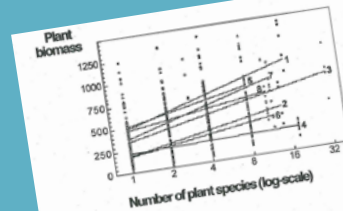
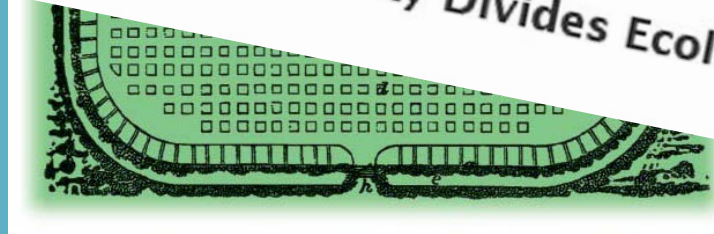


When is more species better?

A long and winding ecological history



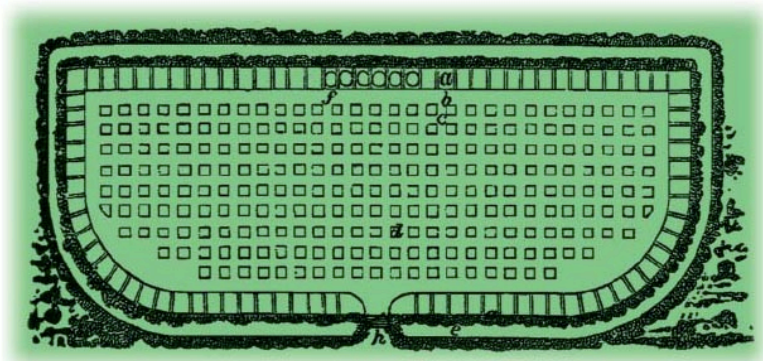
ECOLOGY
Rift Over Biodiversity Divides Ecologists
Jocelyn Kaiser



Janne Bengtsson
Dept. Ecology,
SLU, Uppsala

Monocultures or polycultures?

- Sinclair (1826)
- Woburn Abbey \approx 1810 - diverse communities more productive



In an English country garden. Plan of the *Hortus Gramineus*, or grass garden, at Woburn Abbey in 1817. The plan shows the 242 experimental plots and 85 beds

Darwin and the First Ecological Experiment

Andy Hector and Rowan Hooper

SCIENCE 25 JANUARY 2002 295: 639-40


The third edition of *HGW* reported that diverse transplanted turf communities were more productive than less species-rich communities established from seed

.....which prompted Darwin's statement that more diverse communities are more productive.

.....inevitably there are several caveats.
..... the work conducted around 1820

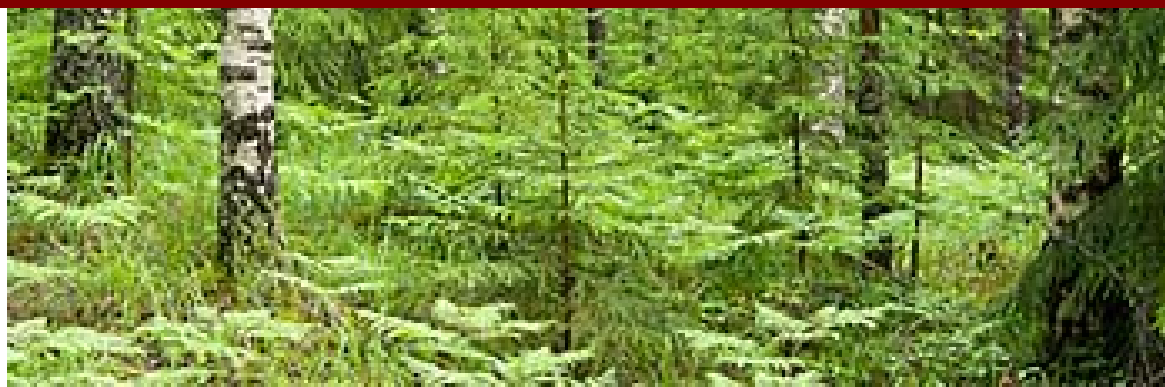
Monocultures or polycultures?

- Discussed in forestry since early 1800-eds
Germany Hartig vs. Cotta (monocultures vs. Mixtures)
Scandinavia Å Tham (1980-90ies)



” ...there is a specific potential for a higher yield of mixed-species stands ... , where species have complementary use of resources.”

Knoke et al. 2008



Monocultures or polycultures?

- A large agricultural literature on intercropping
- Benefits are commonly found (Vandermeer 1989 m fl)



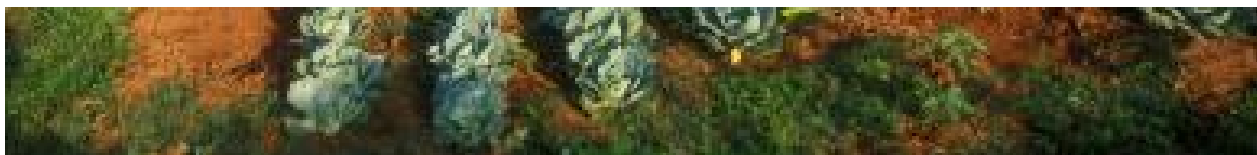
Monocultures or polycultures?

