

# The ecological consequences of biodiversity loss

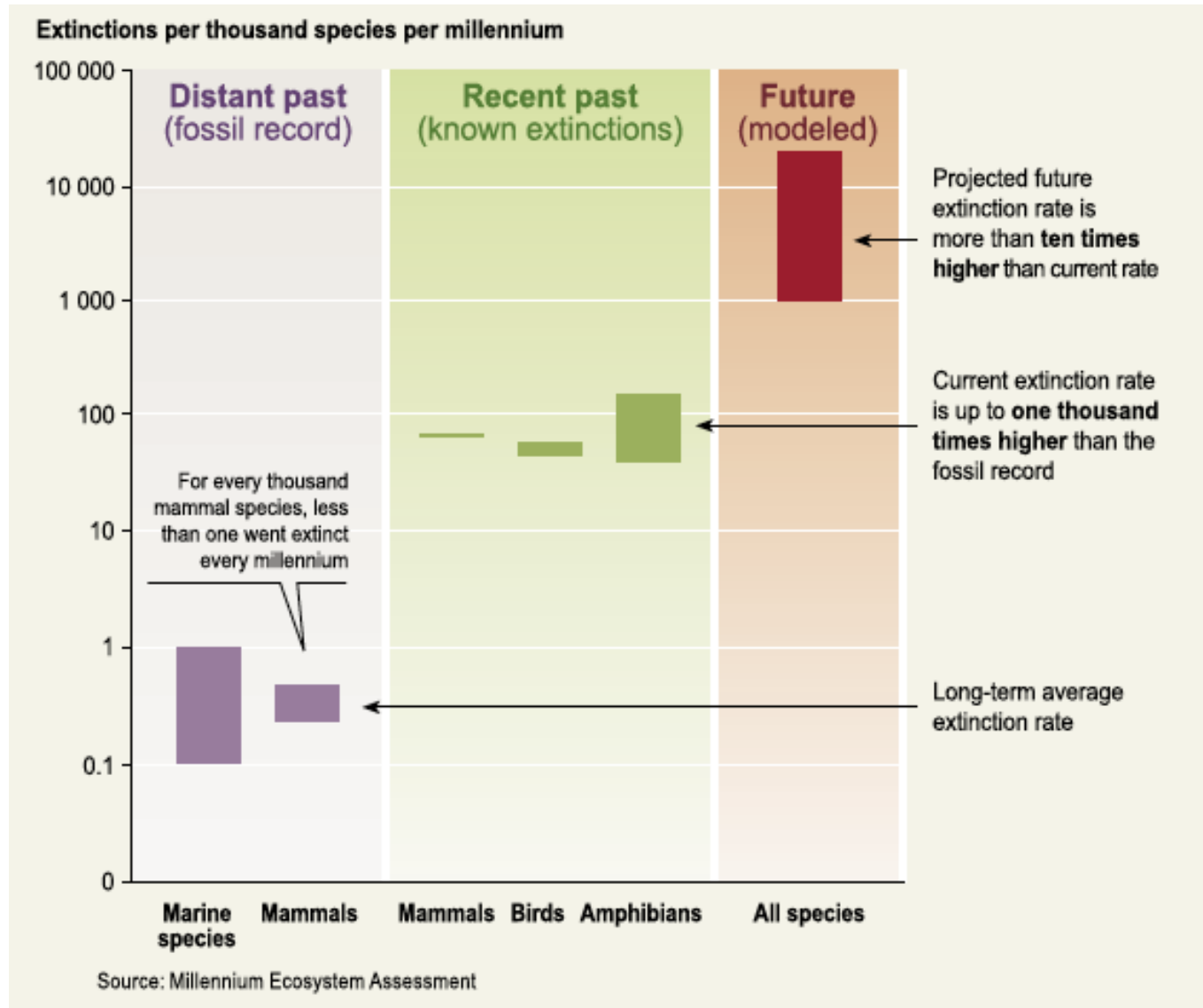
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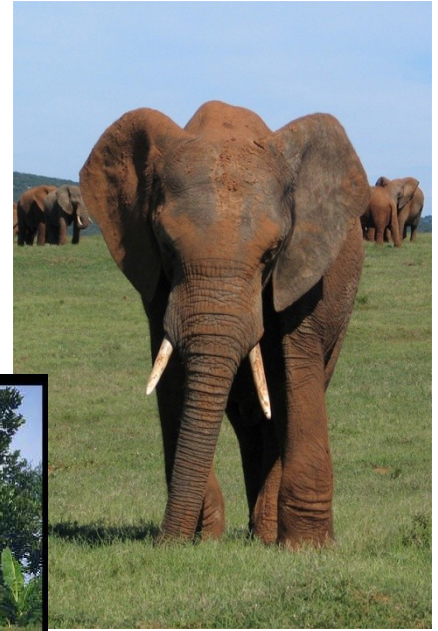


# Heading for a global biodiversity crisis

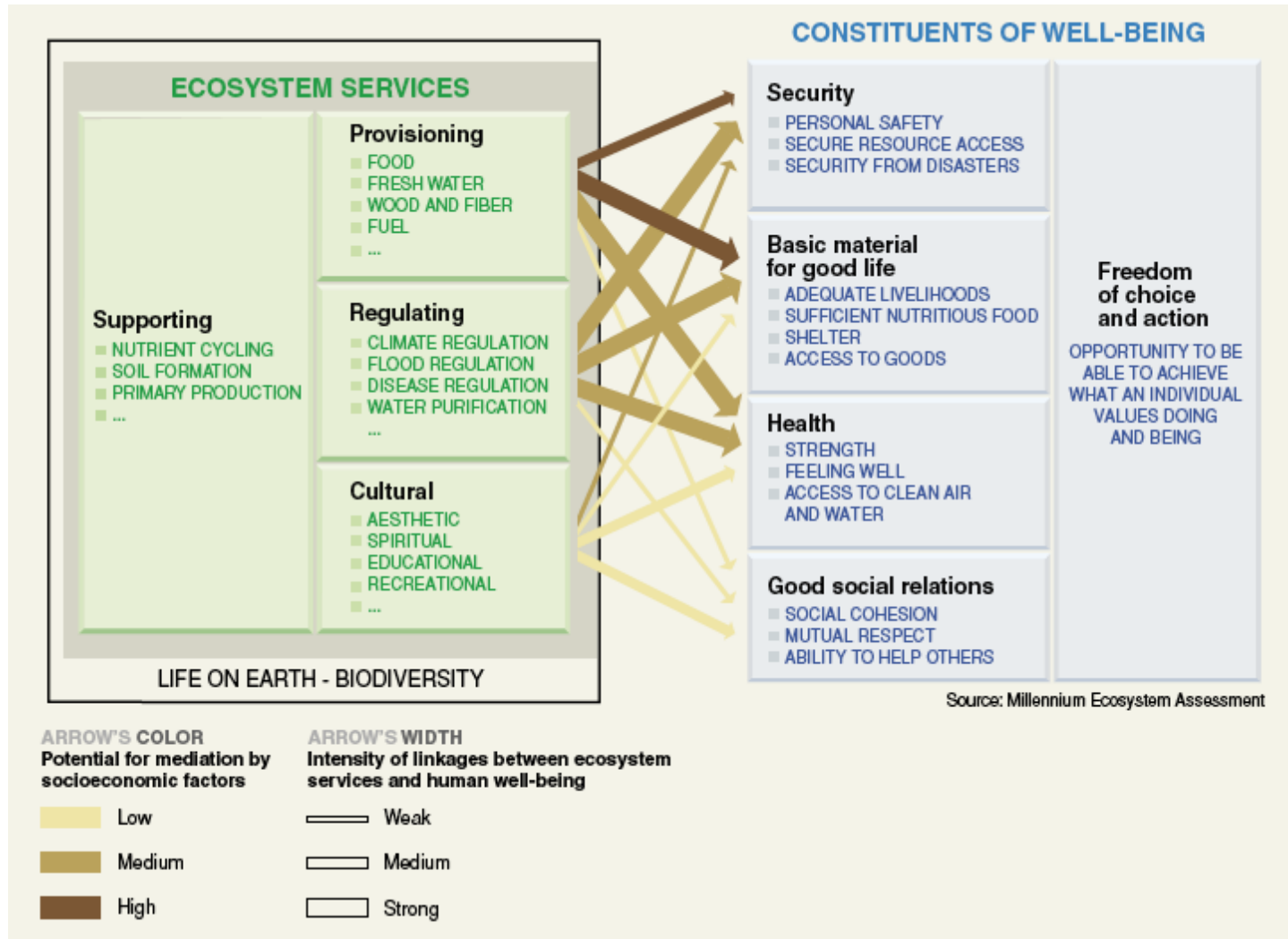




# Why does biodiversity matter?



# Biodiversity, ecosystem services, and human well-being





# Importance of “vertical” diversity



Removal of sea otters



Population explosion of sea urchins



Overgrazing of kelp



- Extinction of other species living in kelp
- Increased wave action, coastal erosion and storm damage
- Evolution of chemical defences in kelp

