high ¹
<i>Lygodium japonicum</i>	inconclusive/no data	high ¹
<i>Microstegium vimineum</i>	mixed/significant	high ¹
<i>Nandina domestica</i>	inconclusive/no data	high ¹
<i>Paspalum boscianum</i>	not studied	not studied
<i>Paspalum notatum</i>	mixed	insignificant ¹
<i>Poncirus trifoliata</i>	not studied	not studied
<i>Rumex crispus</i>	low	low ¹
<i>Setaria pumila</i>	low/insignificant	low/insignificant ¹
<i>Sonchus asper</i>	low/insignificant	not studied
<i>Trifolium dubium</i>	low/insignificant	not studied
<i>Triadica sebifera</i>	significant	high

1 - not based on peer-reviewed research

Results - Relating Habitat Indication to Impacts of Non-Native Species

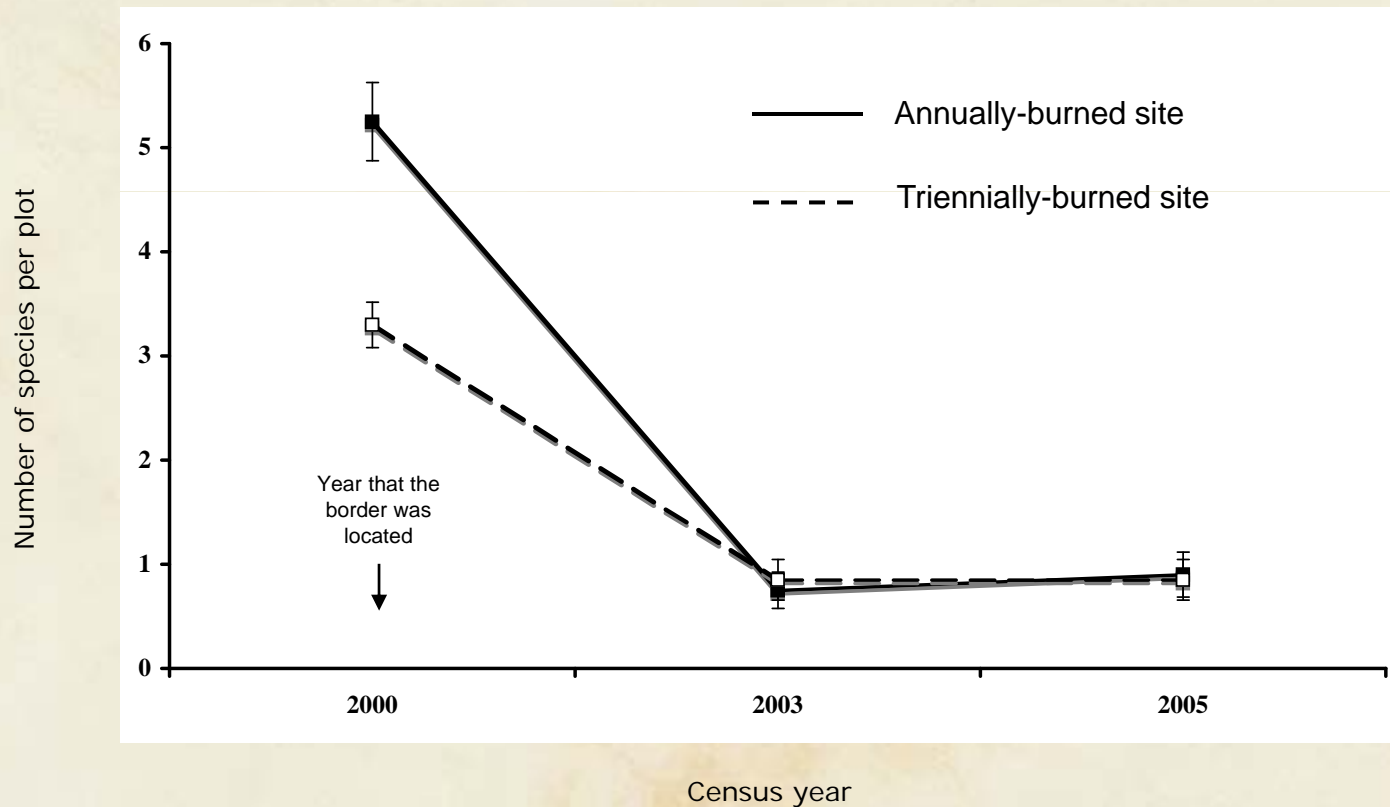




Why do exotic species appear to have greater impacts in resource-poor or undisturbed habitats than in resource-rich or disturbed habitats?

