

The extinction debt on fragmented landscapes

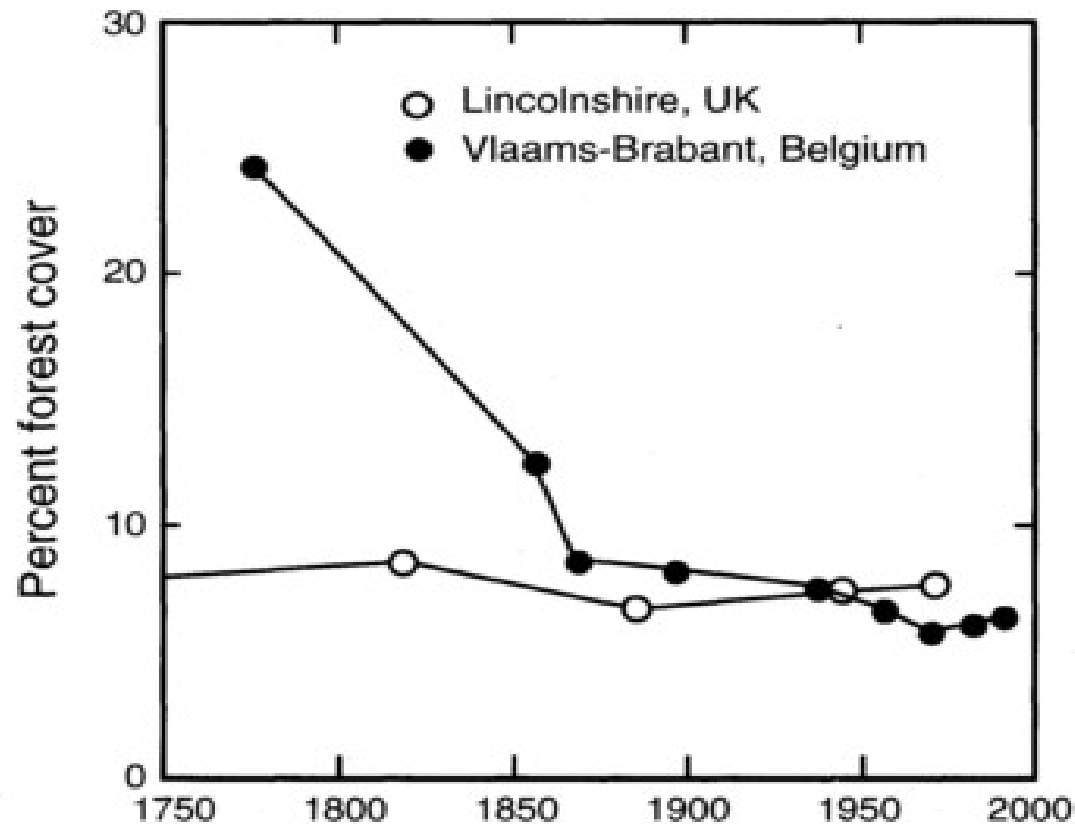


FIG. 1. Changes in percent forest cover in Lincolnshire, United Kingdom, and Vlaams-Brabant, Belgium, since 1750.

What is an extinction debt?

- When landscapes are fragmented theory predicts that species are likely to go extinct in small, isolated fragments.
- The process has been called “relaxation” i.e. a slide back towards an equilibrium
- However: This process may take some time to occur. Long lived species may persist for years, decades or even centuries before being lost

Evidence

- Testing whether an extinction debt actually occurs is challenging.
- In some cases there are long term data sets (for example Lovejoy's fragments in the Amazon)
- Historical data can provide insight
- However in many cases the evidence is indirect.

Evidence

- Deviations from expected species-area curve (eg. Diamond 1972)
- Isolated areas have less species than would be expected given their size
- Snapshot and may not reflect extinction debt if isolation has been recent

Evidence

- Missing species that would be expected to be found in the fragments
- Short lived species or species with large fluctuations in demographic parameters expected to be lost first

A test

- Look at patch occupancy for species in two contrasting areas
 - Patch occupancy should be lower in an area that has been fragmented for a greater time
 - Contrast Belgium with Lincolnshire
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- Vellend, M., Verheyen, K., Jacquemyn, H., Kolb, A., Van Calster, H., Peterken, G. & Hermy, M. (2006) Extinction debt of forest plants persists for more than a century following habitat fragmentation. *Ecology*, 87, 542–548.

