Garlic mustard is not alone : comparisons among co-occurring invasives and natives in the forest herb layer.

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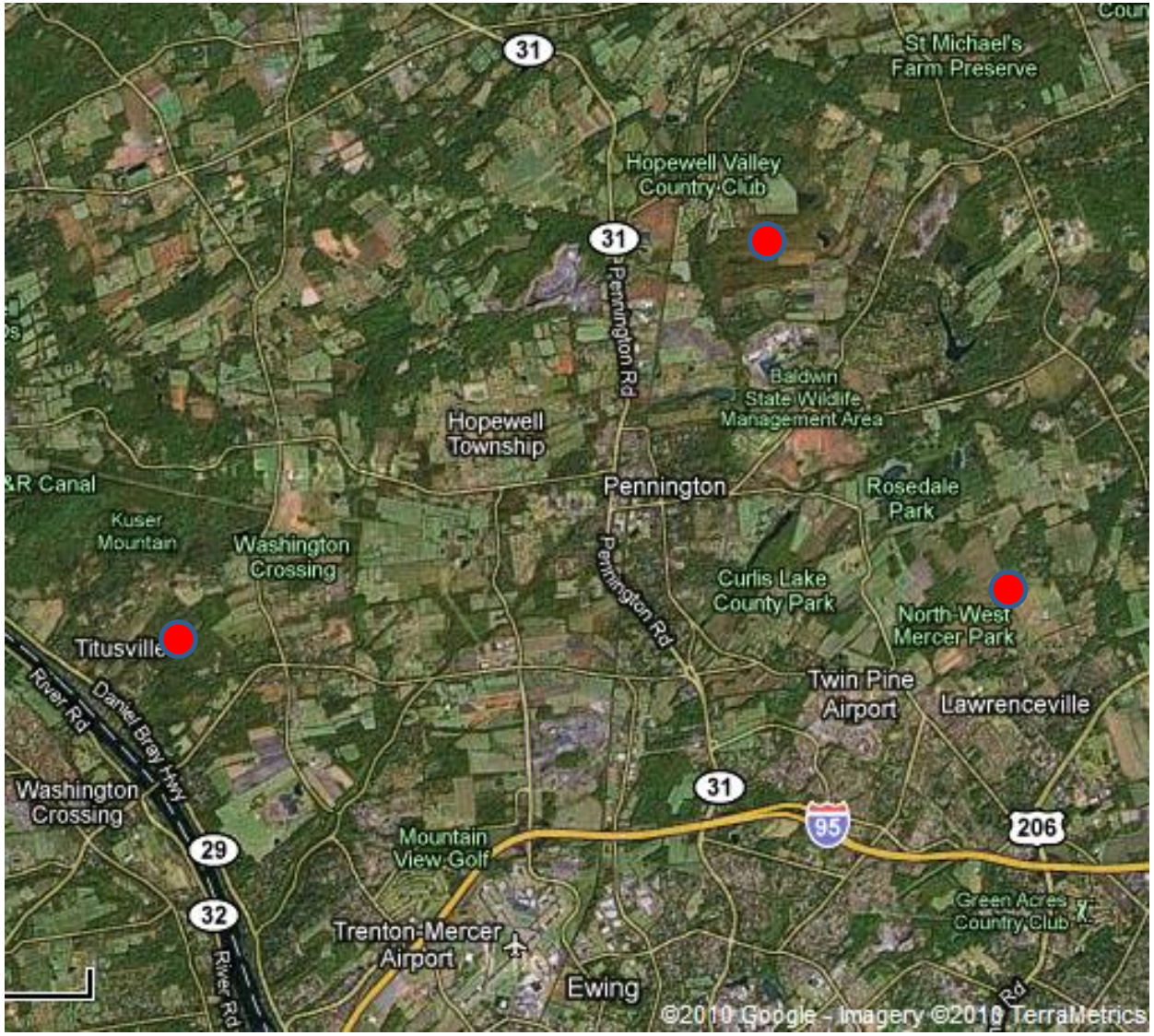
The suburban/exurban forest landscape



The forest herb layer

The forest herb layer

Questions

1a. Do non-native invasive species escape from natural enemy attack more than the native species in the same community?

1b. Do different non-native invasive species in the same community escape equally from enemy attack?

2. Do **1a** and **1b** differ for foliar herbivores (which include specialists) and generalist herbivores (e.g. mammals, like deer)?

3. Are **1a**, **1b**, and **2** influenced by the presence of neighboring species?

4. Does the native vs. invasive status of neighbors influence **3**?

Questions – why they are interesting

1a. Do non-native invasive species escape from natural enemy attack more than the native species in the same community?

Test of the Enemy Release Hypothesis in the community.

Re-evaluates the importance of top-down influences on community structure.

Questions – why they are interesting

1a. Do non-native invasive species escape from natural enemy attack more than the native species in the same community?

1b. Do different non-native invasive species in the same community escape equally from enemy attack?

Invaded communities typically have >1 invasive species; these can become the dominant species in the community.

ERH suggests they all escape enemies, leading to increased role for bottom-up factors in structuring communities – more so as invasive dominance increases.

Questions – why they are interesting

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2. Do 1a and 1b differ for foliar herbivores (which include specialists) and generalist herbivores (e.g. mammals, like deer)?

ERH predicts escape from evolved specialists; no a priori reason for invasive species to escape from generalists.

However, there is a common assumption that invasive species are not eaten by deer, which thereby facilitate their spread.

Needs testing at different deer pressure levels and for multiple species; deer make frequency-dependent food choices.

Deer exclosure effects on *Alliaria petiolata*

no caging

caging

Morrison and Brown 2004. *Bartonia* 62: 25-43

Deer herbivory on *Alliaria petiolata*

Morrison and Brown 2004. *Bartonia* 62: 25-43

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Indirect effects of competitors on enemy attack rates:

- Greater attraction of enemies
- Repel enemies
- Competition, fewer resources for defense.

