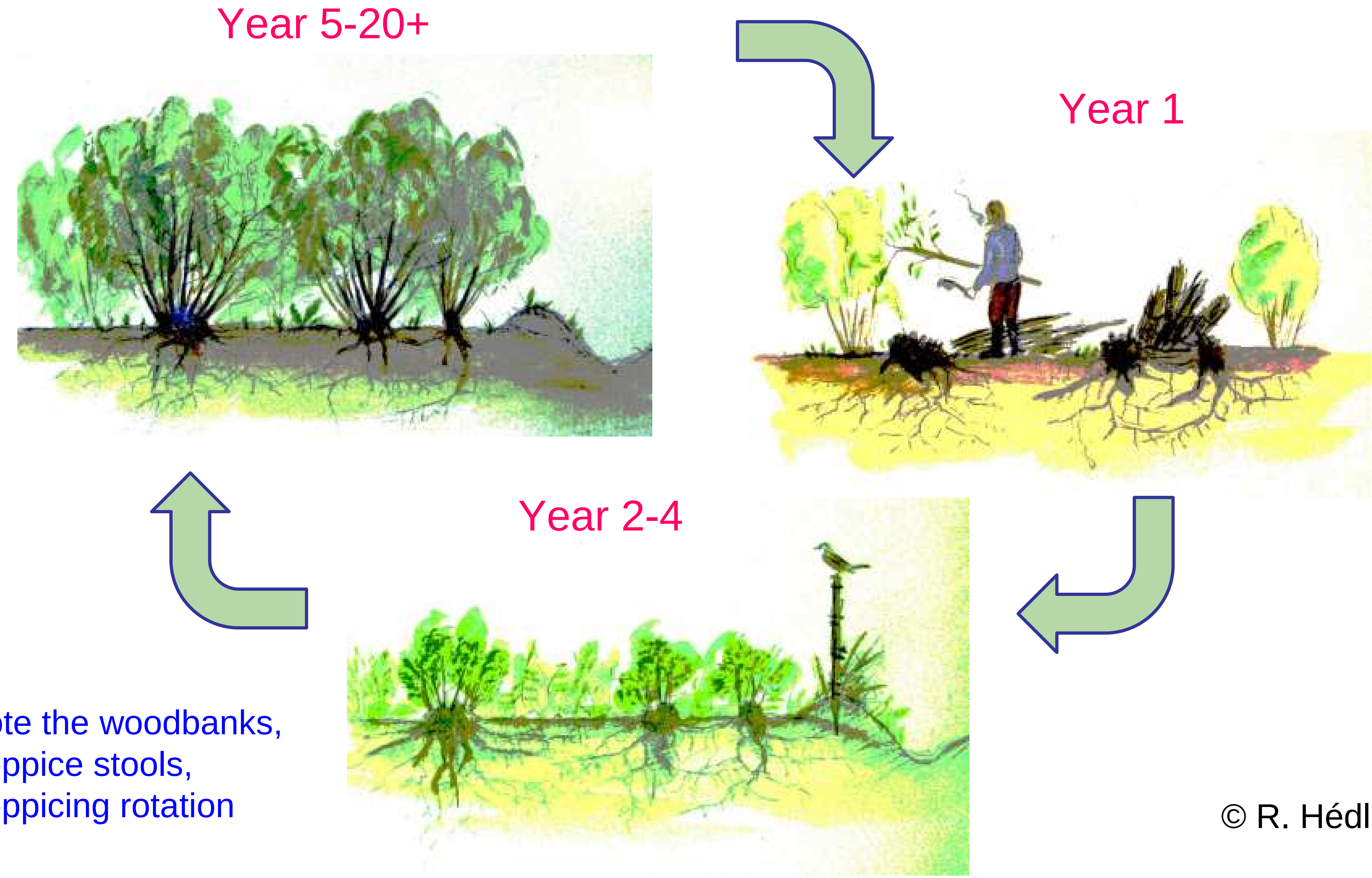
4th EuroCoppice Training School
Boppard, Germany
July 17-23, 2016

Contents:
- ecological features of coppices
- measuring biological diversity
- sampling of vegetation communities

Radim Hédl
Institute of Botany, The Czech Academy of Sciences
Brno, Czech Republic
http://ekolbrno.ibot.cas.cz
http://www.longwood.cz

Coppicing

Short-rotation forest management system utilizing natural resprouting ability of deciduous tree species



note the woodbanks,
coppice stools,
coppicing rotation

Active coppice-with-standards
Bradfield Woods, Suffolk, UK

Abandoned coppice-with-standards
Děvín, Pálava, SE Czech Republic

Converted coppice-with-standards
Bacín, central Bohemia, Czech Republic

Why care about coppicing?

Ancient forest management system, once widespread

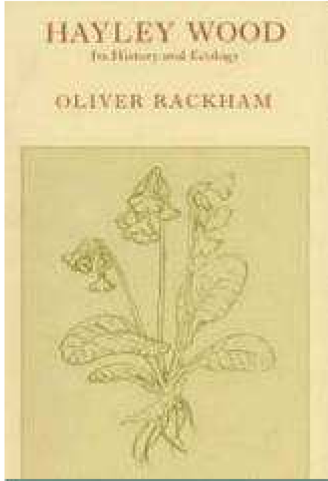
Likely shaped composition and diversity of forest communities

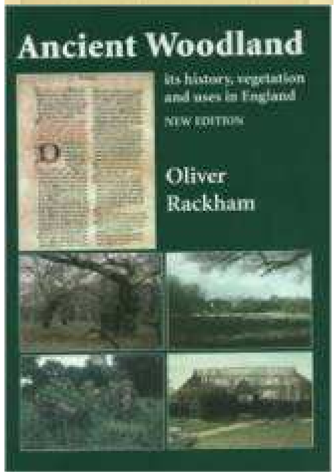
Recent focus of conservationists and foresters

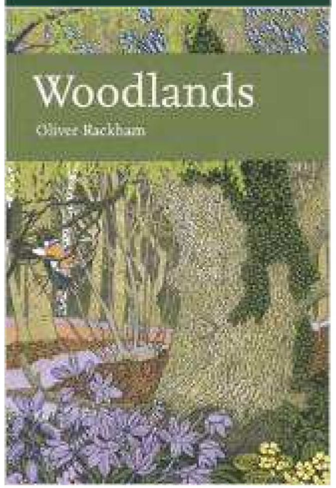
- declining species and habitats
- woody biomass production

Oliver Rackham

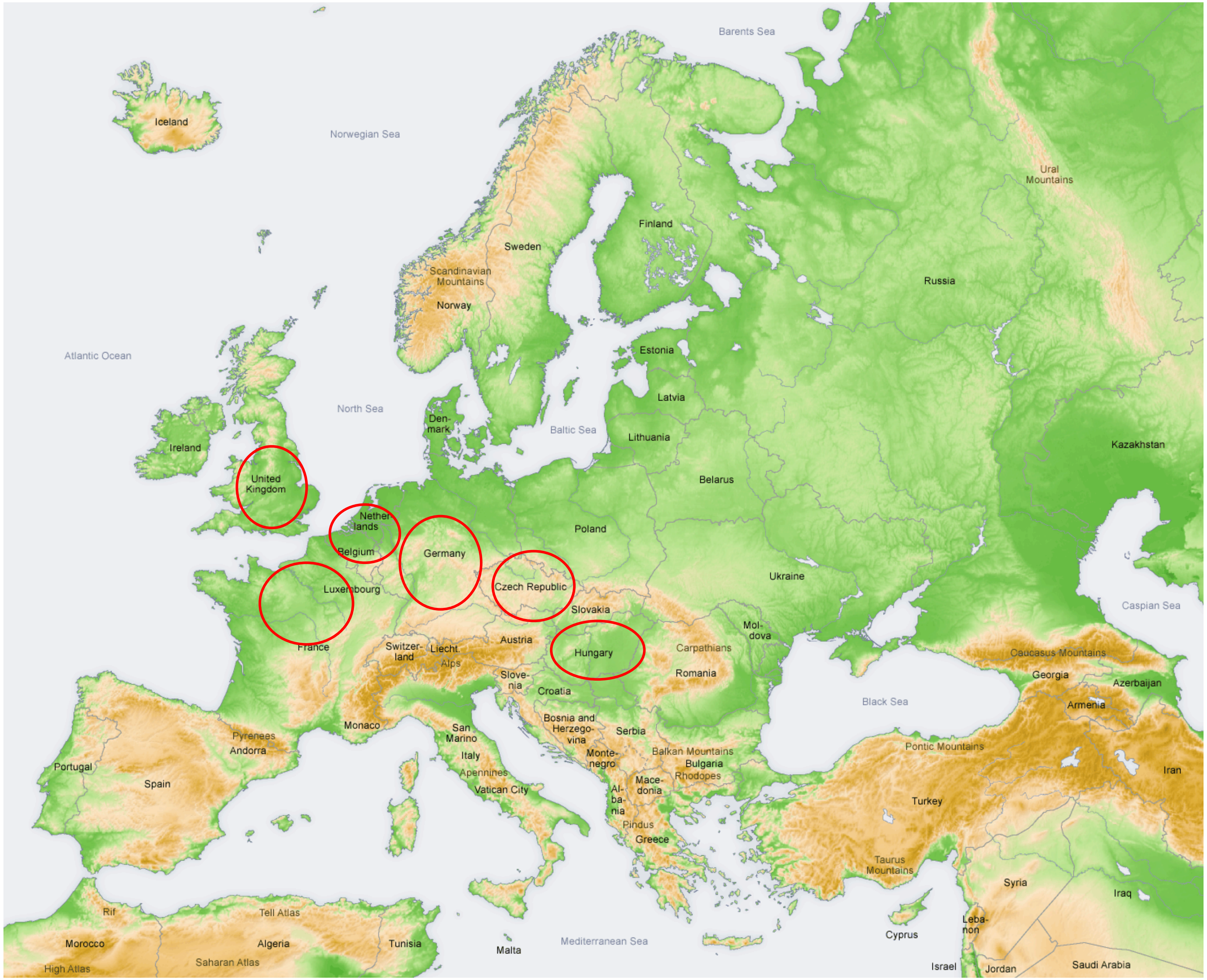
Classic of woodland history research
(Hayley Wood, England, September 2008)







Coppicing in European lowlands in the Middle Ages



Charters

A.D.1249

Szabó et al., 2015, Journal of Historical Geography

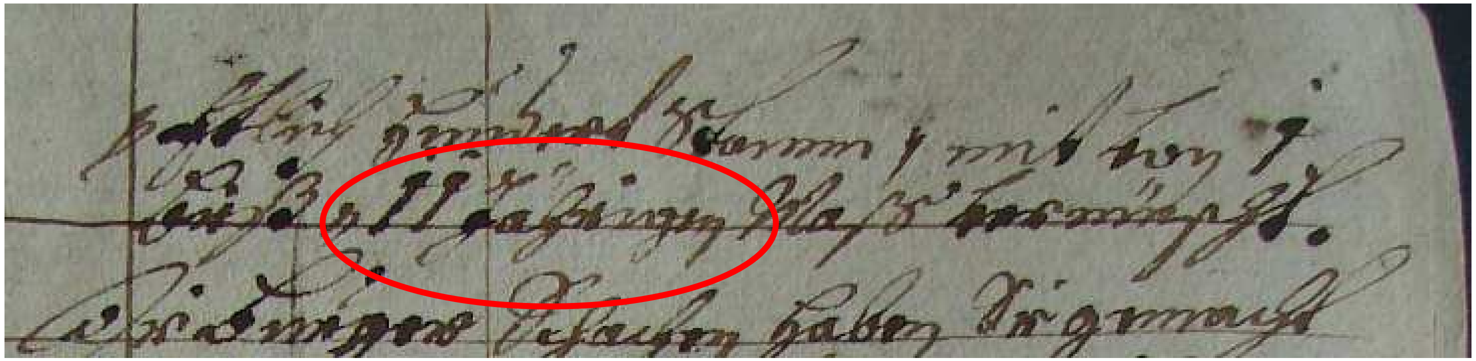
Coppicing cycles – how often were forests cut

Mikulov estate (SE Czech Repubic)

Urbarium from 1384:

“Das holcz, das do get niderhalb des wegs durich die Chlausen, das haist der Lelasch, und ist deselb zeit 2 jar alt gevesen; wann er zw 7 jarn chumpt, so schaczt mann für 36 lb. und 2 lb. ze leitchauff.”

