Experimental evidence for indirect facilitation among invasive plants

Microstegium vimineum
(stiltgrass)

Alliaria petiolata
(garlic mustard)

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Ecology, 92(12), 2011, pp. 2248–2257

Invasive *Microstegium* populations consistently outperform native range populations across diverse environments

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100 YEARS Journal of Ecology

Journal of Ecology doi: 10.1111/1365-2745.12078

ESSAY REVIEW

Pathogen accumulation and long-term dynamics of plant invasions

OPEN ACCESS
IOP PUBLISHING ENVIRONMENTAL RESEARCH LETTERS
Environ. Res. Lett. 7 (2012) 045904 (7pp) doi:10.1088/1748-9326/7/4/045904

Experimental approaches for evaluating the invasion risk of biofuel crops

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Journal of Applied Ecology

Journal of Applied Ecology 2009, 46, 434–442 doi: 10.1111/j.1365-2664.2009.01610.x

Invasive plant removal method determines native plant community responses

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Effects of roads and forest successional age on experimental plant invasions

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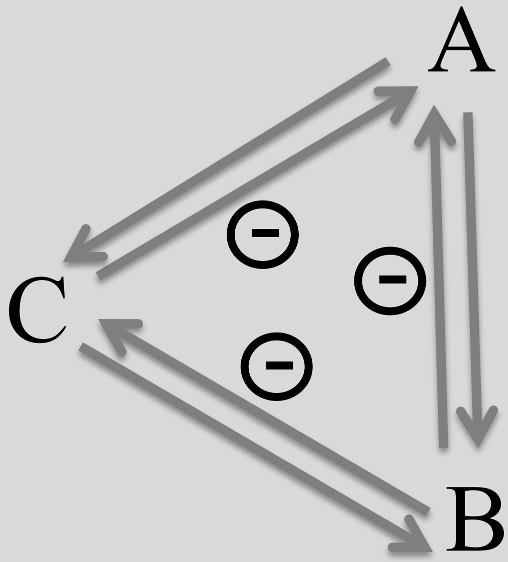
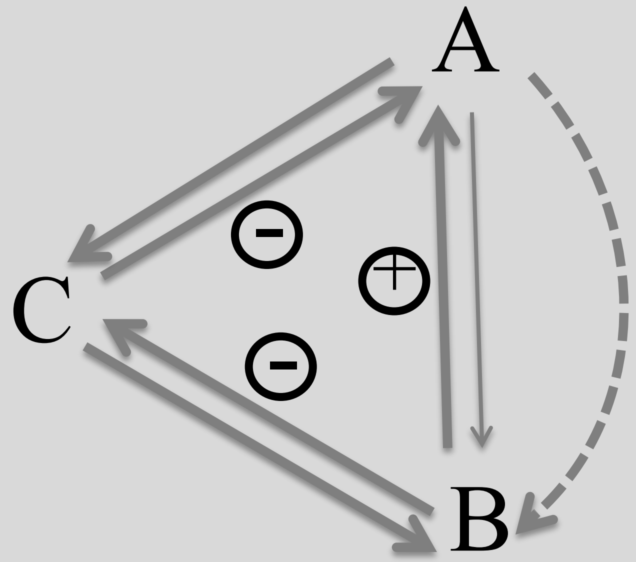
What causes plant invasions?

- Enemy release
- Evolution
- Disturbance
- Facilitation

Competition

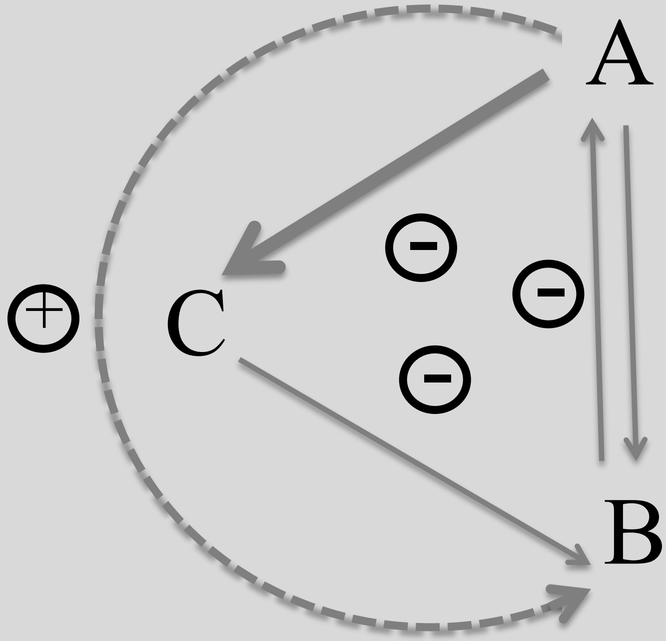


Facilitation



(e.g., nurse plants, nitrogen fixing plants)