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Invasives should be extra-strong competitors, MORE

Alliaria petiolata (ALPE)

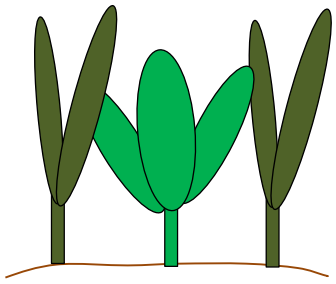
Microstegium vimineum (MIVI)

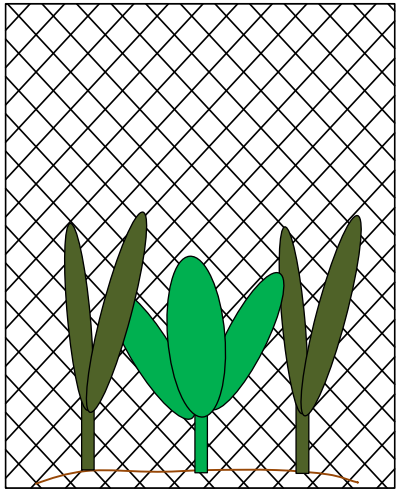
Acer platanoides (ACPL)

Acer saccharum (ACSA)

Experimental Design

Focal	Neighbor				
	NONE	ALPE	MIVI	ACPL	ACSA
ALPE	✓	--	✓	✓	✓
MIVI	✓	✓	--	✓	✓
ACPL	✓	✓	✓	--	✓
ACSA	✓	✓	✓	✓	--





4 focal species
X 4 neighbor species/none
X 2 mammal caging treatments
X 5 replicates (random positions)
X 3 forests
= 480 plots

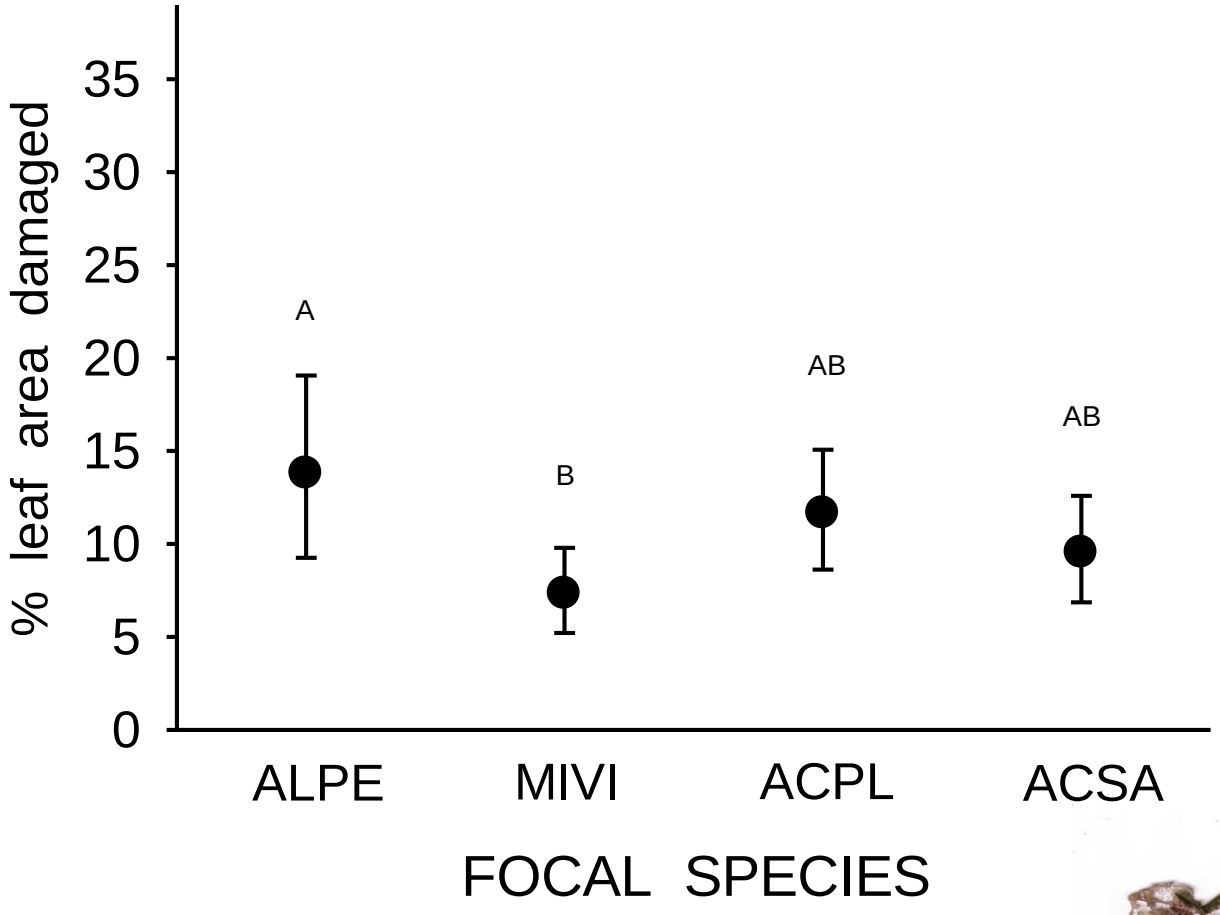
Methods

- Field-collected seed from 5 populations of each species, stratified.
- Pooled seeds from all 5 pops, grew to seedlings in flats in greenhouse.
- Transplanted to cleared 0.25 x 0.25 m field plots and installed 30 cm tall cages, May 10-20.
- Hand-watered for 3 weeks.

- Assessed leaf damage late July :
    - Ordinal scale 0, 1 (<1%), 2 (1-10%), 3 (11-20%) etc., using the interval midpoints for analysis.
    - Leaf holes, mining, shredding, skeletonizing, rolling.
    - Compared to leaf models for area estimates.

