Afforestation & Biodiversity

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Outline

- Introduction
- Recent studies on forest biodiversity
- Future perspectives
- Conclusions

What is biodiversity?

Definition of Biological diversity from Rio Convention 1992:

"the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems"



Does biodiversity matter?

ECOSYSTEM SERVICES

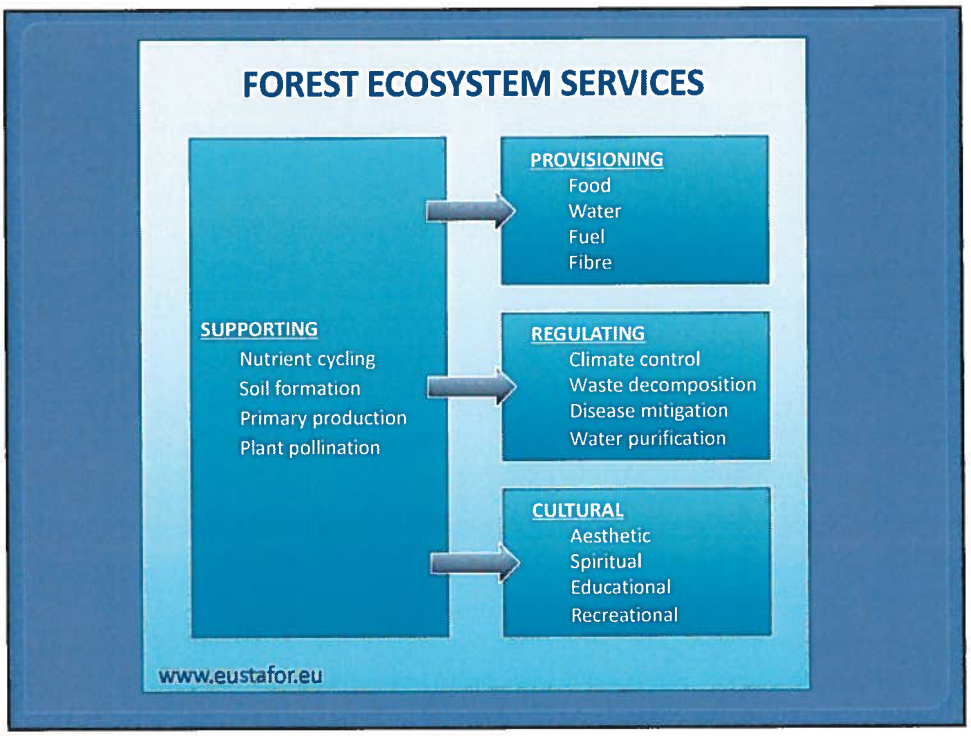
Society values the goods and services provided to humans by natural ecosystem for several reasons:

Aesthetic **Economic** **Amenity** **Ecological**

- *Provisioning*: Food, Water, Fuel, Fibre
- *Supporting*: Nutrient cycling, Primary production, pollination
- *Enriching* : Aesthetics, Education, Recreation
- *Regulating*: Climate control, waste decomposition, disease mitigation

Forest biodiversity

- Compositional, structural, functional
- Forests are home to > 70% of terrestrial species
- Species of conservation concern
- Rainforests are the most diverse terrestrial ecosystem
- Ireland has very few remaining natural forests with relatively few forest specialist species
- Threatened as a consequence of human activity