History of deforestation in Lincolnshire and Belgium

- Lincolnshire historically low (5 to 8%) for over 1000 years
- Belgium more recent history of change
- 25% 1775 to 10% in 1875
- Currently both landscapes are similarly fragmented.

History of deforestation in Lincolnshire and Belgium

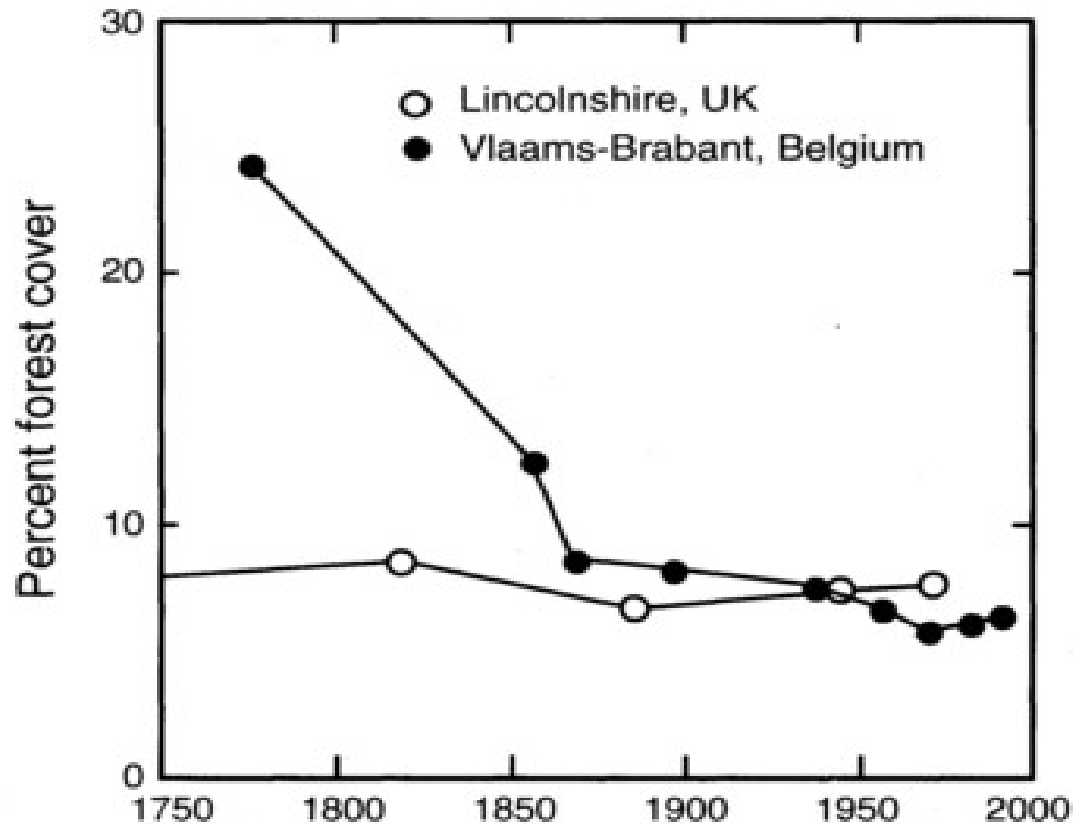


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Predicting Belgian patch occupancy using model fit to Lincolnshire data

