# Ecosystem services: biodiversity, conservation and cultural heritage

concepts and methods

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# Coppice ecosystem services

- Provisioning: fuelwood, timber, food (fruit, nuts, fungi, game), other NTFPs, genetic resources. Attracts resources for Biodiversity Action Plans, agrienvironmental schemes, wildlife reserves, etc
- Regulating: low carbon accumulation rates; prevention of soil erosion and avalanches; reduced fire risk; conservation of specialist species of young growth; pollination
- **Cultural**: aesthetic value of woodland structure, field layers, songbirds, butterflies, historical artefacts (archaeology, woodbanks, sawpits, etc)
- **Supporting:** soil formation and retention, nutrient/water cycling, primary production, habitat for biodiversity

# Open space is required by nearly 80% of woodland Priority Species



## Silvicultural management and temporary open space

| Age<br>(years) | Growth<br>phase   | Short-<br>rotation<br>coppice | Simple<br>coppice <sup>1</sup> | Coppice<br>with<br>standards <sup>1</sup> | High<br>forest <sup>2</sup> |
|----------------|-------------------|-------------------------------|--------------------------------|---|-----------------------------|
| <5             | Open<br>space     | 100                           | 17                             | 12  | 4                           |
| 6-30           | Young<br>growth   | 0                             | 83                             | 62  | 21                          |
| 31-100         | Thicket to mature | 0                             | 0                              | 20  | 58                          |
| >100           | Mature            | 0                             | 0                              | 6   | 17                          |

<sup>1</sup> based on 30-year coppice rotations, with standards covering 30% of area <sup>2</sup> based on 125-year rotations (after Hopkins and Kirby, 2007)

# Winners and losers

#### **Coppice management**

- + open space/young growth
- + seedbank replenishment
- + heliophilous plants
- + small mammals
- + reptiles and amphibians
- + migrant warblers
- + thermophilous lepidoptera

#### **Neglect / high forest management**

- homogenised field layers
- lowered β-diversity
- declining open space
- - declining litter quality
- + shade tolerant species
- + leaf-mining Lepidoptera
- +saproxylic invertebrates
- + hole-nesting birds, bat roosts
- + fungi, mosses and lichens





#### Persistent seedbanks



# Declining seed banks Van Calster et al., 2008



**Chronosequence in post-coppicing beechwoods** Appennines, Central Italy Canullo et al. 2011, Folia Geobot



## Chronosequence in coppiced forest, Norfolk, UK

Ash and Barkham, 1976, J Ecol



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, Biodiv Conserv



**Three levels of coppicing intensity**, S Moravia, Czech Republic 4 years in herbaceous layer after coppicing establishment Hédl et al., Folia Geobotanica, in press











Coppice management in the Alsacian Hardt

Fartmann et al, 2013

#### Ordination of the most frequent butterfly species in coppice-withstandards, French Alsace (Fartmann et al., 2013)



#### Widespread butterflies in woodland, England Butterfly Conservation and CEH





#### Trends in bird densities (territories ha<sup>-1</sup>) in relation to age of coppice regrowth (Fuller and Rothery, 2013)



Age (years of regrowth)







# Roe deer expansion 1967-2008



+ 240%, 1960-2005



# Red deer expansion, 1955-2008



Cervus elephas

#### Degradation of coppice-with-standards in the Cosson massif, France, through browsing pressure of roe and red deer (Ballon and Hamard, 2007)







herbaceous plants < soil macrofungi < ground dwelling arthropods < land snails < saproxylic fungi < hole nesting birds/saproxylic insects < epiphytic < epixylic bryophytes







## Strategies to promote early-successional species

- Group felling
- Variable density thinning (e.g. creating 20% gaps)
- Reducing densities of standard trees
- Wider rides and 'scallops'

#### NOT

- Individual tree selection
- Continuous cover/close to nature forestry
- 'Singling' of coppice stools for conversion to high forest

## Integration of the age-classes (Mason and Zapponi, 2015)



#### Productive matrix:

- Harvested at time t<sub>1</sub>, innovation/regeneration phase
- Harvested at time t<sub>2</sub>, aggradation/growing phase
- Harvested at time t<sub>3</sub>, biostatic/culmination phase

Elements of the FBA:

- 🗹 IDS, Îlot de senescence
- DC, Deadwood corridor

### **Biodiversity strategies**

- Landscape approach: is there adequate young coppice growth within the region?
- For poorly-dispersed species, target coppicing operations within their centralised zone of distribution
- Encourage 'generalist' coppice species by increasing connectivity between patches
- Is there enough old-growth/ tree retention with microhabitats?
- Can emerging markets for biofuels rejuvenate the coppices?



