BEST

Building biodiversity into an ecosystem service-based approach for resource management

Research partnership with

THE UNIVERSITY OF AUCKLAND
NEW ZEALAND
Te Whare Wānanga o Tāmaki Makaurau

UC
UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Manaaki Whenua
Landcare Research

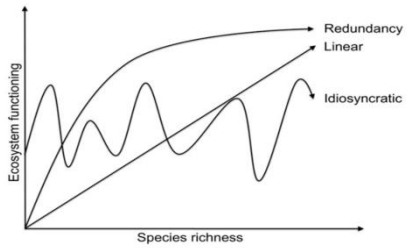
agresearch
āta mātai, mātai whetū

SCION
forests · products · innovation

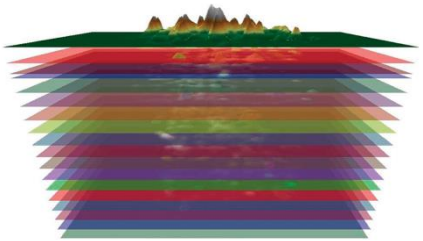
New Zealand's Natural Capital

Māori & governance

Building biodiversity – land cover – ecosystem service relationships



Modelling ecosystem services & human behaviour



Natural resource management decisions

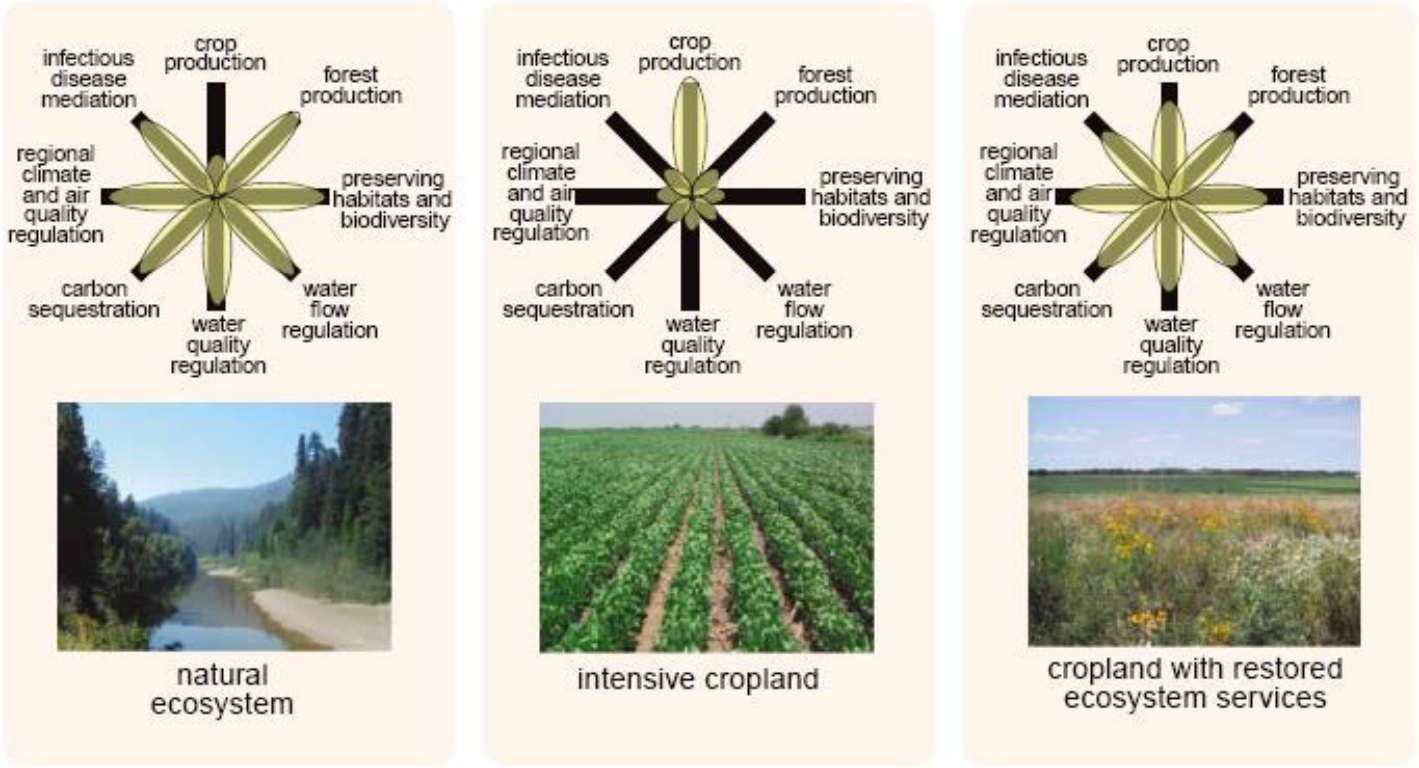
Land managers routinely assess biodiversity and ecosystem services & systematically factor these into natural resource management planning

Focal questions

- How does service provisioning correlate across land covers (bundles, tradeoffs)?

Focal questions

- How does service provisioning correlate across land covers (bundles, tradeoffs)?



Foley et al. (2005) *Science*

Focal questions

- How does service provisioning correlate across land covers (bundles, tradeoffs)?
- Do broad land cover categories like native vs. production determine service provisioning?

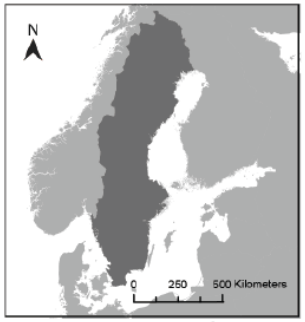
Focal questions

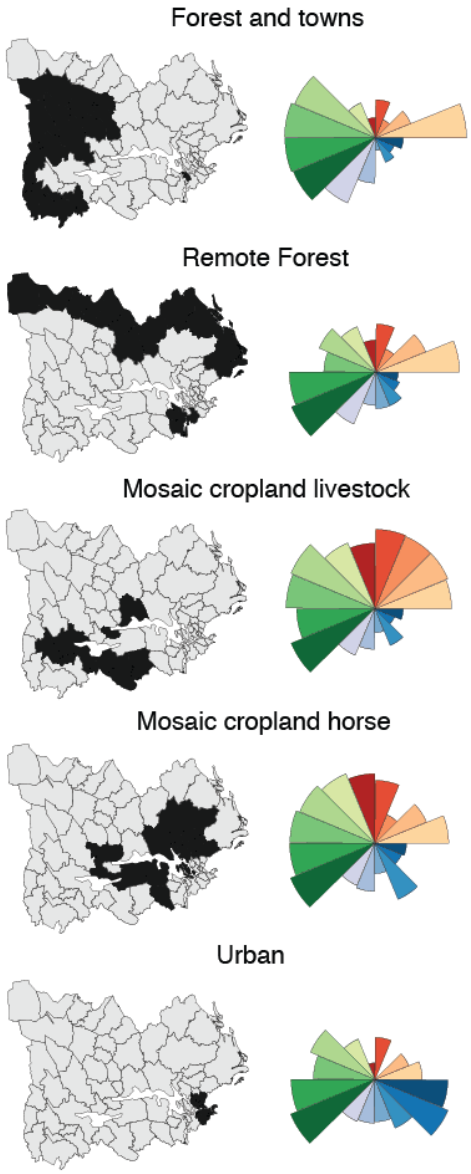
- How does service provisioning correlate across land covers (bundles, tradeoffs)?
- Do broad land cover categories like native vs. production determine service provisioning?
- Are ES with local benefits traded off against global ones (implications for who pays)?

Focal questions

- How does service provisioning correlate across land covers (bundles, tradeoffs)?
- Do broad land cover categories like native vs. production determine service provisioning?
- Are ES with local benefits traded off against global ones (implications for who pays)?
- How do you maximise flows of all services and their resilience at large (e.g. catchment) scales?