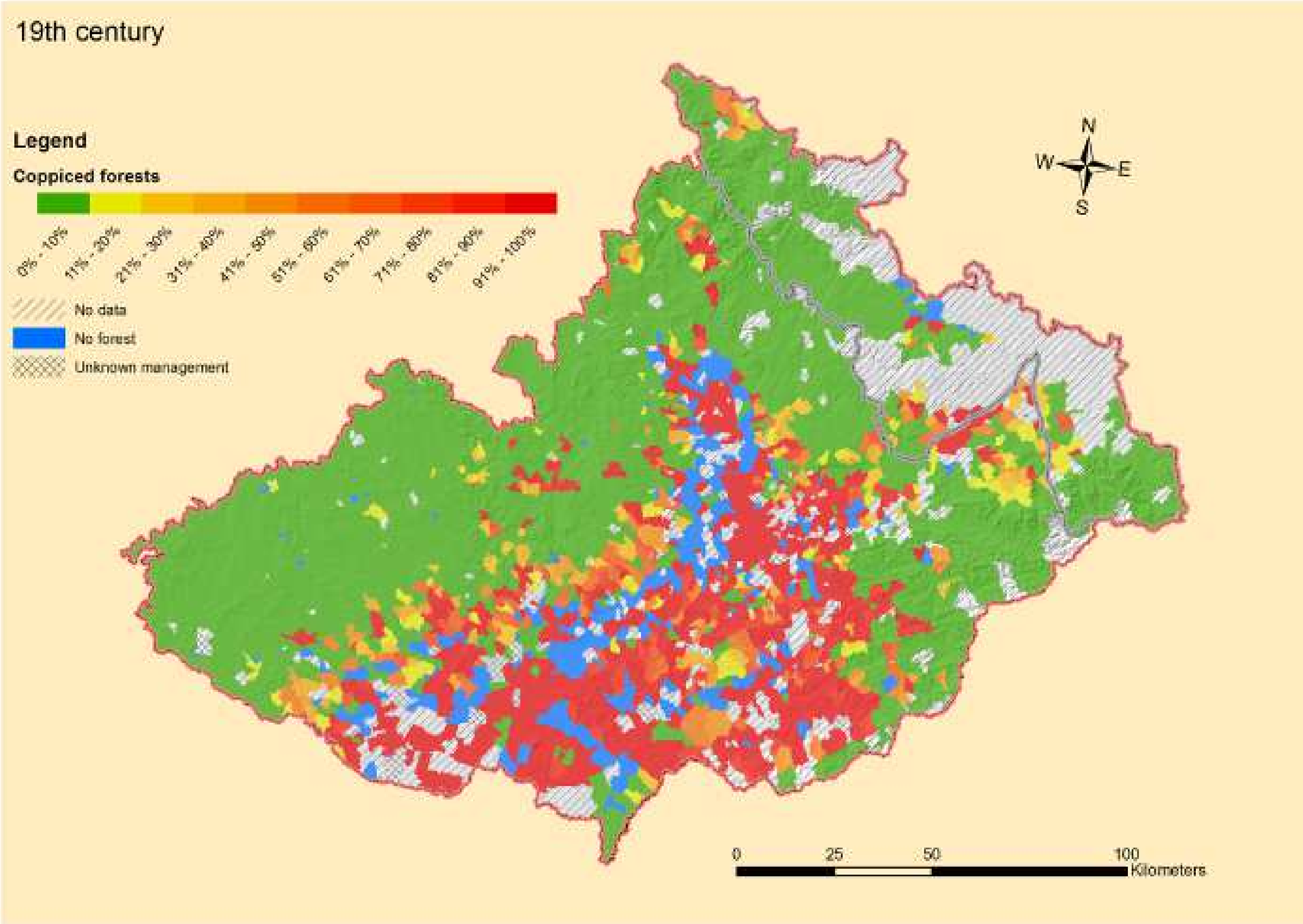
Forest description from 1692:



Coppicing in the 19th century

Moravia, eastern Czech Republic, 28,000 km^2

Source: historical forest database, www.longwood.cz



Perspectives of coppicing research in ecology

1. Long-term legacy of coppicing at the landscape scale

2. Consequences of coppicing abandonment in the 20th century

3. Effects of coppicing restoration

Main ecological effects of coppicing

- shifting mosaic of light and dark environments
  Supporting variety of species strategies
  Plant species persist in soil seed bank (see the next slide)

- nutrient uptake and dynamics (in woody biomass)
  Moderating competition asymmetry through limiting resources
  Shifting mosaic of nitrogen poor – nitrogen rich patches

On a long-term

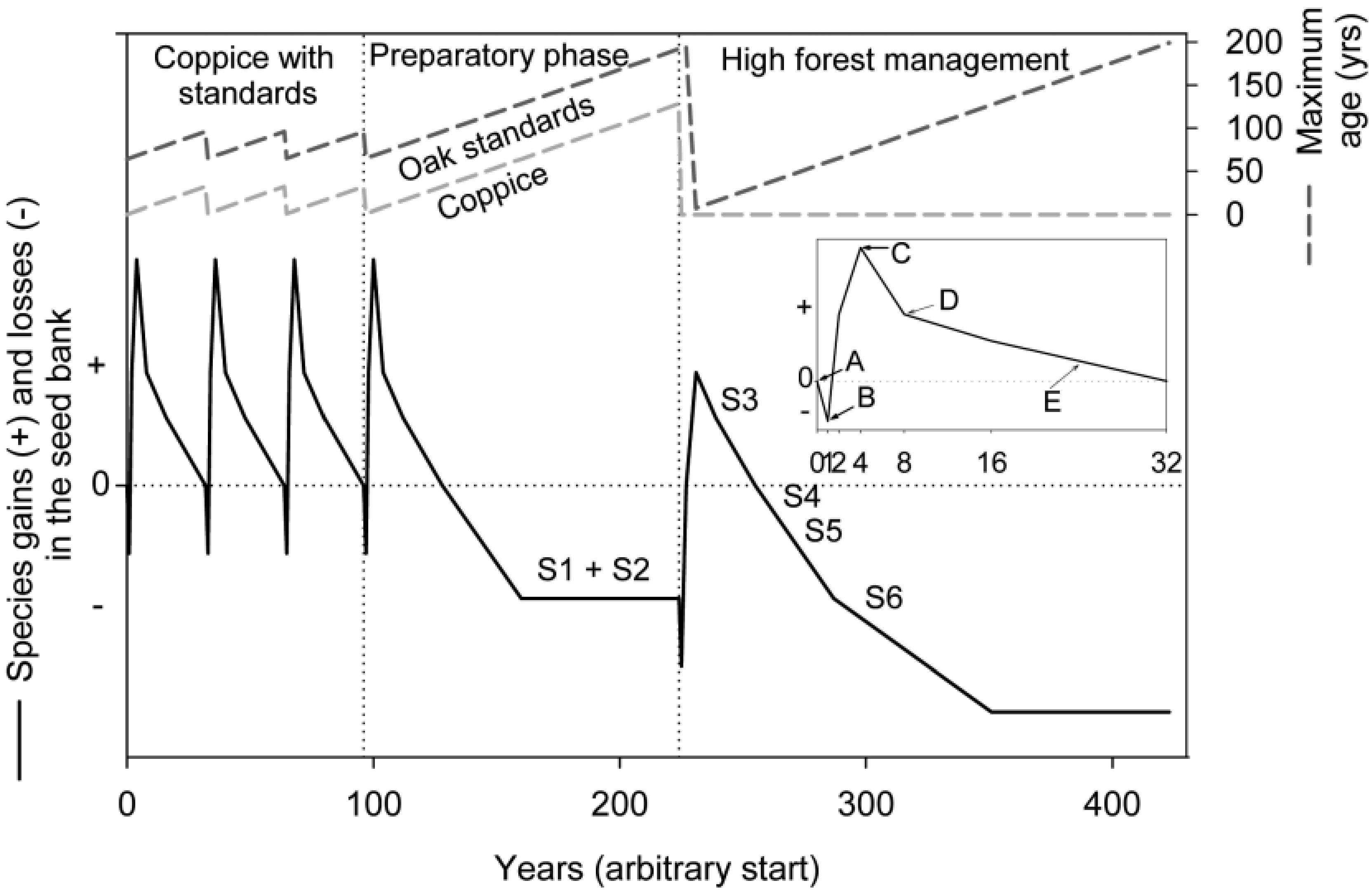
- creation of **specific habitats**
  Abiotic conditions and biotic communities

- maintaining **high biodiversity** on landscape level
  Many of the species-richest woodland communities in Europe

Long-term soil seed bank dynamics

Following the conversion of coppice-with-standards to high forest

Van Calster et al. 2008, Applied Vegetation Science



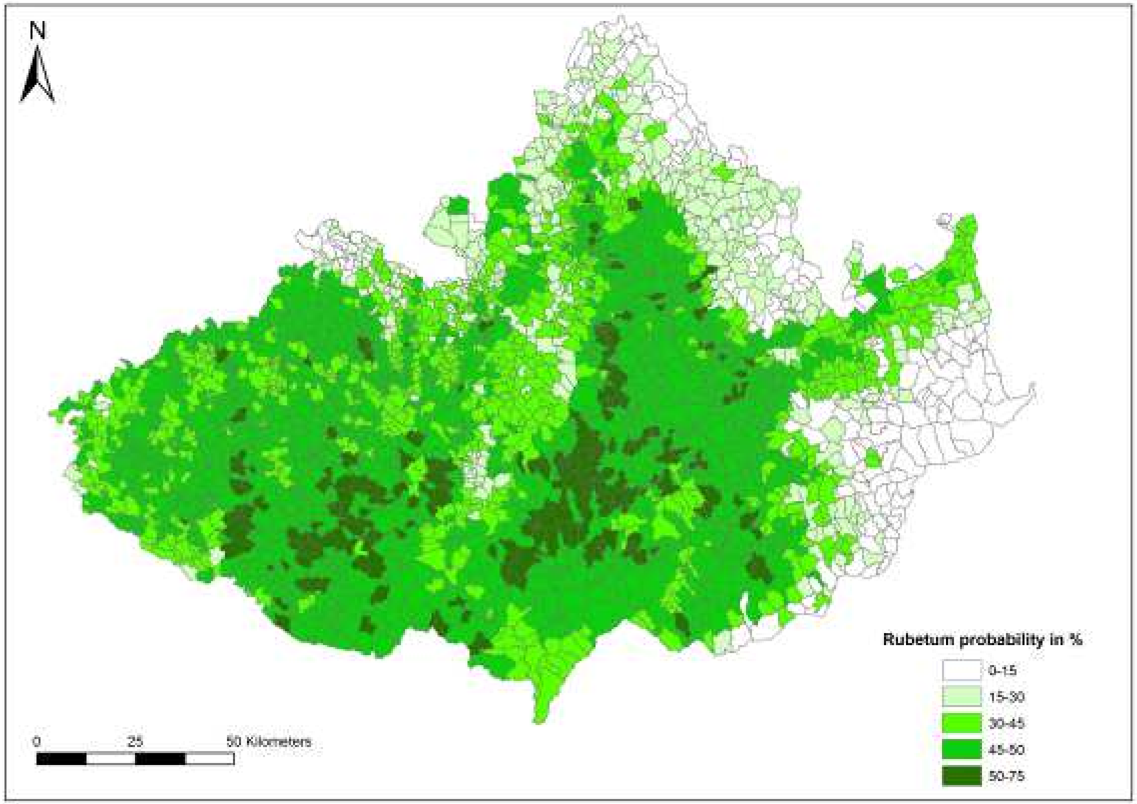
Some of the forest habitats historically formed by coppicing

- Alluvial forests
- Oak-hornbeam forests
- Thermophilous oakwoods
- Ravine forests
- Acidophilous oakwoods

All are listed more specifically
in the EU Habitats Directive
(Natura 2000 habitats)

Examples of plant communities in the Czech Republic historically related to coppicing

1	LBB01	Galio sylvatici-Carpinetum betuli	Carpino-Fagetea
2	LBB02	Stellario holosteae-Carpinetum betuli	
3	LBB03	Carici pilosae-Carpinetum betuli	
4	LBB04	Primulo veris-Carpinetum betuli	
5	LBC01	Galio odorati-Fagetum sylvaticae	
6	LBC02	Mercuriali perennis-Fagetum sylvaticae	
7	LBC03	Carici pilosae-Fagetum sylvaticae	
8	LBF01	Aceri-Tilietum	
9	LBF02	Mercuriali perennis-Fraxinetum excelsioris	
10	LBF03	Arunco dioici-Aceretum pseudoplatani	
11	LCA01	Lathyro collini-Quercetum pubescentis	Quercetea pubescentis
12	LCA02	Lithospermo purpureocaerulei-Quercetum pubescentis	
13	LCA03	Euphorbio-Quercetum	
14	LCB01	Quercetum pubescenti-roboris	
15	LCB02	Carici fritschii-Quercetum roboris	
16	LCC01	Sorbo torminalis-Quercetum	
17	LCC02	Genisto pilosae-Quercetum petraeae	
18	LCC03	Melico pictae-Quercetum roboris	
19	LDA01	Luzulo luzuloidis-Quercetum petraeae	Quercetea roboris-petraeae
20	LDA02	Viscario vulgaris-Quercetum petraeae	
21	LDA03	Vaccinio vitis-idaeae-Quercetum roboris	
22	LDA04	Holco mollis-Quercetum roboris	