Indirect facilitation



after Levine 1999

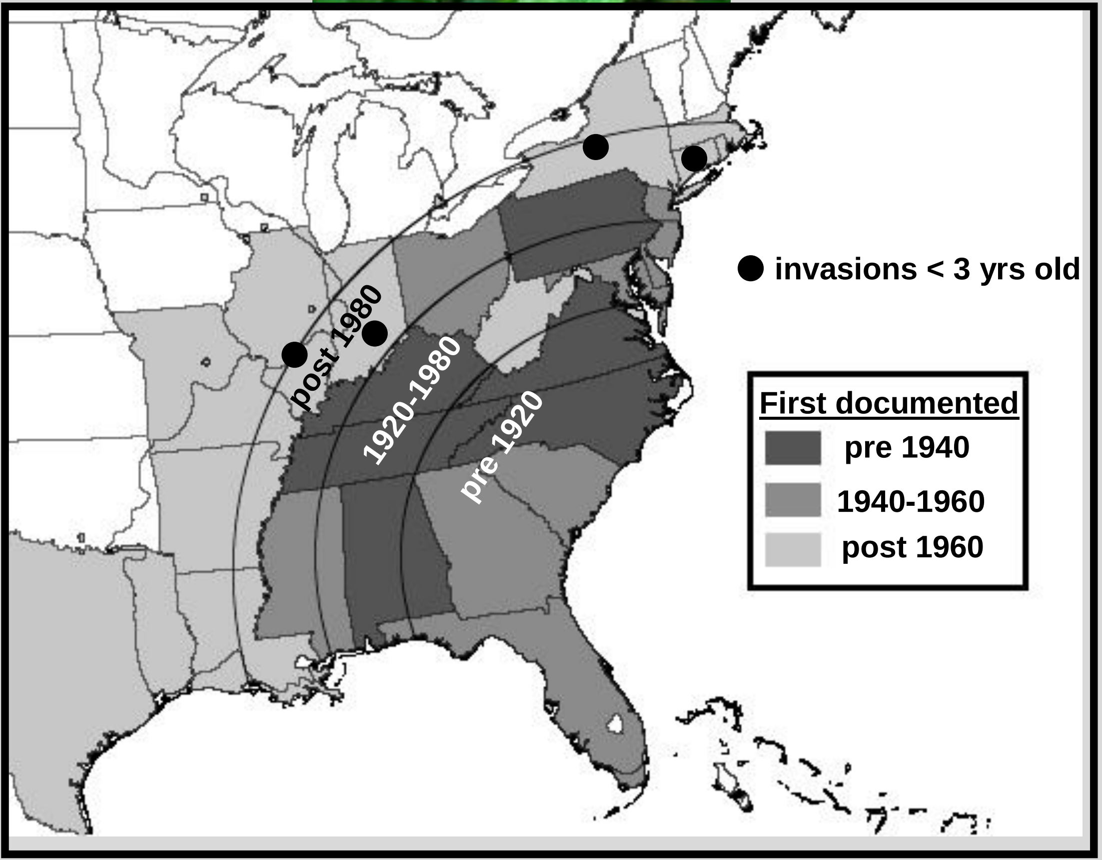
Research question: Do invasions of *Microstegium* facilitate secondary invasions of *Alliaria*?

Microstegium vimineum
(stiltgrass)

Alliaria petiolata
(garlic mustard)

Hypothesis: *Microstegium* invasions will facilitate *Alliaria* because they invade similar habitats but have offset phenologies (C4 vs C3)

Microstegium vimineum
(stiltgrass)

