Sustainable forest management – canopy biology

SustainNET Seminar 2021

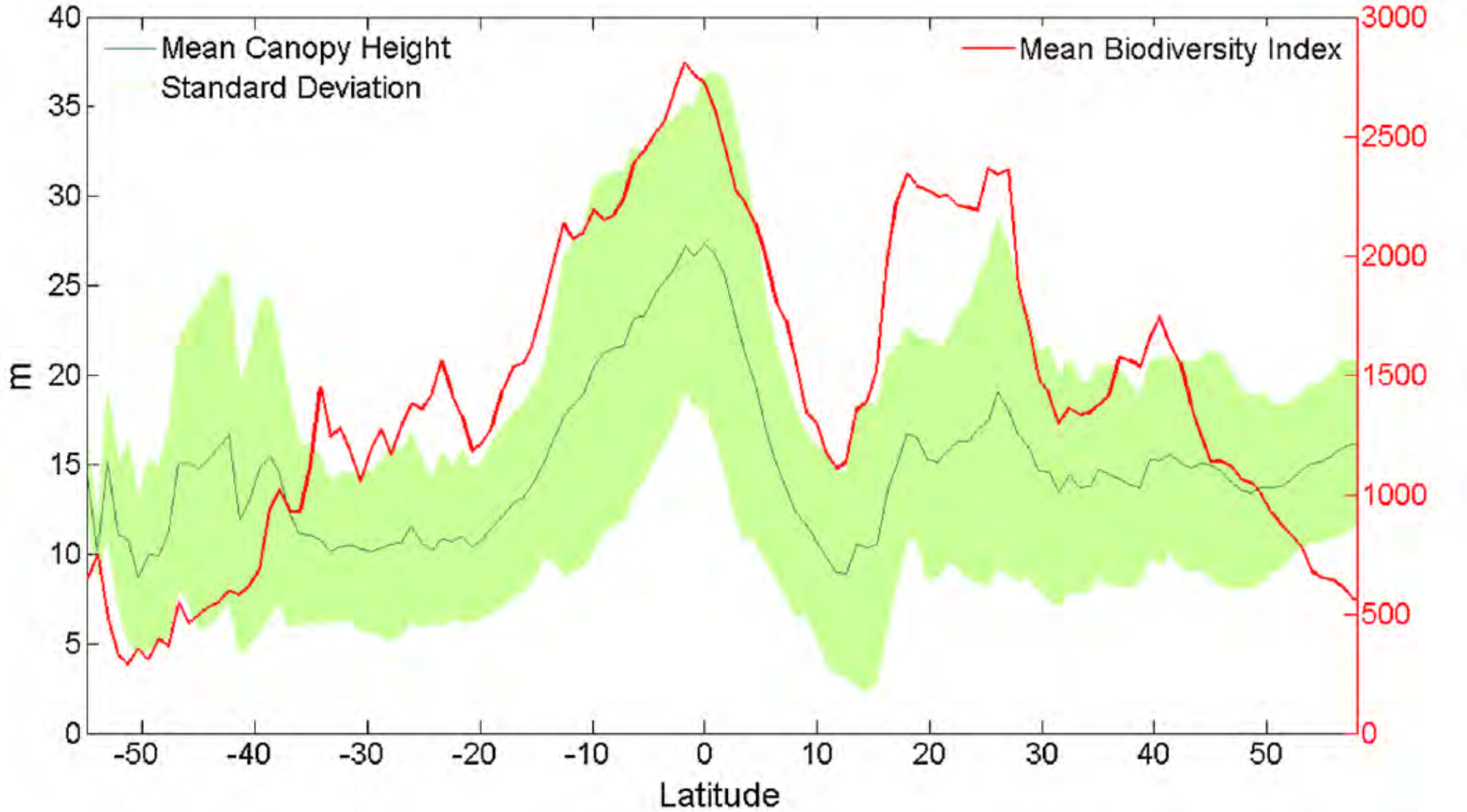
Anne Oxbrough & Sven Batke

“Overhead, at a height, perhaps, of a hundred feet, is an almost unbroken canopy of foliage formed by the meeting together of these great trees and their interlacing branches; and this canopy is usually so dense that but an indistinct glimmer of the sky is to be seen, and even the intense tropical sunlight only penetrates to the ground subdued and broken up into scattered fragments… it is a world in which man seems an intruder, and where he feels overwhelmed.”

Alfred R. Wallace (1878)

Why sample the canopy?

1) High species diversity
2) Highly physiologically active
3) Contribution to global cycles
4) Incredible complex ecology
5) Important to us!

