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How complex is complex enough? Impact models of invasive plants

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Impact assessment

$$I = R \bullet A \bullet E$$

"impact score"
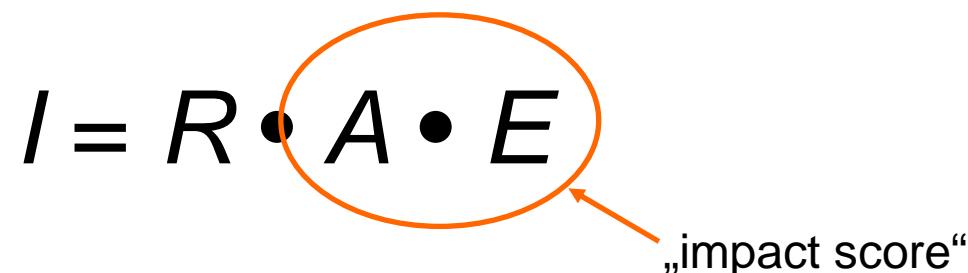
- I = Impact
- R = range
- A = abundance
- E = effect (per individual or biomass unit)

Parker et al. 1999. Impact: toward a framework for understanding the ecological effects of invaders

Conceptual models

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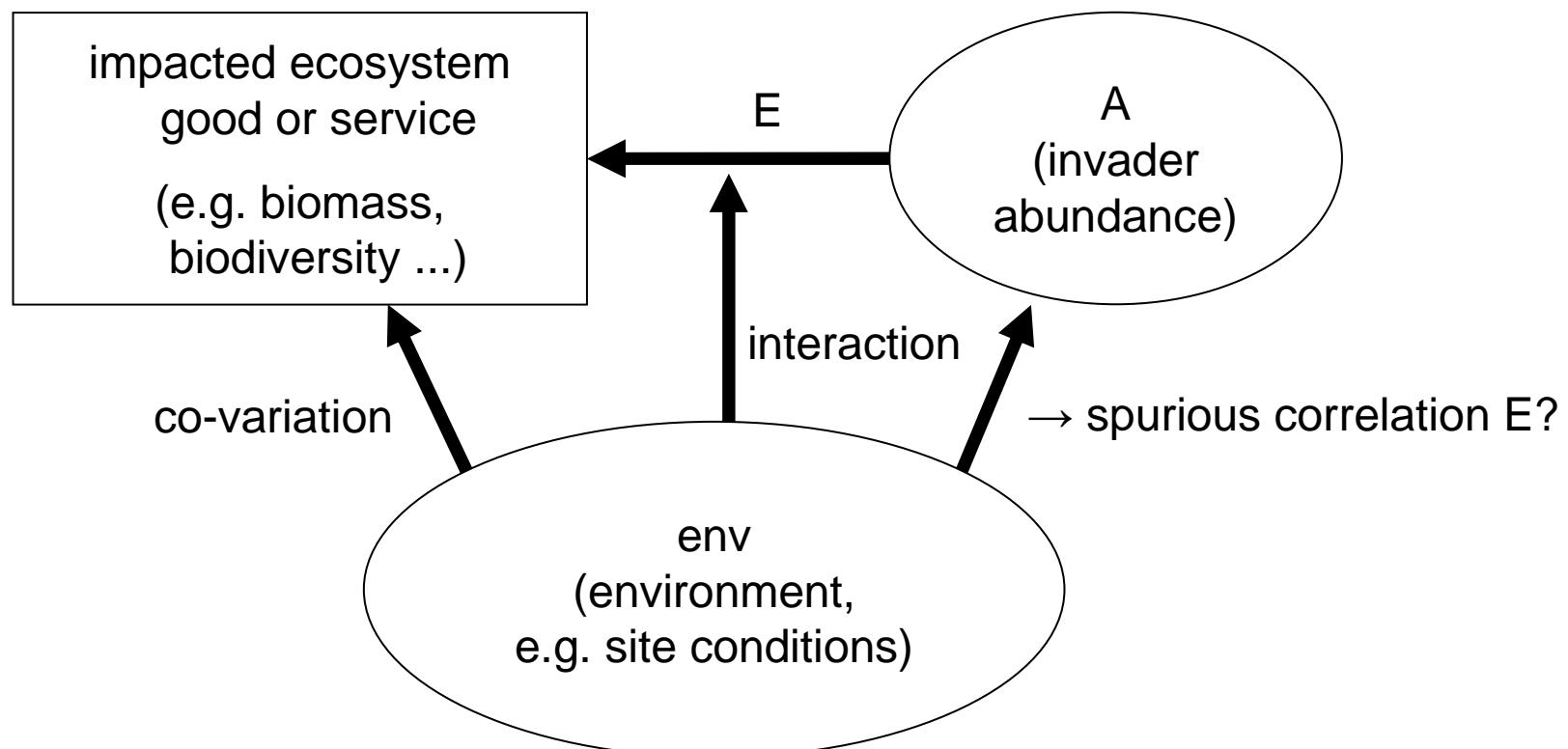
Statistical models

