Environmental change and the biodiversity of the New Forest

Adrian Newton

Department of Life and Environmental Sciences
Faculty of Science and Technology
Bournemouth University

Email anewton@bournemouth.ac.uk

Contents

- The importance of the New Forest for wildlife
- Impacts of environmental change on New Forest biodiversity: research evidence
- Implications for the future of the New Forest

2007: Biodiversity conference

- The first attempt to bring together specialists on different species groups and habitats in the New Forest
- The proceedings provide an overview of biodiversity status and trends, and key management challenges
- Shortly to be available on the New Forest Biodiversity Hub

2007: Biodiversity conference

- The New Forest is of exceptional importance for biodiversity:
    - more than two thirds of the British species of reptiles and amphibians, butterflies and moths, fish, bats, dragonflies and damselflies;
    - at least one sixth of British species in other groups

- In every group the New Forest is home to species of national conservation concern – including 155 plants, 264 butterflies and moths, and 142 lichen species.





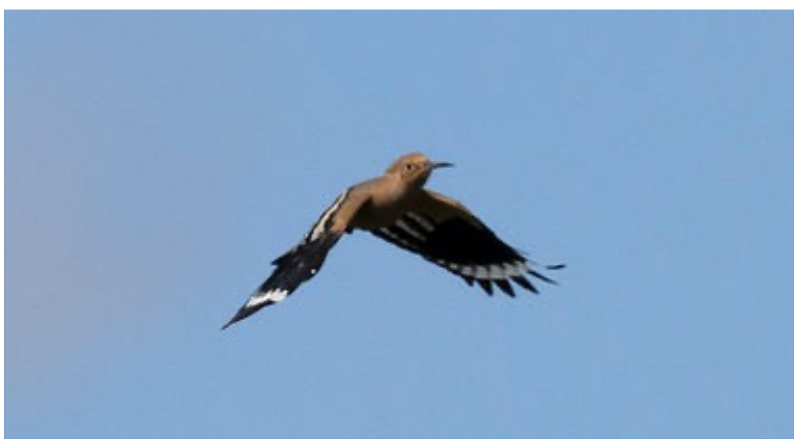


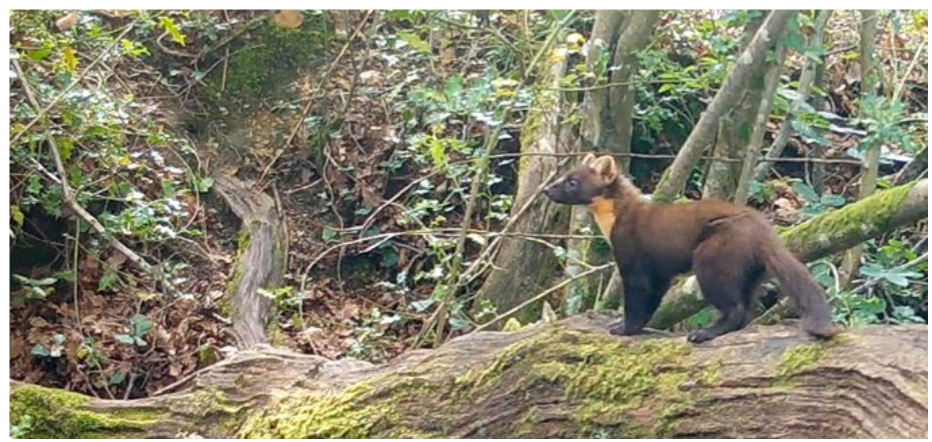


Trends in New Forest biodiversity

- At least 170 species have been lost from the New Forest in the past 150 years or so.
- Losses of butterflies and moths are particularly high, but significant losses also appear to have occurred in lichens, saproxylic beetles and fungi
- Causes include:
  1. forestry operations,
  2. increase in grazing and browsing pressure,
  3. inappropriate habitat management interventions, including scrub control, tree felling and heathland burning
- New species are being discovered, or are arriving, all the time

New Forest wildlife: some recent arrivals



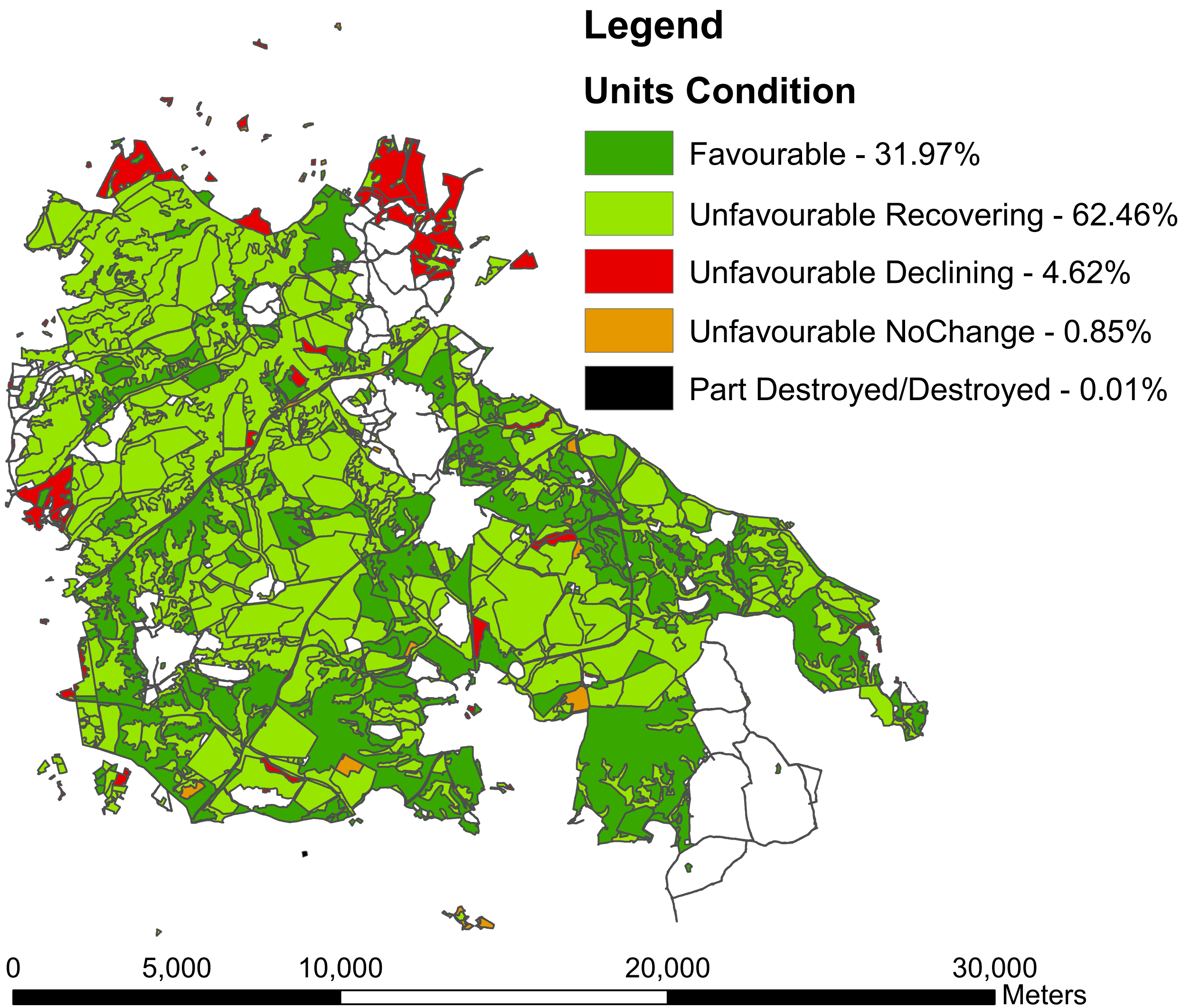


https://www.wildnewforest.co.uk/

New Forest wildlife: some recent arrivals

https://www.wildnewforest.co.uk/

Trends in habitat condition



Condition of habitats in the New Forest, based on results of Common Standards Monitoring (CSM) assessments used by Natural England for SSSI monitoring (Cantarello *et al*. 2010).

Habitat condition

Threat	Habitat type			
	Dry heathland and dry grassland	**Wet heath, wet grassland and mire**	**Pasture, riverine and bog woodland**	**Inclosure woodland**
Forestry and woodland management	3.17	0.73	35.3	45.4
Overgrazing	39.7	0.02	1.79	-
Inappropriate scrub control	34.2	11.5	10.5	-
Drainage	0.19	43.6	17.3	30.2
Public access/ disturbance	0.72	-	-	0.42

Assessment of threats to habitats in the New Forest, based on results of Common Standards Monitoring (CSM) assessments (Cantarello *et al*. 2010). Values presented are percentages of the total area classified as in 'unfavourable condition', attributed to each threat.

2024: an update

- Over the past 17 years, significant efforts have been made to strengthen biodiversity conservation in the New Forest
- At the same time, environmental change has continued to intensify, and the New Forest has experienced unprecedented challenges (eg COVID 19)
- Here I am going to summarize the results of some research undertaken since 2007

Climate change in the New Forest

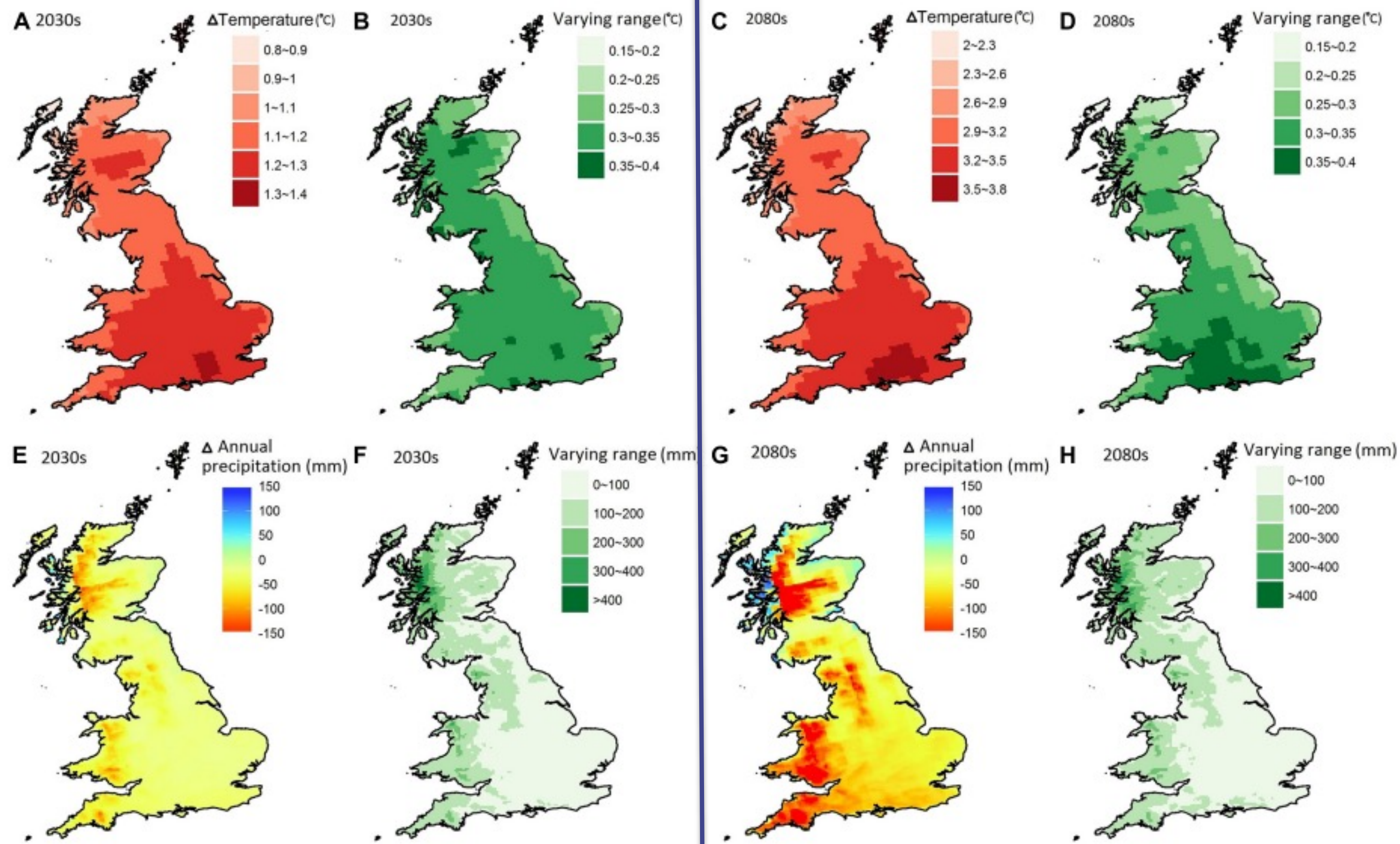


FIGURE 1 | The mean change of the projected annual temperature **(A,C)** and precipitation **(E,G)** averaged over the 2030s and the 2080s relative to the baseline (1975–2004); the range of the projected change of temperature **(B,D)** and precipitation **(F,H)** between the 10 and 90th percentiles in the 2030s and the 2080s.