# But what is the ecological significance of “horizontal” diversity?

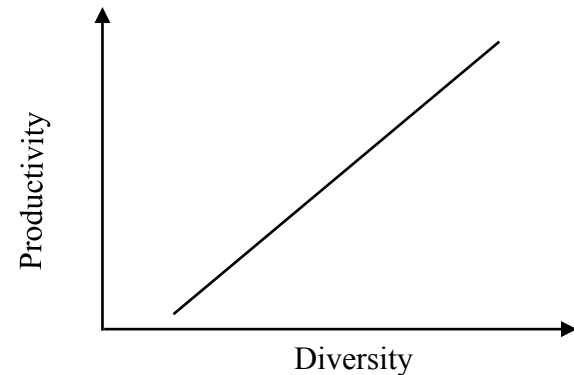
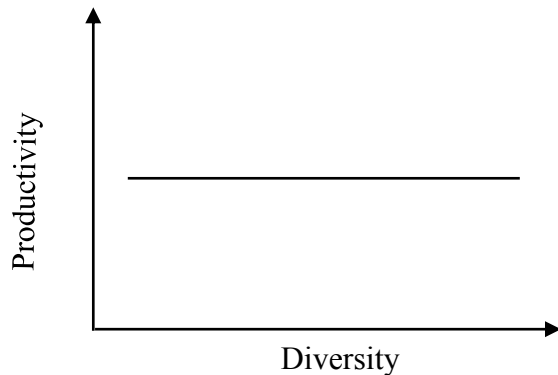
Neutral theory

