A thorny problem: Complex effects of deer browse on co-occurring native blackberry and non-native, invasive multiflora rose in suburban forests

Janet A. Morrison and Olivia Sohn, The College of New Jersey, Ewing, NJ

Abstract

Background/Questions/Methods: In the fragmented landscape of suburban central New Jersey, forests experience variable levels of deer pressure due to their landscape contexts and histories of deer management. Forests with lower deer pressure have more understory vegetation, but it includes abundant populations of invasives, including thorn-bearing plants. The invasive Asian species *Rosa multiflora* has much higher percent cover in forests with lower deer pressure, but the native *Rubus allegheniensis* has more similar cover under lower and higher deer pressure. We hypothesized that deer browse may be a cause for this pattern, in two ways: 1) if deer browse is greater on *R. multiflora* than on *R. allegheniensis*, reduced browse may result in relatively greater increase in *R. multiflora* ; and 2) if *R. multiflora* has a more pronounced induced thorn defense strategy, it may be able to allocate more resources to growth under reduced browse conditions. To test these hypotheses, we measured both species in three forest preserves with lower and three with higher deer pressure, in fenced and unfenced 16 m^2 plots (224 plots). We also quantified deer browse presence/absence and abundance of both species over six years, and after four years measured their thorn: stem length ratio, herb layer percent cover, and heights.

Results/Conclusions: Herb layer cover of *R. multiflora* (ROMU) was less than *R. allegheniensis* (RUAL) in the forests with higher deer pressure, but was much greater than RUAL in the forests with lower deer pressure (cover, species*deer pressure $F_{1,440}$=10.02, P<0.002). ROMU also was much less abundant in forests with higher deer pressure ($\chi2$=108.32, P<0.0001, df=1). Their browse rates were similar under higher deer pressure (ROMU, 13% of 64 plants observed; RUAL, 15% of 180 plants), but much lower for RUAL under lower deer pressure (ROMU,11% of 1988 plants; RUAL, 4% of 1297 plants; $\chi2$=48.42, P<0.0001). Unfenced plants of both species exhibited greater thorn:stem length ratio in forests with higher deer pressure ($F_{1,258}$=28.8, P<0.0001), and in unfenced plots relative to fenced plots across all forests ($F_{1,446}$=20.19, P<0.0001). Fencing increased height of both species in all forests ($F_{1,205}$=5.69, P<0.02), and plants were taller in the forests with higher deer pressure, although this pattern was stronger for RUAL (species x deer pressure $F_{1,205}$=4.14, P<0.05).

Even though browse rates were only slightly lower on ROMU and were much lower on RUAL in the forests with lower deer pressure, ROMU had much greater increases in cover and abundance in those forests, compared to RUAL's increases. Both species have an induced thorn response, but ROMU's is no different in degree than RUAL's, so more allocation to growth in ROMU vs, RUAL under lower deer pressure is unlikely.

Conceptual Framework

suburban landscape ⇒ fragmented forests ⇒ different land use, hunting histories ⇒ variable deer pressure

higher deer pressure ⇒ less vegetation
lower deer pressure ⇒ more vegetation
} including natives **and** invasive, non-natives

But species differ:

Percent cover under lower deer pressure vs. higher deer pressure (Figure 1) :

↑ for non-native, invasive *Rosa multiflora*

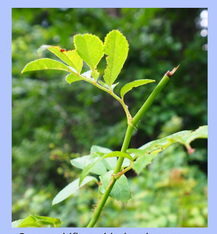
= for native *Rubus allegheniensis*

Question: Does lower deer pressure cause a greater ecological release for *R. multiflora*, thereby supporting its invasion?