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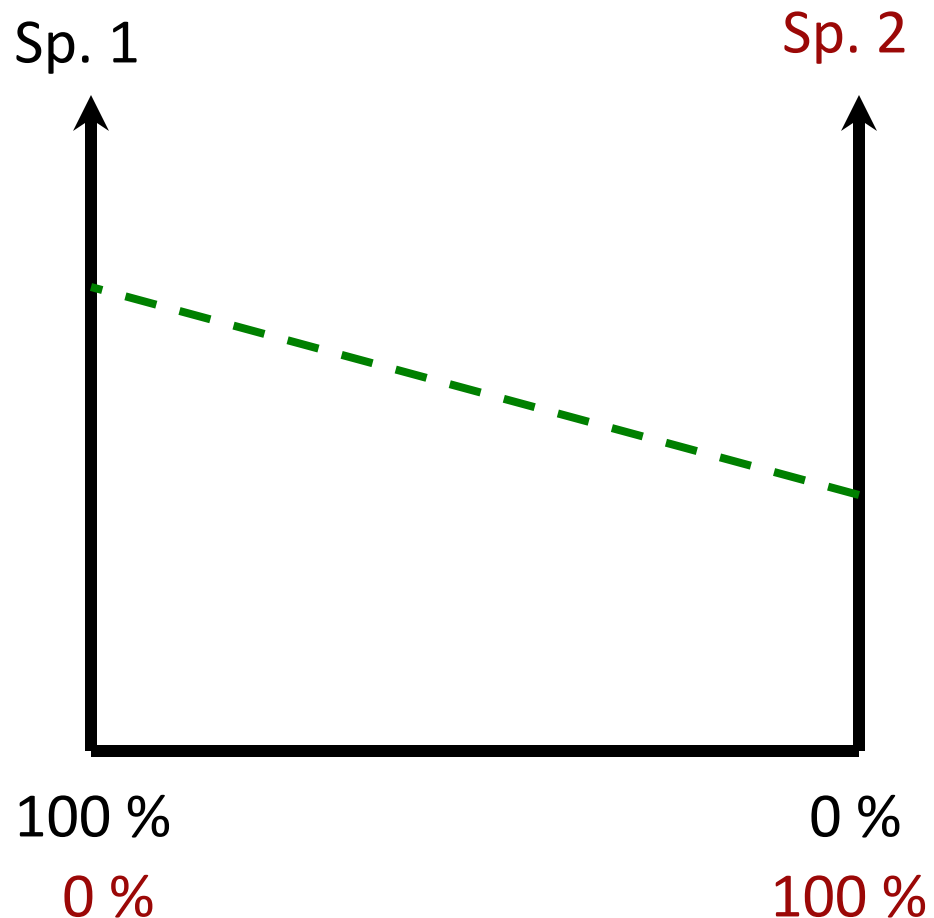
BUT ...

- It matters which species you choose in the mixture
- Few advantages beyond 4-5 species
- More labour intensive
- Temporal intercropping - crop rotations - often even better and easier to handle (Denison 2012)