Functional  
redundancy



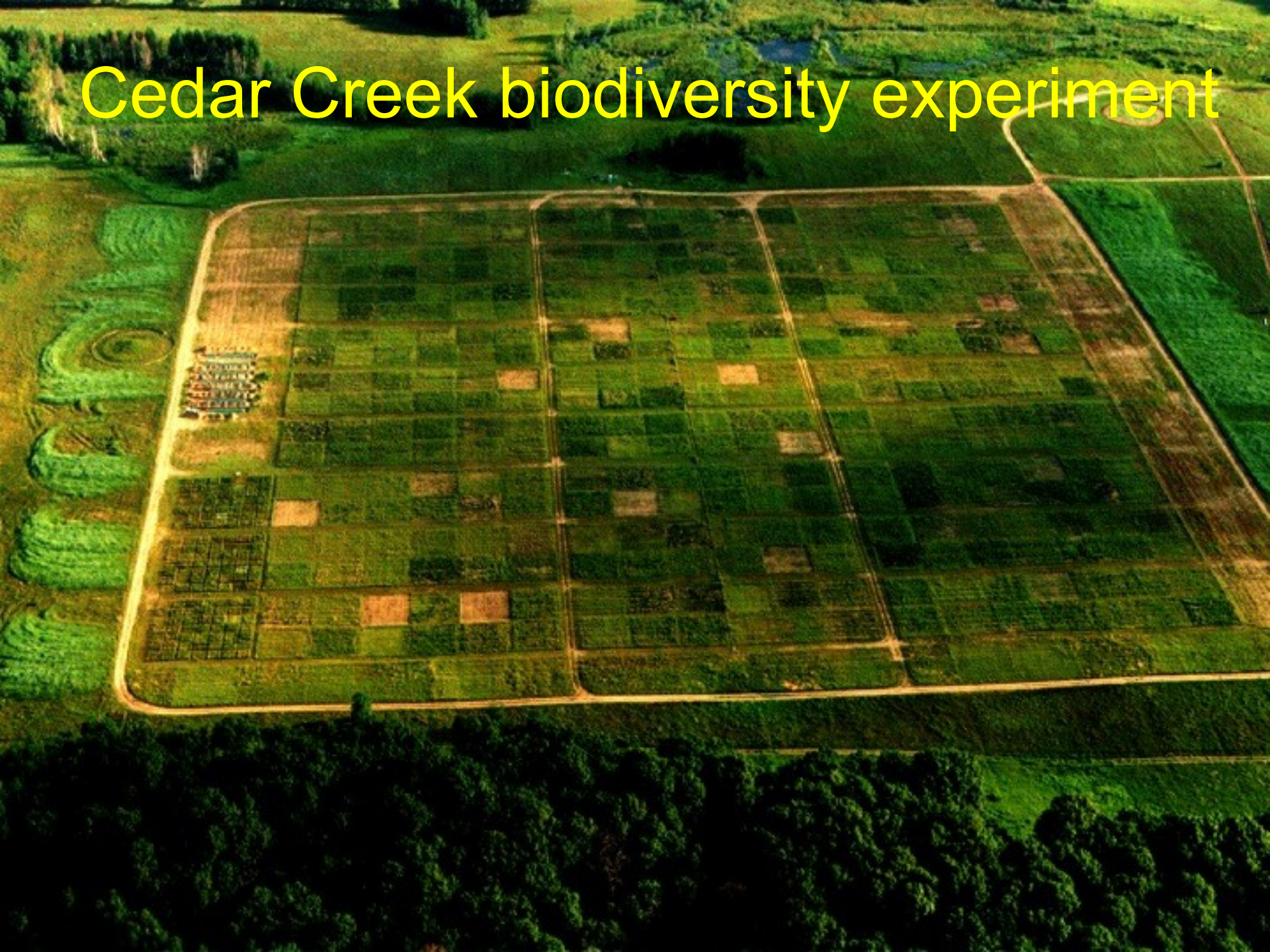
Niche theory

Functional  
complementarity



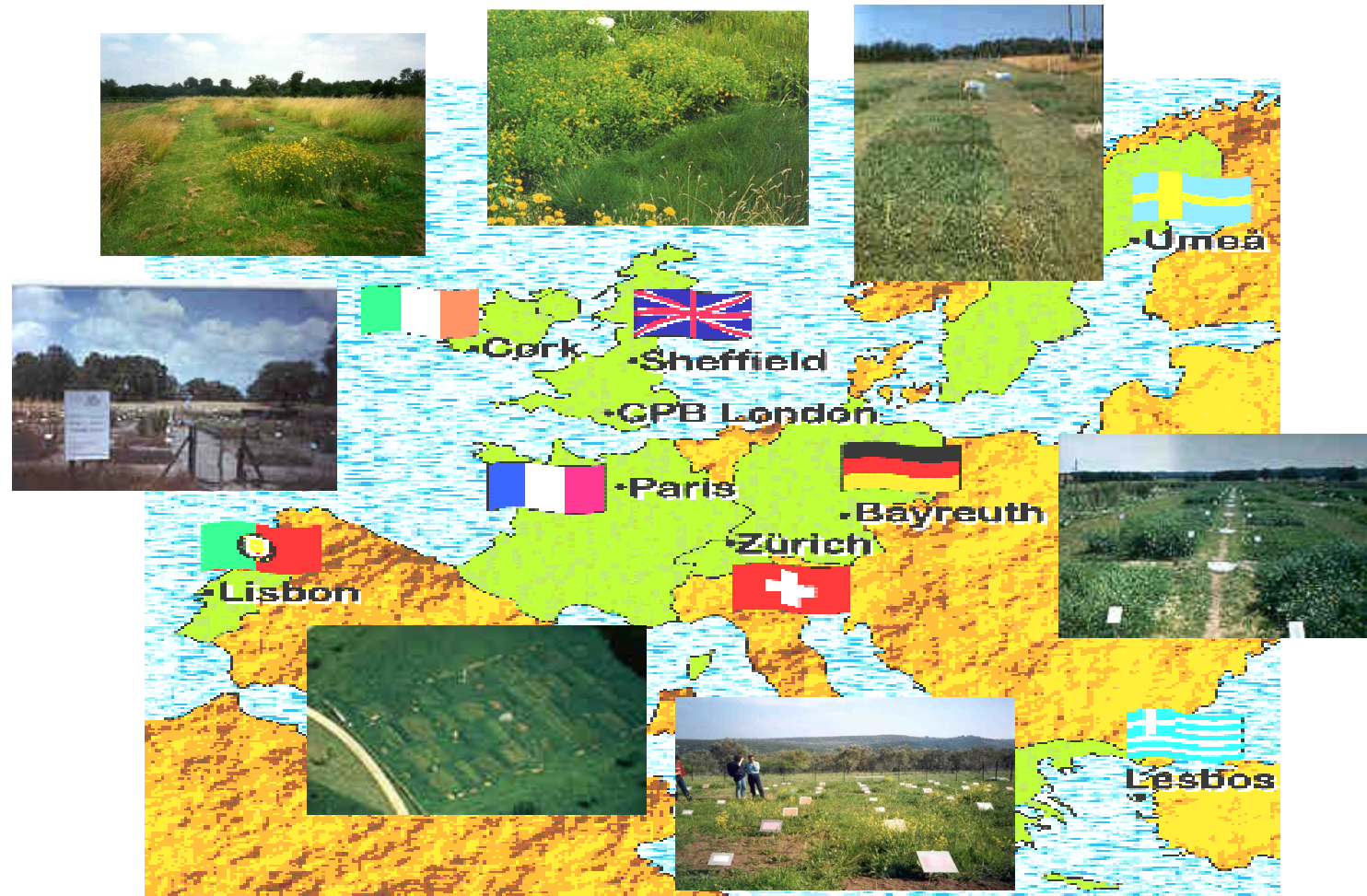


# Cedar Creek biodiversity experiment



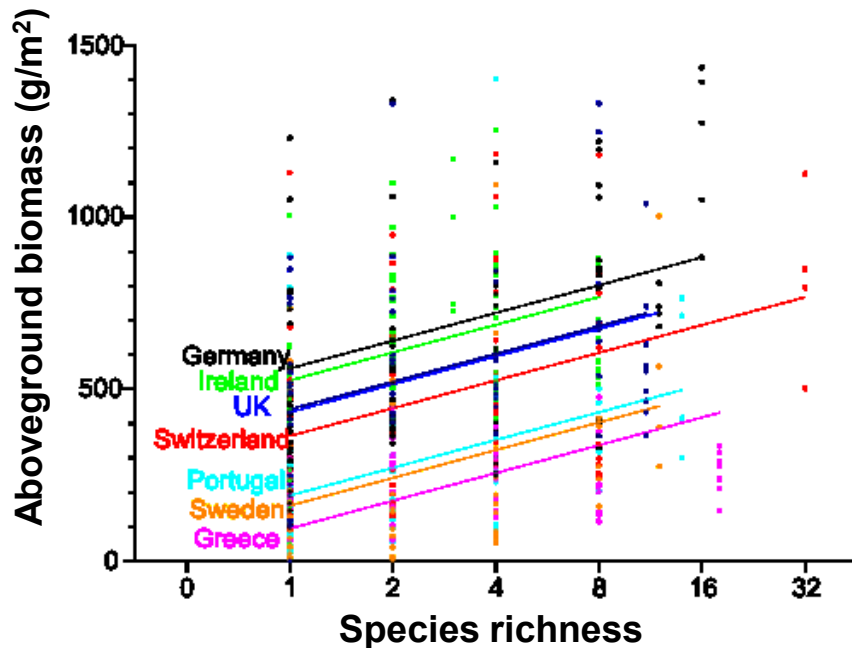


# BIODEPTH biodiversity experiment

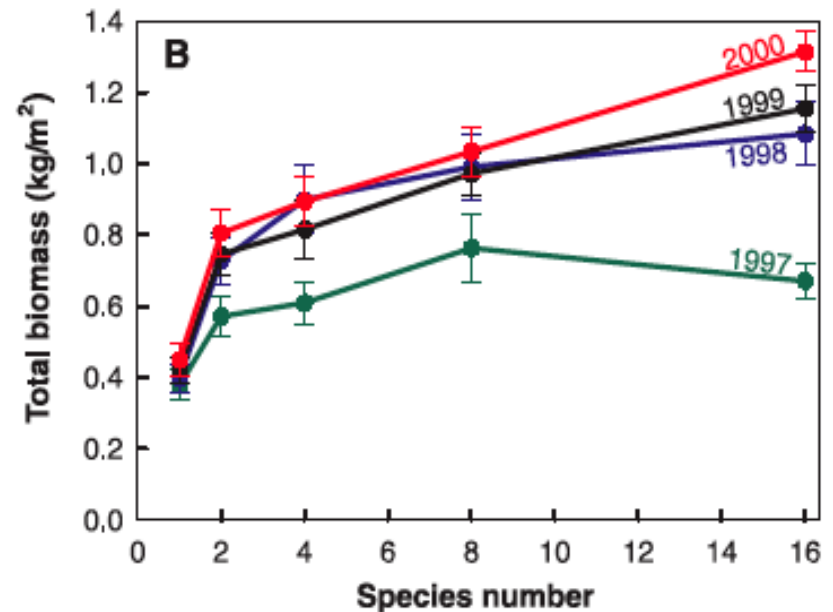




