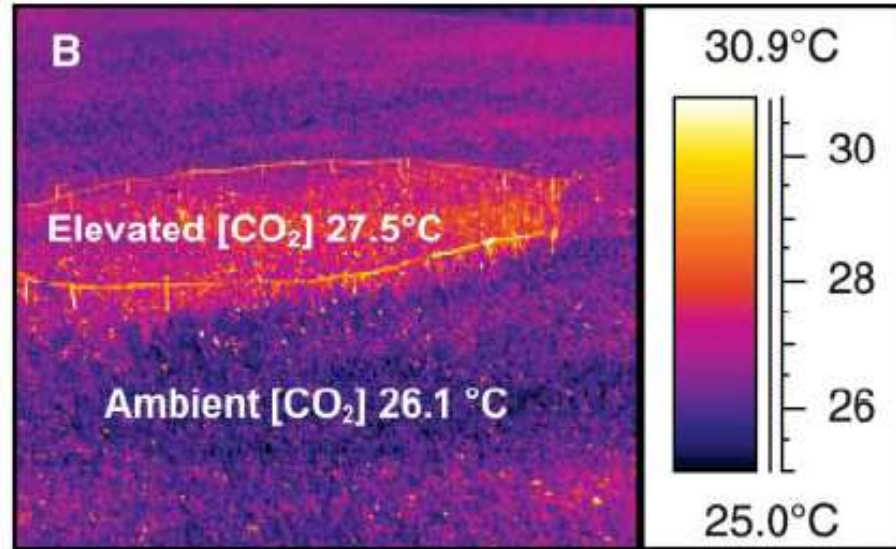


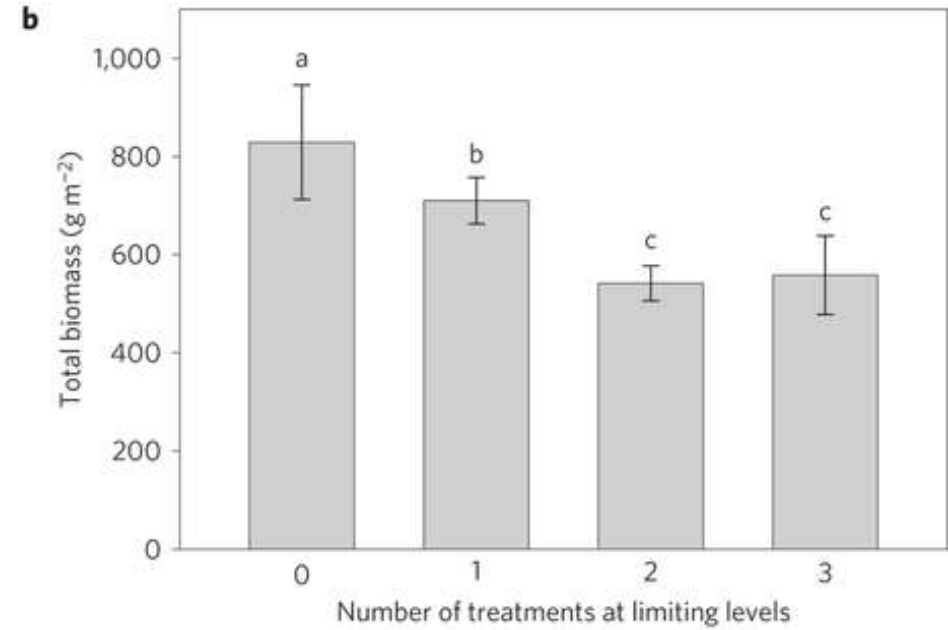
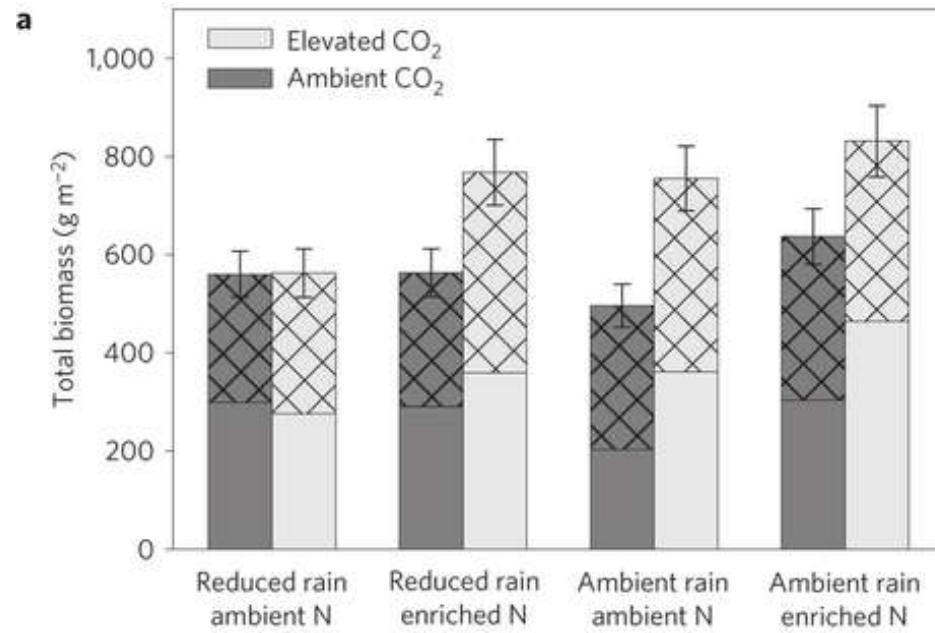
# **Ecosystem ecology: Concepts, data, models**

