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Management options for (sustainably) intensifying production from planted forests:

A EUROPEAN PERSPECTIVE

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1. Setting the scene

Sustainable intensification?

“[…] yields are increased without adverse environmental impact and without the cultivation of more land […]”

Royal Society, 2009. *Reaping the Benefits: Science and the Sustainable Intensification of Global Agriculture*.

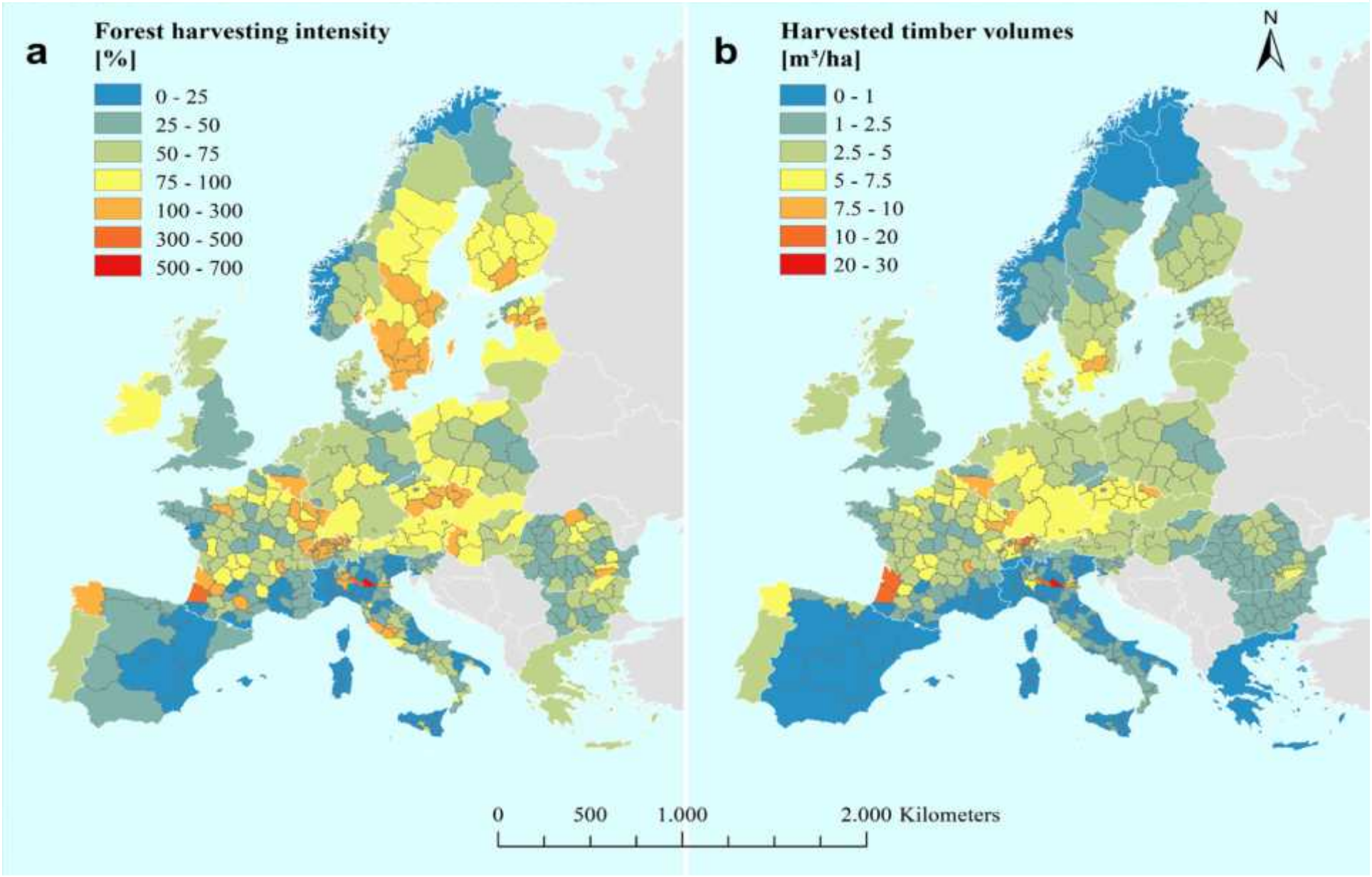
EU_{28} forests

1. **37% of EU land area;**
2. **85% managed and available for wood supply;**
3. **About 75% of annual increment is harvested;**
4. **About 35% of forest area is classed as ‘planted forest’.**

Nabuurs et al. (2015) From Science to Policy 2, EFI

Average harvest intensity (% of increment) and harvested volumes (m^3/ha) for 2000-2010: EU_{27}, Norway and Switzerland.