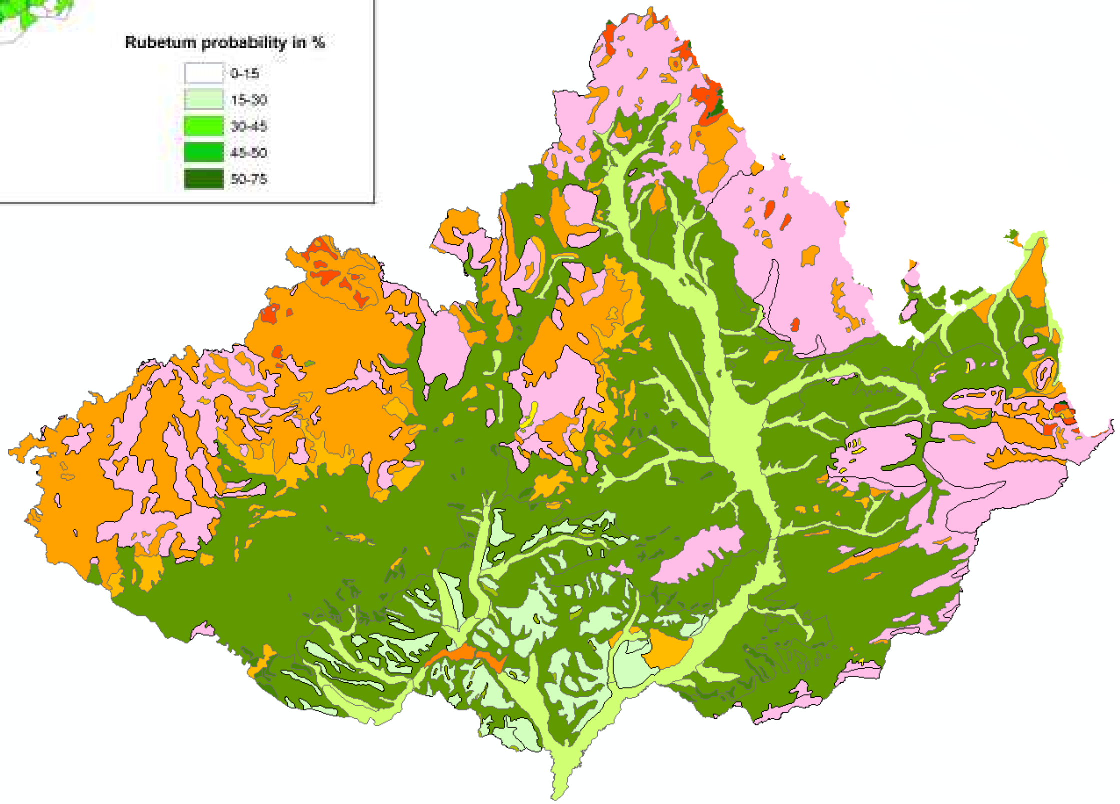


coppicing extent

Late Middle Ages

Moravia (E Czech Rep.)

Szabó et al., 2015,
Journal of Historical
Geography



potential natural vegetation

Oak-hornbeam forest

Acidophilous beechwoods

Eutrophic beechwoods

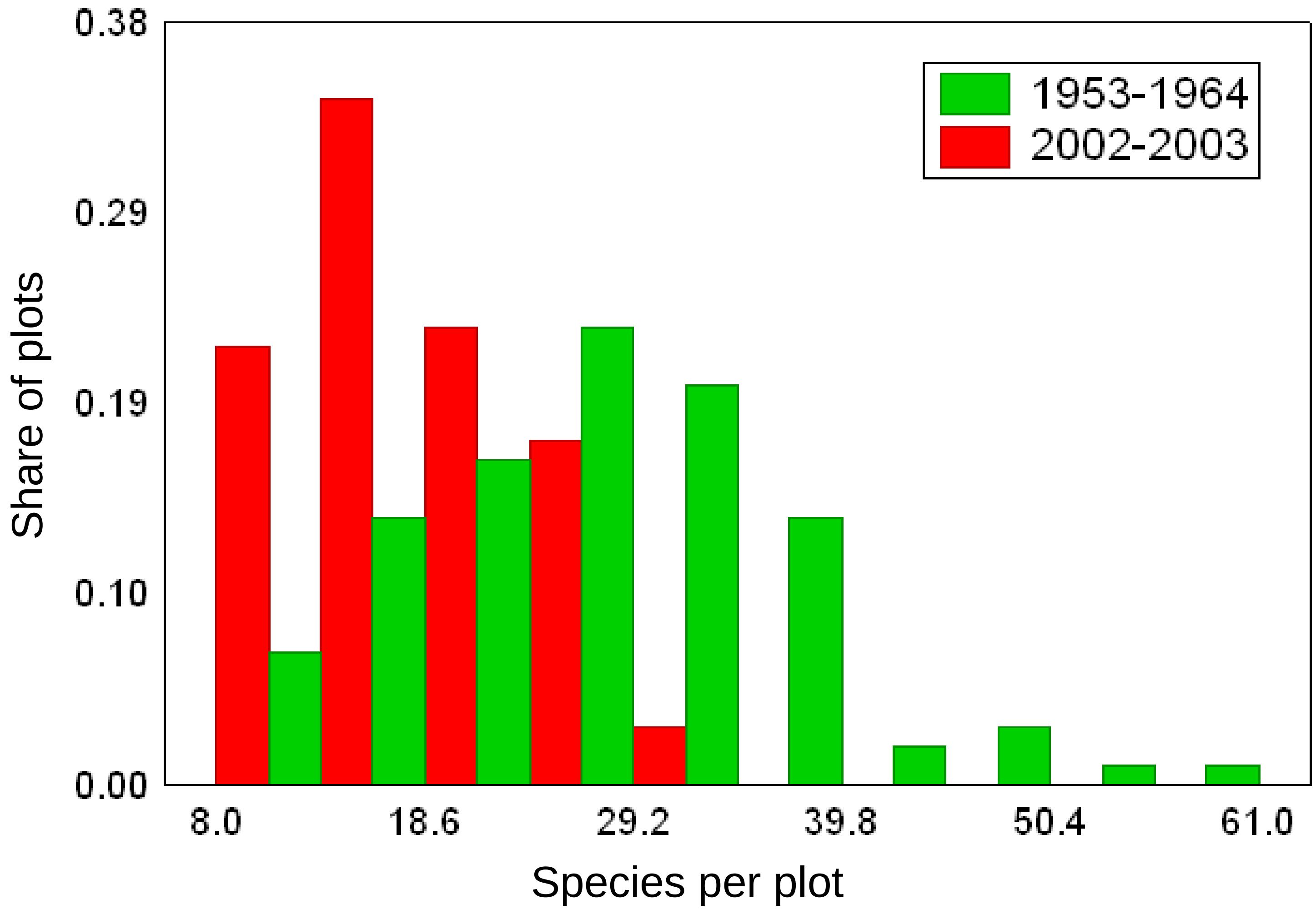
Spruce forest

Abandoned coppice resampled after 50 years

Děvín, southern Moravia, Czech Republic

Vascular plants: Species richness impoverishment

R. Hédl, unpublished



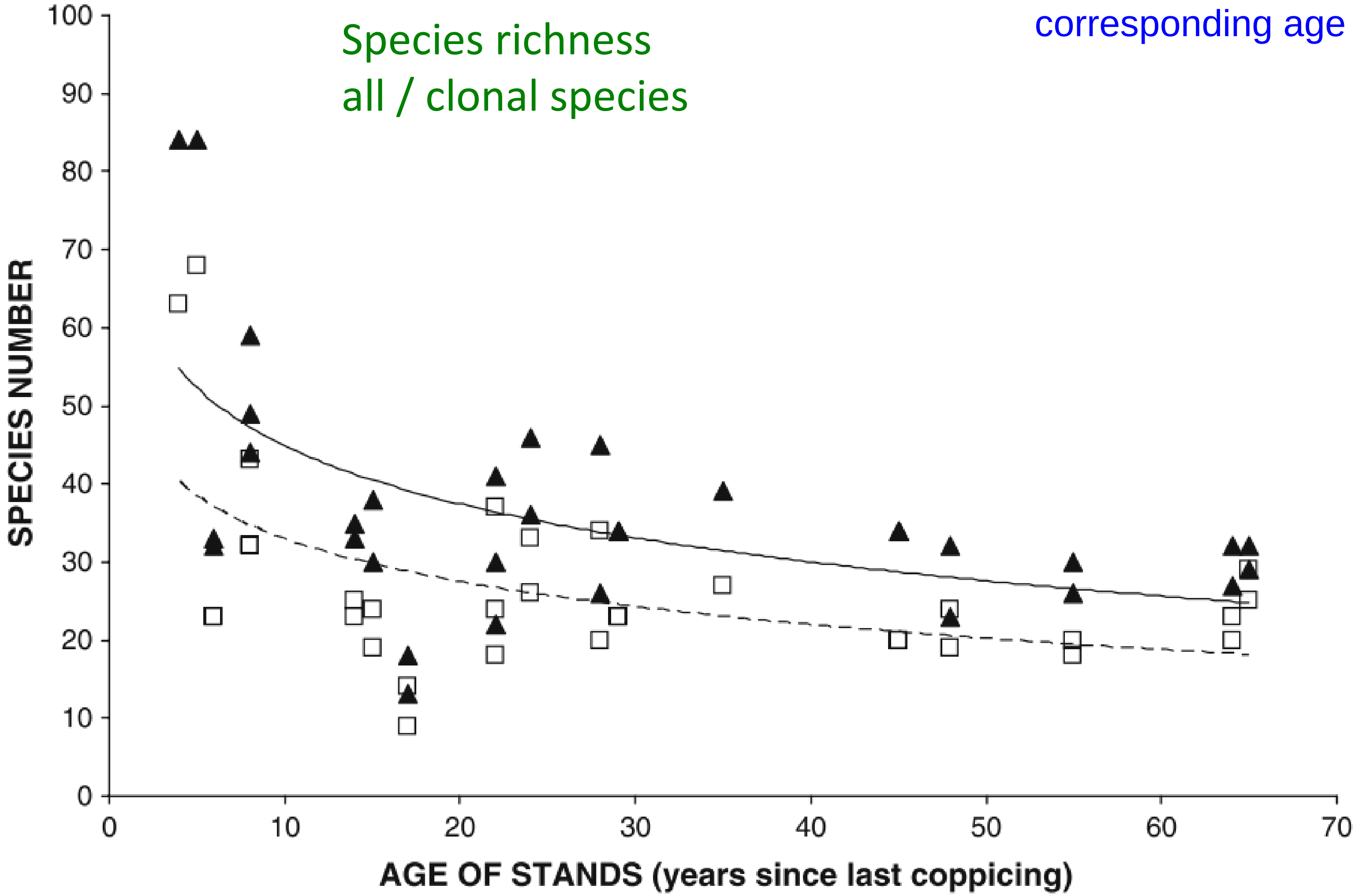
Chronosequence in post-coppicing beechwoods