Mapping & assessing ES





Meacham et al. 2016

Measuring biodiversity and services is difficult

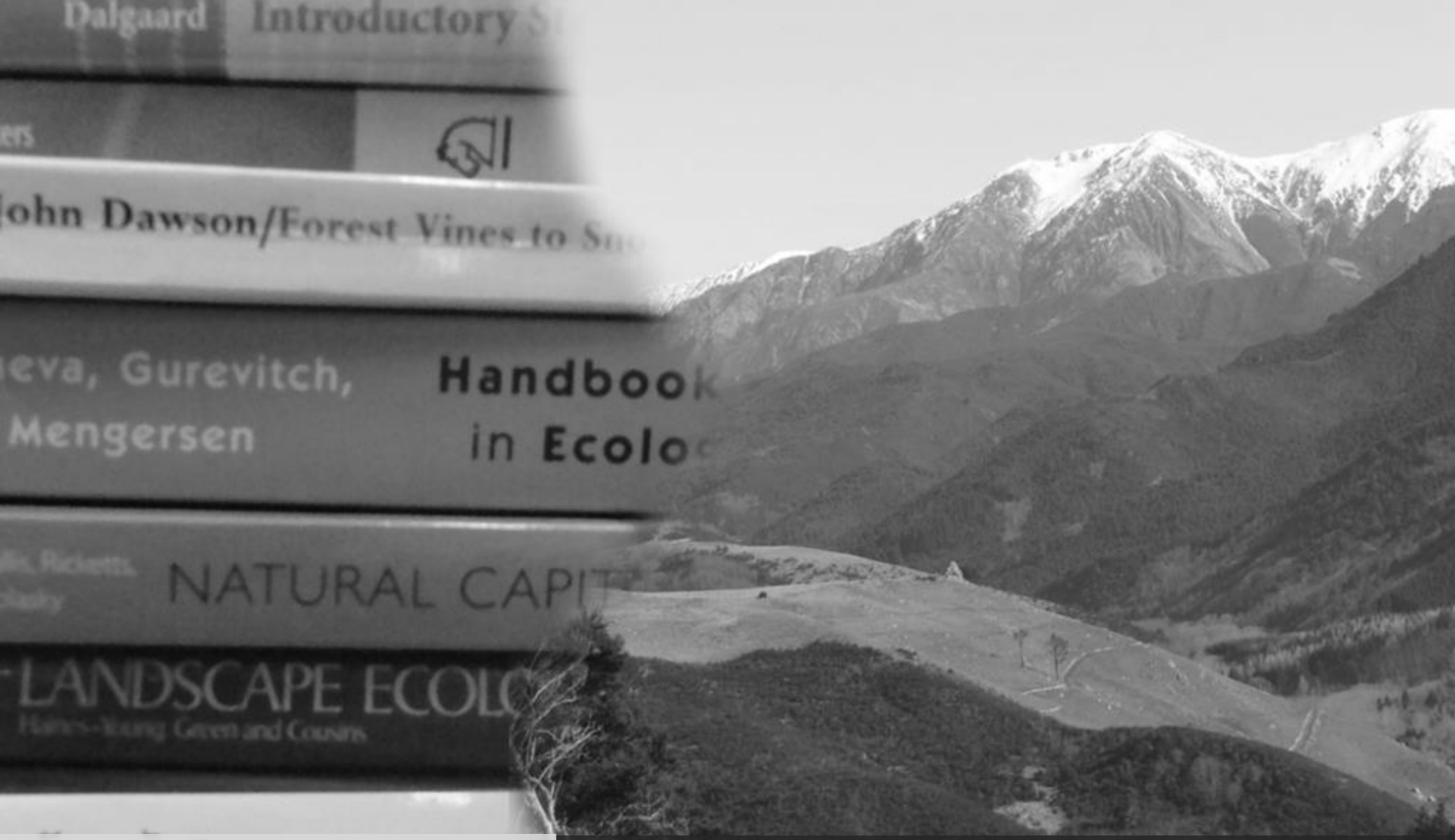
- Cost of measuring BD and ES (need fine information across large scales)

Measuring biodiversity and services is difficult

- Cost of measuring BD and ES (need fine information across large scales)
- Which measure of ES to use (more measures= more cost)?
- Which measure of BD to use?

Measuring biodiversity and services is difficult

- Cost of measuring BD and ES (need fine information across large scales)
- Which measure of ES to use (more measures= more cost)?
- Which measure of BD to use?
- Does biodiversity tell us anything about services that land cover doesn't?



A meta-analysis on:

Land use effects on ecosystem service provision

New Zealand (1970 – 2015)

Data collection

Database search

9,741 References

Abstract screening

Screening & assessment

250 Studies

Full-text assessment

Data extraction

28,577 Data points

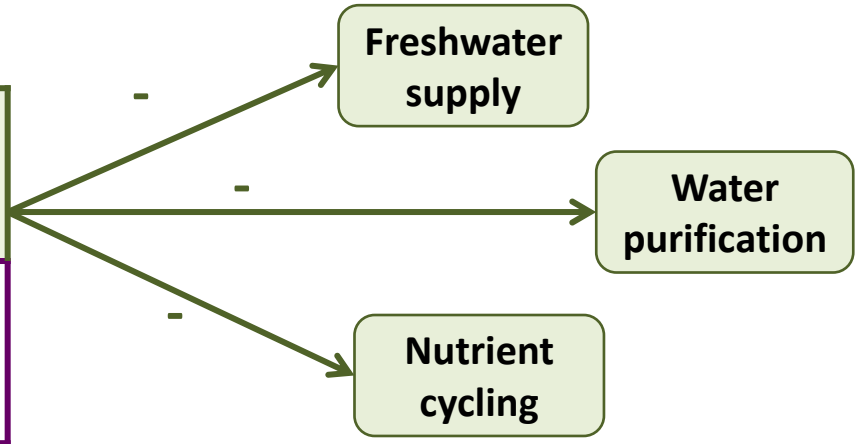
What is a data point?

		Biodiversity indicator	Ecosystem service indicator
Study 1	Land Cover A		7
	Land Cover B		3
Study 2	Land Cover A	17.9	9
	Land Cover C	3.35	5
	Land Cover D	0.51	1

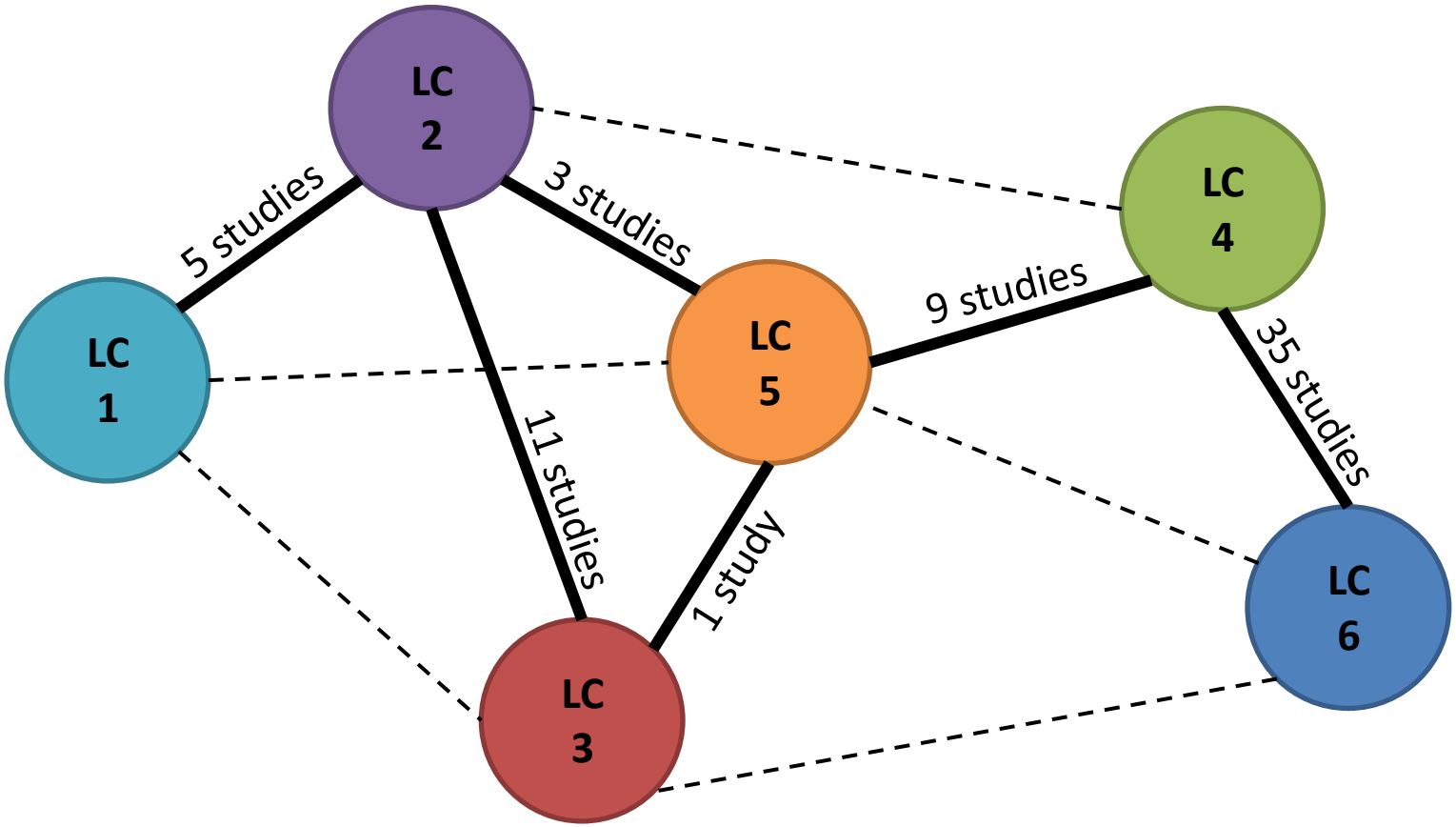
Per study: at least **one** indicator of service provision and **two** land covers