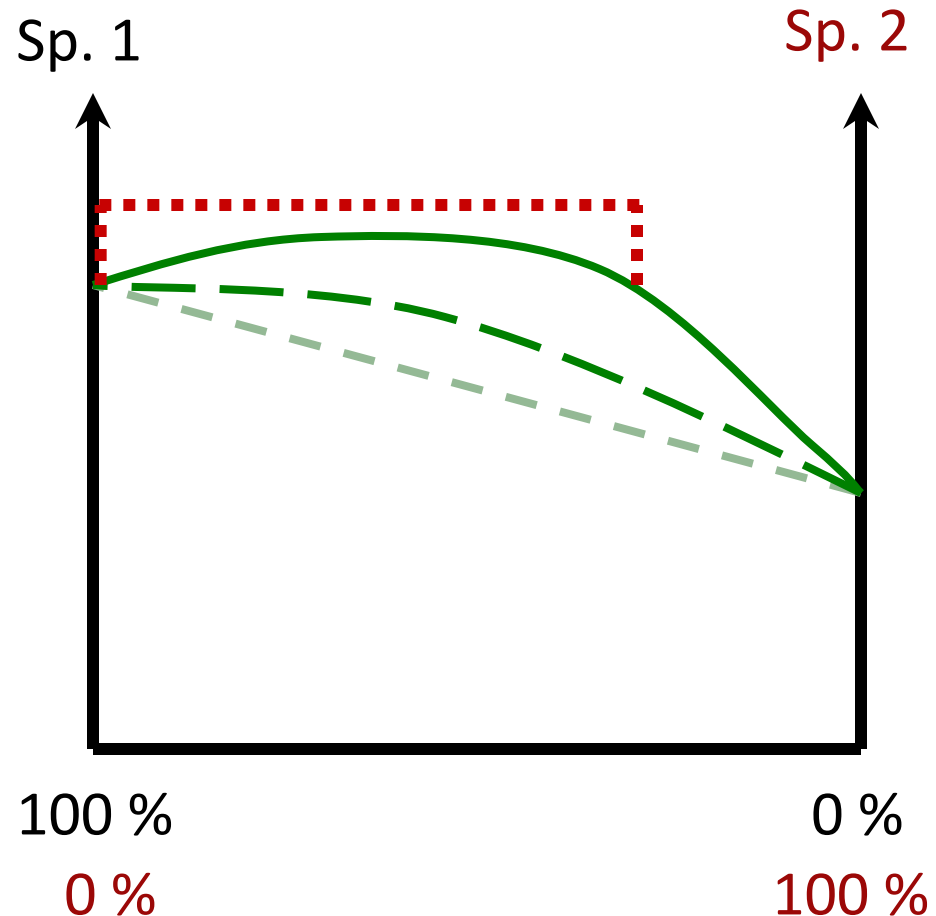
Diversion: Transgressive overyielding

- Required for true mixture effect



Transgressive overyielding

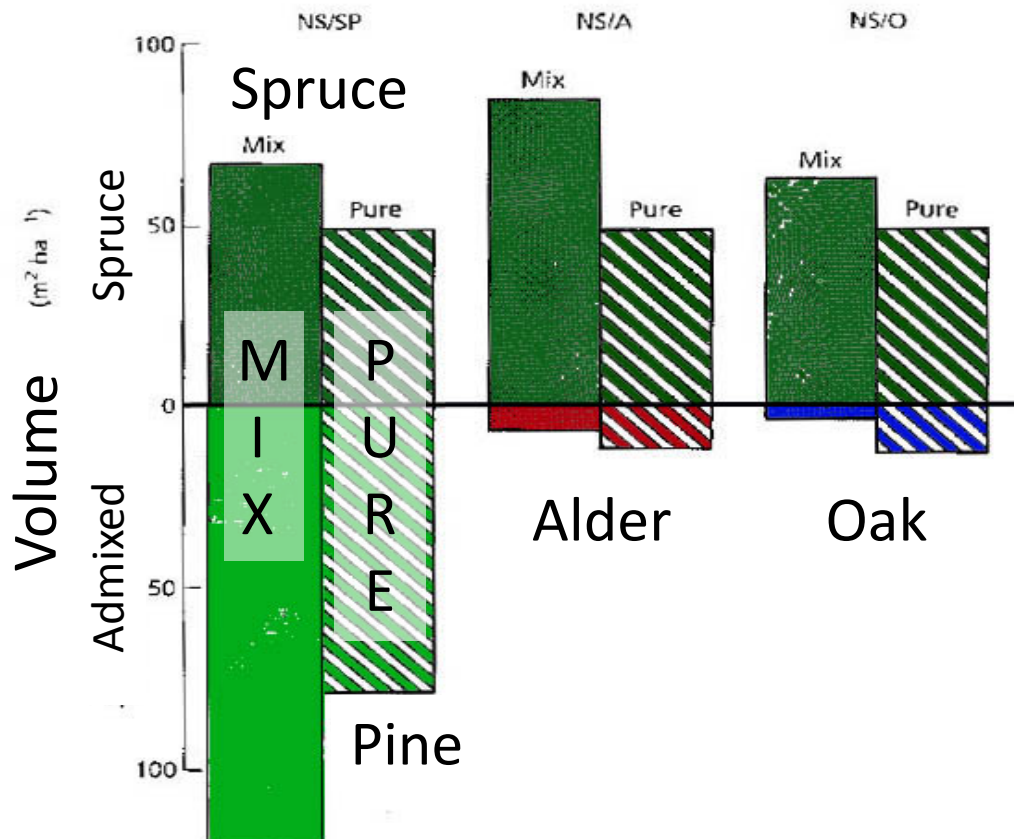
- Required for true mixture effect
- Species should be different (e.g. resource use, response to environment or timing)



It matters which species you mix

- UK – Gisburn (Yorkshire) (Brown 1992)

Mixtures with spruce, pine, alder, oak



Some mixtures don't do very well ...

Ecological mechanisms for a "mixture effect"

- Competitive (transgressive) overyielding complementarity
- Increasing resources (e.g. N-fix)
- Lower pest levels (herbivory) in mixtures
- Higher stand resistance to disturbances (e.g. storms)
- Higher stability over time (insurance effect)

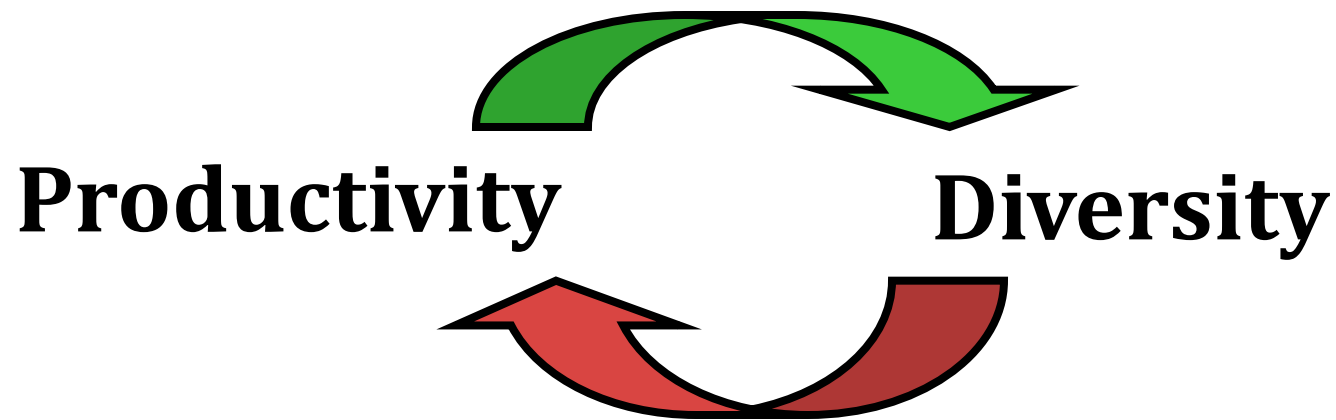
Ecological mechanisms for a "mixture effect"

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These are more common in the intercropping literature (Vandermeer 1989, The ecology of intercropping)