Apennines, Central Italy

Canullo et al., 2011, Folia Geobotanica

Chronosequence: Replacement of time series with stands of corresponding age

Species richness
all / clonal species



Chronosequence in coppiced forest

Norfolk, UK

Ash and Barkham, 1976, Journal of Ecology

Species richness

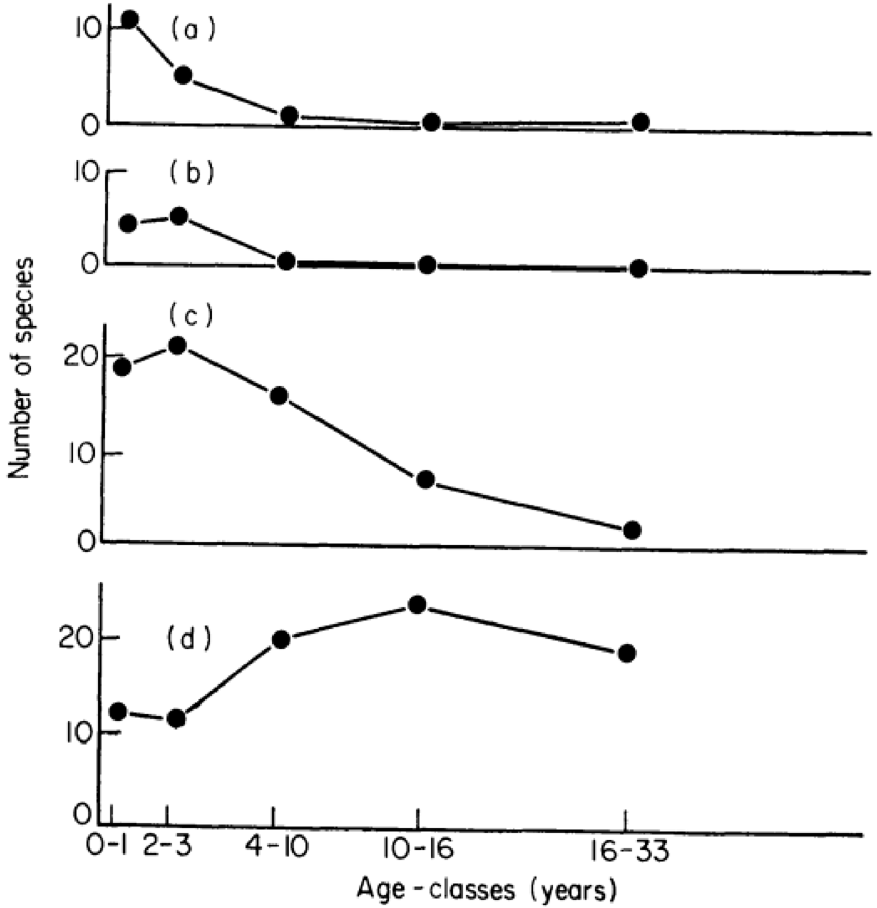
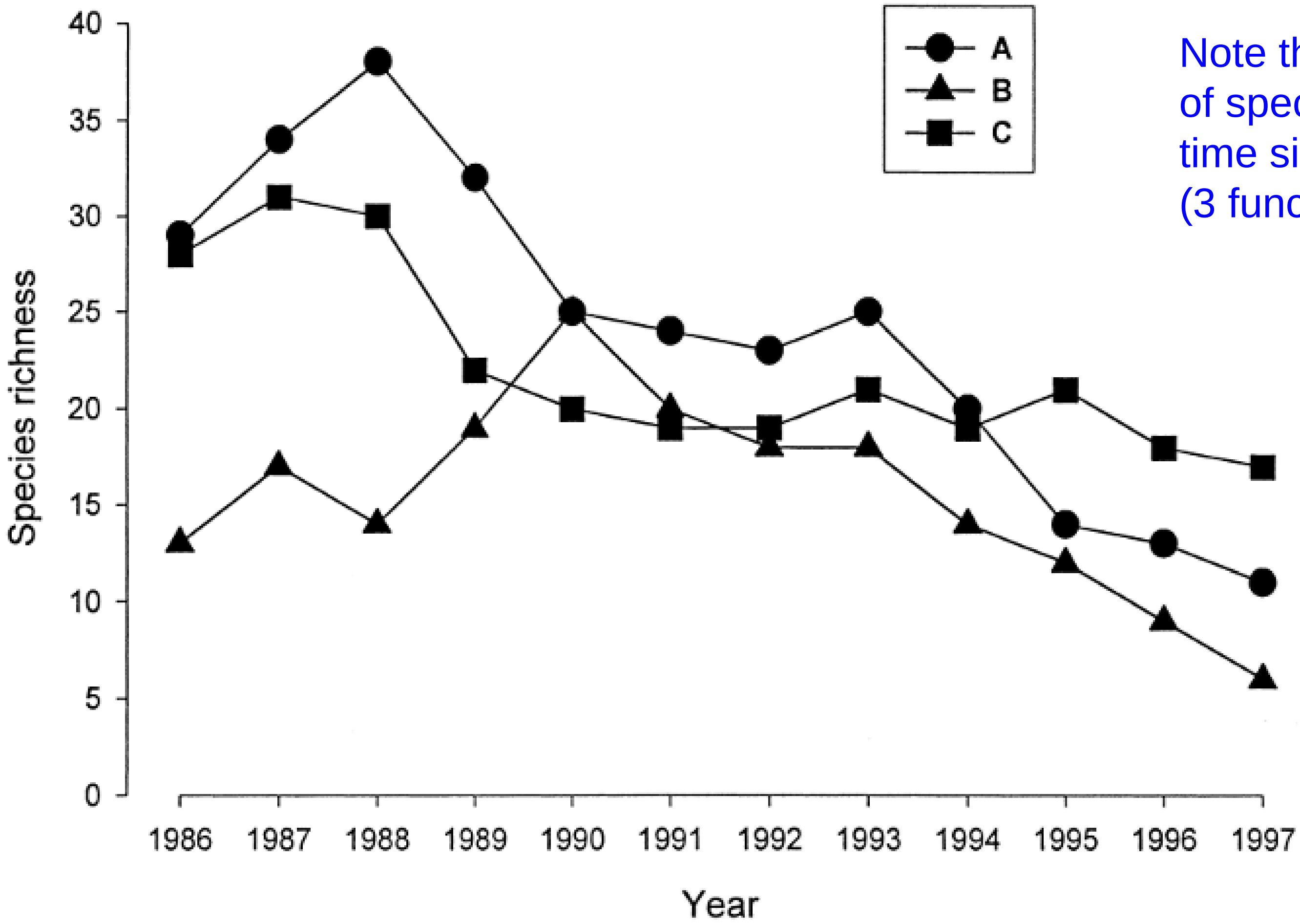


FIG. 4. Numbers of herb and shrub species in the field layer at different times after coppicing: (a) annuals (a total of 20 species involved); (b) biennials (7); (c) perennials of open sites (30); (d) perennials of shaded sites (30).

11-year observation of species richness in coppices

England

Mason and MacDonald, 2002, Biodiversity and Conservation



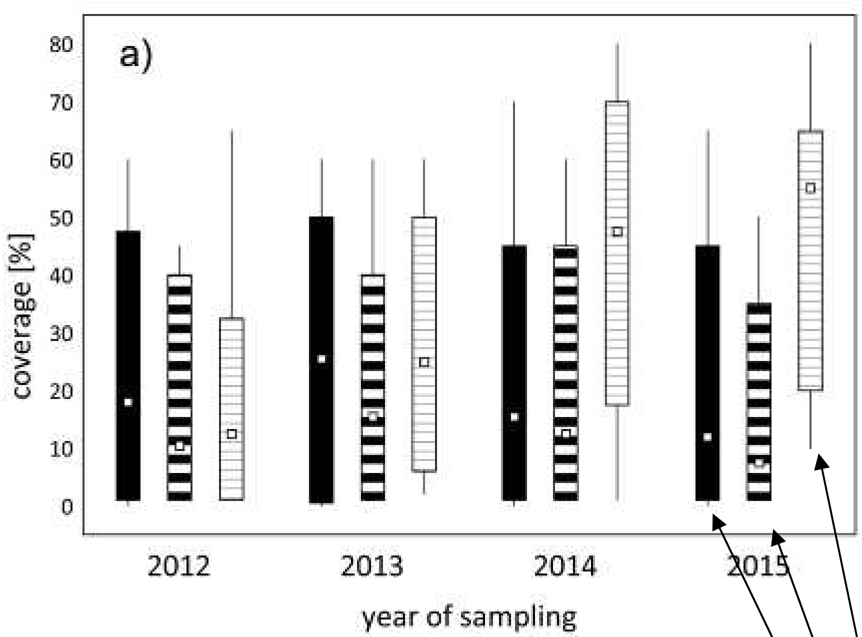
Note the gradual decrease of species richness with time since coppicing (3 functional groups)

Effect of coppicing on plant species richness and coverage

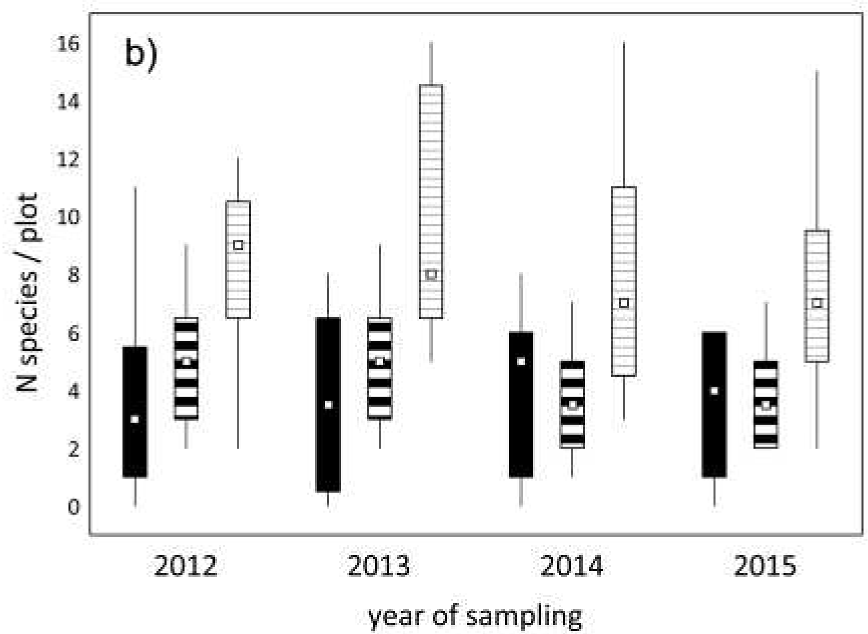
Utinkův háj, Southern Moravia, Czech Republic

4 years in herbaceous layer after coppicing establishment

Hédl et al., Folia Geobotanica, in press



herb layer coverage



herb layer species richness

heavy coppicing
light coppicing
control

Utinkův háj, temporal development since 2012

Just after canopy cutting
Winter 2011-2012

1st year – Sept. 2012
Resprouting oaks

Utinkův háj, 1st year after coppicing

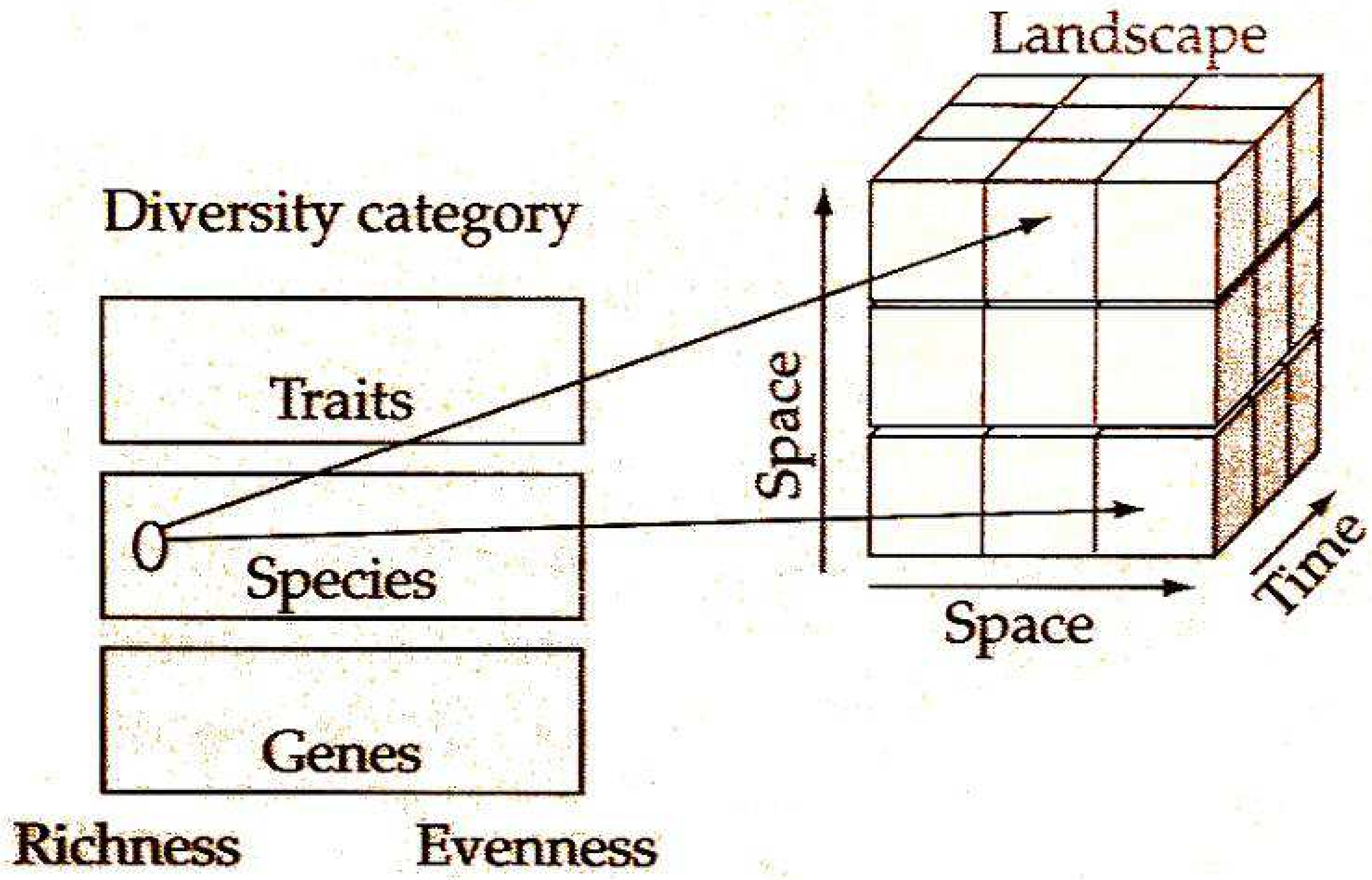
Utinkův háj, 3rd year after coppicing

Biodiversity

Very complex phenomenon
Several possible aspects:

- organizational levels (from genes to biomes)
- taxonomic and functional diversity
- inventory (richness) and relative (heterogenity)

Always consider which category of diversity you want to measure…

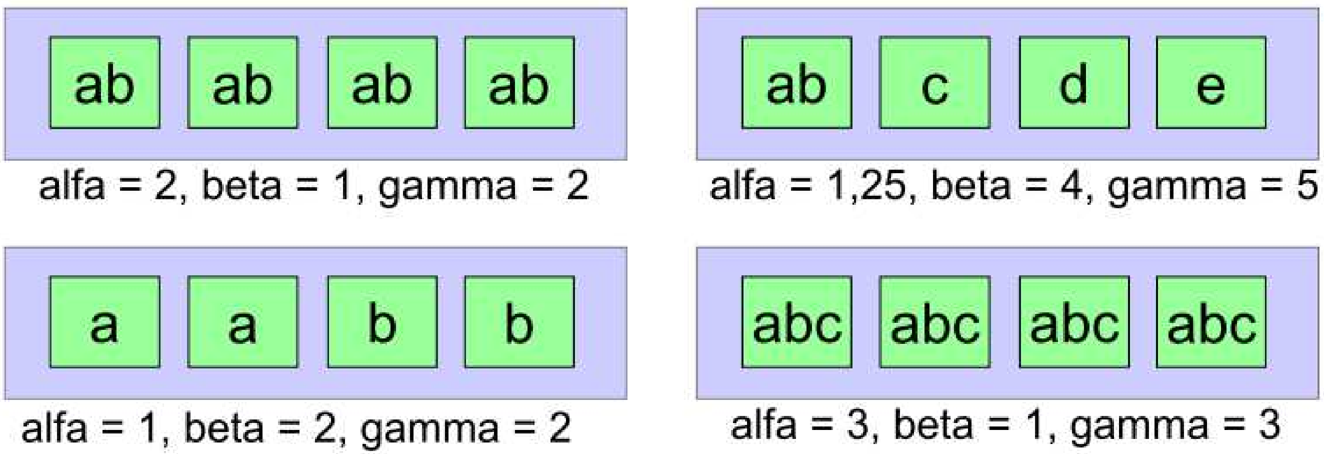


From Magurran, 2004, Measuring Biological Diversity

Biodiversity types in ecology

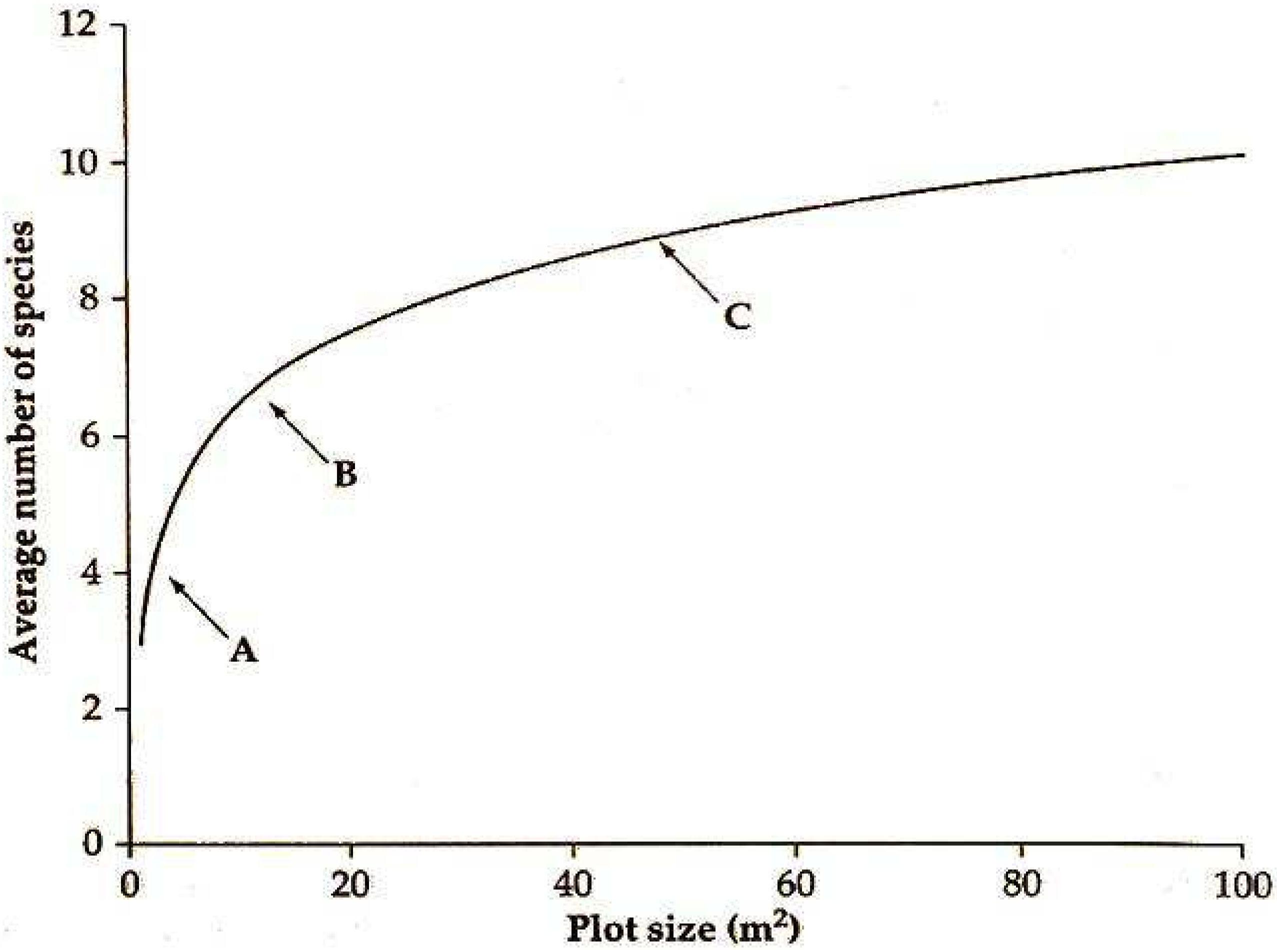
R.H. Whittaker, 1960, Ecological Monographs

- **Alpha**-diversity: richness in plots, small areas
- **Beta**-diversity: relative differences between plots
- **Gamma**-diversity: richness in landscapes, regions



Species-area relationship (SAR)

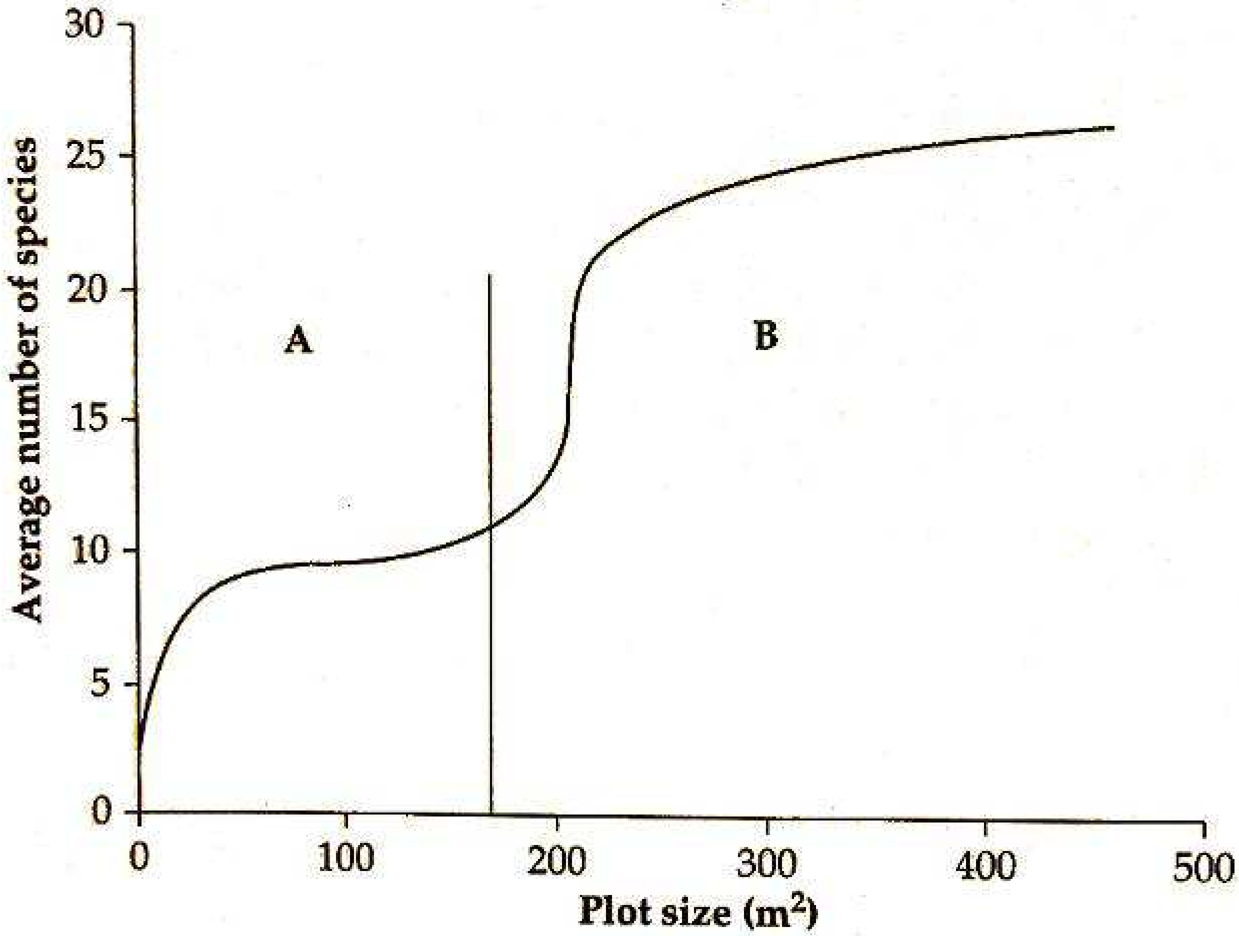
species number usually increases with sampling area



From Magurran and McGill, 2011, Biological Diversity

Species-area relationship (SAR)