- Simple model:
  $y \sim b_0 + E_A * A$

- Environmental co-variation model:

- $y \sim b_0 + E_A * A + b_{env} * env$

- Environmental co-variation & non-linearity model:
  $y \sim b_0 + E_A * A + b_{env} * env + E_{A^2} * A^2$

- Environmental co-variation & non-linearity & interactions model
  $y \sim b_0 + E_A * A + b_{env} * env + b_A * A^2 + b_{A*env} * A * env + b_{A^2*env} * A^2 * env$
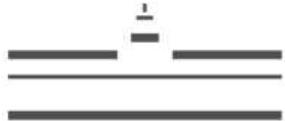
Research questions

- Which model fits best?
- How large is the difference in impact scores between simple and complex models?

Field data & invasive species

	Heracleum mantegazzianum	*Lupinus polyphyllus*	*Rosa rugosa*
No. of plots	202	80	63
Plot size (m²)	25	25/ 100	16
Study regions	Western, central and southern Germany	Rhön mountains (central Germany)	East Friesian Islands (Spiekeroog, Norderney, Juist)
Data	Species richness, invader cover percentage, habitat type		

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Heracleum mantegazzianum

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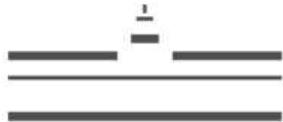
Lupinus polyphyllus

Rosa rugosa

Methods

- GLM(M): (quasi-)Poisson, log link, likelihood ratio tests

- Calculation of impact scores:
  - simple and full model
  - mean(predict(cover=0) – predict(cover=x_i), for all plots i)

- Bootstrap CIs: impact scores from 10.000 resamples of data table

Results – Heracleum mantegazzianum:
full model: $\log(y) \sim 3.2 - 0.003*hmcover + b_i*habitat(i)$