Ecology: Diversity and productivity

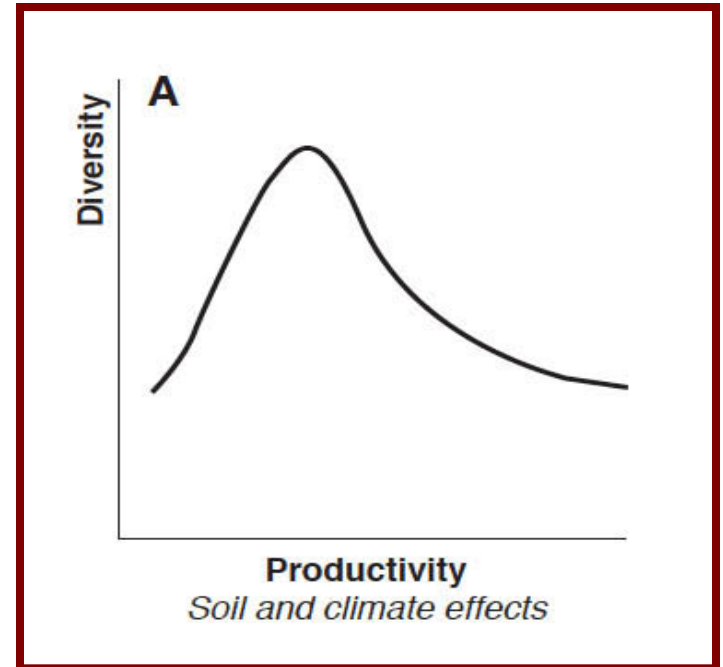
- Old question in ecology



Ecology: Diversity and productivity

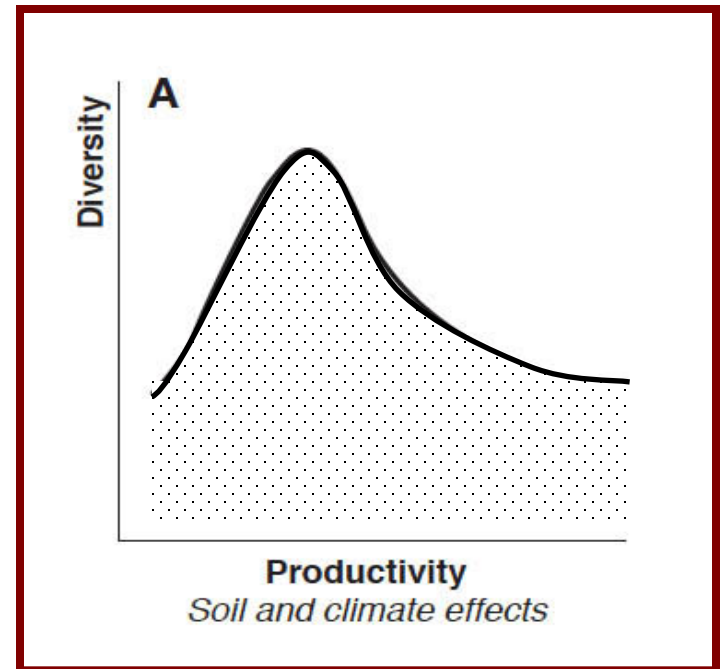
- Old question in ecology
- Traditionally:
Increase at low
but decrease at higher
productivity

(Begon Harper & Townsend 1986)



Ecology: Diversity and productivity

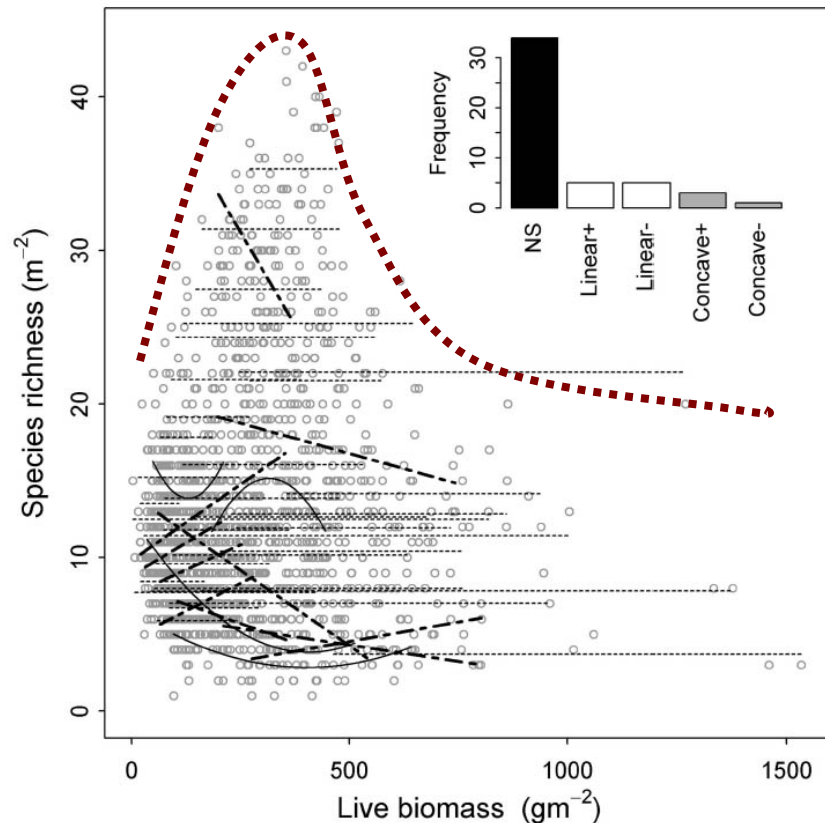
- Old question in ecology
- Traditionally:
Increase at low
but decrease at higher
productivity
(Begon Harper & Townsend 1986)
- But - usually data were
scattered below the line
- Or ...



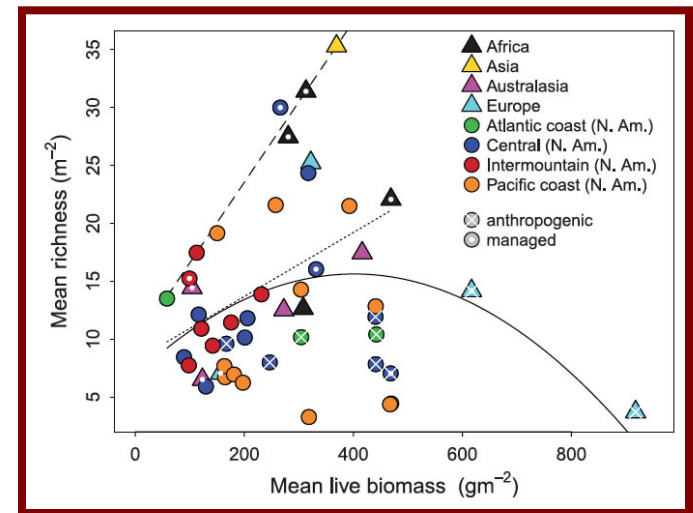
Ecology: Diversity and productivity

- New experiments and analyses question the “well known general pattern”

Within expts.



Among expts.