From Yu et al. (2021)

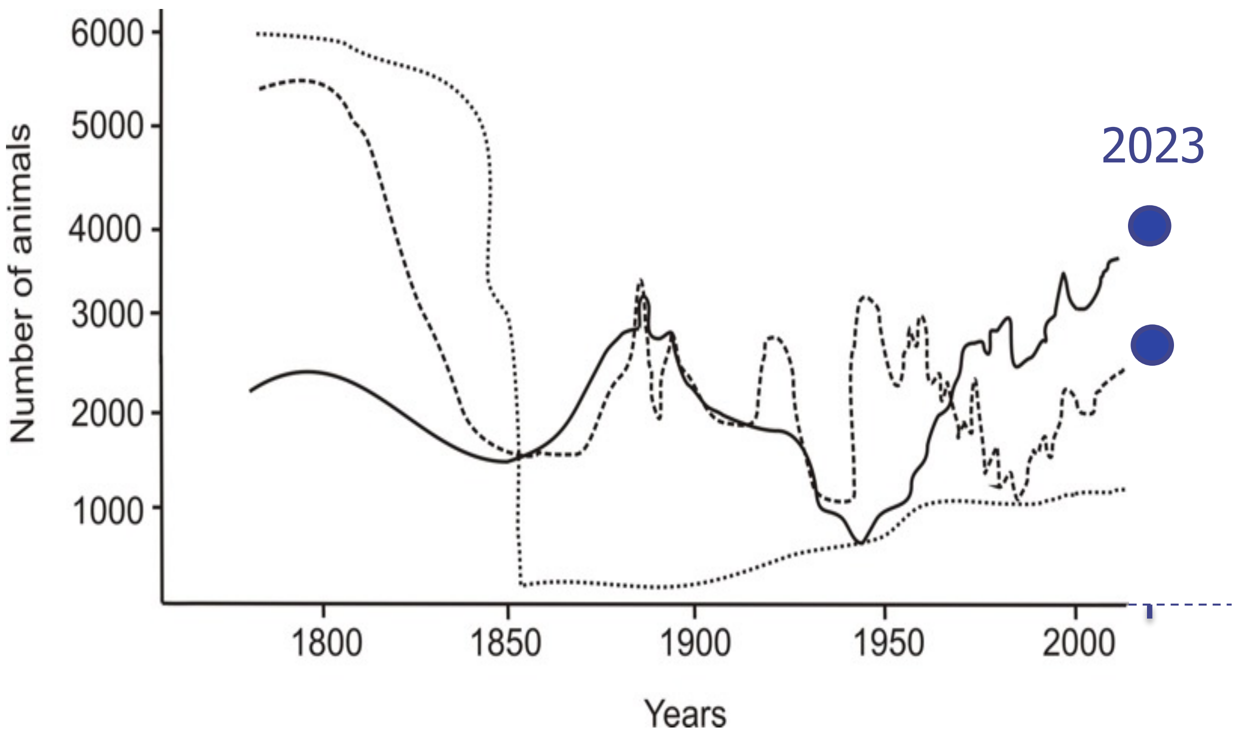
Other forms of environmental change

- Spread of pests and diseases, e.g. diseases affecting alder, oak, holly, ash, elm, etc.
- Spread of invasive species, e.g. *Crassula helmsii*
- Soil degradation
- Nitrogen pollution to soils and waters
- Disturbance change (fire, drought, floods, storms, visitor pressure, herbivore numbers etc.)
- Many of these pressures interact with climate change

Invasive species: *Crassula helmsii*

Photos: Naomi Ewald

Dynamics of large herbivore populations



Newton, A.C. (2011). Social-ecological resilience and biodiversity conservation in a 900-year-old protected area. *Ecology and Society* 16(4), 13. http://dx.doi.org/10.5751/ES-04308-160413

Potential impacts of climate change on New Forest species

- PhD undertaken by Sarah Douglas
- Involved modelling habitat suitability for a range of species across the entire New Forest, using a range of statistical methods, field data, and expert knowledge of species' requirements
- Included climate projections to 2050

Bayesian modelling: study species


Wild Chamomile
Chamaemelum nobile


Slender Marsh-bedstraw
Galium constrictum


Wild Gladiolus
Gladiolus illyricus


Pillwort
Pilularia globulifera

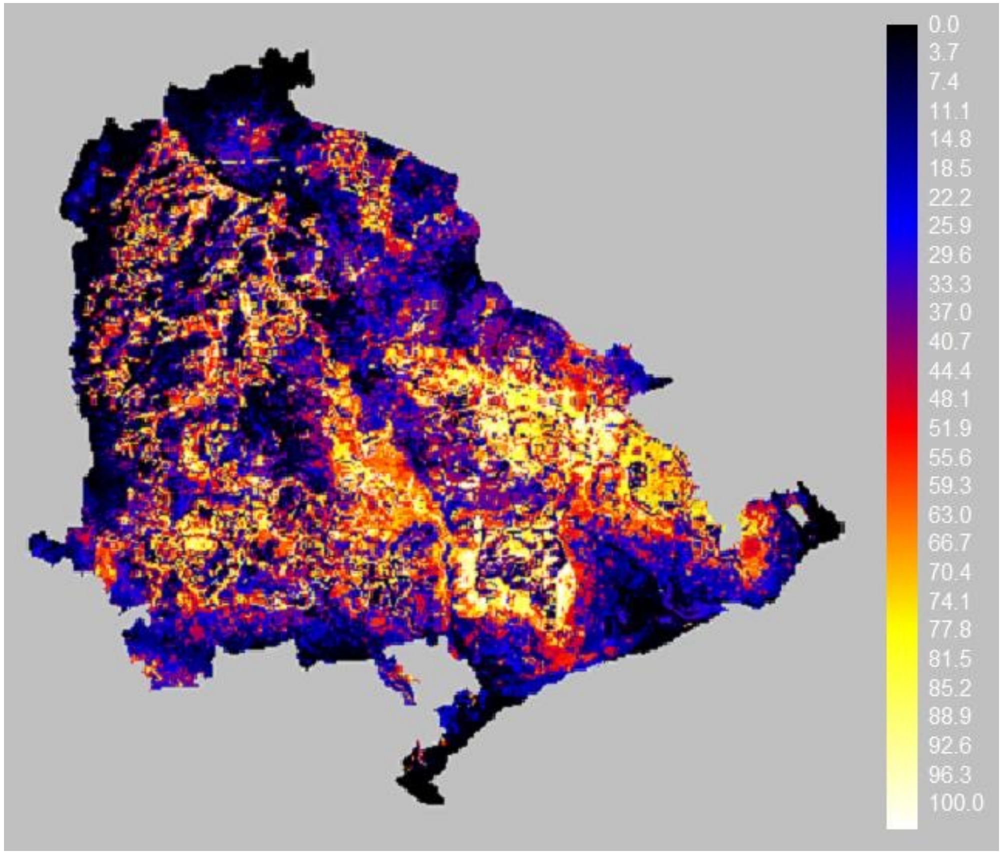

Grayling
Hipparchia semele


Silver-studded Blue
Plebejus argus


Wood Cricket
Nemobius sylvestris


Nail Fungus
Poronia punctata

Habitat suitability model output



HS map for Chamomile.
Lighter the colour, higher the habitat suitability

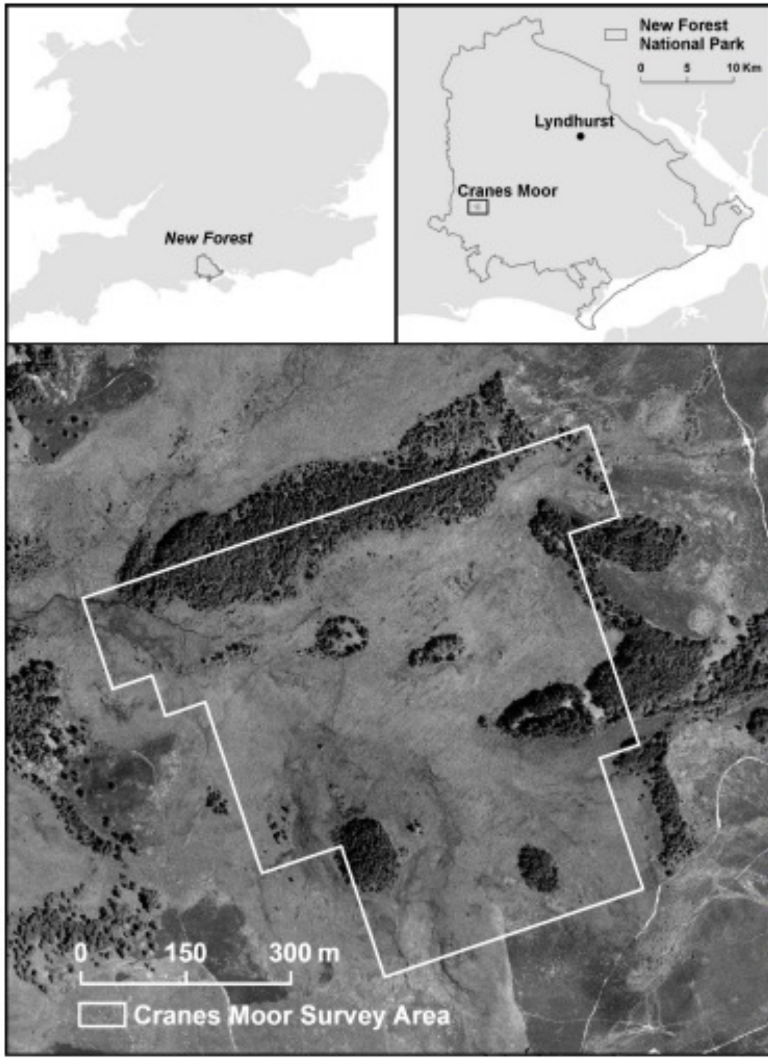
- Models tested with field survey data
- Outputs can be applied at landscape scale

Climate change impacts on species

Species	Presence sites	Absence sites
Chamaemelum nobile	+ 1.6	+ 9.8
Galium constrictum	- 24.2	- 3.4
Gladiolus illyricus	+ 3.3	+ 0.8
Hipparchia semele	+ 8.6	+ 12.5
Nemobius sylvestris	+ 3.8	+ 2.4
Plebeius argus	- 6.0	- 0.25
Pilularia globulifera	- 40.3	- 3.6
Poronia punctata	+ 6.0	+ 19.1

Values are percentages of number of sites suitable for the species in 2050. Note: loss of suitable sites is generally not compensated for by creation of new sites.

Impacts of environmental change: Evidence from Cranes Moor



Resurvey of vegetation plots established by Palmer Newbould in 1951.

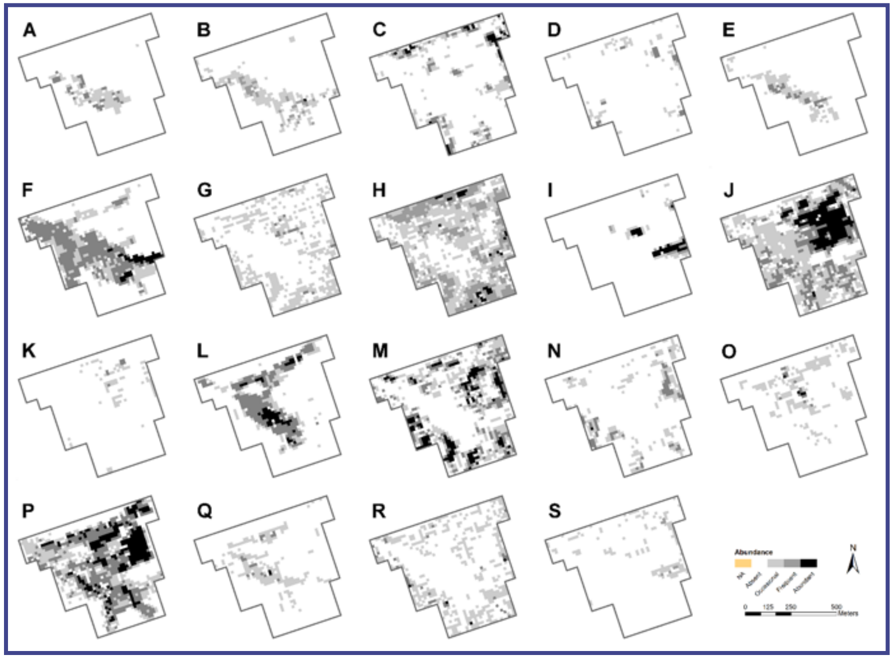
Entire site was covered by a grid of 15 x 15 m plots.

