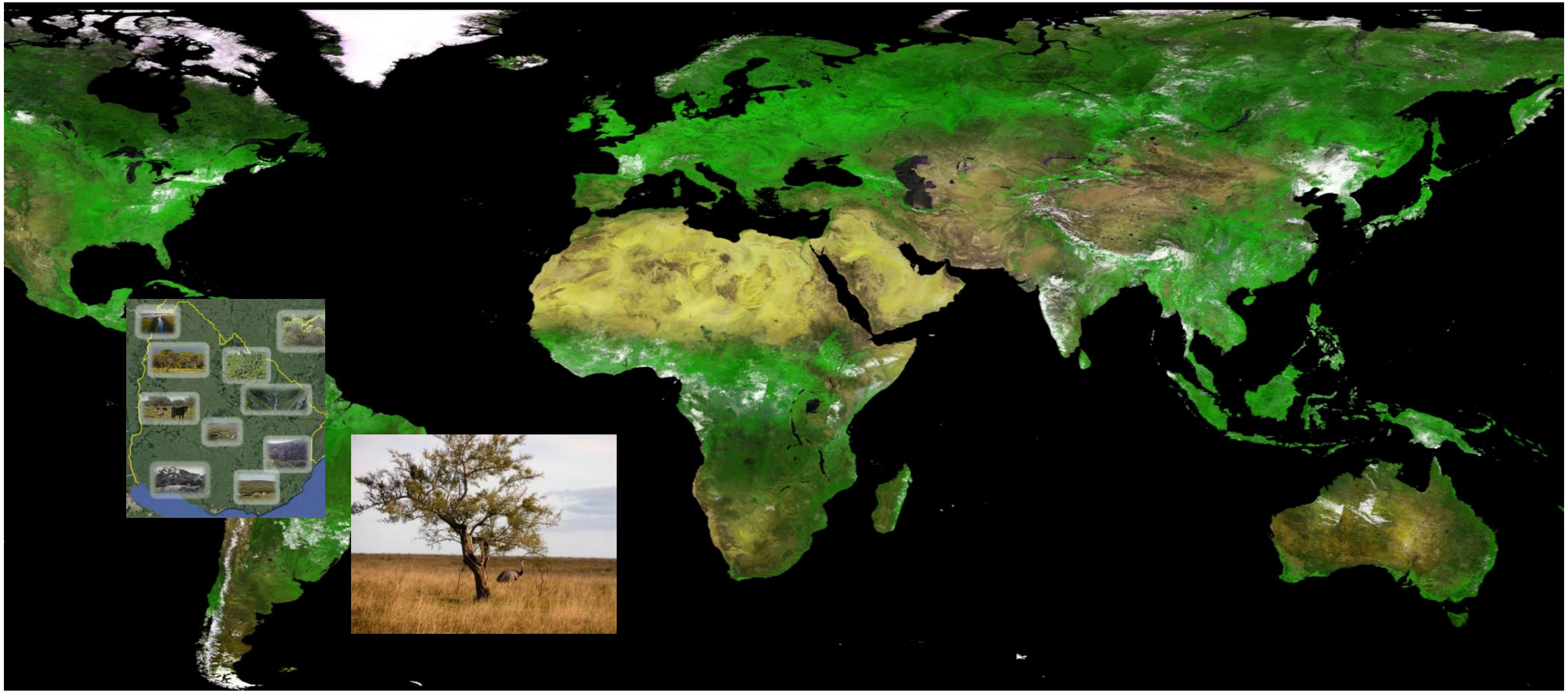
Ecosistemas terrestres

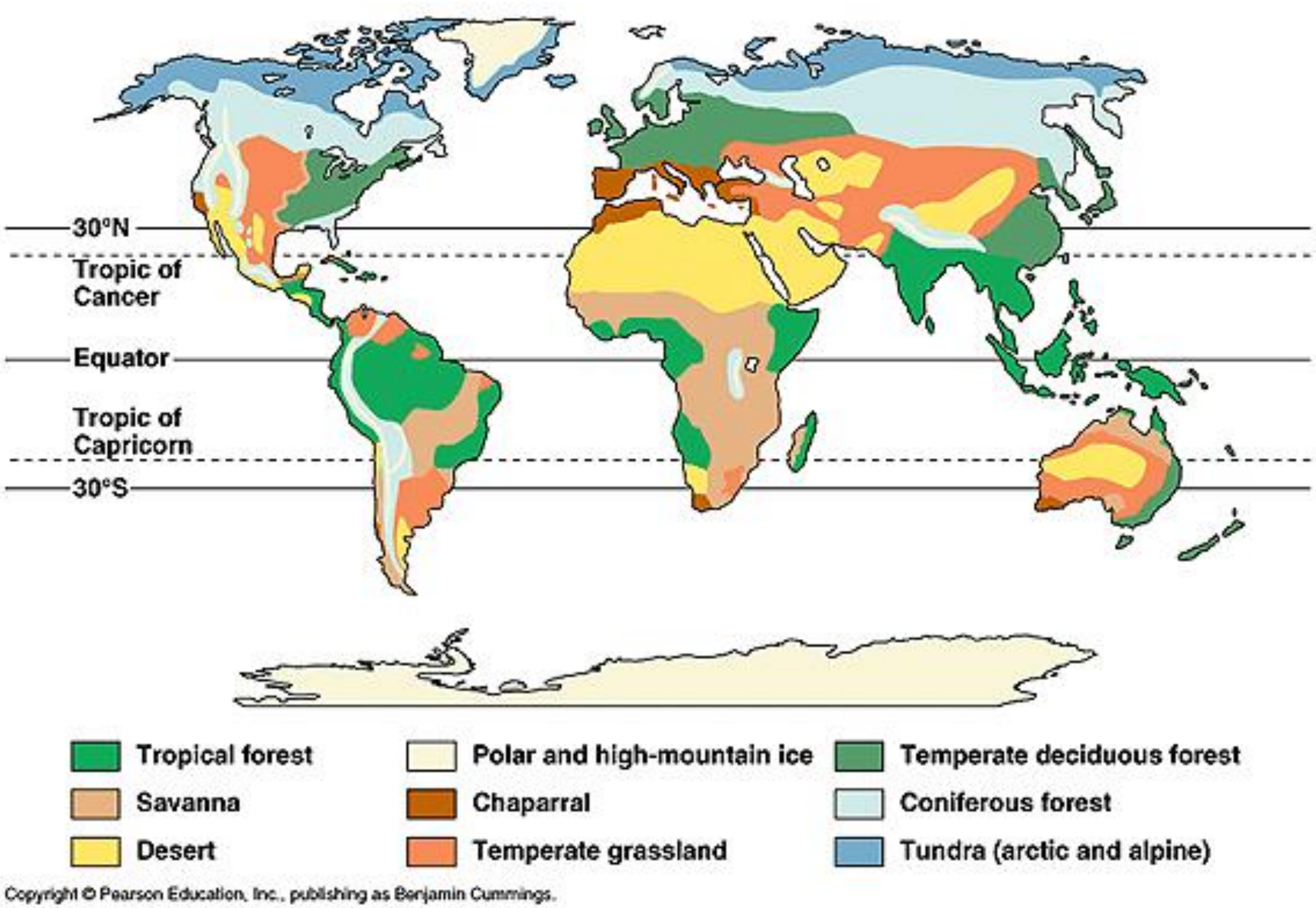


Ing. Rafael Bernardi, PhD.
Depto Ecología y Gestión Ambiental, CURE - UDELAR

Basado en:

Stuart Chapin III et al. 2012. Principles of terrestrial ecosystem ecology. 2nd ed.

Biomas terrestres

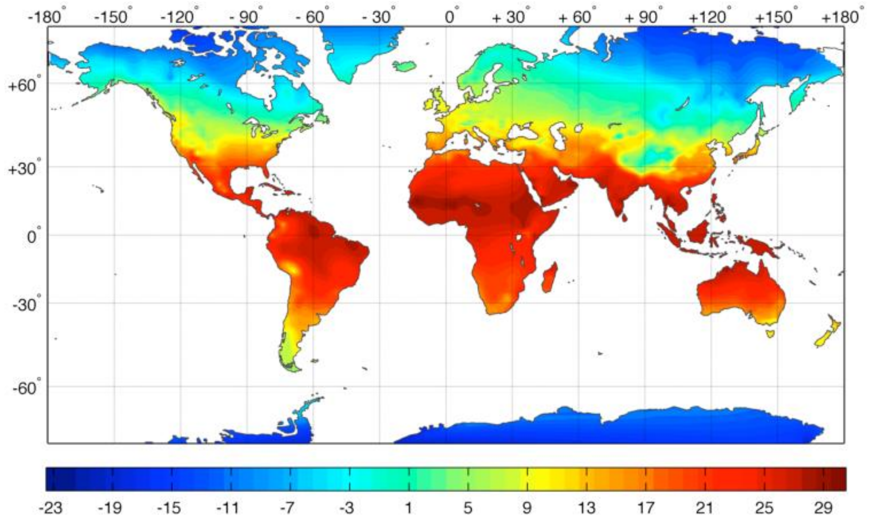


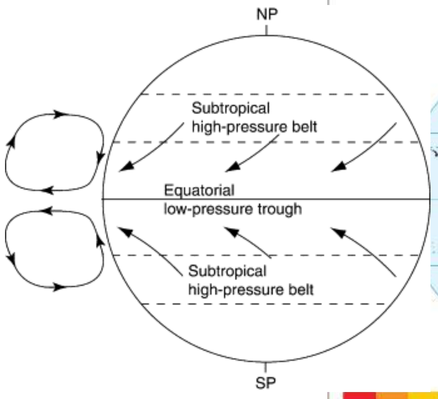
Los Biomas son categorías generales en las que se agrupan los ecosistemas

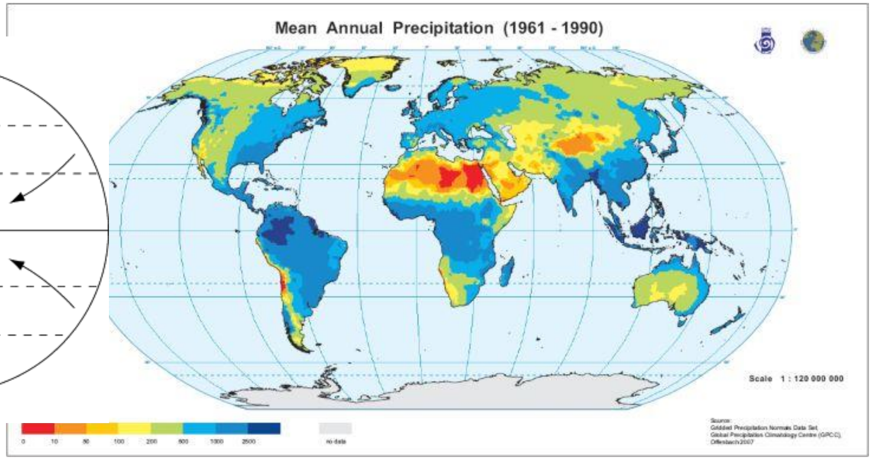
Los biomas suelen clasificarse en función de las especies que habitan y sus nichos, incluyendo condiciones climáticas y biogeográficas.