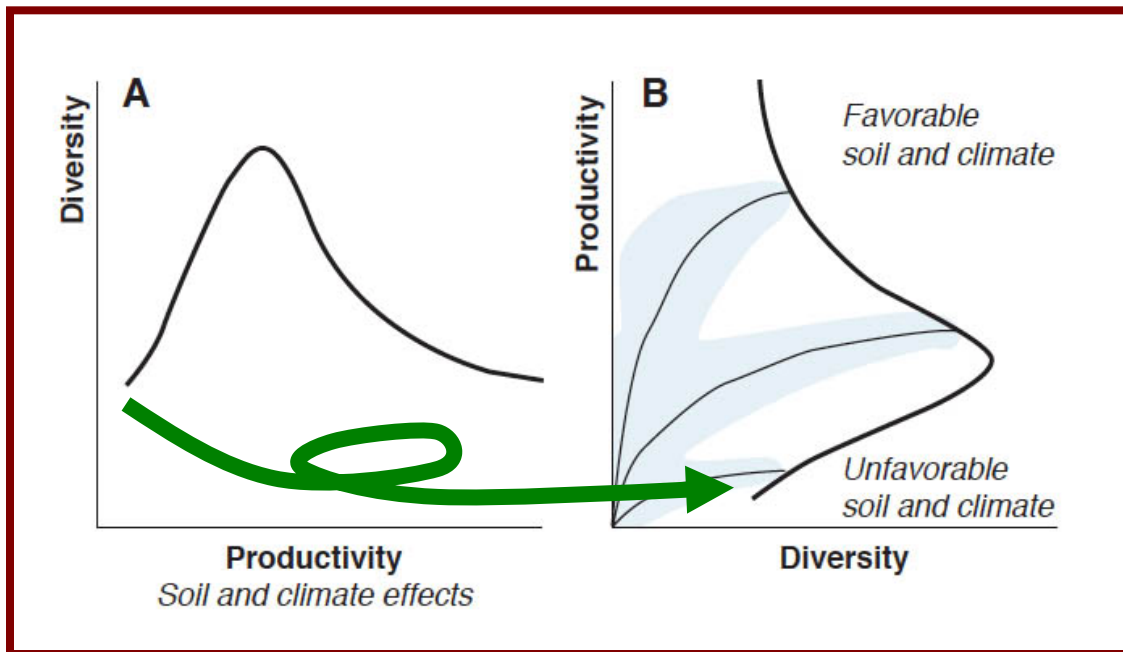


Herbaceous plants

Adler et al. Science (2011)

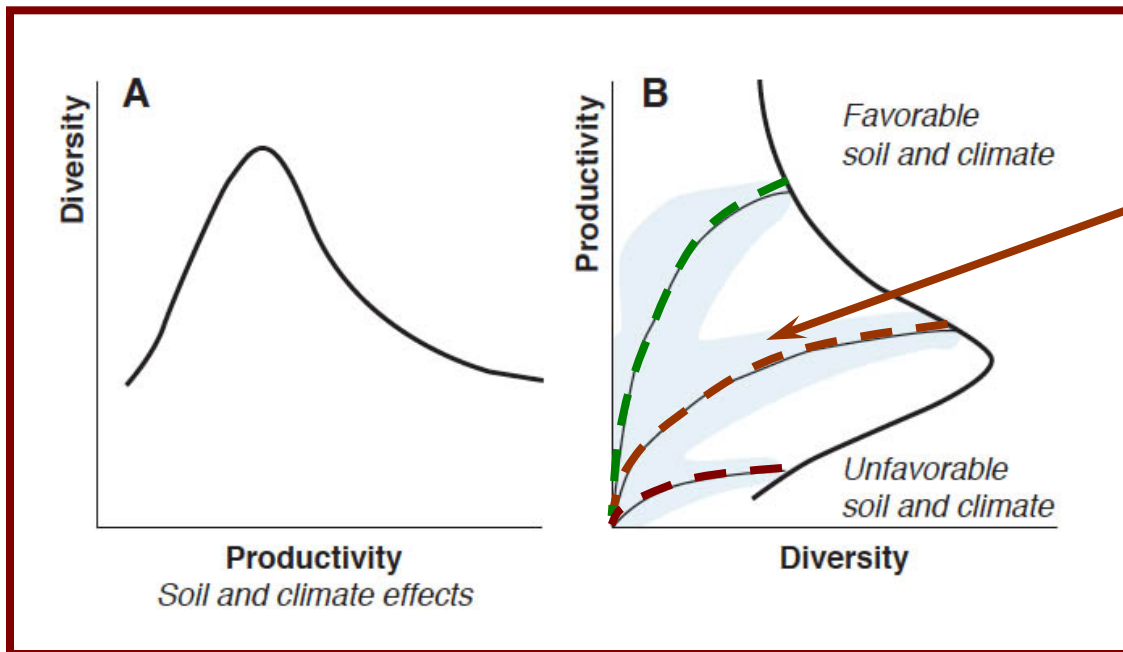
Ecology: Diversity and productivity

- Biodiversity experiments examine the opposite question



Ecology: Diversity and productivity

- Biodiversity experiments examine the opposite question



Consequence of reducing diversity for production (other processes) at a site with a certain productivity?