# Survey and assessment of coppice stands for biodiversity:

methods and tools



|   | 1  | LBB01 | Galio sylvatici-Carpinetum betuli                  |
|---|----|-------|--|
|   | 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         |
| 1 | 0  | LBF03 | Arunco dioici-Aceretum pseudoplatani               |
| 1 | 1  | LCA01 | Lathyro collini-Quercetum pubescentis              |
| 1 | 2  | LCA02 | Lithospermo purpureocaerulei-Quercetum pubescentis |
| 1 | 3  | LCA03 | Euphorbio-Quercetum                                |
| 1 | 4  | LCB01 | Quercetum pubescenti-roboris                       |
| 1 | 5  | LCB02 | Carici fritschii-Quercetum roboris                 |
| 1 | 6  | LCC01 | Sorbo torminalis-Quercetum                         |
| 1 | 7  | LCC02 | Genisto pilosae-Quercetum petraeae                 |
| 1 | 8  | LCC03 | Melico pictae-Quercetum roboris                    |
| 1 | 9  | LDA01 | Luzulo luzuloidis-Quercetum petraeae               |
| 2 | 20 | LDA02 | Viscario vulgaris-Quercetum petraeae               |
| 2 | 21 | LDA03 | Vaccinio vitis-idaeae-Quercetum roboris            |
| 2 | 22 | LDA04 | Holco mollis-Quercetum roboris                     |

Plant communities in Central Europe related to coppicing

#### Carpino-Fagetea

Quercetea pubescentis

Quercetea roborispetraeae

# Sampling strategies

- Random
- Systematic
- Stratified
- Stratified, systematic unaligned
- Permanent samples

#### Sampling design plots / sampling units in the landscape





#### Sampling design





from T. Stohlgren, 2007

Permanent transects at Lady Park Wood, Wye Gorge, Gwent



Mapping of storm damage in permanent transects, Scords Wood, Sussex



## Layers for monitoring vegetation structure



## Definitions and minimum mean heights of layers





## Sample plots and quadrats

- Sample plots: for trees and shrubs 200m<sup>2</sup> 2,500m<sup>2</sup>
- Record species, percentage visual cover and stem diameters
  >5-7cm at breast height (dbh) in each layer
- For multi-stemmed trees, calculate the basal area (πr<sup>2</sup>) for each stem separately and sum.
- For understory field layer vegetation, use smaller quadrats, e.g.
  2x2m 10x10m

#### Examples of nested plot designs



from Stohlgren, 2007

# Species-area relationship (SAR) in theory, species number increases with sampling area



#### **Species-area relationship (SAR)**

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





# Recording cover abundance

| Value | Braun-   | Domin          |
|-------|----------|----------------|
|       | Blanquet |                |
| 10    |          | 91-100%        |
| 9     |          | 76-90%         |
| 8     |          | 51-75%         |
| 7     |          | 34-50%         |
| 6     |          | 26-33%         |
| 5     | 76-100%  | 11-25%         |
| 4     | 51-75%   | 4-10%          |
| 3     | 26-50%   | <4% frequent   |
| 2     | 6-25%    | <4% occasional |
| 1     | 1-5%     | <4% rare       |
| +     | <1%      | only 1-2       |
|       |          | individuals    |

| Stand-type: Coppice                                       | Brief de                        | escription of plot  |                                    |
|---|---------------------------------|---|------------------------------------|
| Plot number: 1<br>Plot position: 1.1<br>Recorders: JJ/GPB | Canopy c<br>understo<br>numbers | lominated by hornbeam with oak standards,<br>ry with occasional holly, large area of bare gr<br>of hornbeam seedlings at first leaf stage, bu | open<br>ound, large<br>t few older |
|   | seedlings                       | /saplings   |                                    |
| 12.6m plots   | BB                              |   | BB                                 |
|   | cover                           |   | cover                              |
| 1. Canopy (>15m)  |                                 |   |                                    |
| Quercus petraea 32  | 1                               |   |                                    |
| Carpnnus betulus (7.5.6.8.5.6) (5.5.8.7.6)                | 5                               |   |                                    |
| (10.5.7.6.6) (5.7.8.10.10)                                |                                 |   |                                    |
| 2. Sub-canopy (>6-15m)                                    |                                 |   |                                    |
|   |                                 |   |                                    |
|   |                                 |   |                                    |
|   |                                 |   |                                    |
| 2 Chrysh Jayon (2 Crz)                                    |                                 |   |                                    |
| 3. Shrub layer (2-6m)                                     |                                 |   |                                    |
| llex aquifolium 7 8 (10.5)                                | 3                               |   |                                    |
| Acer campestre 10   | 2                               |   |                                    |
|   |                                 |   |                                    |
| Understory (2x2m quadrats)                                |                                 |   |                                    |
| Q1  |                                 | Holcus mollis   | 2                                  |
| Hyacinthoides non-scripta                                 | 3                               | Acer seedling   | +                                  |
| Lonicera periclymenum                                     | 2                               |   |                                    |
| Holcus lanatus  | 1                               |   |                                    |
| Carpinus betulus seedlings                                | +                               |   |                                    |
| Rubus fruticosus  | 2                               |   |                                    |
| 02  |                                 |   |                                    |
|   |                                 |   |                                    |
|   |                                 |   |                                    |
|   |                                 |   |                                    |
|   |                                 |   |                                    |
|   |                                 |   |                                    |

