Important notes from Rob:

*King and Tschinkel, 2008, our model PNAS paper is 3,500 words. Keep it short and to the point.*

Title(s):

Not all non-native shrubs provide equally poor food resources to insectivorous songbirds

Abstract:

Biological invasions threaten biodiversity by outcompeting native species and disrupting food webs. Invasive species are highly ranked as causal agents in the decline of endemic populations. Non-native woody plants now occupy nearly every conceivable habitat in terrestrial ecosystems as a result of human activity, either through intentional or unintentional introduction. Removal of invasive shrubs to improve habitats costs conservation organizations xxx million dollars a year. In eastern North American temperate forests, understory plant communities are now dominated by exotic species, in many cases being more numerous that native plants. As the base of forest food chains, it stands to reason that wildlife would be significantly and negatively impacted by the prevalence of invasive plants. For many species of insectivorous birds and mammals, invasive plants threaten populations by provided less food resources and food resources of lower quality. From the plant-insect interaction literature there are several mechanisms proposed: first, invasive plants have lower densities of herbivores compared to native congeners. Second, invasive plants have lower nutritional quality, so herbivores that do feed on them have lower nutrient density. Third, invasive plants have traits not seen in native habitats, such as distinctive architecture, and this provides microhabitat for insects resulting in highly modified insect community composition. As such, it is predicted that wildlife, like migratory insectivorous songbirds, will face significant challenges in meeting nutritional needs in habitats dominated by invasive shrubs. In this project, we tested the hypothesis that food availability and food quality for insectivorous songbirds is lower on inside woody plants compared to native woody plants in the same habitat. Using a wide range of host-plant species, including 6 native species and 4 invasive species, we quantified the prey being taken by birds and the nutritional content of those arthropod guilds. Contrary to predictions from other systems, non-native plants did not have lower abundance or quality of insect prey overall compared to native plants overall. Instead, we saw a wide range of nutritional quality among our exotic host plants, suggesting that not all species are equally detrimental to songbird food availability. These results do not suggest that invasive plants are not worth removing, but it instead suggests that management efforts need to prioritize removal of invasive species over others. Invasive plant management needs to take a more nuanced approach for improving habitat for wildlife given the food quality of some invasive plants is on par or superior to native woody plants in the same habitat.

Keywords:

Invasive species, invasive plants, insectivores, songbirds, forests, food webs, habitat improvement

Introduction:

*P1 – The impacts of invasive plants and cost of removal*

Invasive species are the leading cause of biodiversity decline globally, and to address this challenge over xx billion dollars is spent every year to manage invasive populations. Removal of invasive species is costly, but it can also be a highly effective way to conserve endangered species or maintain ecosystem services. Invasive woody plants are particularly challenging to manage in terrestrial ecosystems, with xxx billion dollars spent removing them from forested habitats.

*P2 – Negative impacts on wildlife as a case study in invasive plant biology*

By displacing native plants and disrupting the base of food chains, invasive plant populations have cascading impacts on all higher trophic levels and soil biology. As such, invasive plant removal if a central feature of habitat improvement plans to promote healthy wildlife populations and facilitate the recovery of declining species.

*P3 – Motivations for invasive plant management and the implicit assumptions about lower food quality in habitat restoration efforts*

The mechanisms by which invasive plants disrupt food webs in particular, has been well demonstrated in many systems.

*P4 – Hypotheses and predictions (this paragraph is not in other PNAS papers, but its important to me to use it as a narrative tool)*

Non-native plants are expected to have significantly fewer herbivores. Furthermore, non-native plants expected to have lower nutritional quality of herbivores. As a consequence, it is anticipated that birds forage less on invasive plants, and thus the predatory effects of these insectivores should be weaker overall on non-natives vs. native plants. In our system, we predicted that biomass and C:N ratios would be lower on our four non-native, invasive shrubs compared to native woody plants in the same habitat.

Methods:

*In PNAS Methods are presented at the end. To save space some methods are put into the supporting information documents*

Results:

P6 – Arthropod biomass across the ten species and bird treatments

P7 – community composition reporting what taxonomic groups birds are removing from native and non-native plants

P8 – Nutritional quality data (again, only 2 paragraphs in King and Tschinkel, 2008)

Discussion:

P9 –

P10 –

P11 –

P12 –

Methods:

P13 – bird exclusion and great hollow habitat information

P14 – arthropod id and processing

P15 – nutritional quality methods

P16 – stats methods 1

We employed a series of Generalized Linear Mixed Models (GLMMs) using the lme4 package (citation) in R version 4.1.2 (citation). These univariate analyses use the following as response variables: (1) total arthropod biomass sampled per plant in grams, (2) spider abundance (Araneae), (3) caterpillar abundance (Lepidoptera), (4) Hemiptera abundance, and (5) aquatic insect abundance (Stoneflies and Mayflies), (6) C:N Content of spiders, and (7) C:N content of putative herbivores. Arthropod biomass (1) was fitted as normally distributed variable after a log-transformation. All abundance models were fitted using the negative binomial distribution (citations). C:N ratio models were fit using the xxx distribution (or this fitted as % mass that is N). Related to these GLMM’s, we performed a set of diagnostic tests to determine the impact of leaf counts on arthropod biomass among host-plant species (Appendix 1).

P16 – stats methods 2

P18 – (K&T had 6 short methods paragraphs, but I don’t think we need that much)

Fig. 1a. & 1b.

Diagram

Description automatically generated

Figure 3: what arthropod groups are birds removing from native vs. non-natives

X axis are the dozen arthropod functional groups

Bar height is the bag effect

Fill = native or non-native groupings

Make a panel of the 4 or 6 most important functional groups like fig 1b

Figure 4: (Not table like in K&T)

Nutritional quality plot (C:N ratio), this should only be a clustered bar chart with the 2 groups among the 10 species if possible.

References: (only 32 in K&T 2008!)

Supporting information:

GLMM table 1

GLMM table 2

GLMM table 3

Variation in insect abundance among native and non-native plants plots from seminars