Data aggregation

		Biodiversity indicator	Nitrate leached from soil
Study 1	Exotic forest		7
	Manuka and / or Kanuka		3
Study 2	Exotic forest	17.9	9
	Low prod. grassland	3.35	5
	Tall tussock grassland	0.51	1

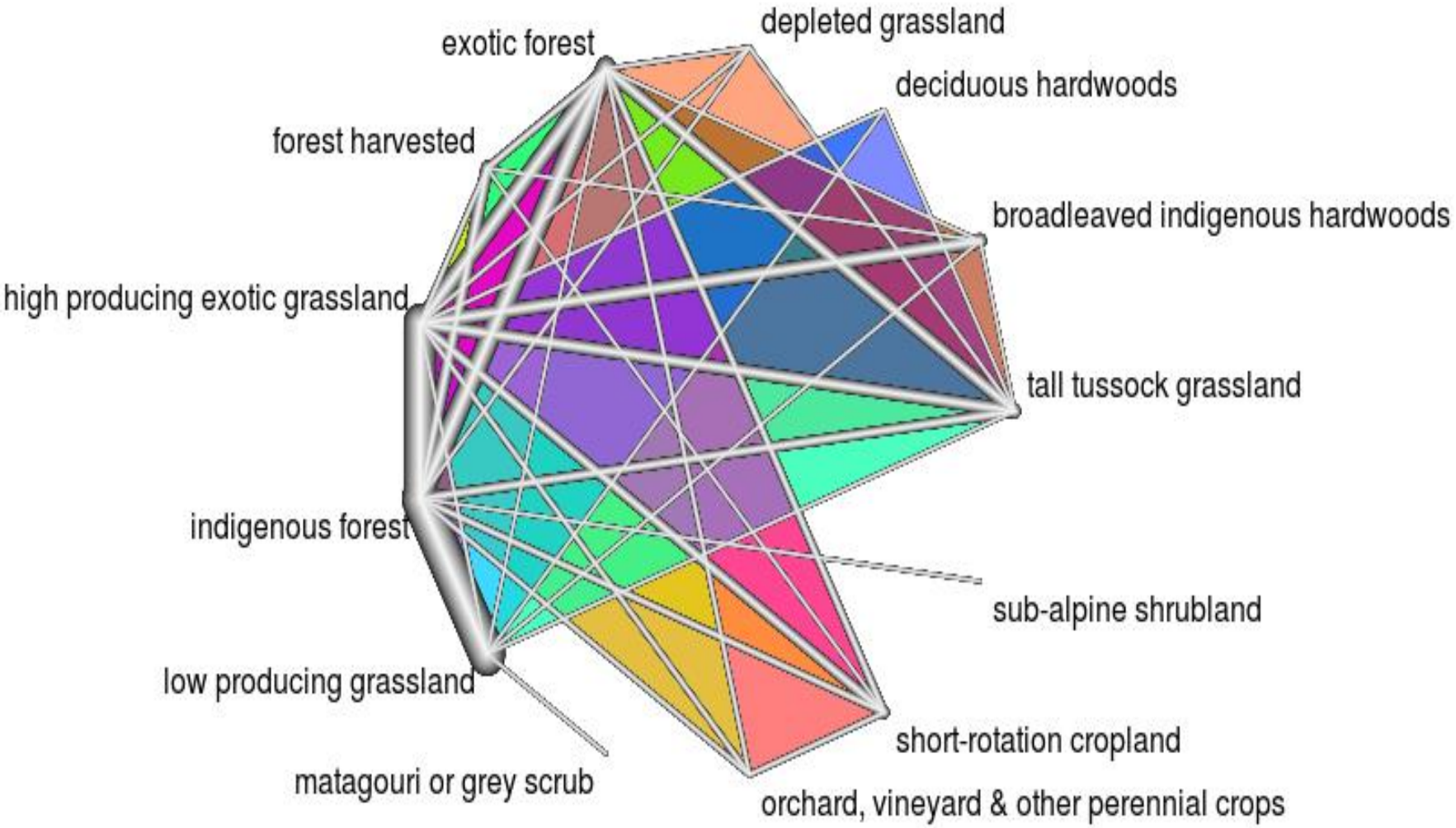


Network meta - analysis



For each of 17 services

Evidence network for habitat provision



Some caveats before we begin

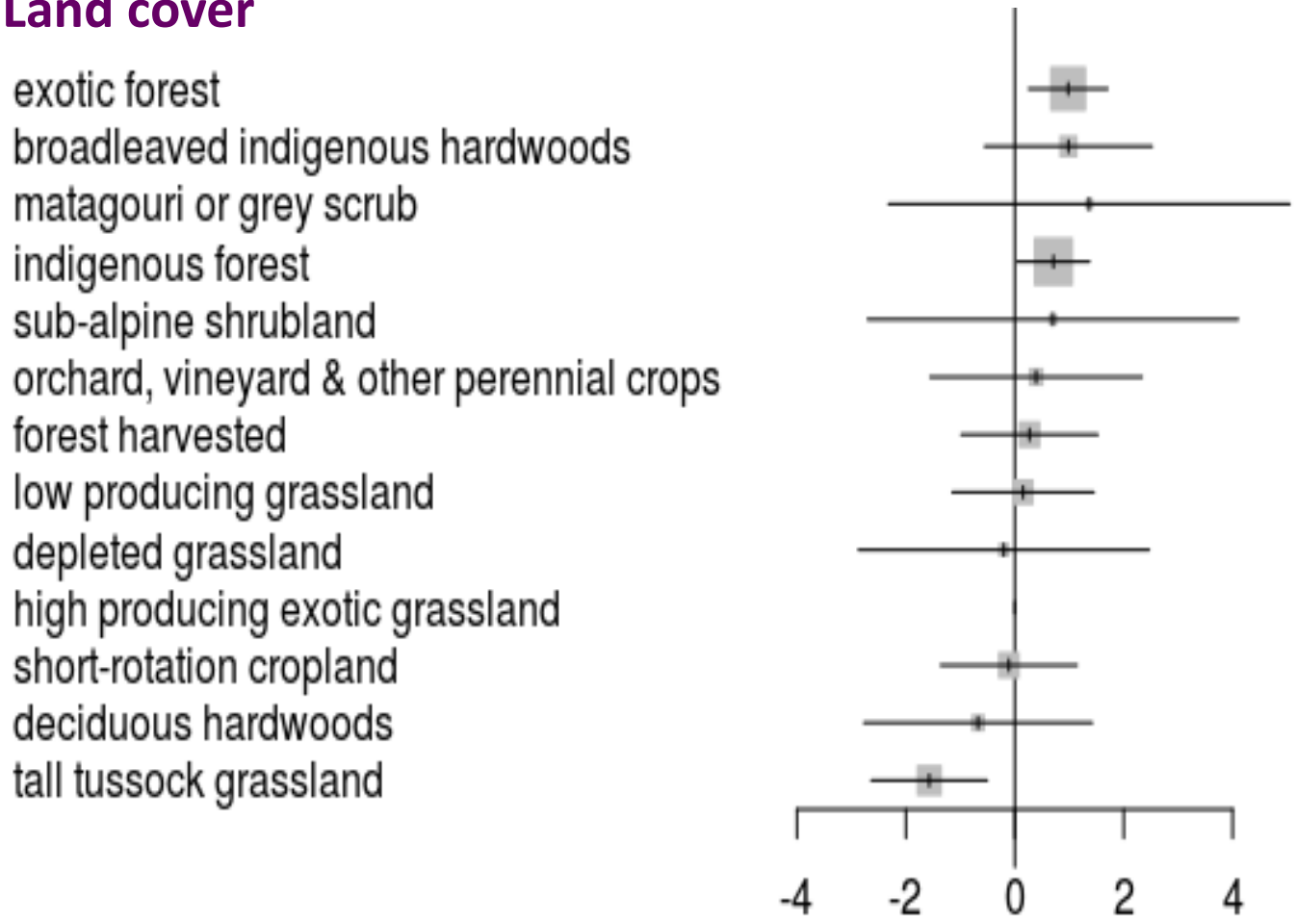
- Excluded “single - land cover” provisioning services (e.g. meat, dairy, wool, crops)

