



Does biodiversity confer resistance to biological invasions?

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NZ Ecol. Soc., Nov. 2015

New Zealand – an invasion ‘hotspot’

Charles S. Elton (1958)

“No place in the world has received for such a long time such a steady stream of aggressive invaders, especially among the mammals”

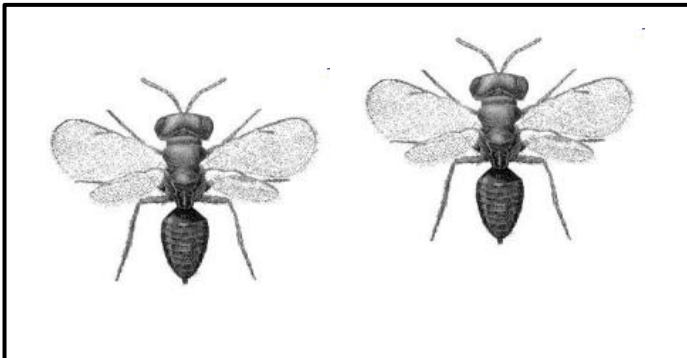


28 mammals

34 birds

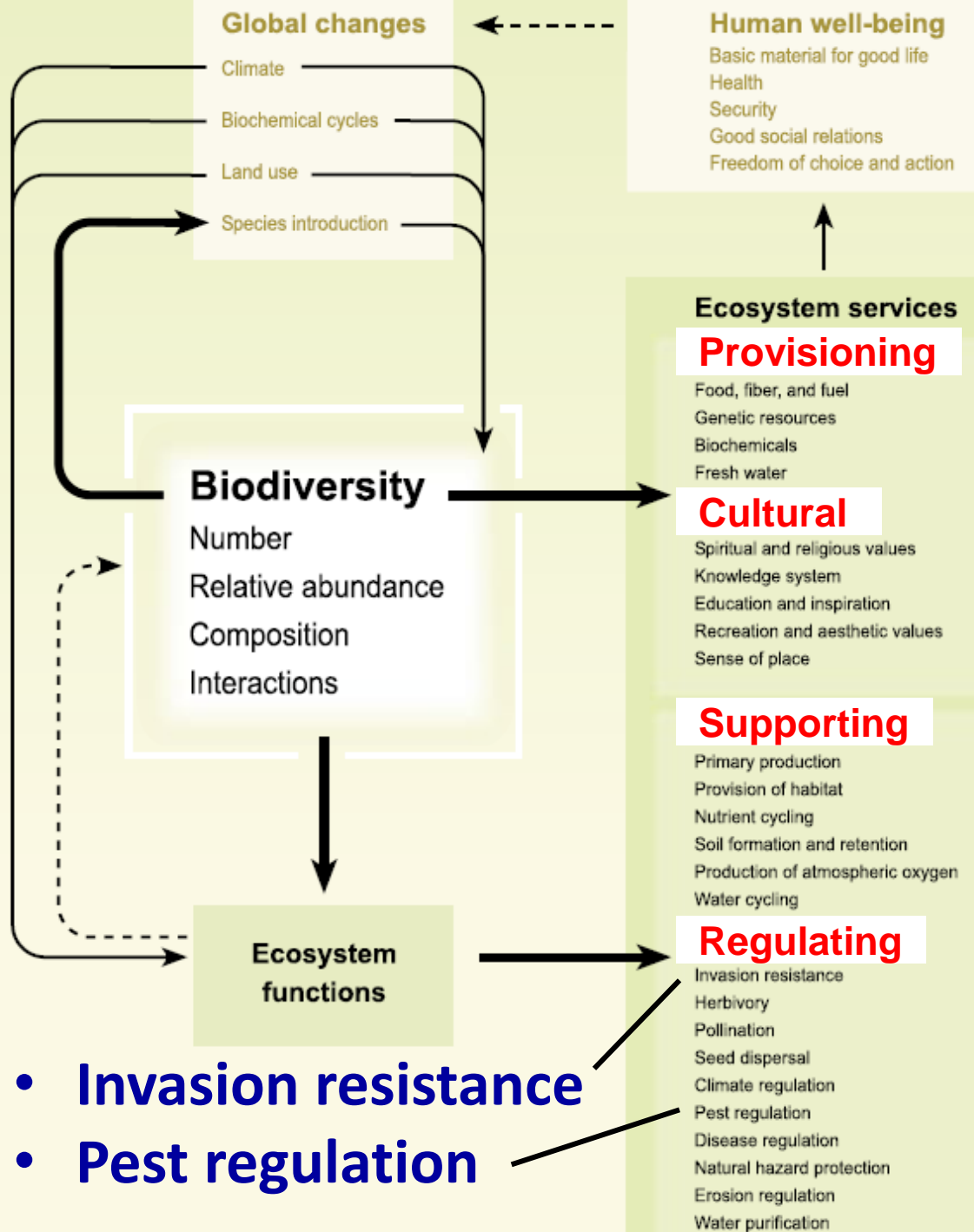
ca 2200 “fungi” (++)

ca 1600 insects (++)