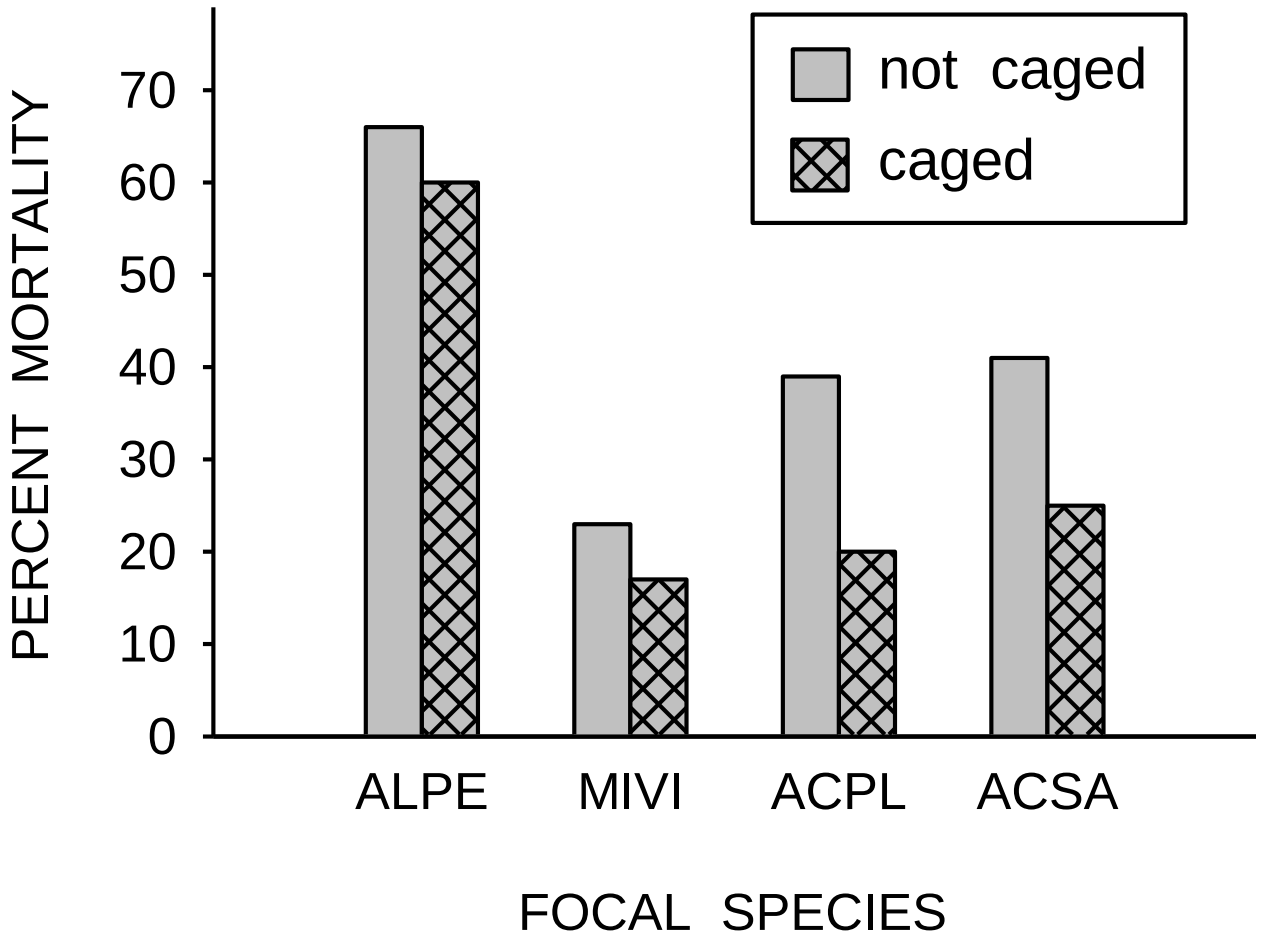
- Assessed mortality early August

Overall foliar damage
(leaf holes, mining, shredding, skeletonizing, rolling)



ANOVA (P = 0.03), backtr. mean ± 95% CL.
N, left to right : 83, 106, 92, 87

Overall mortality, with caging effects



N = 60, 59 (ALPE), 60, 60 (MIVI), 59, 60 (ACPL), 58, 60 (ACSA)

Questions and Answers (for these species and forests)

1a. Do non-native invasive species escape from natural enemy attack more than the native species in the same community? No.

1b. Do different non-native invasive species in the same community escape equally from enemy attack? No.

2. Do 1a and 1b differ for foliar herbivores (which include specialists) and generalist herbivores (e.g. mammals, like deer)?

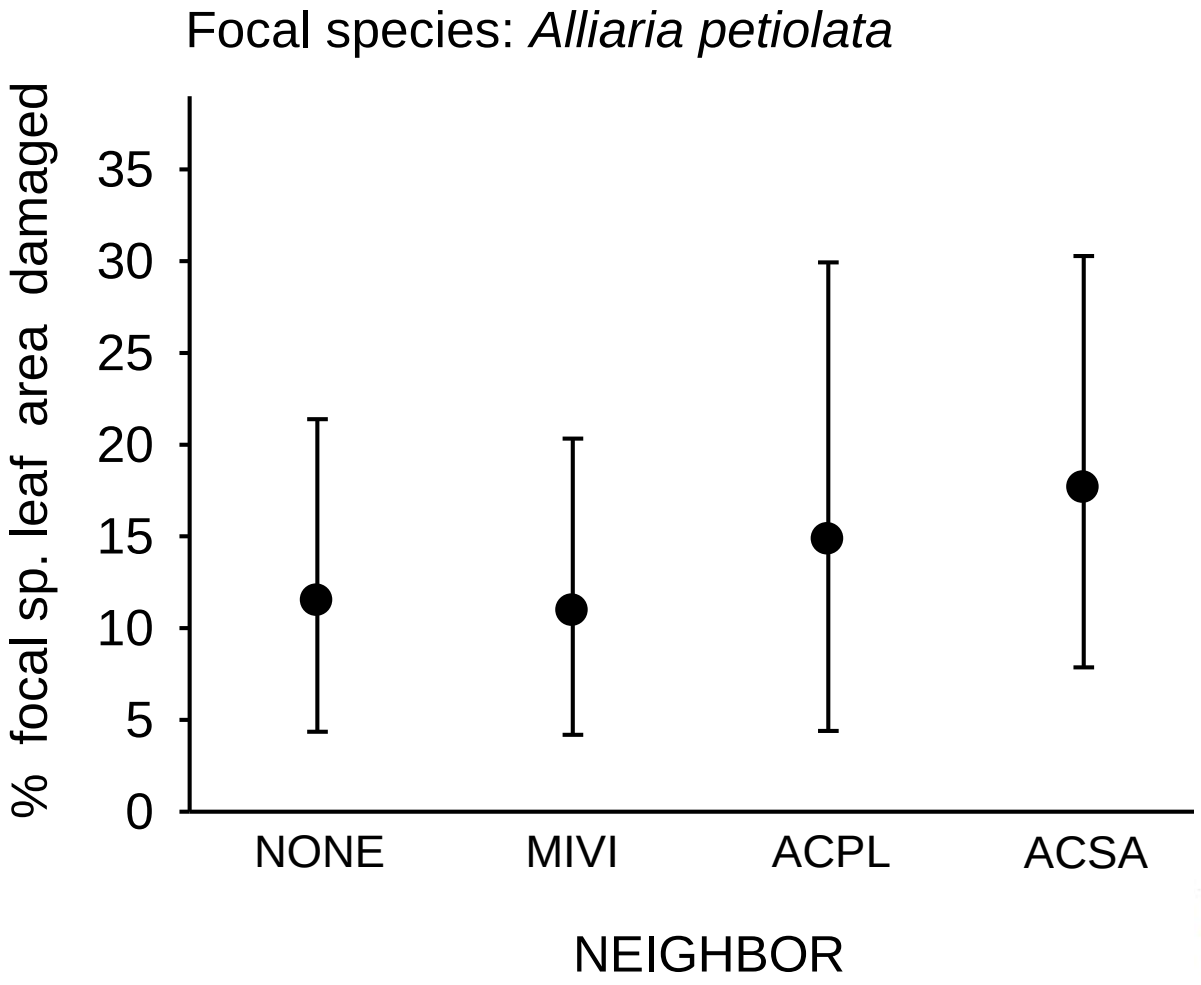
1a: ACSA had foliar damage similar to all three invasives, but was more protected by mammal exclusion than ALPE and MIVI, but was similar to ACPL.

