Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Higher levels of multiple ecosystem services are found in forests with more tree species

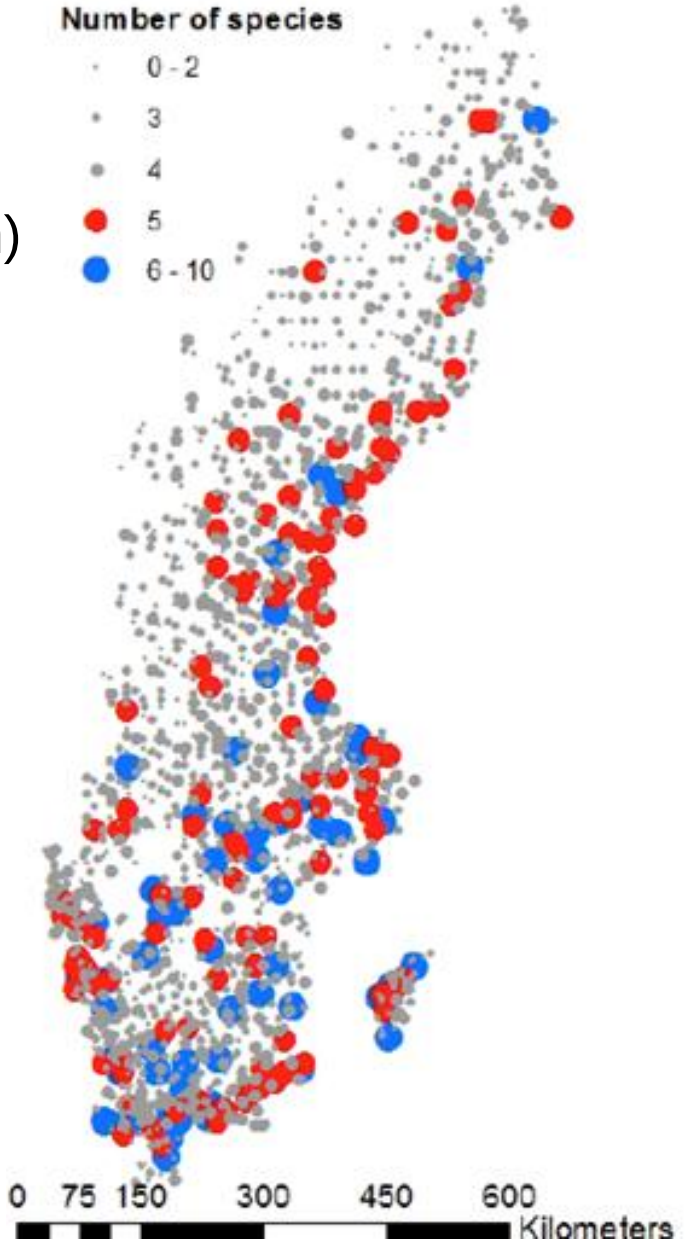
Lars Gamfeldt, Tord Snäll, Robert Bagchi, Micael Jonsson, Lena Gustafsson, Petter Kjellander, María C. Ruiz-Jaen, Mats Fröberg, Johan Stendahl, Christopher D. Philipson, Grzegorz Mikusinksi, Erik Andersson, Bertil Westerlund, Henrik Andrén, Fredrik Moberg, Jon Moen & Jan Bengtsson*. 2013. Nature. Comm. 4:1340.*
Länk: *http://www.nature.com/ncomms/journal/v4/n1/abs/ncomms2328.html*

Project questions

- What are the relationships between ecosystem services and tree species richness?
- What are the relationships between ecosystem services and the biomass of different tree species?
- What are the correlations between ecosystem services – is there any evidence for trade-offs?

The empirical data

- The Swedish National Forest Inventory
- Productive forests (>1 m^3 ha^{-1} yr^{-1})
- Data from 1999-2002 (-5 years for production)
- Plots harvested last 5 years excluded
- Complete plots (10 m radius -> 314 m^2)
- 4,335 plots among 1394 tracts