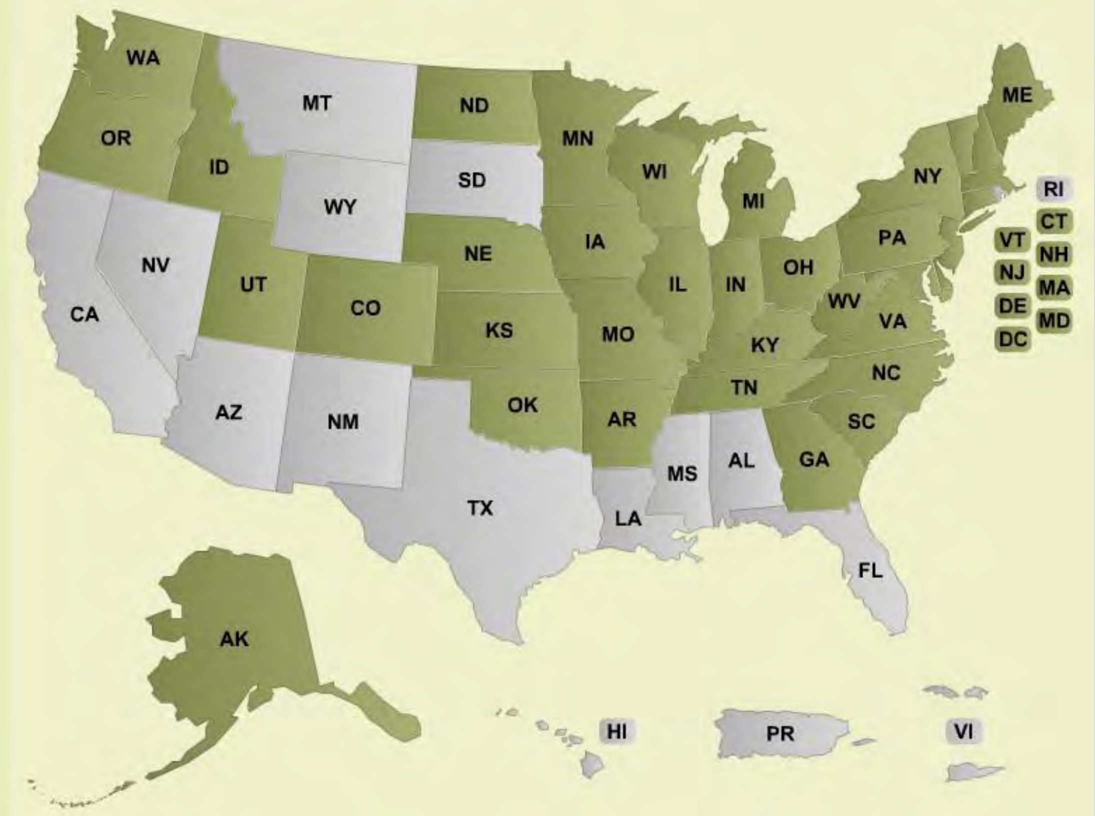


Characteristics

- Shade tolerant annual grass
- Warm season (C4)
- Native to eastern Asia
- Accidentally introduced (in packing material?)

Alliaria petiolata

(garlic mustard)



Characteristics

- Shade tolerant biennial herb
- Cool season (C3)
- Native to Europe, intentionally introduced for medicinal properties

Microstegium invasion experiment

All plots

9 tree sp

12 herb sp

tree saplings	tree saplings + ***Microstegium***
tree seeds	tree seeds + ***Microstegium***