FOREST ECOSYSTEM SERVICES
SUPPORTING
Nutrient cycling
Soil formation
Primary production
Plant pollination
PROVISIONING
Food
Water
Fuel
Fibre
REGULATING
Climate control
Waste decomposition
Disease mitigation
Water purification
CULTURAL
Aesthetic
Spiritual
Educational
Recreational
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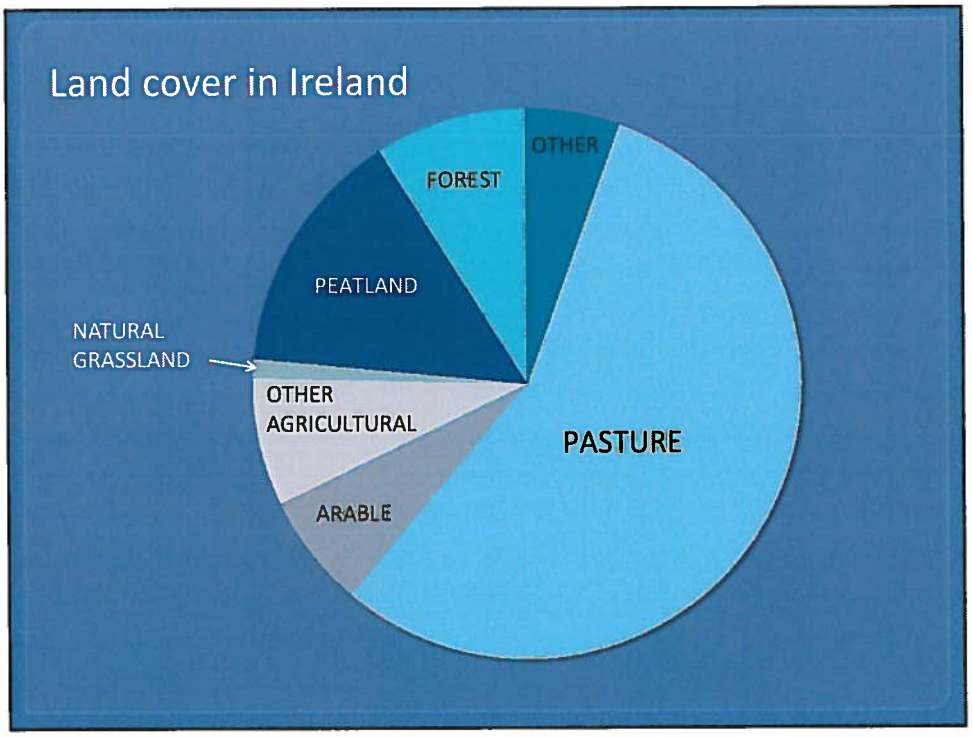

Land cover in Ireland
OTHER
FOREST
PEATLAND
NATURAL GRASSLAND
OTHER AGRICULTURAL
PASTURE
ARABLE

Forest biodiversity in Ireland

- Ireland is committed to the conservation of biological diversity in accordance with Article 6 of the Rio Convention on Biological Diversity.
- National strategy – National Biodiversity Plan.
- The Forest Service is committed to conserving and enhancing biodiversity in forests.
- Forestry practice in Ireland must conform to Sustainable Forest Management, a core component of which is biodiversity conservation.
- Research is necessary to underpin policies.

Forest biodiversity research at UCC

- Several relatively small projects before 2000
- BIOFOREST 2000 – 2006
  COFORD and EPA funded a research project aimed at producing information on biodiversity in plantation forests through the NDP RTDI programme
- PLANFORBIO 2007 – 2013
  COFORD funded research project aimed at addressing gaps in knowledge and emerging priorities

Research themes

- Biodiversity of afforestation habitats
- Biodiversity of first and second rotation forestry
- Biodiversity through the forest cycle
- Different tree species and mixes
- Biodiversity of native woodlands
- Biodiversity of the forest canopy
- Experimental methods to enhance biodiversity
- Biodiversity conservation
- Invasive species
- Grazing

Plant and animal groups

- Epiphytes
- Ground vegetation
- Ground dwelling spiders and beetles
- Canopy invertebrates
- Moths and butterflies
- Birds

Inter-disciplinary collaborative research

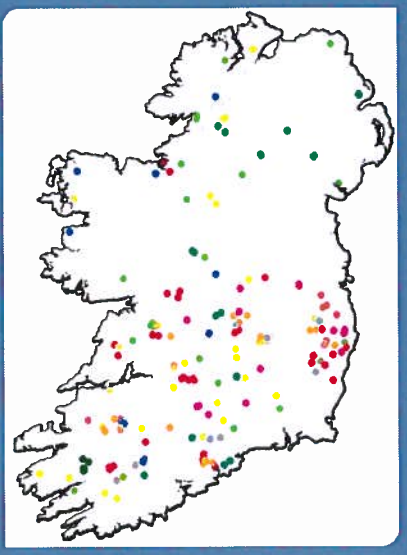
- School of Biological, Earth & Environmental Sciences, UCC
- Dept. of Botany, TCD
- Dept. of Chemical & Life Sciences, WIT
- Coillte
- Forest Research, UK
- University College Dublin
- University of Limerick