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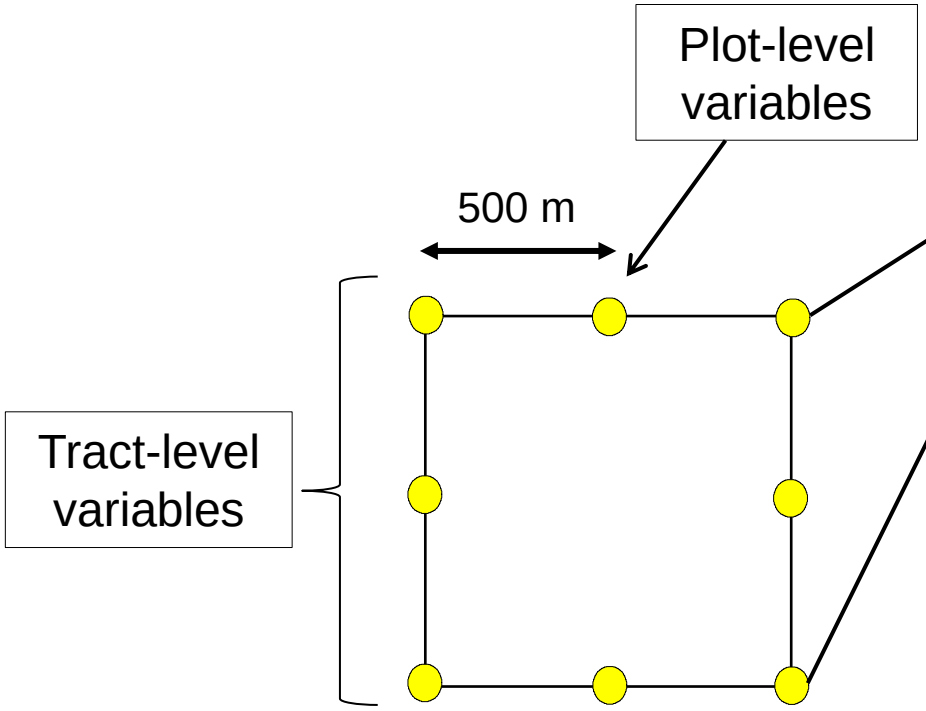
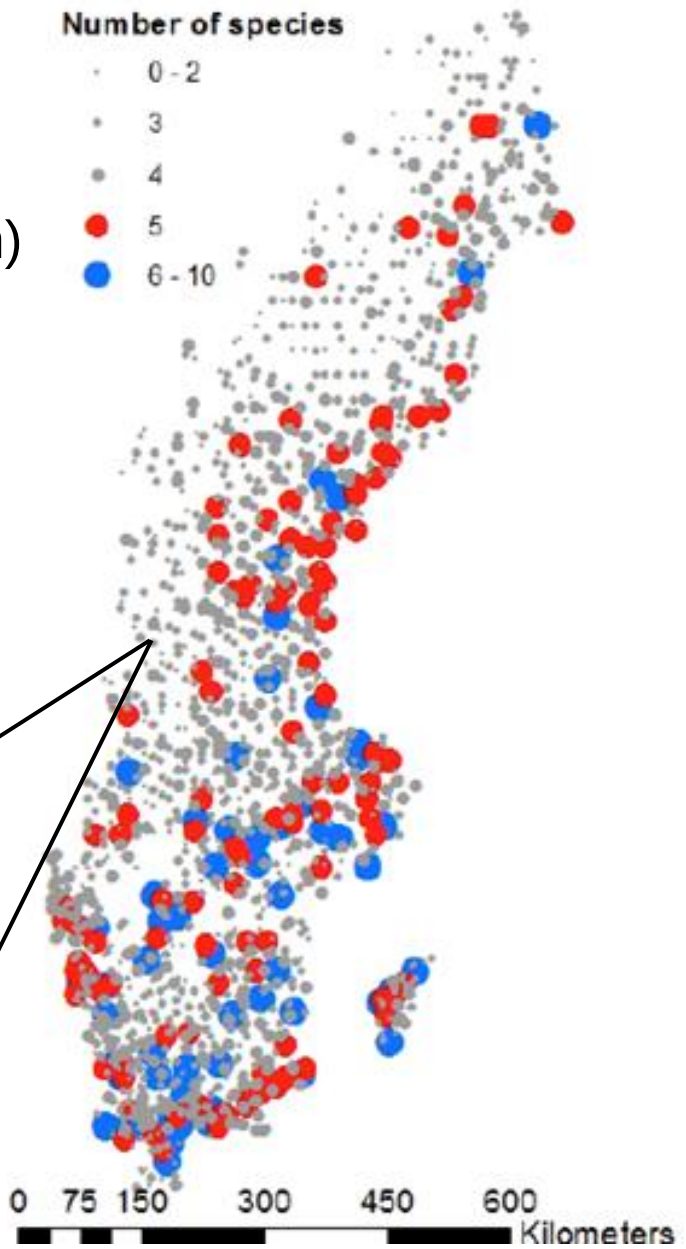




Six ecosystem services

- Tree biomass production (kg m^{-2} yr^{-1})
- Soil carbon storage (g m^{-2} in topsoil)
- Bilberry (*Vaccinium myrtillus*) cover
- Wild game production potential (cover of preferred food)
- Species richness of understory vegetation
- Dead wood occurrence






Analysis approach

Statistical modelling of ecosystems services as a function of environmental variables and tree species richness

environmental variables:

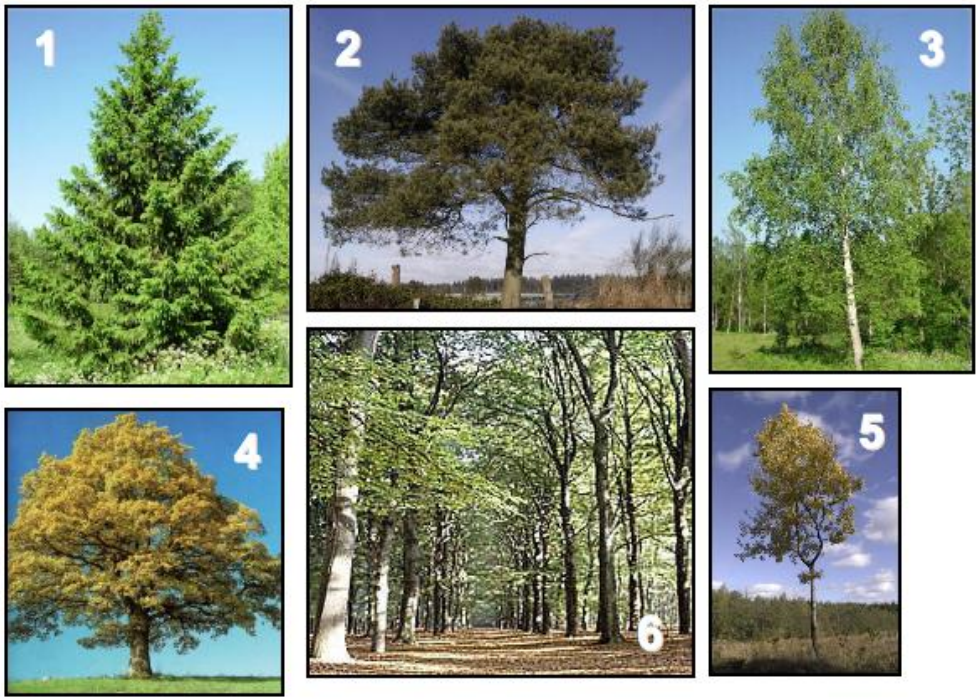
tract
- Temperature
- Nitrogen deposition
- Humidity
- Soil variables (moisture, pH, C:N ratio, soil type)

plot
- Biomasses of dominating tree species
- Interactions between the variables, the variables squared
- *Stem density*
- *Site productivity (a productivity index)*
- *Basal area*

Biomasses of tree species

- 20 tree species (1-10, in any given plot, 98.5% <6 species)

1. Spruce (*Picea abies*)
2. Pine (*Pinus sylvestris*)
3. Birch (*Betula* spp)
4. Oak (*Quercus robur*)
5. Aspen (*Populus tremula*)
6. Beech (*Fagus sylvatica*)