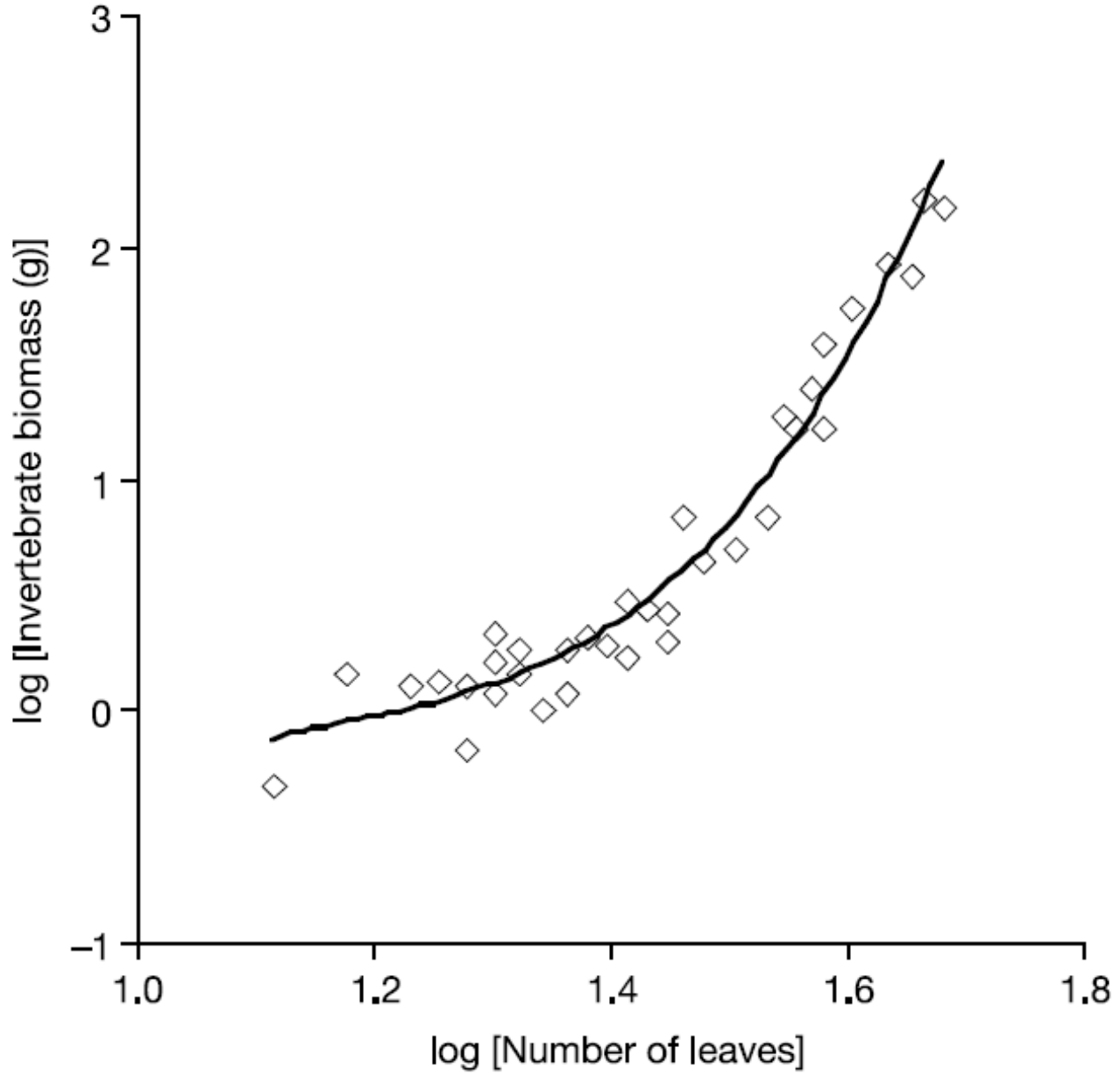


Gatti et al. (2017)

…increased volume and structural complexity.

Impact of plant life on other species…an example

Ellwood and Foster (2004 – Nature)



Overcoming access issues…

Edred John Henry Corner, 1906-1996

- A very controversial biologists
- He taught botany in King Edward College, Singapore
- Training macaque monkeys

Royal Society by David Mabberley (2000)

Overcoming access issues…

Overcoming access issues…

Radeau des Cimes designed by Hallé (1991)

Overcoming access issues…

- Currently there are 11(12) cranes active
- Running costs = 1-5 million USD

Pioneered by Alan Smith (1990) in Panama!

Overcoming access issues…

Overcoming access issues…

Overcoming access issues…

‘Reaching the rainforest roof’ by Mitchell (1982)

Access is not always necessary…

Mechanically dependent plants (Kelly 1985)

Life-form divisions:

a) holo- and hemi-epiphytes
b) Stranglers
c) nomadic vines
d) Climbers
e) hemi-parasites

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Anthurium schlechtendalii

Monstera deliciosa

Philodendron bipinnatifidum
Brazil, plant 30 meters up in the canopy

Mechanically dependent plants (Kelly 1985)

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Viscum album (Santalaceae)

Santalum (Santalaceae)

Struthanthus (Loranthaceae)

EpIG (https://epigdatabase.weebly.com/)

- First epiphyte workshop in Marburg 2018
- 27 participants
- 11 countries
- Highly detailed survey data
- Focus on the Neotropics

Acuña-Tarazona Margoth	Instituto de Ecología A.C.	Mexico
Batke Sven	Edge Hill University	UK
Benavides Ana Maria	Fundación Jardín Botánico de Medellín	Colombia
Boelter Carlos	Instituto Nacional de Pesquisas da Amazônia	Brazil
de la Rosa Manzano Edilia	Autonomous University of Tamaulipas	Mexico
Einzmann Helena	University of Oldenburg	Germany
Guzman Valeria	Goettingen University	Germany
Hietz Peter	University of natural resources and life sciences Vienna	Austria
Irume Mariana Victória	Instituto Nacional de Pesquisas da Amazônia	Brazil
Jímenez-Alfaro Borja	University of Oviedo	Spain
Kessler Michael	University of Zurich	Switzerland
Kreft Holger	Goettingen University	Germany
Kromer Thorsten	Universidad Veracruzana	Mexico
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López Jiménez Derio Antonio	Centro del Cambio Global y la sustentabilidad (CCGS)	Mexico
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Soto Medina Edier Alberto	Universidad del Valle	Colombia
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Wolf Jan	Univesity of Amsterdam	Netherlands
Zartman Charles E.	Instituto Nacional de Pesquisas da Amazônia	Brazil
Zotz Gerhard	University of Oldenburg	Germany
Zuleta Daniel	Universidad Nacional de Colombia	Colombia

EpIG – Epiphyte Inventory Group

- >32,000 species in checklist
- >40,000 sampled trees
- Abundance/cover/biomass data available
- Host tree information available

Individual database

Data arrangement and validation

Quality check

Species check

Database merge

Epiphyte distributions (vascular species only!)

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REPORT

Journal of Vegetation Science
IAVS

EpIG-DB: A database of vascular epiphyte assemblages in the Neotropics

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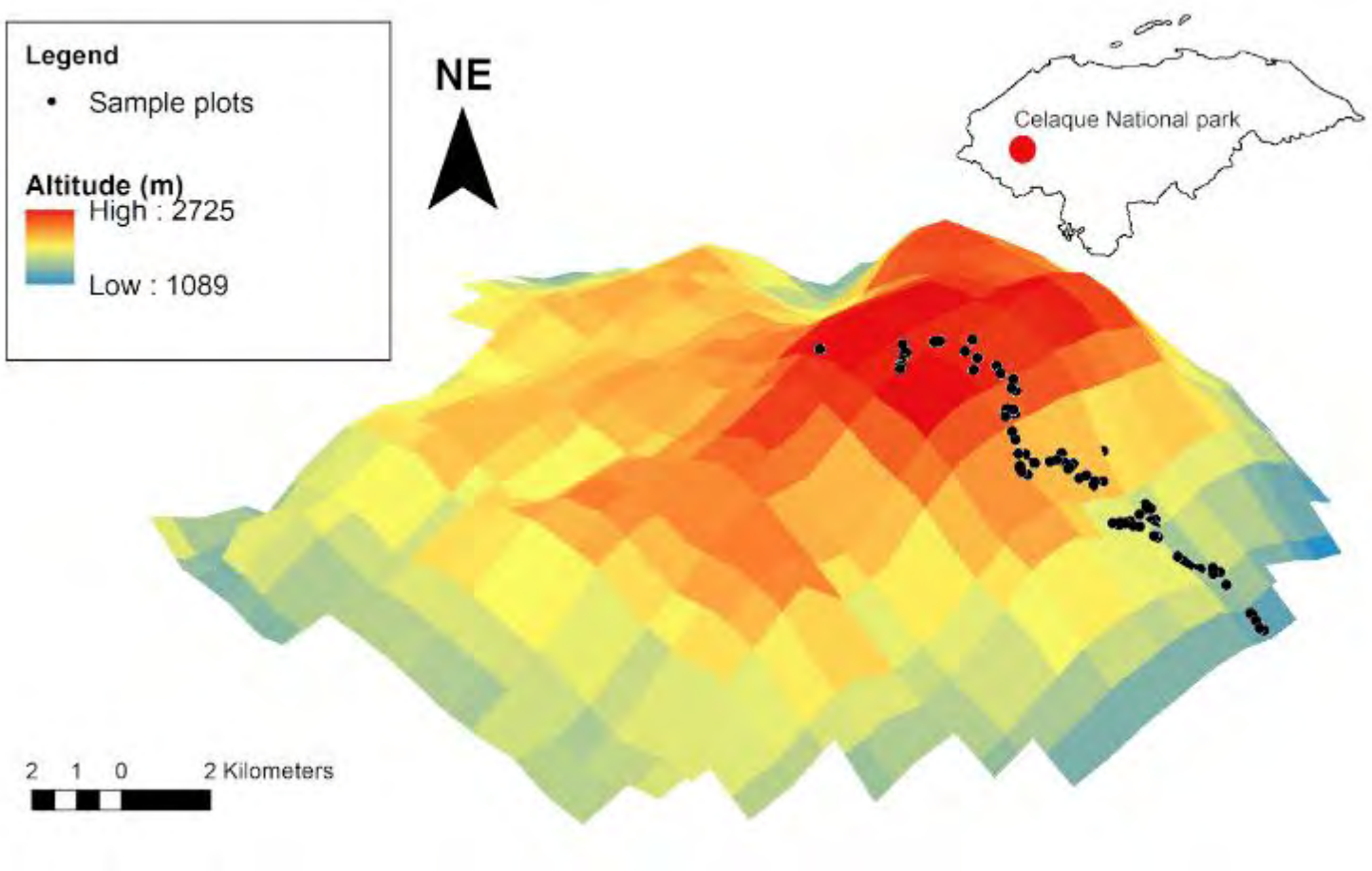
Nowhere to escape – Diversity and community composition of ferns and lycophytes along the highest mountain in Honduras