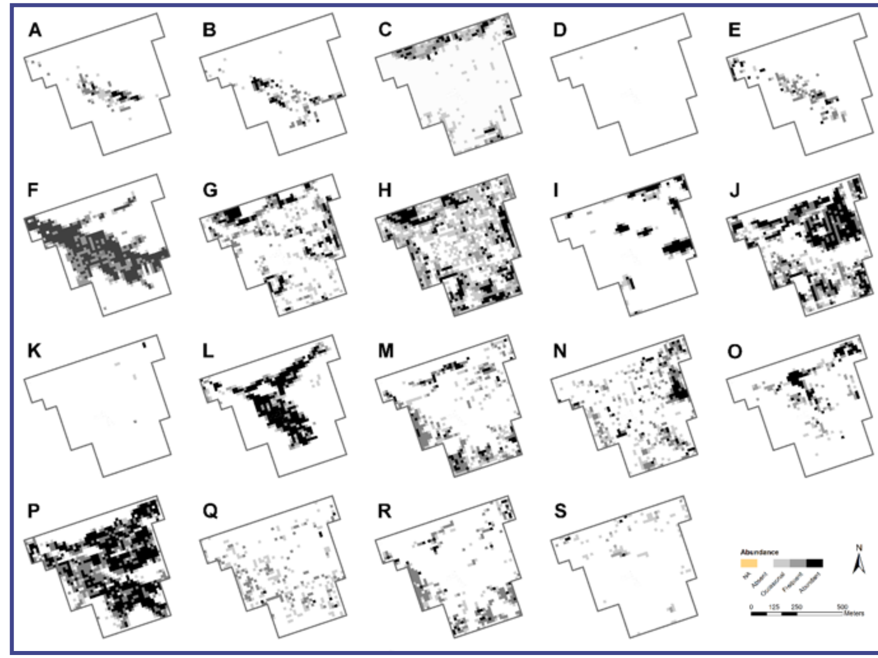
Evidence from Cranes Moor

Evidence from Cranes Moor

Figure 3 Scenes from Cranes Moor. Clockwise from top right, bog asphodel *Narthecium ossifragum*, fieldwork underway, marsh orchid *Dactylorhiza* sp., clubmoss *Lycopodiella inundata*, pale butterwort *Pinguicula lusitanica* and a colourful *Sphagnum* carpet.

Evidence from Cranes Moor



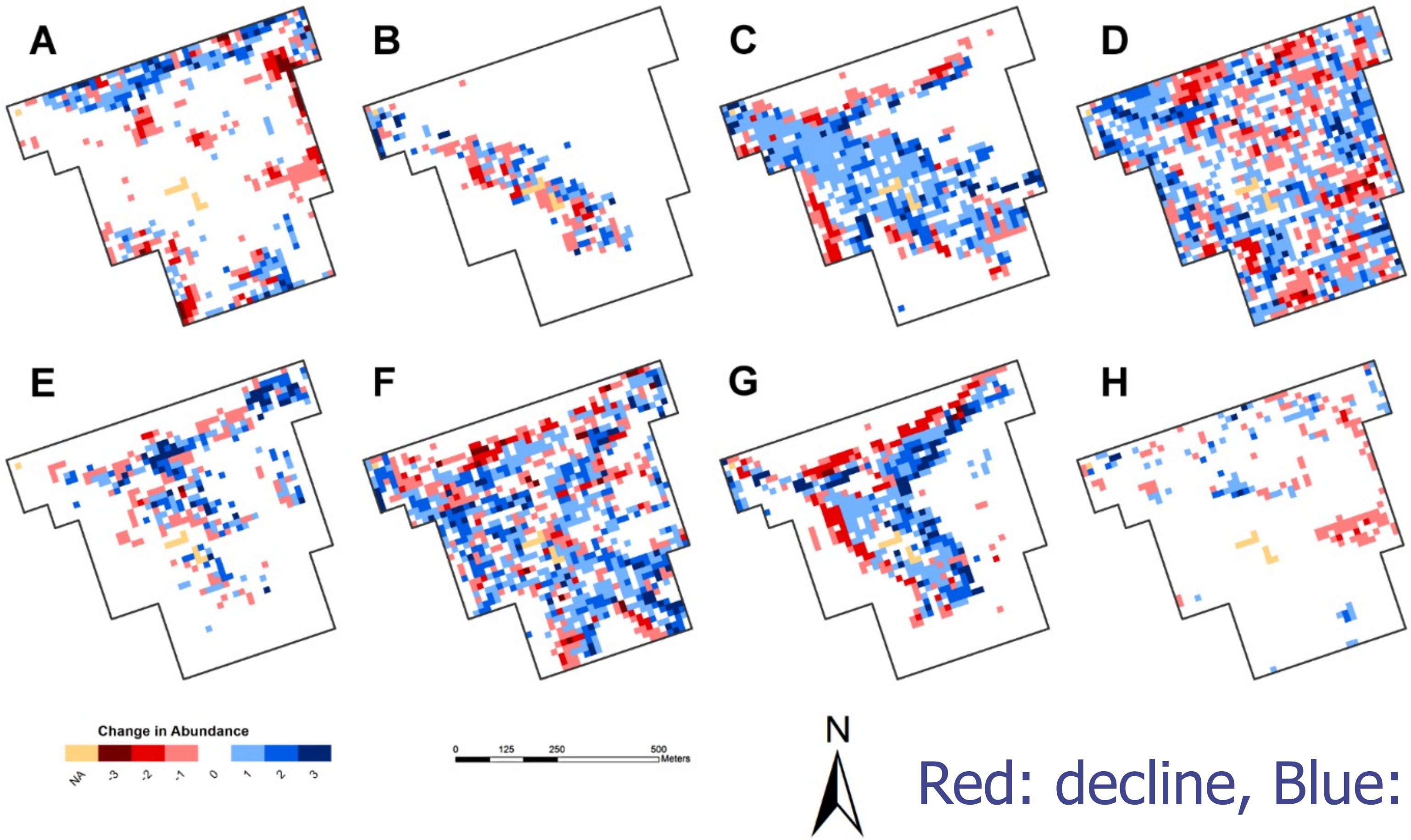


1951

2016

Intensity of shading indicates abundance of each species within each survey plot

Evidence from Cranes Moor



Red: decline, Blue: increase

Maps showing distribution changes in species between 1951 and 2016. A – *Erica cinerea*, B – *Menyanthes trifoliata*, C – *Myrica gale*, D – *Pinus sylvestris* (seedling), E – *Sphagnum magellanicum*, F – *Sphagnum papillosum*, G – *Schoenus nigricans*, H – *Ulex europaeus*.

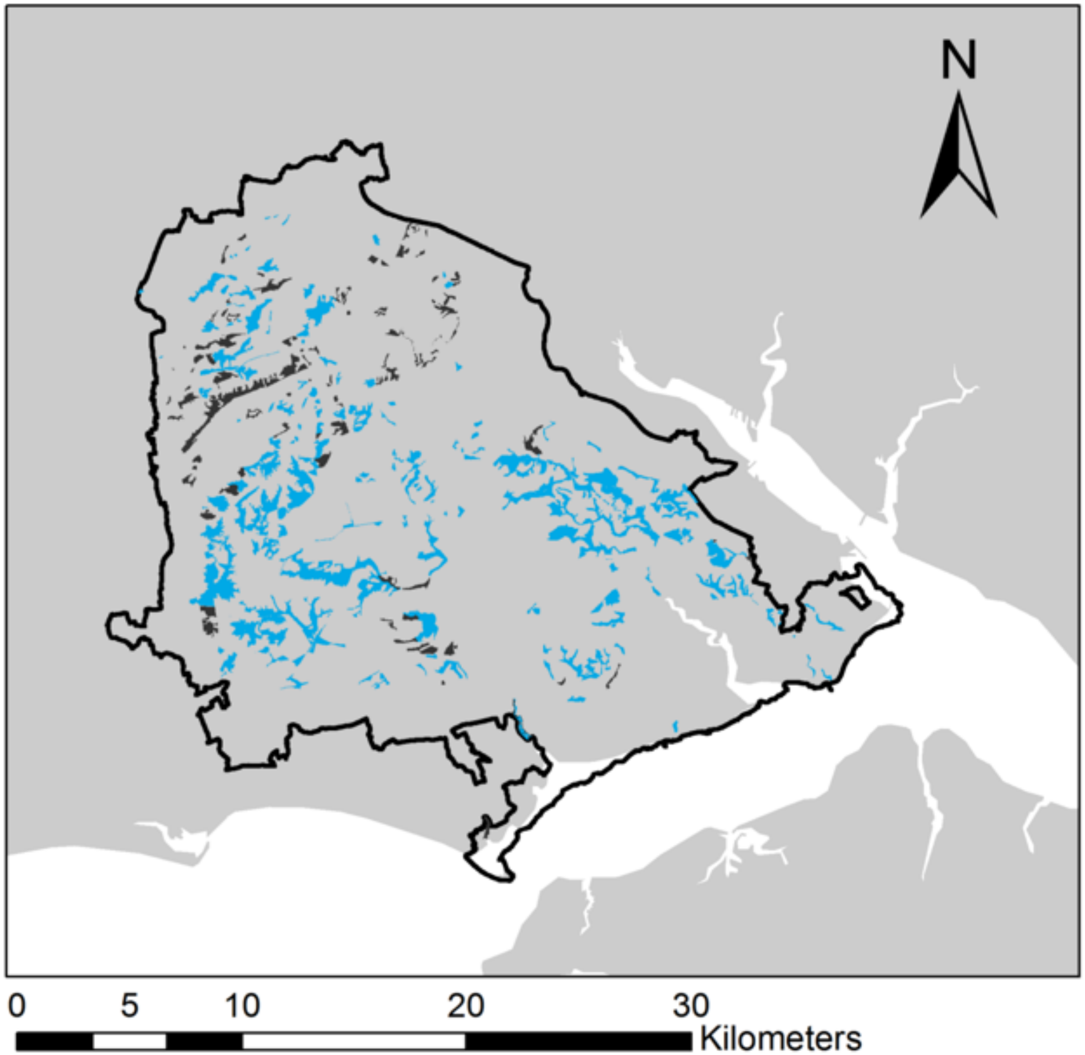
Evidence from Cranes Moor

- Over 65 years, mean species richness declined by 26%.
- The area of occupancy declined in 37% of species, which were primarily those typical of nutrient-poor bog communities.
- Occupancy increased in 21% of species, especially those that were more tolerant of higher nutrient availability.
- These changes were associated with an increase mean trait values for nitrogen and mean temperature, and a decline in trait values for precipitation.
- **Eutrophication** and **climate change** have been key drivers of floristic change on this site.

Effectiveness of mire restoration

- PhD by Alexander Lovegrove
- Examined the effectiveness of wetland restoration actions undertaken under
  - Life 2 (1997-2001),
  - Life 3 (2002-2005),
  - Rural Pathfinder Scheme (2006-2009) and
  - HLS scheme (2010 – 2013).
- 60 mires surveyed in total.

Effectiveness of mire restoration



The locations of wetland SSSI sub-units in the New Forest, showing those in "Favourable" status (black) and all other categories (blue) in 2013

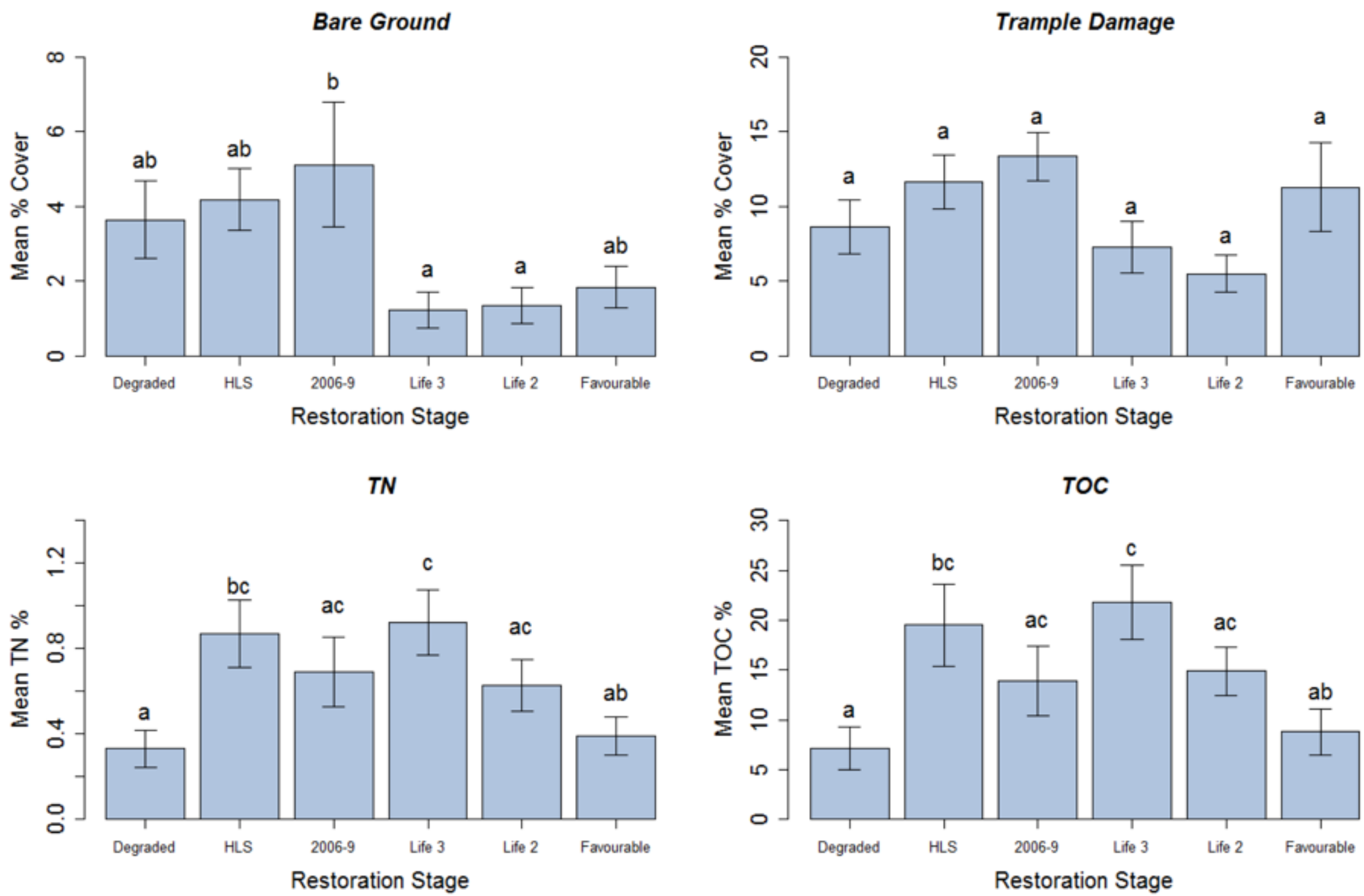
Effectiveness of mire restoration

Two Life II Restoration locations.