Input from other agencies

- Formal Steering Group
  - National
    - Forest Service
    - NPWS
    - Independent
  - International
    - Forest Research, UK
    - European Environment Agency
    - English Nature
    - Centre for Ecology and Hydrology, UK

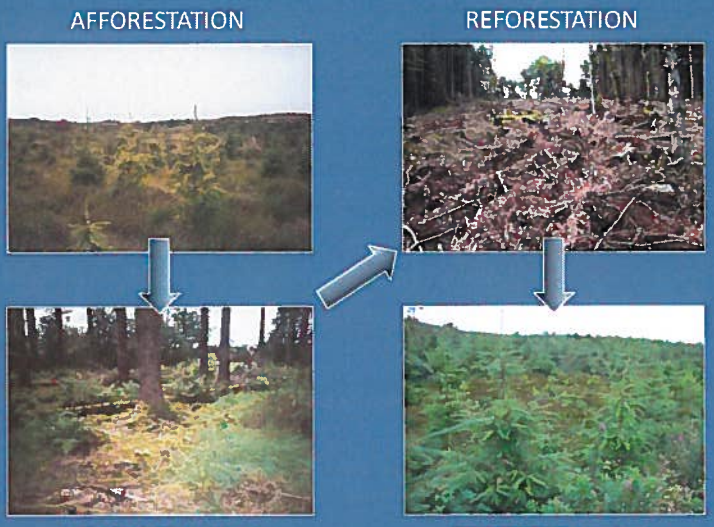
10 studies across 200 sites

- Pre-afforestation habitats (BIOFOREST)
- 1st rotation growth stage (BIOFOREST)
- 2nd rotation growth stage (FORESTBIO)
- Open space in forests (BIOFOREST)
- Road width experiment (BIOFOREST & BIOPLAN)
- Native woodlands (FORESTBIO)
- Level 1 monitoring (BIOFOREST & BIOPLAN)
- Testing forest indicators (BIOPLAN)
- Impact of grazing (BIOPLAN)
- Mixed canopy plantations (FORESTBIO)



PRE-AFFORESTATION HABITATS

Forest Rotations



Forest Cycle

- Stages of forest cycle delineated by stand age and forest structure
- Representative stands of the different stages were surveyed

Stage	PRE-THICKET	THICKET	MID-ROTATION	MATURE
Age	4 - 8	9 - 19	20 - 29	30 - 50
Forest Structure	Low open canopy	Closed canopy	Reopening OR closed	Tall open canopy

Effects of afforestation

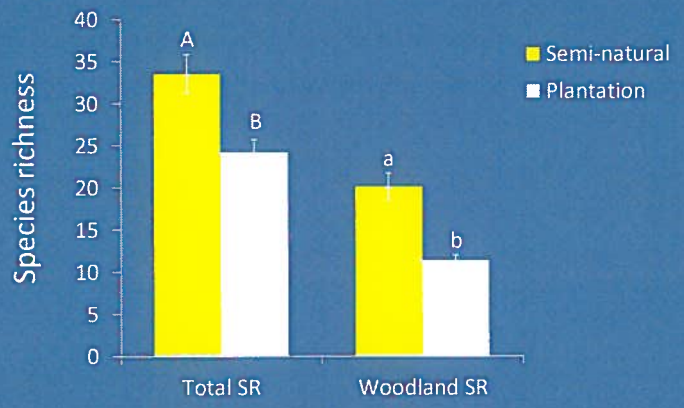
- Initial effect is to change relative abundances of plant and animal species.
- Afforestation of semi-natural habitats would result in a net loss of biodiversity.
- Afforestation of improved and semi-improved grassland would be neutral or positive.
- Proximity to old semi-natural woodland and scrub in the landscape increase the species richness of typical woodland plants.

Biodiversity in forest plantations

- Different forest types support different plant and animal diversity.
- Biodiversity changes through the forest cycle.
- The paucity of native woodlands in Ireland means that plantations have the potential to provide important habitats for populations of some forest species that would otherwise be scarce, especially in intensively farmed landscapes.