Johan Reyes-Chávez[1,2], Megan Quail[2], Stephanie Tarvin[2] and Sven P. Batke[1,2*]

Hot of the press!
J. Trop. Ecol.



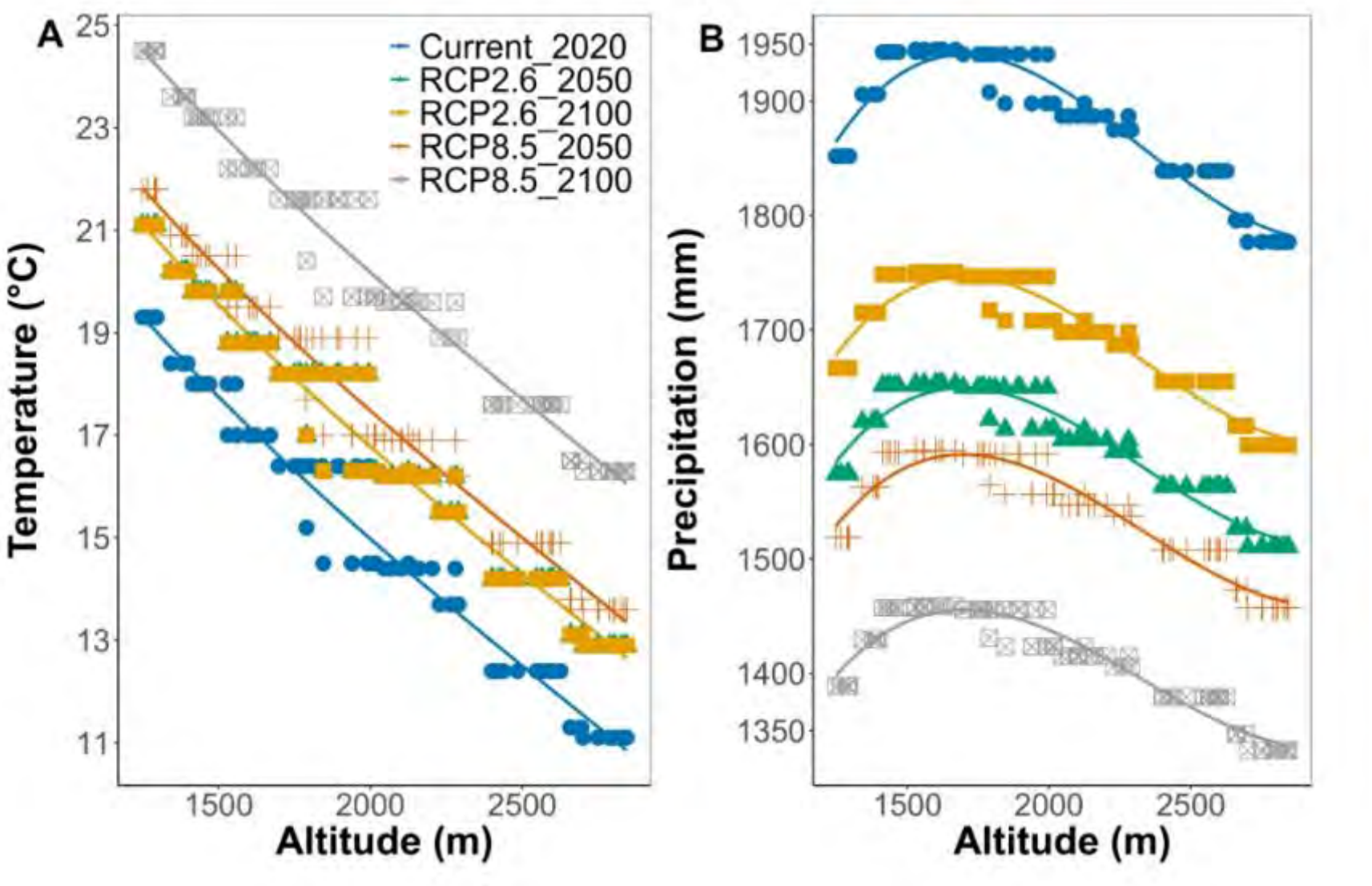
Climate Change projections

1.5˚C increase scenario

=

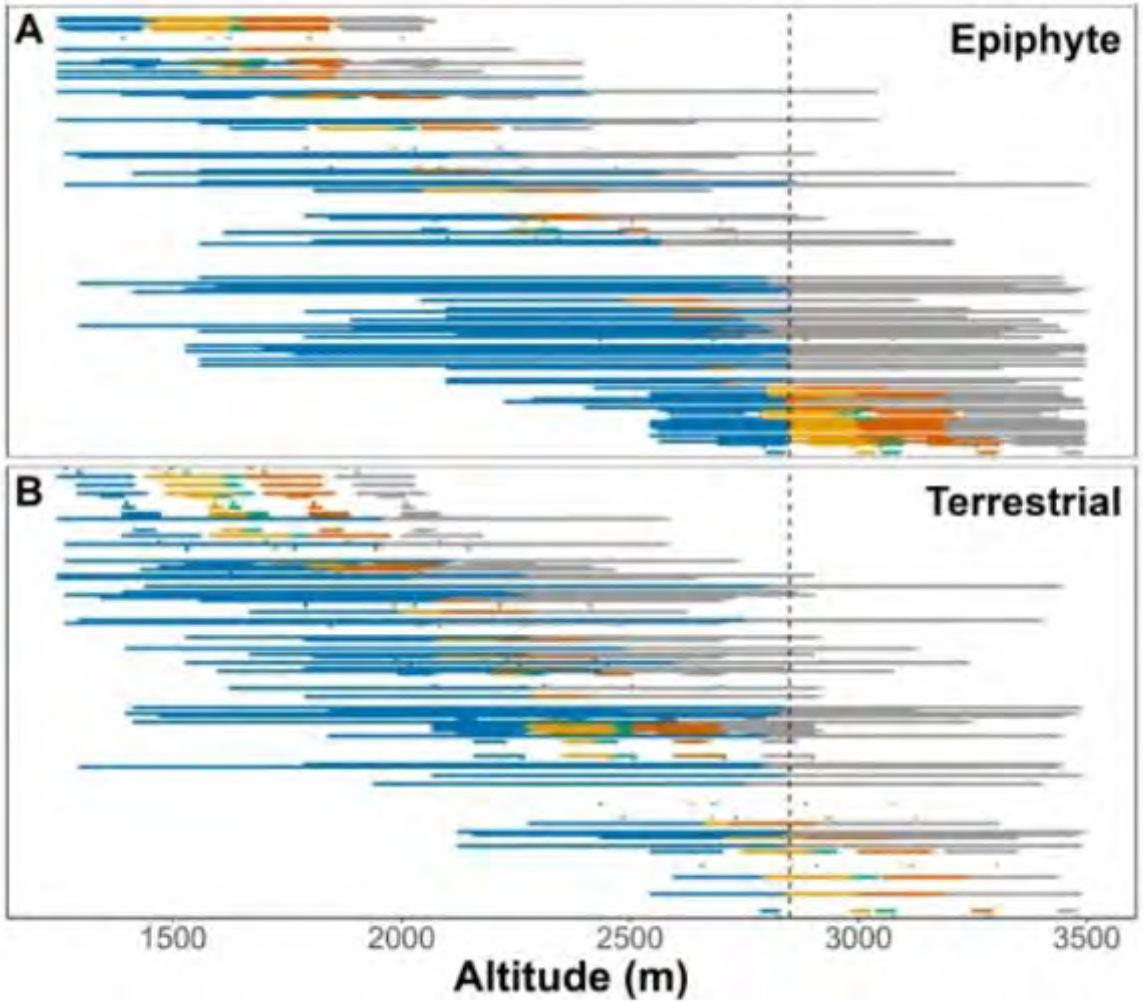
loss of >50% of the geographic range of 8% of plant species by 2030