“Redhill Bog”, is a very grassy mire.

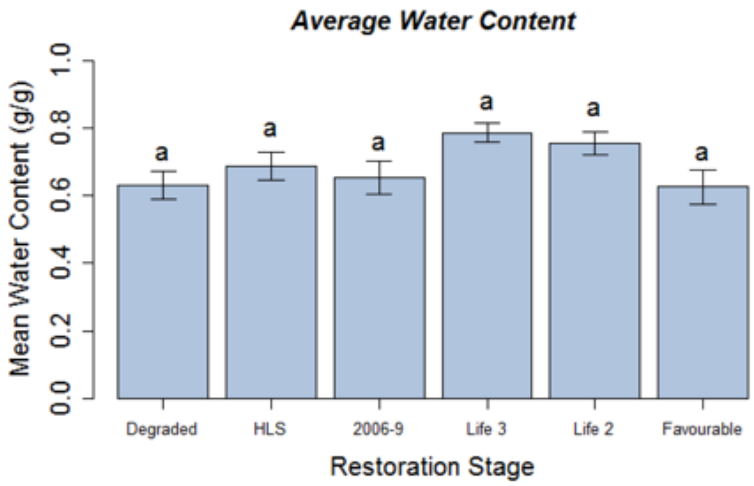
“Milking Pound Bottom” still has high grass cover but shows more open conditions

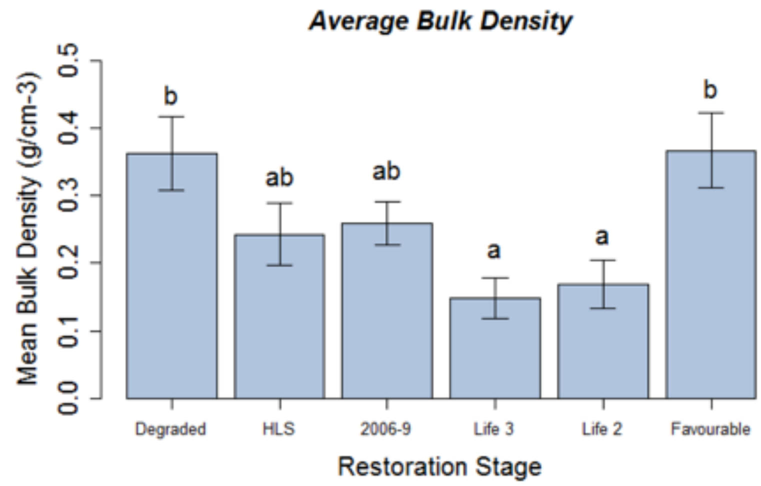
Effectiveness of mire restoration

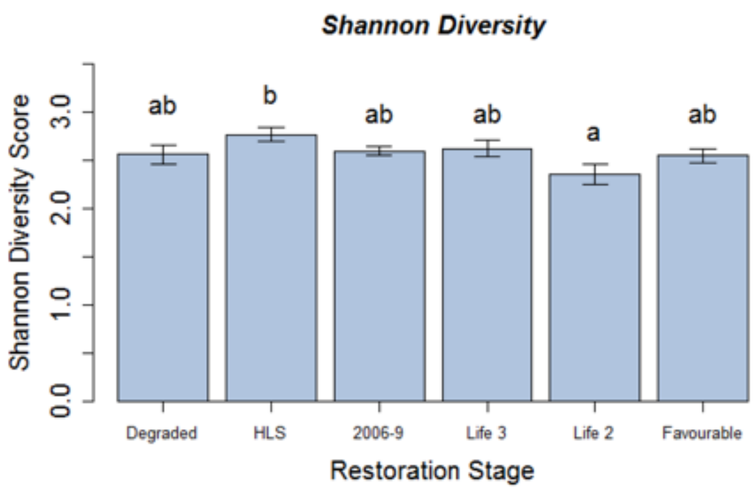


Carbon and nitrogen *higher* in some restored plots, bare ground also sometimes *higher*

Effectiveness of mire restoration





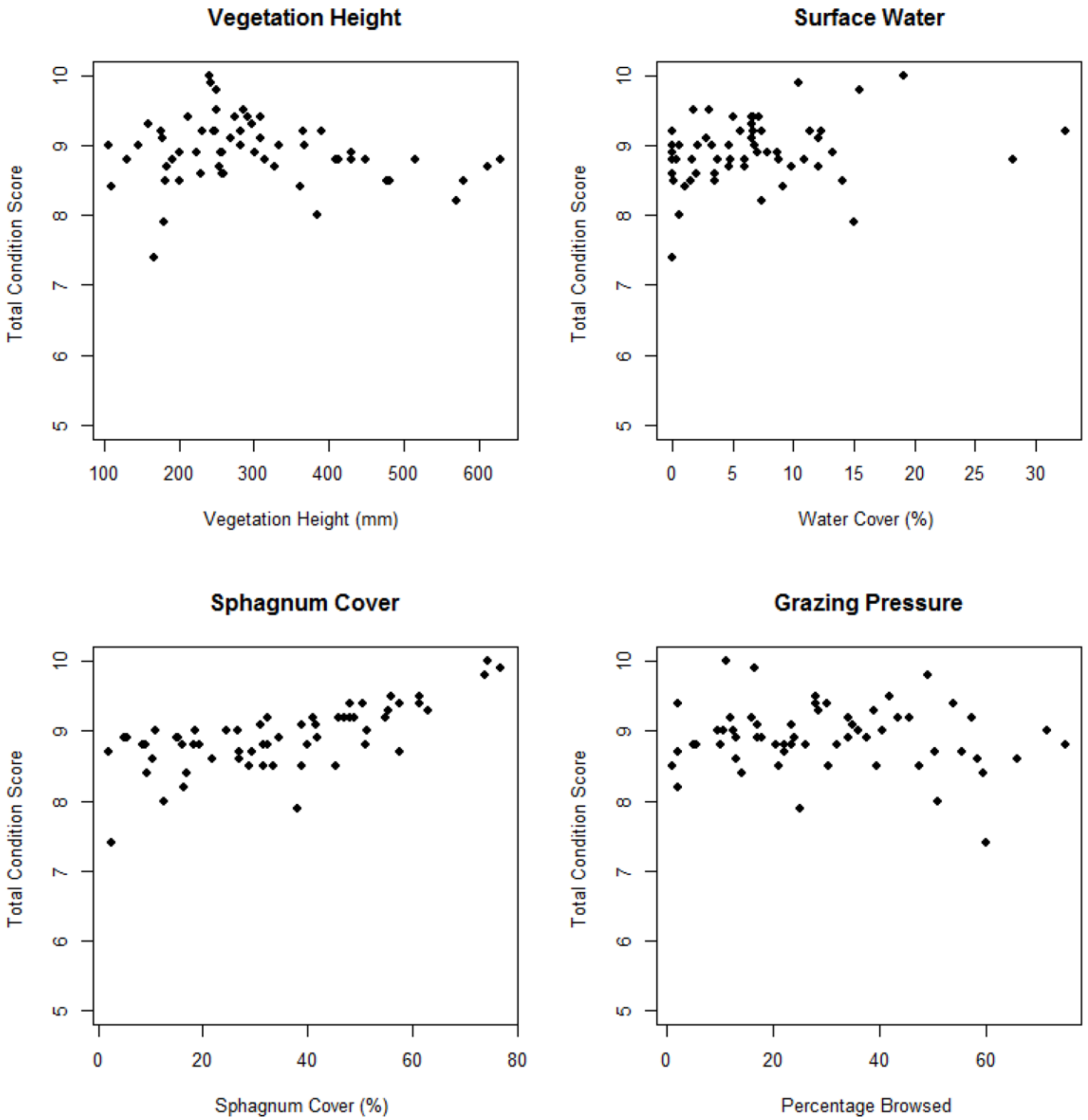


- No impact on soil water content
- Some improvement in soil compaction in older restorations – but 'favourable' sites the same as 'degraded'
- No impact on plant species richness

Effectiveness of mire restoration

- Mire restoration not generally effective – but situation may have changed since 2013
- Values of soil compaction (bulk density) very high compared to other studies, similar to drained mires elsewhere
- High soil compaction reduces habitat quality for plants and soil invertebrates, impedes *Sphagnum* development and increases soil erosion risk
- High soil compaction associated with high herbivore pressure (livestock) which is very widespread in New Forest mires

Effectiveness of mire restoration



CSM scores poorly correlated with key vegetation characteristics except *Sphagnum* cover

Dynamics and thresholds of ecosystem services in wooded landscapes

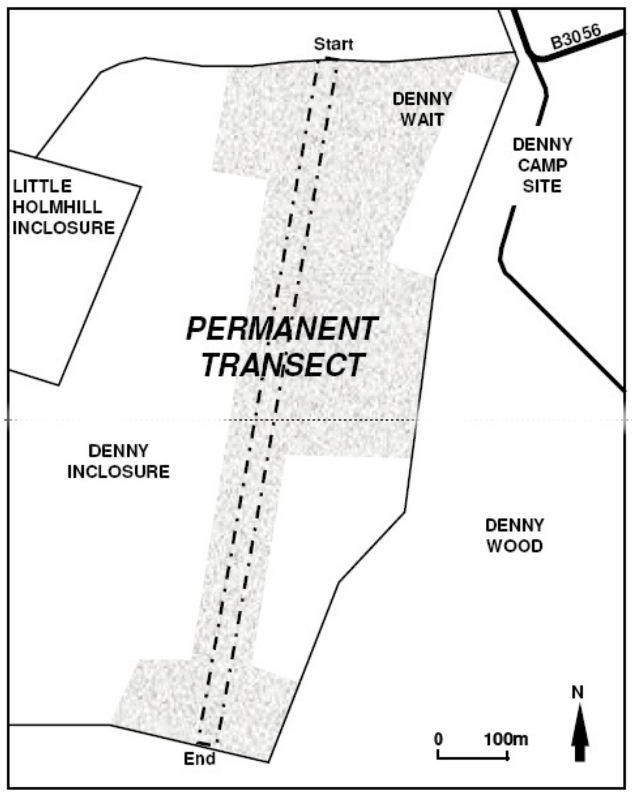
- Project focused on New Forest National Park, UK
- Integrated different approaches – long term plots, gradient analysis, and spatial modelling