Biodiversity and the Provision of Ecosystem Services

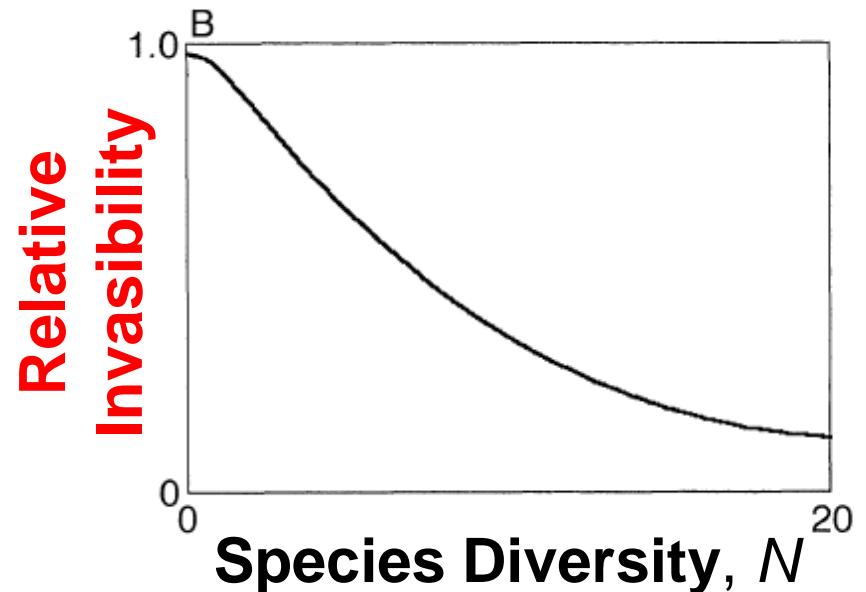
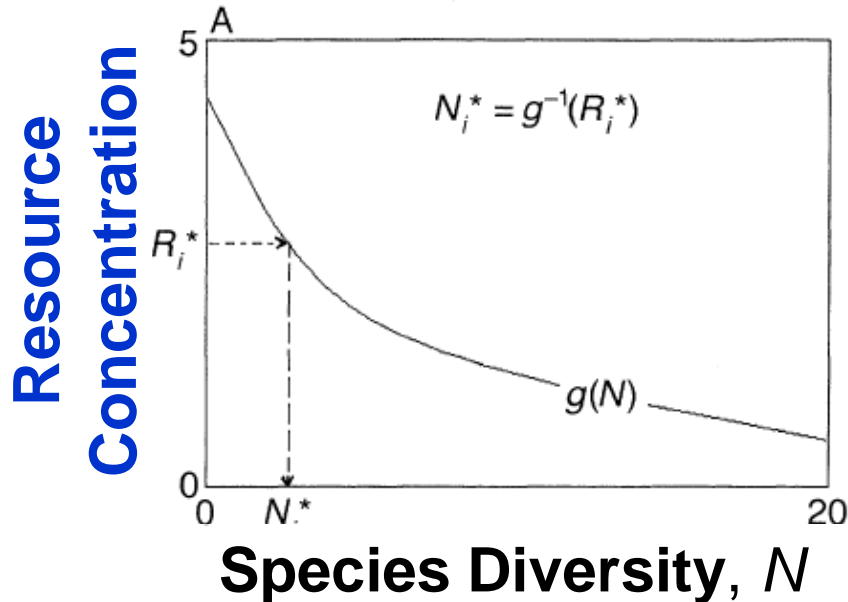
Millennium Ecosystem Assessment (2005):
www.millenniumassessment.org



'Diversity-invasibility hypothesis'

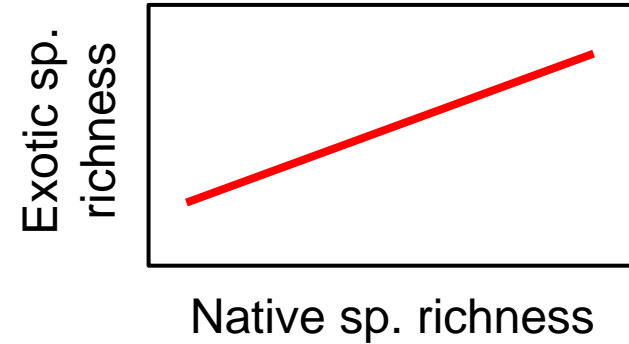
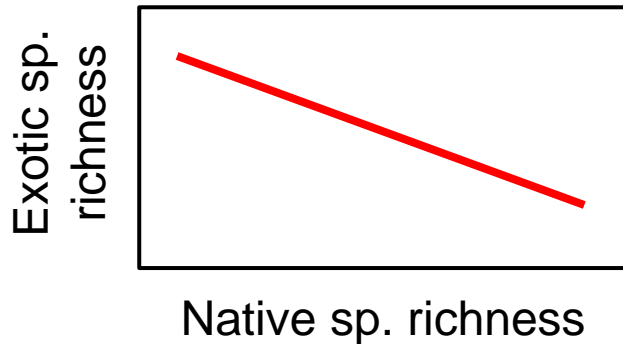
David Tilman (1999) The ecological consequences of changes in biodiversity (*Ecology*)

- Evidence from grassland experiments and theoretical considerations



Assessing invasion resistance & relative invasibility

- Relationship between native species richness and exotic species richness



- Ratio of native species and exotic species richness
- (Relative) Abundance of exotic species
- Rate of spread of invasive species
- 'Impact' of exotic species
- Effect of trophic level? Plant vs. herbivore invasions?