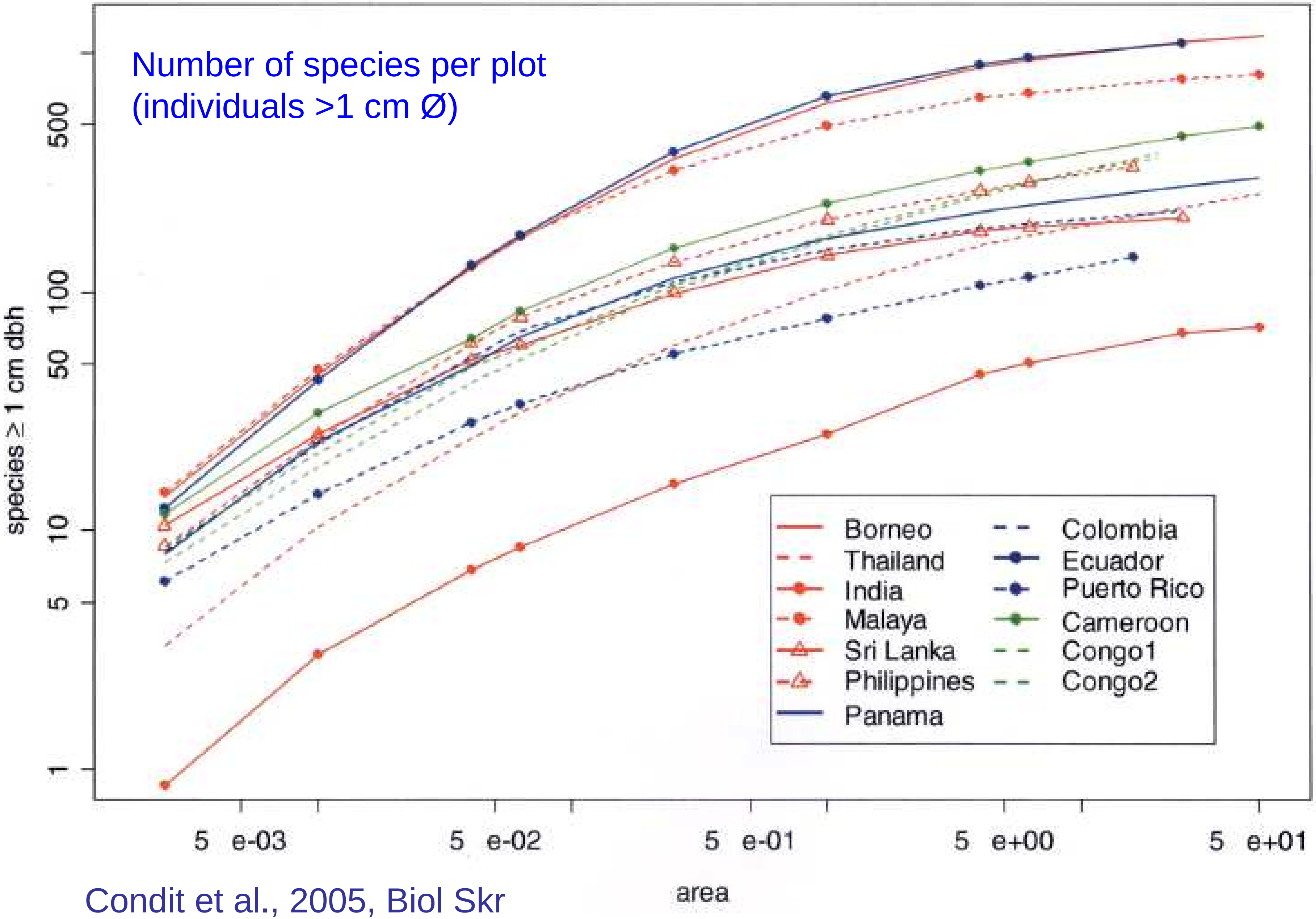
in theory, distinct species assemblages can be defined by SAR sampling



A and B:
two different
biotic communities

From Magurran and McGill, 2011, Biological Diversity

Species richness in tropical rain forests



Condit et al., 2005, Biol Skr

Beta-diversity of tree species in tropical rainforests

1ha plots in three regions of central and southern America

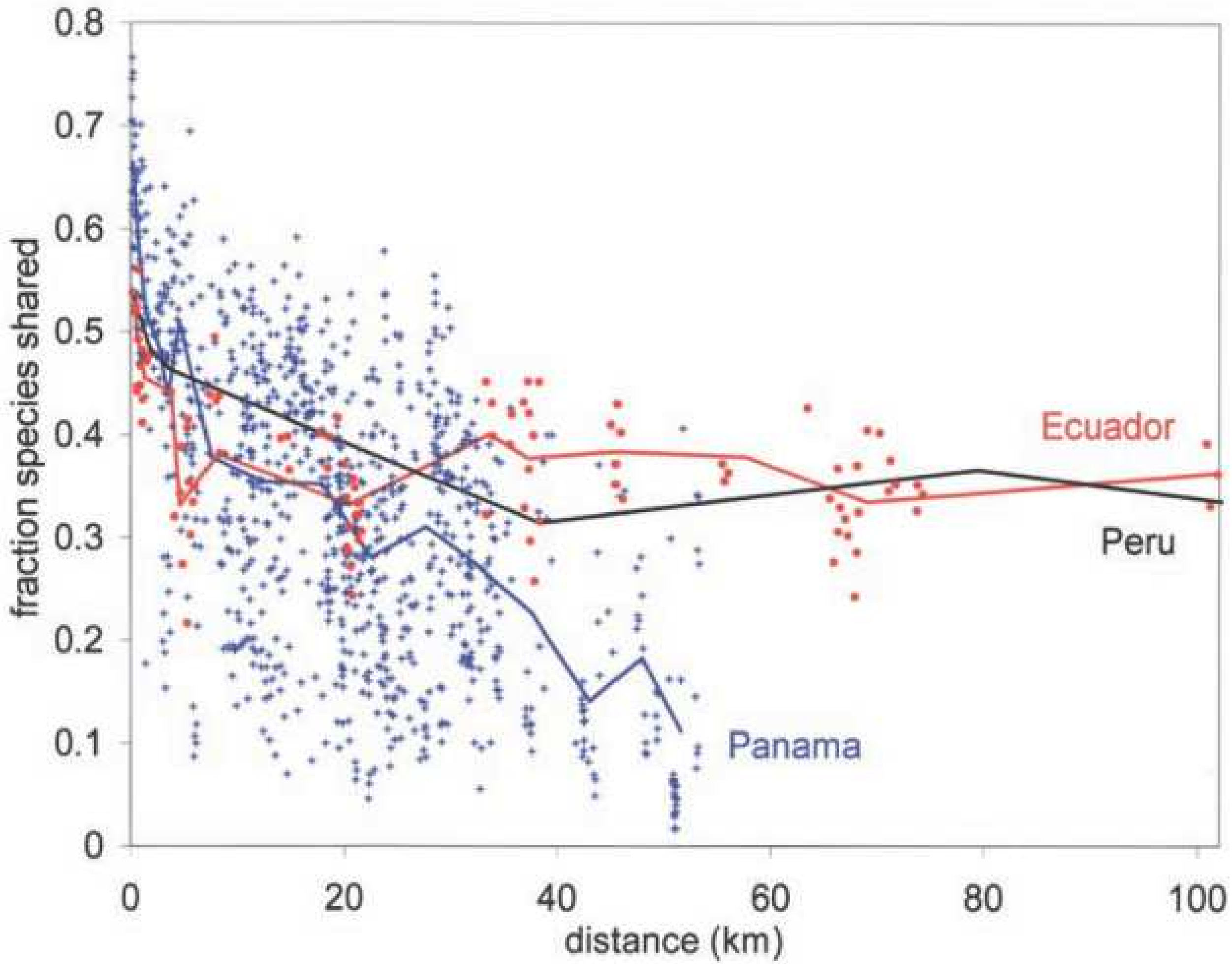


Fig. 1. Sørensen similarity index between pairs of 1-ha plots as a function of distance between the plots. Only the four corner hectares of the BCI 50-ha plot were used to avoid undue influence of the single site. In Ecuador, the 25-ha plot was not included here, because species names have not yet been matched with the single hectares. Solid lines connect average values in various distance categories: red for Ecuador, black for Peru, and blue for Panama. Individual points for Peru were omitted to reduce clutter.