Ground Vegetation

Semi-natural woodlands significantly more species rich than plantations



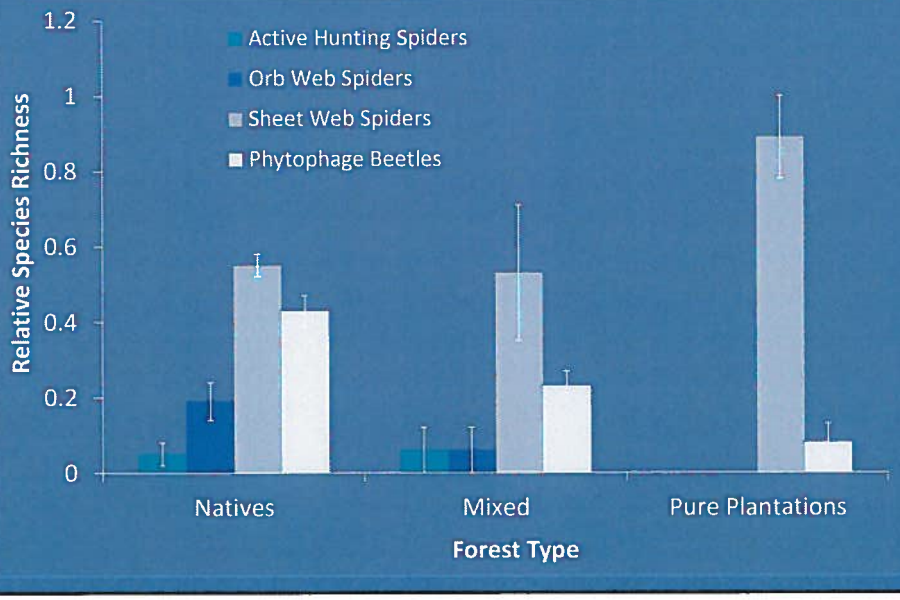
Ground Vegetation

- Vascular plants and bryophyte ground flora communities in pre-thicket sites were distinct from all other stages
- Differences were found between rotations
- Afforestation stands have higher species richness or diversity
- Retention of typical woodland species between rotations
- Over reforestation cycle this initial gain on afforestation is lost

Ground-dwelling invertebrates

- Species richness of forest-associated spiders increases over forest cycle and is lost after felling
- Open habitat spiders colonise stands after clear-felling.
- Rare spiders associated with the pre-afforestation habitat are lost and do not recolonise.
- Biodiversity of pre-thicket stands is lower in successive rotations
- Later stages are more similar.

Guild composition in different forest types



Deadwood

- Logs
  - Volume: Ash > Plantations
  - Size: Vast majority < 20cm diameter, < 1% over 40cm (Oak and Ash)
- Snags
  - Density 70-90 per Ha (high)
  - Similar size distribution to logs (very few large snags)
- Stumps
  - Volume: Plantations > Oak and Ash
  - Rotation, thinning

Deadwood

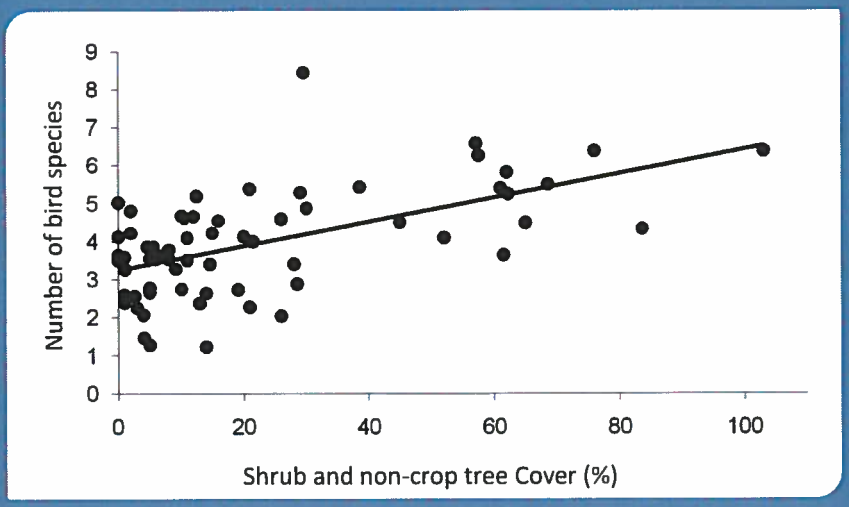
- Very different to old-growth (high log:volume, low density of large snags)
- Historical exploitation of Irish forests (coppice, timber), climate
- Saproxylic research needed: few data