# Species diversity increases plant biomass production in grasslands

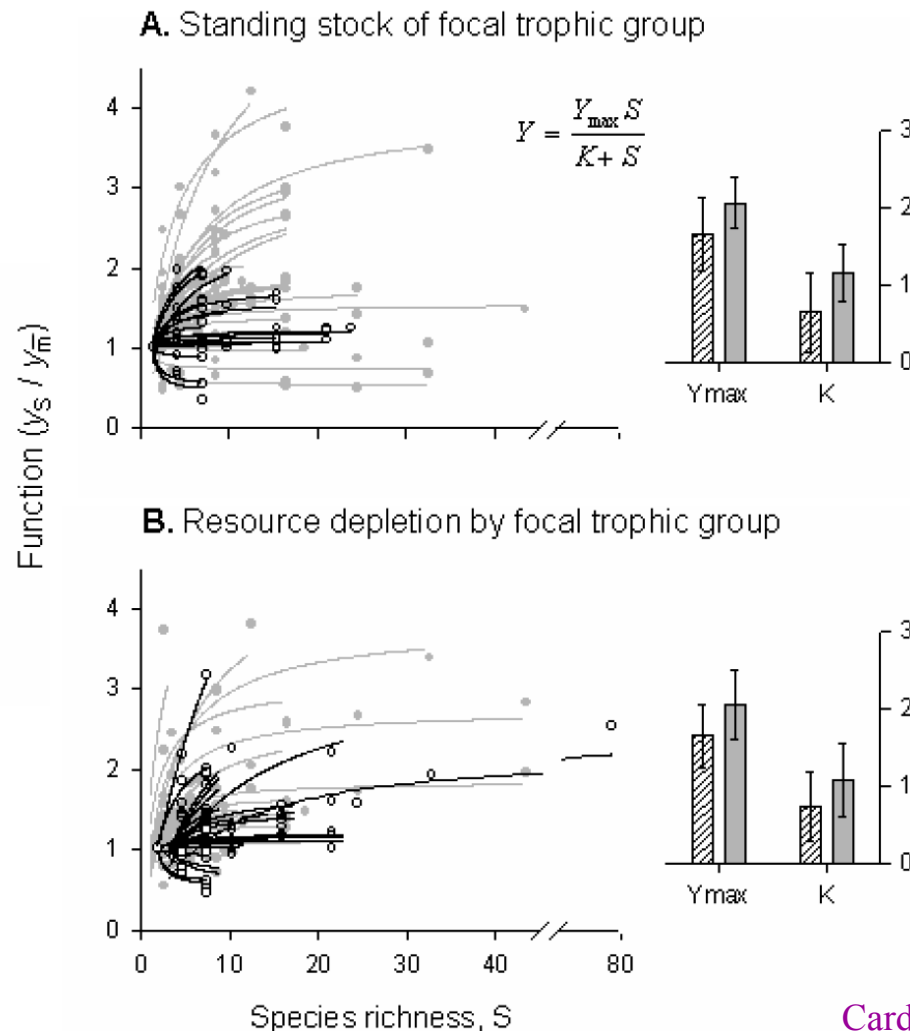


Hector et al., *Science* 286: 1123–1127 (1999)



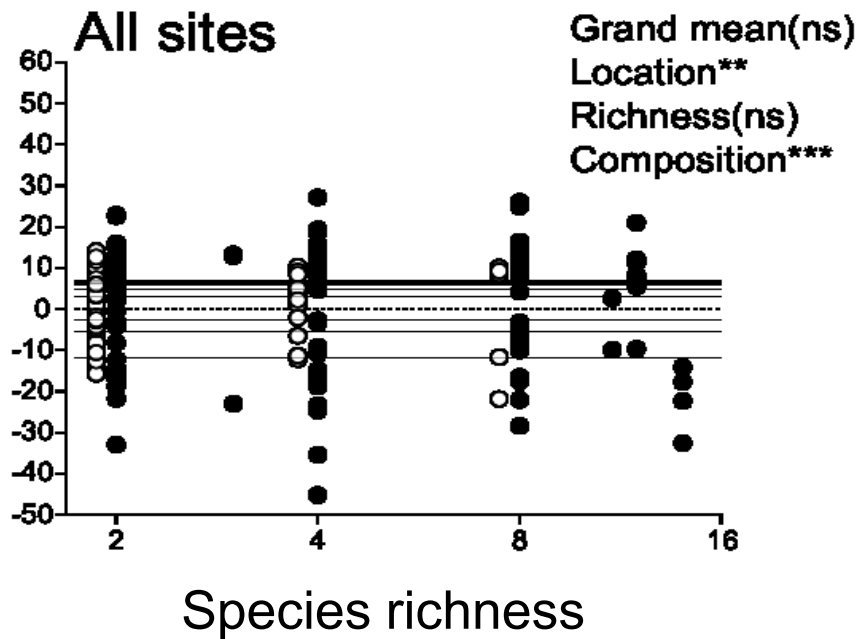
Tilman et al., *Science* 294: 843–845 (2001)

# A general form of biodiversity–ecosystem functioning relationships?

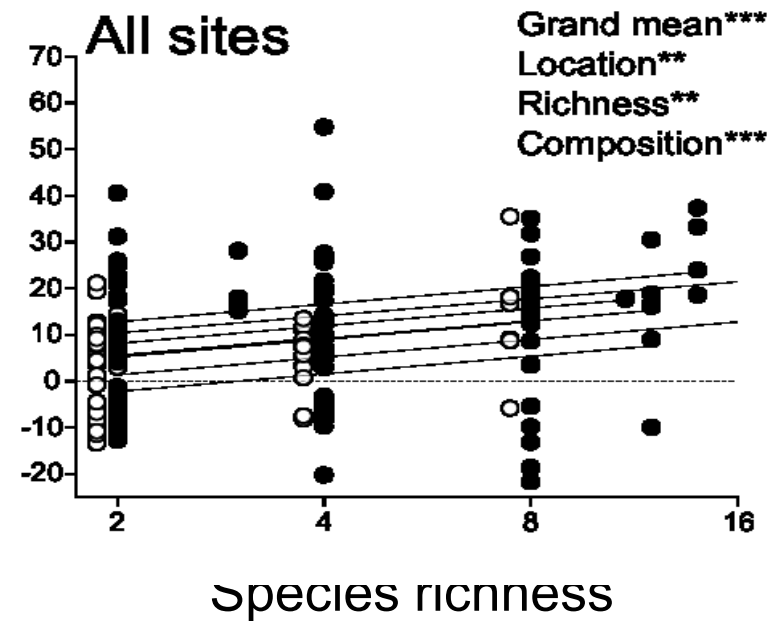