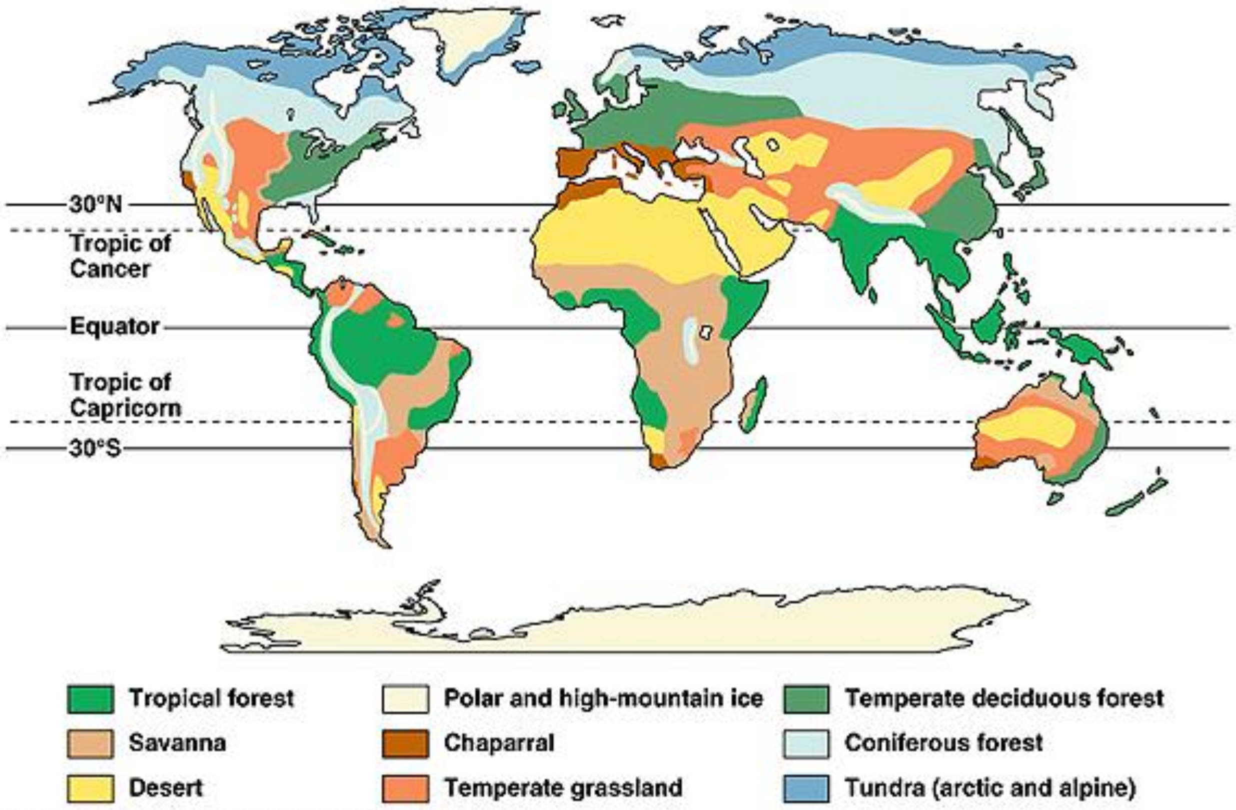
Generalmente se asocian a un tipo de vegetación dominante.

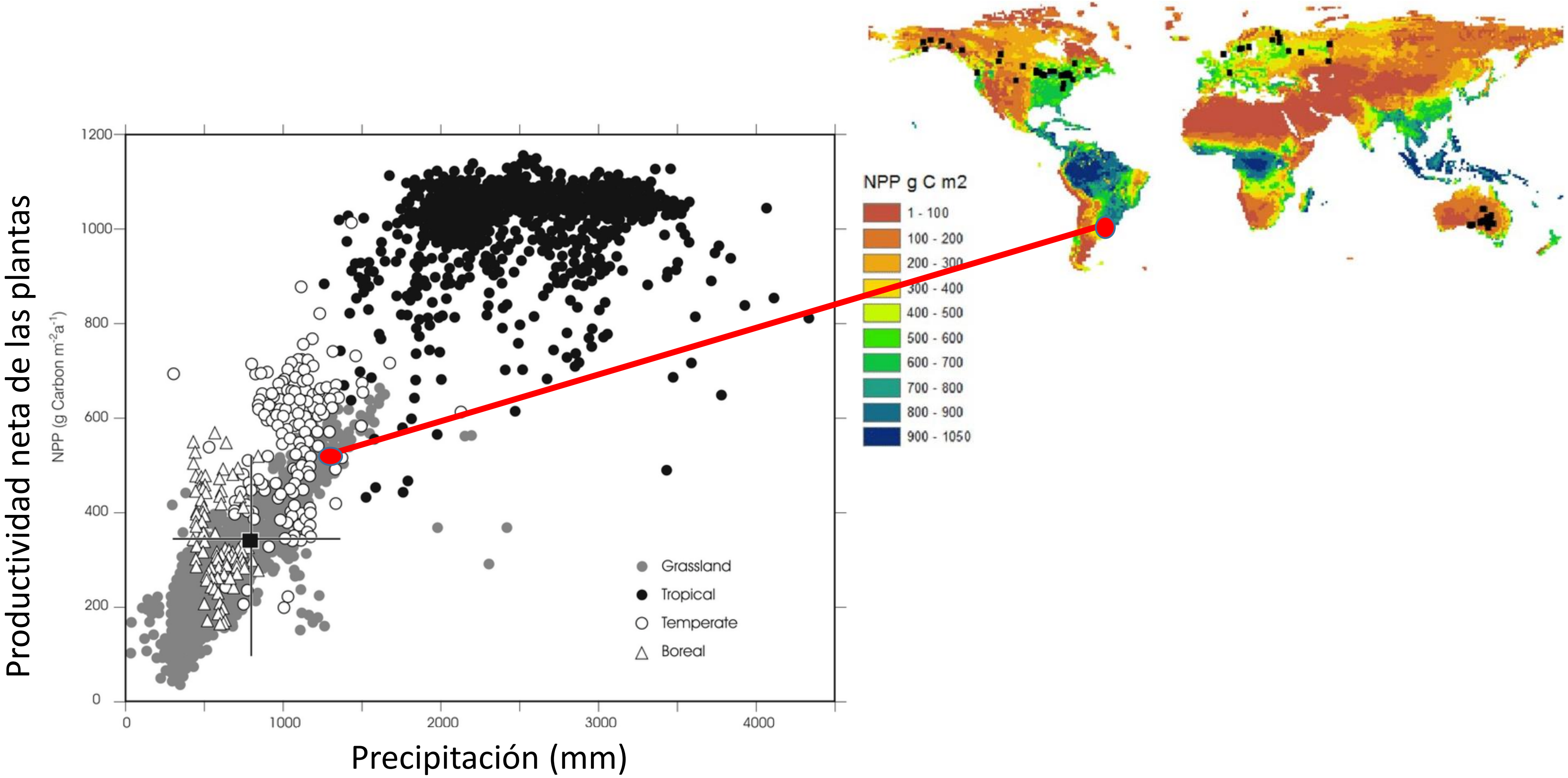
Clima y biomas terrestres

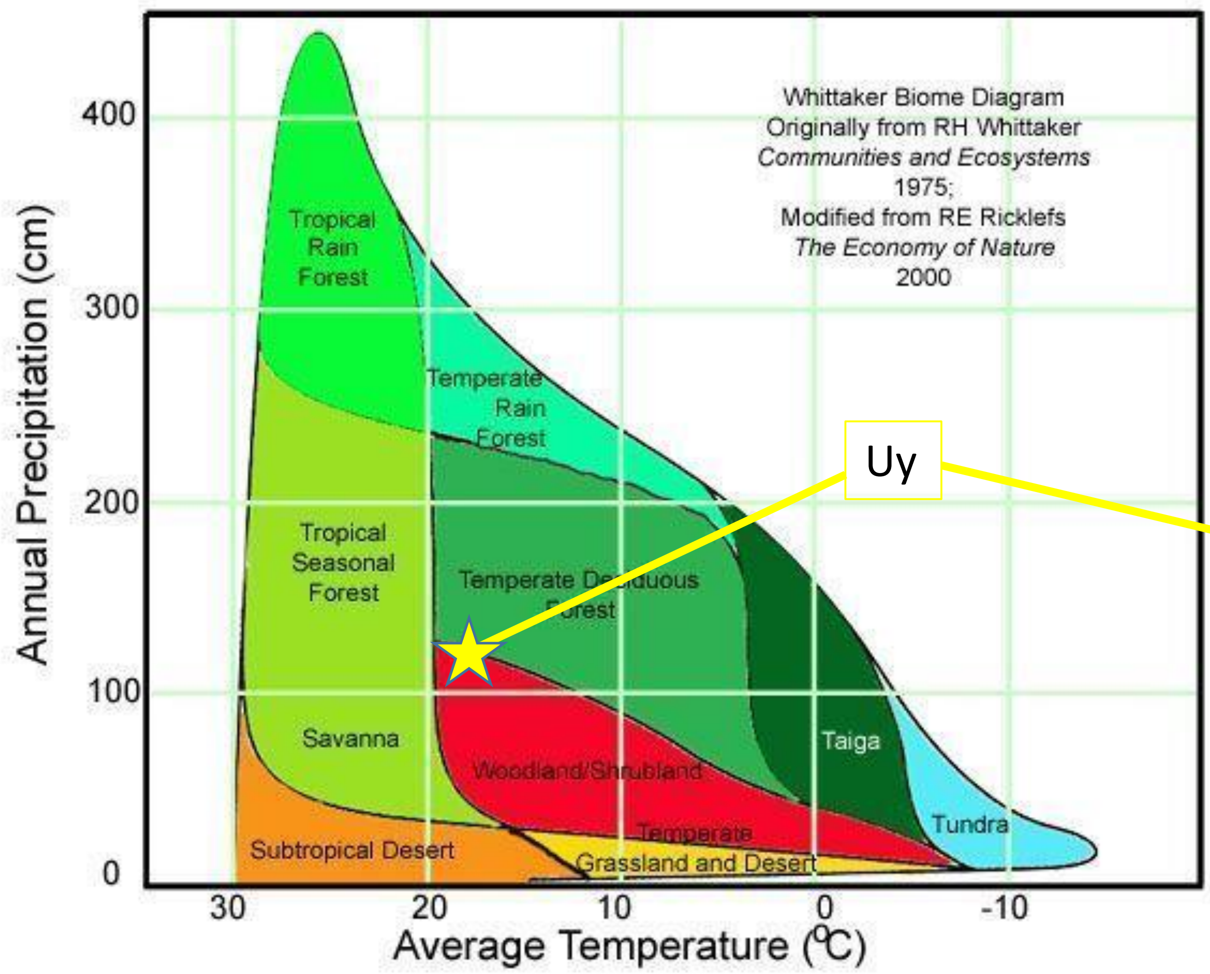









Productividad neta de las plantas
NPP (g Carbon m-2a-1)
1200
1000
800
600
400
200
0
0
1000
2000
3000
4000
Precipitación (mm)
Grassland
Tropical
Temperate
Boreal
NPP g C m2
1 - 100
100 - 200
200 - 300
300 - 400
400 - 500
500 - 600
600 - 700
700 - 800
800 - 900
900 - 1050