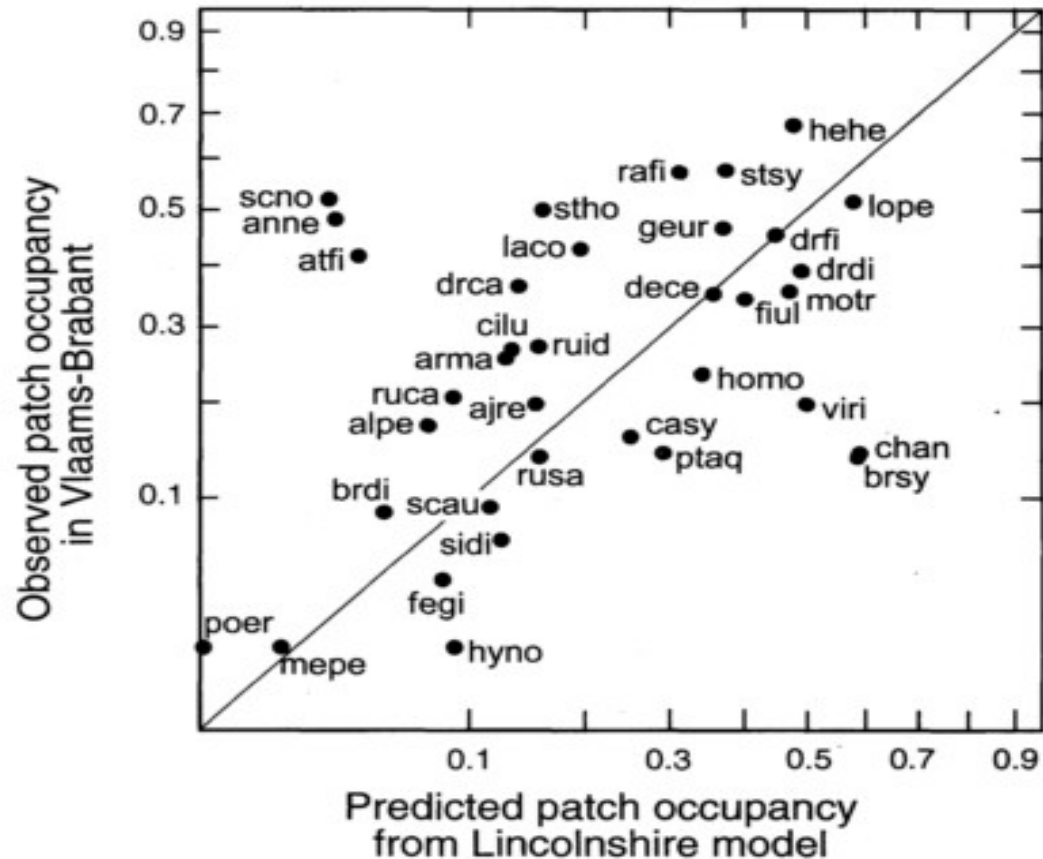


FIG. 2. Observed average patch occupancy for 36 species in Vlaams-Brabant vs. predicted patch occupancy based on logistic regression models parameterized with data from Lincolnshire ($r = 0.43$, $P = 0.009$). The diagonal is the 1:1 line.