# Biodiversity effects on plant biomass production in BIODEPTH

Selection effect ( $g^{1/2}/m$ )



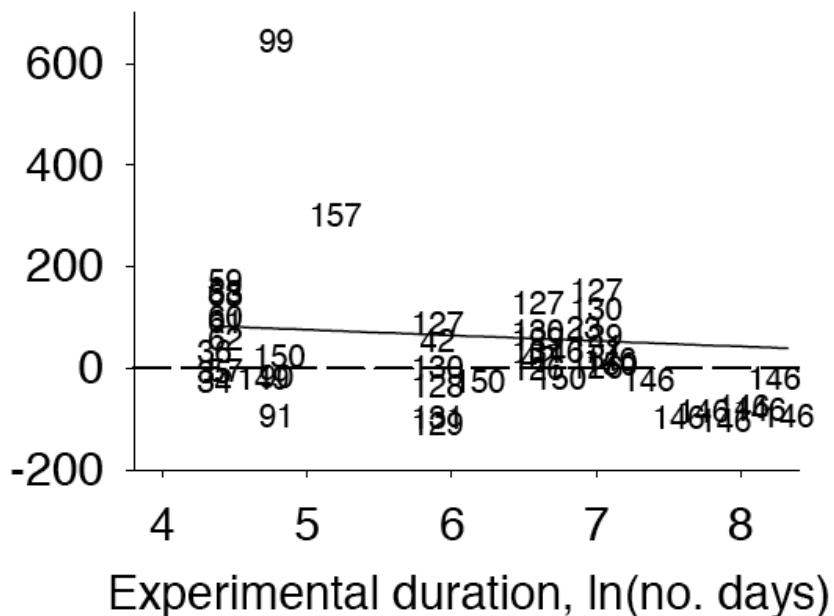
Complementarity effect ( $g^{1/2}/m$ )



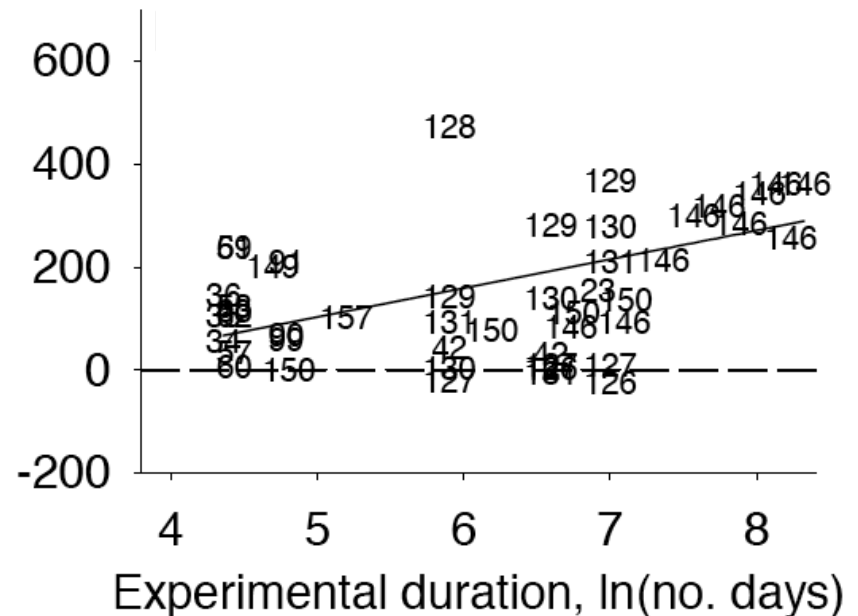


# Biodiversity effects on plant biomass production: A meta-analysis

Selection effect ( $g/m^2$ )