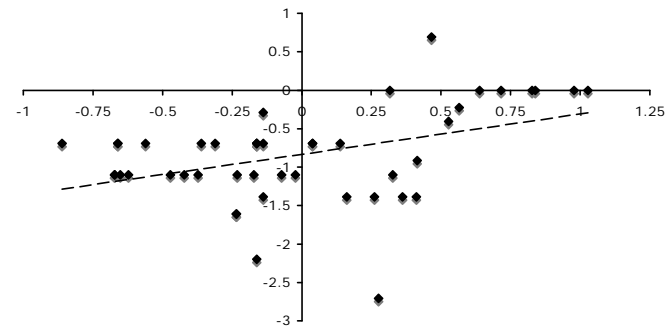
- Review the relationship between the impact of *Imperata cylindrica* on pine flatwoods species and plant height
- Review the relationship between plant species richness and *Microstegium vimineum* in recently disturbed and mature forests

Declines in Species Richness as a Result of Cogongrass Invasion in Longleaf Pine Flatwoods



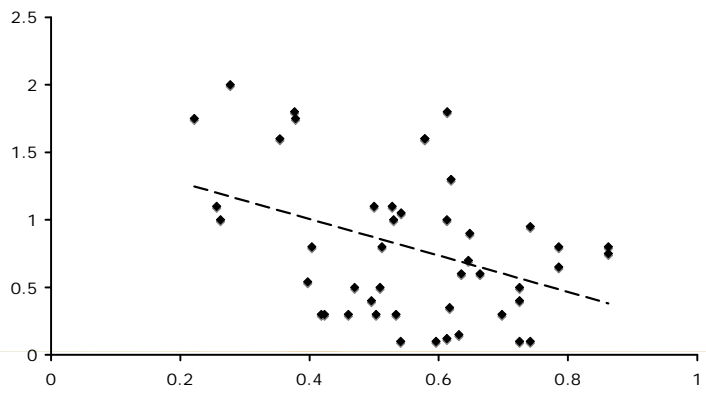
Vulnerability of Longleaf Pine Flatwoods Indicators to Displacement is Related to Short Stature

Change in frequency
(2000 to 2005)



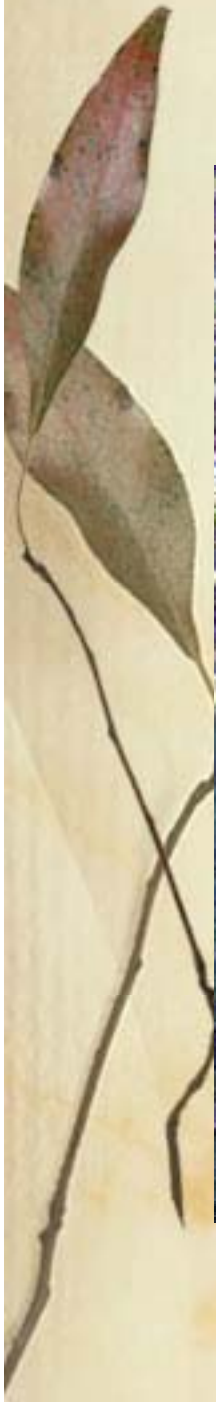
Maximum height (m) (adjusted for initial density)

Maximum height (m)



Flatwoods indication

Little Effect of *Microstegium vimineum* on Disturbed Communities



$R^2 = 0.0055$

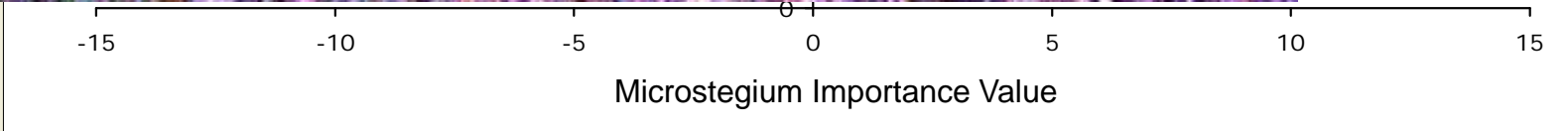
10

Microstegium Importance Value

Negative Effect of *Microstegium vimineum* on Mature Forest Species



$r^2 = 0.1288$





Conclusions

- Non-native species are more indicative of anthropogenically-disturbed habitats than are native species as a group.
- With respect to natural habitats that are not anthropogenically-disturbed, non-native species are least common within nutrient-poor/dry soils.
- The per capita competitive effect of non-native species is greater in resource-poor and undisturbed habitats than in resource-rich habitats or disturbed habitats.
- Reasons appear to relate to size asymmetry in resource-poor habitats and reduced competitive displacement in disturbed habitats.



Research Needs

- More studies that quantify impact of non-native species on community composition under field conditions; most studies of potential competitive effects (e.g., allelopathic potential) are premature.
- Greater focus on stress-tolerance traits of non-native species
- More studies on the per capita effects of invaders on natural communities; differences among communities in vulnerability to impact.



Implications for Restoration

- Results apply better to preservation than to restoration.
- Ecosystem Hippocratic Oath – Minimize harm to the ecosystem when treating invaders, which in some cases means doing no treatment.
 - Impacts High – Early Detection and Aggressive Chemotherapy
 - Impacts Low – Selective Surgery or No Treatment



Acknowledgments

- Cooperative Agreement - USDA Forest Service; Southern Research Station - 07-CA-11330127
- Joint Venture – USDA Forest Service: Southern Research Station – 08-JV-11330127-121
- Ted Leininger - Project Leader - Center for Bottomland Hardwoods Research; Stoneville, Miss.
- National Audubon Society and Strawberry Plains Audubon Center
- Christine Bertz, Katie Griffin, Jason Chesser, the 2008 and 2010 General Ecology classes at Ole Miss, Sarah Hinman, Sean Cralle, Sherry Surrette, Jeff Cannon and many others!