- For individual ES – Land cover comparisons:

  - Competing evidence from different indicators
  - Comparisons may not hold for land cover changes
  - Differing strength of direct & indirect evidence

Habitat provision across land covers

Land cover



Habitat provision across land covers

Land cover

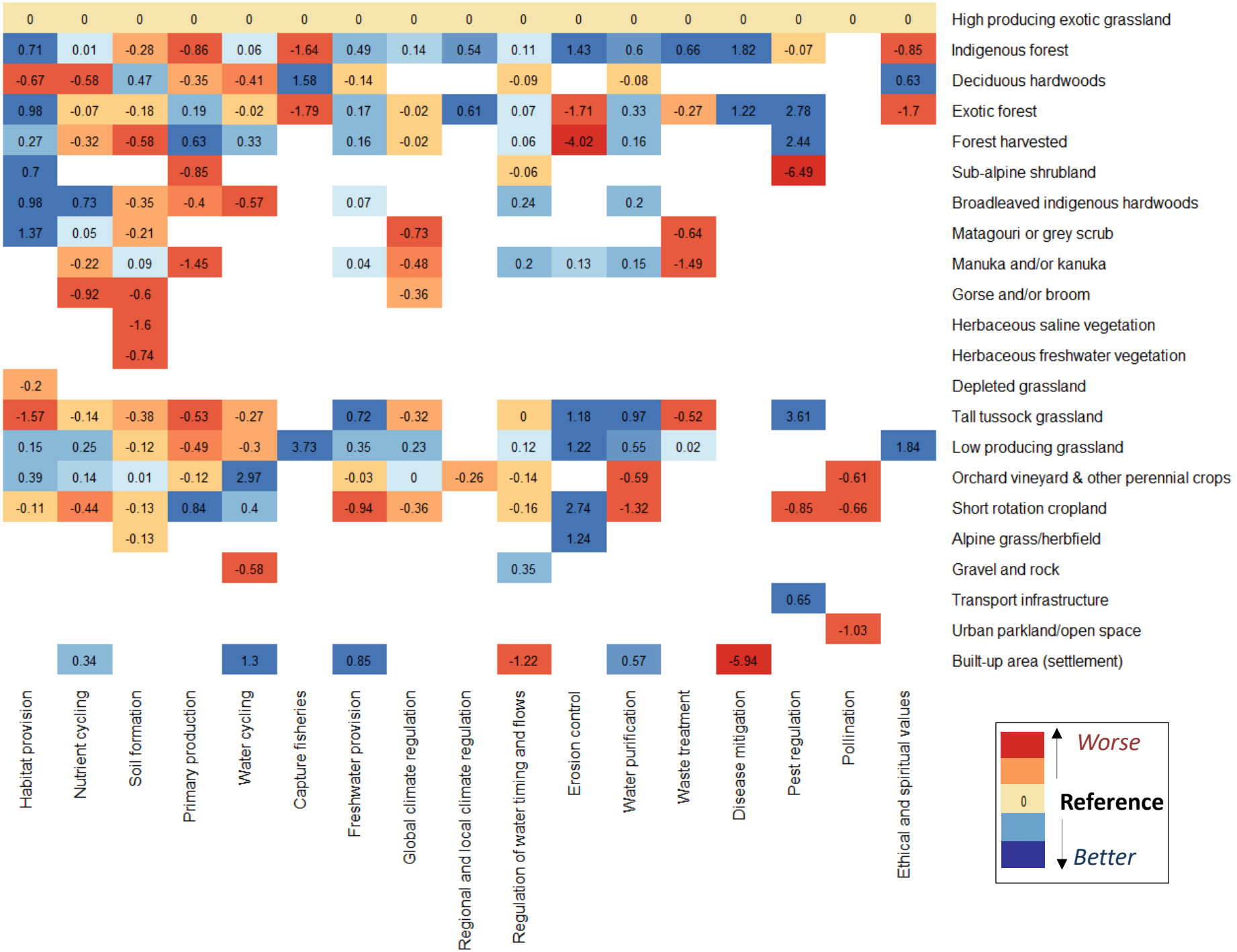
exotic forest
broadleaved indigenous hardwoods
matagouri or grey scrub
indigenous forest
sub-alpine shrubland
orchard, vineyard & other perennial crops
forest harvested
low producing grassland
depleted grassland
high producing exotic grassland
short-rotation cropland
deciduous hardwoods
tall tussock grassland