Canopy invertebrates

- Differences in invertebrate communities between semi-natural oak forests and both plantation forest types.
- Semi-natural oak ≠ Pure plantations ≠ Mix plantations
- Large differences in tree sizes at pure and mix plantations
  - Smaller trees = less canopy area.
  - Oaks in mixes outcompeted, stunted
  - Less habitat available
- Edge effects??
  - Isolated oaks in coniferous matrix

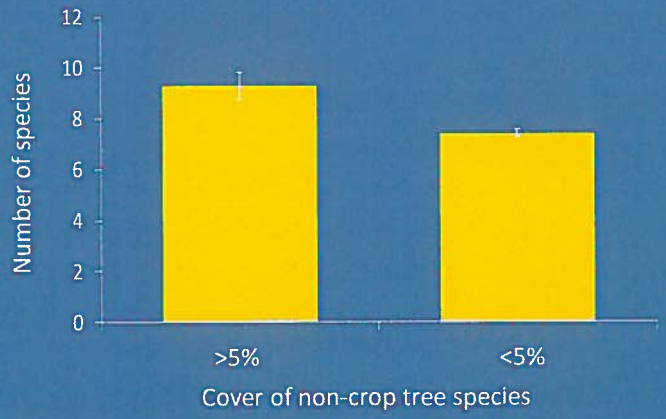
Between 80 and 90% of birds detected during a survey of 12 mature conifer plantations around Ireland were of just five species:

Chaffinch
Goldcrest
Robin
Wren
Coal Tit

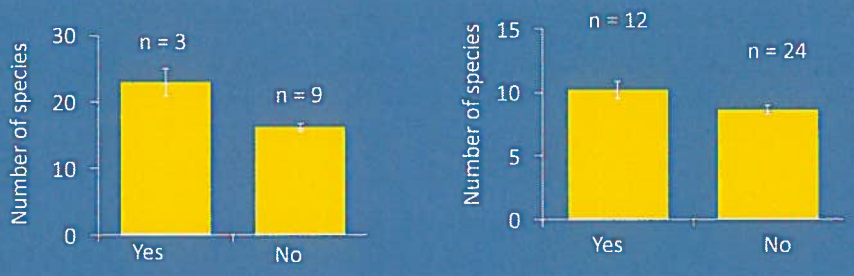


Bird species richness along forest roads is positively related to cover of shrubs and non-crop trees

Bird species richness at the scale of the stand



Number of bird species is higher in areas with over 5% cover of non-crop trees.



Forests with a broadleaved element have higher bird species richness than those without (t=4.67, d.f.=10, p=0.001).

Within these forests, areas with broadleaves support more bird species than other areas (t=2.26, d.f.=34, p=0.03).