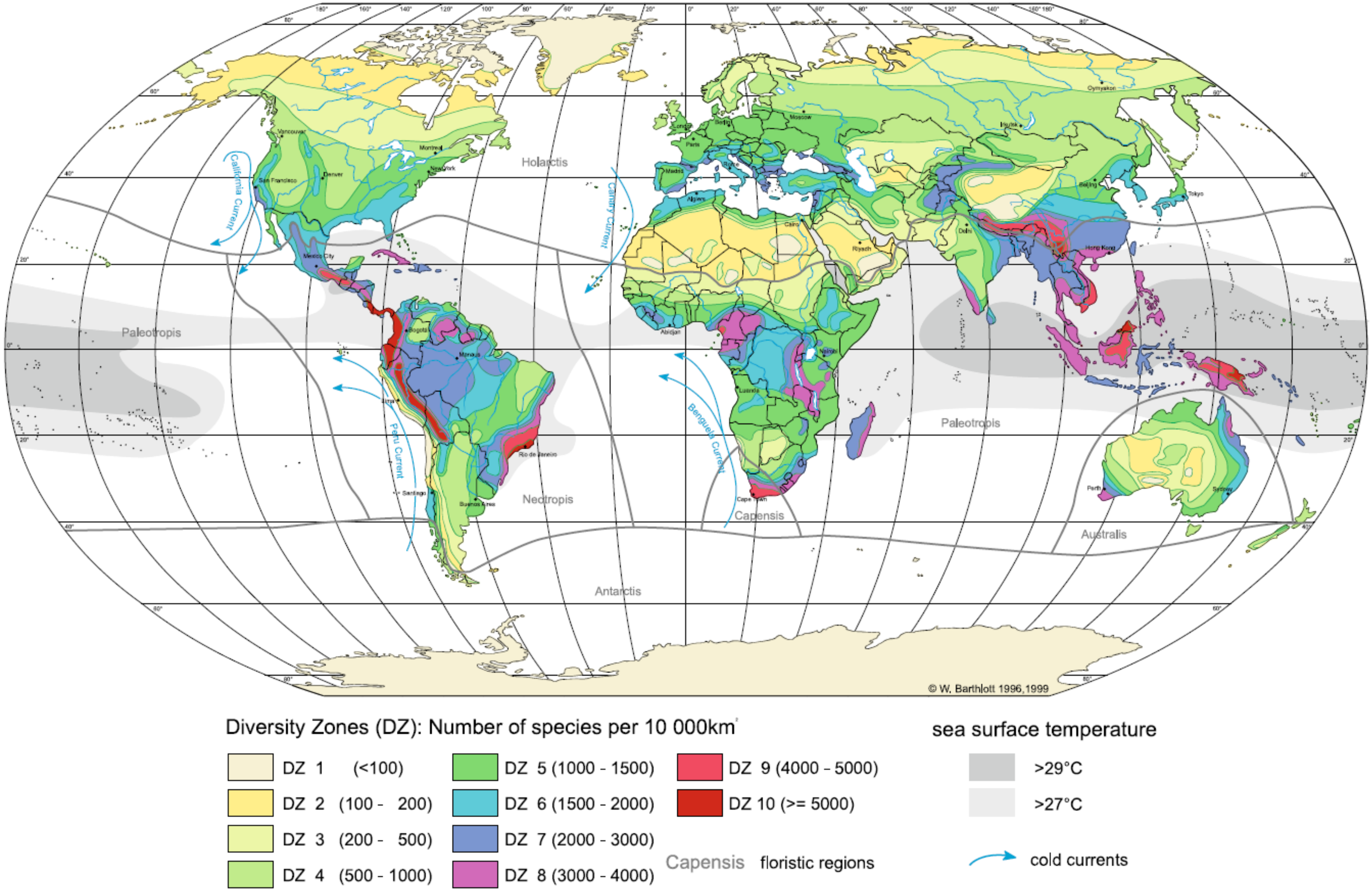

Whittaker Biome Diagram
Originally from RH Whittaker
Communities and Ecosystems
1975;
Modified from RE Ricklefs
The Economy of Nature
2000
Tropical Rain Forest
Temperate Rain Forest
Tropical Seasonal Forest
Temperate Deciduous Forest
Savanna
Woodland/Shrubland
Taiga
Tundra
Subtropical Desert
Temperate Grassland and Desert
Annual Precipitation (cm)
400
300
200
100
0
30
20
10
0
-10
Average Temperature (°C)

Uy

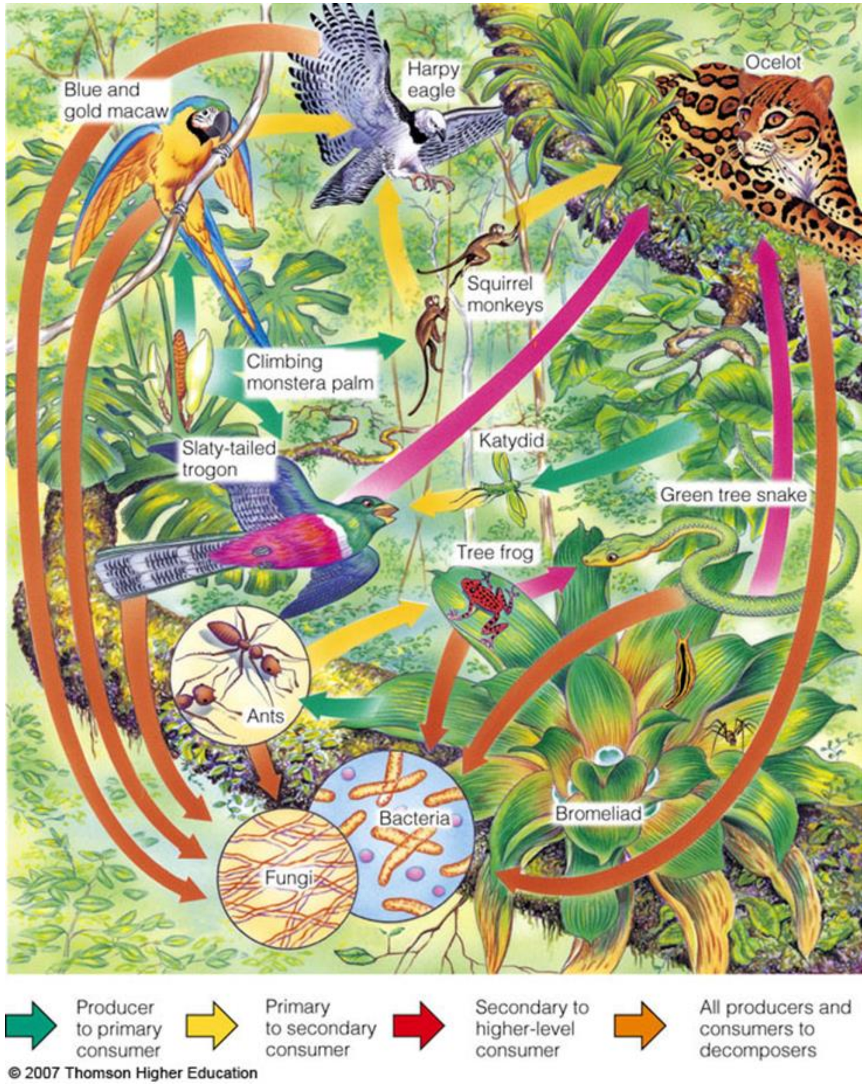
Vs.

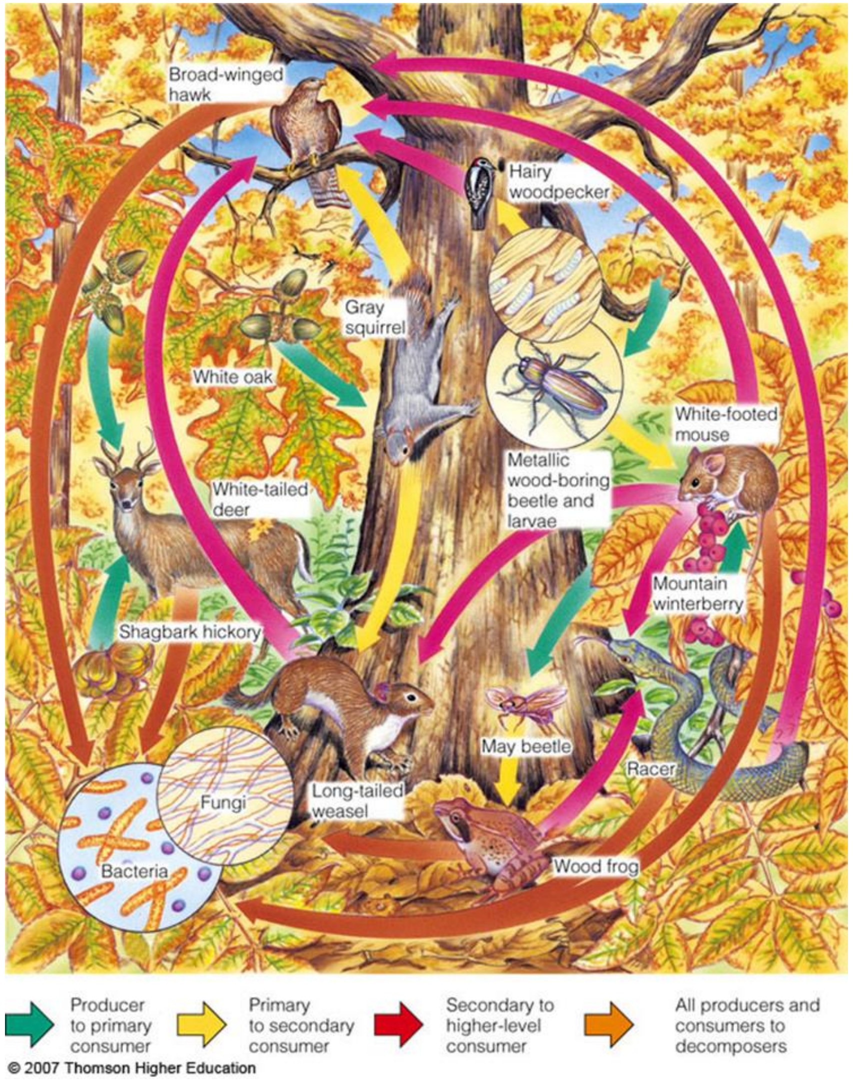
?