(Levers et al., 2014. *Forest Ecology and Management*, 315, 160-172)



Is there a Problem we need Sustainable Intensification to solve?

"[Europe has] well established and relatively stable […] areas of planted forests. […] The main issues […] will be climate change, adaptation to extreme events and managing forest health impacts."

p. 65 in Payn et al (2015) *Forest Ecology and Management*, 352, 57-67.

<20 publications revealed by keywords: "SI, Europe, forests".

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2. The need for intensification – a British case study

Sitka spruce in the British Isles

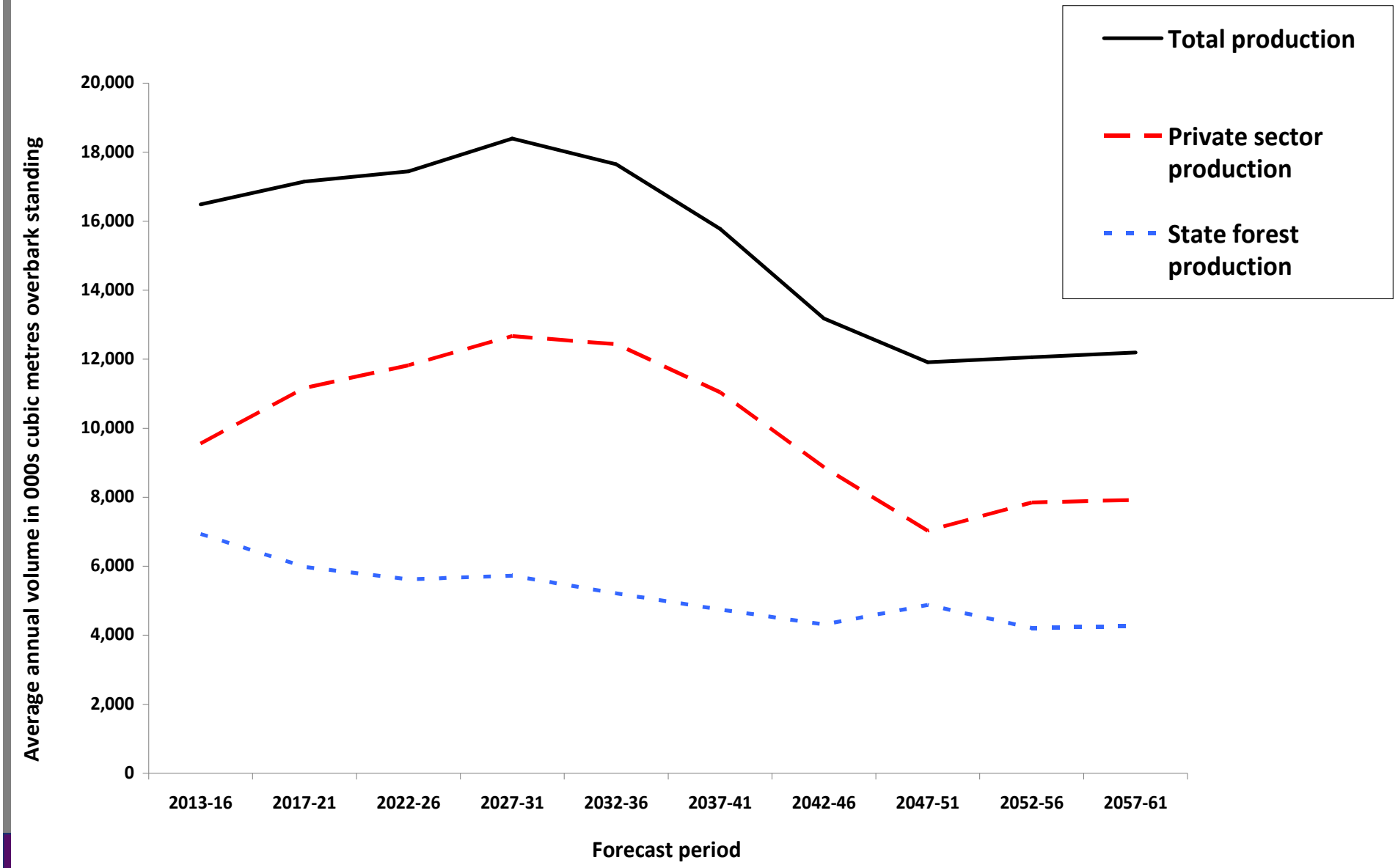
1. Introduced in 1831;
2. First trial plantations in 1880s;
3. Operational plantations from 1920s;
4. The major species in British forests (>30 per cent of forest area).