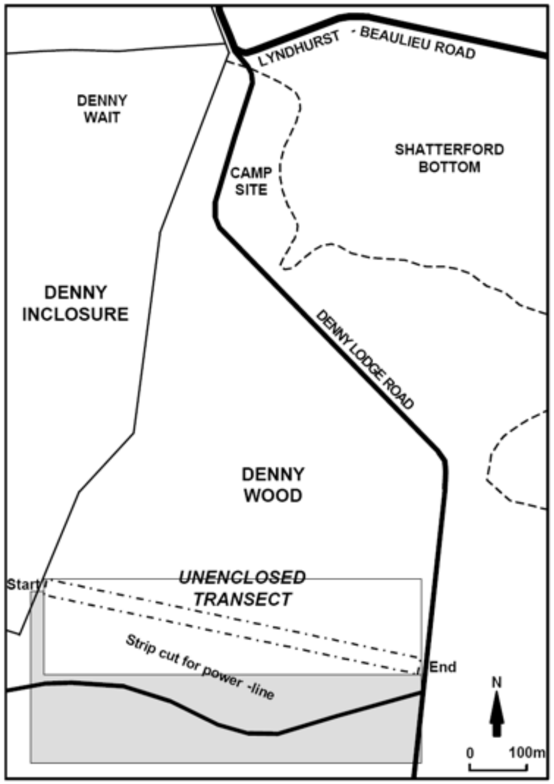
NERC SCIENCE OF THE ENVIRONMENT

bess biodiversity & ecosystem service sustainability

Denny Wood transects

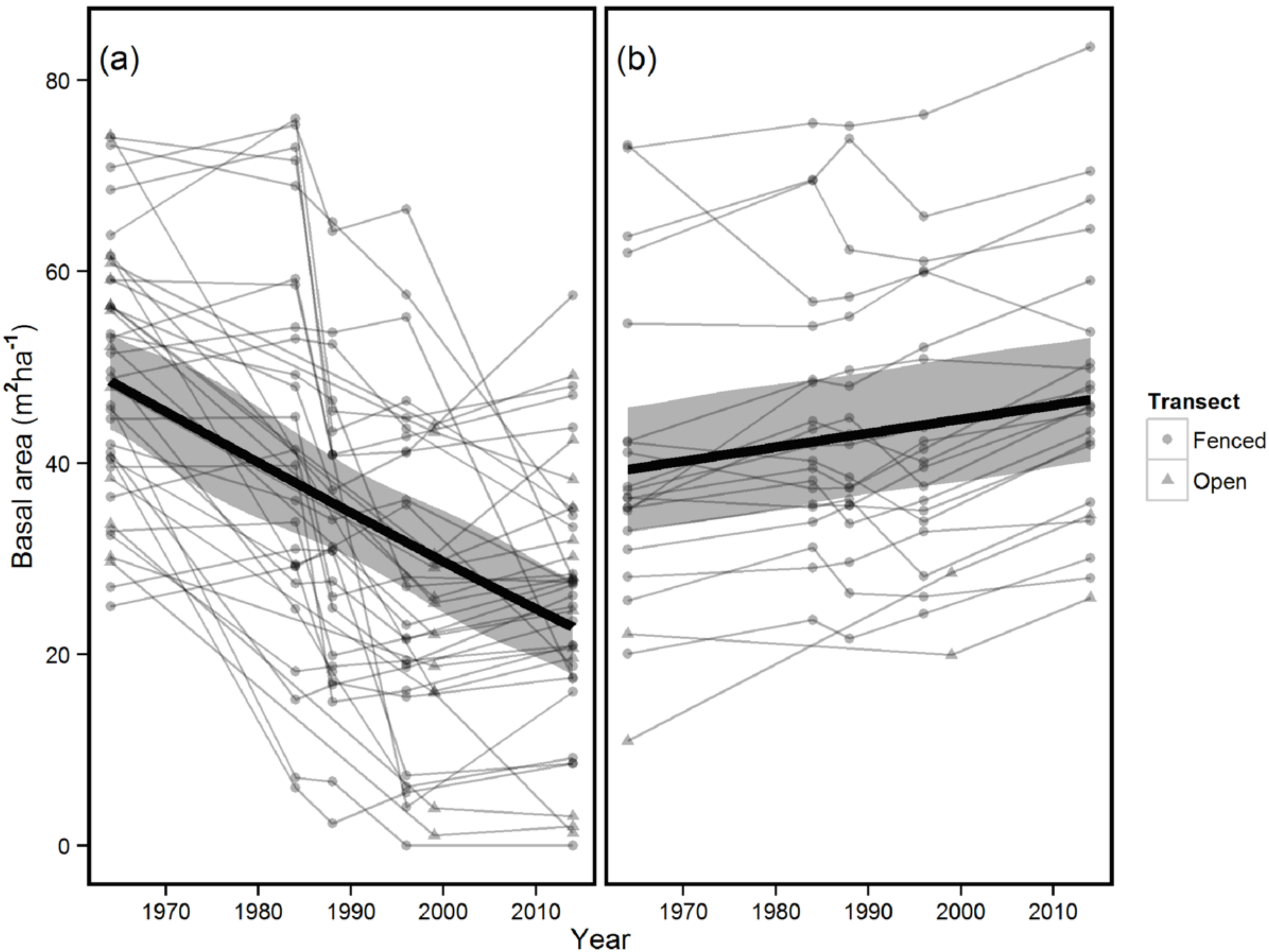
- The project resurveyed two transects originally established in the 1950s in Denny Wood
- All individual trees were measured and mapped and have been resurveyed regularly since