Complementarity effect ( $g/m^2$ )



# The results of biodiversity experiments support niche theory

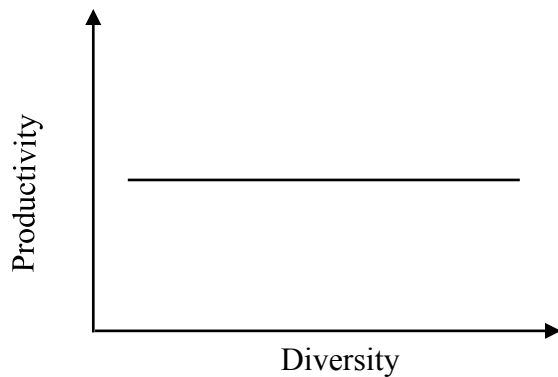
Neutral theory

Functional  
redundancy

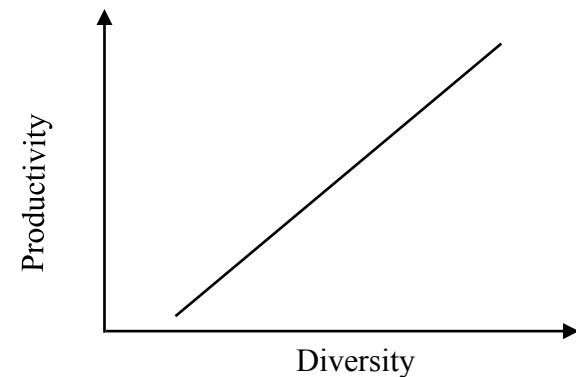


Niche theory

Functional  
complementarity

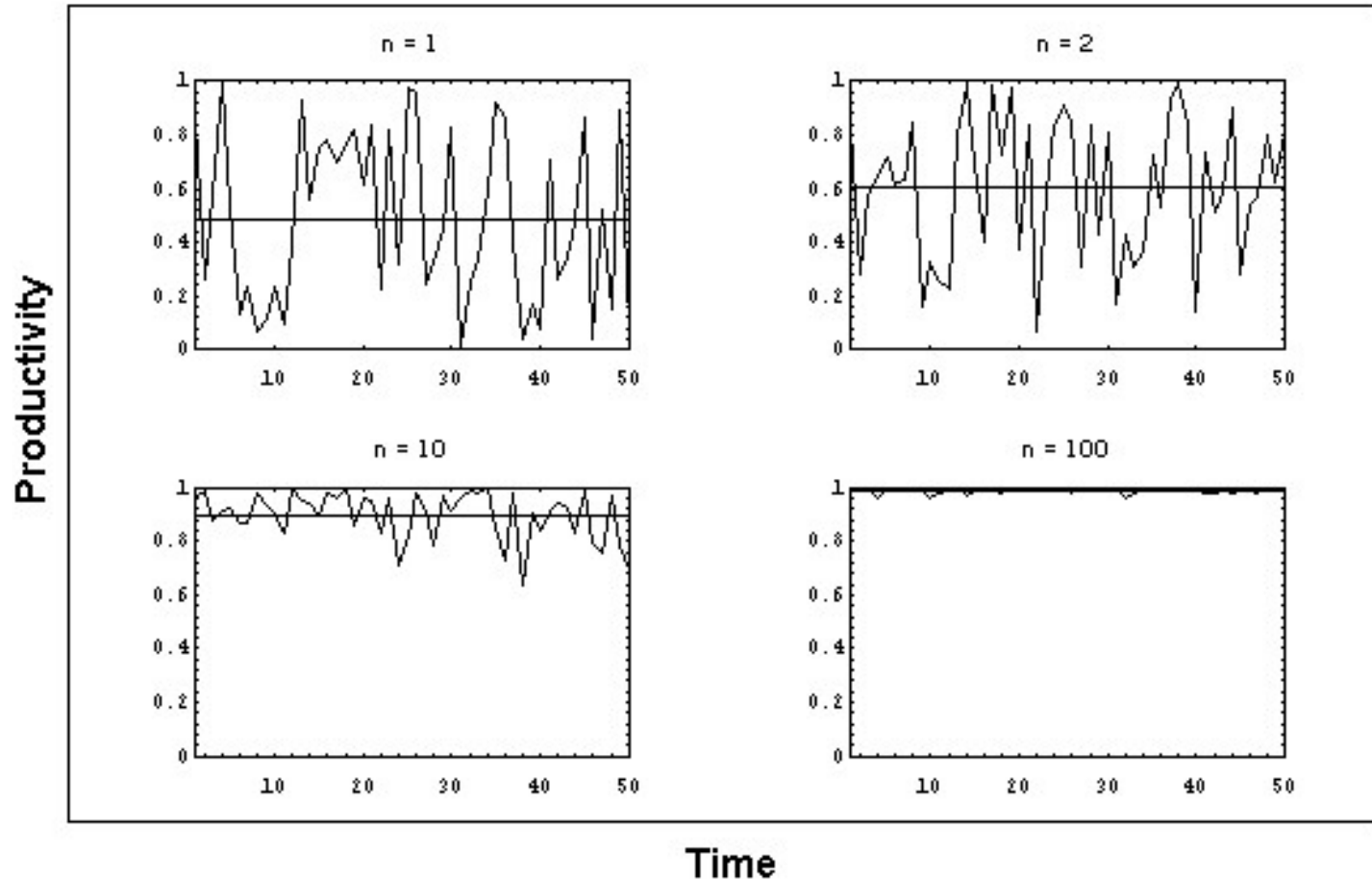


~~No net biodiversity effect  
No complementarity effect  
No selection effect~~



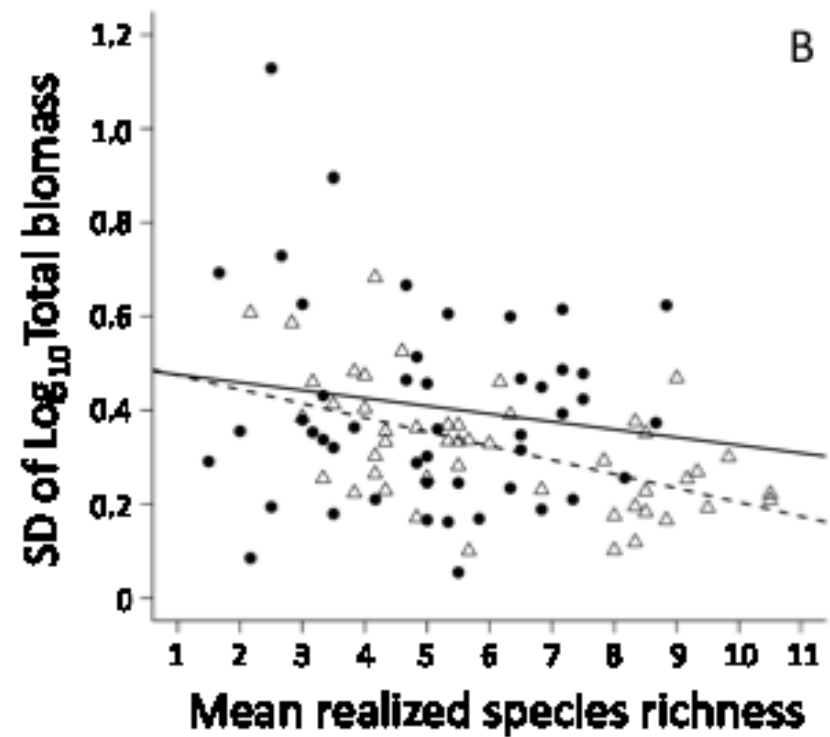
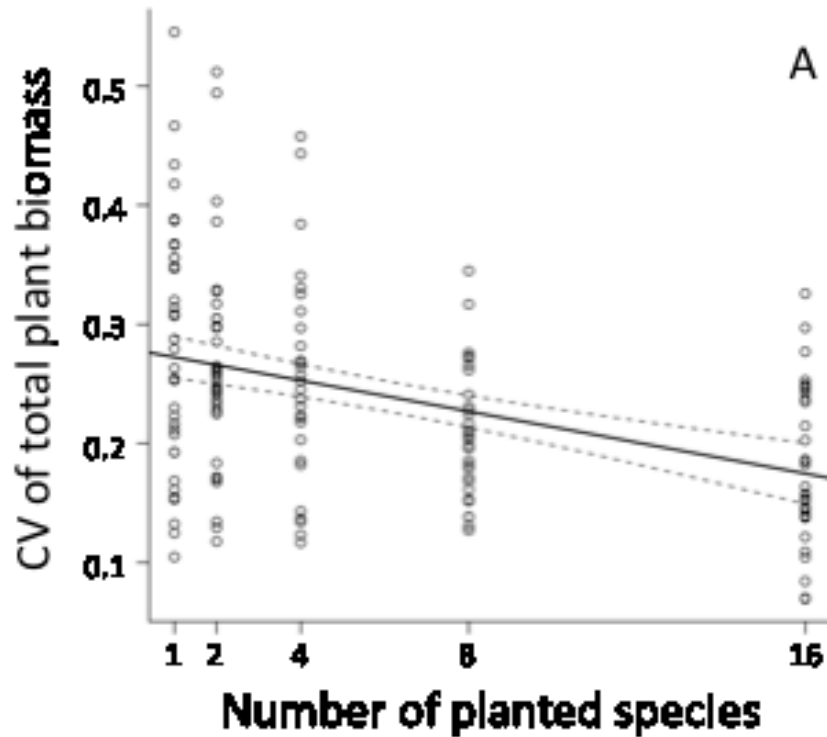
Positive net biodiversity effect  
Positive complementarity effect  
Variable selection effect

# Biodiversity as insurance against environmental changes





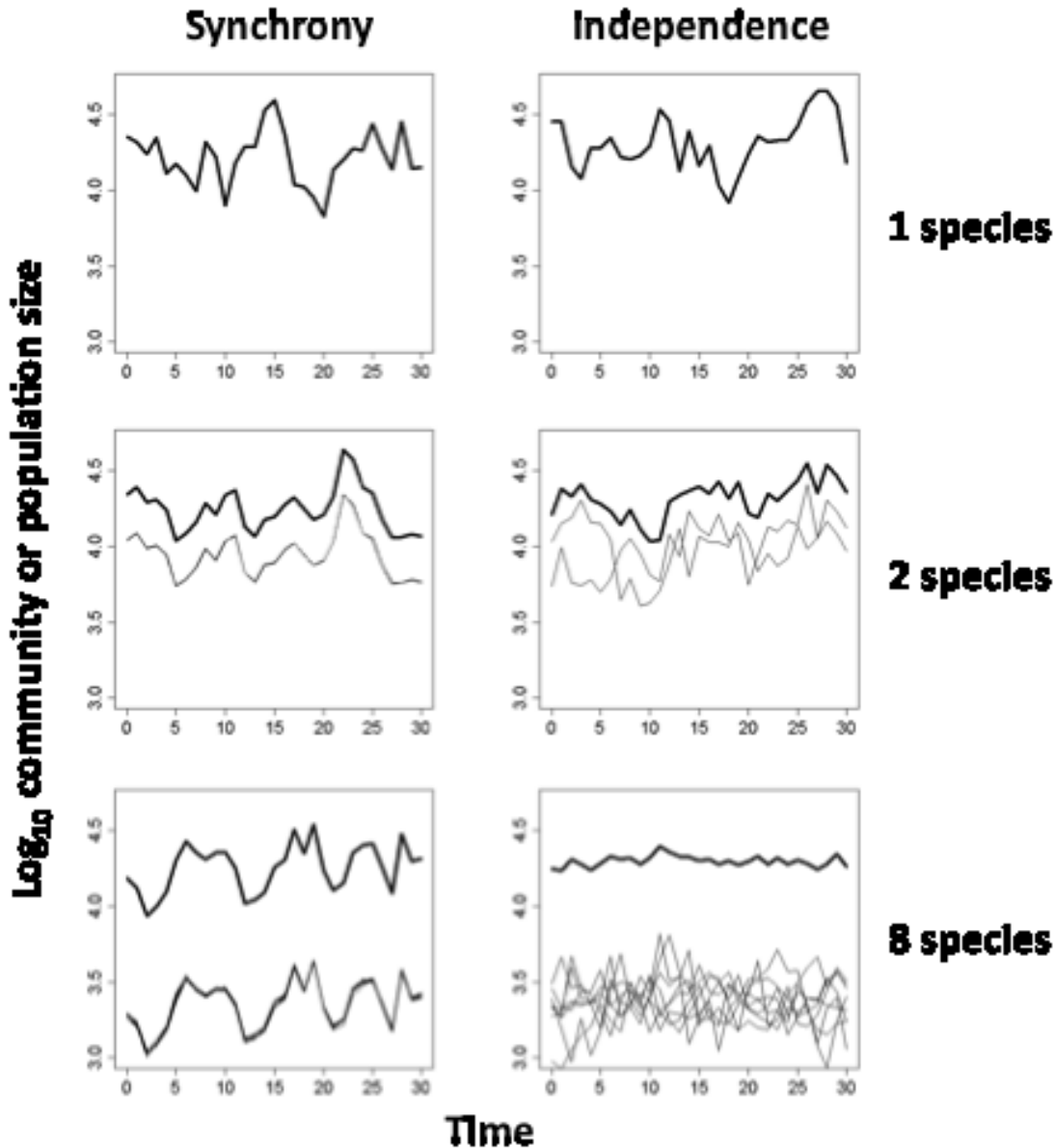
# Biodiversity as insurance: Experimental evidence in grasslands and aquatic food webs



Based on Tilman et al., *Nature* 441: 629–632 (2006)