GLOBAL BIODIVERSITY: SPECIES NUMBERS OF VASCULAR PLANTS

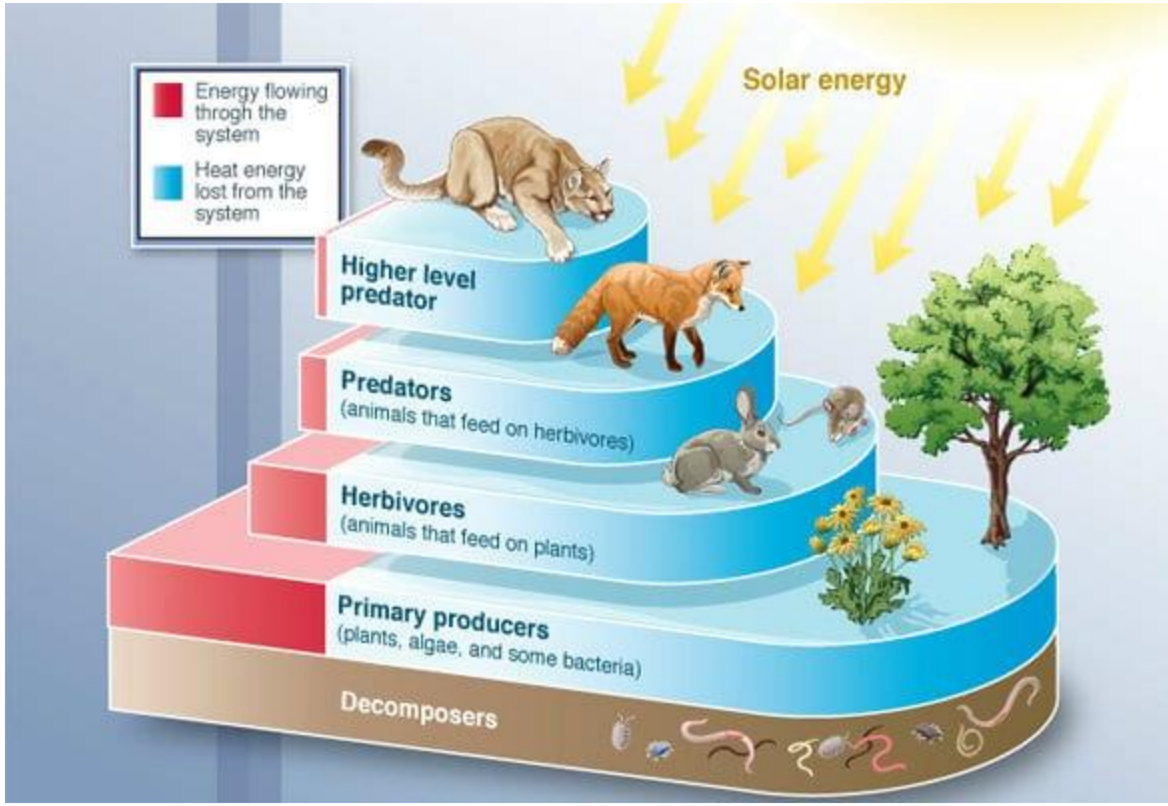


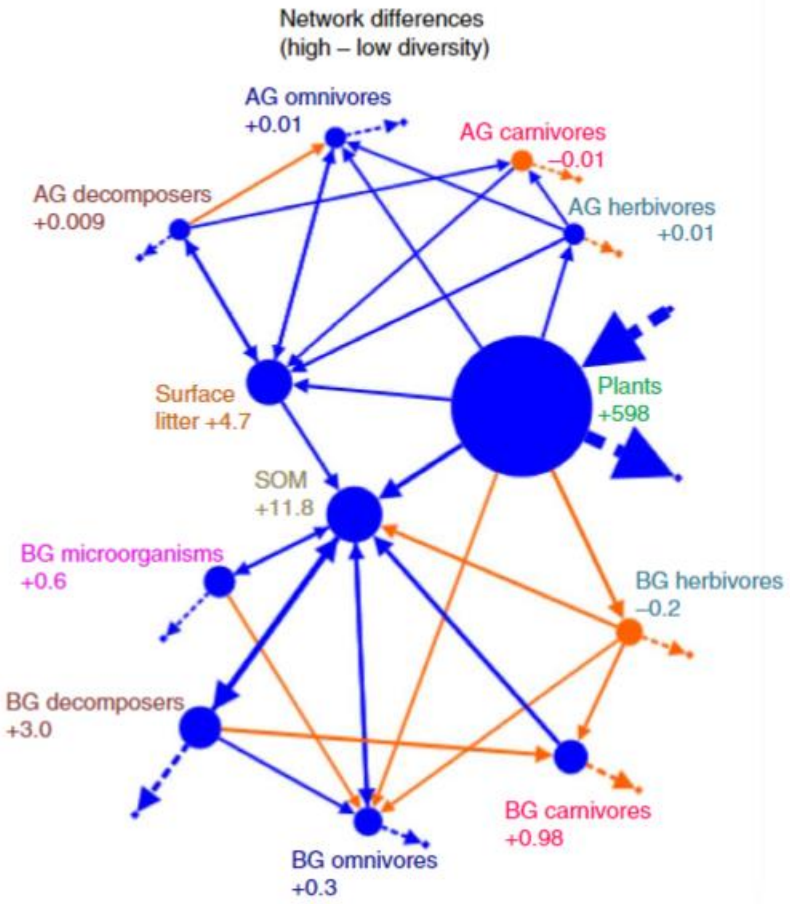
Bosques tropicales y templados





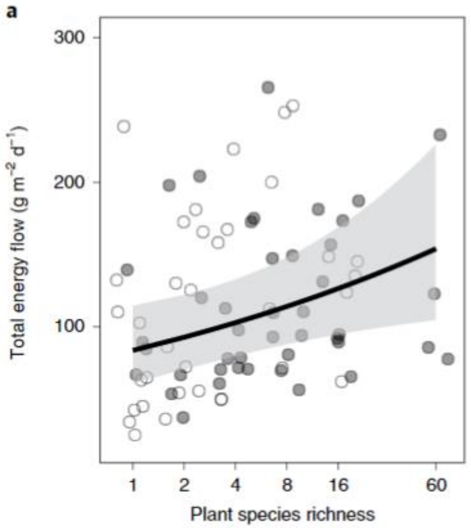
Pastizales

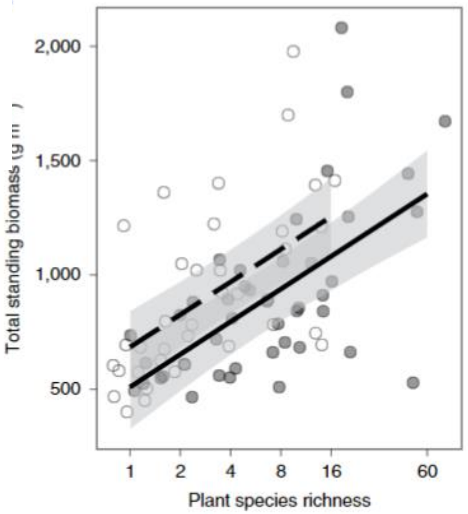


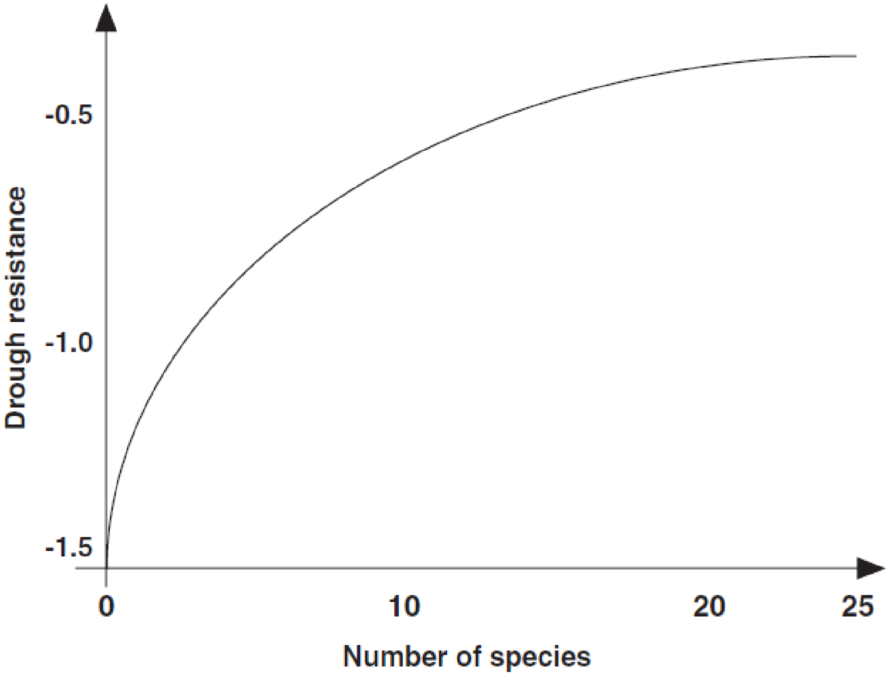


Buzhdygan et al. NEE 2020

Biodiversidad: función y resiliencia







Resistencia a la sequía en función de la biodiversidad en pastizales
Tilman and Downing (1994)

Buzhdygan et al. NEE 2020

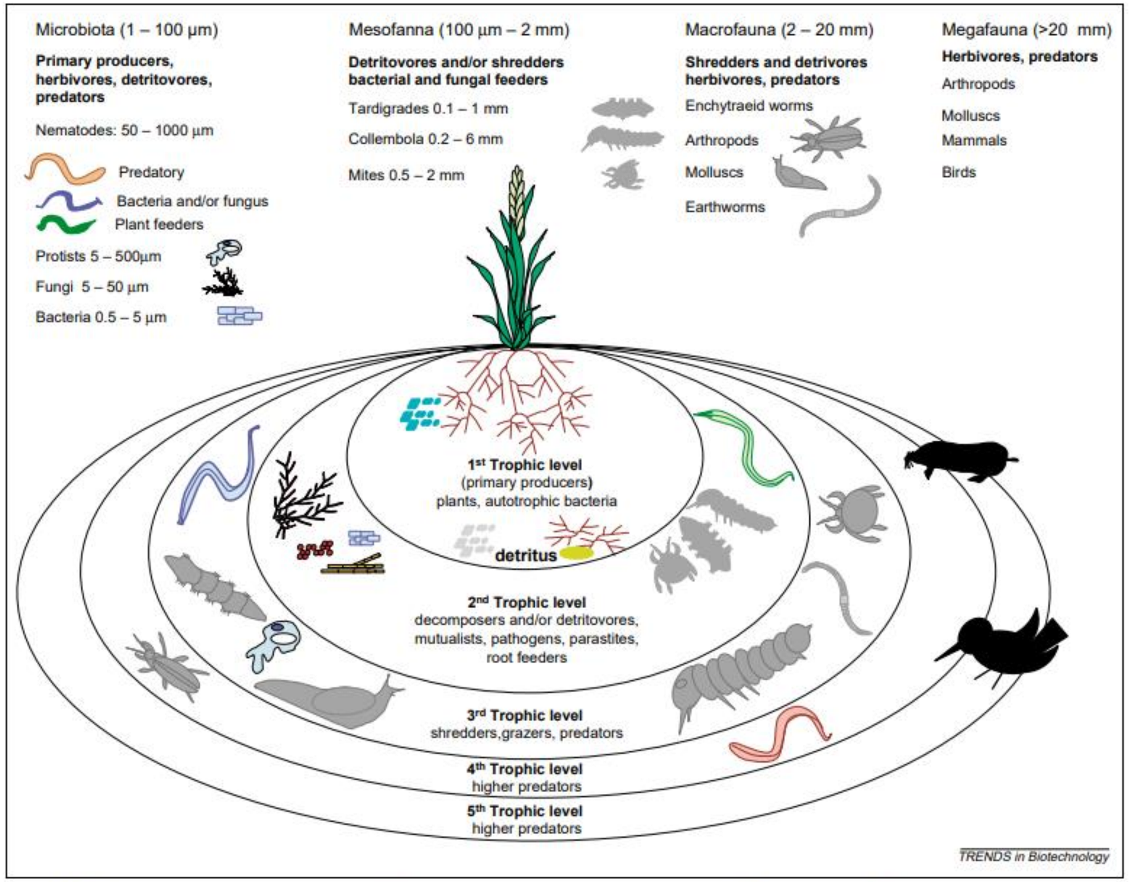
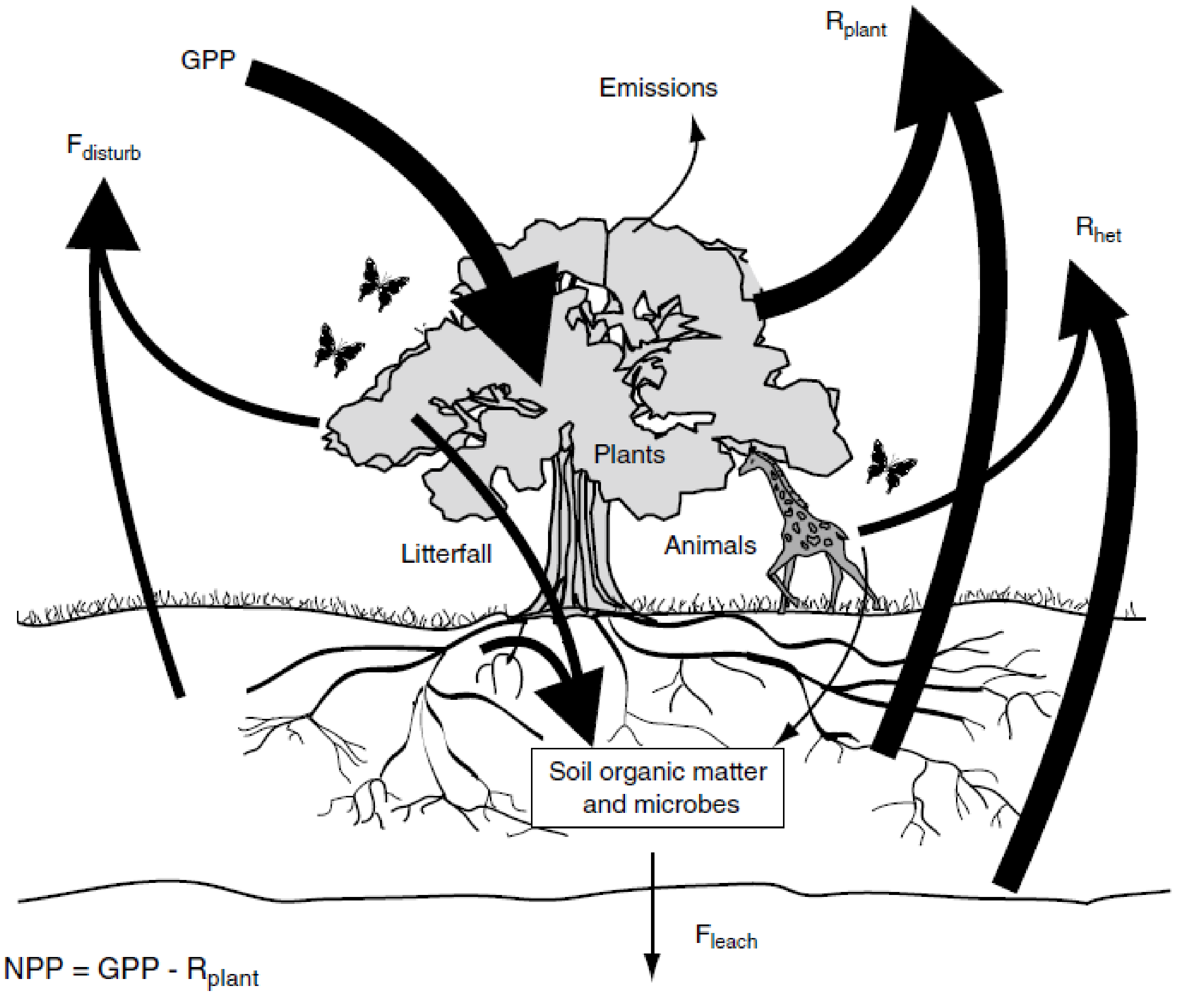