BEST: Land use, biodiversity and ecosystem services



Biodiversity

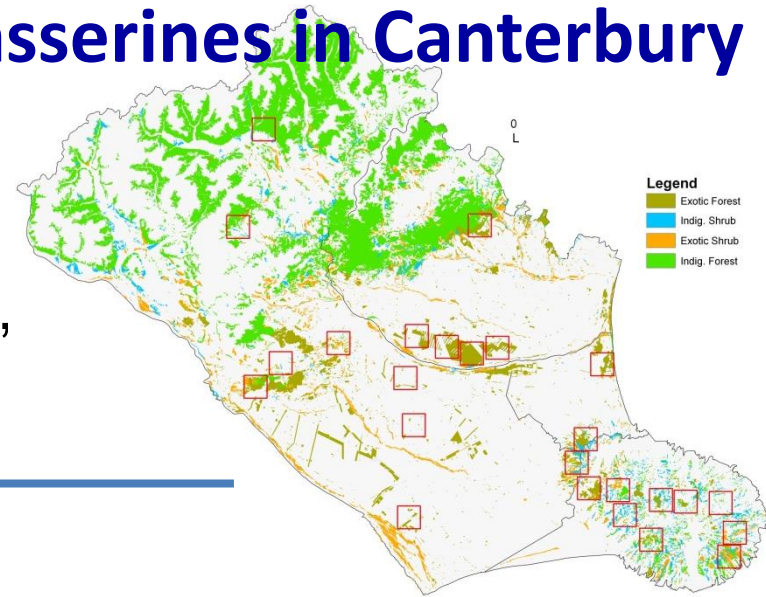
**Land
use**

**Ecosystem
Services**

**WORK
IN PROGRESS**

Case study: Native and exotic passerines in Canterbury

5-minute bird counts,
823 plots,
in native forest, native scrub, pine forest,
exotic scrub, grassland (pasture).



Ecology, 95(1), 2014, pp. 78–87

Habitat filtering by landscape and local forest composition in native
and exotic New Zealand birds

JEAN-YVES BARNAGAUD,^{1,2,3,8} LUC BARBARO,^{1,2} JULIEN PAPAIX,^{4,5} MARC DECONCHAT,⁶
AND ECKEHARD G. BROCKERHOFF⁷

Forest Ecology and Management 258S (2009) S196–S204

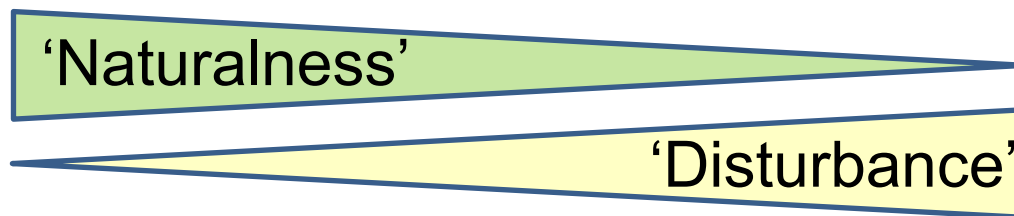
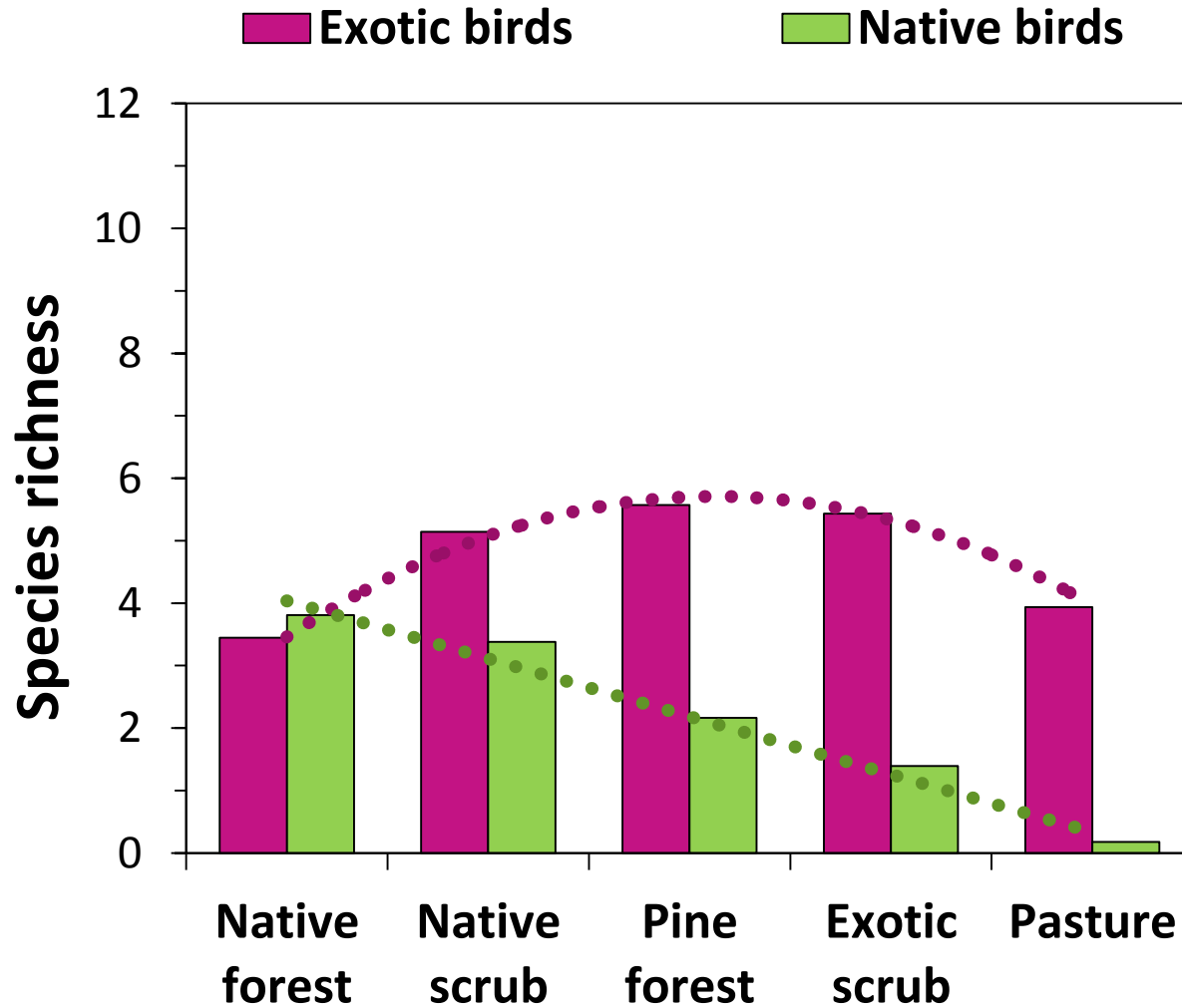
Effects of surrounding landscape composition on the conservation value
of native and exotic habitats for native forest birds