Reference land cover

worse than reference

better than reference

Looking across ES

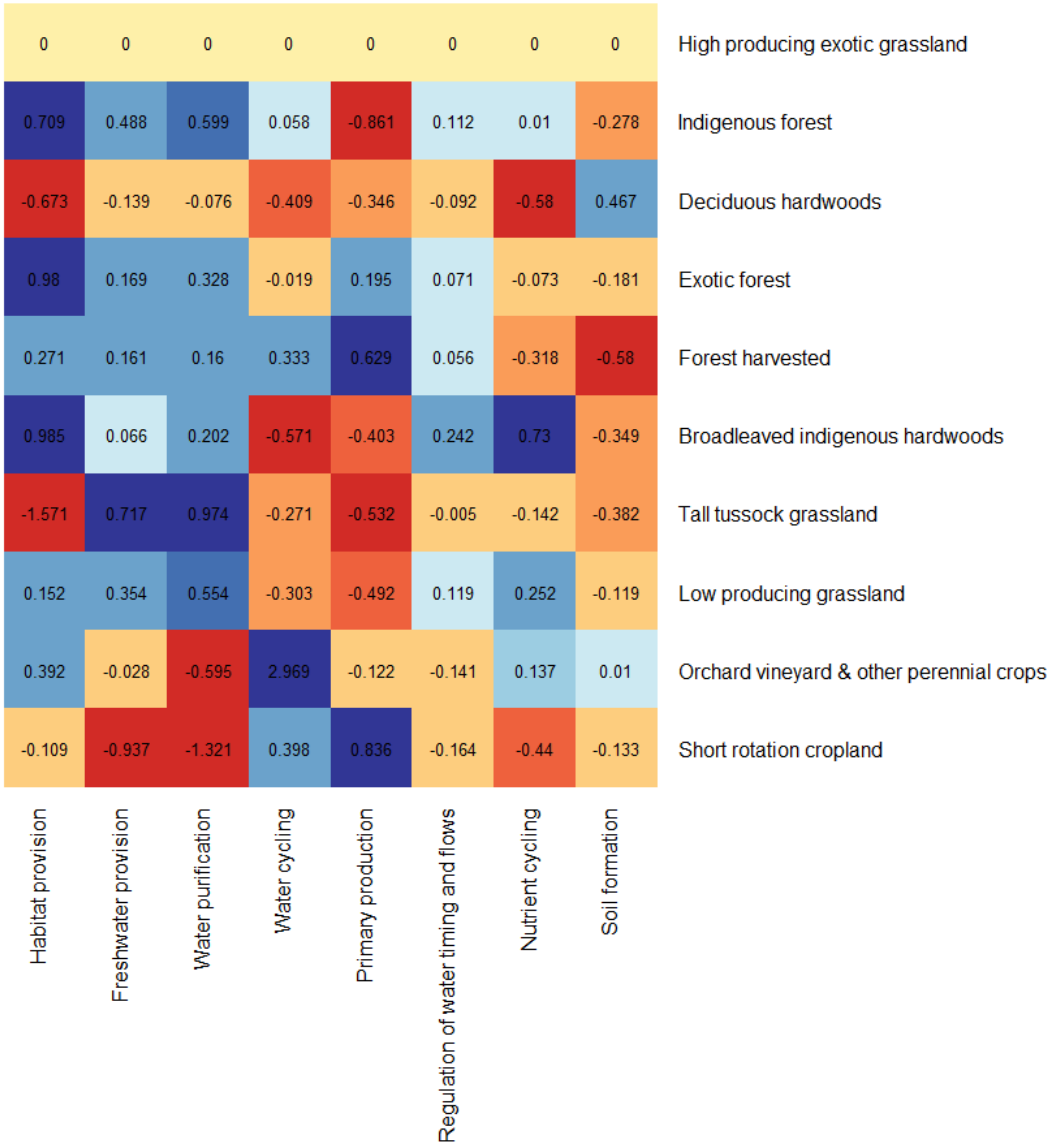

High producing exotic grassland
Indigenous forest
Deciduous hardwoods
Exotic forest
Forest harvested
Sub-alpine shrubland
Broadleaved indigenous hardwoods
Matagouri or grey scrub
Manuka and/or kanuka
Gorse and/or broom
Herbaceous saline vegetation
Herbaceous freshwater vegetation
Depleted grassland
Tall tussock grassland
Low producing grassland
Orchard vineyard & other perennial crops
Short rotation cropland
Alpine grass/herbfield
Gravel and rock
Transport infrastructure
Urban parkland/open space
Built-up area (settlement)
Habitat provision
Nutrient cycling
Soil formation
Primary production
Water cycling
Capture fisheries
Freshwater provision
Global climate regulation
Regional and local climate regulation
Regulation of water timing and flows
Erosion control
Water purification
Waste treatment
Disease mitigation
Pest regulation
Pollination
Ethical and spiritual values
Worse
Reference
Better

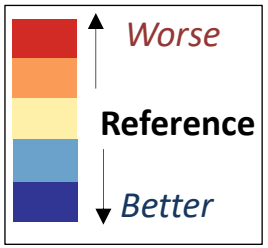
First take-home messages

- No “silver bullet” land cover to provide all ecosystem services
- Trade-offs are always present
- Provisioning of multiple services requires a mosaic of land uses in the landscape