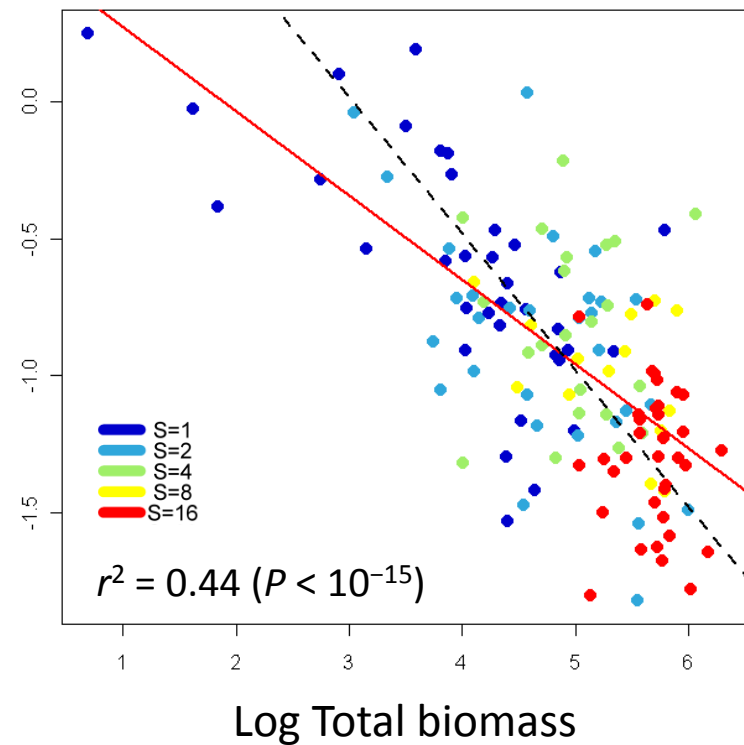
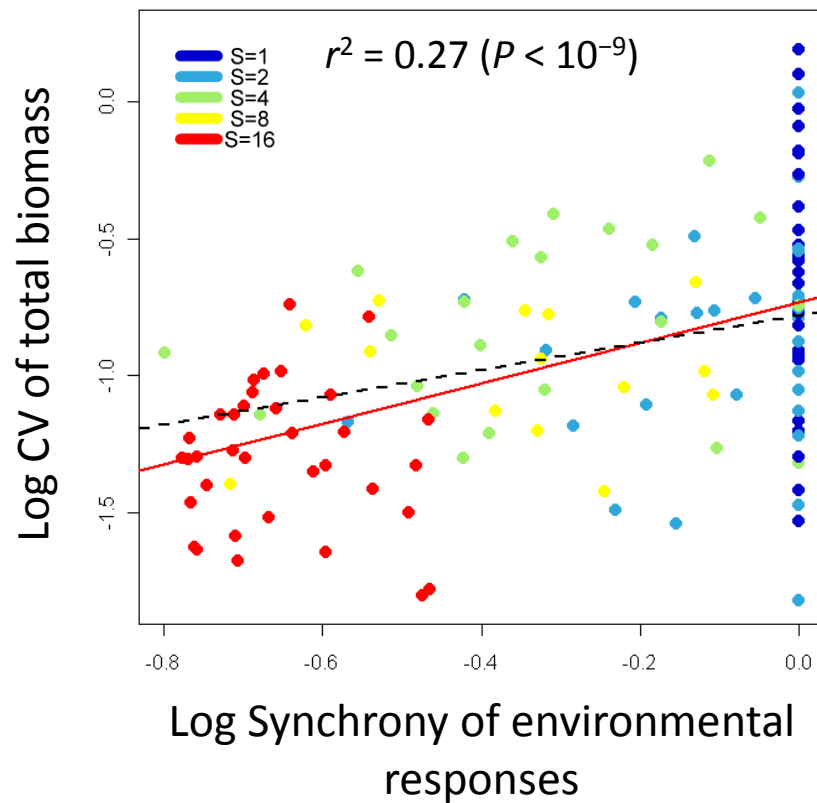
Steiner et al., *Ecol. Lett.* 8: 819–828 (2005)

# Biodiversity as insurance: Mechanisms



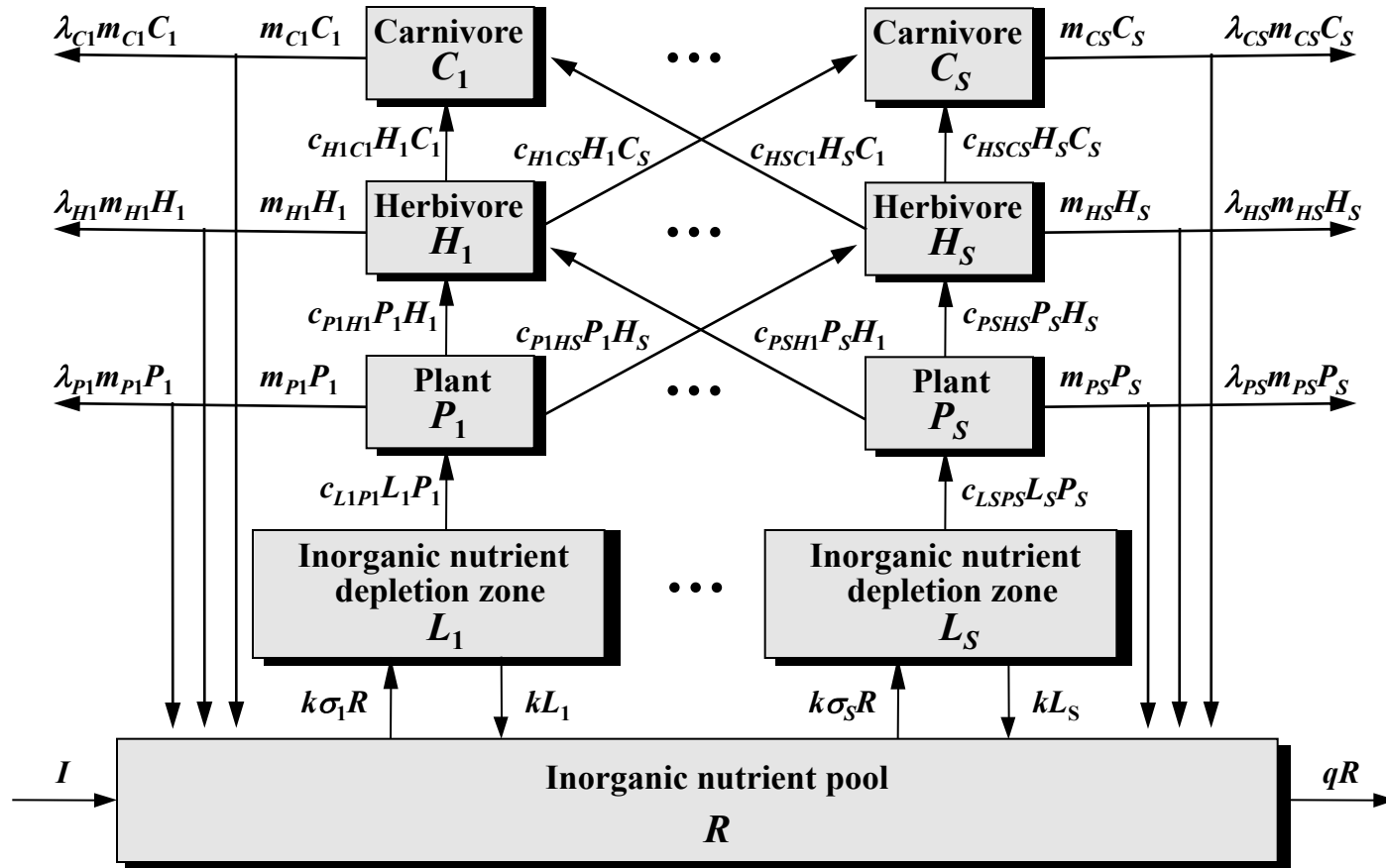
1. Asynchrony of species environmental responses  
(= temporal complementarity)
2. Overyielding  
(= functional complementarity)