Ecology: Diversity and productivity

- What has been found? Some examples ...
Ecologists focussed on grasslands

1. Biodepth 1997-2000

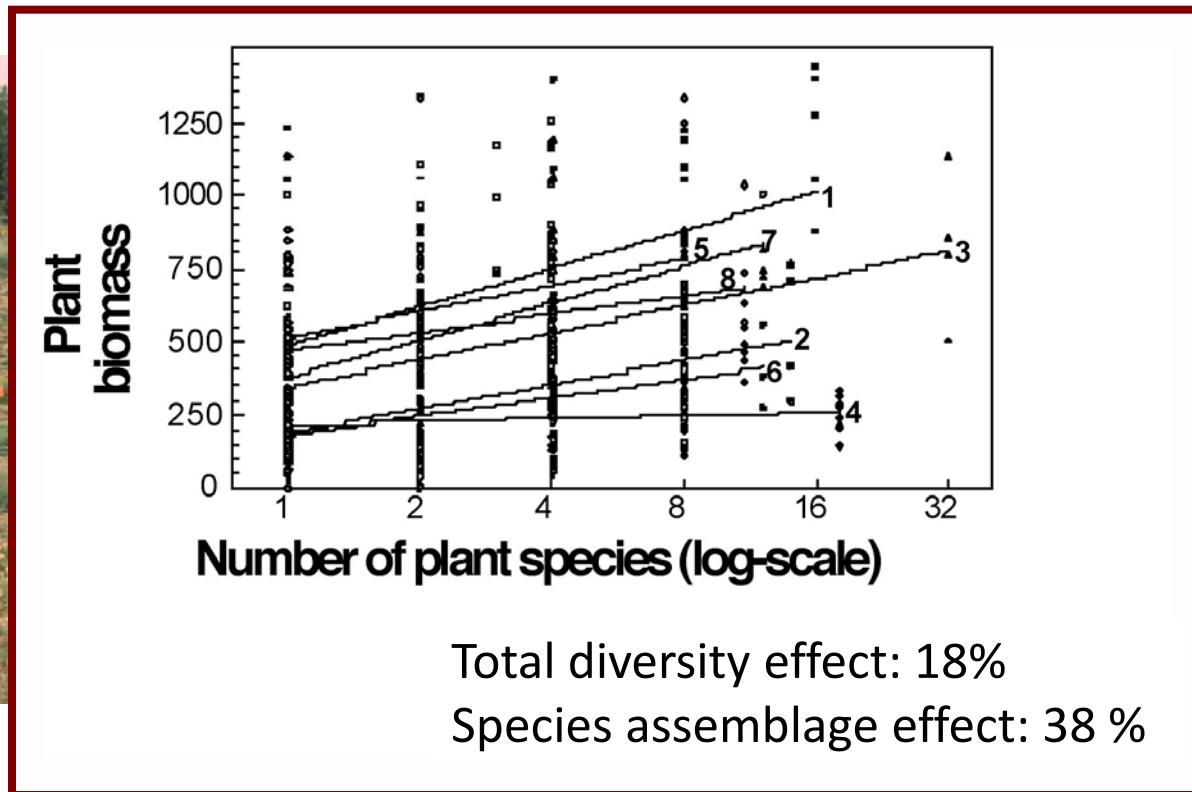


Ecology: Diversity and productivity

1. Biodepth 1997-2000

Diversity effects largely due to complementarity

Other processes related to diversity: N-leaching etc

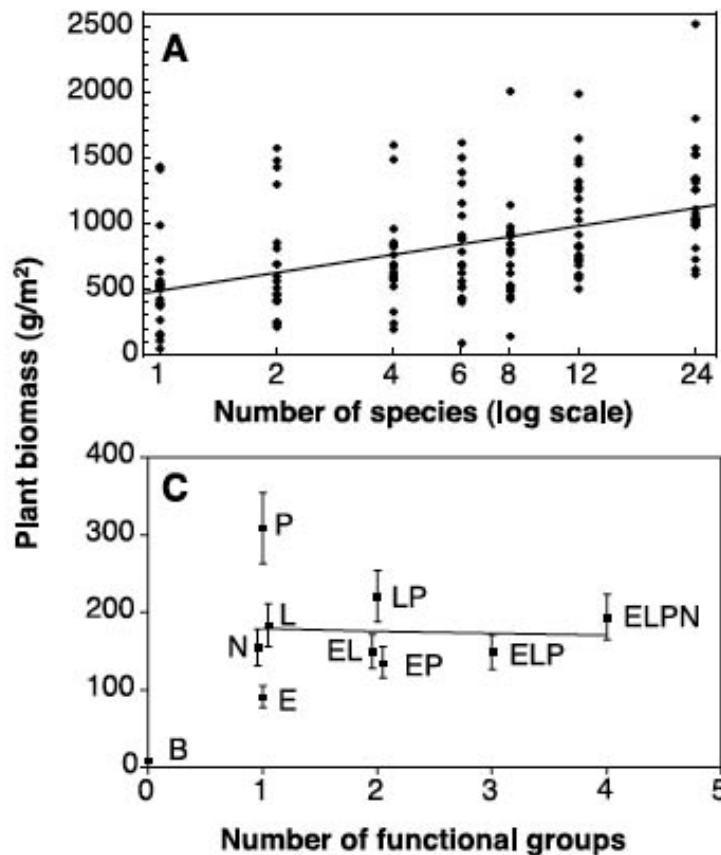


Ecology: Diversity and productivity

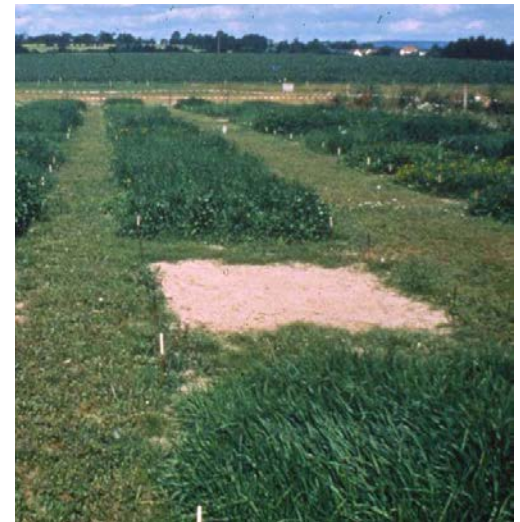
2. But not all similar experiments showed this



No clear effects
(Hooper et al 1997)



Stronger effects
(also over time)
(Tilman et al 1997)



Ecology: Diversity and productivity

3. And a great controversy:

Did the studies show a "true diversity effect?"