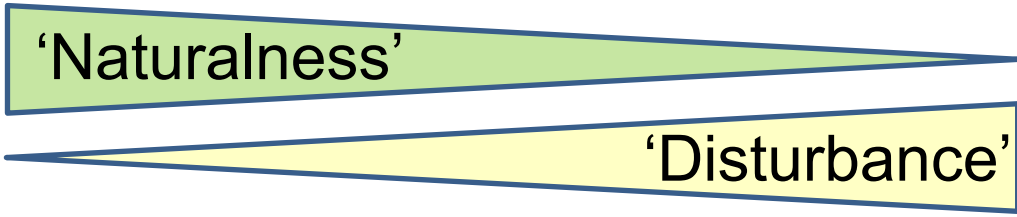
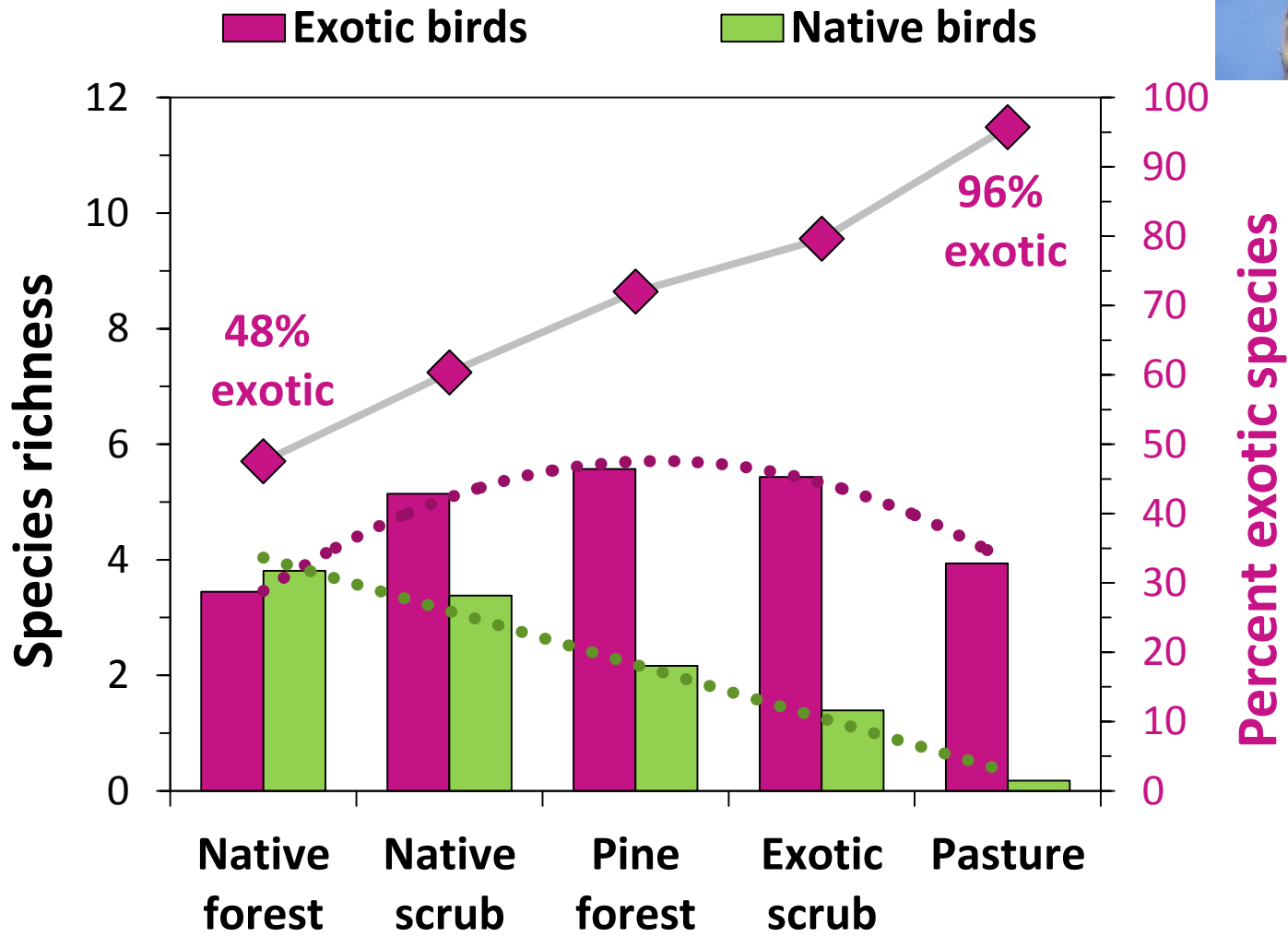
M. Deconchat^{a,*}, E.G. Brockerhoff^b, L. Barbaro^c

^aINRA, UMR1201, Dynafor, Forest dynamics in rural landscapes, BP52627, F-31326 Castanet, France

^bSCION (New Zealand Forest Research Institute), P.O. Box 29237, Christchurch 8540, New Zealand