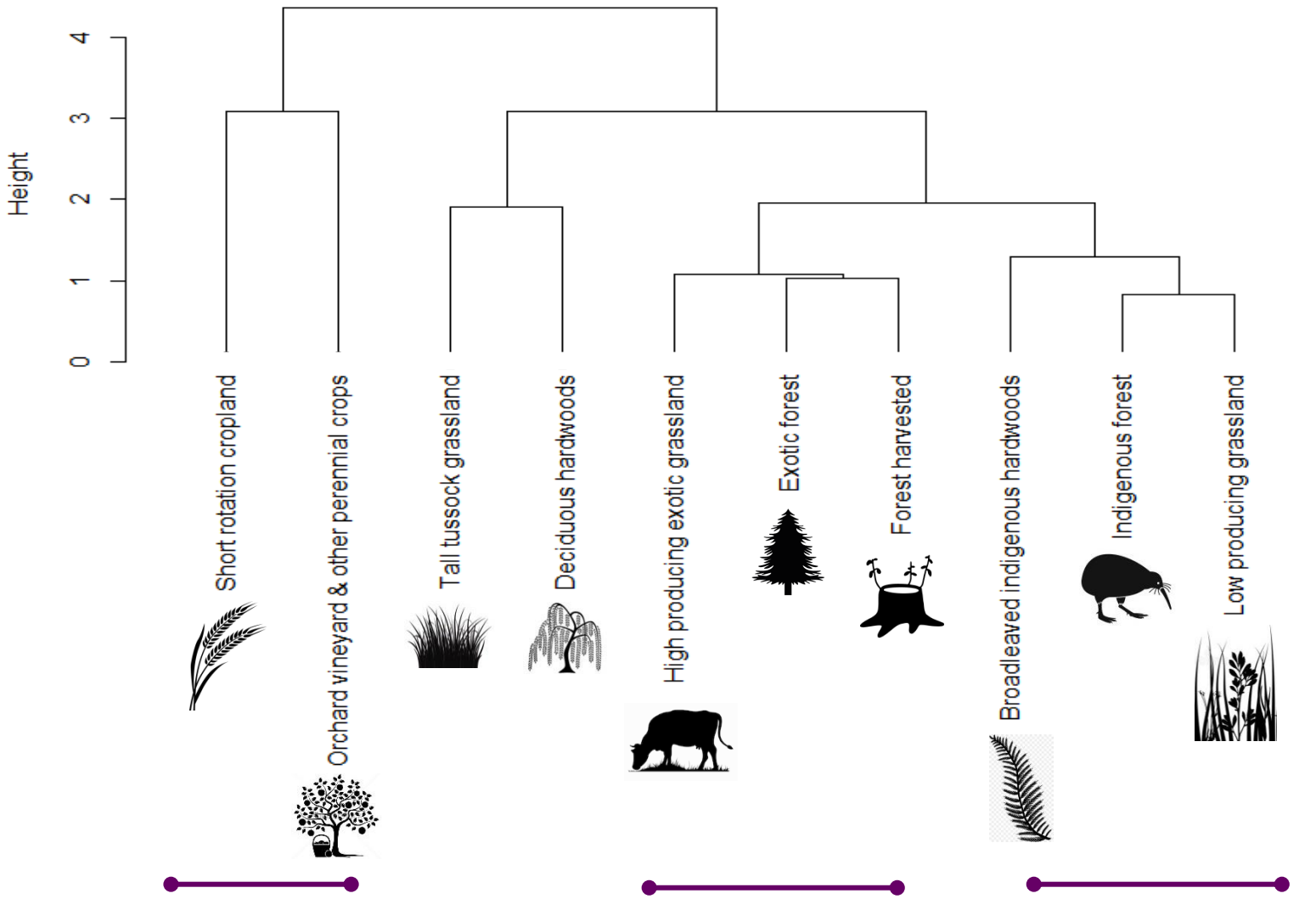


Data subset to explore tradeoffs





Land covers in ecosystem service space

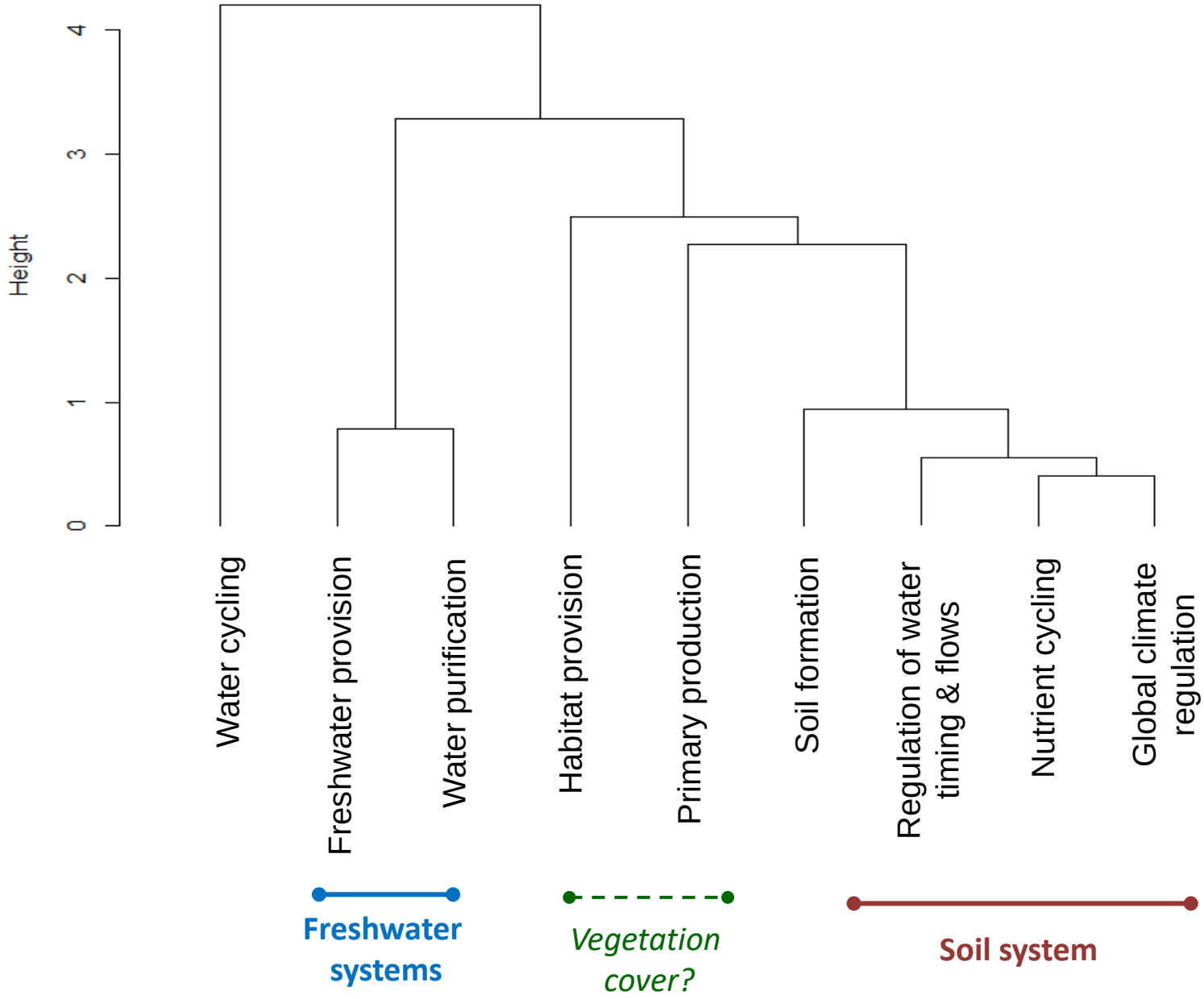


Intensive production
Exotic vegetation cover

Production
Exotic veg. cover

Extensive production
Native veg. cover

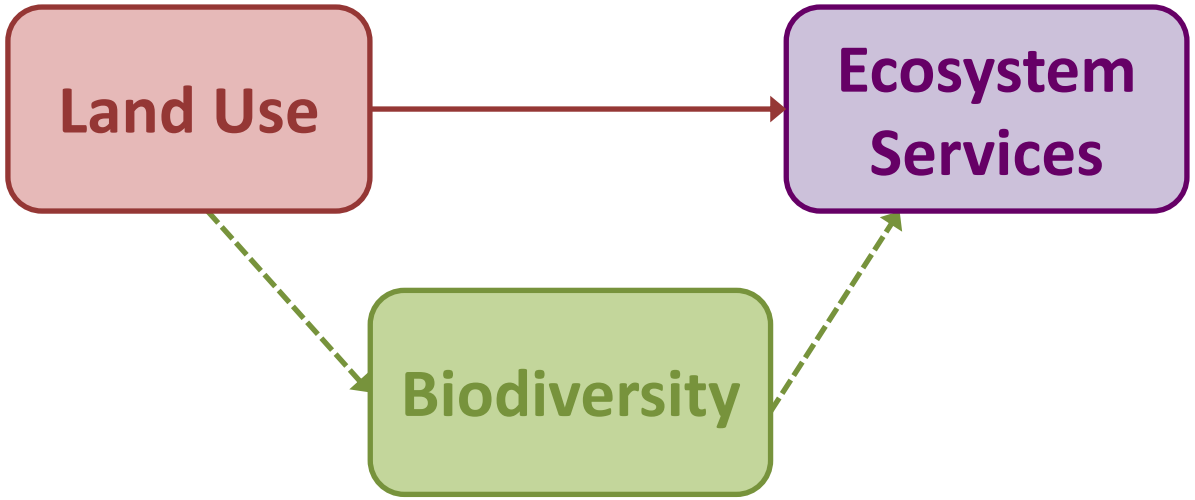
Ecosystem services in land cover space



Second take-home messages

- Land covers will provide similar services depending on:
  - Production intensity ✓
  - Presence of native vegetation cover ✓
  - Forest cover ✗
- Services with different scale of benefits are not traded-off across land covers

Does biodiversity tell us anything that land cover doesn't?