34 plots Panama
16 plots Ecuador
14 plots Peru

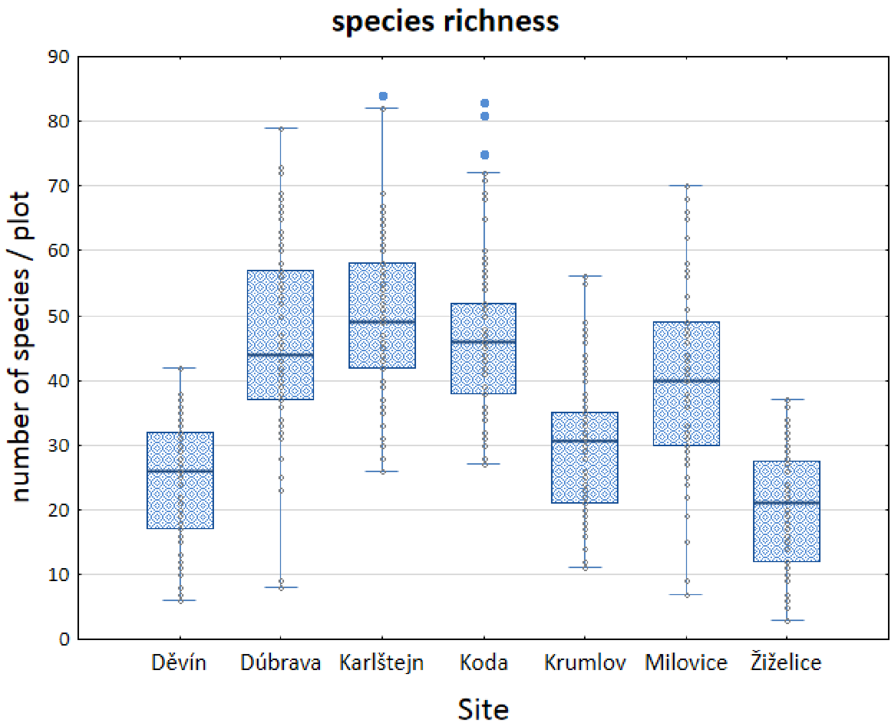
Condit et al. 2002, Science

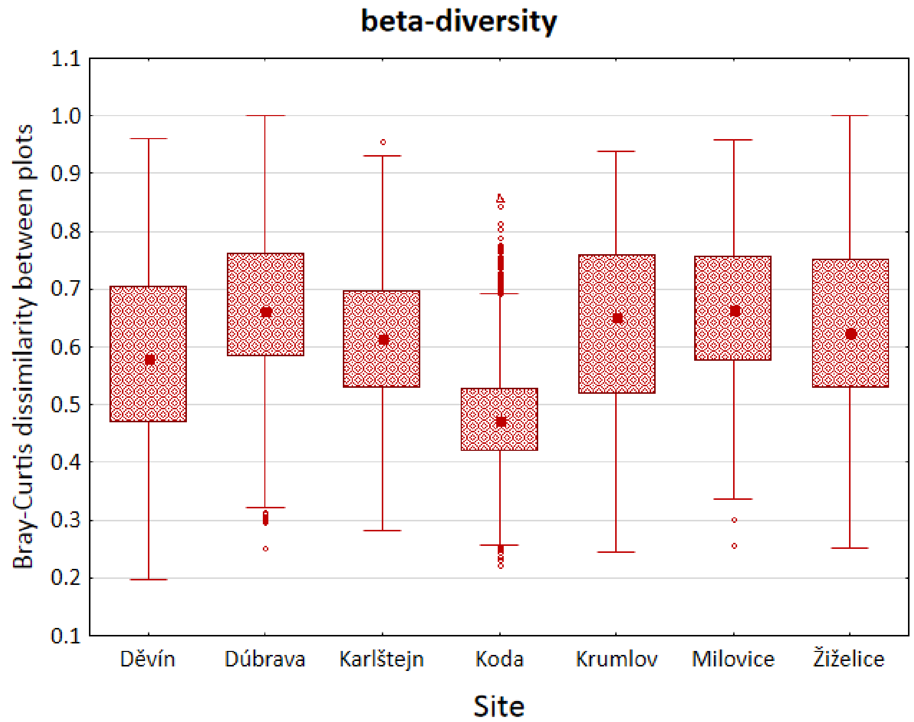
Forest vegetation diversity

Alpha- and beta-diversity

7 sites in the Czech Rep., 600 plots

Hédl et al., unpublished





How to sample species richness

- **Individual-based**

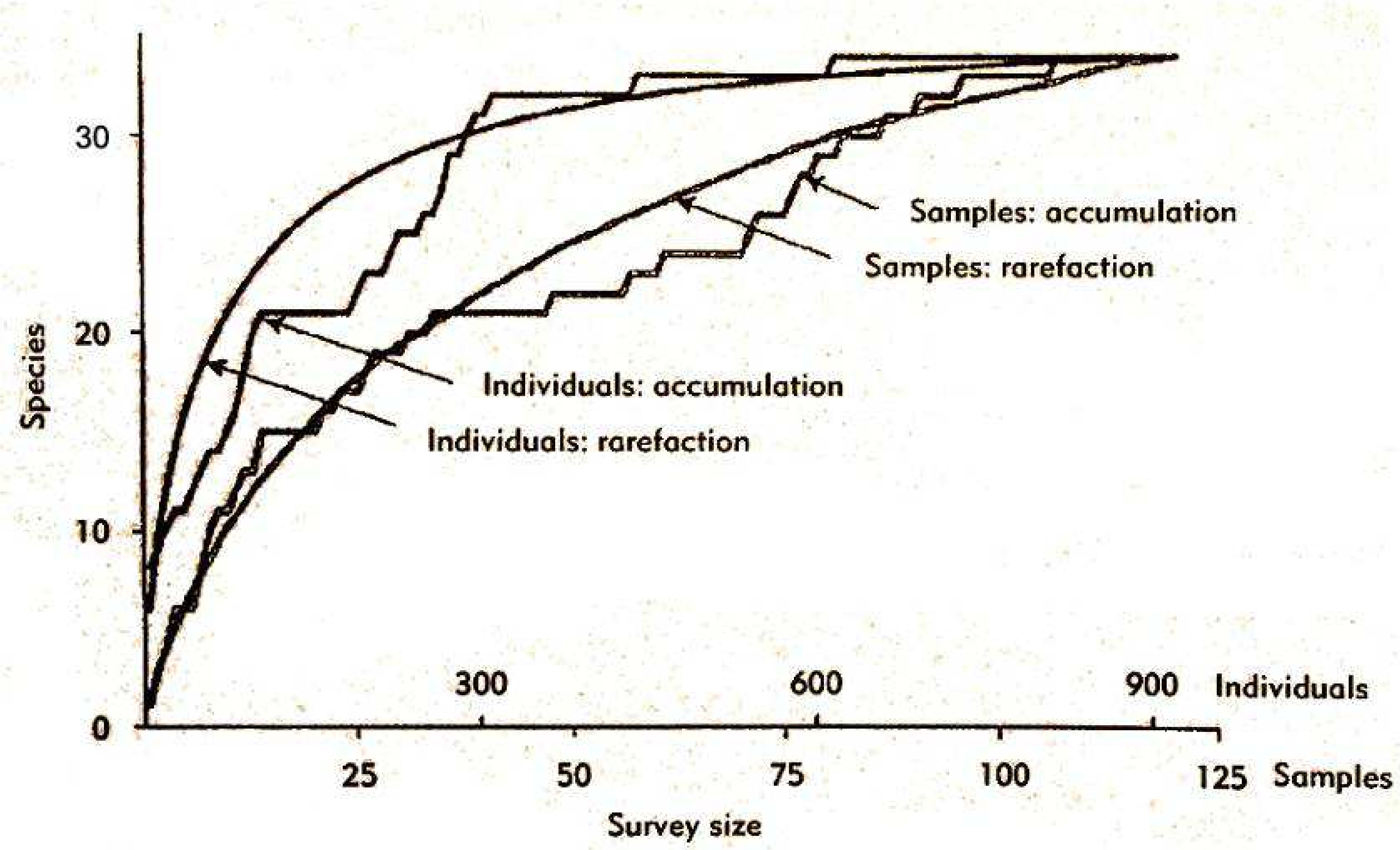
- each individual is recorded
- species are with counted abundances

- **Sample-based**

- samples with species lists – from plots, traps, etc.
- many samples in space or time

Species richness estimate

accumulation and rarefaction curves

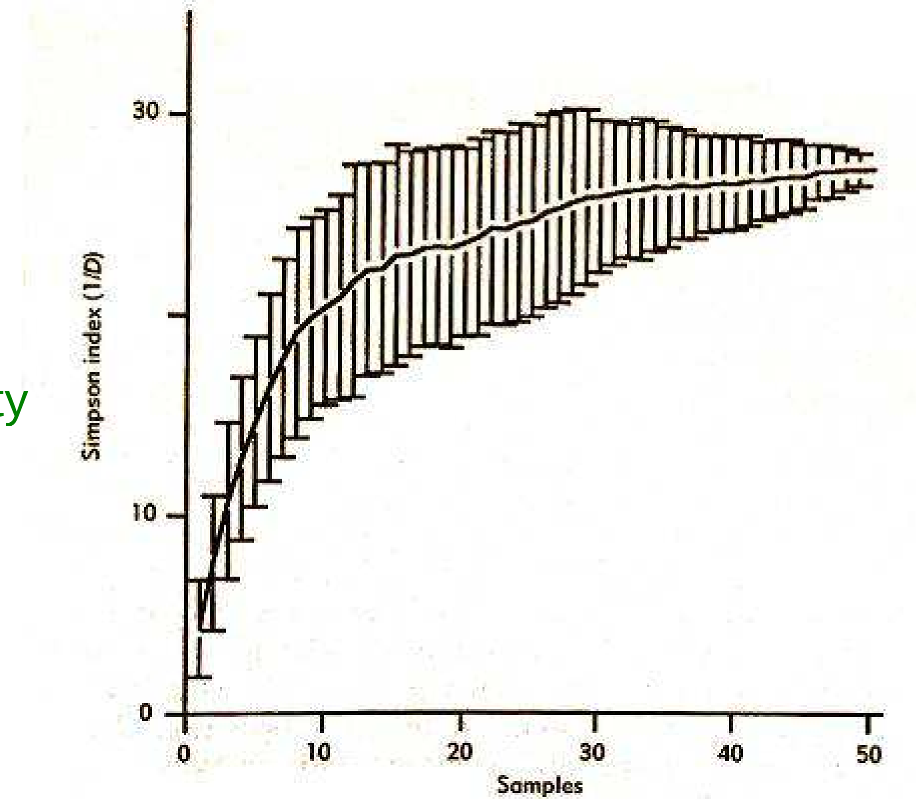


From Magurran, 2004, Measuring Biological Diversity

Species richness estimate

Rarefaction: statistical estimate from increasing number of sampling units

An index
of diversity



Number of samples

From Magurran, 2004, Measuring Biological Diversity

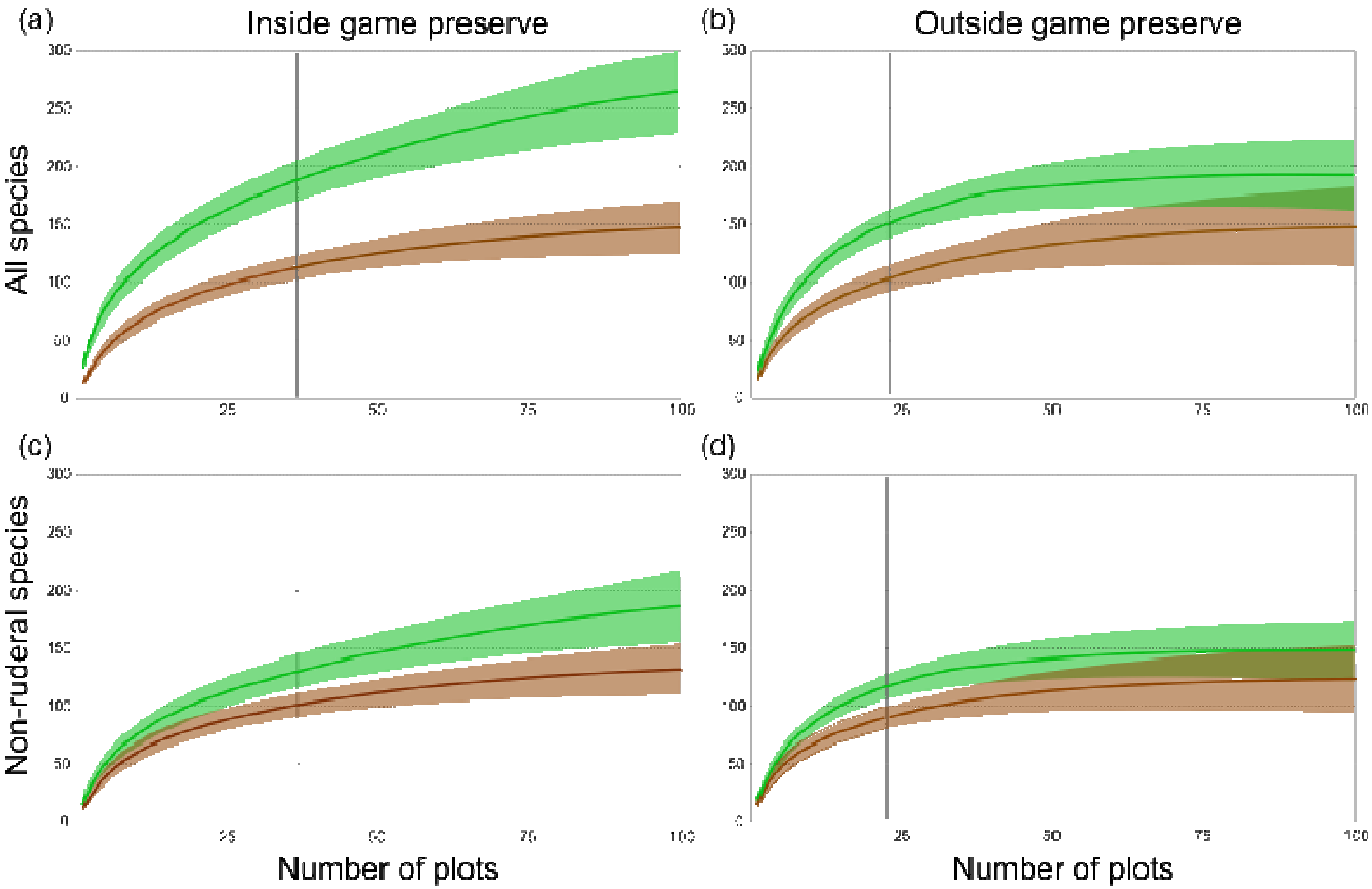
Sample-based rarefaction

comparing high vs. low deer density (left vs. right-hand side graphs and two time slices (green and brown)

Vild et al., Applied Vegetation Science

all species

excluding ruderals

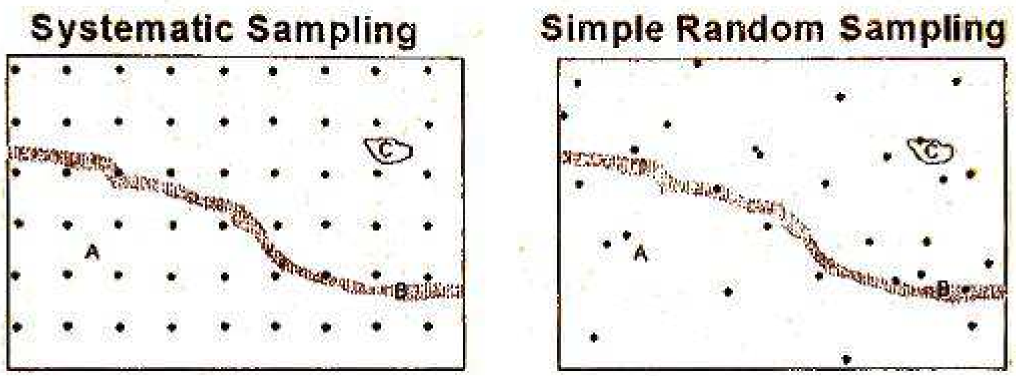


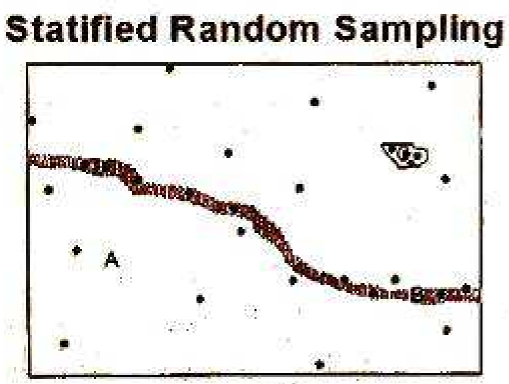
Sampling design

sampling units (mostly plots) in the landscape

From Hédl, 2005, Monitoring of vegetation change
[in Czech]

Sampling design





Design/ Veg. Type	System- atic	Random	Stratified Random
Type A	52	26	17
Type B	2	3	9
Type C	0	1	4
Total Plots	54	30	30

Figure 3.12. Potential effects of various sampling designs on capturing plant diversity information from three vegetation types in a hypothetica landscape.

from Stohlgren, 2007, Measuring plant diversity

Nested plot designs

Enable sampling of biodiversity on various spatial scales

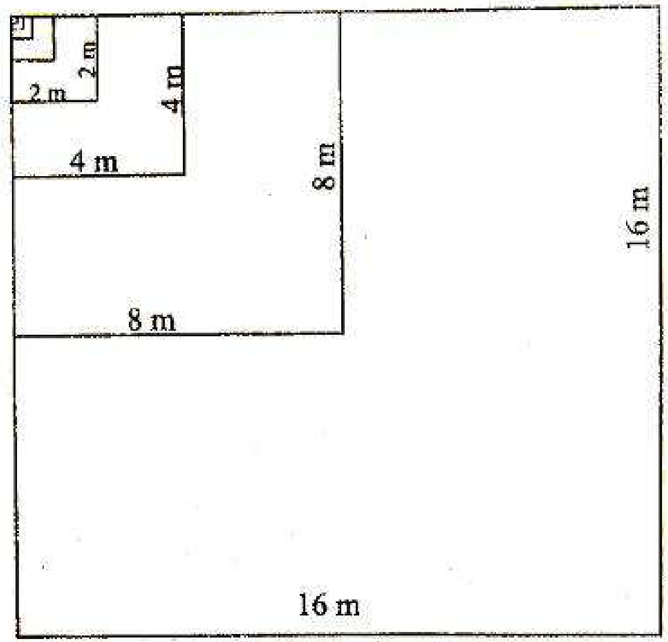


Figure 5.3. Nested-quadrat design described by Reed et al. (1993) to investigate scale-dependence of vegetation-environment correlations in a Piedmont woodland in North Carolina. Square quadrat sizes less than 2 m on a side are 1 m, 0.5 m, 0.25 m, and 0.125 m on a side. The design was replicated in contiguous grid cells over a 256 m x 256 m study area (i.e., sixteen 16 m x 16 m cells).