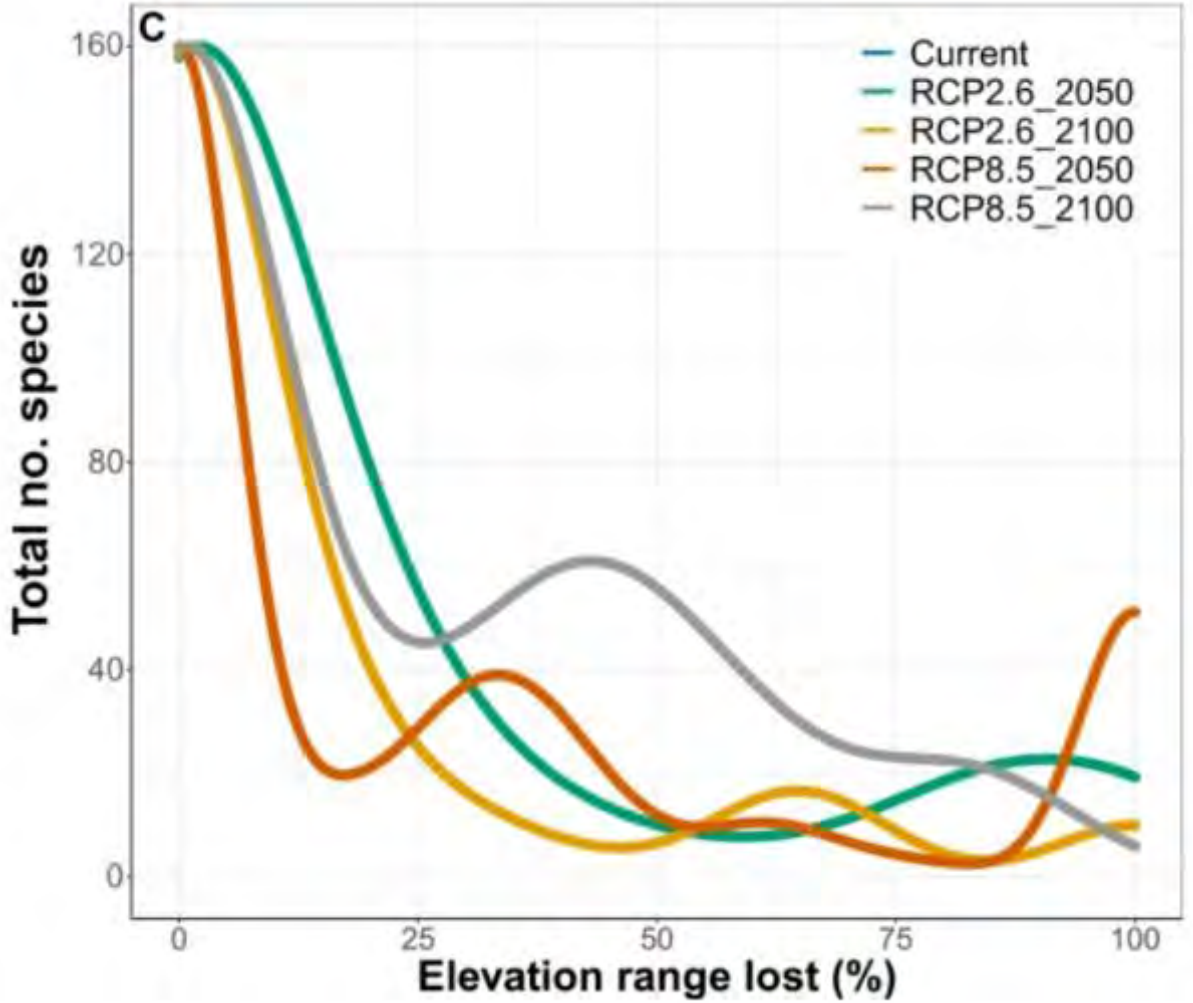
Its getting hot up here!



Some results…

- 160 species (epiphytes and terrestrial)
- 63 are expected by 2050 to shift their range fully or partially above the max. altitude of the mountain





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SustainNET Seminar 2021

Anne Oxbrough and Sven Bakte Part 2

Pre-1992 forest management approach

Sustainable forest management

Economic

Social

Environmental

Sustainable forest management – WHO CARES?

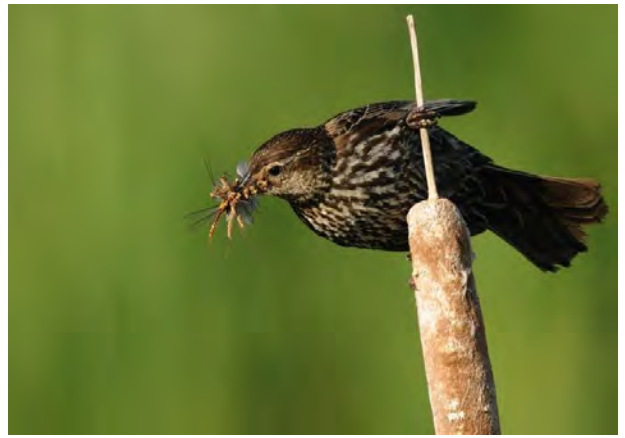
Biodiversity &
Ecosystem functioning

↓

Health Resilience

↓

FUTURE GENERATIONS
=
Sustainability



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journal homepage: www.elsevier.com/locate/foreco