Associated with young forest habitat

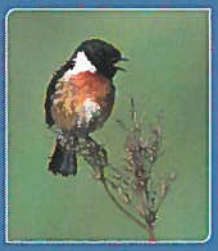
Willow warbler

Redpoll

Associated with open habitats

Whitethroat

Grasshopper Warbler



Stonechat

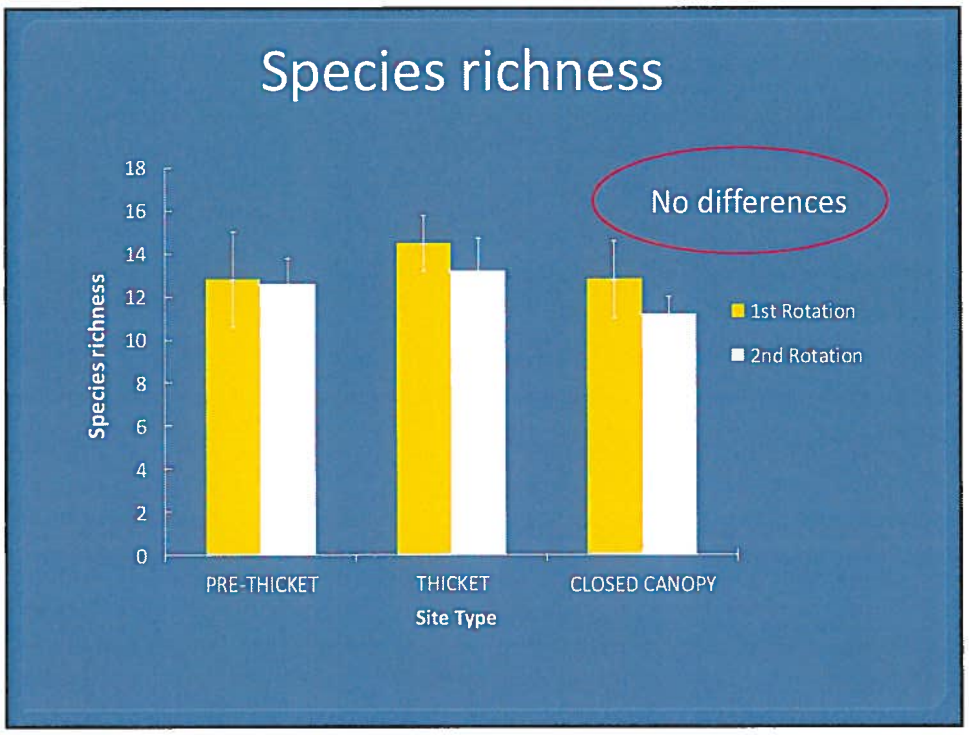
Meadow Pipit

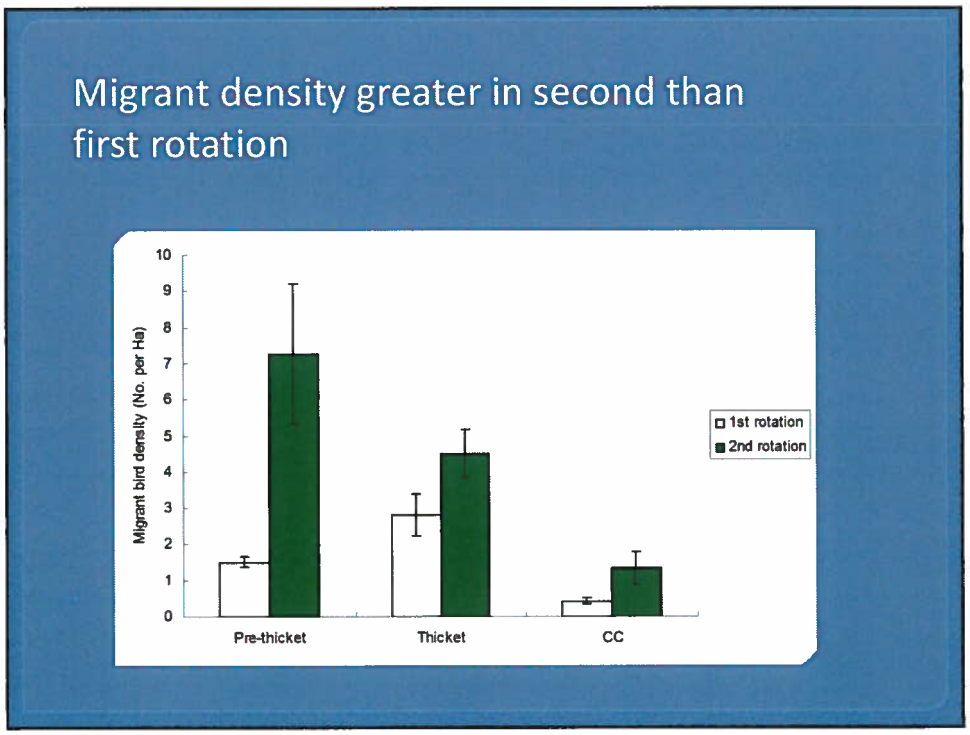
Reed Bunting

Associated with mosaics of forests and open habitats

Nightjar

Hen Harrier


Species richness
No differences
Species richness
18
16
14
12
10
8
6
4
2
0
1st Rotation
2nd Rotation
PRE-THICKET
THICKET
CLOSED CANOPY
Site Type