Science

www.sciencemag.org

Science 25 August 2000:

Vol. 289 no. 5483 pp. 1282–1283

DOI: 10.1126/science.289.5483.1282

ECOLOGY

Rift Over Biodiversity Divides Ecologists

Jocelyn Kaiser

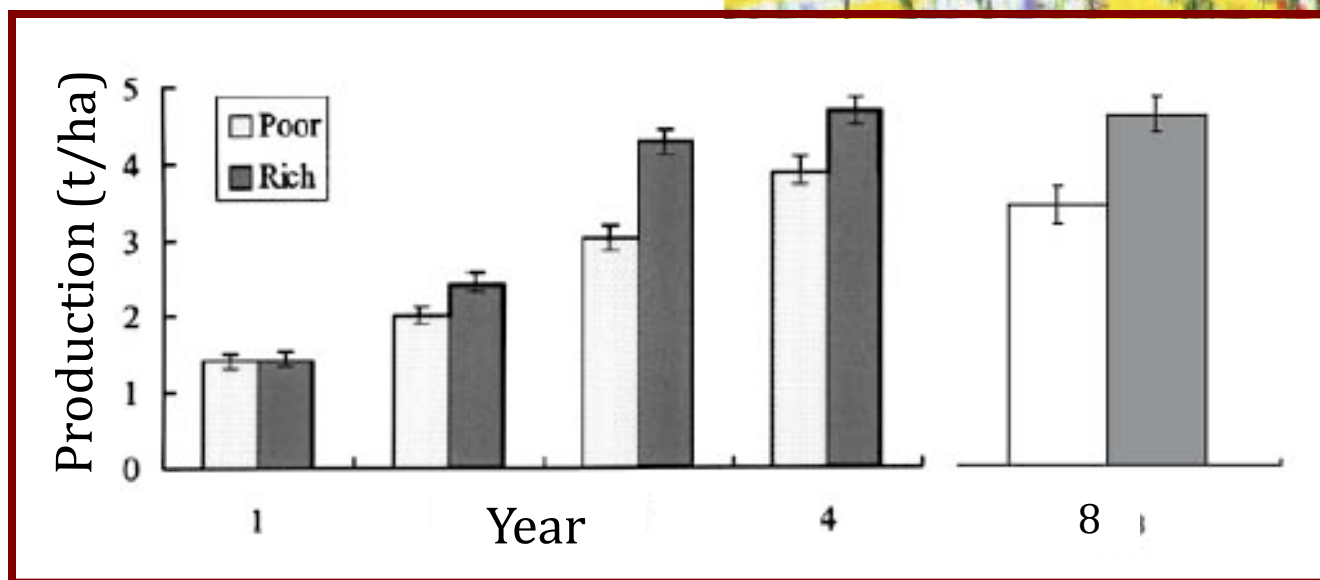
An acrimonious dispute has broken out over whether the data on biodiversity are robust enough to inform public policy

Ecologists who are less critical of the disputed studies argue that a different line of research might be more fruitful. Hooper suggests that rather than simply counting numbers, experimentalists should devote more attention to what a plant does—whether it sequesters a mineral for other plants, or how deep its roots are.

"Composition matters more than diversity," he says.

Ecology: Diversity and productivity

3. Permanent hay meadows ...



Insown species-rich meadows were more productive over 8 years

Restoring wild flowers increases hay yield

Growing hay meadows with many wild-flower species boost yields by 40 percent compared with growing just a few types of agricultural grasses.

James Bullock said, 'We took arable fields and re-created hay meadows with many wild-flower species. We contrasted their agricultural output with plots where we had sown only a few types of grasses. These grasses were those often selected by farmers to increase yields.'

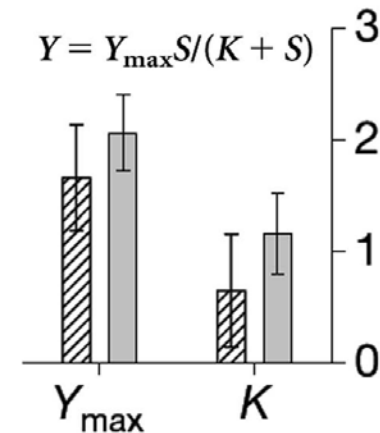
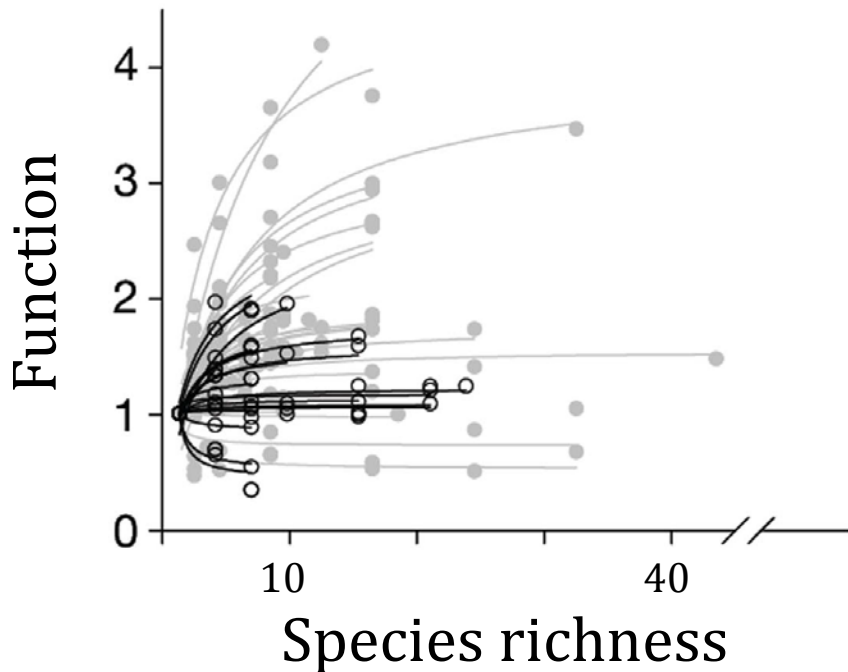
The team found that, as well as increasing hay yield, the wild flowers made the hay more nutritious as cattle fodder than hay from the grass plots, and the effects went on increasing over eight years.