Figure 1. Soil food web showing an outline classification of the soil biota based on type, body size and trophic level. These components have a variety of interactions ranging from the competitive or predatorial to the cooperative and symbiotic. Size class is based on the width of the organism according to Swift [38].

www.sciencedirect.com

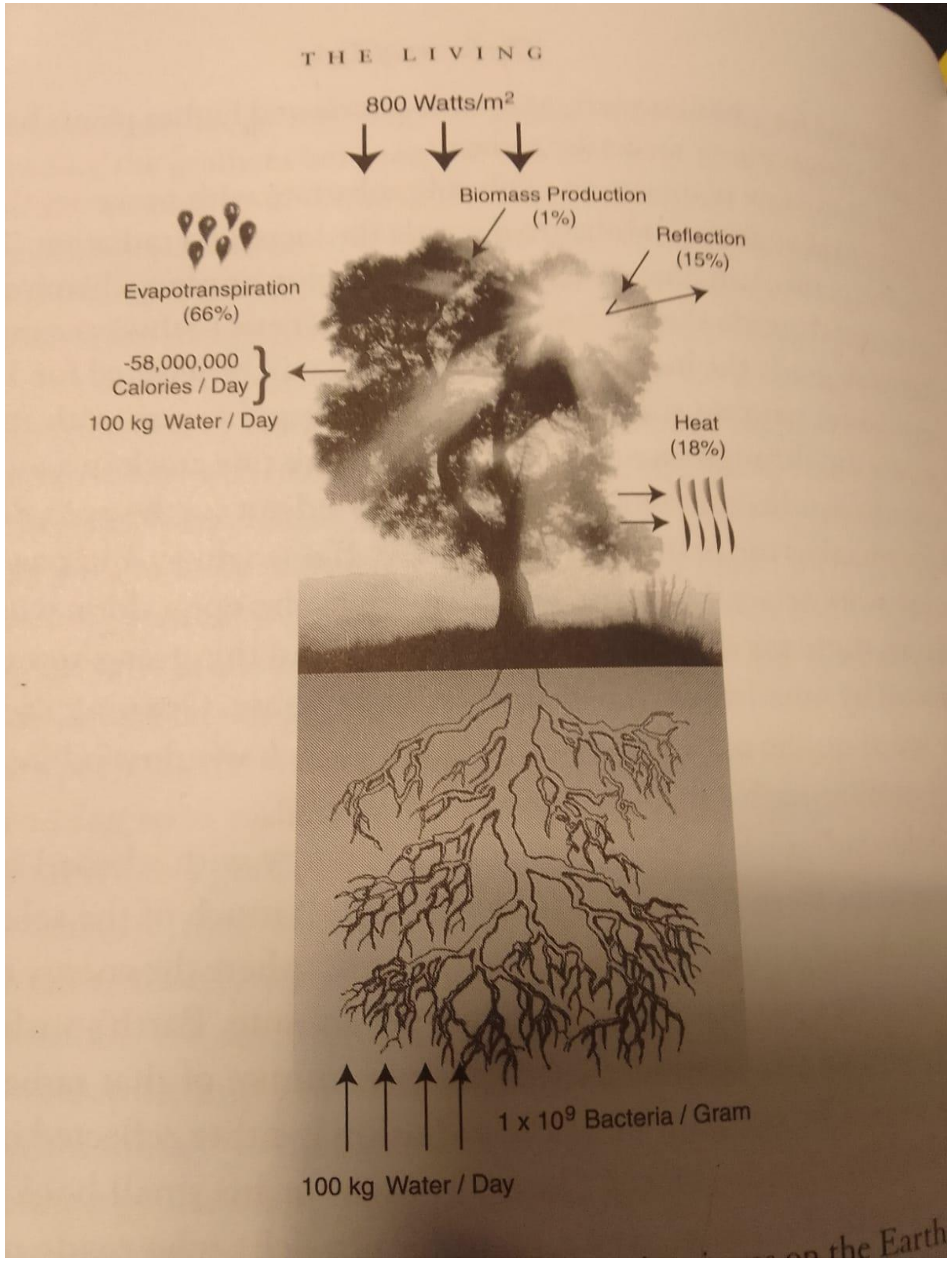


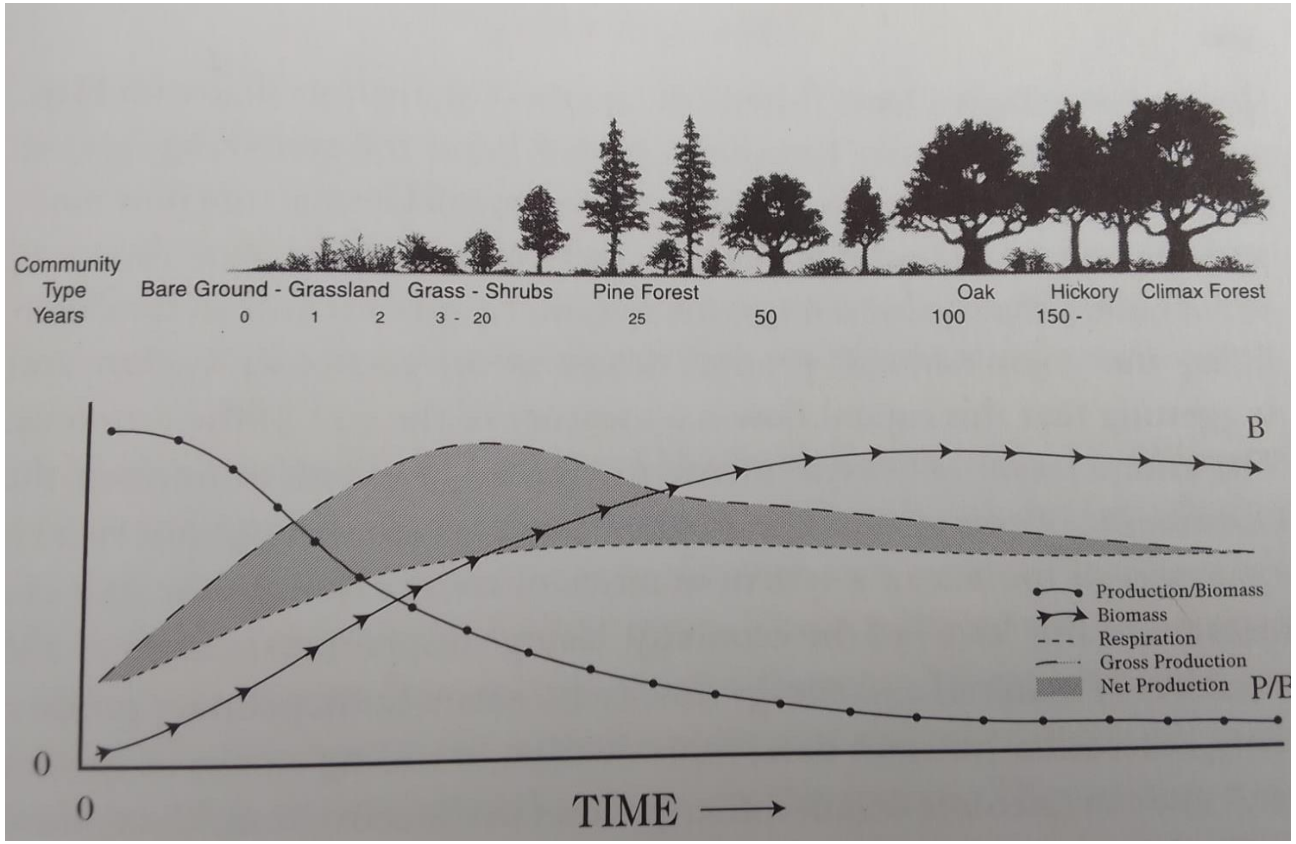
$$NPP = GPP - R_{plant}$$

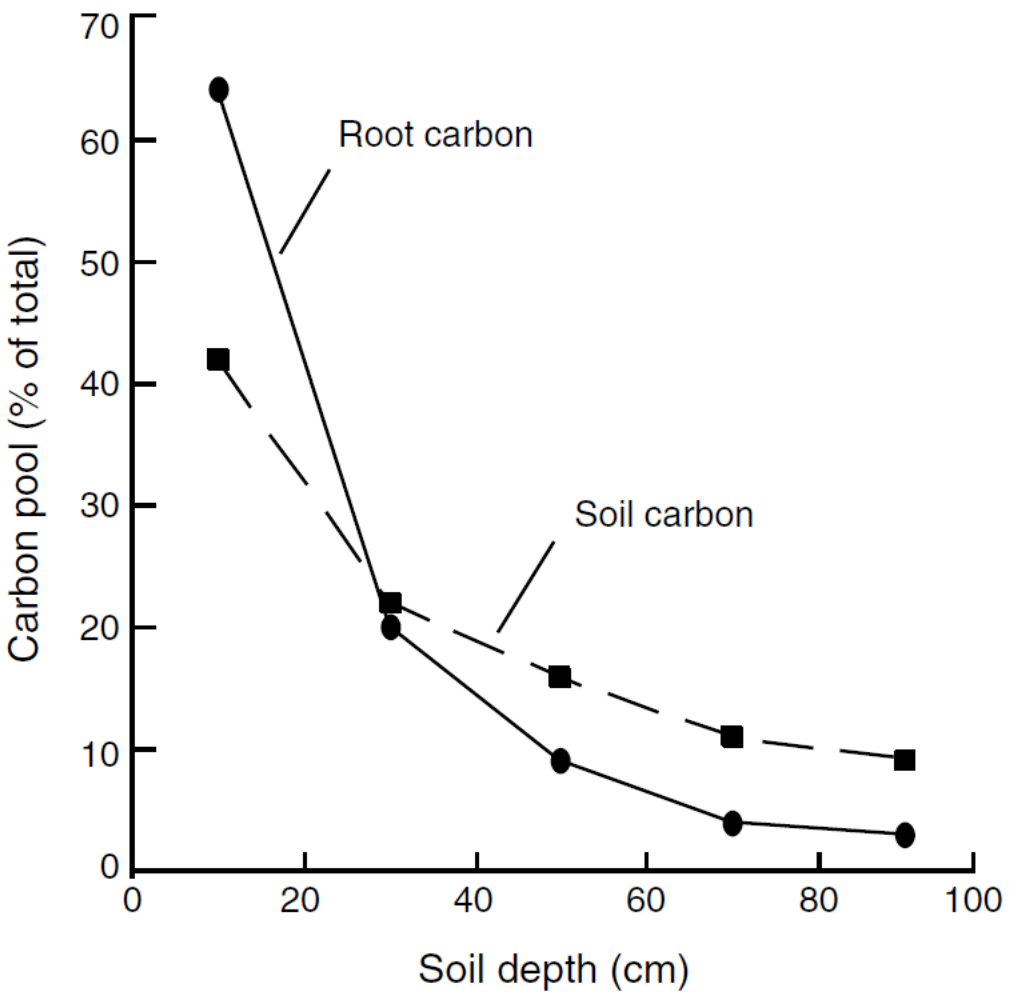
$$NEP = GPP - (R_{plant} + R_{het})$$

Lilley et al. 2006, Tree.