**Dr. Whendee Silver**

# CO<sub>2</sub> increase induced stomatal closure and increased surface temperature



# Nutrients and water make a difference



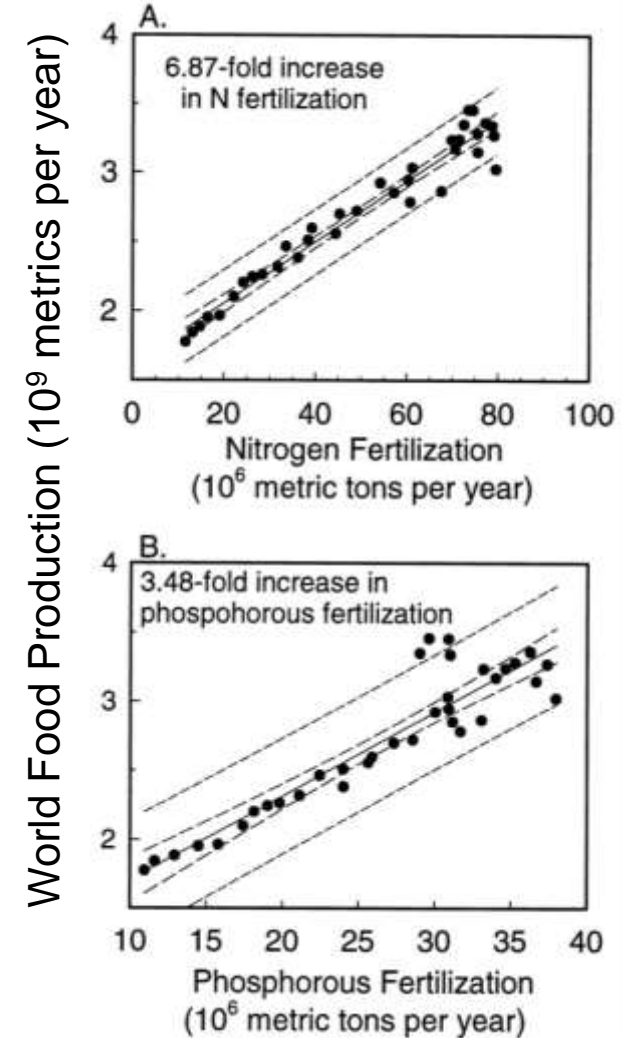
# Liebig's Law of the Minimum



Justus von Liebig  
(1803-1873)



## Liebig's Barrel



# Net carbon balance of an ecosystem (net ecosystem production = NEP)

$$NEP = GPP - R_{auto} - R_{hetero}$$

Where: GPP is gross photosynthesis

$R_{auto}$  is plant respiration

$R_{hetero}$  is the respiration of heterotrophs

- **Carbon dioxide is one resource that plants need to do grow, but not the only resource!**
- **Nitrogen, water, phosphorus, other nutrients, temperature, physical stability, light....**
- **Pathogens and disease, herbivory, toxic chemicals, disturbance**