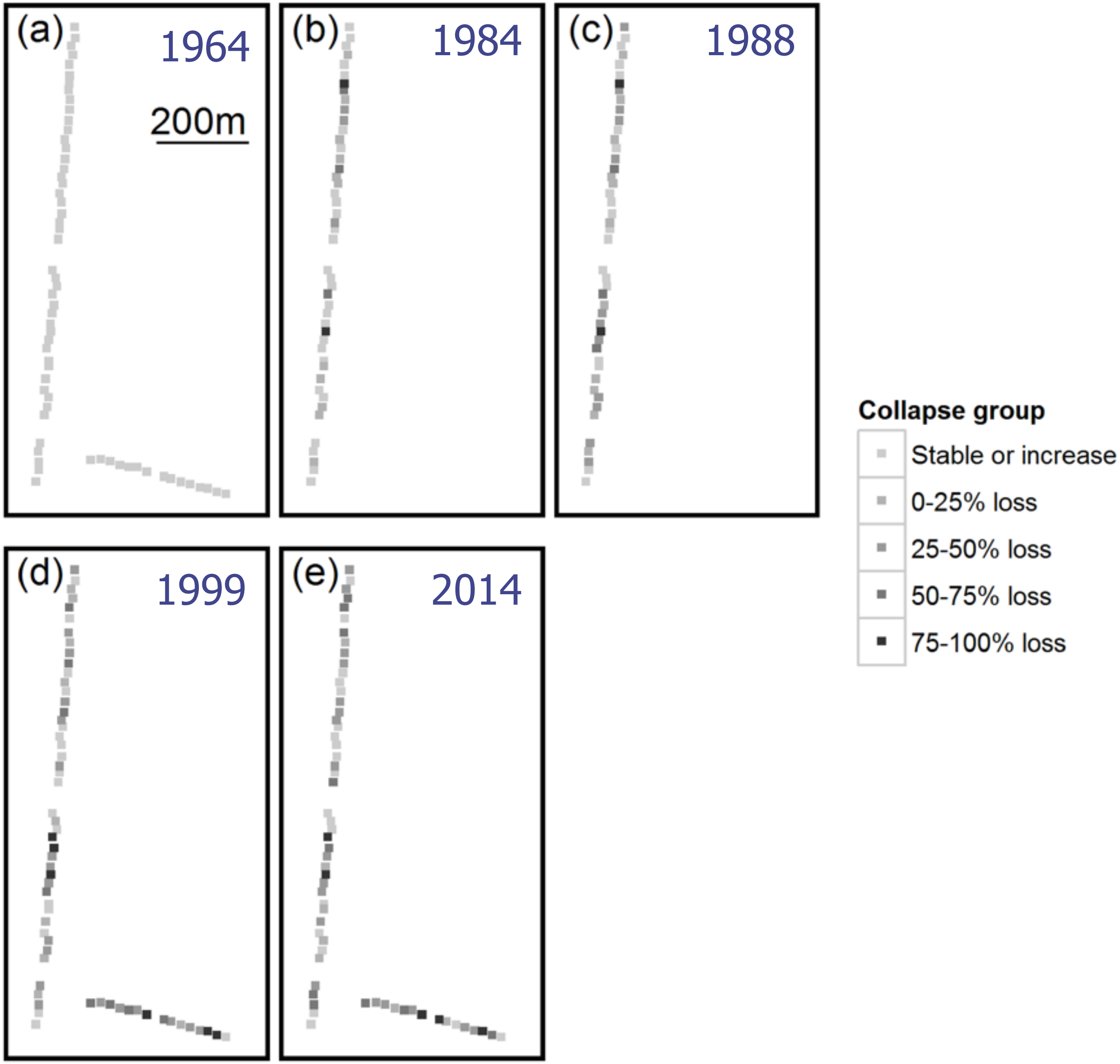


Denny Wood transect

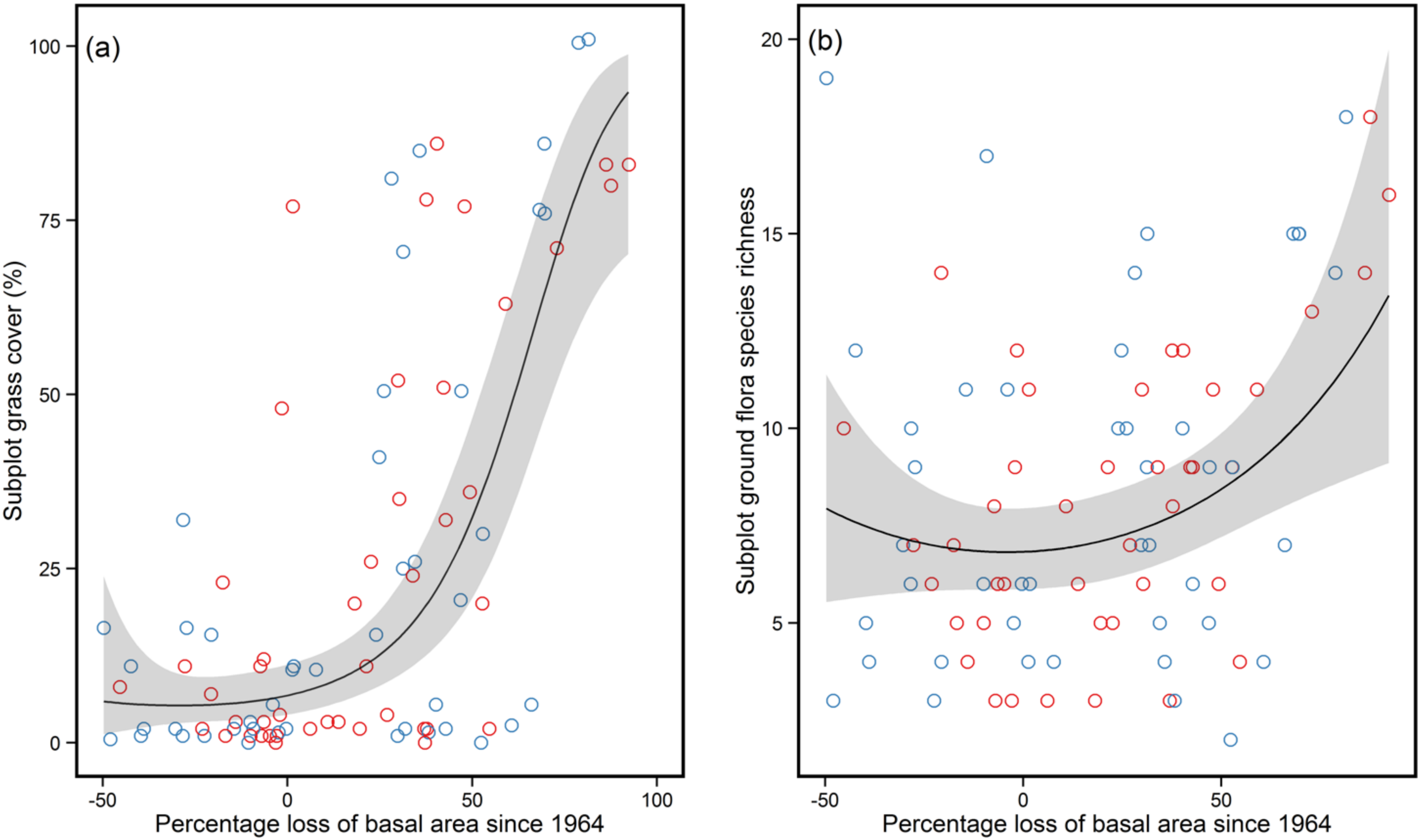
Long-term monitoring: Denny Wood

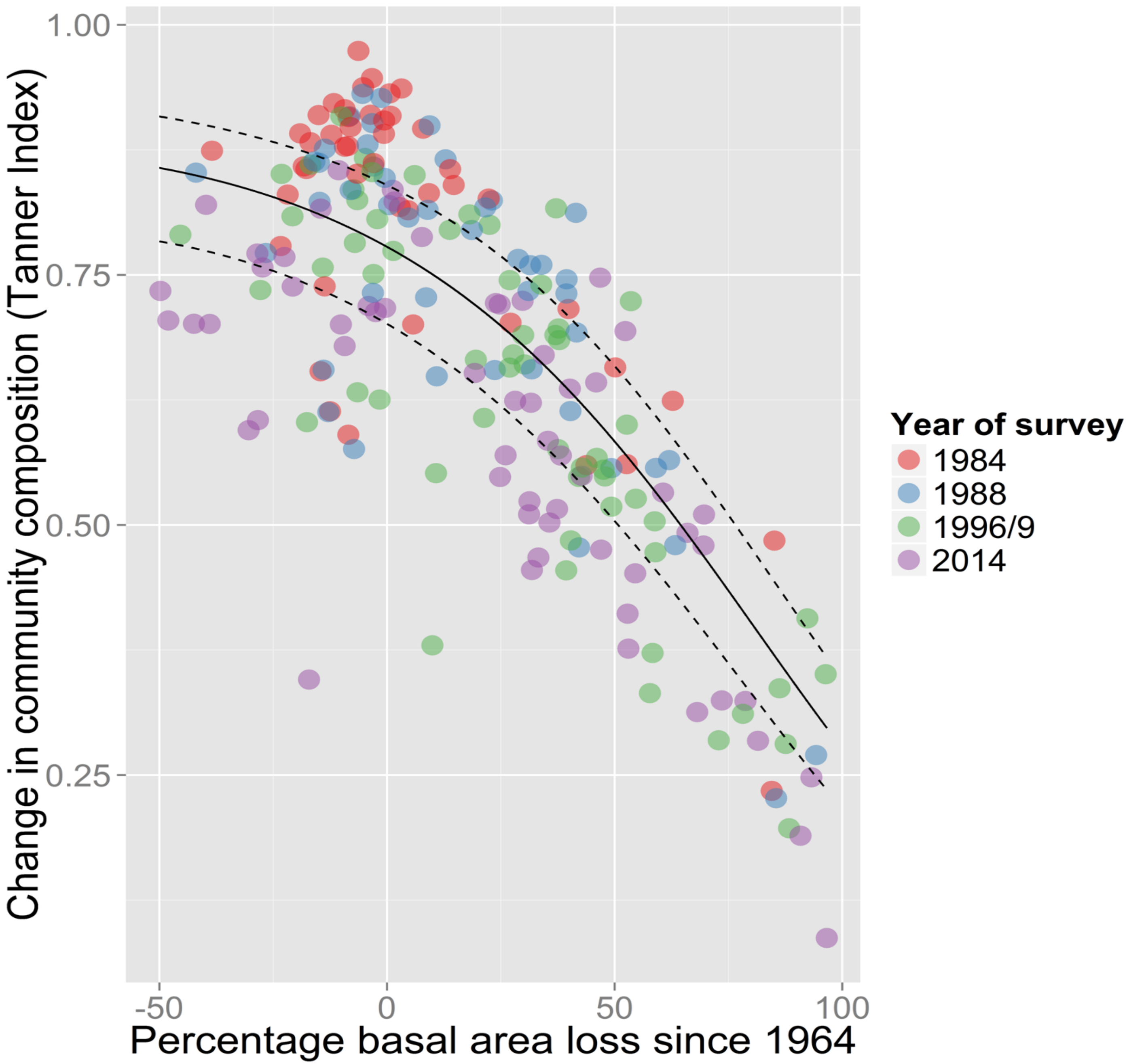


Long-term monitoring: Denny Wood



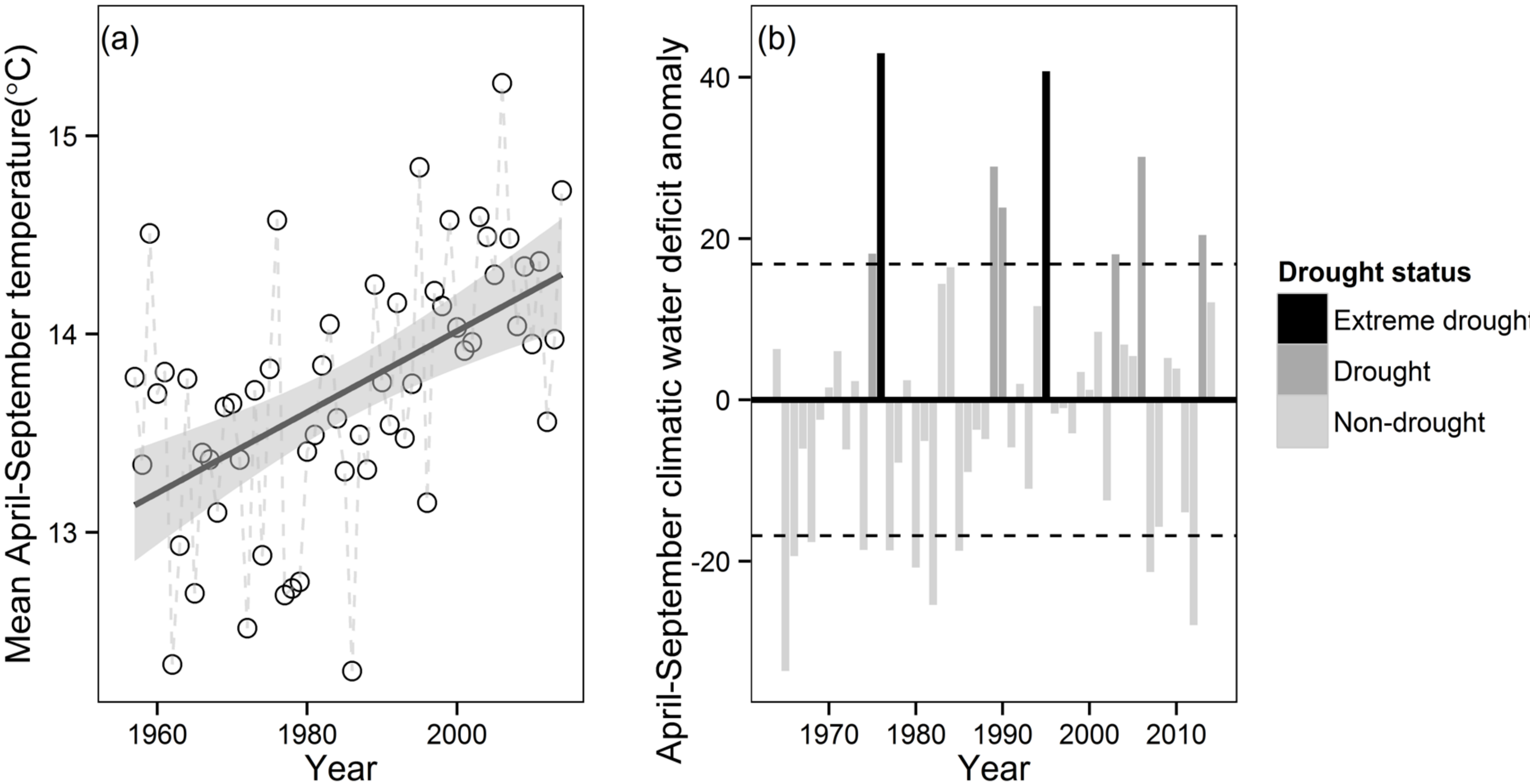
Long-term monitoring: Denny Wood





1.00
0.75
0.50
0.25
Change in community composition (Tanner Index)
-50
0
50
100
Percentage basal area loss since 1964
Year of survey
1984
1988
1996/9
2014

New Forest: climate



Martin, P., et al. (2015) Stand collapse in a temperate forest and its impact on forest structure and biodiversity. *Forest Ecology and Management* 358, 130-138.

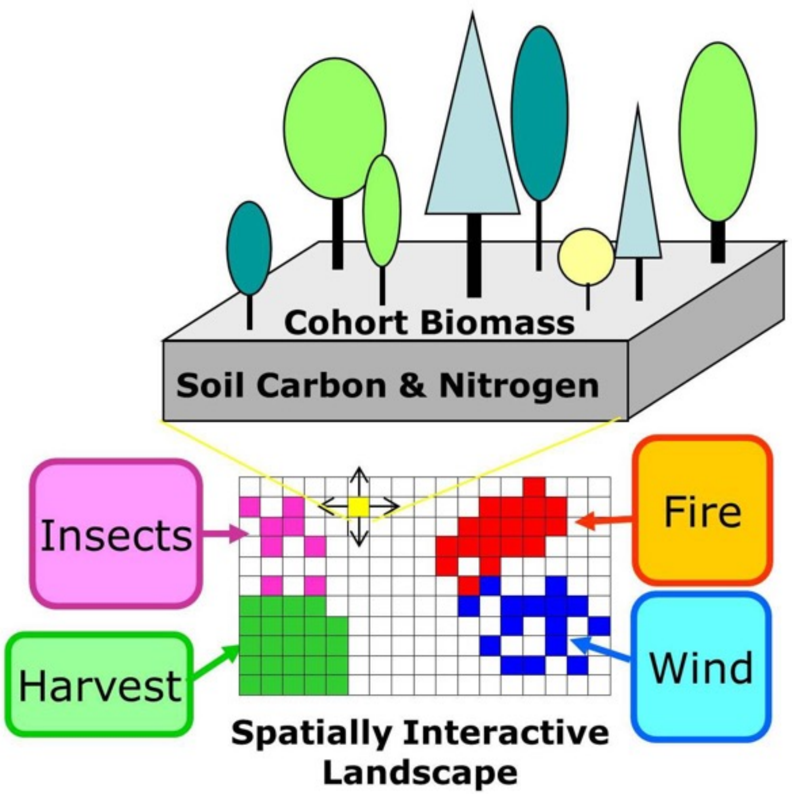
Martin, P., et al. (2017) Analysis of ecological thresholds in a temperate forest undergoing dieback. *PLoS ONE* 12(12), e0189578.

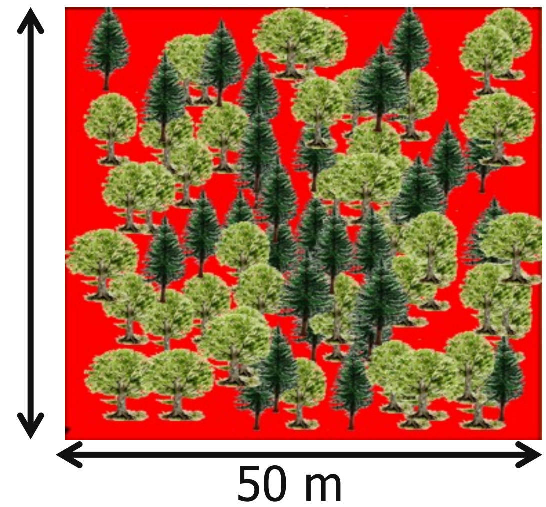
Denny Wood: unenclosed transect

- 50 years ago, this was closed forest, dominated by beech
- Now an open, park-like landscape, with grassy understorey, and most canopy trees are oak
- No evidence that beech is recovering, partly because browsing intensity is very high

New Forest: landscape modelling

LANDIS-II sponsored by Portland State University





- 223 survey plots (0.25 ha)
- Data collected on:
  - Dbh trees >10 cm
  - No of sapling
  - No of seedling
- Additional plots:
  - Soil data, ground flora, lichen, fungi, recreational and aesthetics values

Measuring resilience of wooded landscape

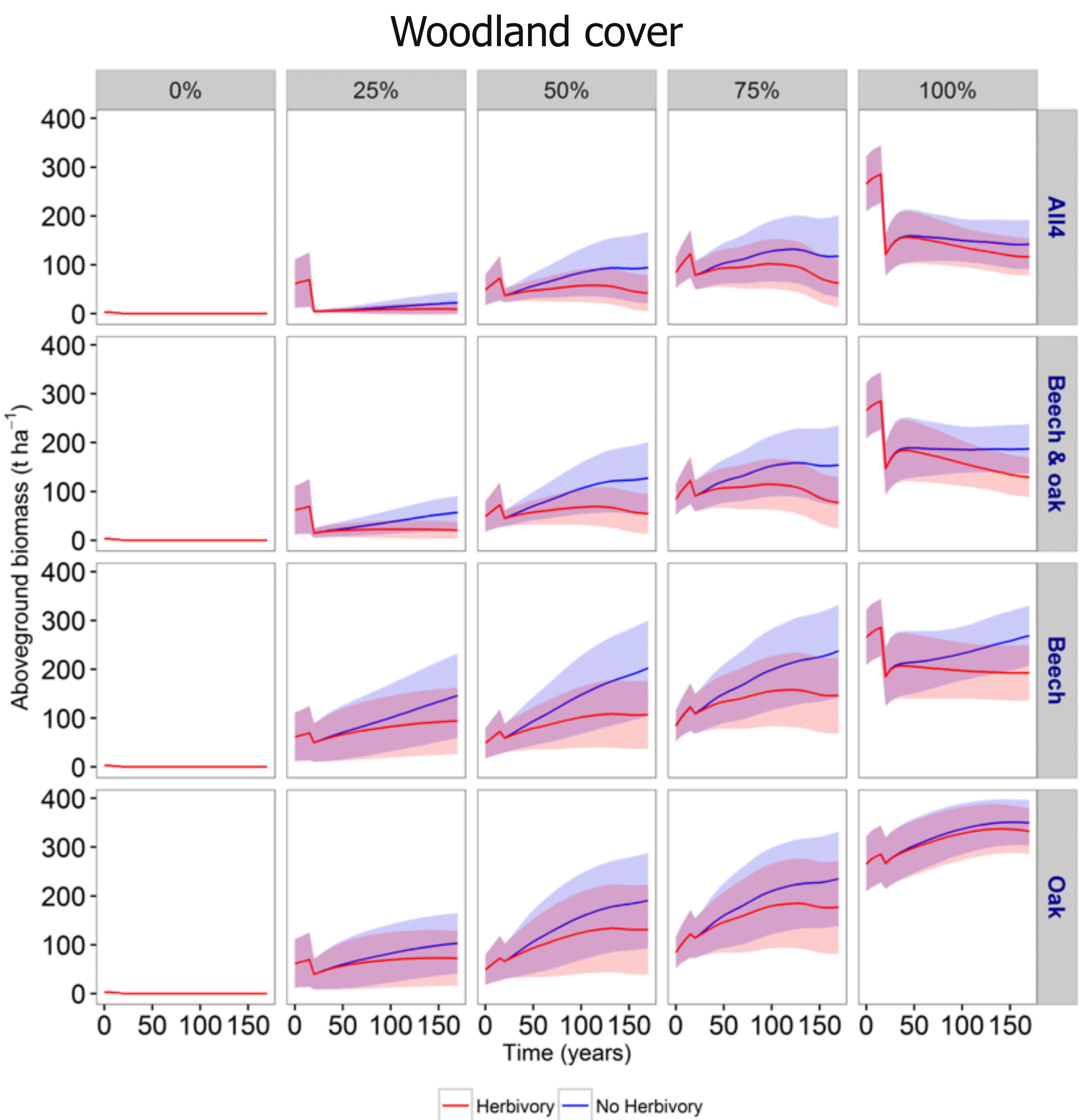
- We used a computer model of the New Forest, incorporating field data, to simulate the impact of different forms of disturbance

- For most measures of biodiversity, values declined sharply when disturbance affected >40% of the landscape.