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Tree species richness

Analysis approach

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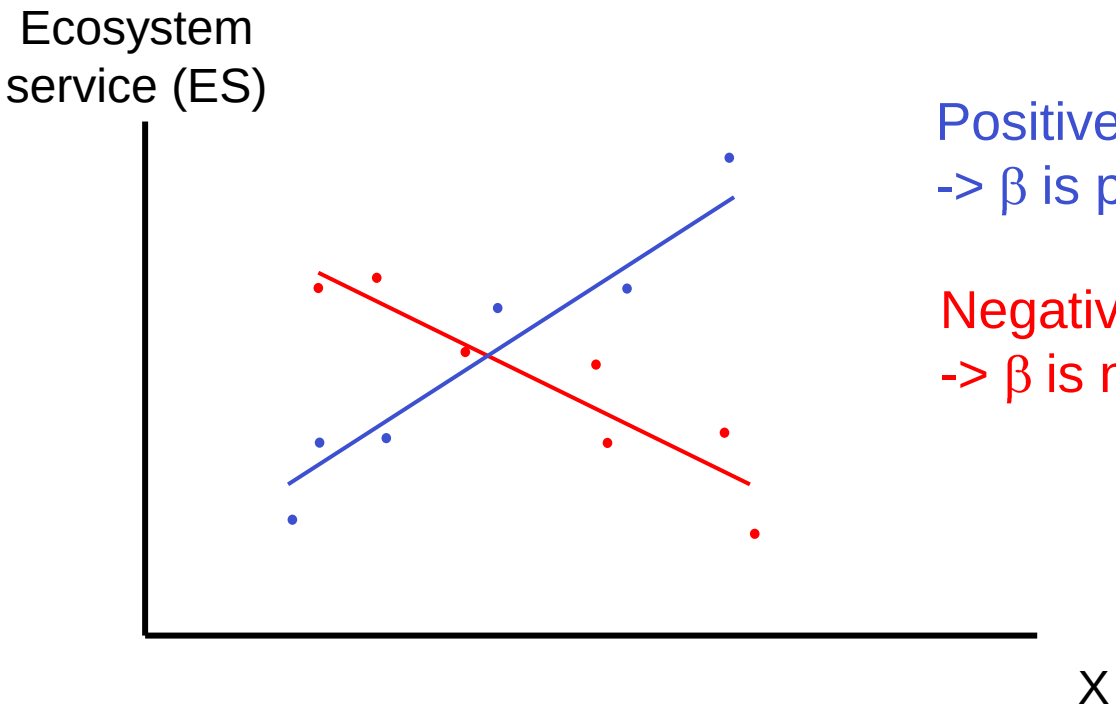
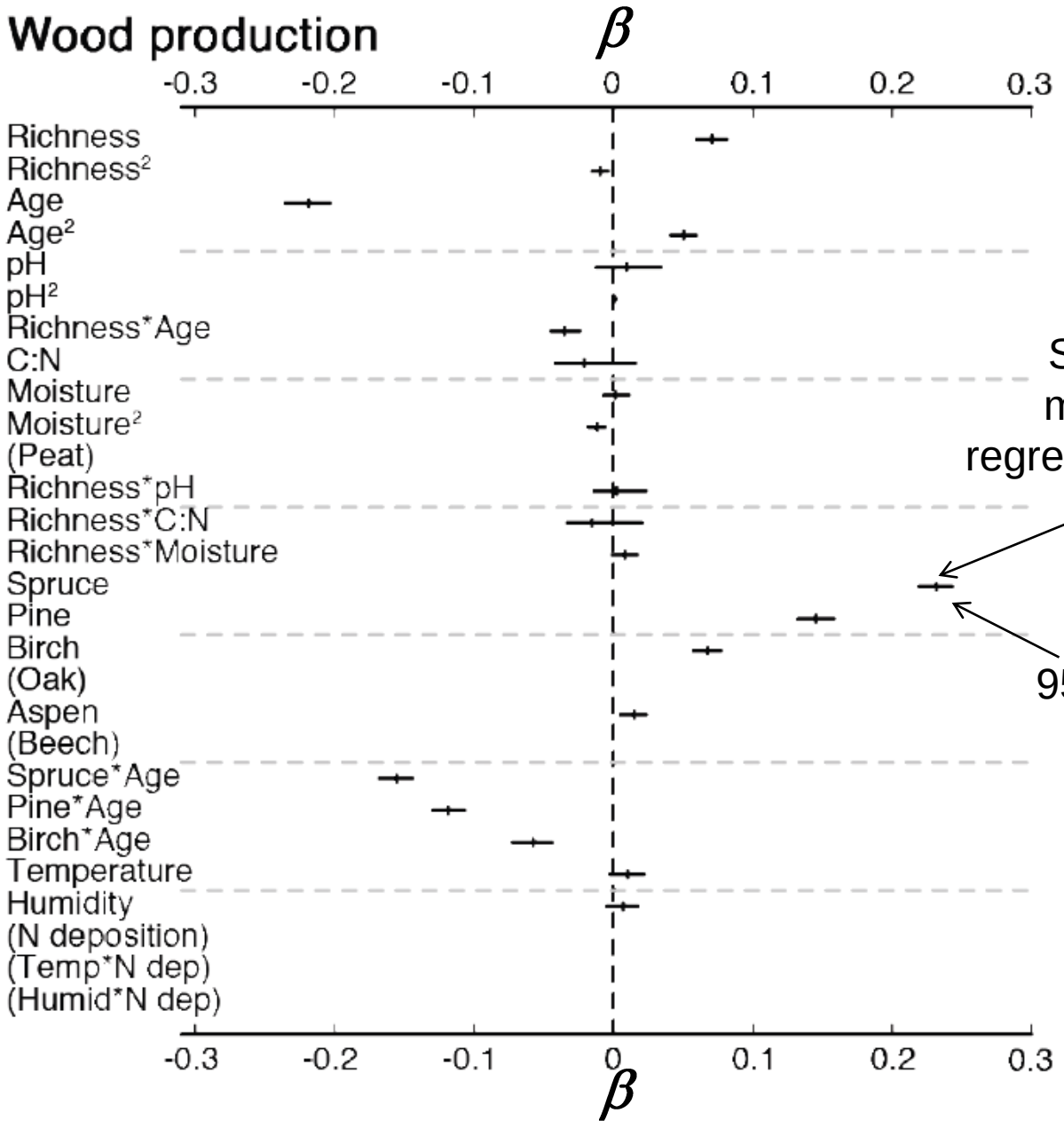
$$ES = \alpha + \beta X$$