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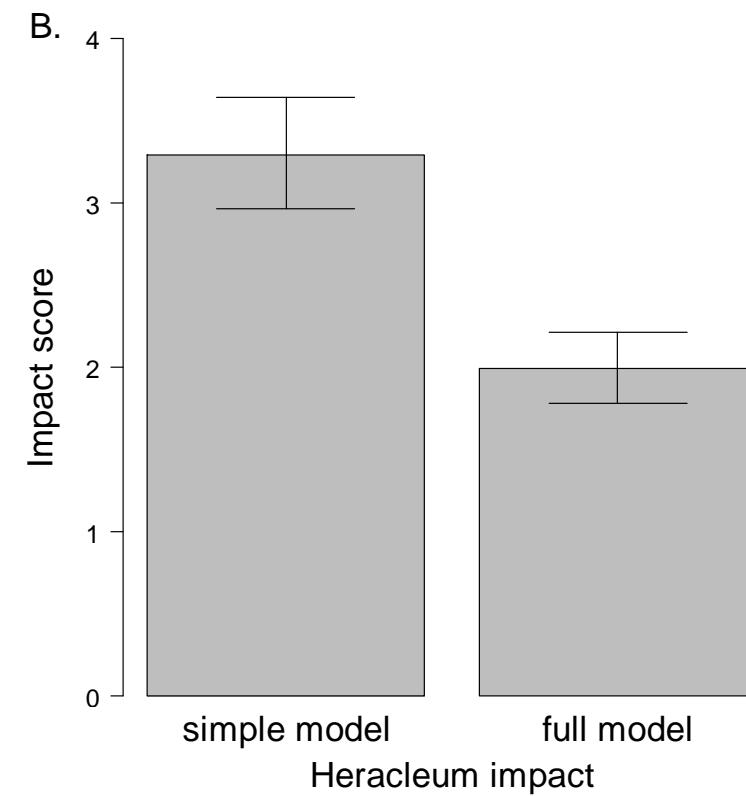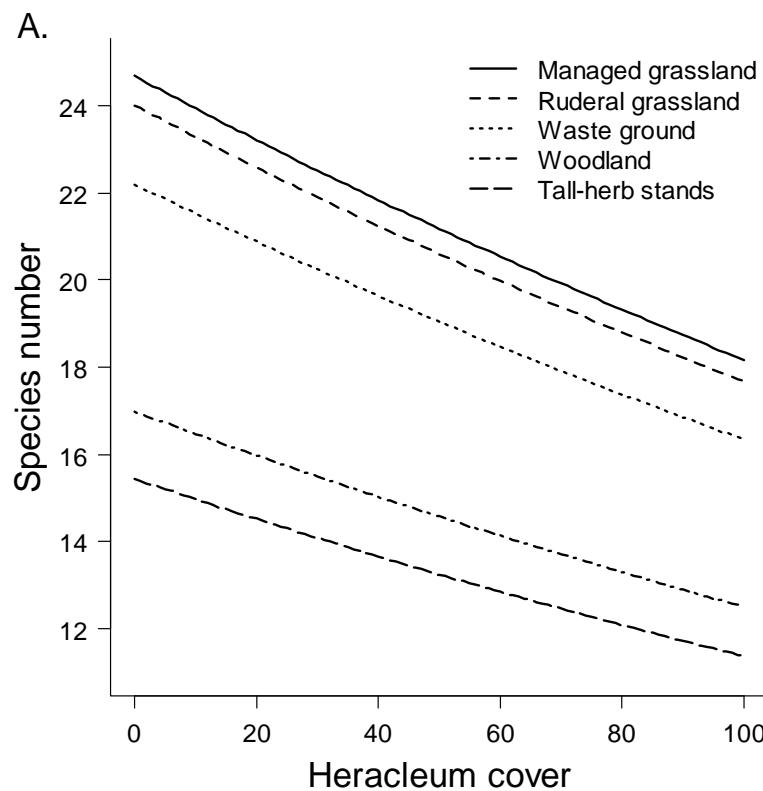
Results – Lupinus polyphyllus
full model: $\log(y) \sim 3.6 - 0.002 * \text{lpcover} + b_i * \text{lpcover} * \text{habitat}(i)$ (*)

C.

Managed grassland
Ruderal grassland

Species number

Lupinus cover

D.

