

Impact scores of invasive plants are biased by disregard of environmental co-variation and non-linearity

Aims

The aims of our study were to model the effects of three invasive plants on species richness, and to assess the influence of model choice on impact scores.

Methods

A. We modeled effects of *Heracleum mantegazzianum*, *Lupinus polyphyllus*, and *Rosa rugosa* on species richness with Generalized Linear Models (GLM) using 1. simple linear models (“basic”), and 2. models that accounted for environmental co-variation and non-linearity (“full”) :

$\text{richness} \sim \text{habitat type} + \text{invader cover} + (\text{invader cover})^2$ (Thiele et al. 2010a, see bottom left).

B. We calculated impact scores by averaging predicted species loss over all sampled sites (see Equ. 1) using the basic and full models (Thiele et al. 2010b, see bottom right).

$$\text{Equ. 1: } \frac{\sum_{i=1}^n (\hat{y}_0 - \hat{y}_{x_i})}{n}, \text{ where } \hat{y} = \text{predicted species richness, } x_i = \text{invader cover of site } i, \text{ and } n = \text{number of sampled sites.}$$

Results

All full models showed significant habitat effects on species richness. *Heracleum mantegazzianum* had regular linear effects; *L. polyphyllus*’ effects interacted strongly with habitat type; effects of *R. rugosa* were non-linear. Impact scores differed markedly between the basic and full models (Fig. 1).

Conclusions

The choice of effect model is important for assessment of impacts of invasive plants. Effect models should account for environmental co-variation and include non-linear terms, if significant.

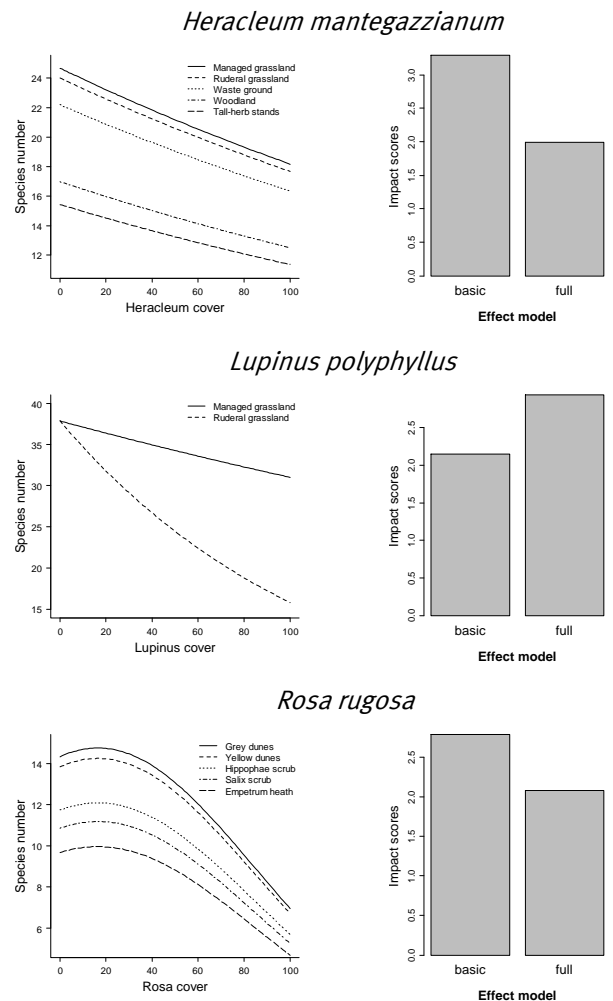
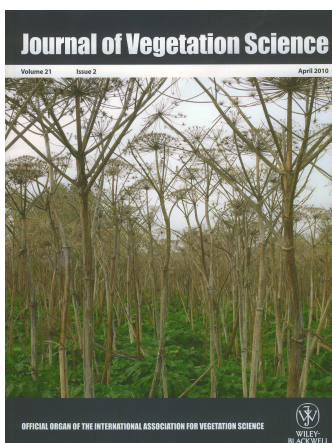


Fig. 1, left panels: Effect models (GLM) of three invasive plants on species richness. Models included habitat type, invader cover and squared invader cover (if significant). **Right panels:** Impact scores based on simple linear models („basic“) and on the GLM shown in the left panels („full“).



Competitive displacement or biotic resistance? Distinguishing relationships between community diversity and invasion success of tall herbs and shrubs

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Abstract

Questions: Are negative invasion-diversity relationships due to biotic resistance of the invaded plant community or to post-invasion displacement of less competitive species? Do invasion-diversity relationships change with habitat type or invader traits?

Location/Species: Lowlands and uplands of western and southern Germany. *Heracleum mantegazzianum*, *Lupinus polyphyllus* and *Rosa rugosa* in central Germany. *Lupinus polyphyllus* and *Rosa rugosa* in southern Germany.

Methods: We tested the significance and estimated response shape of invasion-diversity relationships using generalized linear (mixed effects) modelling within different plant groups, stratified based on site, life cycle and community association.

Results: We found negative, positive and neutral relationships between invader cover and species richness. There were negative linear correlations of invader cover with small plant species throughout, but no negative linear correlations with tall species. Invasion-diversity relationships tended to be more negative in early-successional habitats, such as dunes or abandoned grasslands, than in late-successional habitats.

Conclusions: Invasion-diversity relationships are complex, they vary among habitat types and among species groups.

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Keywords: biotic resistance, community diversity, competitive displacement, invasion success, post-invasion displacement, species richness, tall herbs, shrubs.

Introduction

Invasion biologists generally assume negative relationships between plant invasions and the diversity of the invaded plant community. The hypothesis of biotic resistance predicts that the presence of native plants, in terms of probability of establishment and abundance, is lower in species-rich communities (Levine et al. 2004). On the other hand, the local extinction of an invader may reduce the richness and diversity of resident species (Buisson et al. 2004; Warren & Morgan 2004; Haddad et al. 2006; Kollmann 2008). Thus, the relationship between abundance of invasive species and richness of native species is often found to be ambiguous and inconsistent in plant communities.

Experimental studies have produced evidence for both hypotheses. For example, in a field experiment, native diversity was found to be positively related to invasion success (Warren & Morgan 2004; Haddad et al. 2006; Kollmann 2008). The variability of observational evidence between habitat types and native plant diversity has often been explained by co-variation of environmental factors and community diversity, leading to positive correlations at intermediate scales, while correlations may be negative within habitat types (Otte & Chanson 2002; Davies et al. 2003; Fridley et al. 2003; Prentice et al. 2005).

different groups of resident species. Negative invasion-diversity relationships are due to asymmetric competitive displacement of inferior species and not due to biotic resistance. Small species are displaced in early-successional habitats, while there is little effect on persistence of tall species.

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