Standard management of Sitka spruce forests in northern Britain

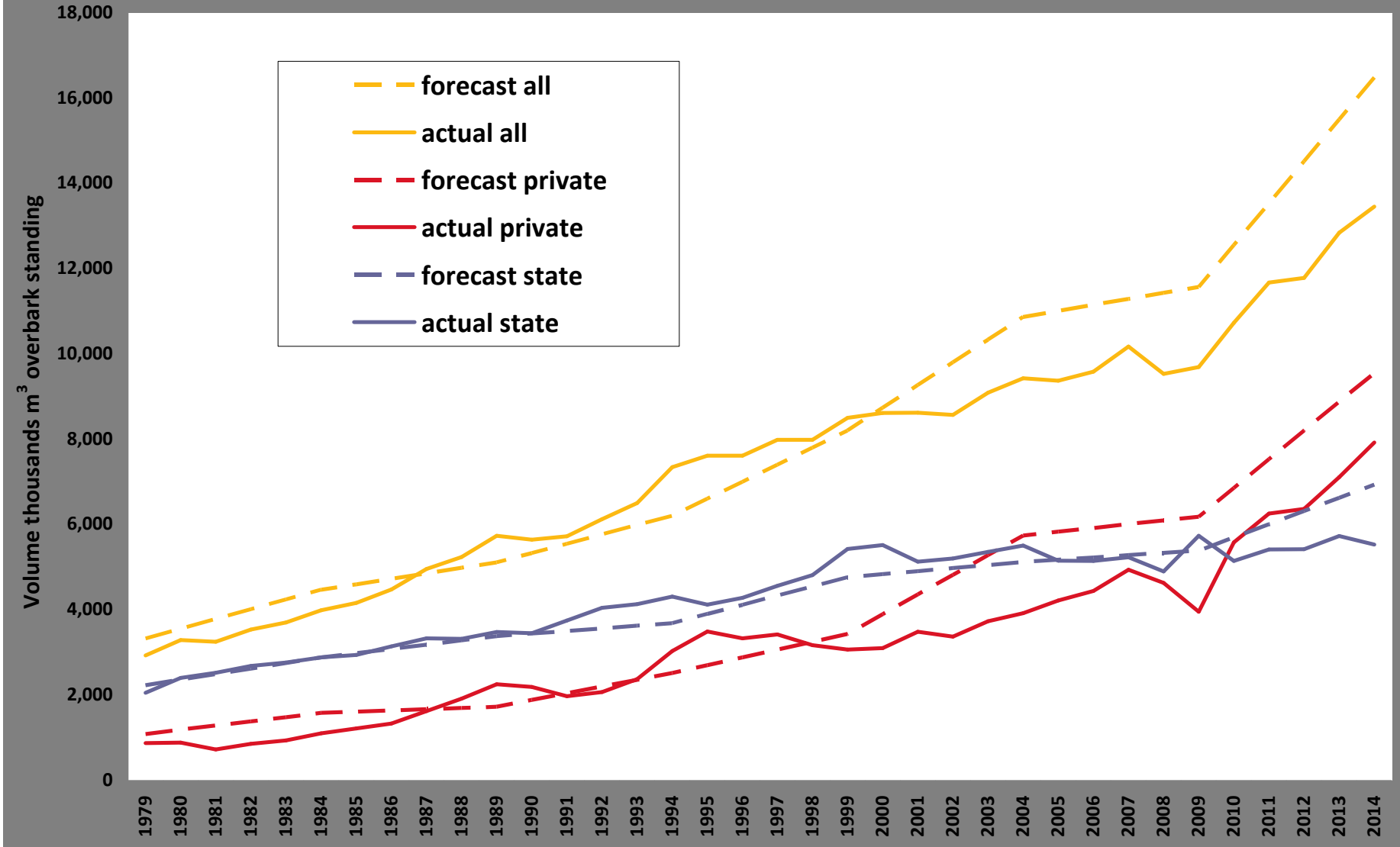
- **Silvicultural system** - Patch clear felling with replanting;
- **Coupe size**: 1-50 ha depending on visibility;
- **Planting** -2500-2700 stems ha^{-1};
- **Fertilizer** - P(K) on poorer site types;
- **Thinning** – 0-4 times depending on wind risk;
- **Rotation** – 35-50 years depending on productivity;
- **Felling volume** – 400-700 m^3 ha^{-1} or more
- **Average productivity** - 14 m^3 ha^{-1} yr^{-1} but up to 24 or more

Forests are simple and lack species and structural diversity

50 year forecast of softwood availability in Great Britain (NFI, 2014)



Actual production of softwood timber against forecast in GB from 1979-2014 (NFI, 2016)



A problem Sustainable Intensification can help to solve?