2a. ALPE had more foliar damage than MIVI and ACPL, but ALPE and MIVI were less protected by mammal exclusion than ACPL.

3. Are **1a**, **1b**, and **2** influenced by the presence of neighboring species?

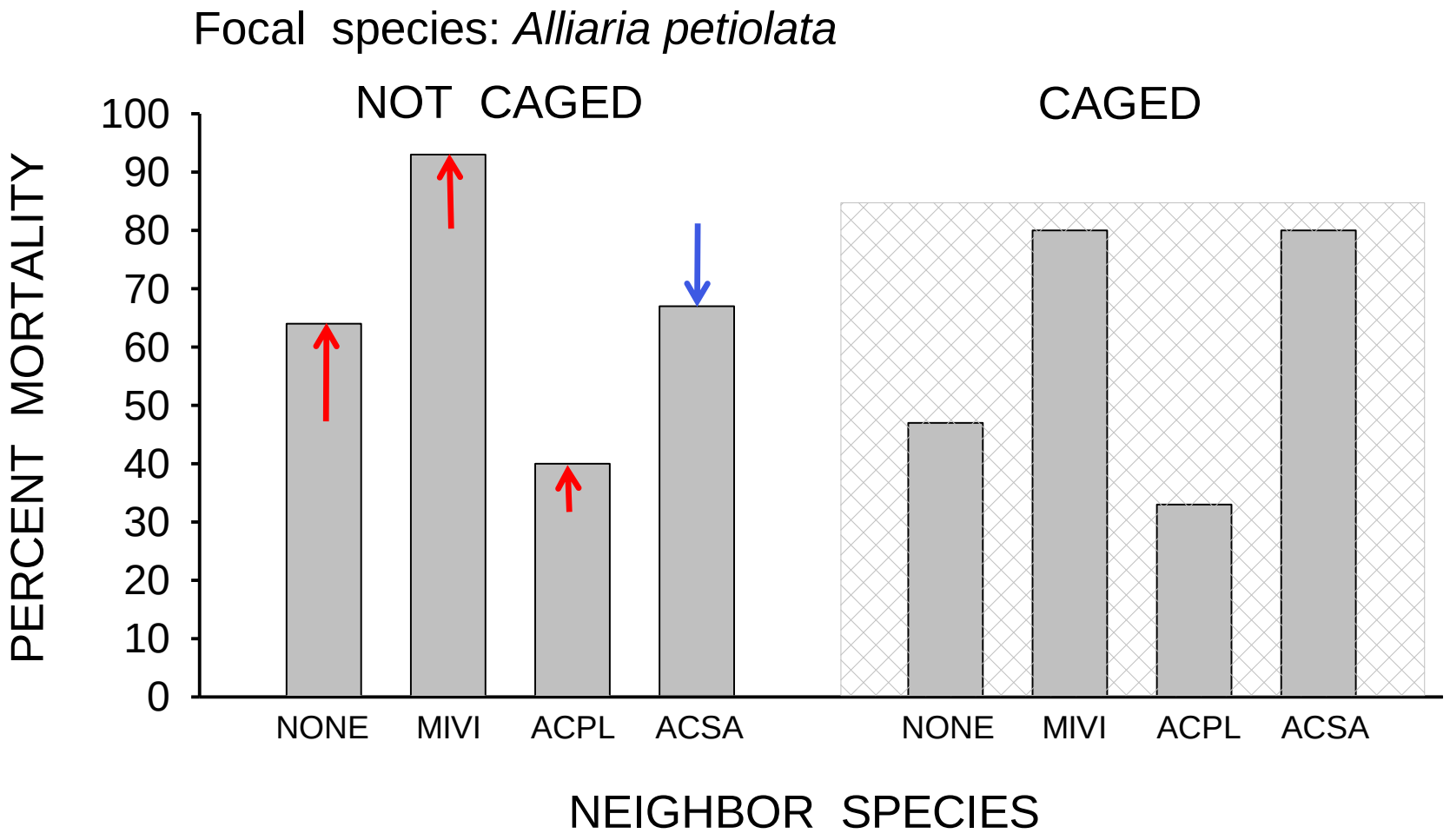
4. Does the native vs. invasive status of neighbors influence **3**?