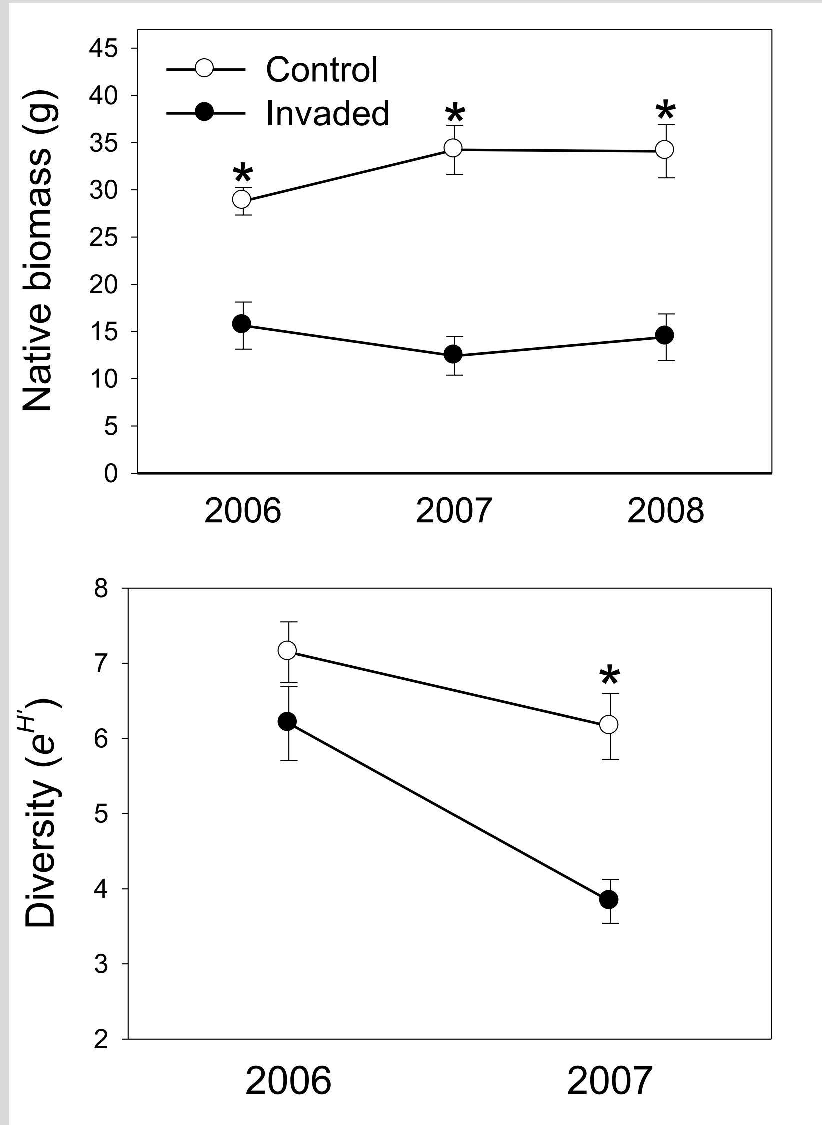
x 8 replicates


Control


Invaded

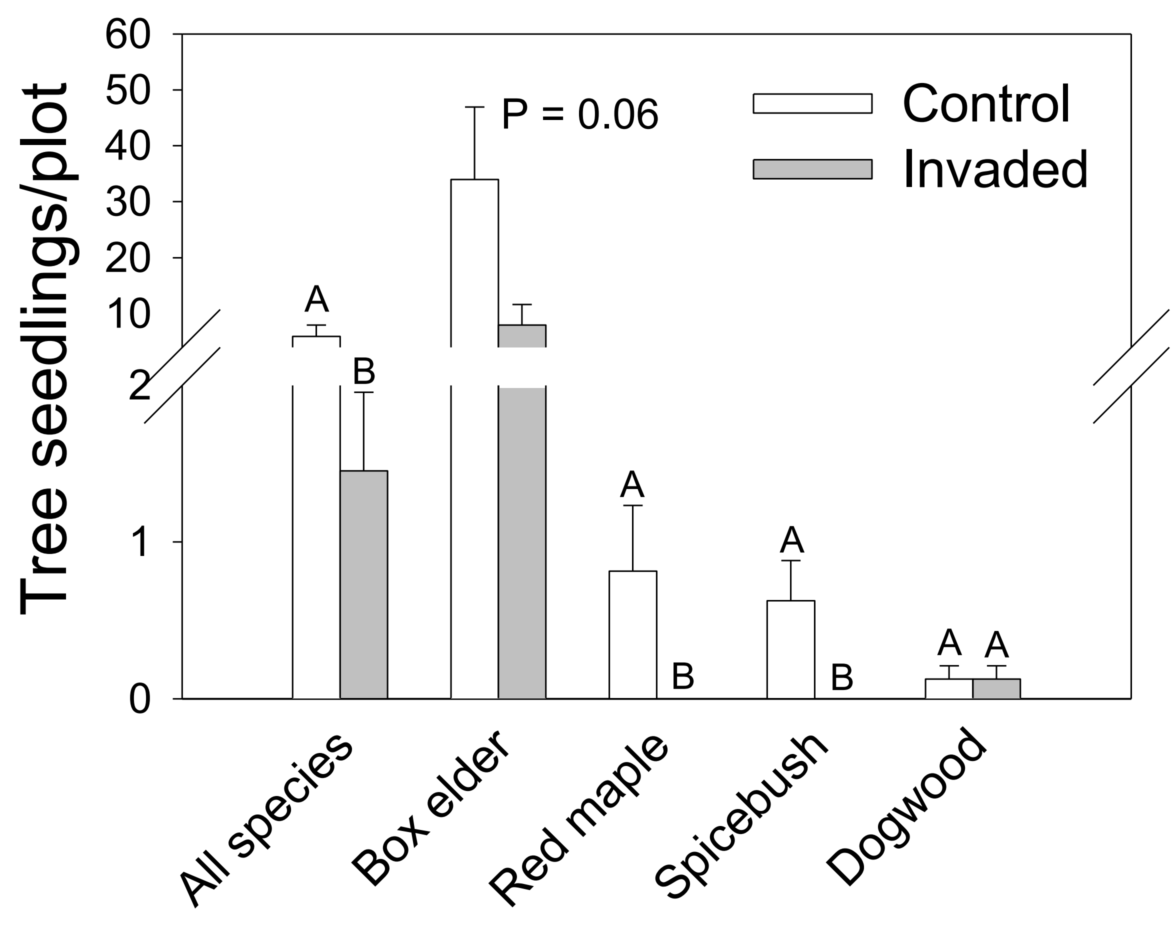
IU Research and
Teaching Preserve
Bayles Road