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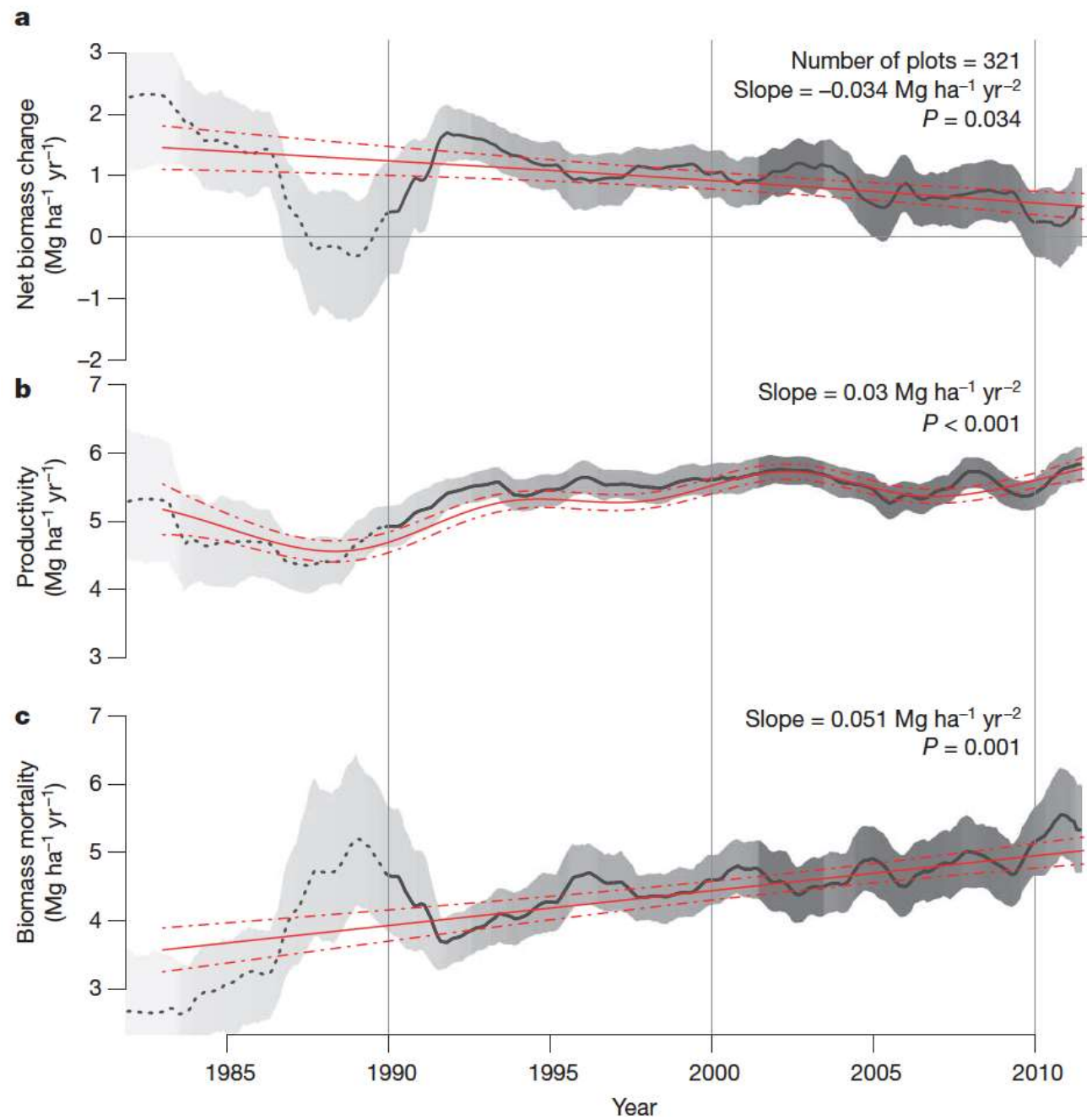
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Carbon dioxide is one resource that plants need to do grow, but not the only resource!

Nitrogen, water, phosphorus, other nutrients, temperature, physical stability, light....

Pathogens and disease, herbivory, toxic chemicals, disturbance

***These also affect heterotrophic respiration!***



Nitrogen



# Causes of N fixation in the Environment

3



Electrical Power Plants  
(Burning of Fossil Fuels)



Automobiles  
(Burning of Fossil Fuels)



Agriculture (Synthetic Fertilizers &  
Leguminous Crops)

# Humans have doubled the amount of fixed N in the biosphere

## Processes/Organisms that fix N:

Lightening

<3 Tg/yr

Free-living bacteria

~44 Tg/yr

Symbiotic N Fixation

~100 Tg/yr

} ~147

## Human-doubling of N fixation

Fossil Fuel Combustion

~20 Tg/yr

Fertilizer production

>80 Tg/yr

Cultivation of N fixing Row Crops

~40Tg/yr

} ~140

1 Tg =  $10^{12}$ g

## Estimated regional and sub-regional annual nitrogen fertilizer consumption 2007 and 2012

Regions	Share of world consumption (%)	Annual growth (%)
World		1.4
Africa	3.4	2.9
North America	13.5	0.3
Latin America	6.3	2.4
West Asia	3.5	1.7
South Asia	19.6	2.2
East Asia	38.3	1.3
Central Europe	2.7	1.8
West Europe	8.4	-0.3
Europe and C Asia	3.0	2.4
Oceania	1.4	4.9

# Estimated Total Reactive Nitrogen Deposition from the Atmosphere (Wet and Dry)