ALPE foliar damage, neighbor effects



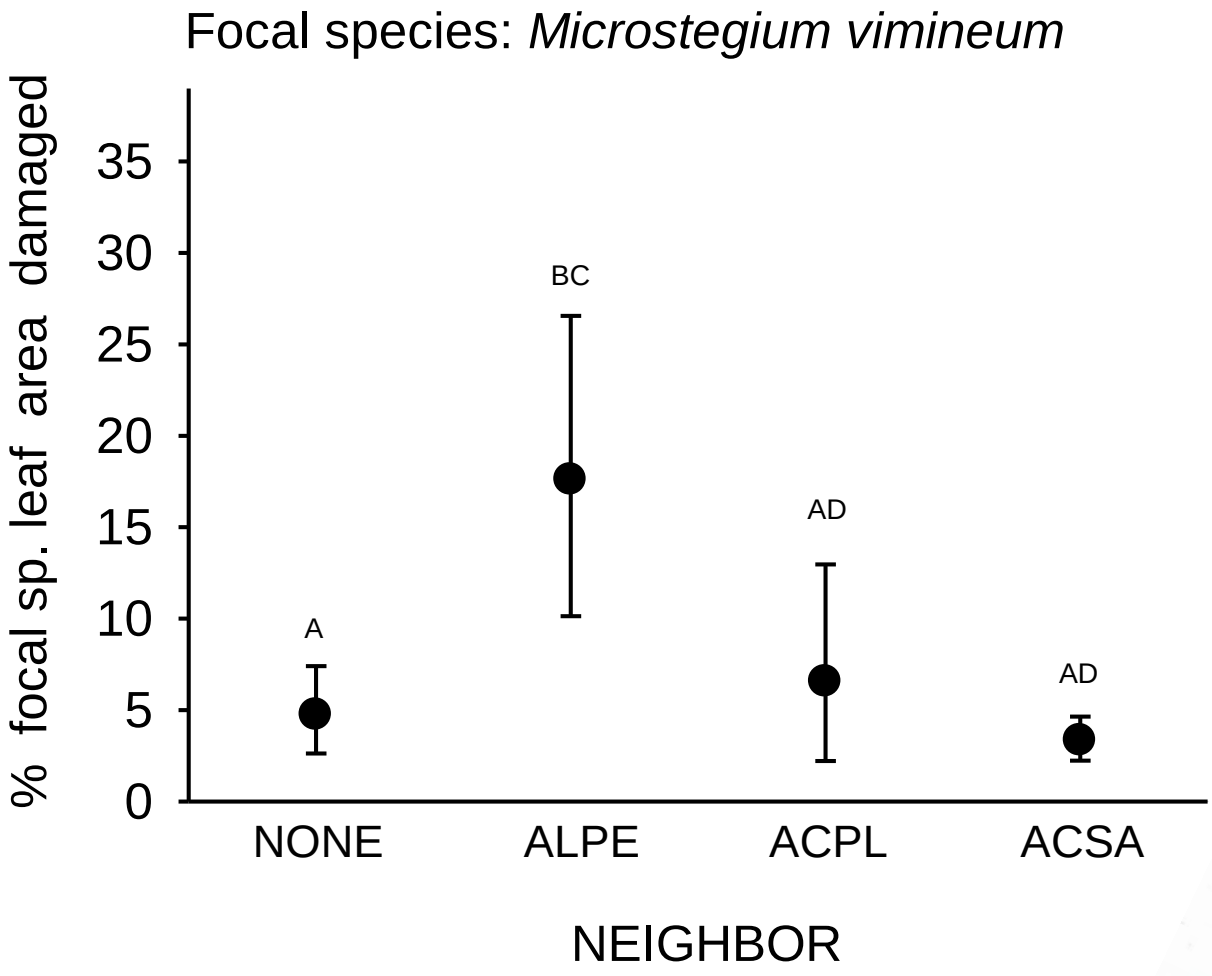
ANOVA (ns); backtr. mean ± 95% CL.
N, left to right : 22, 18, 19, 22.