Results: *Microstegium* reduced native plant productivity and diversity



Flory, S.L and K. Clay *Biological Invasions*, 2010

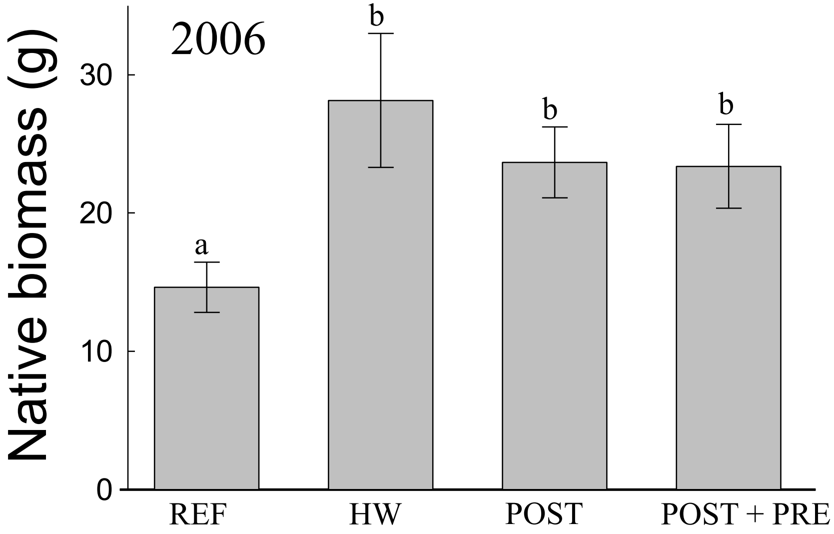
Microstegium reduced tree regeneration

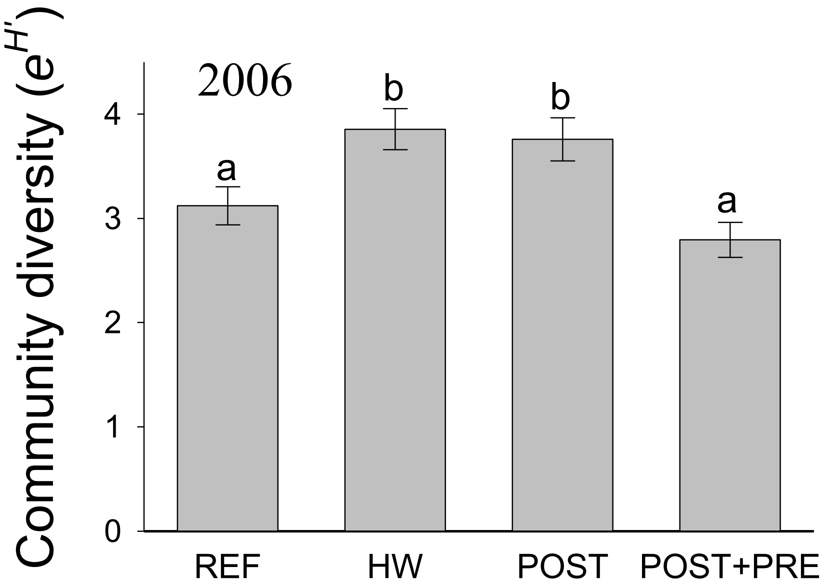


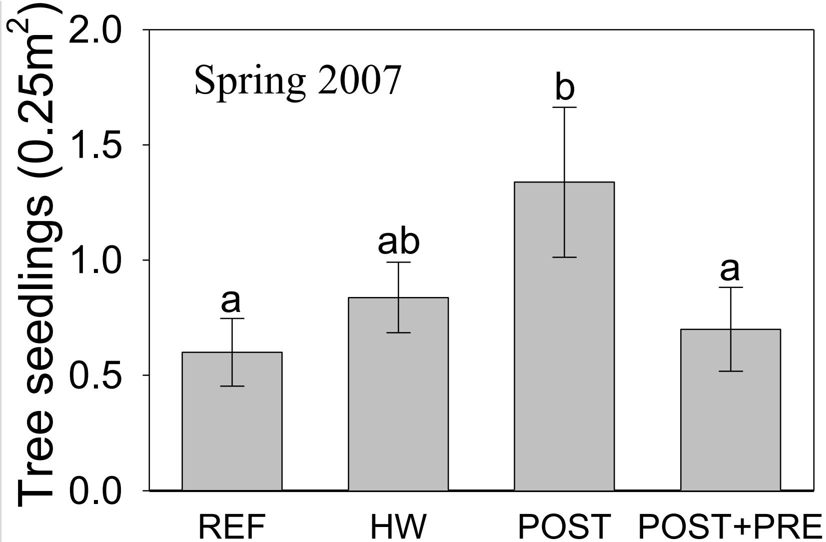
>400% greater natural tree regeneration in control plots

Flory, S.L and K. Clay *Oecologia*, 2010

Method of *Microstegium* removal determines native species response







Flory, S.L and K. Clay *Journal of Applied Ecology*, 2009

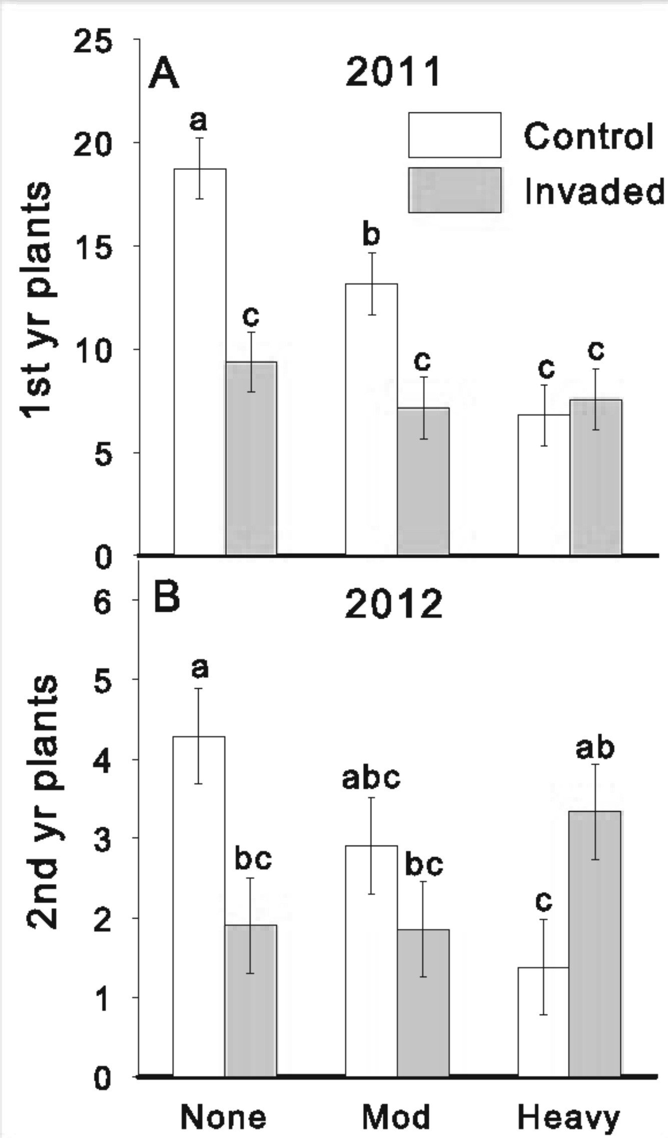
3 disturbance levels x 2 invasion treatments x 7 replicate plots

Disturbance levels:

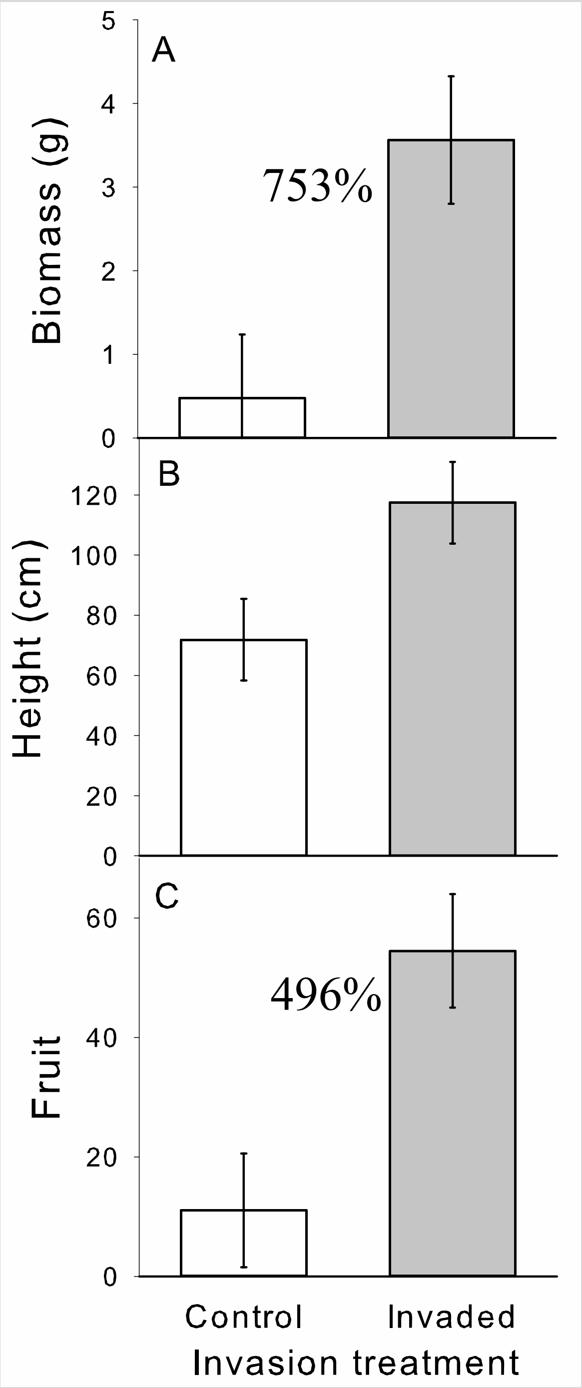
1. No disturbance
2. Moderate disturbance (raked)
3. Heavy disturbance (raked and litter removed *Microstegium*-invaded areas can have nearly 2 x litter)

3 disturbance levels x 2 invasion treatments x 7 replicate plots

Seed addition:
- 50 seeds/quadrat 2008
- Additional 200 seeds/quadrat 2009
- Few seeds germinated in 2010 or 2012, followed only cohort that germinated in 2011

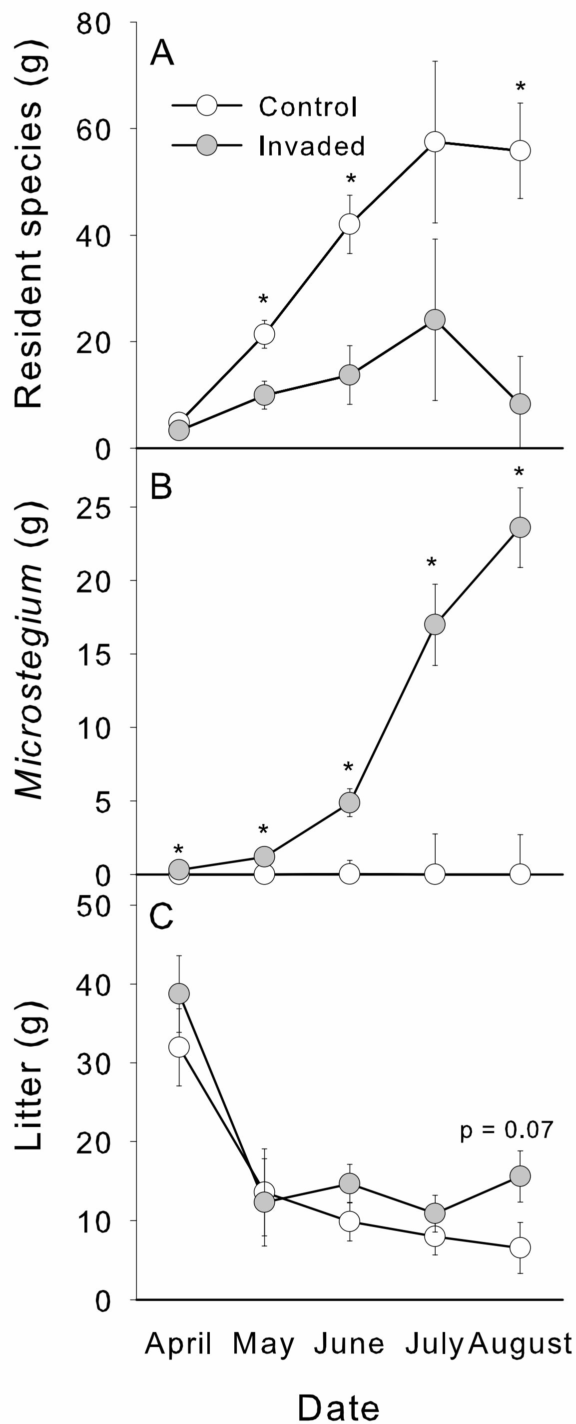

A
2011
Control
Invaded
1st yr plants
25
20
15
10
5
0
a
c
b
c
c
c
B
2012
2nd yr plants
6
5
4
3
2
1
0
a
bc
abc
bc
c
ab
None
Mod
Heavy