- Browsing intensities observed in 2013 were found to reduce woodland resilience to episodic disturbance events, such as windthrow or pathogen attack

- Need to protect tree regeneration from herbivory to increase woodland resilience to environmental change

Measuring resilience of wooded landscape

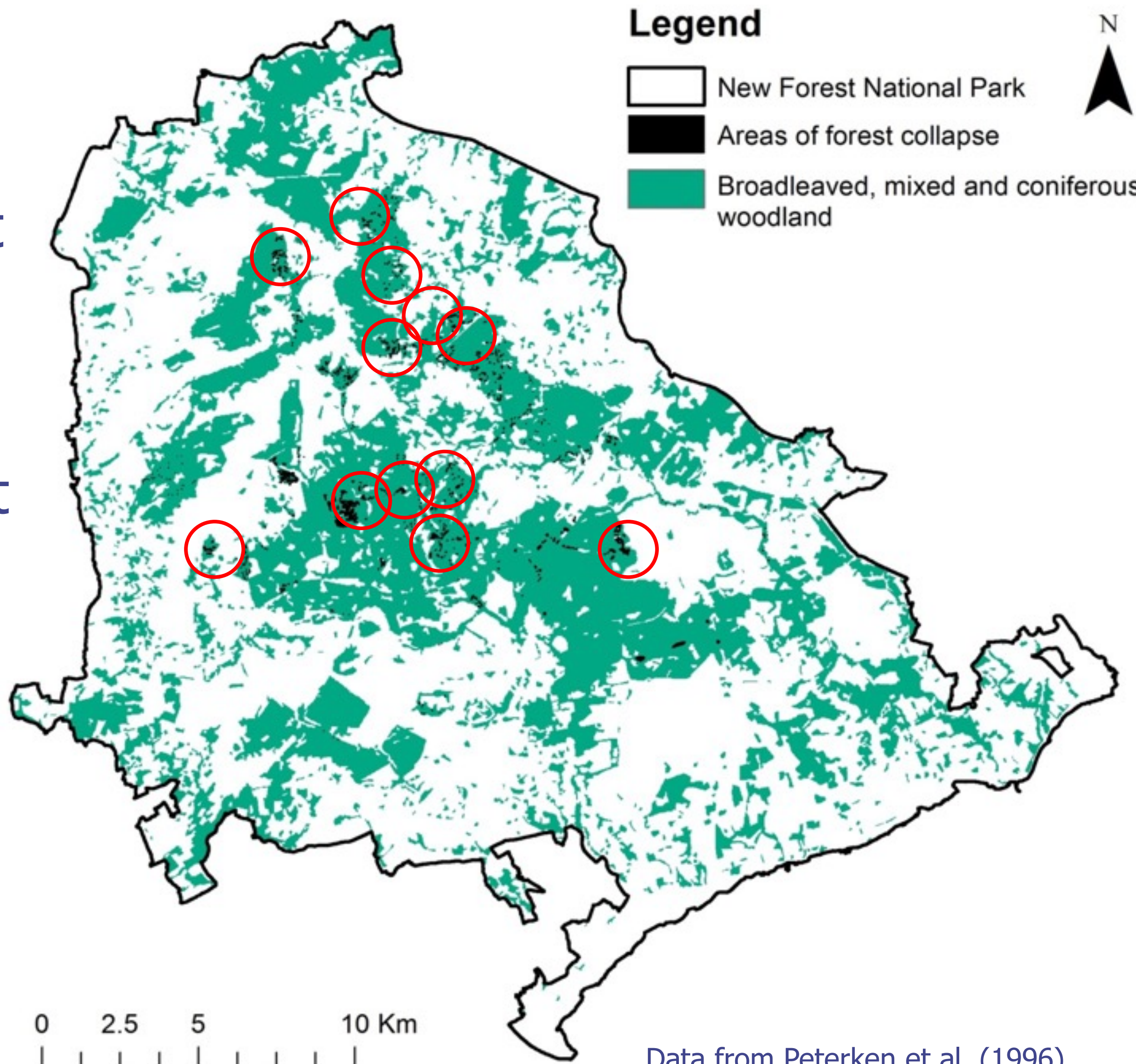


Cantarello et al. (2017) *Ecology and Evolution* 7, 9661-9675.

Beech dieback in the New Forest

Beech dieback is occurring throughout the New Forest woodlands

5 plots established at each site, along 12 gradients of collapse



Data from Peterken et al. (1996)

Monitoring condition of woodlands

- PhD studies of Paul Evans

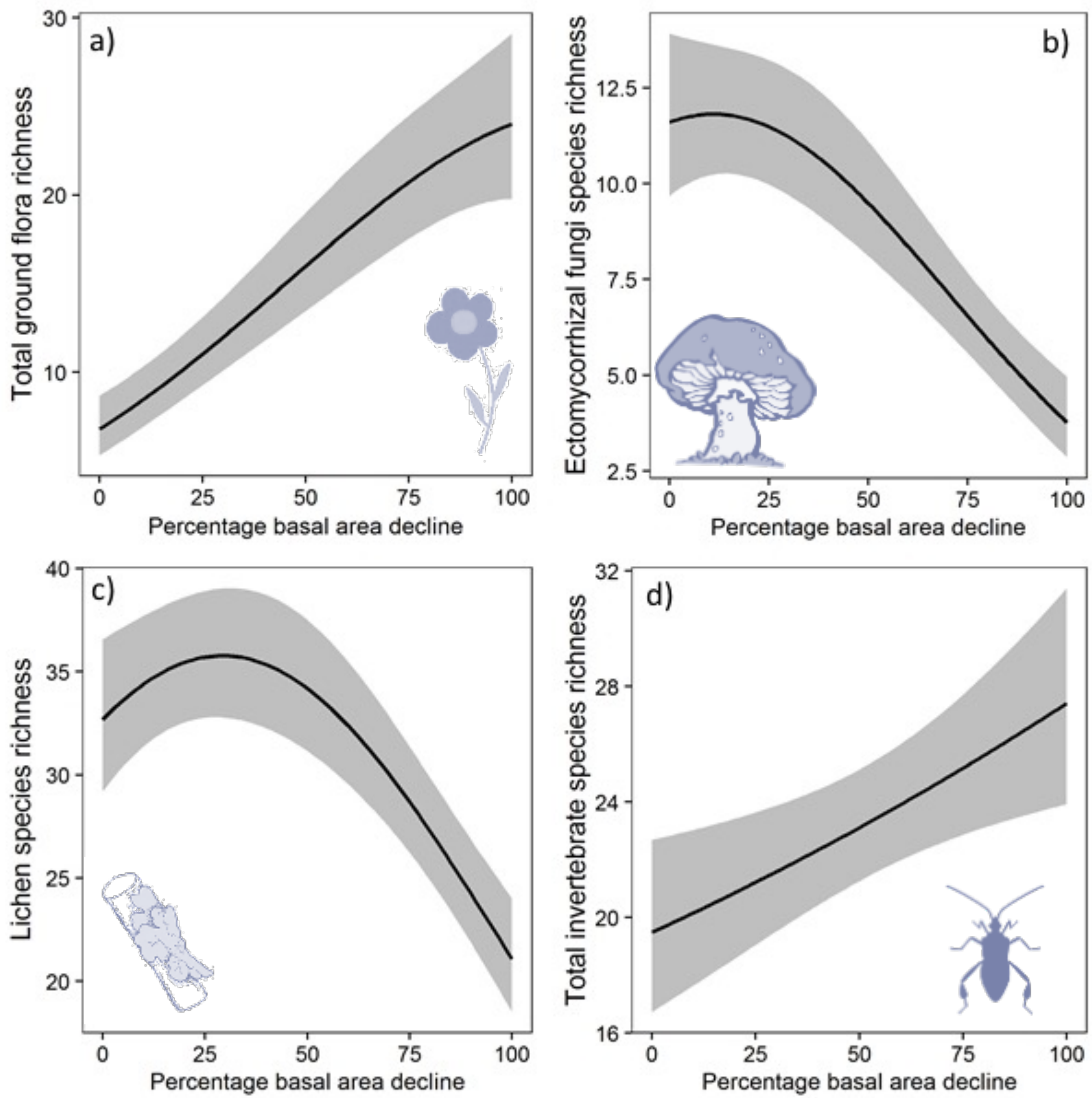
- Analysed 102 indicators along 12 replicate gradients of stand dieback, including CSM indicators

- CSM condition scores did not vary much across dieback gradients; few statistically significant results were detected

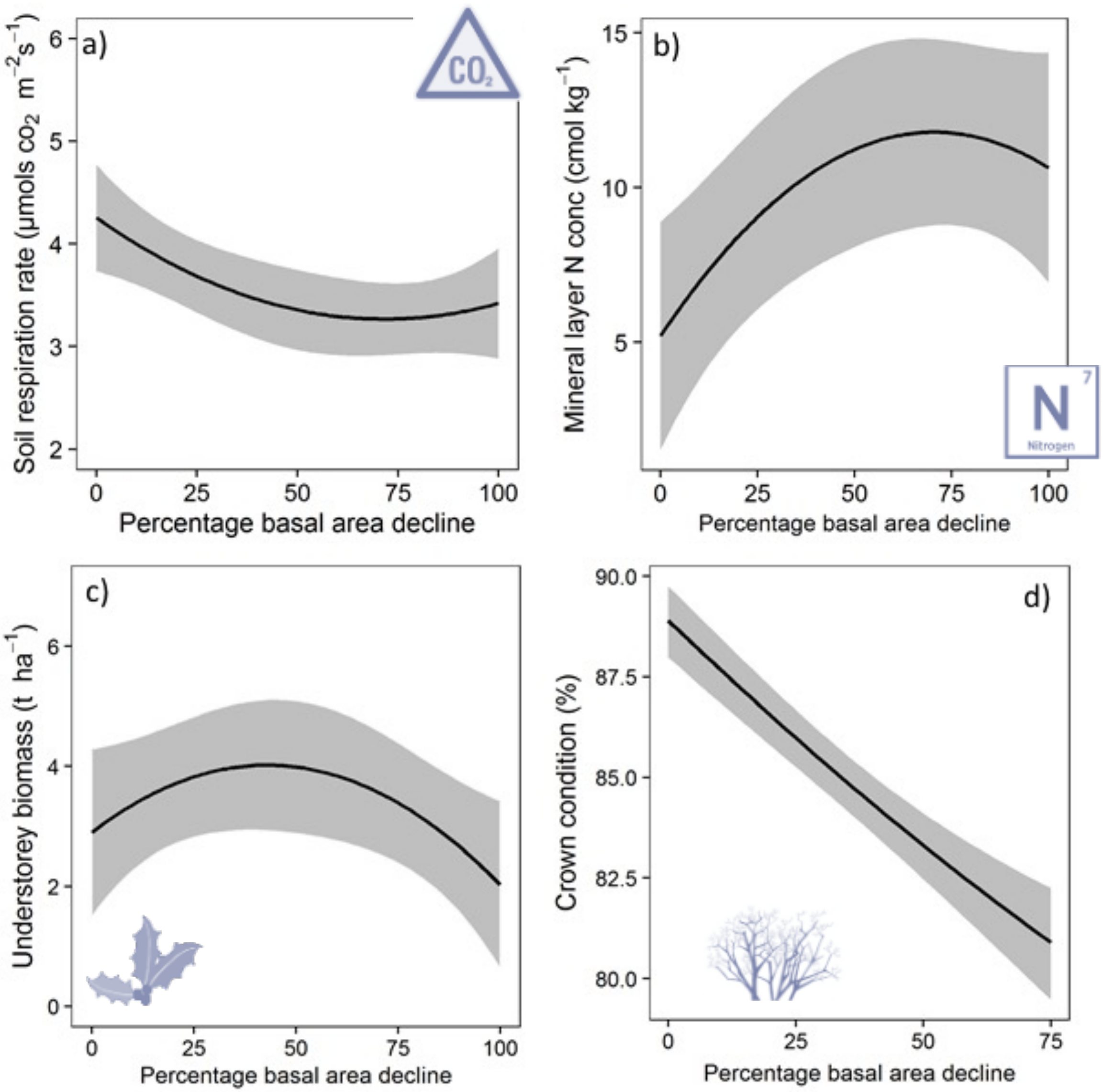
- 35 other indicators *did* display significant differences between dieback stages (eg measurements of canopy openness, litter cover, sward height, and deadwood volume)

Evans, PM et al. (2019) Testing the relative sensitivity of 102 ecological variables as indicators of woodland condition in the New Forest, UK. *Ecological Indicators* 105575.

Gradient analysis



Gradient analysis



Evans et al. (2017) Thresholds of biodiversity and ecosystem function in a forest ecosystem undergoing dieback *Science Reports* 7: 6775

Implications for the future New Forest

- Environmental change is already having an impact throughout the New Forest, and these impacts are likely to intensify in future

- Different pressures affecting the New Forest can also *interact*, further intensifying their impact

- How we use and manage the New Forest will affect its *resilience* to such pressures

- New Forest biodiversity is likely to change profoundly in coming decades – but how?