Positive relationship
-> β is positive

Negative relationship
-> β is negative

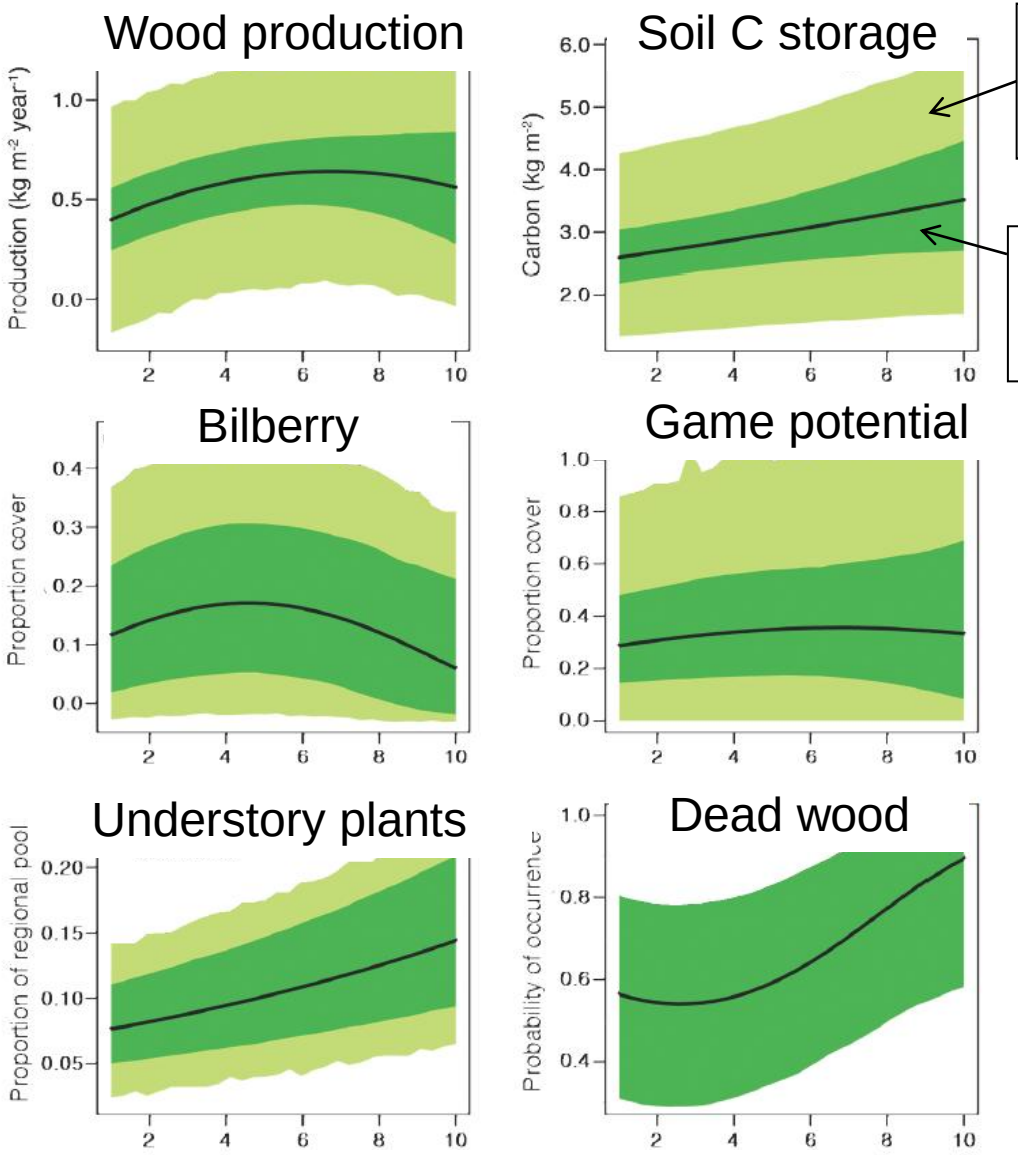
Tree biomass production



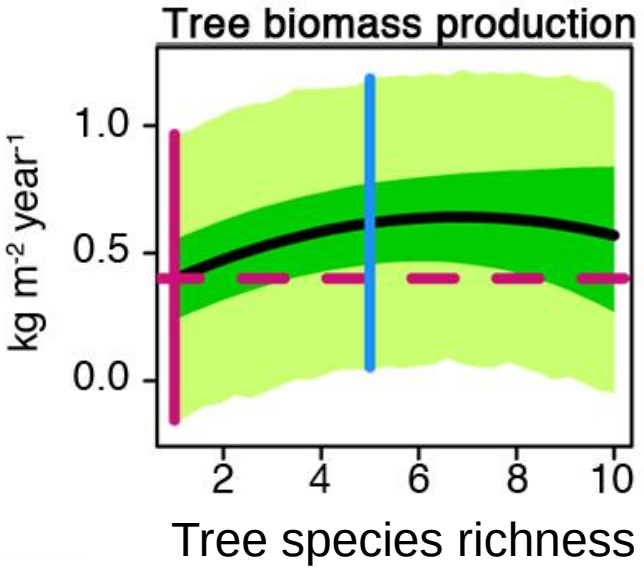
Short vertical:
most probable
regression slope value

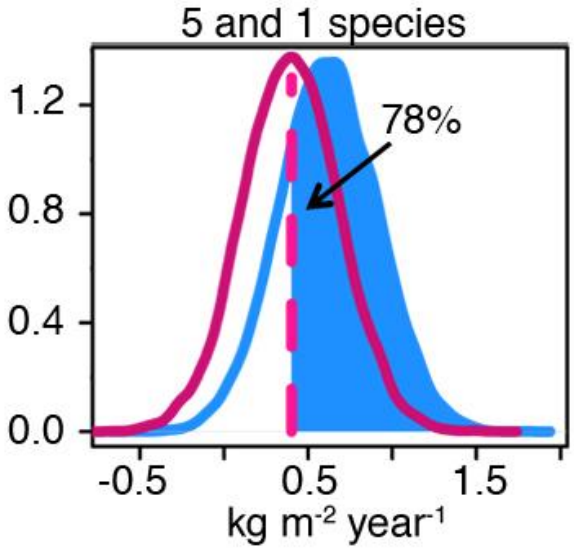
Horizontal:
95% conf. interval

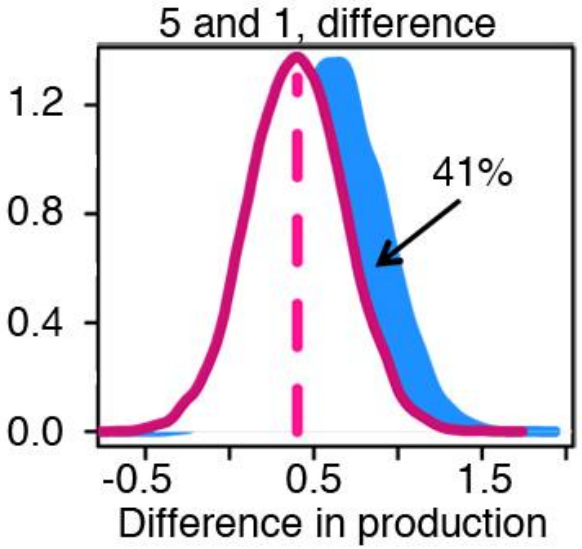
Relationships ecosystem services and tree species richness