©2013 Frank Hassler

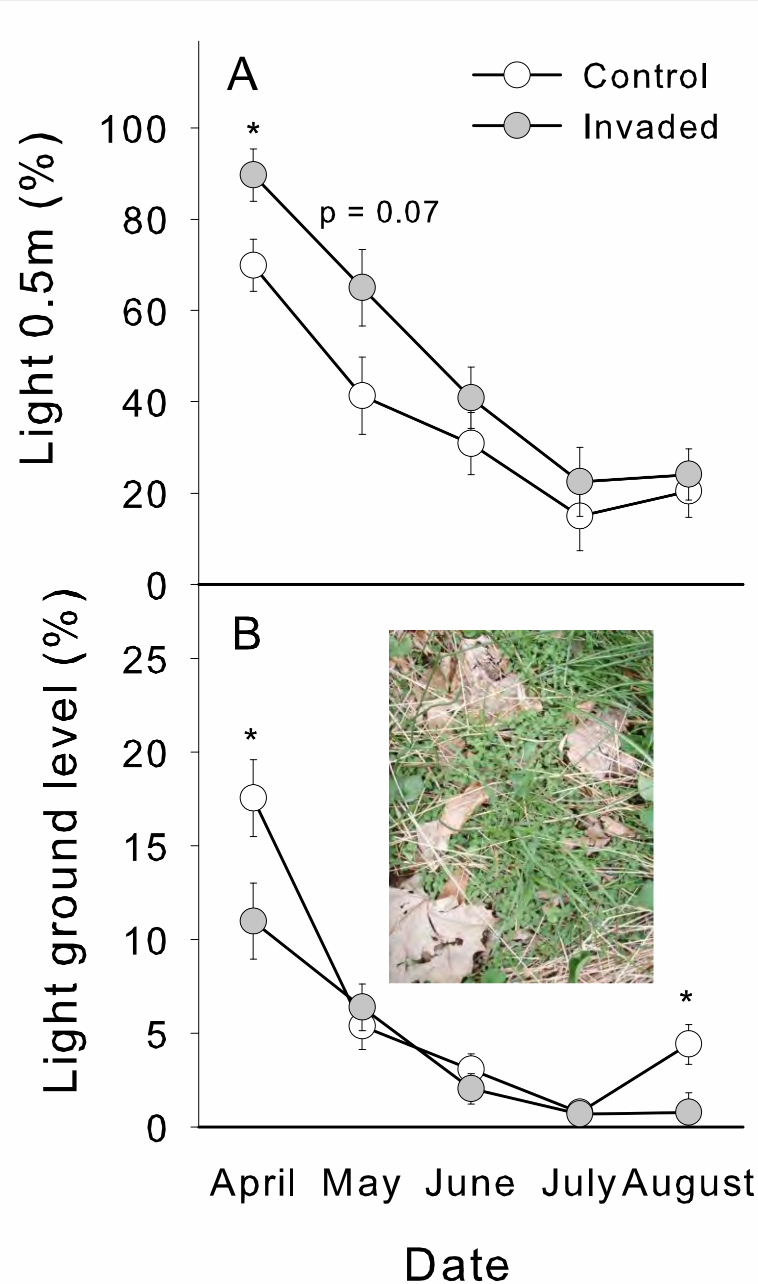


Per plot: 316% greater biomass and 214% greater fruit production

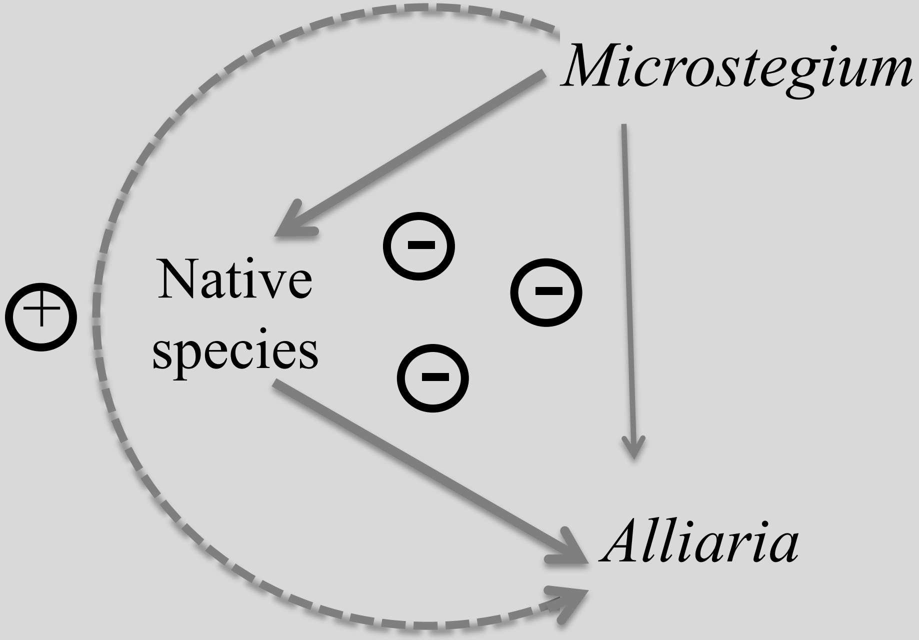
Mechanisms of facilitation:
suppression of resident competitors