Commercial spruce plantations support a limited canopy fauna: Evidence from a multi taxa comparison of native and plantation forests

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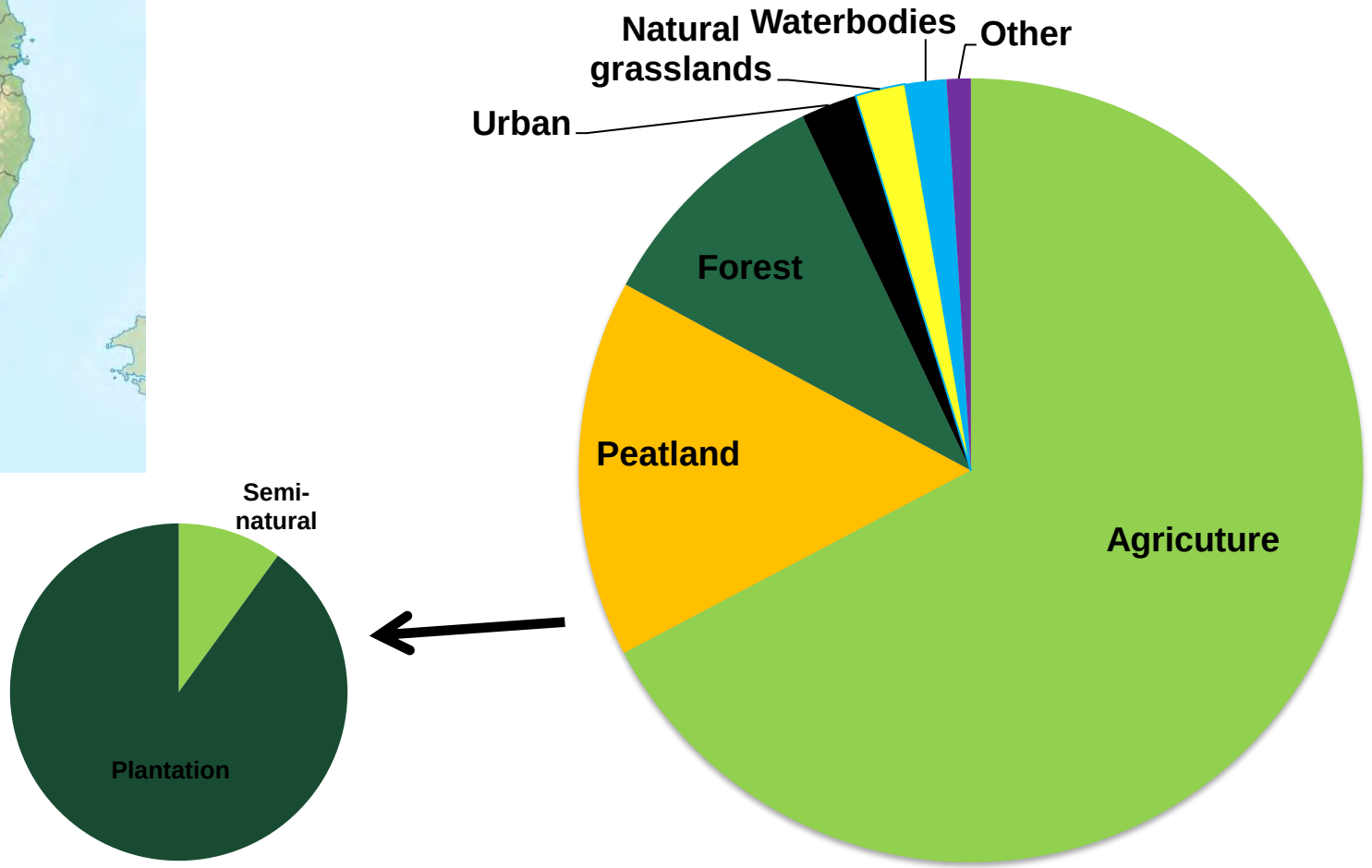
Forest cover in Ireland



Corine land cover data 2006

Semi natural native woodlands

- Cover 1% land area (10% of all forest)
- Small patches (70% <10ha)
- Oak Ash Birch Holly Hazel
- Yew, juniper, Scots pine?

Afforestation

- Non native species
- Monocultures
- 14.5% by 2030

Typical forests

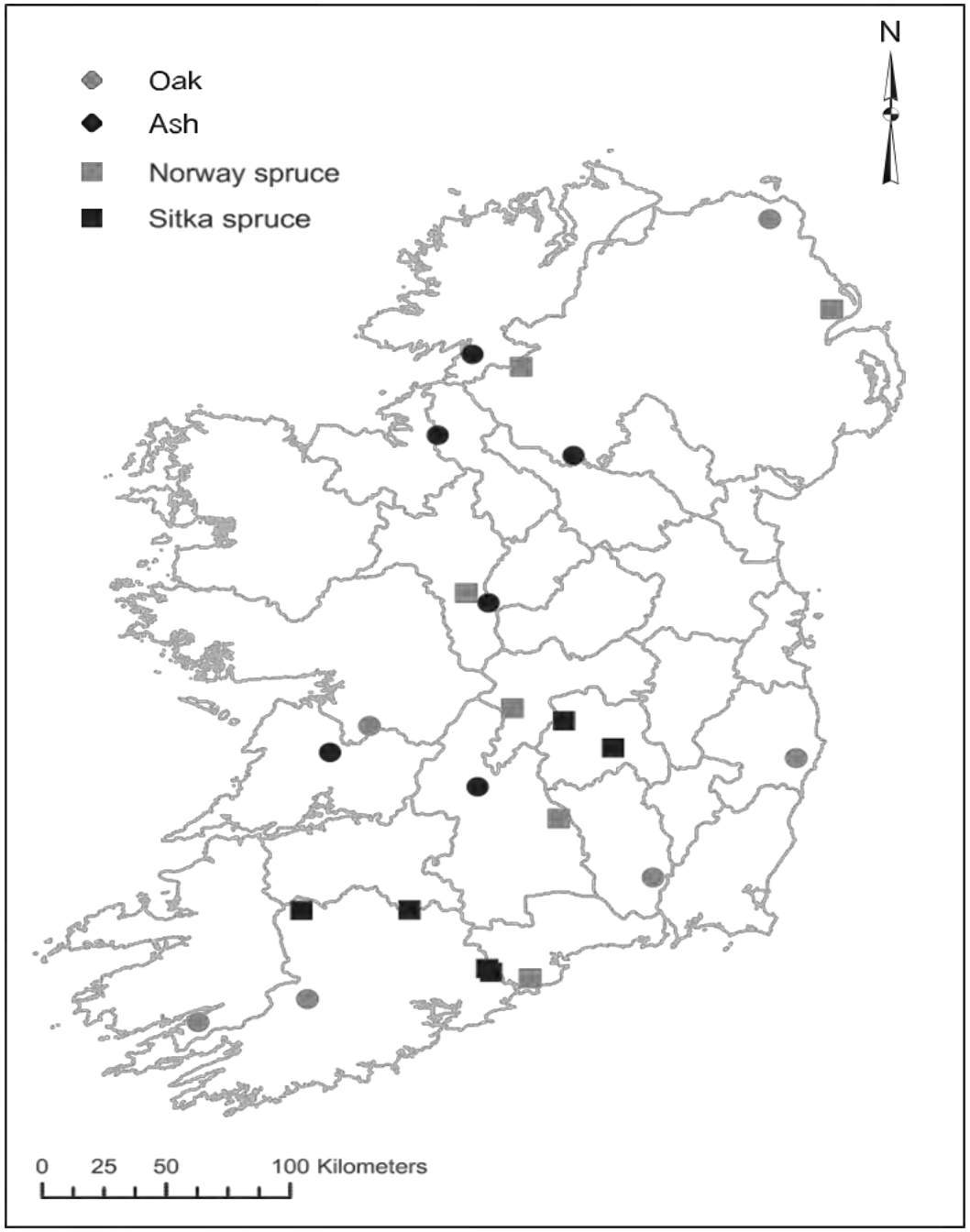
- Sitka spruce (60%)
- Norway spruce
- Larch
- Lodgepole pine

