



# Consequences of Intraspecific Competition for Management of a Stage Structured Invasive Plant (*Alliaria petiolata*)

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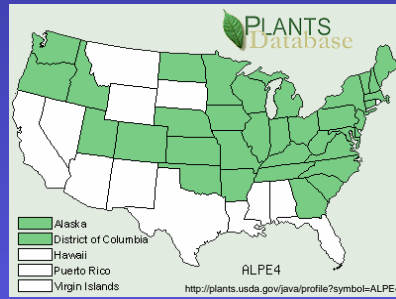


## INTRODUCTION

Management of invasive species often targets a particular life stage in structured populations. Evaluating the success of management requires measuring the survivorship and reproductive success of the targeted stage class, and considering the possibility for increased fitness in the non-targeted stage class due to a release from intraspecific competition. Management of the invasive biennial, *Alliaria petiolata* (garlic mustard) typically involves removing adults by pulling or clipping and is applied early or late during the growing season. In this study we evaluate the effectiveness of these management types on survival and fitness of the targeted adults and its consequences for co-occurring juveniles. Our study highlights the necessity of examining fitness of plants in the non-targeted life stage in order to fully evaluate the effectiveness of different management techniques. These results may be applicable to management of other stage-structured invasive species.

## STUDY SPECIES

*Alliaria petiolata* (Brassicaceae) is an obligate, biennial herb. Seeds germinate in early spring and juveniles form small basal rosettes during the first year. At our study site, Tyson Research Center in St. Louis, Missouri, adults flower in April and May, set seed June and July, and die in late summer. Seeds require cold stratification for germination.



## QUESTIONS

Part 1: What are the effects of management and its timing on adult plants (targeted stage class) and their progeny?

Part 2: What are the effects of managing adult plants on co-occurring juveniles (non-targeted stage class)?

## METHODS

**Part 1: Effects of management and its timing on adult plants and their progeny**

One of six treatments (clip at 50% early and late, clip at the base early and late, pull and leave on the ground, and unmanaged) was applied randomly to 300 adult plants in a substantial *A. petiolata* infestation at Tyson Research Center in St Louis, Missouri. Number of stems were recorded to estimate size. Seeds were collected at the end of the adult growing season to quantify fecundity and seed weight. Seeds were cold stratified and monitored in a greenhouse to quantify seed germination and germination timing; seedlings were harvested to quantify biomass.

Fecundity data were analyzed with ANCOVA and linear regression. Germination proportions were analyzed with chi-square analysis. ANCOVA and subsequent ANOVAs were used to examine the effects of germination timing and management treatment on seedling biomass.

**Part 2: Effects of management on co-occurring juveniles**

One of three management treatments (pull adults, clip adults, and unmanaged) was applied randomly to 40 m<sup>2</sup> quadrats. Juveniles were tagged and survival was recorded after 10 days and at the end of the adult growing season.

Survival data were analyzed with chi-square analysis.

## RESULTS: PART 2

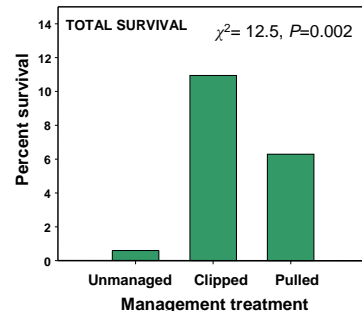
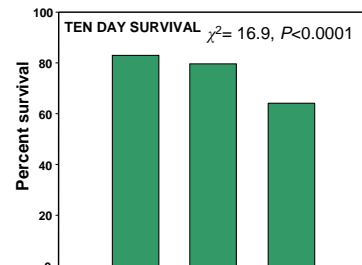


Figure 5. Survival of *Alliaria petiolata* juveniles in 1-m<sup>2</sup> plots in which adult individuals were unmanaged, clipped at ground level, or pulled. The top panel indicates early (ten day) survival; the bottom panel indicates total survival of all tagged juveniles to end of the experiment.