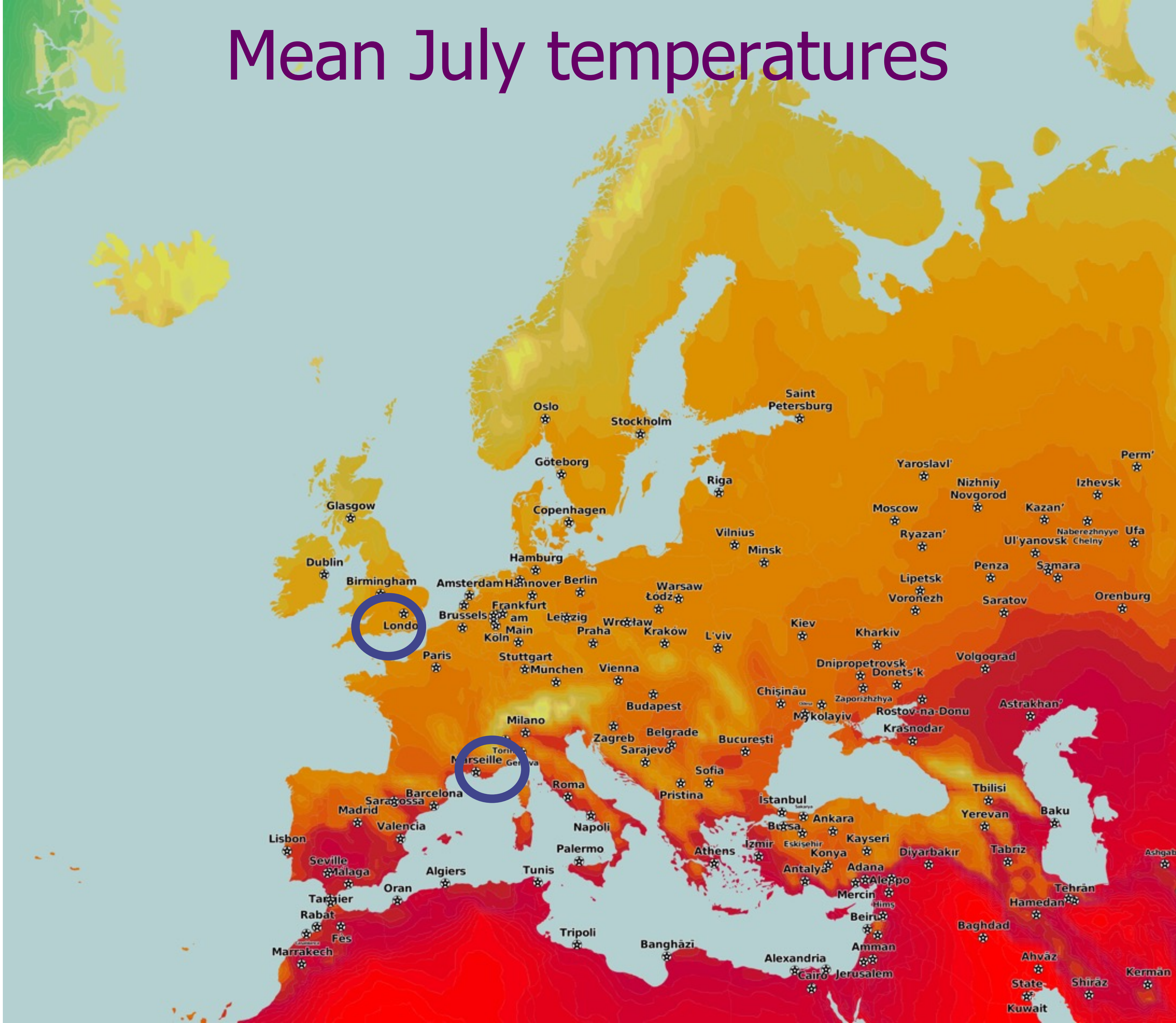


Loss of keystone species: beech

Loss of keystone species: heather

Damage by heather beetle *Lochmaea suturalis* more common when heather is droughted

Mean July temperatures



Conclusions

- Evidence indicates that climate change, eutrophication and livestock herbivory have already had a negative impact on New Forest biodiversity
- Together with pressures other pressures (invasive species, diseases, disturbance changes etc.), these impacts are likely to intensify in future
- Different pressures can interact, increasing their impacts
- Livestock herbivory and trampling are reducing resilience and undermining restoration efforts

Recommendations for future monitoring

- The future New Forest is going to be a very different place – so we should monitor change as it happens
- Species are being lost, and new species are arriving, all the time – but we lack evidence of what is happening, owing to a lack of systematic monitoring
- We also need improved monitoring of habitat condition, as CSM is inadequate
- We also need to better monitor threats (eg spread of tree diseases, invasive species etc.)
- Permanent sample plots are invaluable for detecting long-term change

Appendices

List of recent publications

- Lovegrove, A.T., Newton, A.C., Evans, P.M., Diaz, A., Newton, A.C., Davy, L. and Newbould, P.J. (2020). Changes in vegetation structure and composition of a lowland mire over a sixty-five-year interval. *Ecology and Evolution* 10(24), 13913-13925.
- Evans, P.M., Newton, A.C., Cantarello, E., Sanderson, N., Jones, D.L., Barsoum, N., … Fuller, L. (2019). Testing the relative sensitivity of 102 ecological variables as indicators of woodland condition in the New Forest, UK. *Ecological Indicators* 107, 105575.
- Gosal, A. S., Newton, A. C., & Gillingham, P. K. (2018). Comparison of methods for a landscape-scale assessment of the cultural ecosystem services associated with different habitats. *International Journal of Biodiversity Science, Ecosystem Services & Management* 14(1), 91–104.
- Martin, P., Newton, A.C., Cantarello, E., Evans, P.M. (2017) Analysis of ecological thresholds in a temperate forest undergoing dieback. *PLoS ONE* 12(12), e0189578. https://doi.org/10.1371/journal.pone.0189578
- Cantarello, E., Newton, A.C., Martin, P.A., Evans, P.M., Gosal, A. and Lucash, M.S. (2017) Quantifying resilience of multiple ecosystem services and biodiversity in a temperate forest landscape. *Ecology and Evolution* 7(22), 9661-9675.

List of recent publications

- Evans, P.M., Newton, A.C., Cantarello, E., Martin, P., Sanderson, N., Jones, D.L., Barsoum, N., Cottrell, J.E., A'Hara, S.W. and Fuller, L. (2017) Thresholds of biodiversity and ecosystem function in a forest ecosystem undergoing dieback. *Scientific Reports* 7, Article number: 6775 doi: 10.1038/s41598-017-06082-6
- Martin, P.A., Newton, A.C. and Bullock, J.M. (2017) Impacts of invasive plants on carbon pools depend on both species' traits and local climate. *Ecology* 98(4), 2017, pp. 1026–1035
- Spake, R., van der Linde S., Newton A.C., Suz L.M., Bidartondo, M.I., and Doncaster, C.P. (2016) Similar biodiversity of ectomycorrhizal fungi in set-aside plantations and ancient old-growth broadleaved forests. *Biological Conservation* 194, 71–79.
- Spake, R., Barsoum, N., Newton, A.C. and Doncaster, C.P. (2016) Drivers of the composition and diversity of carabid functional traits in UK coniferous production forests. *Forest Ecology and Management* 359, 300-308.
- Martin, P.A., Newton, A.C., Pfeifer, M., Khoo, M. and Bullock, J.M. (2015) Species richness and carbon storage responses to reduced impact logging in tropical forests: a meta-analysis. *Forest Ecology and Management* 356, 224-233.

List of recent publications

- Martin, P., Newton, A.C., Evans, P., and Cantarello, E. (2015) Stand collapse in a temperate forest and its impact on forest structure and biodiversity. *Forest Ecology and Management* 358, 130-138.
- Douglas, S., Newton, A.C. (2014). Evaluation of Bayesian networks for modelling habitat suitability and management of a protected area. *Journal of Nature Conservation* 22, 235-246.
- Newton, A.C., Cantarello, E., Tejedor, N. and Myers, G. (2013). Dynamics and conservation management of a wooded landscape under high herbivore pressure. *International Journal of Biodiversity.* Article ID 273948, 15 pp. doi:10.1155/2013/273948
- Newton, A.C. (2011). Social-ecological resilience and biodiversity conservation in a 900-year-old protected area. *Ecology and Society* 16(4), 13. http://dx.doi.org/10.5751/ES-04308-160413
- Cantarello, E. and Newton, A.C. (2008). Identifying cost-effective indicators to assess the conservation status of forested Natura 2000 sites. *Forest Ecology and Management* 256, 815-826.

List of recent publications

- Newton, A.C., Cantarello, E., Douglas, S., Martin, P., Evans, P., Gosal, A. (2015) Managing landscape resilience: the example of the New Forest. In: Wild Thing? Managing landscape change and future ecologies. Ed. I.D. Rotherham and C. Handley. Pp. 123-144. Wildtrack Publishing, Sheffield.
- Newton, A.C. (2013). Biodiversity conservation and the traditional management of common land: the case of the New Forest. In *Cultural severance and the environment*. *The ending of traditional and customary practice on commons and landscapes managed in common*. Ed. I. Rotherham. Springer Verlag. Pp. 353-370.
- Newton, A.C., Cantarello, E., Lovegrove, A., Appiah, D., Perrella, L. (2013). The influence of grazing animals on tree regeneration and woodland dynamics in the New Forest, England. In *Trees, Forested Landscapes and Grazing Animals - A European Perspective on Woodlands and Grazed Treescapes* pp. 163-179. Ed. I. Rotherham. Routledge, Oxford.

Species group	**No. species of conservation concern**	**Estimated total no. of species**	**Approx. percentage of total number of species in Britain**
Birds	37	302	17%
Mammals other than bats	3	19	35%
Bats	13	13	81%
Reptiles and amphibians	12	12/13	92%
Fish	>2	22	88%
Invertebrates	544	5000-10,000	17-33%
Dragonflies and damselflies	9	31	69%
Saproxylic beetles	53	326	55%
Butterflies and moths	72 RDB, and 192 NN	1488 (of which 33 are butterflies)	66%
Other invertebrates	403 including Coleoptera, Hymenoptera, Diptera, Orthoptera, Hemiptera, Crustacea	1539 Coleoptera, 22 Orthoptera, 296 taxa of macro-invertebrate recorded from Forest streams	
Vascular plants	72 RDB, 43 nationally rare or scarce	Approx. 540	36%
Lichens	64 RDB, plus 78 other	421	18%
Fungi	89	2600	22%
Bryophytes	33	326	32%

From Newton (2010) Biodiversity in the New Forest

Species trends

Species group	Trends
Birds	>3 species lost during the last century. Some species (such as nightjar and woodlark) are stable or increasing, others (such as Dartford warbler, snipe, curlew and redshank) are declining.
Bats	No evidence of species losses. Insufficient data to determine trends.
Reptiles and amphibians	One extinction of a native species (Natterjack toad). Sand lizard lost but reintroduced.
Fish	No evidence of losses. Insufficient data to determine trends.
Vascular plants	One species known to have gone extinct in the middle of the 20th century: summer lady's-tresses (*Spiranthes aestivalis*). Little evidence of declines in species, although few monitoring data available.
Lichens	Few monitoring data available. Most uncommon species appear to be stable. A total of 13 species were recorded from New Forest woods in the 19th century and have not yet been refound, and may therefore be extinct. In addition, four leafy species recorded since 1967 appear to have been lost and a further four are declining and rare.
Fungi	Few monitoring data available. Little evidence of declines. Extinctions hard to evaluate although 18 species of conservation concern have not been seen in the past 50 years and may be extinct.
Bryophytes	Four species of liverwort have apparently become extinct. Most species generally stable.

Species trends

Species group	Trends
Invertebrates	
Dragonflies and damselflies	One extinction. Some evidence of historic declines in some species; others appear stable.
Saproxylic beetles	>5 species believed to be extinct; 27 further species not reported in past 25 years. Insufficient data to determine trends, although some species appear to have declined.
Butterflies and moths	General decline of many species in recent decades; 124 species believed to have been lost.
Other invertebrates	Insufficient data to determine trends. Some extinctions are likely to have occurred as many rare species have not been recorded for a long time, e.g. New Forest cicada may now be extinct. Groups such as Orthoptera appear to have undergone significant declines.

Key finding: Information is lacking on most species. We need much greater monitoring efforts to determine how species are faring.

Climate change in the New Forest

Compared to 1990, by 2070 the Met Office projects:

- Winters will be between 1 and 4.5 ^{o}C warmer
- Winters will be up to 30% wetter
- Summers will be between 1 and 6 ^{o}C warmer
- Summers will be up to 60% drier
- Hot summer days will be between 4 and 7 ^{o}C warmer

Climate change in the New Forest

- Hot spells will become more frequent and severe.
- The intensity of rainfall will increase.
- Extreme events (eg droughts, storms, floods) will become more likely.
- There will be no ‘new normal’, the climate will keep on changing.