- 40-50 year rotation
- Thinned ~20-25 yrs
- Clear cut

Key Questions

1. Do plantations support canopy invertebrate assemblages similar to native forests?

2. Does the canopy fauna in second rotations plantation support more forest specialists than first rotations?



Experimental Design

- Thirty closed-canopy forests:
  - Six ash (*Fraxinus excelsior*) dominated semi-natural woodlands
  - Six oak (*Quercus petraea*) dominated semi-natural woodlands
  - Six closed canopy (20–50 years old) first rotation Sitka spruce (*Picea sitchensis*) plantations
  - Six second rotation Sitka spruce plantations
  - Six Norway spruce (*Picea abies*) first rotation plantations.

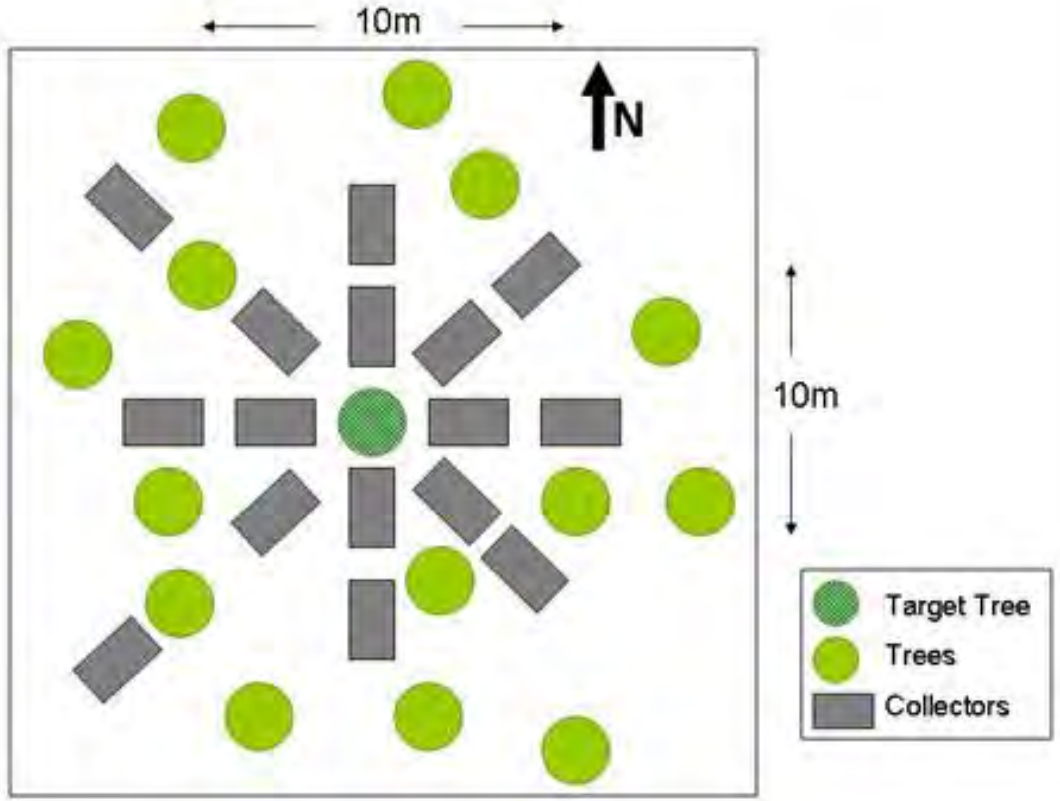
Canopy fogging

- A natural pyrethroid (Pybuthrin 33)
  - non-persistent
  - no phytotoxic effects
  - not harmful to vertebrates

- 6-10 minutes, full coverage

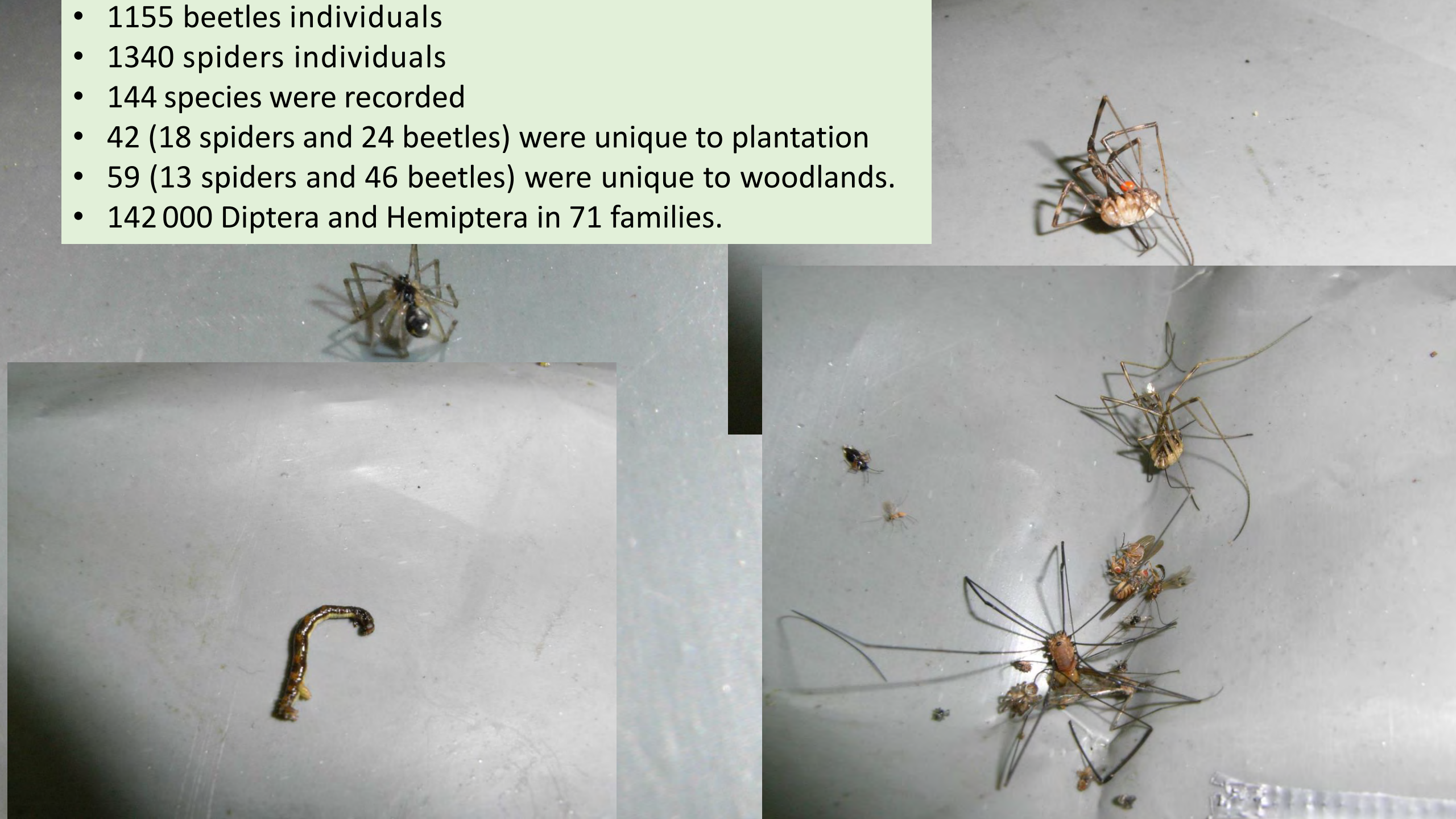
- Away from water courses
- Low wind (< 8 km h-1), dry canopy
- After a dry, calm night to minimise fog dispersion.