# Biodiversity as insurance: Mechanisms in the Cedar Creek experiment

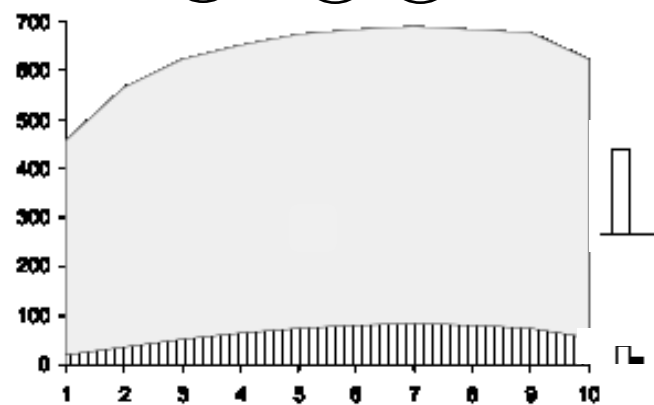
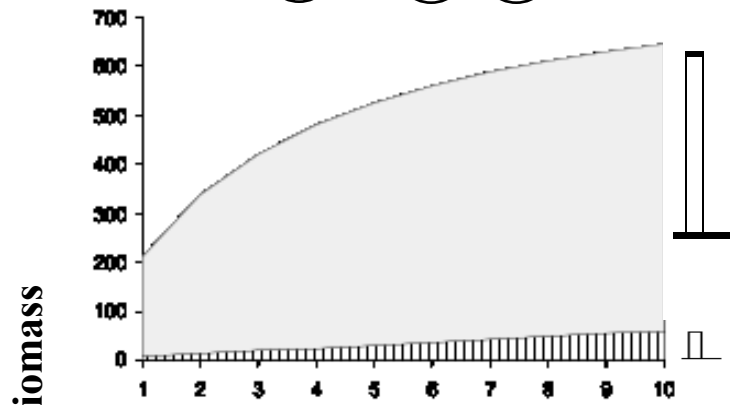
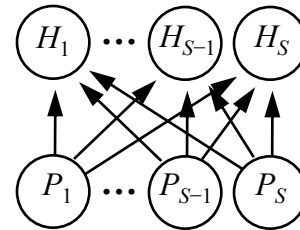
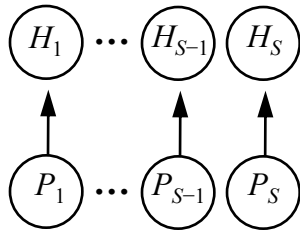




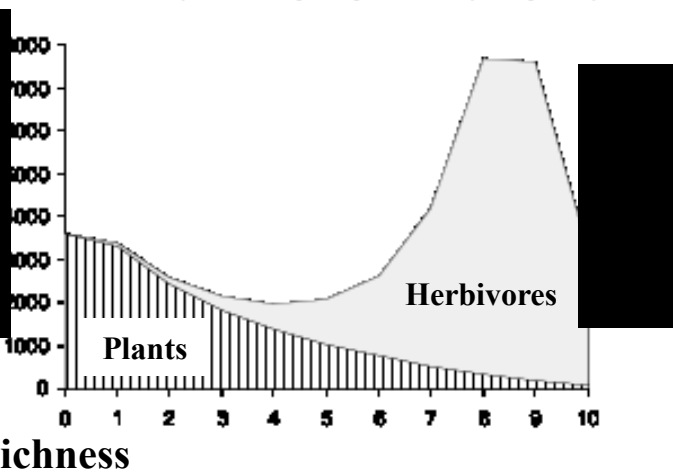
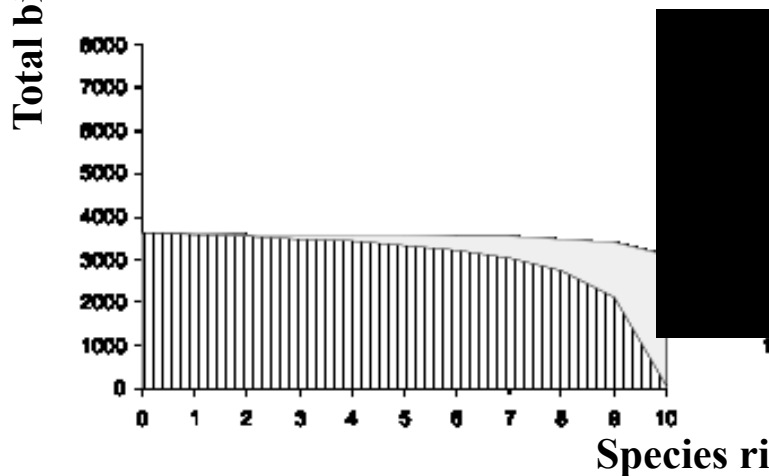
# Complex BEF relationships in food webs



# Complex BEF relationships in food webs

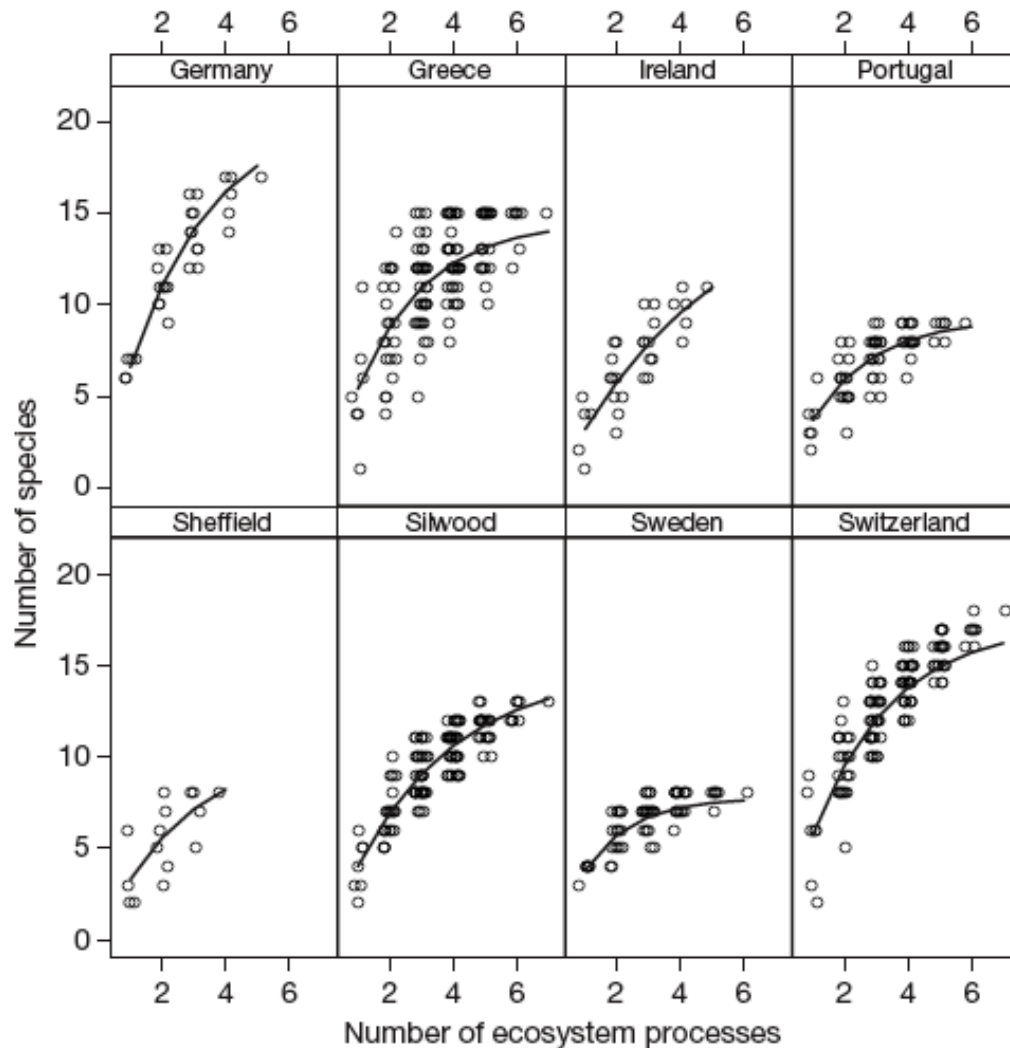


*Both plant diversity and herbivore diversity vary*



*Herbivore diversity alone varies*

# Biodiversity and ecosystem multifunctionality



# Conclusions

- Biodiversity loss does have significant impacts on ecosystem functioning and stability, and hence on ecosystem services, in particular:
  - Horizontal diversity enhances resource use and biomass production through functional complementarity between species
  - Horizontal diversity stabilises ecosystem properties through a combination of temporal and functional complementarity between species

# Conclusions

- Trophic (and non-trophic) species interactions make biodiversity effects more complex; they are potentially a major source of surprises and uncertainty
- The ecological consequences of biodiversity loss are still underestimated because recent work has focused on small scales and single ecosystem processes
- There is now strong, rigorous scientific evidence that the loss of biodiversity and associated ecosystem services may be a serious threat to human well-being



Thank you !