ALPE mortality, with caging and neighbor effects

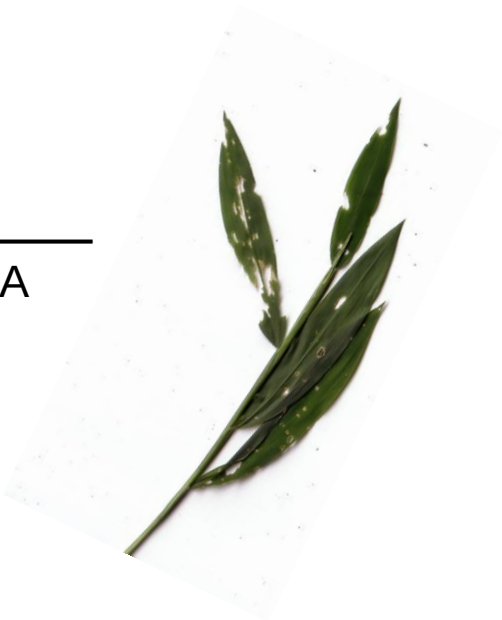


G-test : mortality x neighbor x caging, P = 0.01

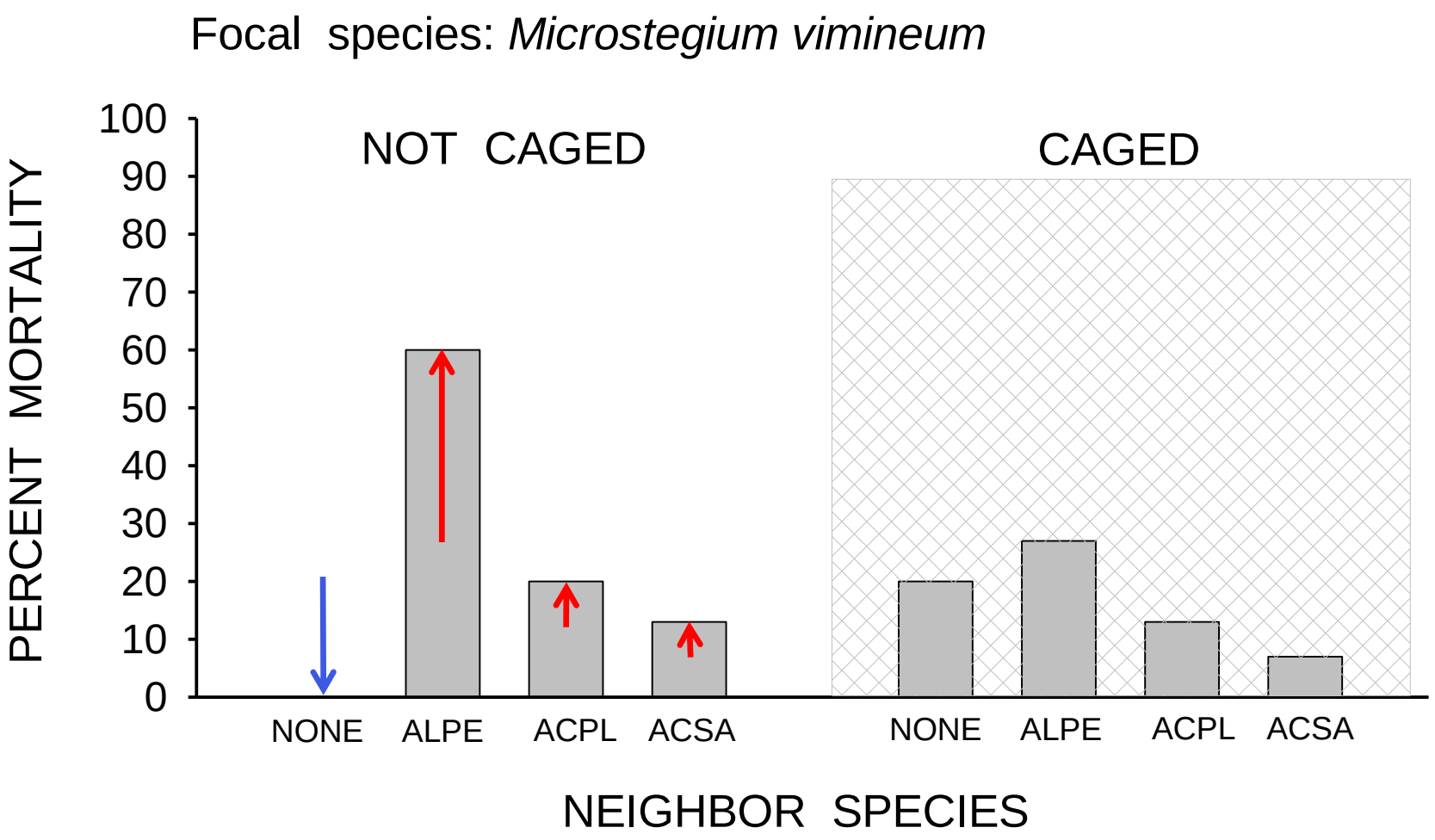
MIVI foliar damage, neighbor effects



ANOVA ($P < 0.001$); backtr. mean $\pm$ 95% CL.
N, left to right : 26, 27, 26, 27.