## Plotless sampling: the point-centred quarter method



#### Plotless sampling record sheet

Site: Recorders:

| Sample point | Quarter | Species          | Distance<br>d (m) | Dbh (cm) | BA (cm <sup>2)</sup> |
|--------------|---------|------------------|-------------------|----------|----------------------|
| 1            | NW      | Quercus petraea  | 0.7               | 42.5     | 1418                 |
|              | NE      | Acer campestre   | 3.5               | 25       | 491                  |
|              | SW      | Carpinus betulus | 1.9               | 8.9.8    | 154                  |
|              | SE      | Carpinus betulus | 2.6               | 6.7.5.9  | 150                  |
| 2            | NW      |                  |                   |          |                      |
|              | NE      |                  |                   |          |                      |
|              | SW      |                  |                   |          |                      |
|              | SE      |                  |                   |          |                      |
| 3            | NW      |                  |                   |          |                      |
|              | NE      |                  |                   |          |                      |
|              | SW      |                  |                   |          |                      |
|              | SE      |                  |                   |          |                      |
| 4            | NW      |                  |                   |          |                      |
|              | NE      |                  |                   |          |                      |
|              | SW      |                  |                   |          |                      |
|              | SE      |                  |                   |          |                      |
|              |         |                  |                   |          |                      |

### Dead wood assessment

1. Fallen dead wood: use the line transect method 25m transects, randomly located Total length L (m/ha) =  $\pi$  10<sup>4</sup> N/ 2t ,

where t = transect length

Convert lengths to volumes, using diameter classes 5-10, 11-20, 21-30cm, etc.

Add to this....

#### Dead wood assessment cont...

#### 2. Standing dead wood

High stumps 0.5-1.5m (measure diameter at the cut level) Low snags >1.5-4m (measure diameter in the middle) High snags >4m (measure at dbh) Convert to volume:  $\pi r^2$  x length (except x0.3 for high snags)

**Decay classes** (both standing and dead wood) 1= recently fallen, bark on; 2 = bark loose, wood sound; 3 = rot starting; 4 = well-rotted

#### Dead wood assessment form

#### Site: Recorders:

| Transect | t Fallen dead wood diameter |       | Standing dead wood diameter |            |         |       |       |     |
|----------|-----------------------------|-------|-----------------------------|------------|---------|-------|-------|-----|
|          | class (cm)                  |       |                             | class (cm) |         |       |       |     |
|          | 5-10                        | 11-20 | 21-30                       | >31        | 5-10    | 11-20 | 21-30 | >31 |
| 1        | 5,10,8,5                    |       |                             |            | 9       |       |       |     |
| 2        | 7,8,9,5                     |       |                             |            | 7,5,7,8 |       |       |     |
| 3        |                             |       |                             |            |         |       |       |     |
| 4        |                             |       |                             |            |         |       |       |     |
| 5        |                             |       |                             |            |         |       |       |     |
| 6        |                             |       |                             |            |         |       |       |     |
|          |                             |       |                             |            |         |       |       |     |

#### Species diversity

Species diversity measures <u>both</u> the number of species <u>and</u> the spread of abundance between them, expressed as an index. This is more properly species <u>richness</u>, not <u>density</u>, which is the number of species

A widely used diversity index is the Shannon-Weiner index (H):

 H = ∑ pi In pi, where <u>pi</u> is the proportion of the ith species and <u>In</u> is the natural logarithm



#### Diversity types in ecology

After 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 similarity

Used to compare between two samples or stands. Many indices are available:

• e.g. Sørenson's index = <u>2w</u>

 $\bullet$ 

- A + B
- Where w = the number of species in common between the two stands and A is the total number of species in stand A and B is the total number of species in stand B.

# Sampling fauna

 Bird surveys: breeding bird surveys point counts
 Butterfly sampling: measured transects
 Other invertebrates: pitfall traps netting/beating light trapping
 Mammals: box traps, nest boxes (small mammals) dung counts, bat detectors

## Breeding bird territories

All species map



Blackbird territories delineated



## Pitfall trap for invertebrates in low vegetation



## Malaise trap for flying insects



Flight interception trap for flying insects



# Water trap for flying insects



# Robinson light trap for moths



Owen trap for insects emerging from soil or dead wood



#### **Forest vegetation diversity and soil acidity** 7 sites in the Czech R., 600 plots