1. >60 per cent of the softwood resource is spruce (mainly Sitka). Figure in Scotland and Ireland is > 80 per cent;
2. Historic undercutting of the forest resource, especially in the private sector;
3. A predicted 30 per cent decline in amount of timber available for the processing sector from 2030s;
4. Important sector in the rural economy (>1 billion euros in Scotland in 2015).

How can we sustainably intensify production from these spruce forests?

1. **Use of genetically improved material;**
2. **Better site adapted silviculture to manage nutrition and water availability to the trees;**
3. Increase the amount of new planting of spruce – potential land-use conflicts?

Percentage increase in growth of improved Sitka spruce at 15 years

(average of plots in operational plantings)

Parameter	% increase
Mean tree volume (m^3)	200

94% of all Sitka spruce nursery stock sold in Britain in 2013/14 derived from improved material.

Predicted genetic gain of around 20-30 % in volume

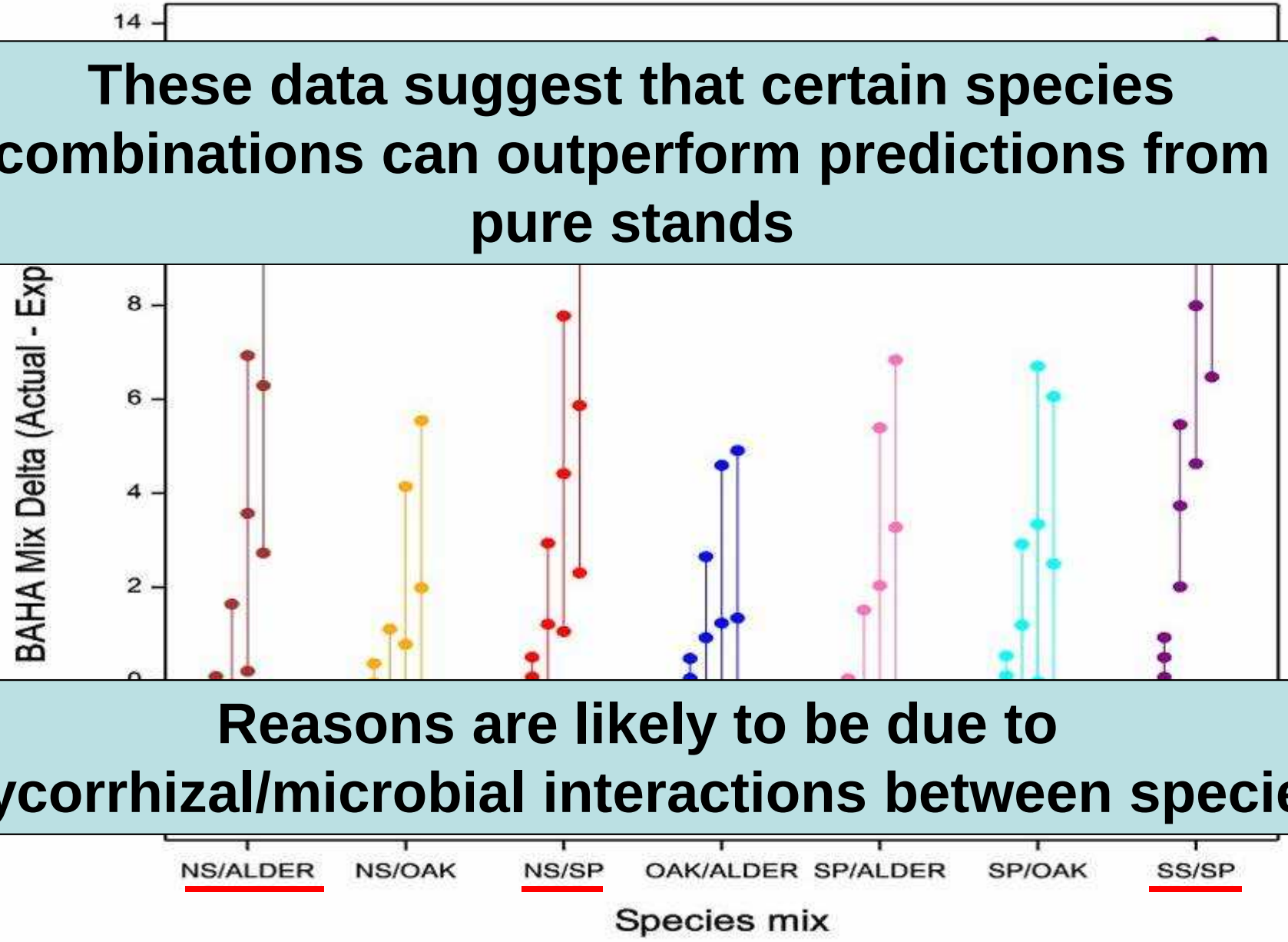
Green (i.e. best quality) sawlog volume (m^3 ha^{-1}) at 35 years (Mochan et al., 2008)

Silvicultural impacts in a 30 years old Sitka spruce cultivation experiment in north England

Parameter	No cultivation	Cultivation	Signif	5%LSD	Yield class
Survival (%)	79	95	***	4.2	
20	1.4	1.7	**	0.1	
Basal area@ 30 yrs	39.8	39.9	ns	2.4	16
Basal area @ 30 yrs - fertiliser	37.1 (no fertiliser)	42.7 (phosphate)	***	2.4	16
Basal area @ 30 yrs - strips	54.0	55.5	ns	0.7	

Gisburn second rotation – basal area development at 6,10, 15, 20 years.