Traits

March 2006

EXTINCTION DEBT FOR FOREST PLANTS

545

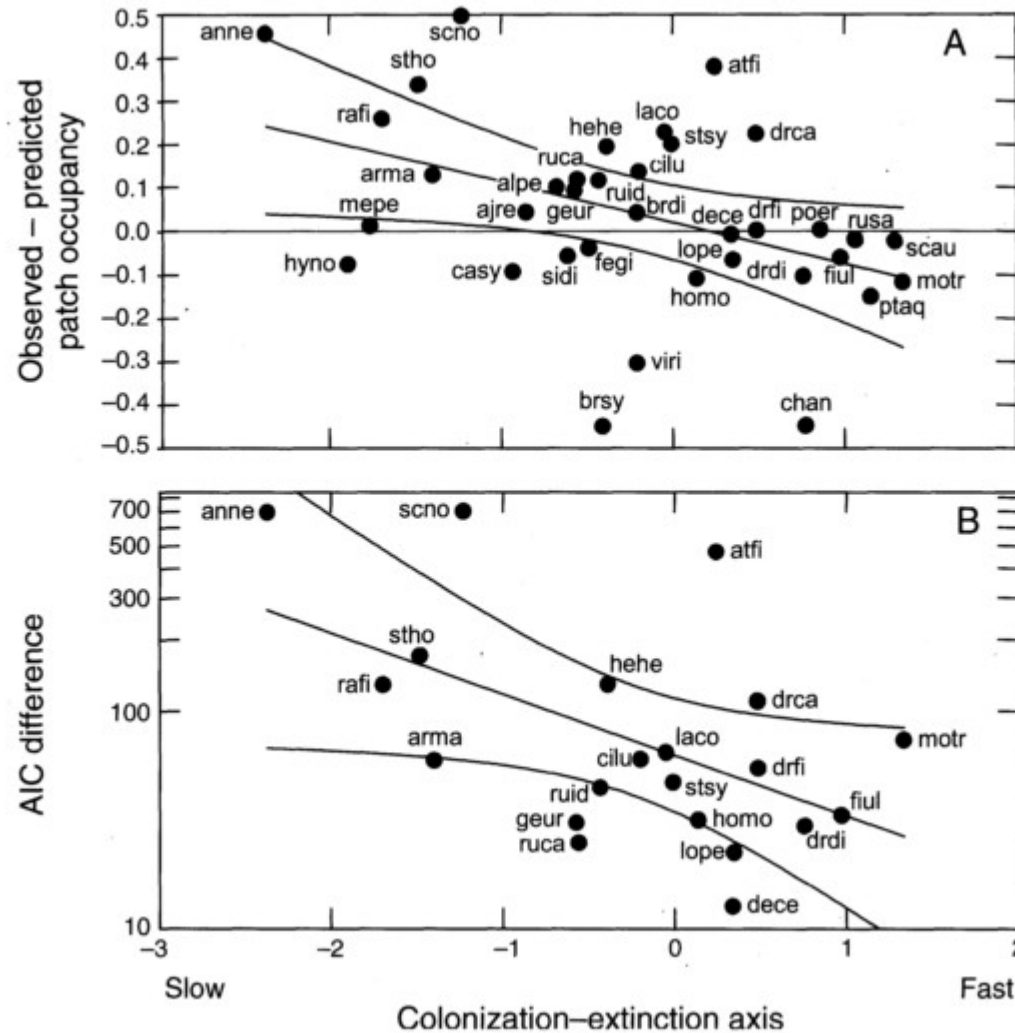


FIG. 3. (A) The difference between observed and predicted patch occupancies (see Fig. 2) vs. species' positions on a colonization-extinction axis for 36 species ($r^2 = 0.18$, $P = 0.009$). Colonization and extinction rates increase from left to

Historical effects

- Another demonstration of the importance of history
- Time lags of 50-100 years in response of species.
- Present day connectivity does not predict as well as past connectivity
- Lindborg, R. (2004) Historical landscape connectivity affects present plant species diversity. *Ecology*, 85, 1840-1845.

Fragmentation of grassland in Sweden

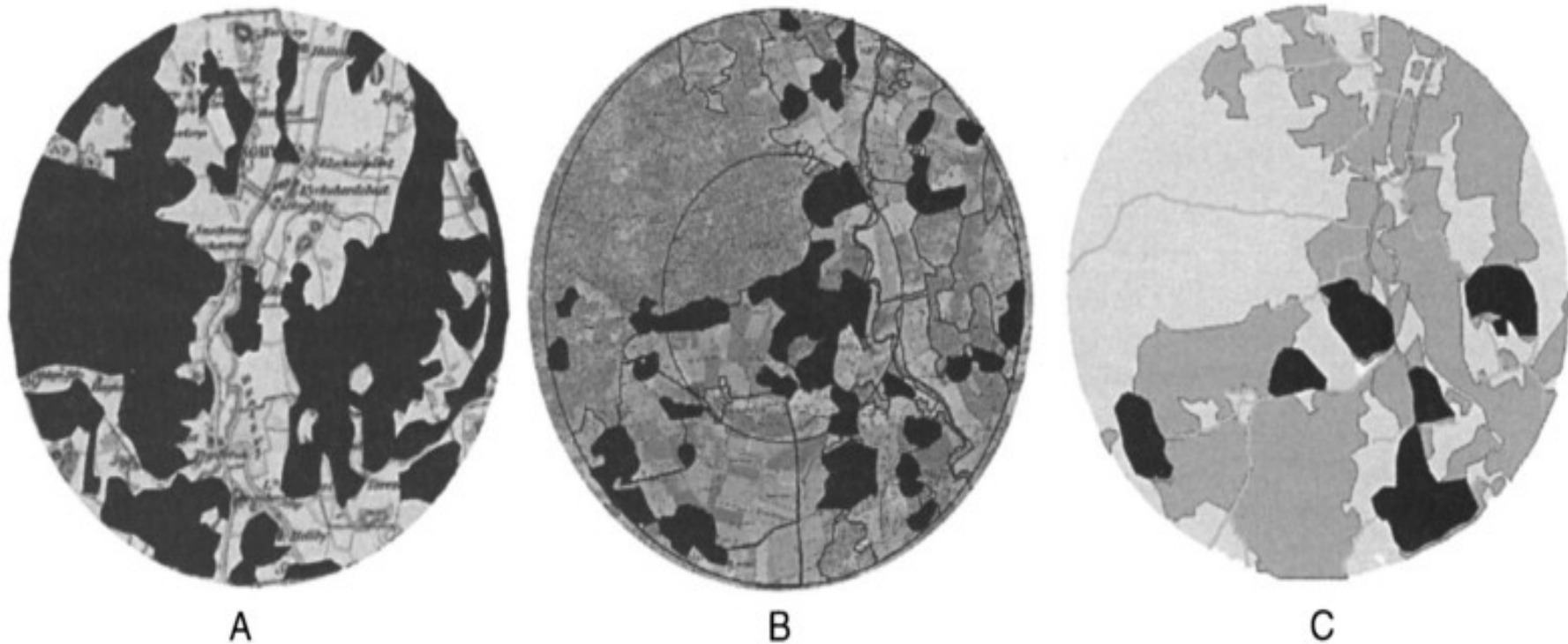


FIG. 1. Distribution of seminatural grasslands (marked in black) in one of the study sites in Sweden representing tree time layers: (A) 1900, (B) 1950, and (C) the present. Each circle has a radius of 2 km.