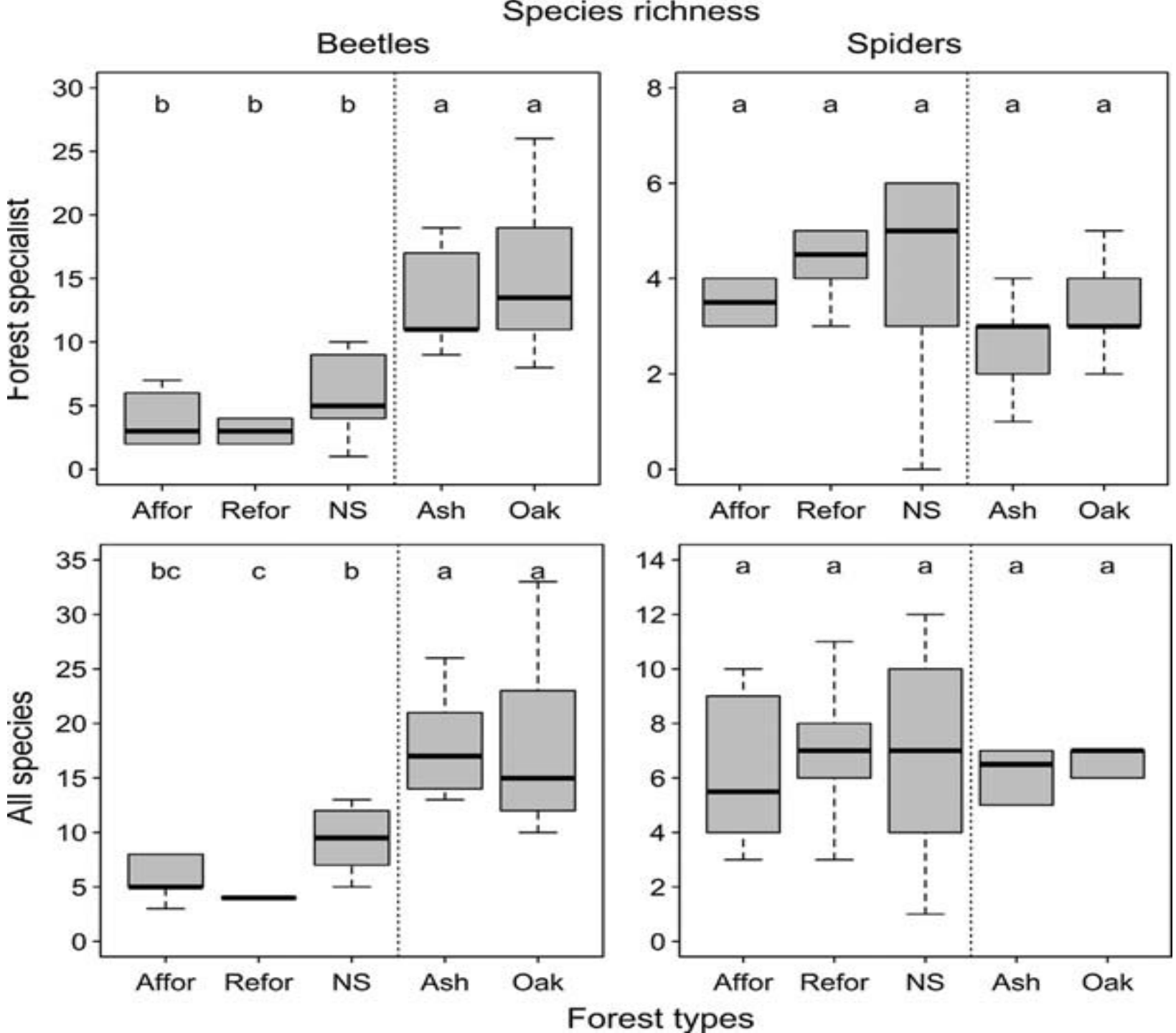
16 plastic sheets, with a combined area of 24 m^2