Migrant density greater in second than first rotation
Migrant bird density (No. per Ha)
10
9
8
7
6
5
4
3
2
1
0
1st rotation
2nd rotation
Pre-thicket
Thicket
CC

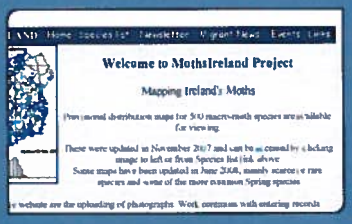
Birds

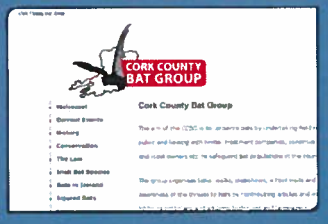
- Native v Plantation
  - Diversity
    - Oak & Ash > Mid-rotation & Mature
  - Density
    - No differences
  - Important structural features
    - Diversity: Understorey cover, shrub cover field cover, stem density (+)
    - Density: Understorey cover (-)

Recommendations for pre-afforestation site selection

Improve application procedure and utilise local knowledge

- Develop screening criteria to identify afforestation projects requiring a sub-threshold EIA
- Consultation procedures for grant applications should be more comprehensive
- Local authorities should comment on conservation issues pertaining to grant applications





Recommendations for pre-afforestation site selection

- Consider site biodiversity in context of the surrounding landscape prior to afforestation
- Avoid afforesting semi-natural habitats

Recommendations for forest planting

Plantation edges

- Complex edges should be incorporated in plantations to increase the proportion of edge habitat
- Plantation boundaries should be left unplanted to allow development of complex edge structure

Recommendations for forest planting

- Native tree species can be included in forest stands to increase the range of plant and animal species supported, particularly in the forest canopy
- Supplementary habitats (treelines, hedgerows, scrub etc.,) can increase the biodiversity of afforestation sites.

Recommendations for forest management

- Sitka spruce plantations should be rigorously thinned to prevent canopy closure

- Broadleaved woody vegetation should be promoted in conifer plantations

Recommendations for forest management

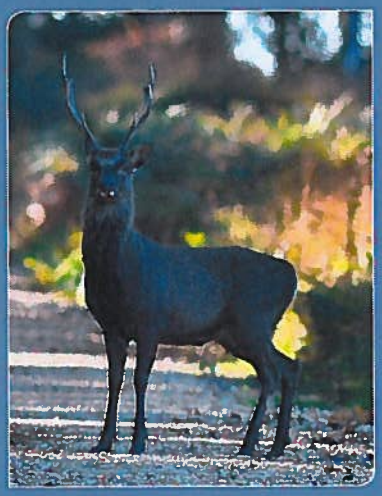
- Managing for deadwood is particularly important in Ireland because deadwood volumes in Irish forests are currently very low.
- Snags, stumps and woody debris (coarse and fine) all support a range of species.



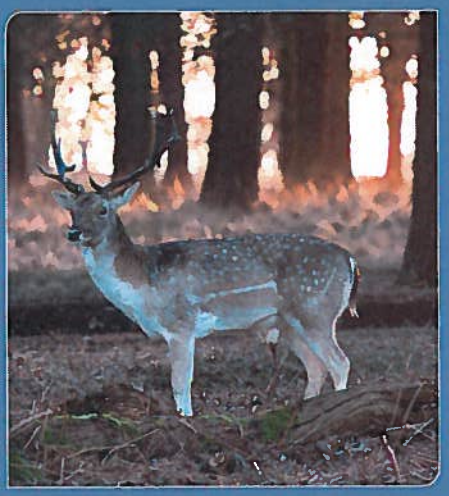
Future perspectives

- Grazing
- Assessment tools
- Bio-energy and Wind energy
- Climate change
- Colonists
- Identification and valuation of forest ecosystem services