Confidence about relationship

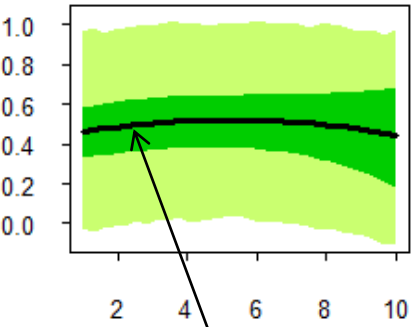






Relationships ecosystem services and tree species richness

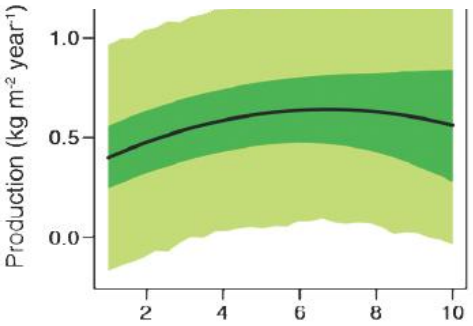
Wood production



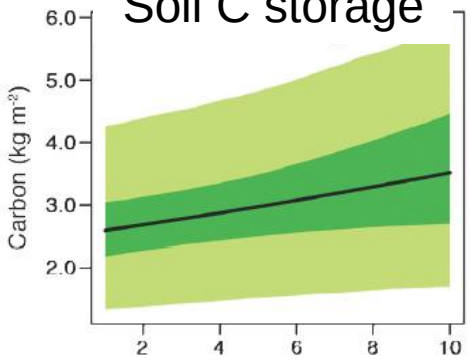
If including also stem density

No additional effect of
- Site productivity
- Basal area

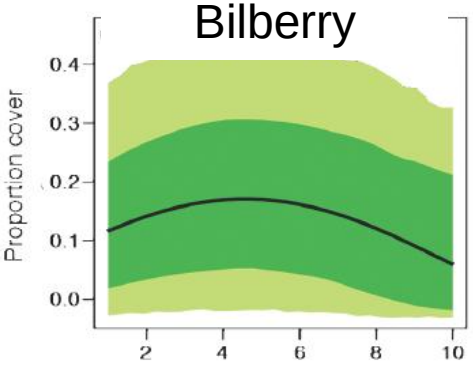
Wood production



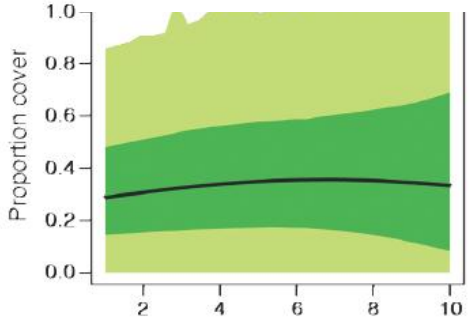
Soil C storage