Impact score

simple model   full model

Lupinus impact
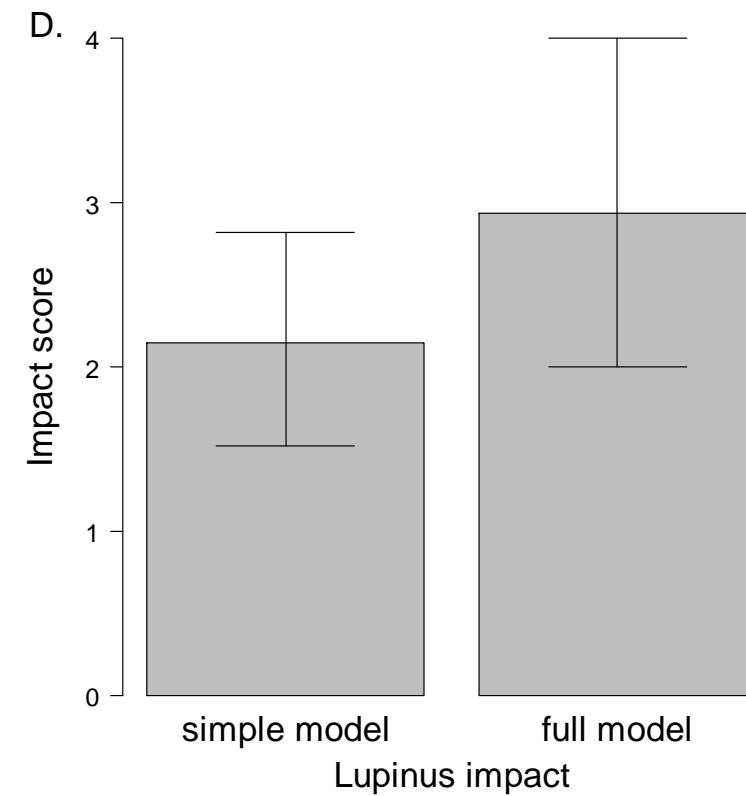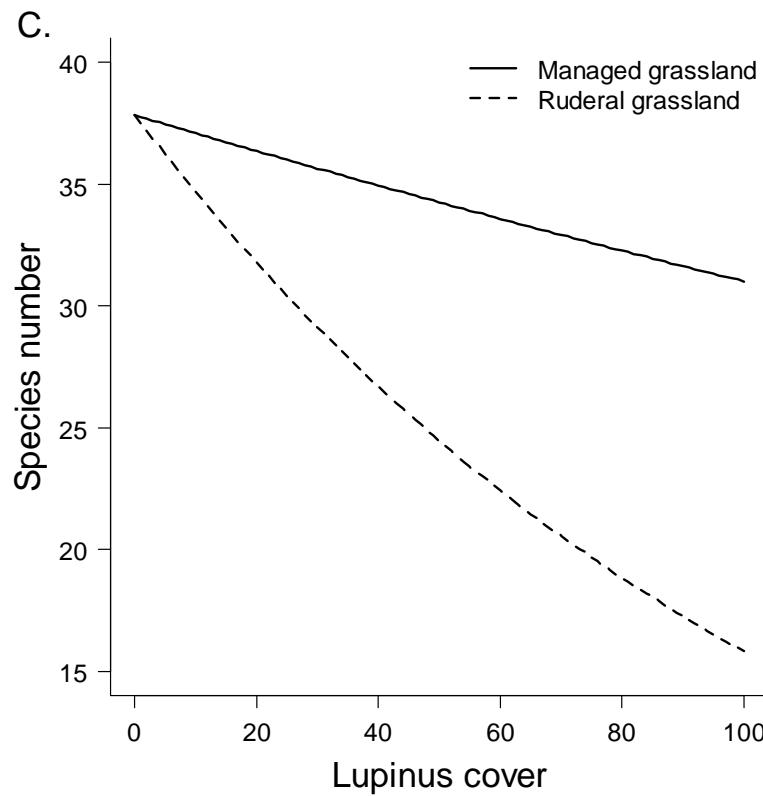
* the model also included „plot area" to correct for plots of 25/100 m²

Results – Rosa rugosa
full model: $\log(y) \sim 2.5 + 0.004*\text{rrcover} - 0.4*(\text{rrcover})^2 + b_i*\text{habitat}(i)$