Energía, agua y crecimient







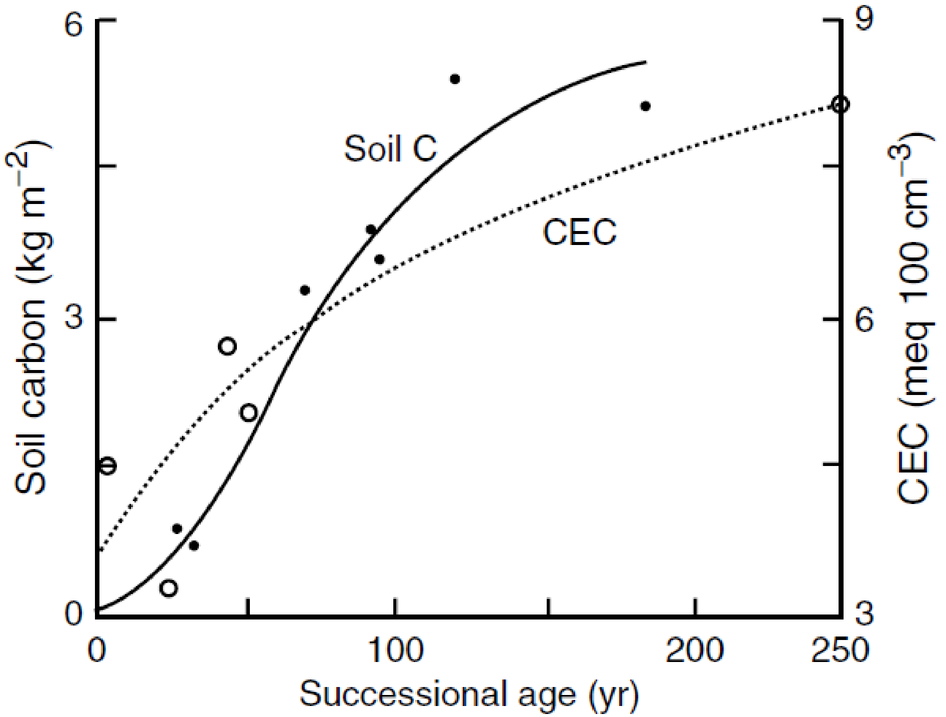
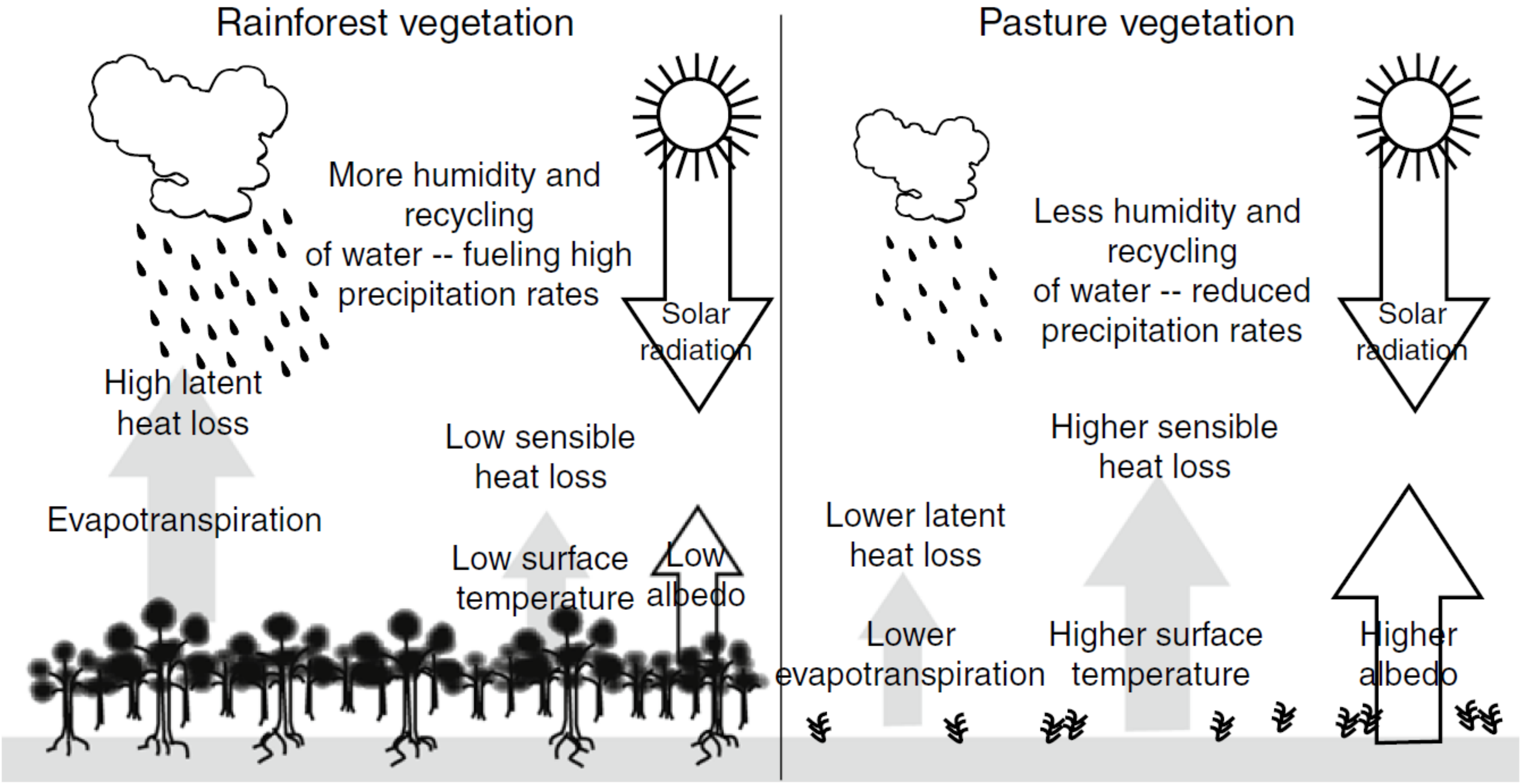
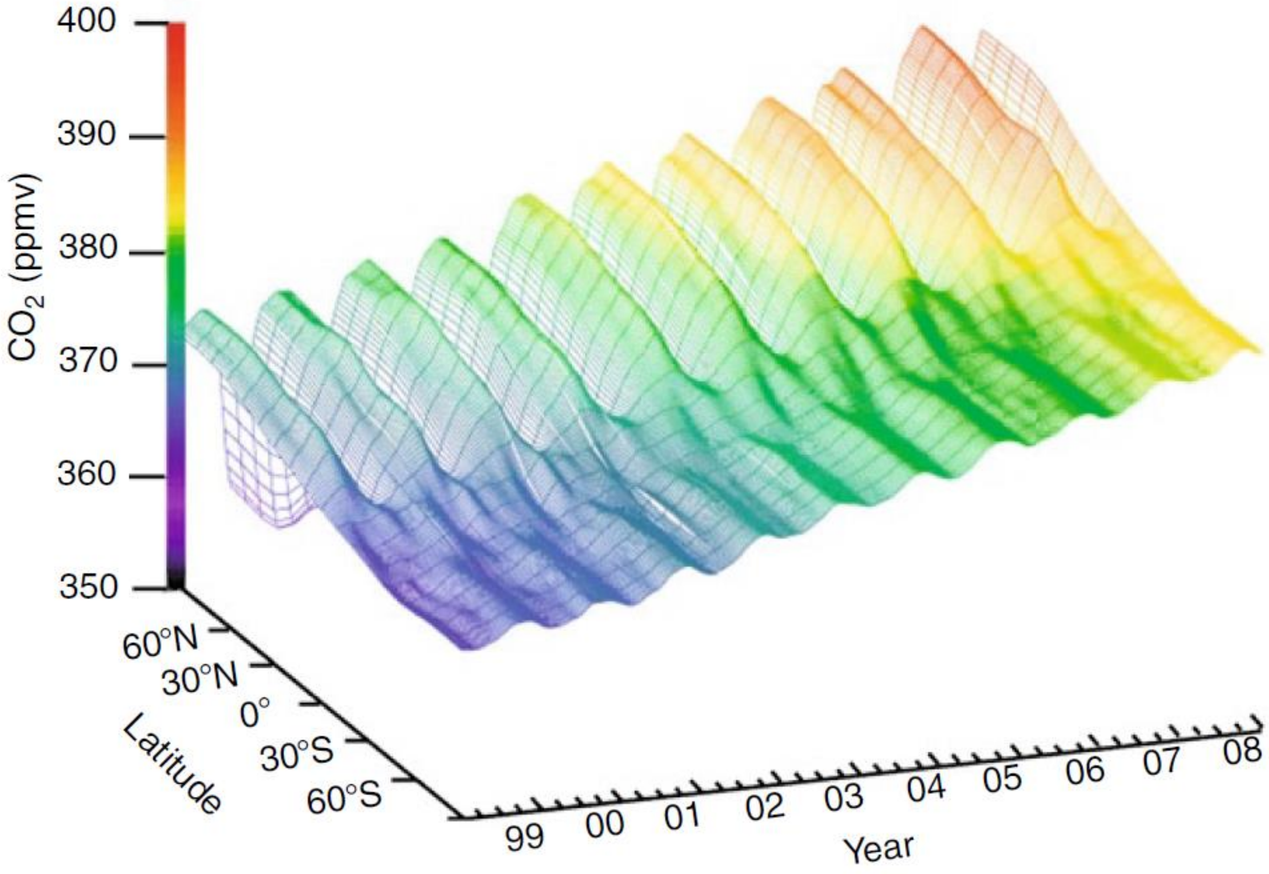


Fig. 12.15 Accumulation during succession of soil organic carbon (Crocker and Major 1955) and associated change in cation exchange capacity (CEC) of mineral soil (Ugolini 1968) after deglaciation at Glacier Bay Alaska. Measurements were mad[illegible] to [illegible] depth of 4[illegible] in mineral soil. The accumulation of soil carbon contributes to the increased