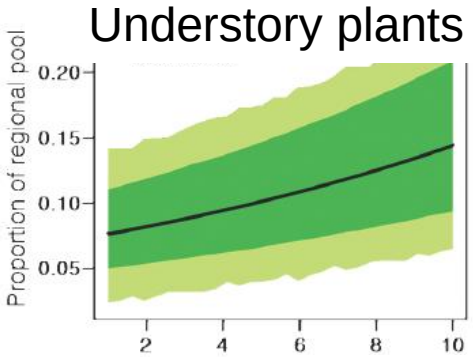
Bilberry



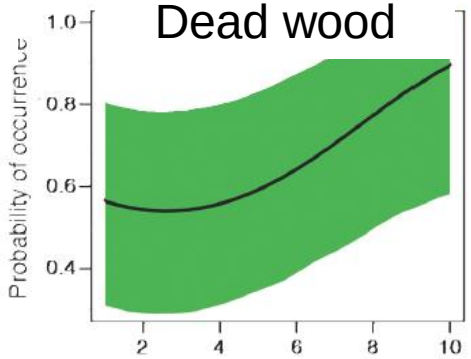
Game potential



Understory plants

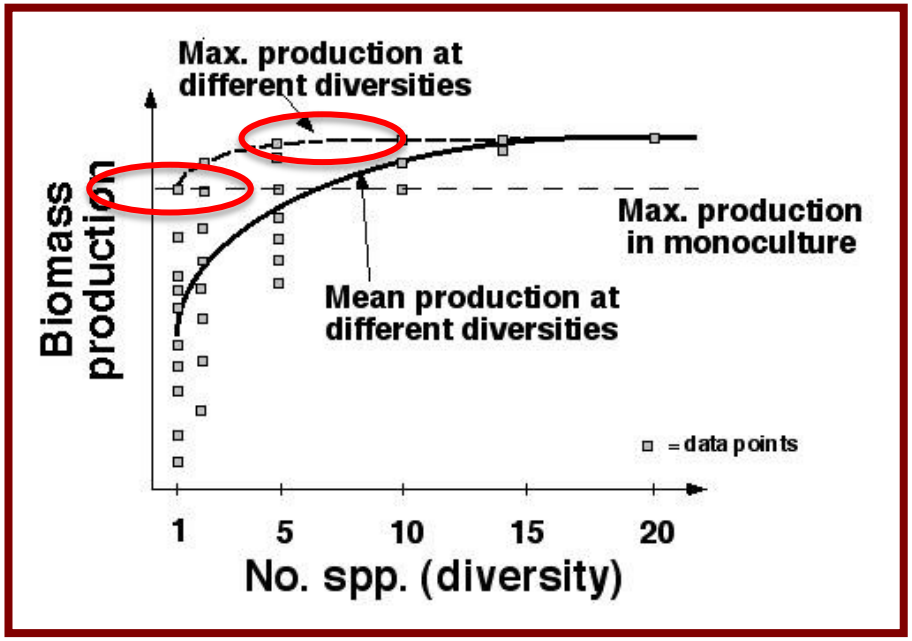


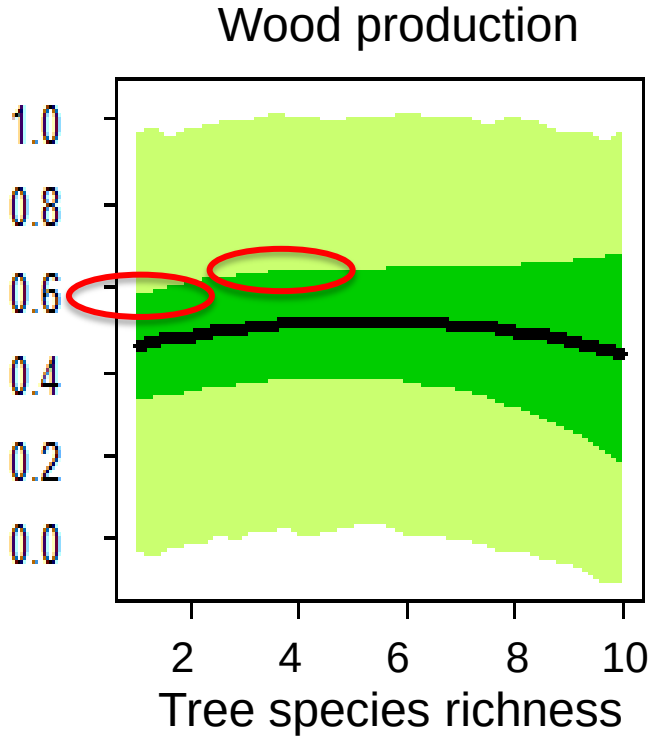
Dead wood



Tree species richness

Tree species composition and site properties of multi-species plots with high productivity?





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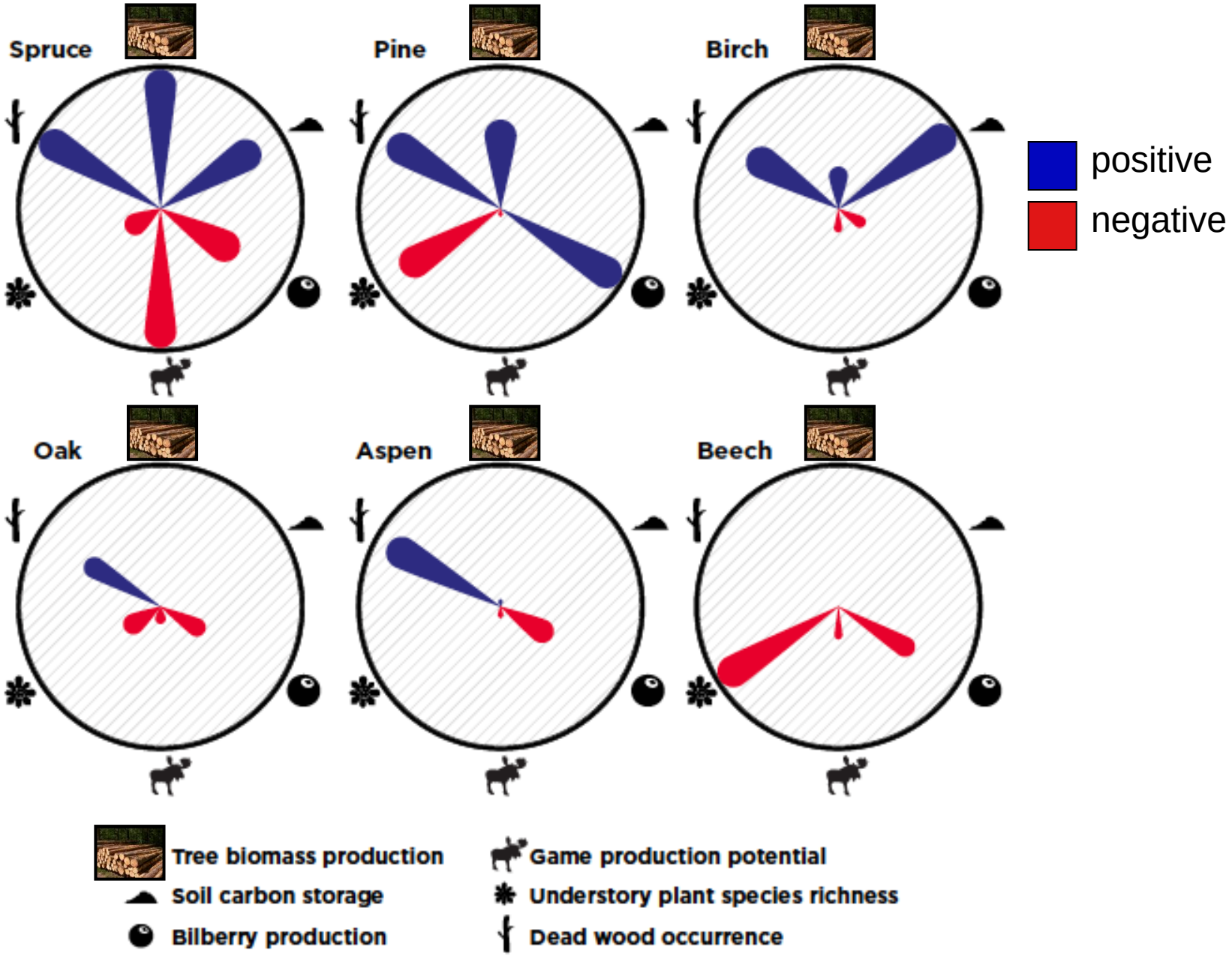
Tree species identity