Mechanisms of facilitation:
increased light availability



Indirect facilitation

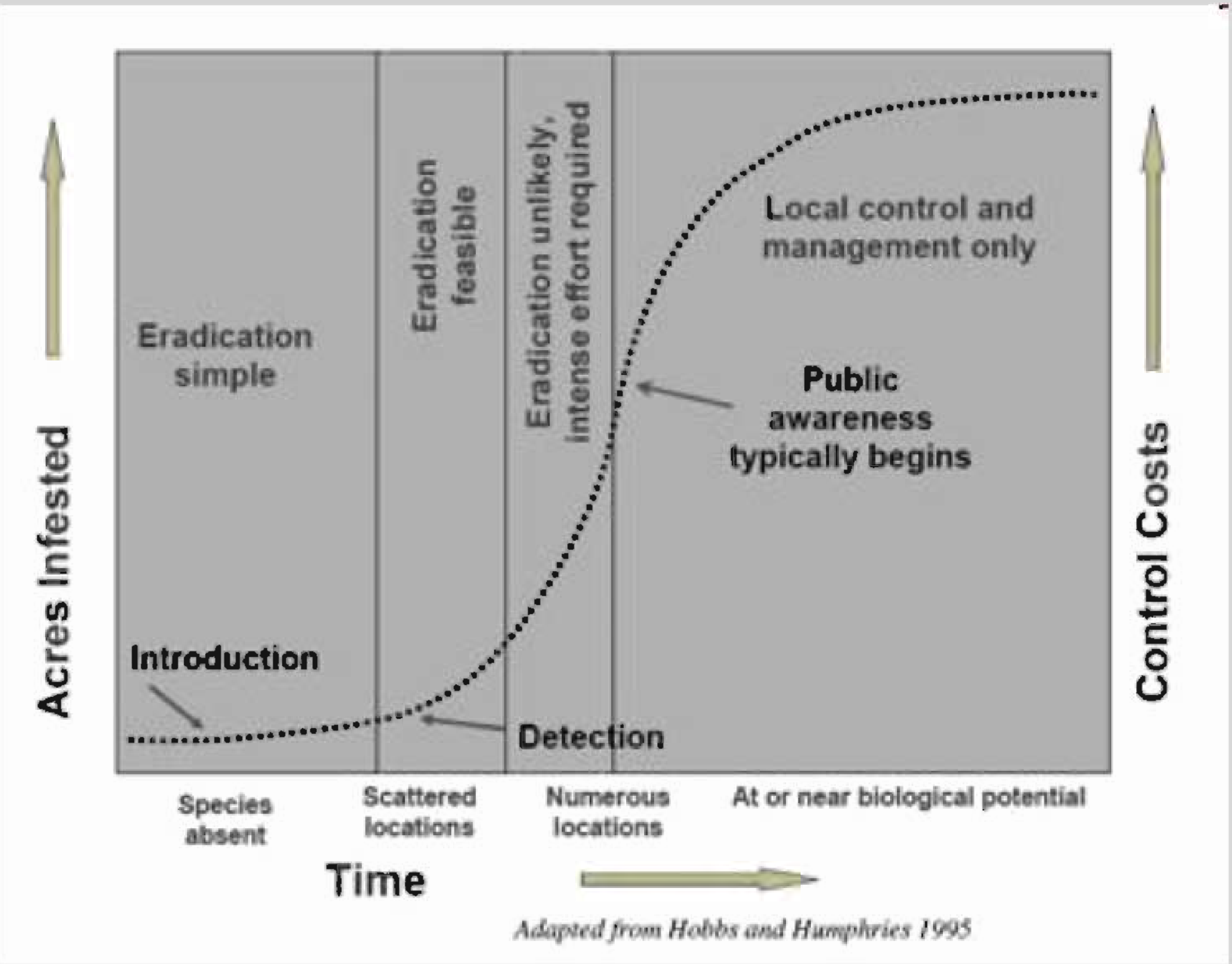


- *Microstegium* suppresses native species
- Reduced native species increases light availability
- Little direct competition due to offset phenologies
- Unknown how *Alliaria* affects *Microstegium* invasions

Consequences of invasion

- Native plant diversity
- Forest succession
- Arthropod diversity
- Nutrient dynamics
- Decomposition
- Disease vectors
- Carbon storage
- Fire behavior

*Facilitation of other invasive species


Acres Infested
Control Costs
Eradication simple
Eradication feasible
Eradication unlikely, intense effort required
Local control and management only
Public awareness typically begins
Introduction
Detection
Species absent
Scattered locations
Numerous locations
At or near biological potential
Time
Adapted from Hobbs and Humphries 1995

Take home messages

1. Global travel and trade will continue to result in non-native plant introductions
2. Plant invasions can have significant community and ecosystem consequence
3. Understanding causes and mechanisms of plant invasions will increase management efficiency and inform priorities
4. Early detection and rapid response is likely the most effective and efficient method for conservation of natural areas threatened by invasive species