These data suggest that certain species combinations can outperform predictions from pure stands



Reasons are likely to be due to mycorrhizal/microbial interactions between species

Mason & Connolly, Forestry, 2014

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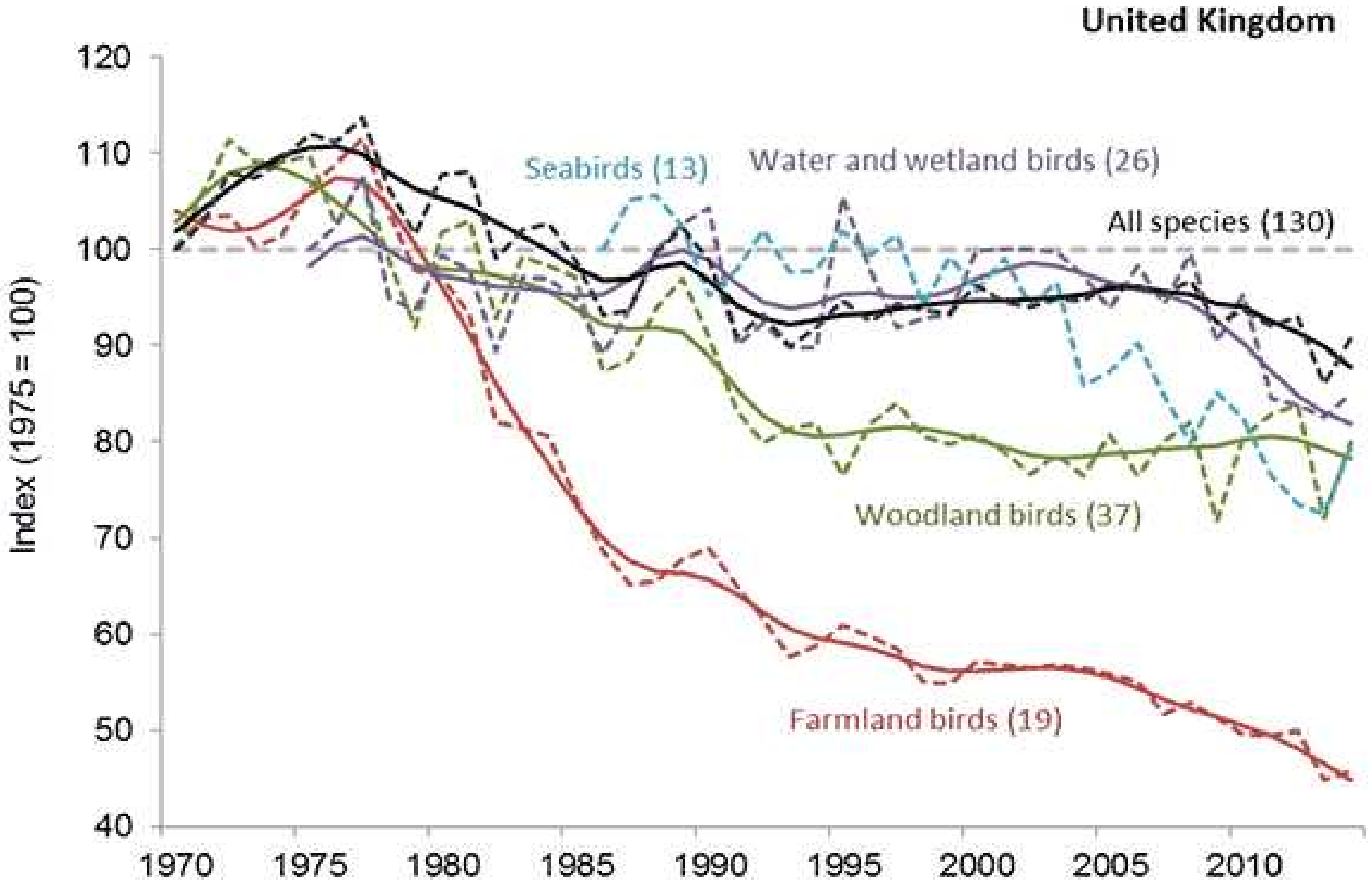
Sustainable Intensification and Ecosystem services in Sitka spruce forests - Biodiversity

Populations of wild birds in the UK, by habitat, 1970 to 2014.