IMPORTANT ISSUE 1: Deer management



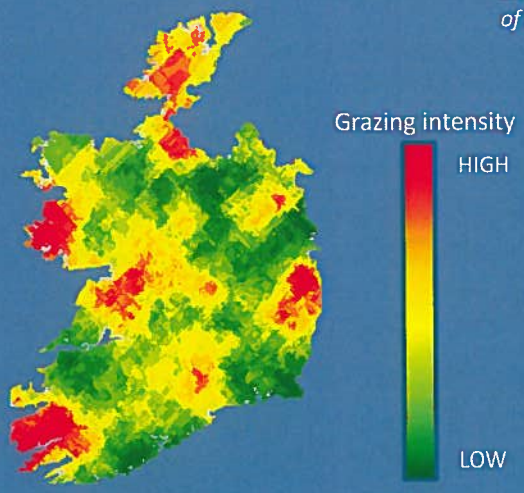
Sika Deer



Fallow Deer

Grazing intensity in Ireland

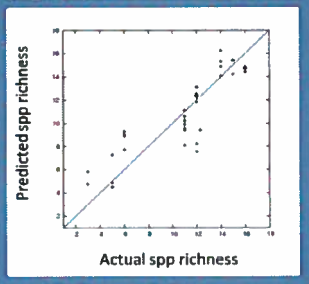
Derived from National Survey of Native Woodland data



IMPORTANT ISSUE 2: Quantifying biodiversity

Deciduous

Coniferous



O'Sullivan *et al.*, Frontiers in Artificial Intelligence, 2010

IMPORTANT ISSUE 3: Bio-energy

Willow Coppice

Hazel Coppice

IMPORTANT ISSUE 6: Wind-energy

IMPORTANT ISSUE 4: Climate change

Phenology

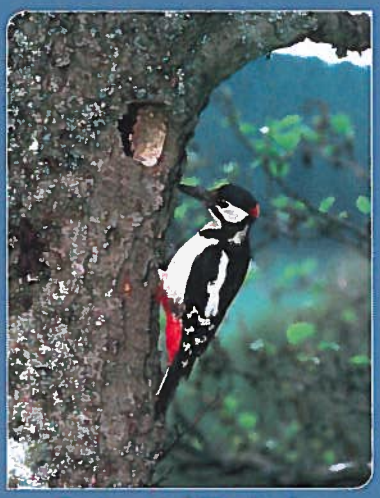
Forest fires

Invasive species and disease

Range expansions

Planted tree species

IMPORTANT ISSUE 5: Colonists

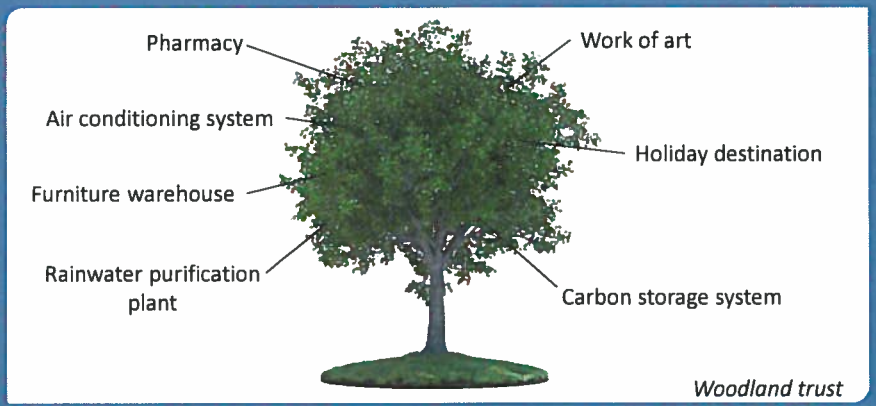


Great-spotted Woodpecker

Common Buzzard

IMPORTANT ISSUE 6: Valuing of forest services

- Economic value of Irish forest ecosystem services
- Inform policy that influences these services



Conclusions

- Forests represent about 11% of land area- small plot sizes- 'grainy landscape'
- Forests – mostly composed of coniferous species/though proportion of deciduous increasing
- Forest biodiversity-dominated by species generalists
- Biodiversity influenced by agriculture land-use
- Opportunities for forests to contribute to Ireland's biodiversity- though rate of planting/felling means recent gains- may be at risk
- Natural/human influences important

Some of the PLANFORBIO Team

www.ucc.ie/en/planforbio