from Stohlgren, 2007, Measuring plant diversity

Nested plot designs

Enable sampling of biodiversity on various spatial scales

The Whittaker Plot design

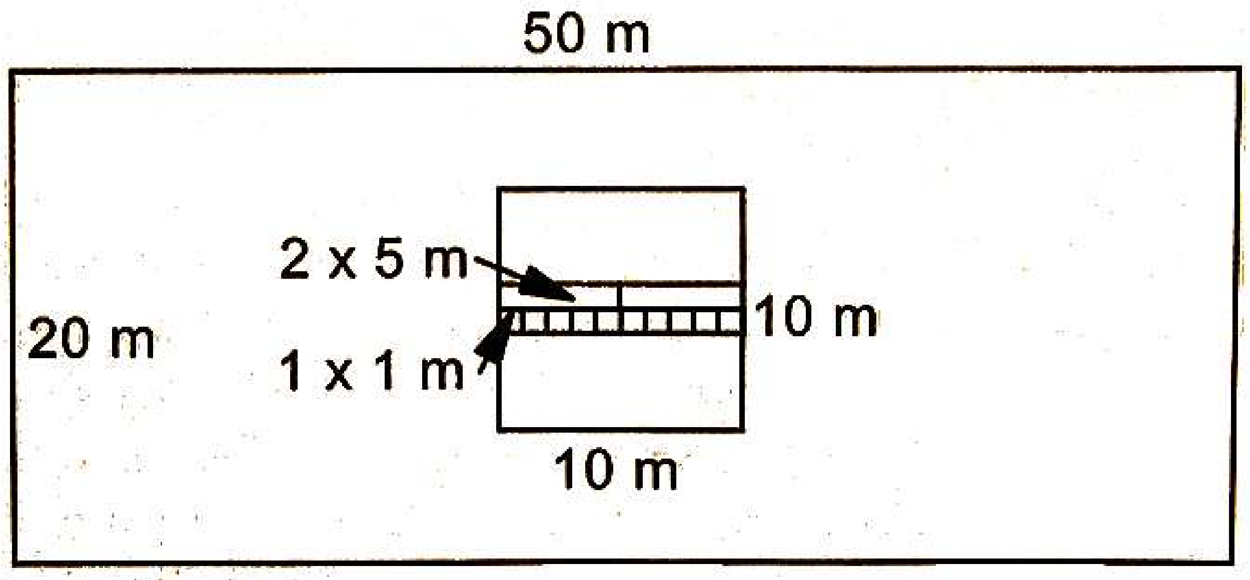


Figure 5.6. The Whittaker Plot design, a nested plot design (Shmida 1984).

from Stohlgren, 2007, Measuring plant diversity

Nested plot designs

Enable sampling of biodiversity on various spatial scales

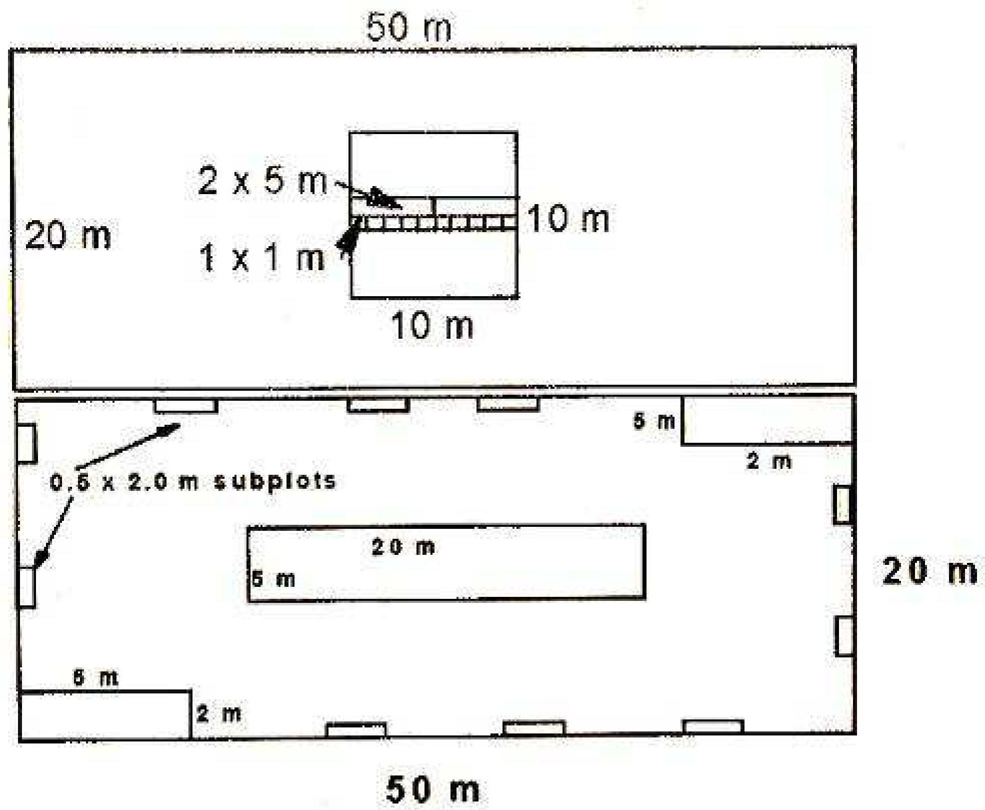


Figure 6.1. Top: the original Whittaker Plot design (Shmida 1984). Bottom: The Modified-Whittaker Plot design (Stohlgren et al. 1995b).

from Stohlgren, 2007, Measuring plant diversity

Nested plot designs

Enable sampling of biodiversity on various spatial scales

Sampling for genotypic diversity

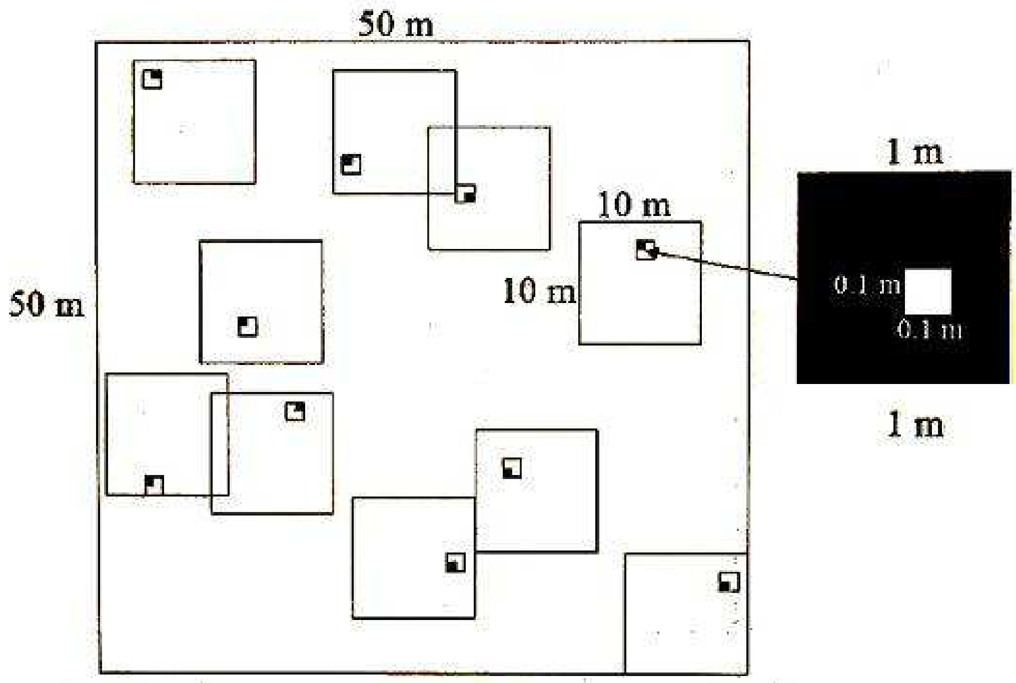


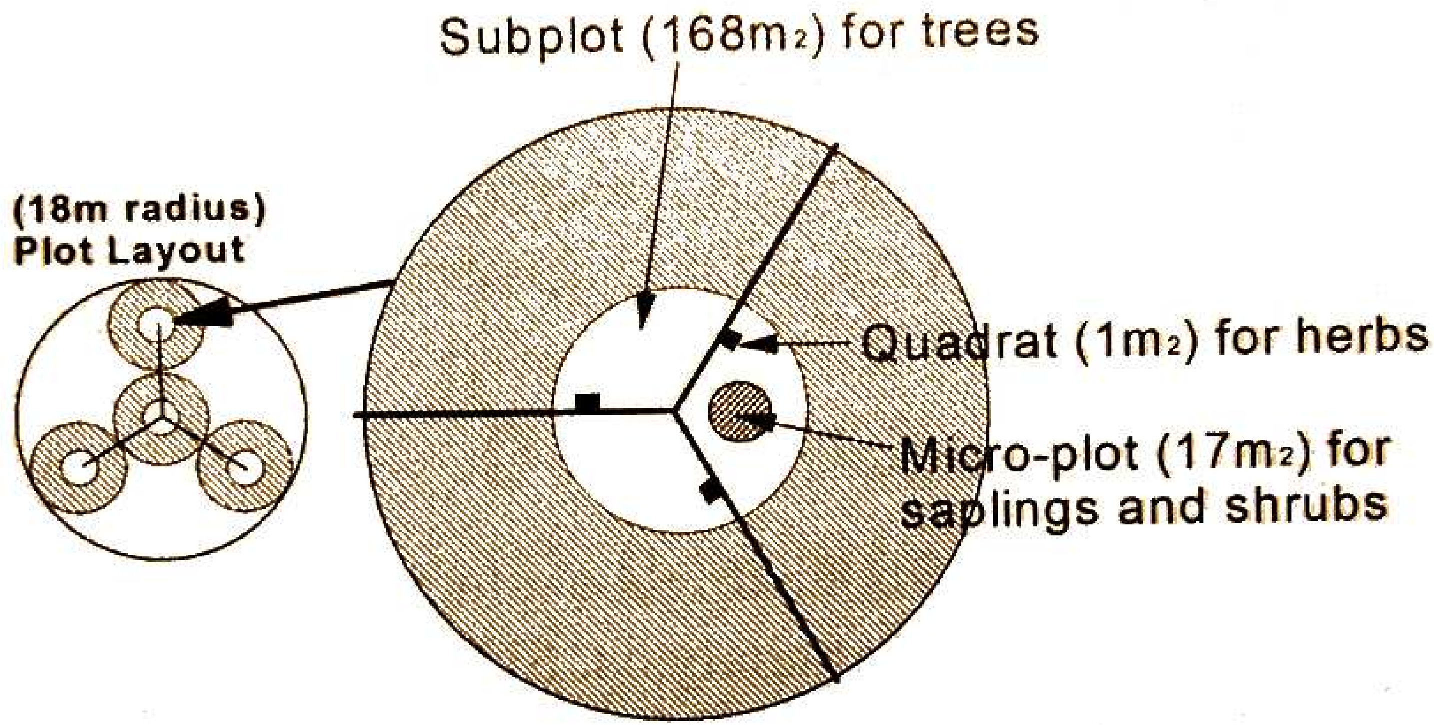
Figure 5.12. A rendition of the sampling design offered by Bell and Lechowic (1991) to assess genotypic variation in two plant species and environmental heterogeneity in forests in Montreal, Canada.

from Stohlgren, 2007, Measuring plant diversity

Nested plot designs

Enable sampling of biodiversity on various spatial scales

Forest inventory plots



from Stohlgren, 2007, Measuring plant diversity

Further reading

Magurran A.E. (2004) Measuring biological diversity. Blackwell Publishing.

Magurran A.E. & McGill B.J. (2011) Biological diversity: frontiers in measurement and assessment. Oxford University Press.

McGill B.J. et al. (2015) Fifteen forms of biodiversity trend in the Anthropocene. Trends in Ecology & Evolution 30: 104-113.

Rackham O. (2009) Woodlands. HarperCollins UK.

Stohlgren T.J. (2007) Measuring plant diversity: lessons from the field. Oxford University Press.

Whittaker R.H. (1960) Vegetation of the Siskiyou mountains, Oregon and California. Ecological Monographs 30: 279-338.