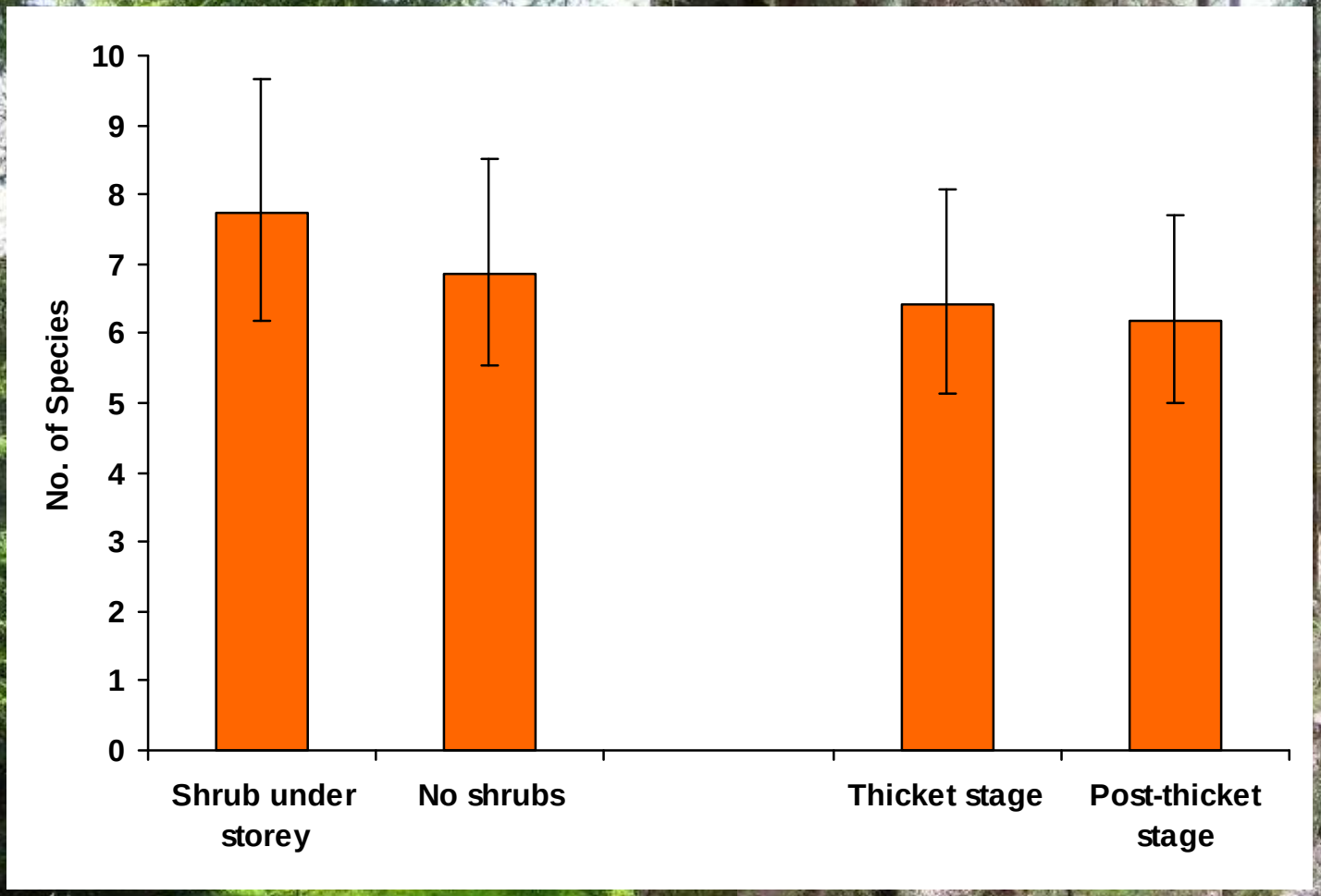
Source: BTO, Defra, JNCC, RSPB



Breeding birds: close-to-nature (CCF) vs normal management

CCF stand at 55 years

Even-aged stand at 35 years



Calladine et al., ***Forest Ecology and Management***, 344 (2015) 20–29

Scarce ‘forest’ species found ONLY in CCF


Goshawk


Nuthatch


Redstart


Willow Tit


Hawfinch

Conclusions - Sitka spruce

- Genetic improvement is already providing improvements in growth and will affect log outturn;
- These improvements not incorporated in forecasts;
- Silvicultural practices that influence nutrition and soil moisture (e.g. use of mixtures) can also improve yields;
- Insufficient knowledge of improvements available by linking appropriate silviculture and best genetic material;
- Therefore, there is a PRODUCTIVITY GAP between potential and actual outputs, which is unquantified;
- BUT, provision of other ecosystem services through 'CCF systems' will provide the 'social licence to operate' that will be critical for any sustainable intensification in British forests.