^cINRA, UMR1202 Biodiversity Genes & Communities, F-33612 Cestas, France

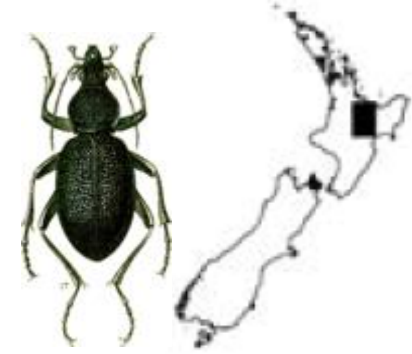




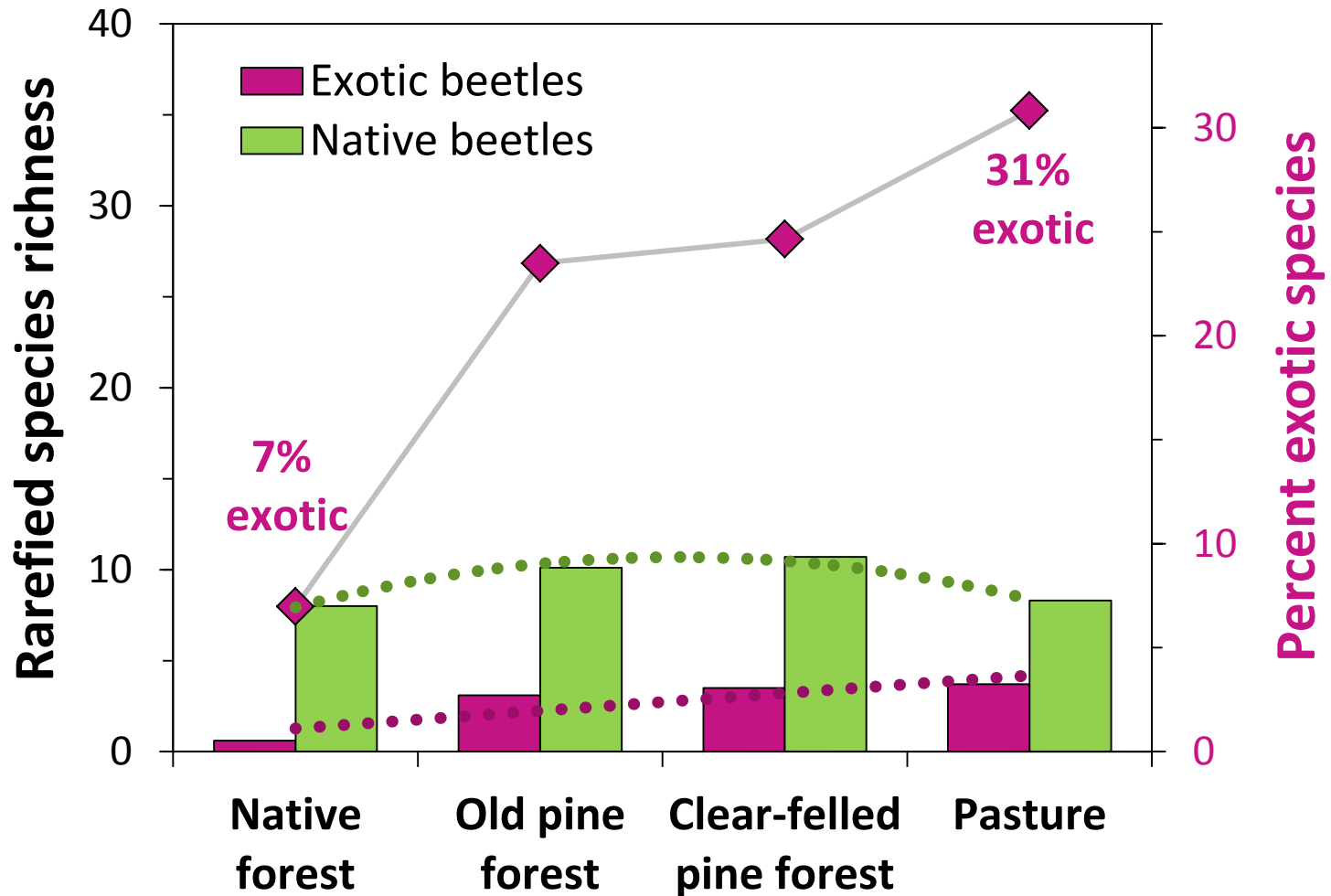
Non-native plantation forests as alternative habitat for native forest beetles in a heavily modified landscape

Stephen M. Pawson · Eckehard G. Brockerhoff · Esther D. Meenken · Raphael K. Didham