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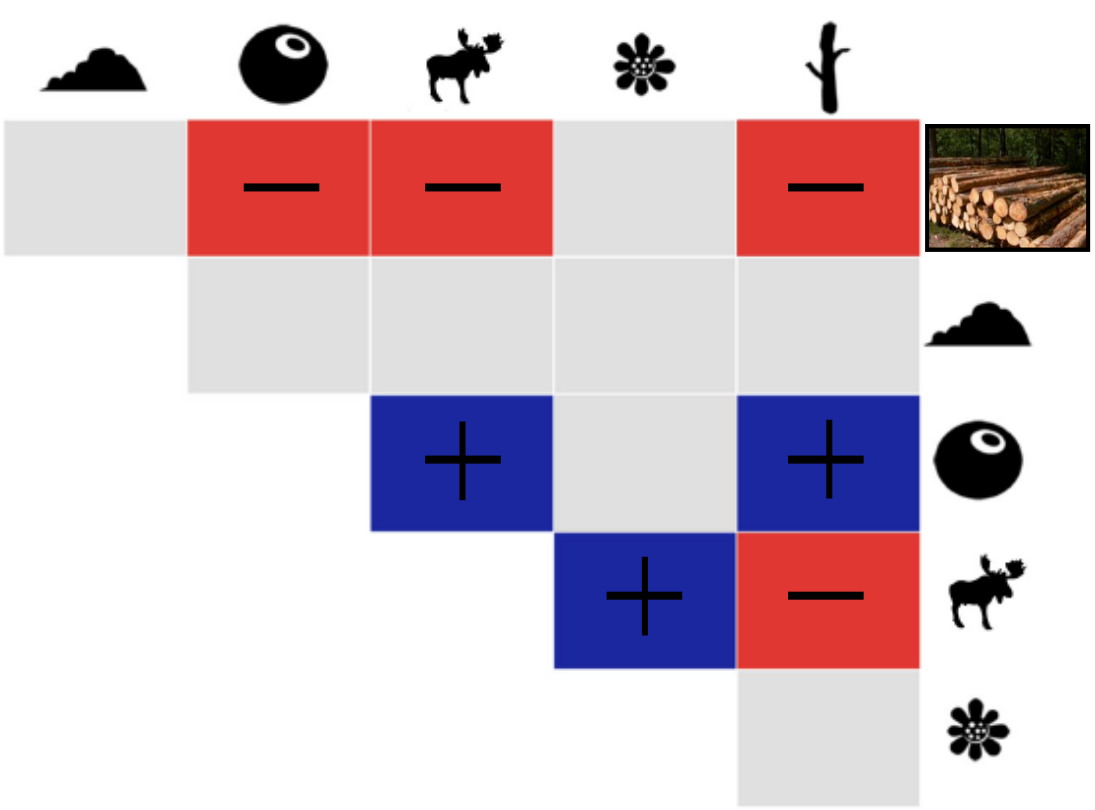
Trade-offs between services



positive

negative

Tree biomass production

Soil carbon storage

Bilberry production

Game production potential

Understory plant species richness

Dead wood occurrence

Conclusions

- There are positive relationships between ecosystem service levels and tree species richness, after accounting for environmental variables and tree biomasses
- The biomass of specific species important, but in addition there is a positive relationship to tree species richness
- More species-rich forest show higher multifunctionality
- Trade-offs between services exist, but higher levels of multiple services may be obtained with some mixing of tree species