Two hypothesized mechanisms:

IF . . . . . Deer browse on *R. multiflora* > *R. allegheniensis*
THEN . . . Greater growth and release of *R. multiflora* under lower deer pressure

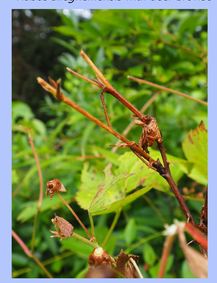
IF . . . . . Induced thorn defense in *R. multiflora* > *R. allegheniensis*
THEN . . . Greater resource allocation to growth in *R. multiflora* under lower deer pressure



Rosa multiflora with deer browse

Rosa multiflora intact

Rubus allegheniensis with deer browse



Rubus allegheniensis intact

Methods

- Suburban central New Jersey: 3 forests with lower deer pressure and 3 forests with higher deer pressure (determined by browse rates on many species, vegetation abundance, herb layer plant species richness, oak seedling abundance, hunting history).
- 36 to 40 16 m^2 plots in each forest; half fenced since 2013 to exclude deer.
- Measured percent cover in Fall 2017 of *Rubus allegheniensis* and *Rosa multiflora*; 10% increment estimates in 16 0.25 m^2 quadrats per plot.
- Counted number of plants of each species with and without deer browse in a 4m^2 section of each plot, annually from 2012-2017. Deer bites have a distinctive 'shreddy' tip (see photos).
- Measured thorn density in Spring 2017 for each species by calculating the ratio of number of thorns per cm stem, with observations made on the distal 10 cm of the youngest stem.
- To investigate induced thorn defense: Compared the ratios on unfenced plants growing in forests with lower and higher ambient deer pressure, and compared ratios between fenced and unfenced plants in all plots (and some additional plants outside of plots).
- Measured maximum height of individuals of each species in Summer 2017, in a 4m^2 section of all plots in all forests.

Results

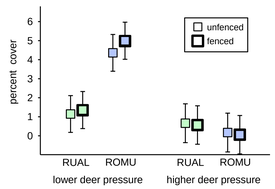
1. PERCENT COVER

Percent cover of *Rubus allegheniensis* and *Rosa multiflora* in three forests with lower and three with higher deer pressure, measured within 16 m^2 plots fenced for 4.5 years, or unfenced.
(Fall 2017; mean ± 95% CL; N= 53 to 59 plots per group)

- Lower deer pressure: *R. multiflora* > *R. allegheniensis*.
- Higher deer pressure: Lower cover for both species, especially *R. multiflora*

(species*deer pressure, $F_{1,440}$=10.02, P<0.002).

- No significant effect on cover from 4 years of fencing.



2. ABUNDANCE

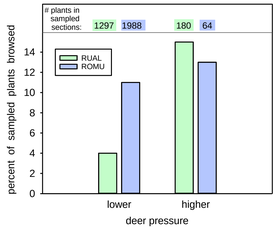
Top strip - total number of *Rubus allegheniensis* and *Rosa multiflora* plants encountered in 4 m^2 sections of the plots surveyed annually from 2012-2017.

- Both species were less abundant under higher deer pressure, but more so for *R. multiflora* (χ^2=108.32, P<0.0001, df=1).

3. BROWSE

Bar graph - Percent of sampled plants with presence of deer browse.

- Lower deer pressure: *Rosa multiflora* browsed more frequently than *Rubus allegheniensis* (χ^2=48.42, P<0.0001, df=1).
- Higher deer pressure: No significant difference between species, but greater browse rates for both species, especially for *R. allegheniensis*.

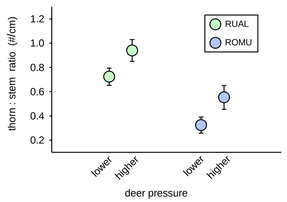


4. THORN DEFENSE I

Number of thorns per cm stem for unfenced *Rubus allegheniensis* and *Rosa multiflora* in three forests with lower and three with higher deer pressure (Spring 2017; mean ± 95% CL; left to right N = 83, 48, 90, 42).

- Both species had greater thorn density under higher deer pressure.