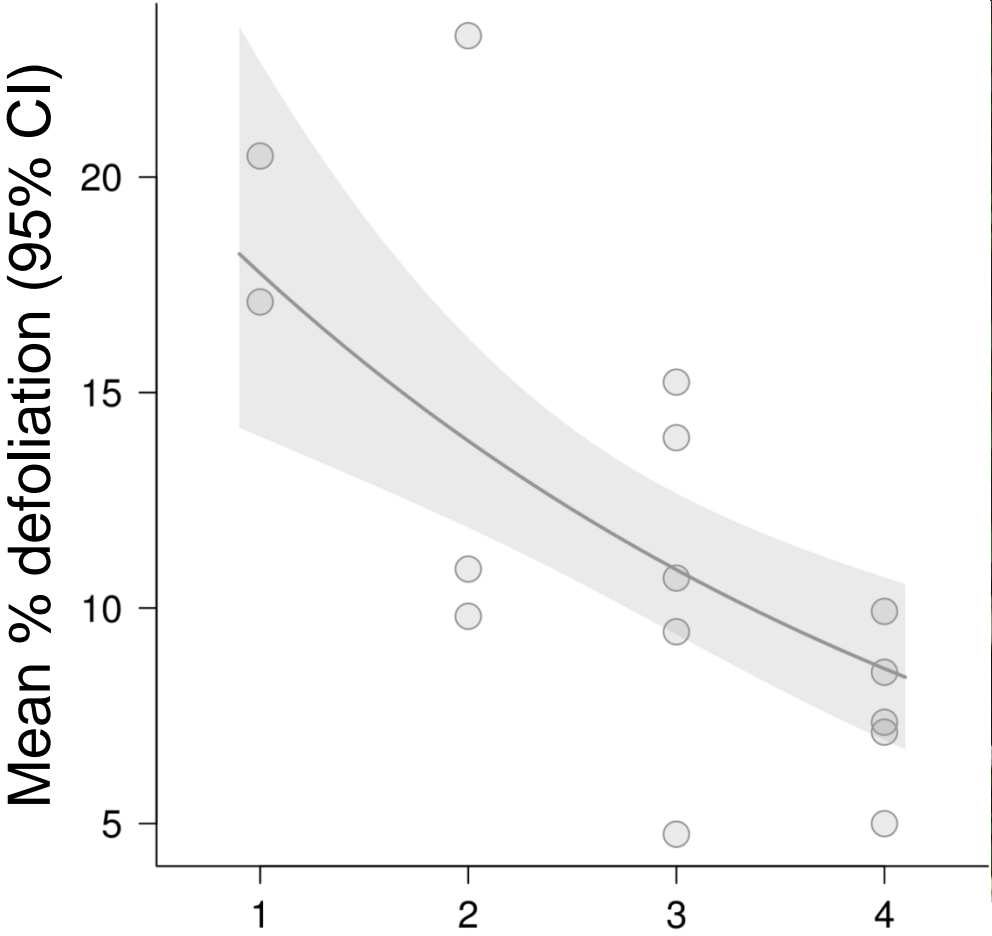
Biodivers Conserv (2008) 17:1127–1148



126
pitfall
traps



Asian chestnut gall wasp (*Dryocosmus kuriphilus*) invasion in Italy



Tree species richness within plot



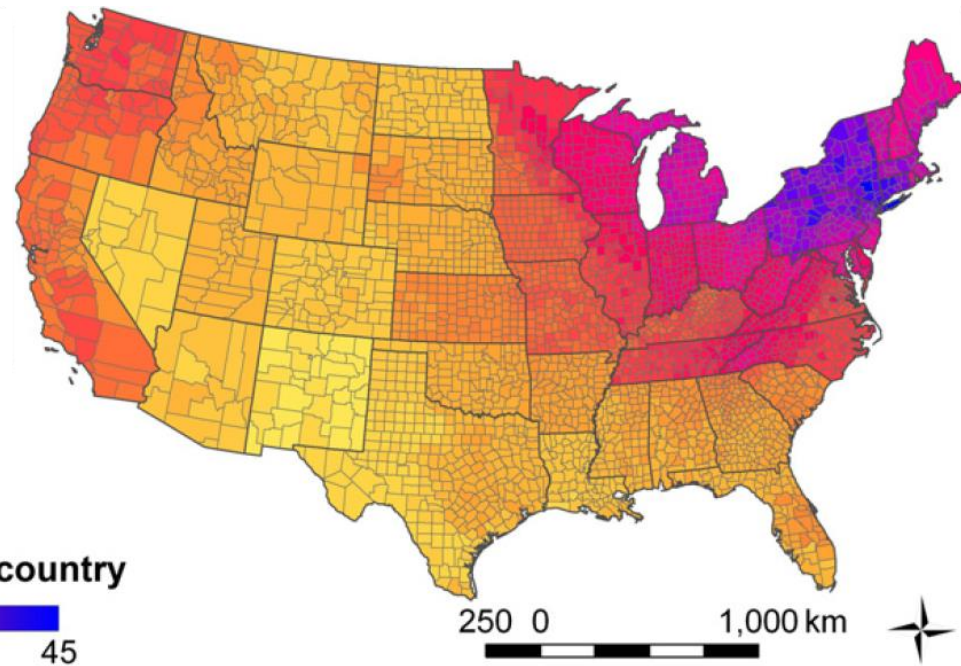
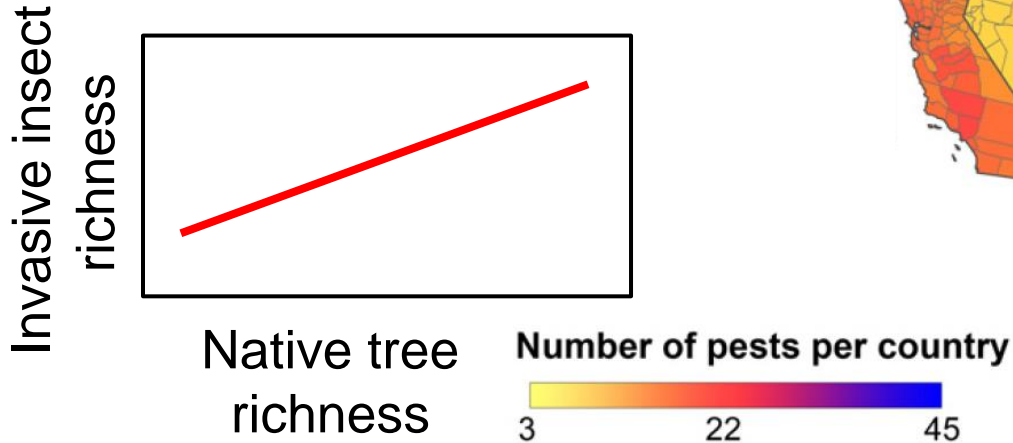
Guyot et al. (2015)
PLOS ONE

Mechanisms? How may biodiversity confer “resistance” to invasion? (Herbivores)

- Diversity causes resource dilution effect
(Association of non-host species; “associational resistance”)
- Diversity reduces “physical host apparency”
(Physical detectability of host)
- Diversity reduces “info-chemical host apparency”
(Interference with host finding by non-host odourants)
- Diversity enhances activity of natural enemies of pests
(Insect predators, parasitoids, birds)

Jactel & Brockerhoff (2007) Ecology Letters
Bertheau et al. (2010) Ecology Letters
Castagneyrol et al. (2014) J. Appl. Ecol.