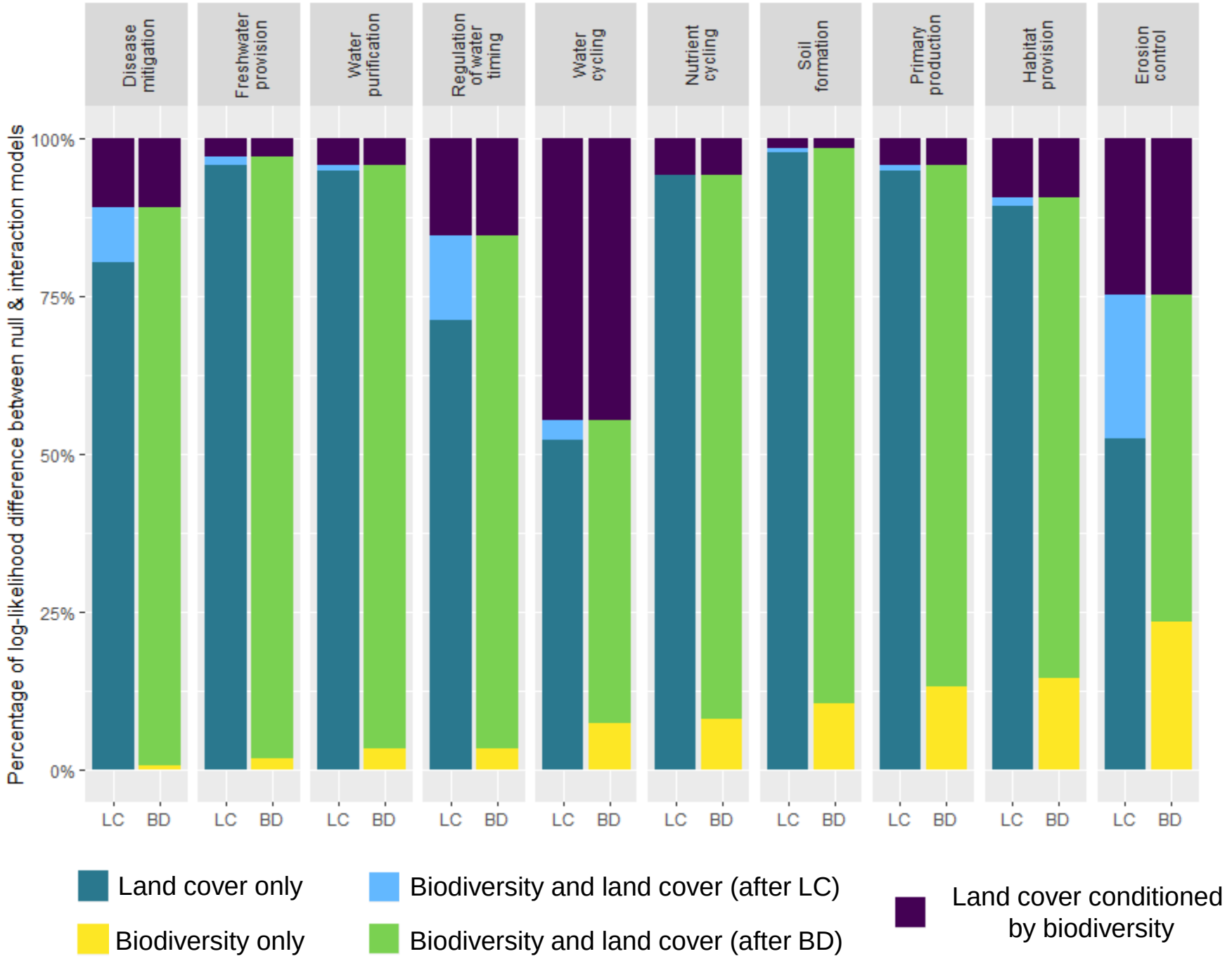


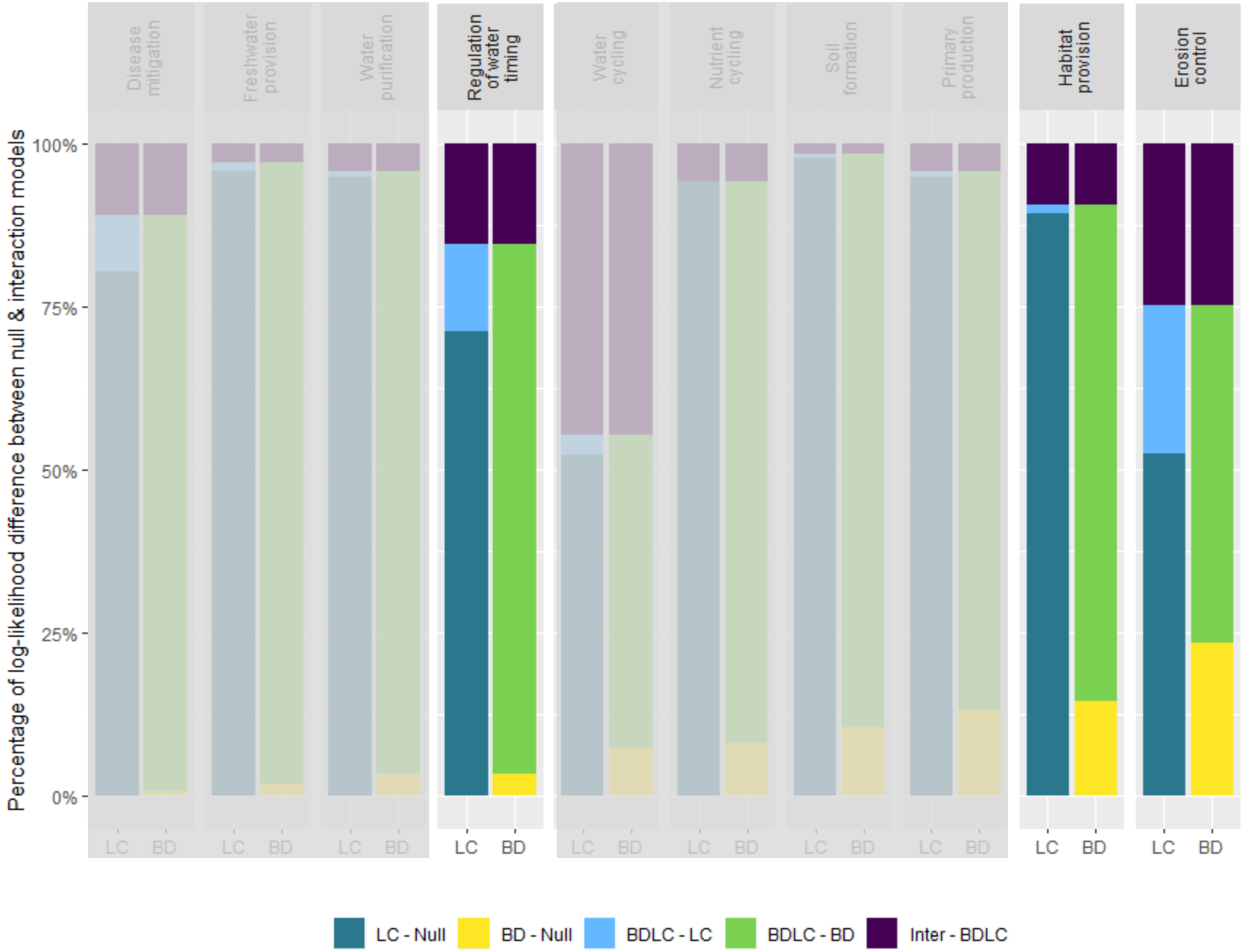
Biodiversity data subset

- 11 studies with matched biodiversity and ecosystem service data
  - 10 ecosystem services
  - 6 land covers
  - 86 sites
- Species richness as biodiversity indicator






Disease mitigation
Freshwater provision
Water purification
Regulation of water timing
Water cycling
Nutrient cycling
Soil formation
Primary production
Habitat provision
Erosion control
Percentage of log-likelihood difference between null & interaction models
100%
75%
50%
25%
0%
LC
BD
Land cover only
Biodiversity only
Biodiversity and land cover (after LC)
Biodiversity and land cover (after BD)
Land cover conditioned by biodiversity


Disease mitigation
Freshwater provision
Water purification
Regulation of water timing
Water cycling
Nutrient cycling
Soil formation
Primary production
Habitat provision
Erosion control
Percentage of log-likelihood difference between null & interaction models
100%
75%
50%
25%
0%
LC
BD
LC - Null
BD - Null
BDLC - LC
BDLC - BD
Inter - BDLC


Disease mitigation
Freshwater provision
Water purification
Regulation of water timing
Water cycling
Nutrient cycling
Soil formation
Primary production
Habitat provision
Erosion control
Percentage of log-likelihood difference between null & interaction models
100%
75%
50%
25%
0%
LC
BD
Land cover only
Biodiversity and land cover (after LC)
Land cover conditioned by biodiversity
Biodiversity only
Biodiversity and land cover (after BD)

Third take-home messages

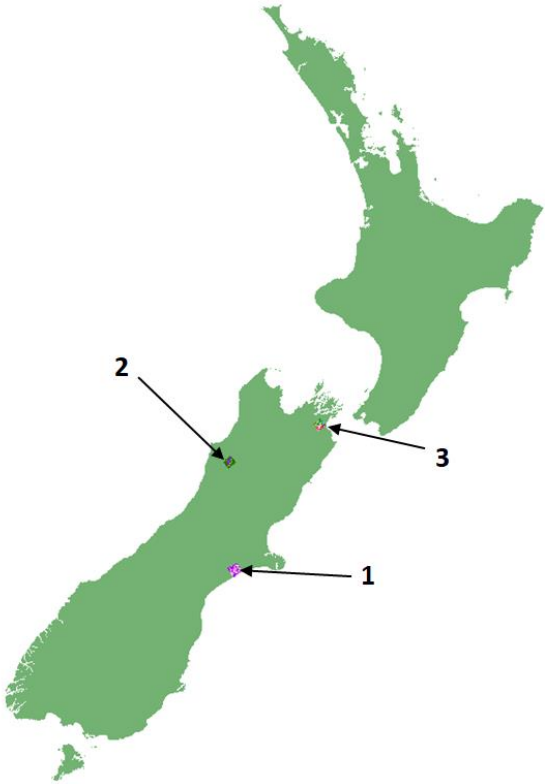
- Land cover often provides a **good surrogate** measure for the effect of biodiversity on ecosystem service provision

- **Exceptions** to this are:
  - Habitat provision
  - Regulation of water timing & flows
  - Erosion control

- Improving biodiversity could **alleviate** land-use impacts on:
  - Habitat provision
  - Water cycling
  - Nutrient cycling

Moving forward….

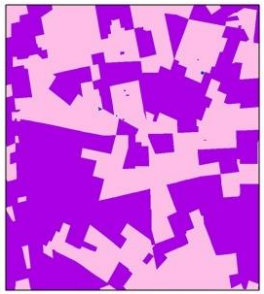
How can we maximize delivery and resilience of ecosystem services in actual landscapes?