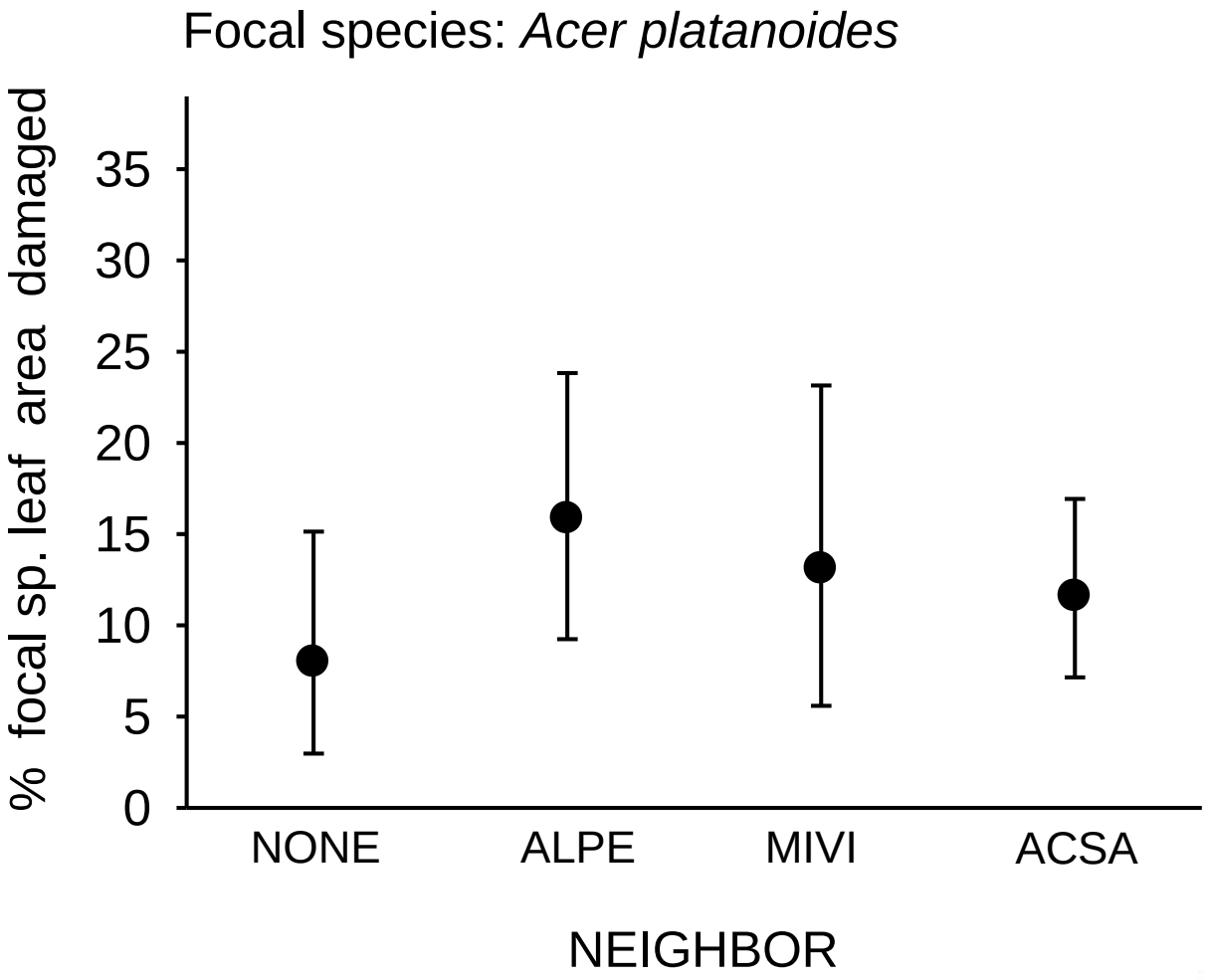


MIVI mortality, with caging and neighbor effects



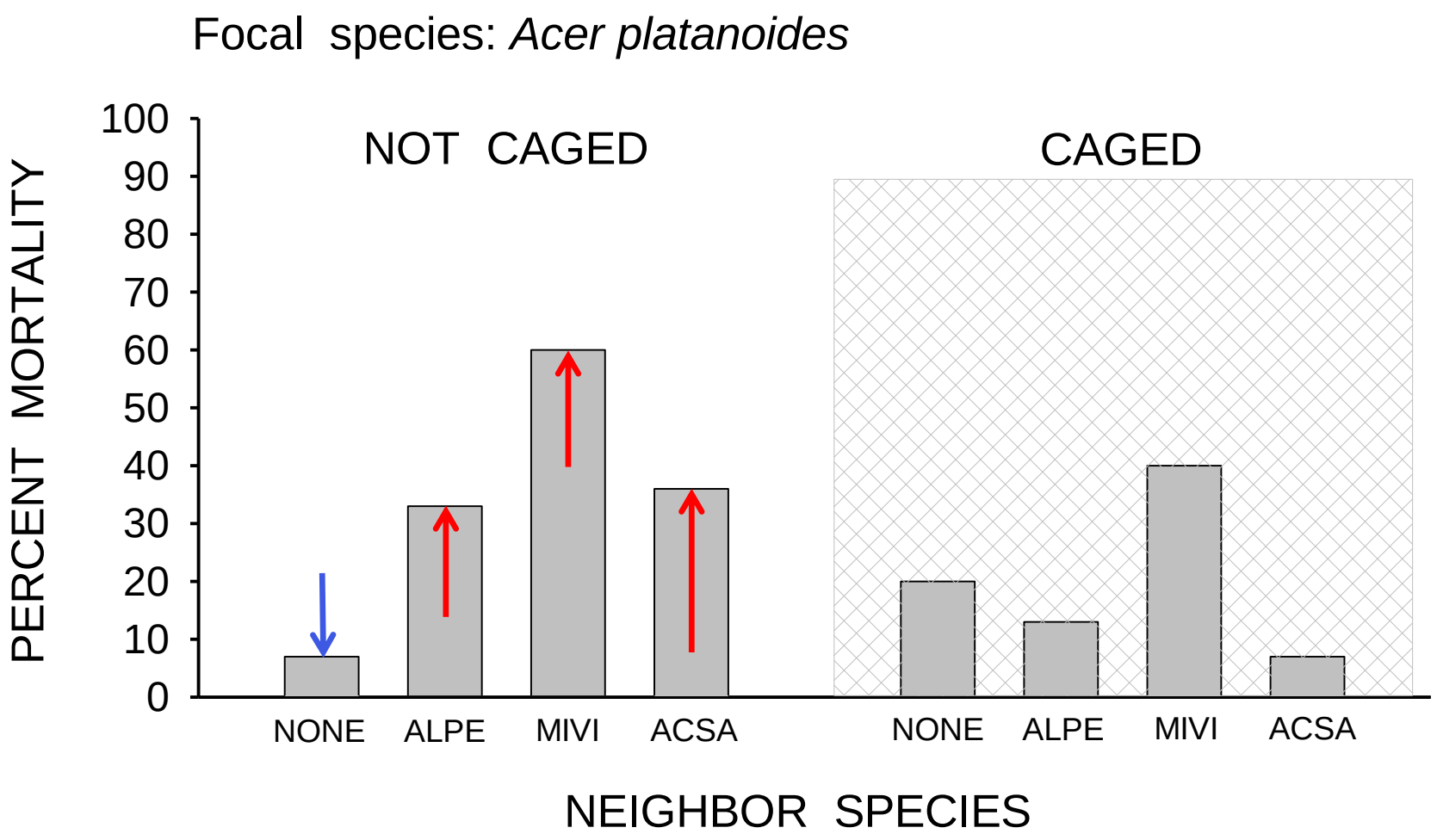
G-test : mortality x neighbor x caging, P = 0.02

ACPL foliar damage, neighbor effects



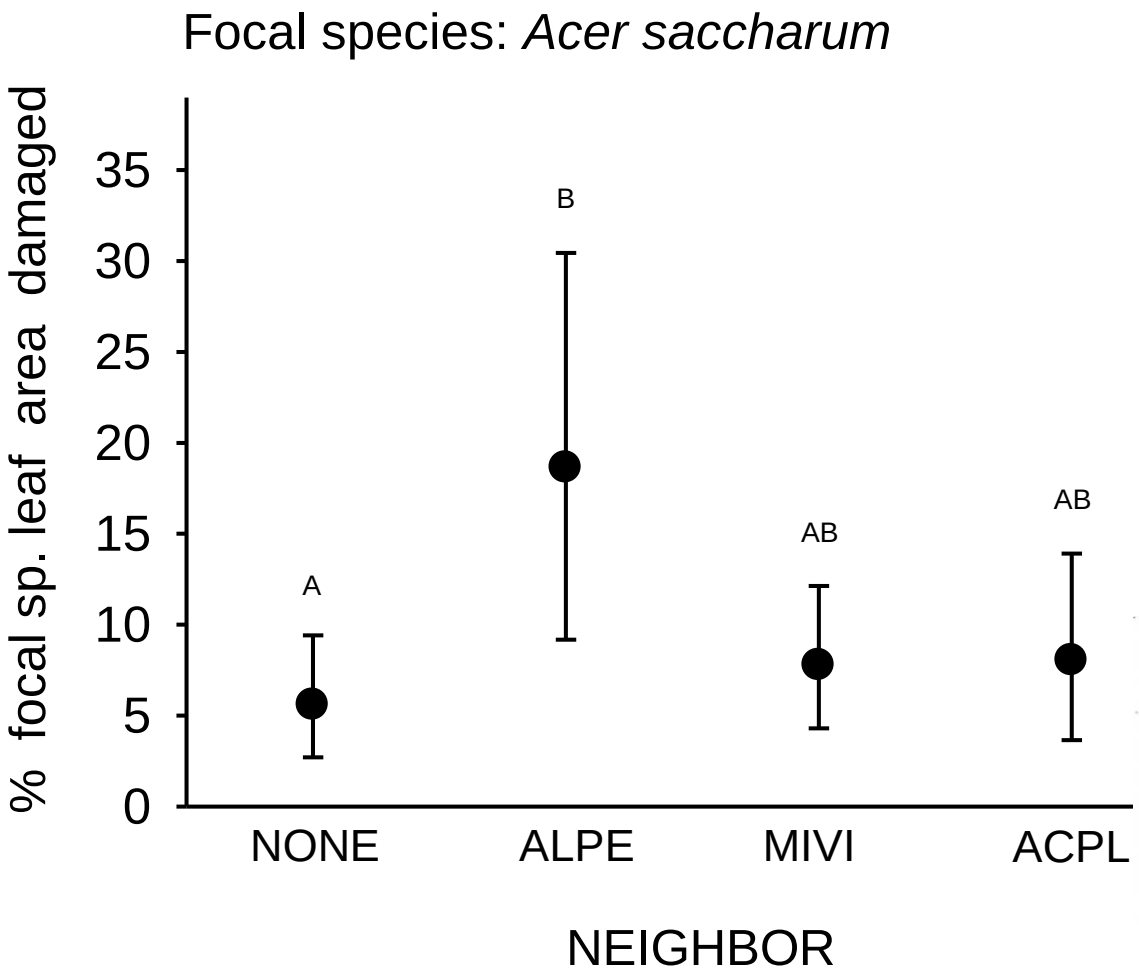
ANOVA (ns); mean ± 95% CL.
N, left to right : 24, 24, 18, 26.