Alien forest insect pests (established, by county)

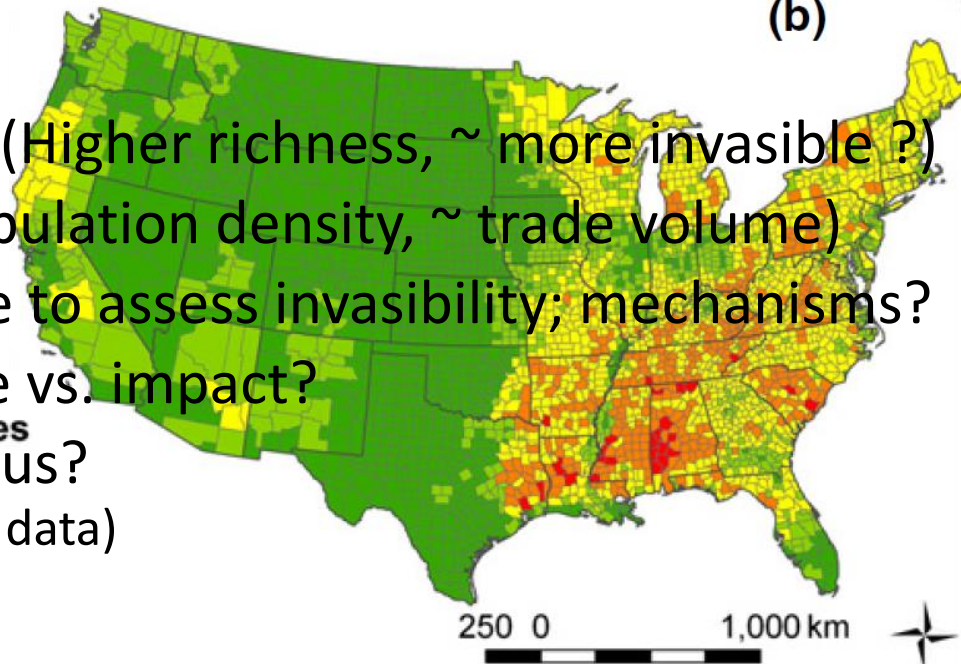


(b)

Tree species (by county)

- Richness, species/genus/family (Higher richness, ~ more invasible ?)
- Propagule pressure (Human population density, ~ trade volume)
- Richness relationships adequate to assess invasibility; mechanisms?
- Confounding factors? Presence vs. impact?
- Invasibility per tree species/genus?

Number of tree species



Liebholt et al. (2013)

Diversity & Distribution



NZ 'agriculture' depends on <10 exotic crops in monocultures



Example: NZ plantation forests (>90% *Pinus radiata*)

Putting all eggs into one basket?

- If a high-impact pest arrives, losses are likely to be high



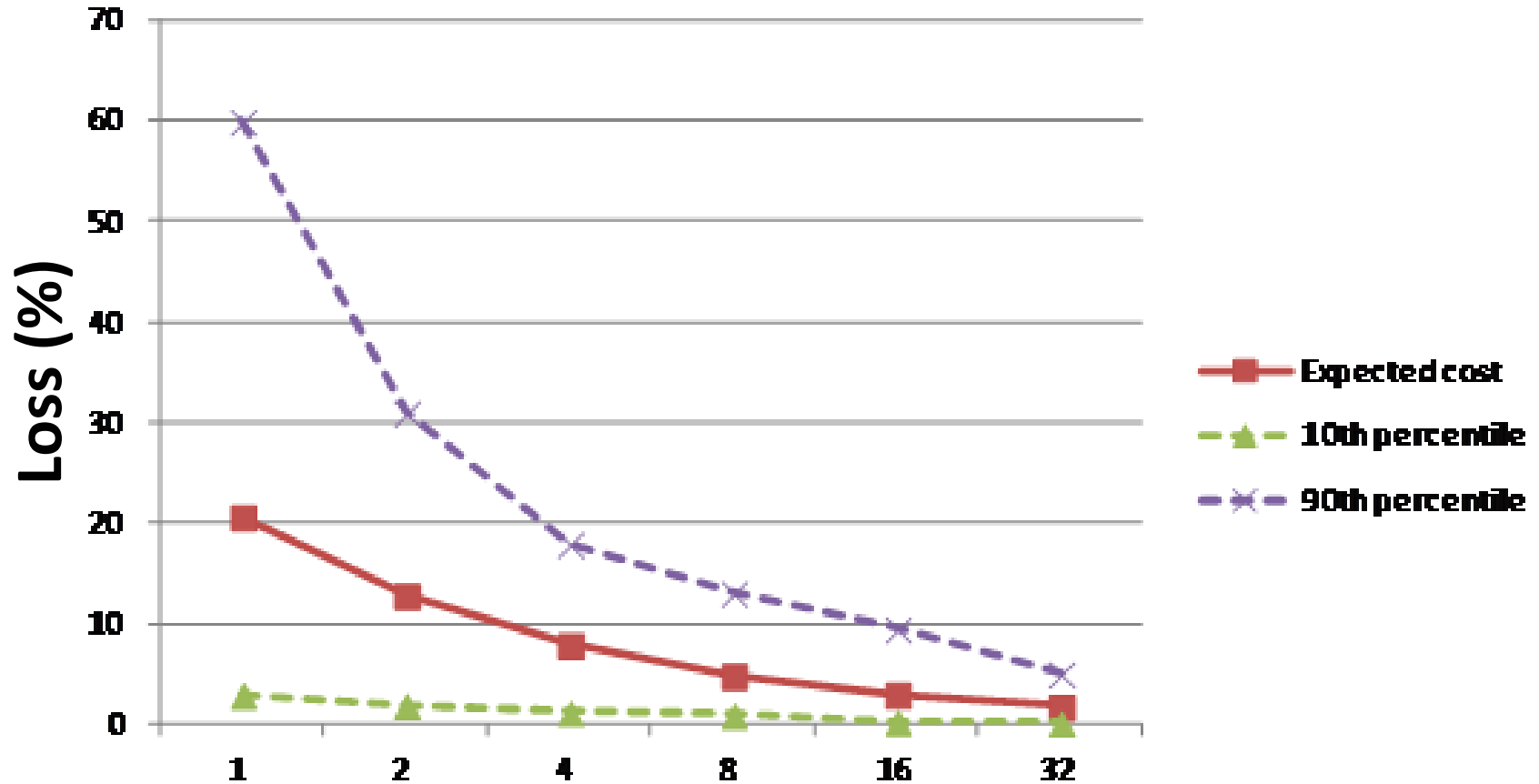
Many species (many baskets) better?