(deer pressure, $F_{1,258}$=28.8, P<0.0001; species*deerpr, NS)

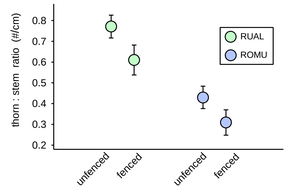


5. THORN DEFENSE II

Number of thorns per cm stem for *Rubus allegheniensis* and *Rosa multiflora* in six forests (combined lower and higher deer pressure), measured within 16 m^2 plots fenced for 4 years, or unfenced (Spring 2017; mean ± 95% CL; left to right N = 131, 77, 132, 107).

- Both species had greater thorn density in unfenced plots.

(fencing, $F_{1,446}$=20.19, P<0.0001; species*fencing, NS)

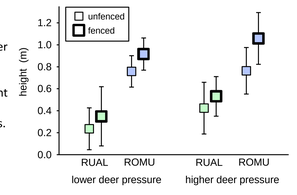


6. PLANT HEIGHT

Heights of *Rubus allegheniensis* and *Rosa multiflora* plants in three forests with lower and three with higher deer pressure, in plots fenced for 4 years, or unfenced (Summer 2017, mean ± 95% CL; left to right N = 26, 13, 46, 44, 17, 29, 21, 17)

- Both species were taller in fenced plots.
- Both species were taller under higher deer pressure, but especially *R. allegheniensis*.

(fencing, $F_{1,205}$=5.69, P<0.02; species*deer pressure, $F_{1,205}$= 4.14, P<0.05)



Discussion

Forests in central New Jersey (a typical suburban/exurban landscape consisting of forested stands, housing/lawns, corporate parks, towns, small cities, and small farms) are subject to a very high regional deer density (32 deer/km^2), but deer pressure can still be variable among forested parcels.

Forests with lower ambient deer pressure had much more cover of the non-native, invasive, thorny rose *Rosa multiflora* than did forests with higher deer pressure, while cover of a native thorny plant, *Rubus allegheniensis,* was similar between lower and higher deer pressure (Result 1). Similarly, while both species had more individuals in the forests with lower deer pressure, this was much more pronounced for the invasive rose (Result 2). These patterns suggest that the invasive plant may be more susceptible to deer pressure than the native – even though they both are defended from generalist, vertebrate herbivores by thorns – and thereby may be more prone to ecological release when deer pressure is lower.

Indeed, *R. multiflora* was browsed more frequently than *R. allegheniensis*, but only in the forests with lower ambient deer pressure (Result 3). As yet in these forests, there was no significant cover difference in fenced vs. unfenced plots but, as shown in Result 1, cover is trending upwards for *R. multiflora* in the fenced plots, where it is protected from deer browse. Perhaps the similarity of the two species' browse rates in the forests with higher deer pressure is because deer are less discriminating when there are fewer plants to choose.

Interestingly, the seemingly more-preferred *R. multiflora* had only slightly reduced browse in the forests with lower deer pressure, yet had dramatically greater cover and abundance. This suggests an ability for very strong ecological release with just a small reduction in deer browse.

Both species exhibited similar and strong induced thorn defenses, with greater thorn density in the forests with greater deer pressure (Result 4) and, across all forests, outside of fences vs. fenced plots (Result 5). This similarity suggests that greater allocation to growth vs. defense is not a mechanism for the greater cover of *R. multiflora* vs. *R. allegheniensis* in the forests with lower deer pressure.

Still, the fact that *R. multiflora* has an induced thorn defense indicates the potential for this invasive plant to allocate more resources to growth when deer pressure is lower. Its taller heights in fenced plots, especially in the forests with higher deer pressure (Result 6) support this idea.

Acknowledgements For field assistance: Morrison lab students, friends, family – too numerous to name – but thanks to all, especially Kiara Proano, Ryan Goolic, Daniela Nattes, and Mike Eppel. For research permits: Mercer County Parks, Friends of Hopewell Valley Open Space. For funding, the National Science Foundation (DEB 1257833, DEB 0933977), TCNJ Academic Affairs (Support for Scholarly Activity & the Mentored Undergraduate Summer Experience), and funding for Morrison's Barbara Meyers Pelson '59 Chair in Faculty-Student Engagement at TCNJ.