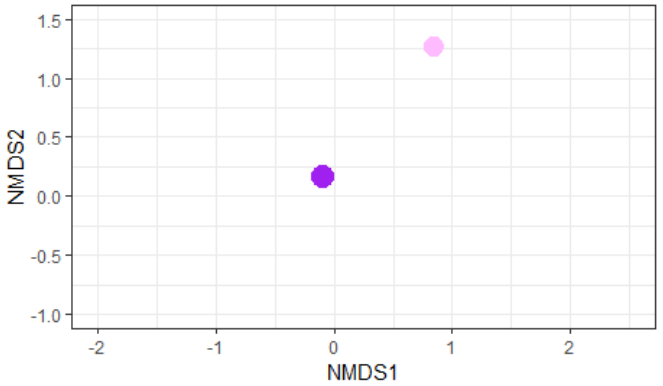


Land covers

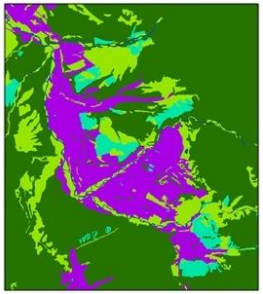
- Broadleaved indigenous hardwoods
- Deciduous hardwoods
- Exotic forest
- Forest harvested
- High producing exotic grassland
- Indigenous forest
- Low producing grassland
- Orchard, vineyard & other perennial crops
- Short - rotation cropland
- Tall tussock grassland

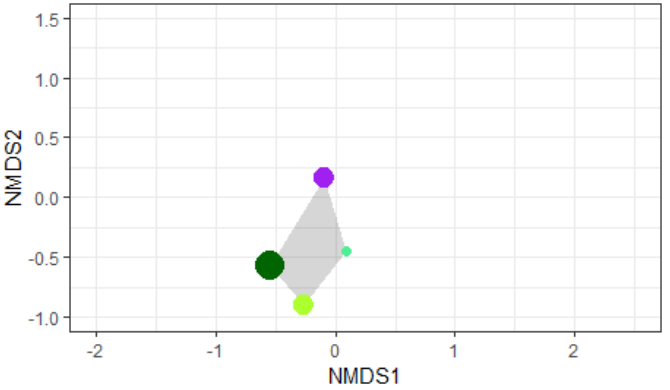
Case 1



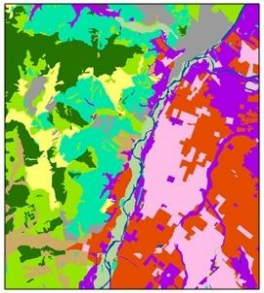


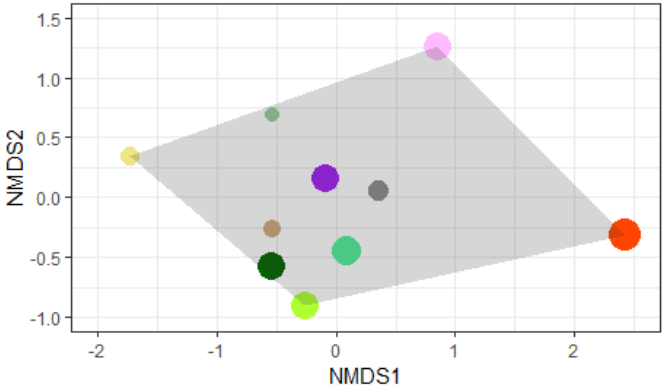
Case 2





Case 3





Point area is proportional to land cover extent in each case

Special thanks to:

MBIE - BEST project team

Shinichi Nakagawa
Malgorzata Lagaisz
Eckehard Brockerhoff

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

LANDCARE RESEARCH
MANAAKI WHENUA

Sol Heber
Jessica Furlong
Sophia K. Hunt
Melanie Hamzah
Matthew B. Scott

Karen Adair
Catherine Febria
Leo Condron
Angus McIntosh
Matthew Turnbull

INTER-DISCIPLINARY ECOLOGY AND EVOLUTION LAB

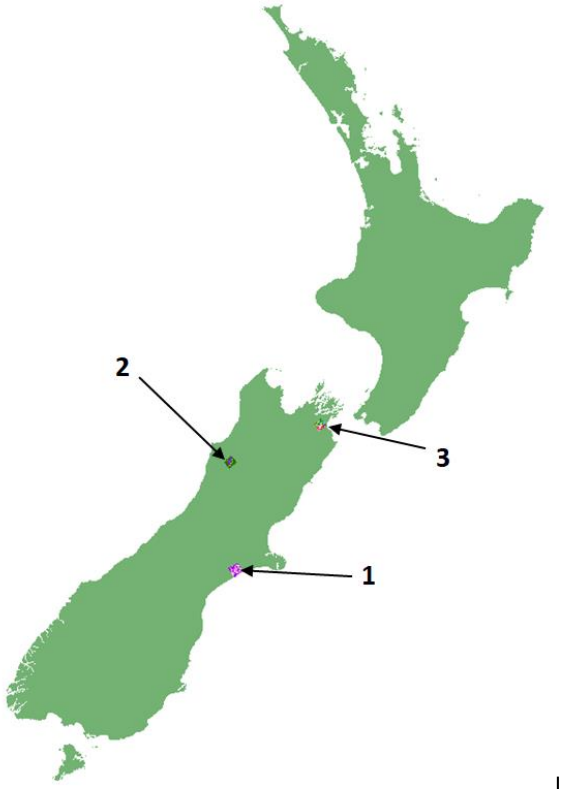
I-D E E L

the Stouffer Lab
complexity in ecology

TYLIANAKIS LAB GROUP

& many thanks to you…

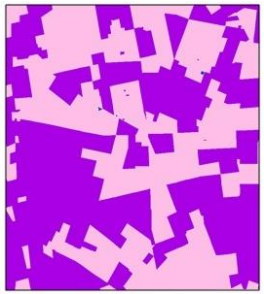
cgomezcre@gmail.com

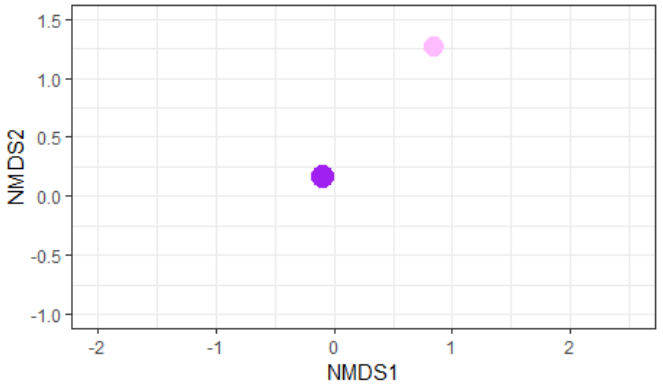


Land covers

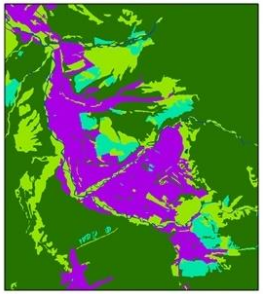
- Broadleaved indigenous hardwoods
- Deciduous hardwoods
- Exotic forest
- Forest harvested
- High producing exotic grassland
- Indigenous forest
- Low producing grassland
- Orchard, vineyard & other perennial crops
- Short - rotation cropland
- Tall tussock grassland

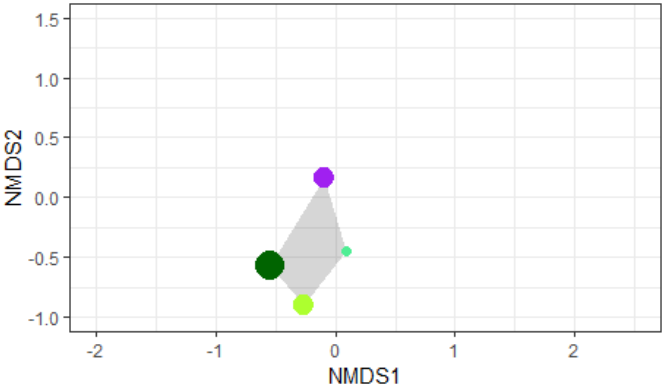
Case 1



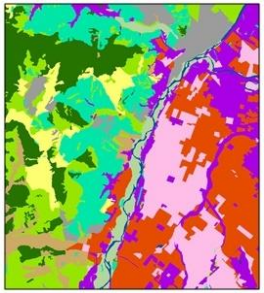


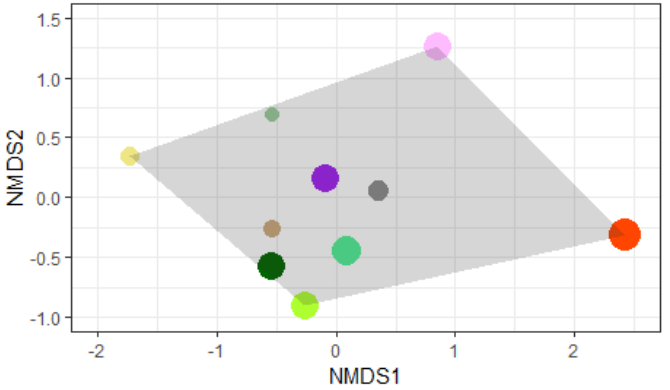
Case 2





Case 3





Point area is proportional to land cover extent in each case