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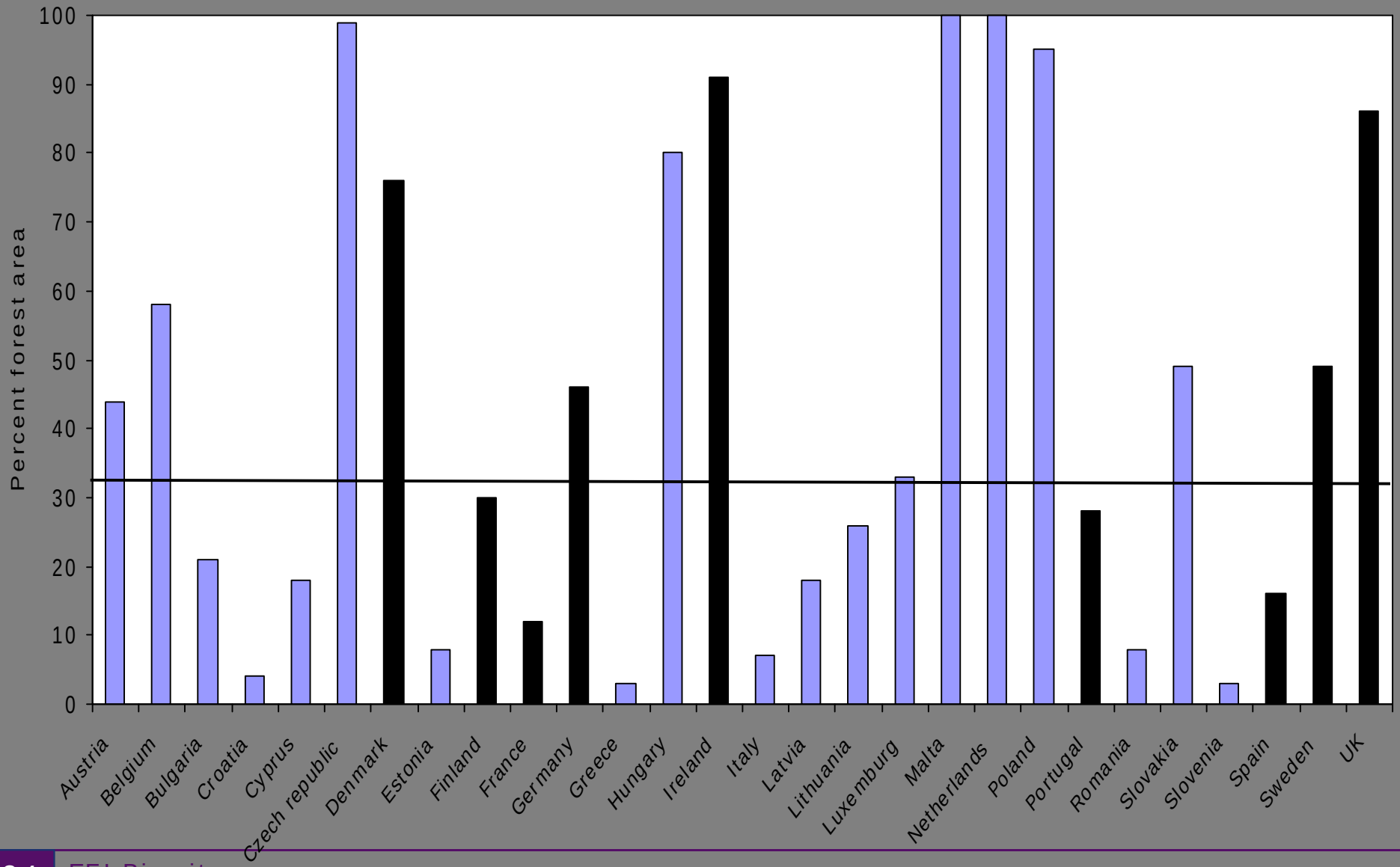
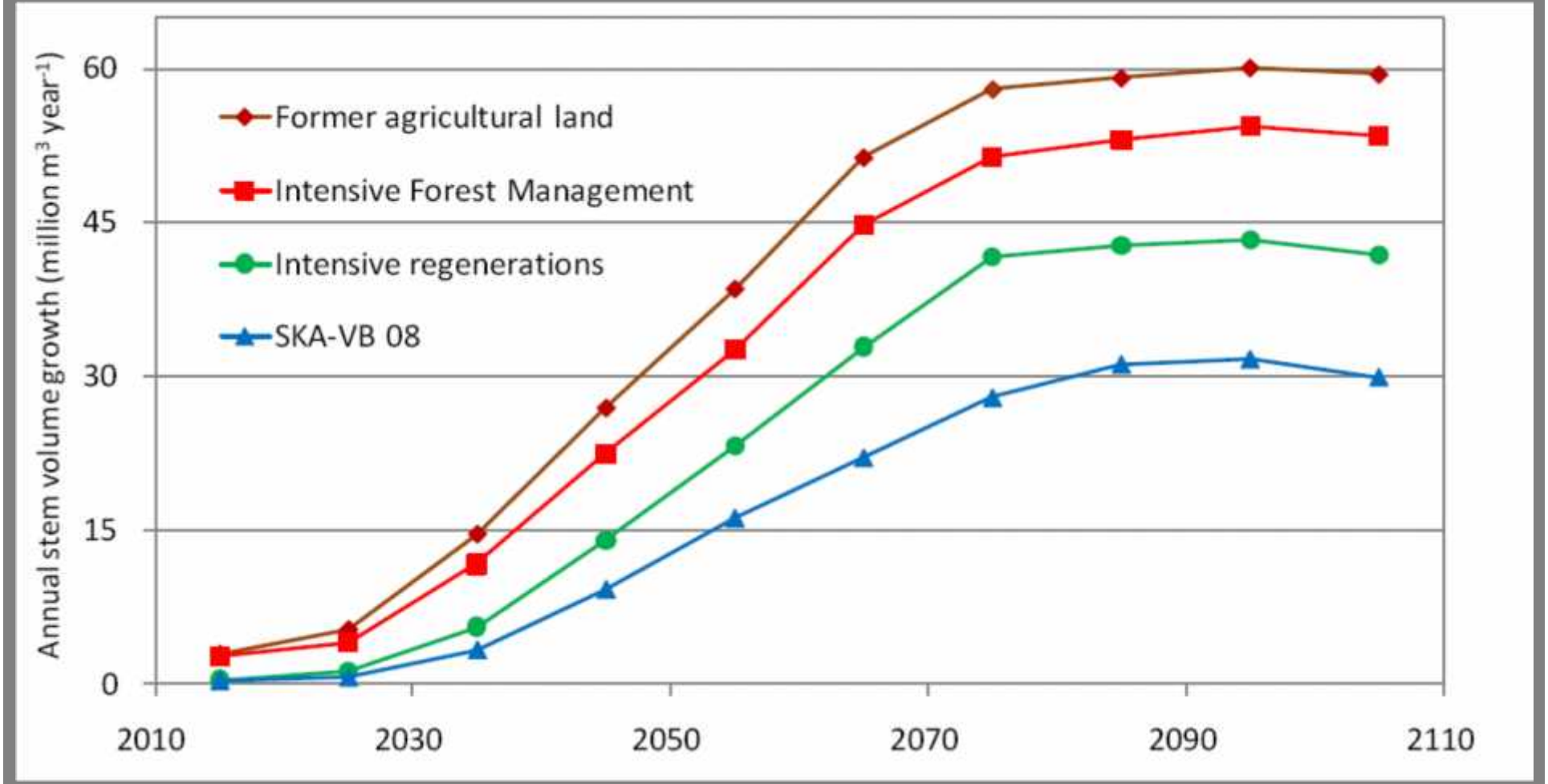
3. EUROPEAN IMPLICATIONS

Planted forest area (%) by EU Member State -
after FAO Forest Resources Assessment 2015



Impacts of intensification of forest management upon annual volume growth in Sweden.

[Nilsson et al., *Forests,* 2011, 373-393.



Observations about SI in European forests

1. Not discussed very much;
2. There is not a single solution. Usefulness of the concept varies with country/region, forest type and site;
3. Likely to be of value where resource demand/supply is changing over time;
4. Both genetics and silviculture have a role in delivering SI, as well as techniques linked with precision forestry;
5. Have to consider impacts of climate change, plus pest/disease hazards;
6. A mixed forest approach may prove increasingly important in delivering SI.

Pinus pinaster **provenance hybrids near Bordeaux**

"We believe […] that SI provides a valuable approach to negotiating the [forest-environment] challenges we face. […] SI does not proscribe or advocate the use of particular inputs or techniques. […] SI is best envisaged as a pragmatic process of enquiry and analysis for navigating the issues and concerns."

Garnett & Godfray (2012) *Sustainable intensification in agriculture*, FCRN, Oxford.

Western hemlock - Sitka spruce mixed forest on Haida Gwaii, British Columbia, Canada

Merci de votre attention