E. Species number vs Rosa cover, with legend: Grey dunes, Yellow dunes, Hippophae scrub, Salix scrub, Empetrum heath.

F. Impact score for simple model and full model (Rosa impact).
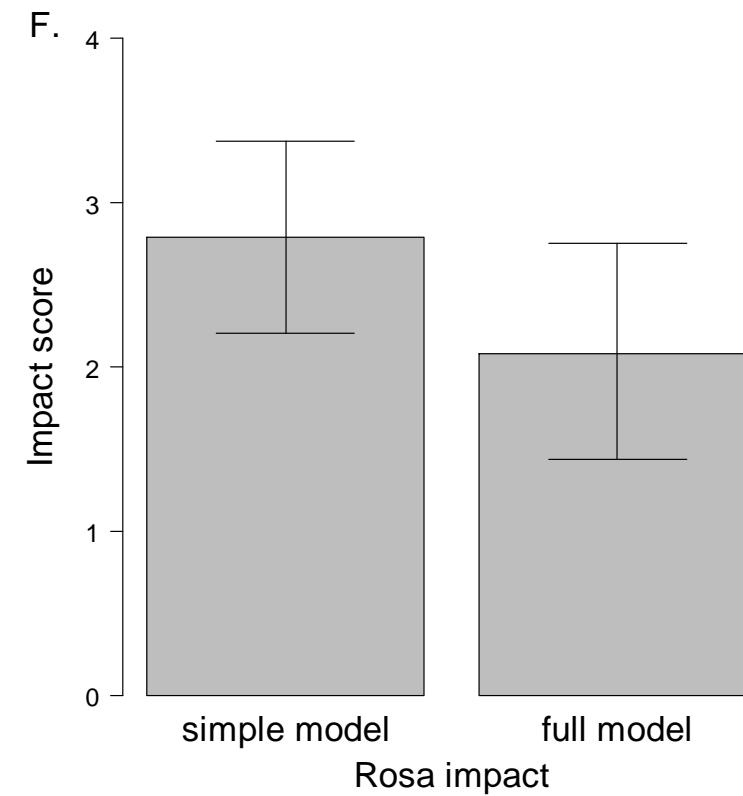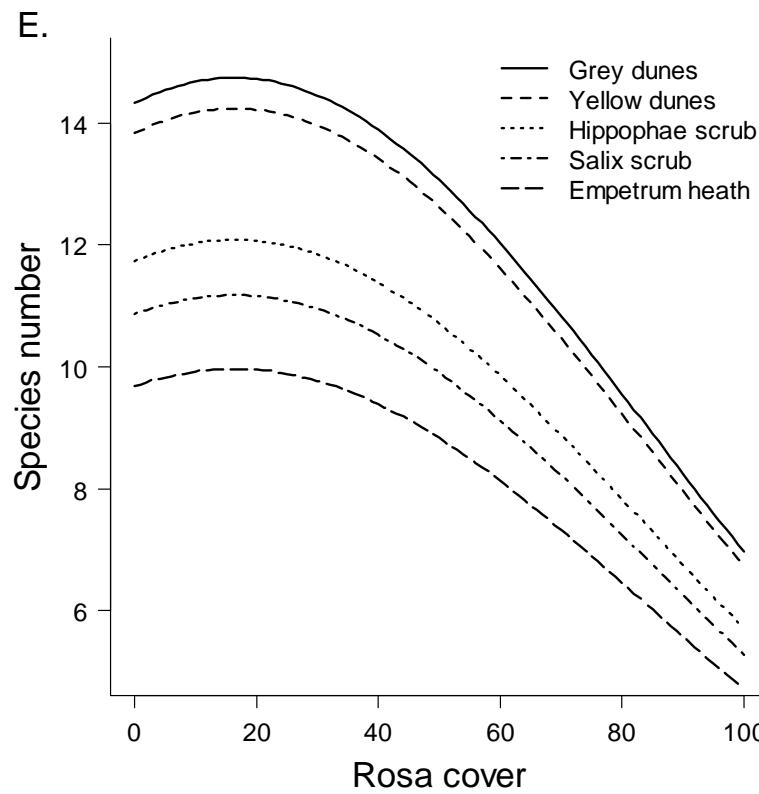
Conclusions

- Simple models are too simple!
- Environment, non-linearity and interactions matter
- One model fits all? No!
- Some potential for generalisation for functional types of invaders?
- Impact assessment is understudied

Thiele, Isermann, Kollmann, Otte (2011) Impact scores of invasive plants are biased by disregard of environmental co-variation and non-linearity. Neobiota 9. http://www.pensoft.net/journals/neobiota