## RESULTS: PART 1

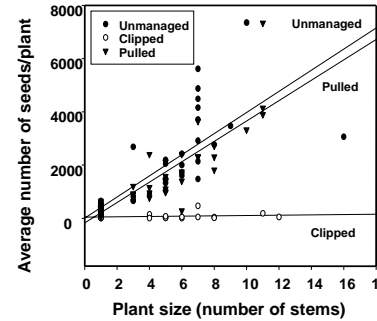


Figure 1. Plant size affected seed production in unmanaged and pulled plants, but not clipped plants. Clipping plants is the most successful way to reduce seed production of adult garlic mustard.

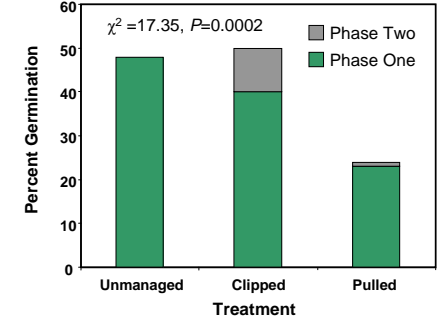


Figure 2. Chi-square analysis indicates that seeds produced by adult plants in the pulled treatment were the least likely to germinate in the first phase of germination.

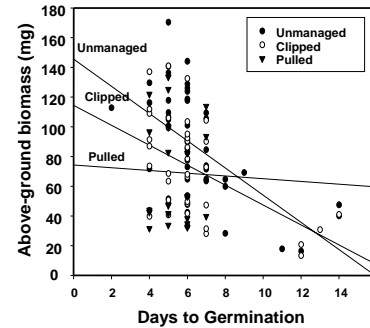


Figure 3. ANCOVA analysis indicates that individuals that germinated earlier were significantly larger than those that germinated later.

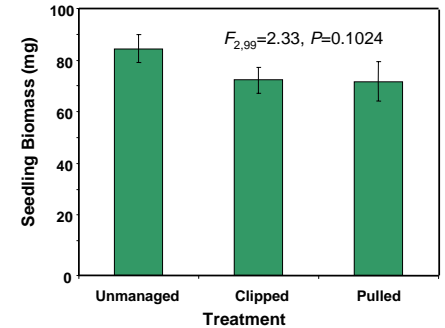


Figure 4. ANOVA analysis suggests that seedlings from unmanaged plants were larger than clipped and pulled seedlings.

## CONCLUSIONS



- In *Alliaria petiolata*, the type of management and its timing significantly differ in reducing the reproductive output of adult plants.
- The most effective treatment for adults (clipping plants at the base) is also the treatment that most facilitates the survival of juveniles in the population.
- Pulling plants and leaving them on the ground results in no difference in number of seeds produced than unmanaged plants, indicating that this management approach would be wasteful in terms of finances and time.
- Incorporating our estimates of seed production and germination, unmanaged plants produce 31 times as many juveniles as pulled plants and 13 times as many juveniles as clipped plants.
- In all, these results demonstrate that management of adult plants must have the goal of preventing any seed production because control strategies that result in significant decreases in seed number and seed weight still allow for high numbers of juveniles in the following year.

ACKNOWLEDGEMENTS: We thank Tyson Research Center for providing logistical and financial support. We are grateful to J. Buck, J. Chase, K. Powell and E. Dangremond for help with the field experiments, E. Miner, M. Dyer and the Washington University greenhouse staff for help with the germination experiment, and J. Burns, K. Moriuchi, J. Chase, K. Smith, and students in ENSt 393 for helpful comments on this project. This research was funded by grants from the Howard Hughes Medical Institute, Lenette Undergraduate Research Fellowship, and the Environmental Studies Program at Washington University to BJT, and by the National Research Initiative of the USDA Cooperative State Research, Education and Extension Service, grant number #05-2290 to TMK.