Rainforest vegetation
Pasture vegetation
More humidity and recycling of water -- fueling high precipitation rates
Solar radiation
High latent heat loss
Low sensible heat loss
Evapotranspiration
Low surface temperature
Low albedo
Less humidity and recycling of water -- reduced precipitation rates
Solar radiation
Higher sensible heat loss
Lower latent heat loss
Lower evapotranspiration
Higher surface temperature
Higher albedo

Función ecosistémica y ciclos: Metabolismo y carbono atmosférico



Eficiencia en ecosistemas: exergía

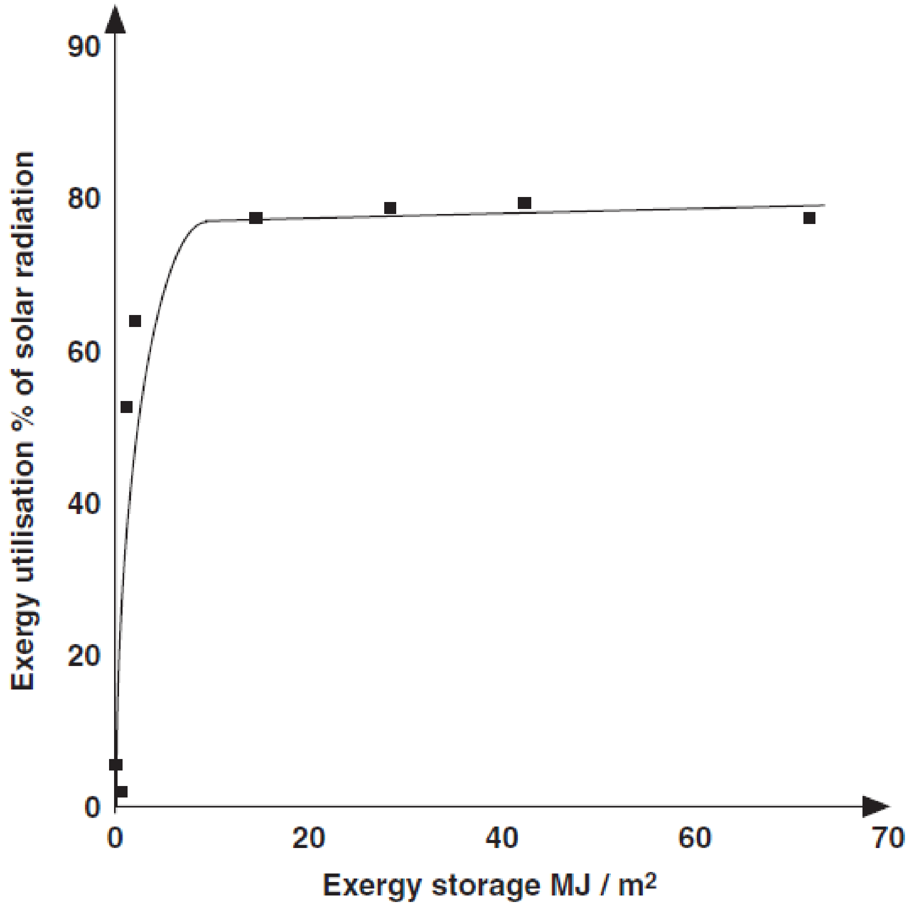
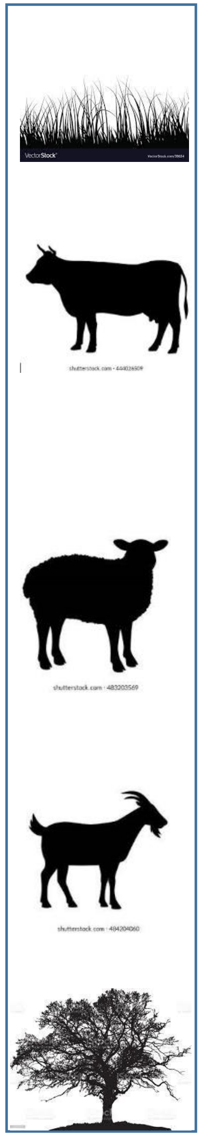


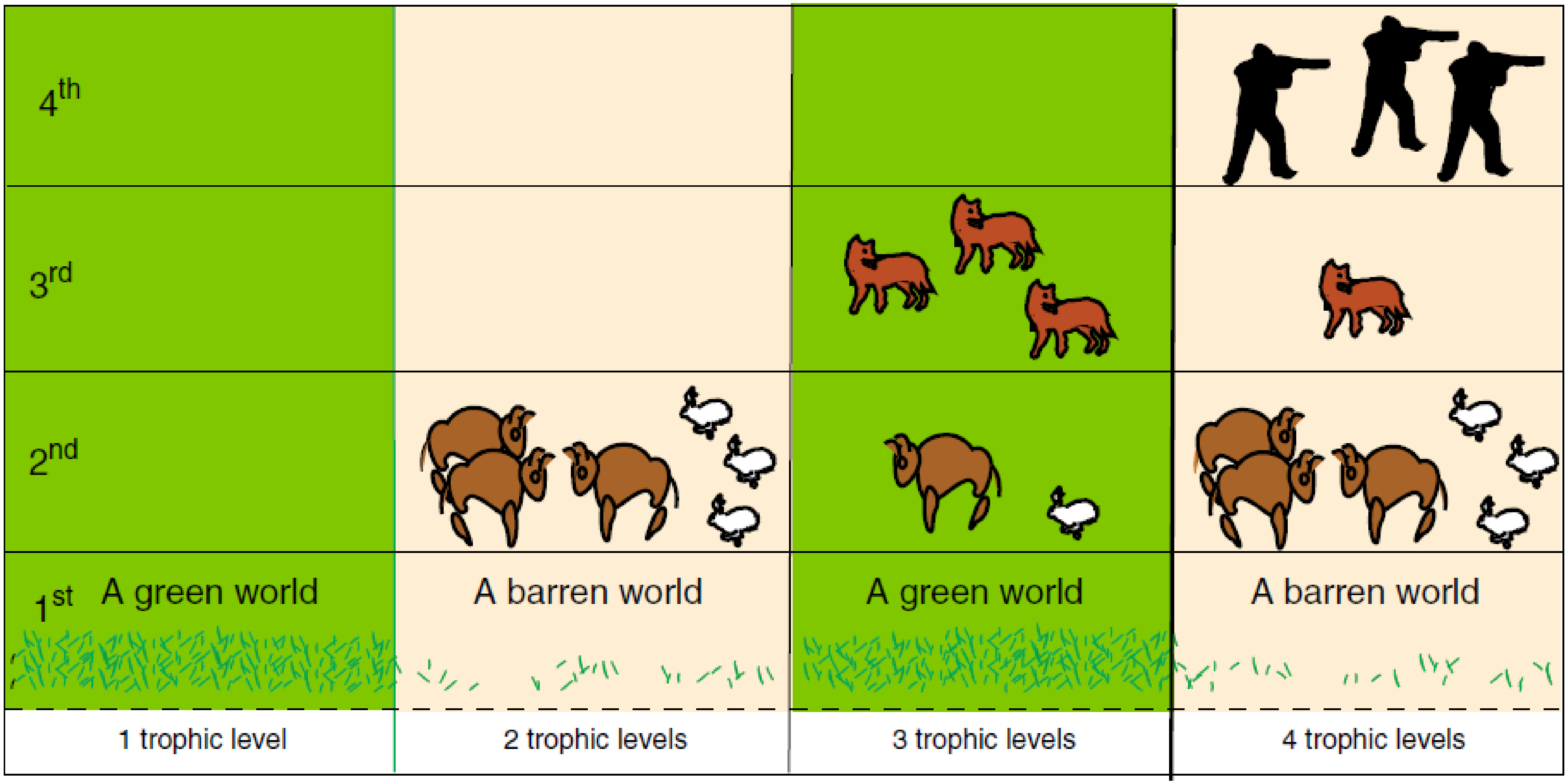
Table 6.5 Exergy utilization and storage in a comparative set of ecosystems

Ecosystem	Exergy utilization (percent)	Exergy storage (MJ/m^2)
Quarry	6	0
Desert	2	0.073
Clear-cut forest	49	0.594
Grassland	59	0.940
Fir plantation	70	12.70
Natural forest	71	26.00
Old-growth deciduous forest	72	38.00
Tropical rain forest	70	64.00

Controles sobre productividad

- "Desde abajo": Agua, suelo
- "Desde arriba": Consumidores, Fuego

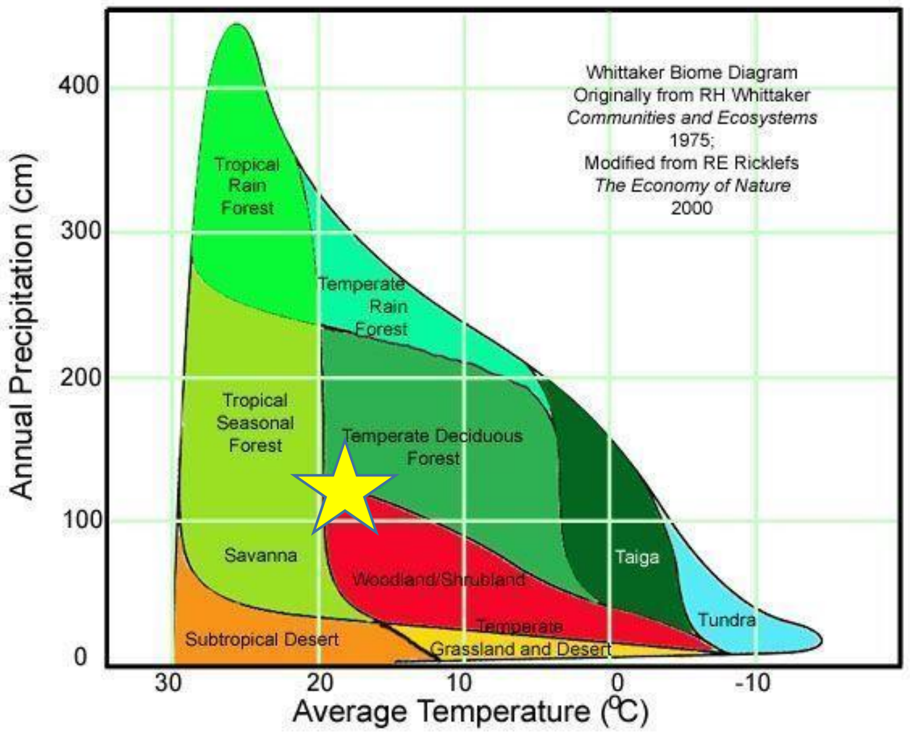




4th
3rd
2nd
1st
A green world
A barren world
A green world
A barren world
1 trophic level
2 trophic levels
3 trophic levels
4 trophic levels

Perturbaciones y estados alternativos

- Volviendo a Uruguay:



Algunos ecosistemas se apartan de la determinación climática.