Ecology: Diversity and productivity

4. But the world is not only grasslands ...

Recent meta-analyses:

Single functions show positive relation with diversity



Cardinale et al Nature 2006

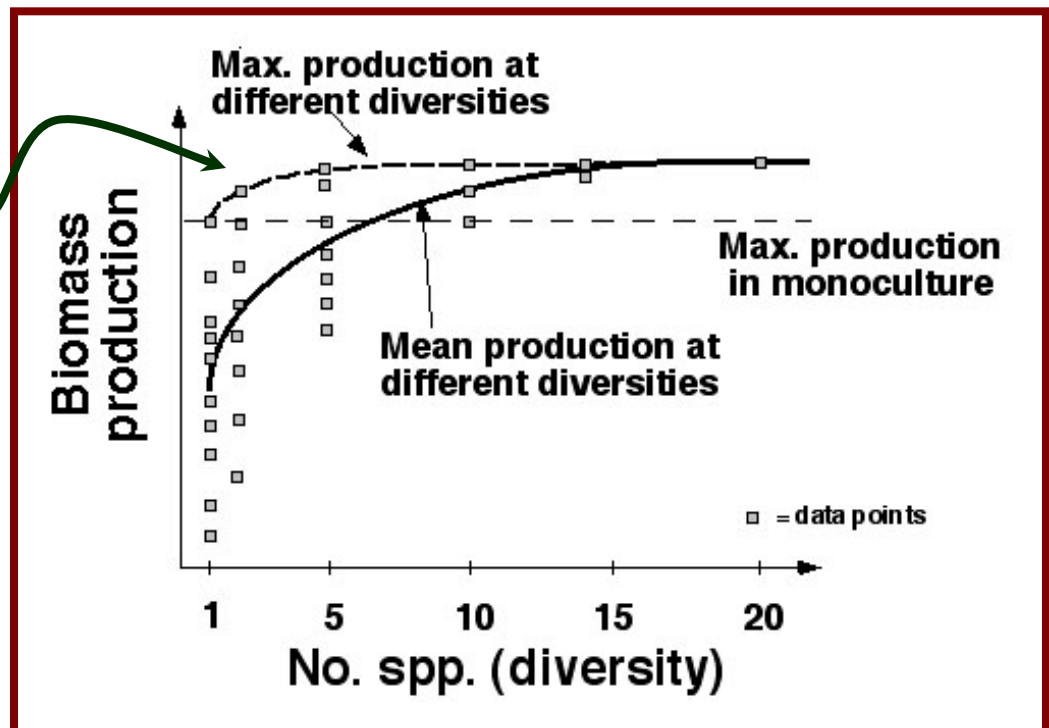
Ecology: Diversity and productivity

... but also ...

”... presently little evidence that diverse polycultures outperform their most ... productive monocultures”

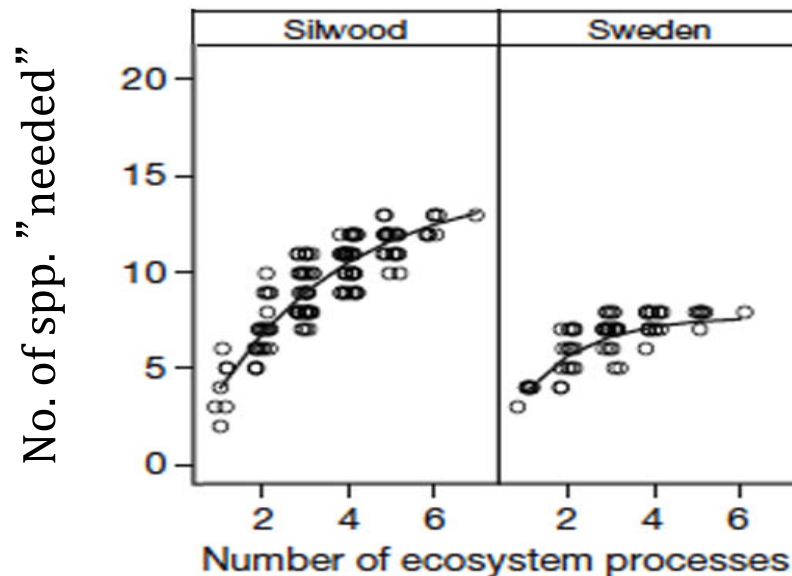
Cardinale et al. 2011

Ecologists still
interested in if
this effect exists
... and the
mechanisms



Monocultures or polycultures?

- Finally - ecosystems are multifunctional
Species do different things
- Is diversity important for "whole ecosystem functioning"? For multiple ecosystem services?



Context of our study is ecological

1. INTRODUCTION

'We have done the easy stuff, working experimentally with herbaceous communities, and have learned a great deal about the diversity/functioning/stability relationship. However, we now must move on to address those ecosystems that control a good portion of the carbon, nutrient and water balances of the earth—the forests'.

Harold Mooney [1, p. VI]

from Hector et al. 2011

Context of our study is ecological - but also responding to policy

- EU (and Swedish government) aims to include ecosystem services in policy and natural capital accounts by 2020.
- **1.3.2 The link between ecosystems, ecosystems services and biodiversity ...**

The assessment of the multiple ecosystem services in combination with the analysis of synergies and trade-offs between these services is the basis for valuing the multi-functionality of ecosystems for human well-being.

MAPPING AND
ASSESSMENT OF
ECOSYSTEMS AND
THEIR SERVICES



The question has come again and again
in the history of ecology
... but the answers have lived for short time

(after an aforism by Samuli Paronen)

... perhaps there is no clear answer - it all depends
and that's what stimulates me as a scientist



*Allting är mycket osäkert,
och det är just det som
lugnar mej, sade Too-ticki
(Tove Jansson: Trollvinter)*

*Everything is very uncertain,
and that is what calms me, said Too-Ticki*