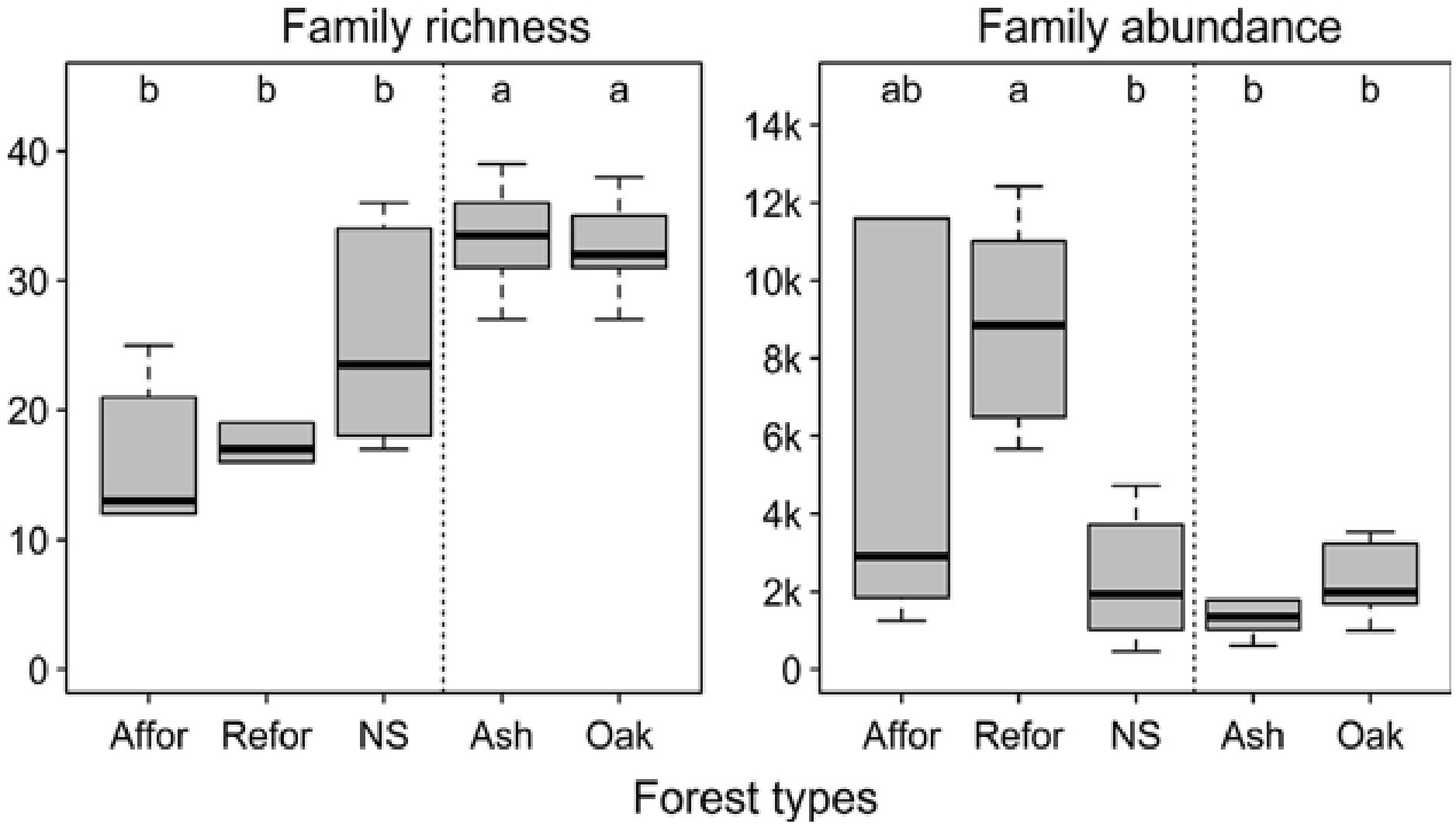
Results

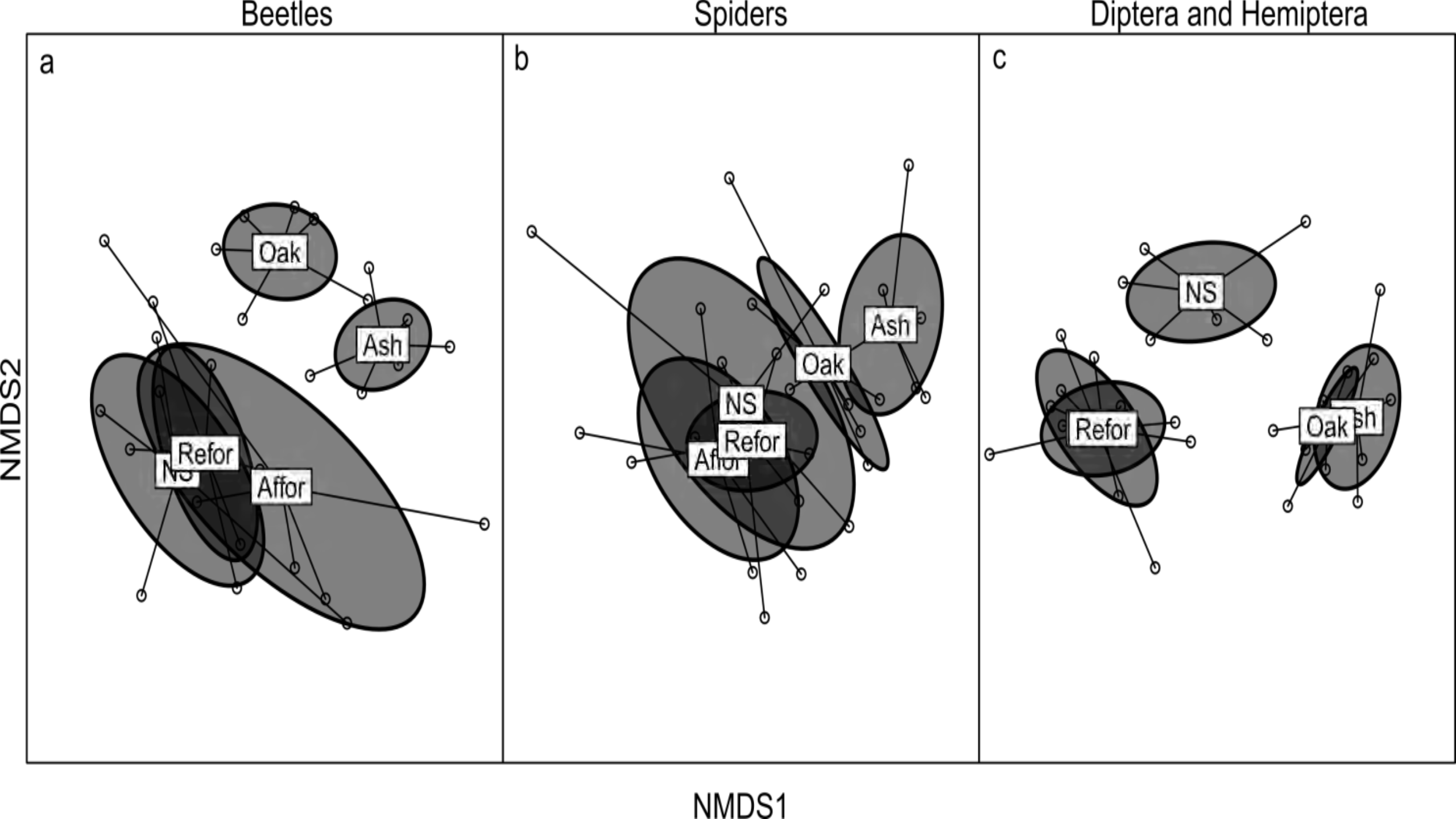
- 1155 beetles individuals
- 1340 spiders individuals
- 144 species were recorded
- 42 (18 spiders and 24 beetles) were unique to plantation
- 59 (13 spiders and 46 beetles) were unique to woodlands.
- 142 000 Diptera and Hemiptera in 71 families.




Species richness
Beetles
Spiders
Forest specialist
All species
b b b a a
a a a a a
bc c b a a
a a a a a
Affor Refor NS Ash Oak
Forest types

Diptera and Hemiptera




Beetles
Spiders
Diptera and Hemiptera
a
b
c
Oak
Ash
Refor
NS
Affor
Oak
Ash
NS
Refor
NS
Refor
Oak
NMDS2
NMDS1

Case Study: Key findings

- Plantations vs native semi natural woodlands
  - ~half the number of beetle species
  - ~ half the number of Diptera and Hemiptera families

- Norway spruce plantations:
  - different to those of native forest
  - consistently higher richness than Sitka spruce plantations.

- No differences between first rotation and second rotation Sitka spruce plantations.

- Sitka spruce plantations contained far greater total abundance of invertebrates, due to vast numbers of aphids and midges.

Case Study: Implications for Management

- Sitka spruce are of limited benefit to the canopy fauna typical of native forests

- Large aphid populations
  - May provide abundant food for insectivores
  - May also lead to reduced crop production through defoliation.

- Progressive forestry management:
  - diversify the plantation canopy fauna
  - may also increase productivity and resilience to pest species.

Thanks