ACPL mortality, with caging and neighbor effects



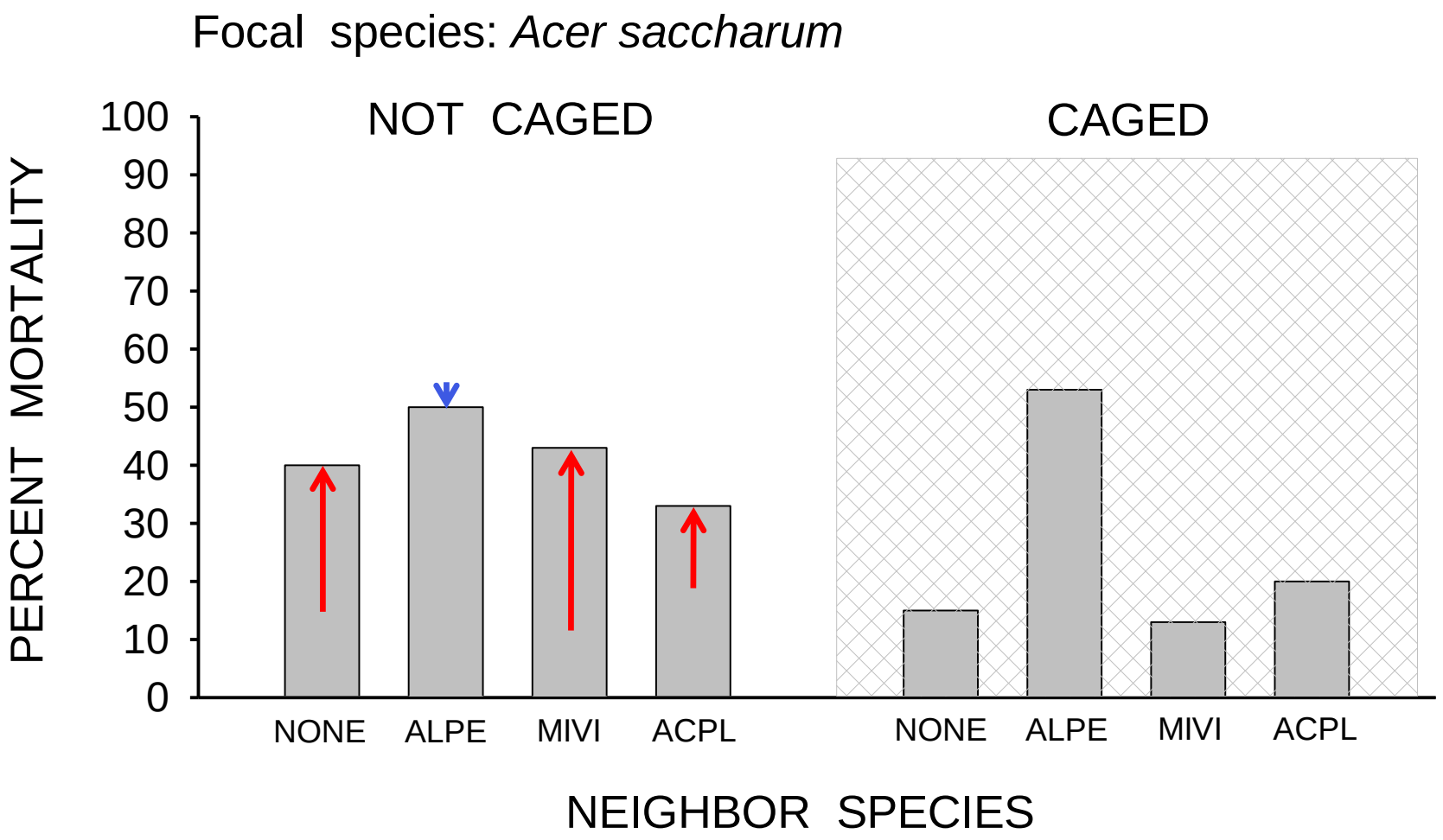
G-test : mortality x neighbor, P = 0.05
mortality x caging, P = 0.02

ACSA foliar, neighbor effects



ANOVA (P = 0.01); mean ± 95% CL.
N, left to right : 22, 22, 23, 20.

ACSA mortality, with caging and neighbor effects



G-test : mortality x caging, P = 0.06

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1a: ACSA had foliar damage similar to all three invasives, but was more protected by mammal exclusion than ALPE and MIVI, but was similar to ACPL.

2a. ALPE had more foliar damage than MIVI and ACPL, but ALPE and MIVI were less protected by mammal exclusion than ACPL.

3. Are 1a, 1b, and 2 influenced by the presence of neighboring species?
In some cases, yes; in some cases, no.

4. Does the native vs. invasive status of neighbors influence 3? Not in a consistent pattern :

Summary of neighbor influence on foliar damage

Focal	Neighbor				
	NONE	ALPE	MIVI	ACPL	ACSA (native)
ALPE	⊘	--	⊘	⊘	⊘
MIVI	⊘	↑	--	⊘	⊘
ACPL	⊘	⊘	⊘	--	⊘
ACSA (native)	⊘	⊘	↑	⊘	--

Summary of neighbor influence on mortality from mammals

Focal	Neighbor				
	NONE	ALPE	MIVI	ACPL	ACSA (native)
ALPE	⊘	--	⊘	⊘	↓
MIVI	↓	↑	--	⊘	⊘
ACPL	↓	⊘	⊘	--	⊘
ACSA (native)	⊘	↓	⊘	⊘	--

Main Conclusions and Further Directions

Invasive species, including garlic mustard, can be just as susceptible to natural enemies as natives in their community.

Needed: more experimental field studies with invasives additions, in more sites, especially those that vary in deer pressure, and with more species, to be able to generalize about invasive and native species.

Species attributes, rather than native status, determine susceptibility to generalist mammals (deer) (e.g. woody vs. herbaceous species) .

Needed: jettison assumption that invasives as a class are not eaten by deer; test this with more species of contrasting attributes.

Not all invasive species are created equal: e.g. some are more vulnerable to enemies than others ; there is a continuing role for top-down influences in the future forest community.

Needed: Communities with multiple, dominant invasive species are the present and future of many suburban forests – it is time to study their interactions with each other, jointly on natives, and with deer.

Acknowledgements