- More “pests” are a concern, but a high-impact pest affects only a part, not all the forest
- Dutch Elm Disease & Emerald Ash Borer; still a forest



Simulation model: Forest loss due to pest invasions

- (1) Invasion rate & impacts according to historic US insect invasions;
- (2) host specificity; (3) host dilution effect; (4) stochasticity; 50 years

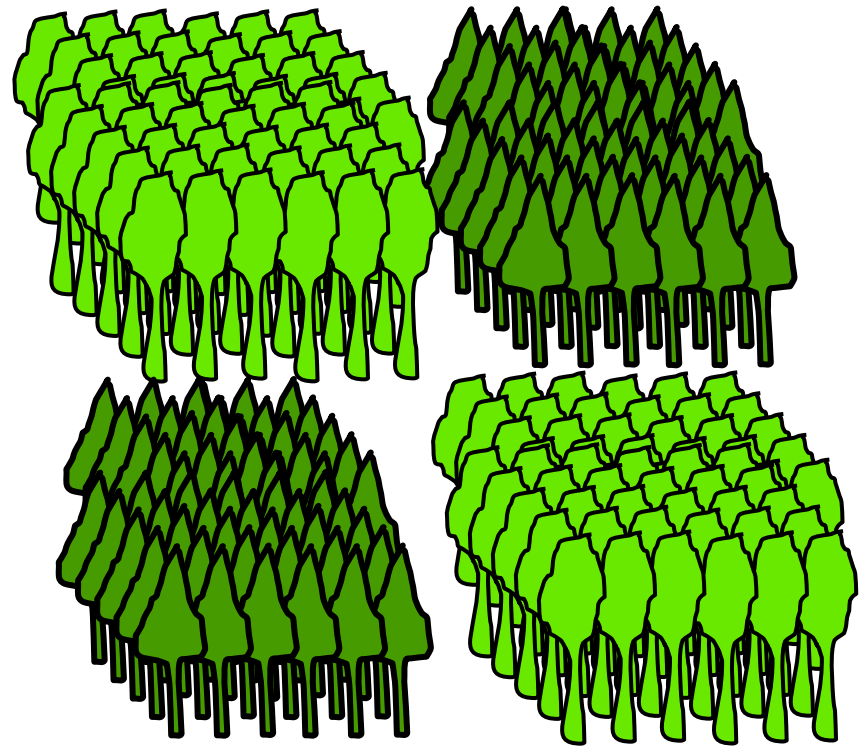
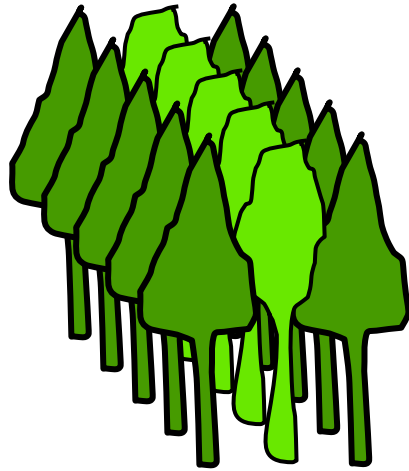
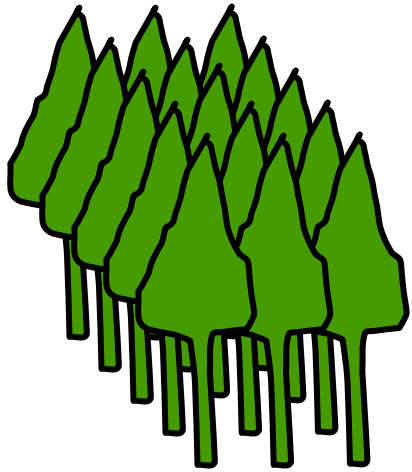


Number of tree species (1-32)

Brockerhoff and
Kimberley (unpubl.)

How can we diversify planted forests?

- Completely mixed stands are possible, but difficult
- Alternating rows of different species
- Mosaic of stands of different species



Conclusions

- Invasion resistance highly desirable (globalisation, invasions).
- BD may confer resistance to invasion but evidence is unclear.
- Uncertainty about scale effects and ‘confounding’ variables,
- ... and limited evidence for forests and herbivores generally.
- Complex, multi-factorial processes, multiple scales.
- Topic needs more research!
- Diversification of production systems needs consideration.
- Currently a small side project ... deserves more attention -
Link with BioHeritage NSC, ‘Interdependencies’?

Thank you!

Acknowledgements

- MBIE Core Funding to Scion.
- MBIE project 'Building biodiversity into an ecosystem service based approach for resource management (BEST).



Landcare Research
Manaaki Whenua