Species richness related to historical connectivity

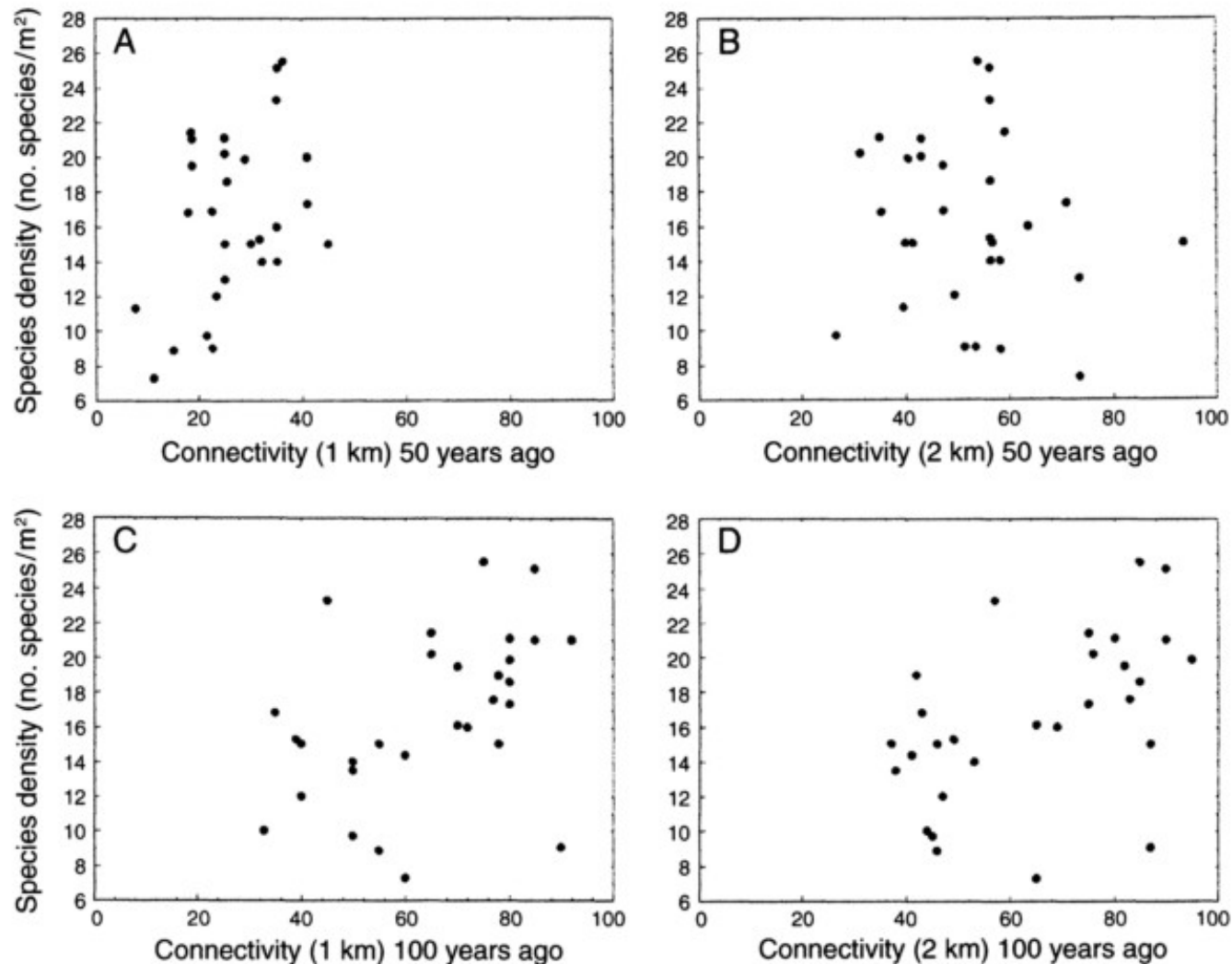


FIG. 2. The relationships between species density (species/m²) in Swedish seminatural grasslands and site connectivity 50 and 100 years ago, at two different spatial scales.