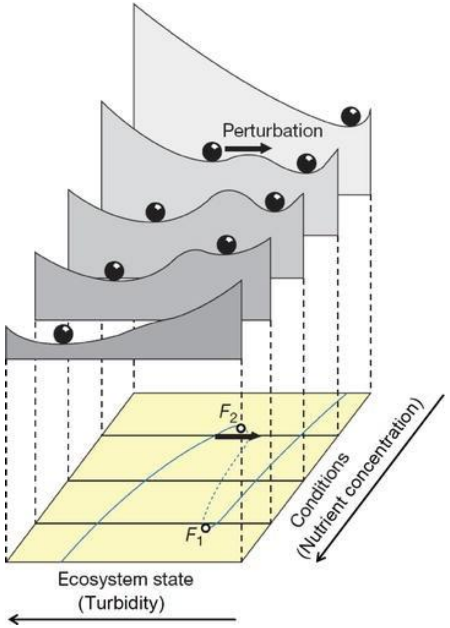
En éstos operan controles de arriba abajo sobre la vegetación:

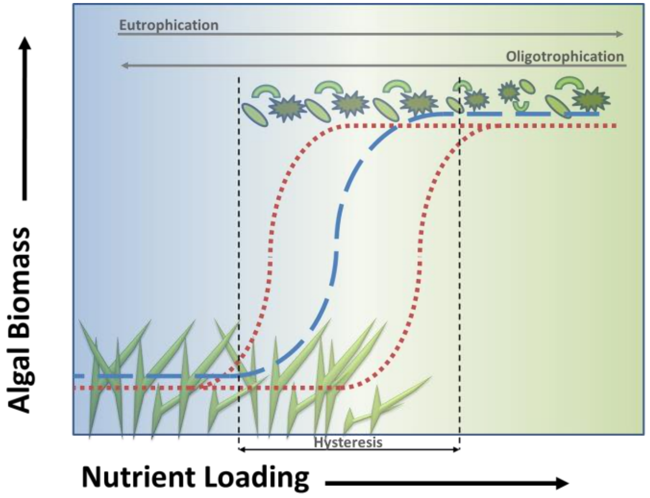
Perturbaciones que remueven vegetación:

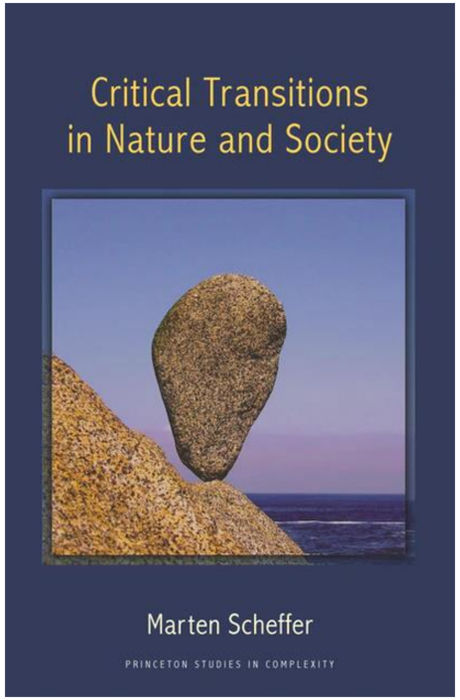
Fuego

Herbivoría

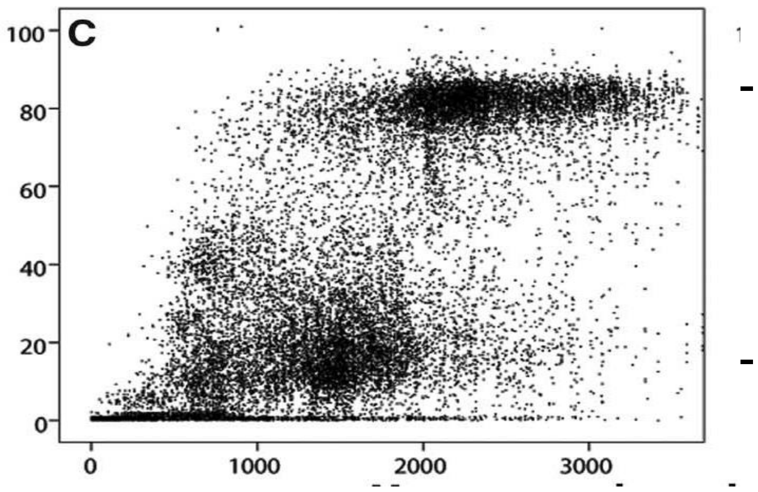
Se generan feedbacks o ciclos de retroalimentación
Pueden persistir durante cientos o miles de años, configurando
Estados Alternativos de Ecosistemas


Perturbation
F2
F1
Conditions
(Nutrient concentration)
Ecosystem state
(Turbidity)


Eutrophication
Oligotrophication
Algal Biomass
Hysteresis
Nutrient Loading

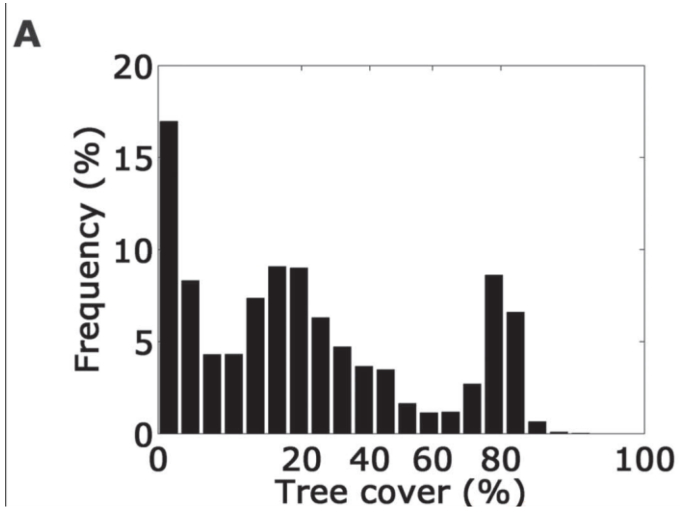

Critical Transitions
in Nature and Society
Marten Scheffer
PRINCETON STUDIES IN COMPLEXITY

S.A.

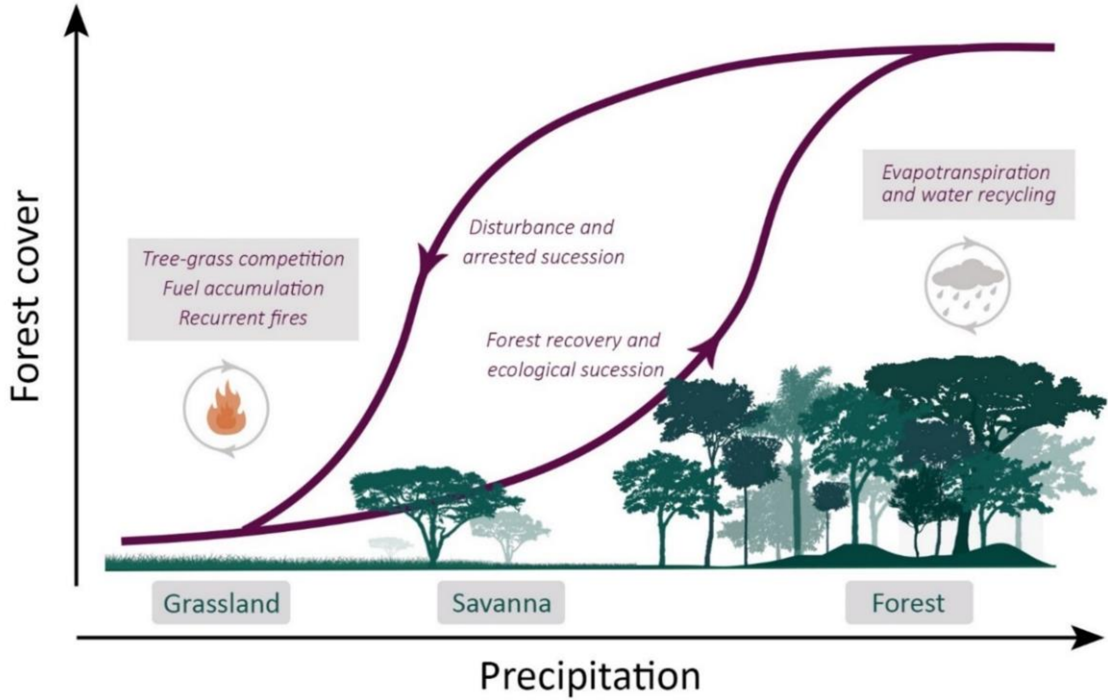


- Pastizales, (sabanas) y bosques estados estables (Hirota et al. 2011, Staver et al 2011)

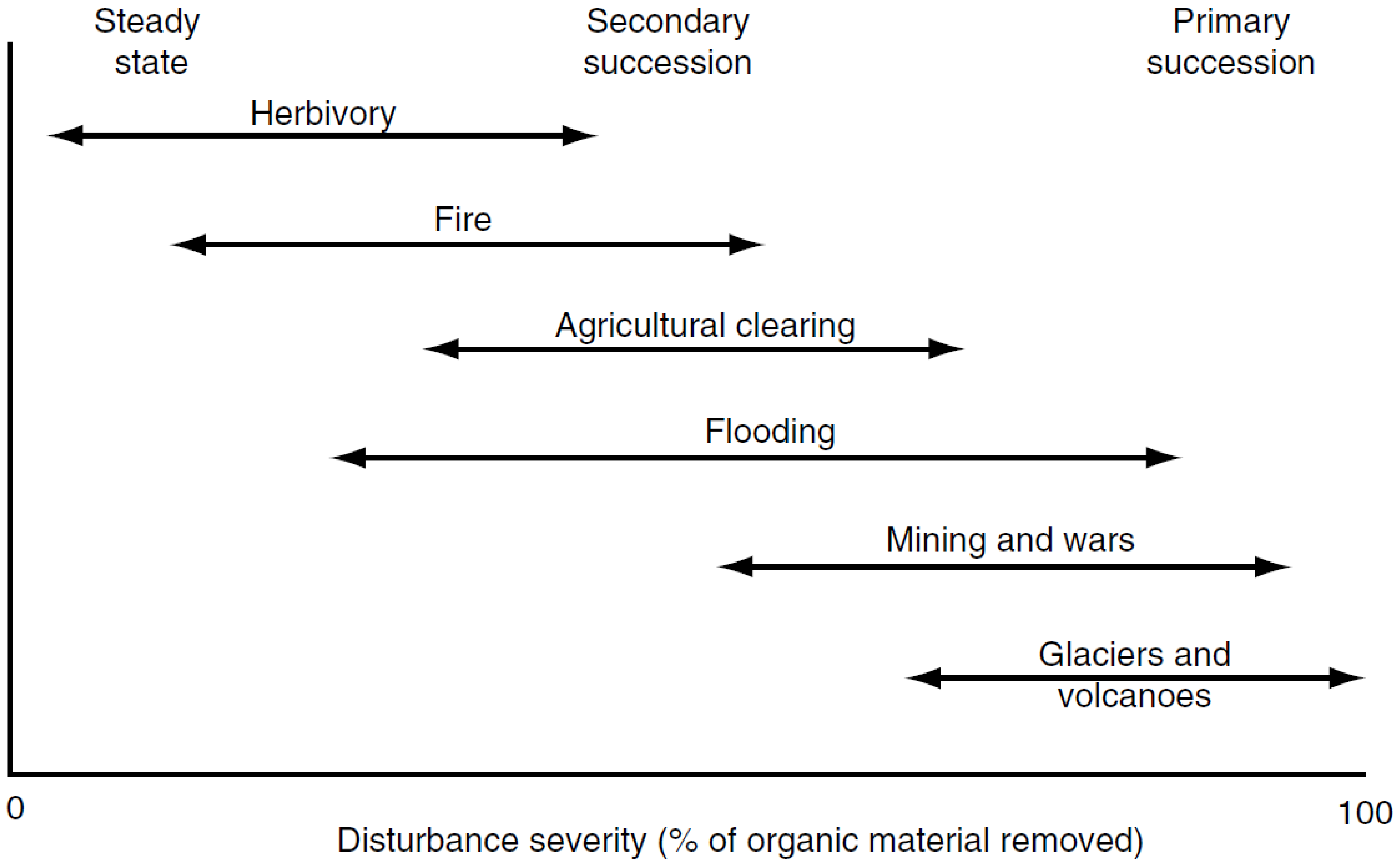
- Sugieren transiciones críticas entre estados: fuego, herbivoría

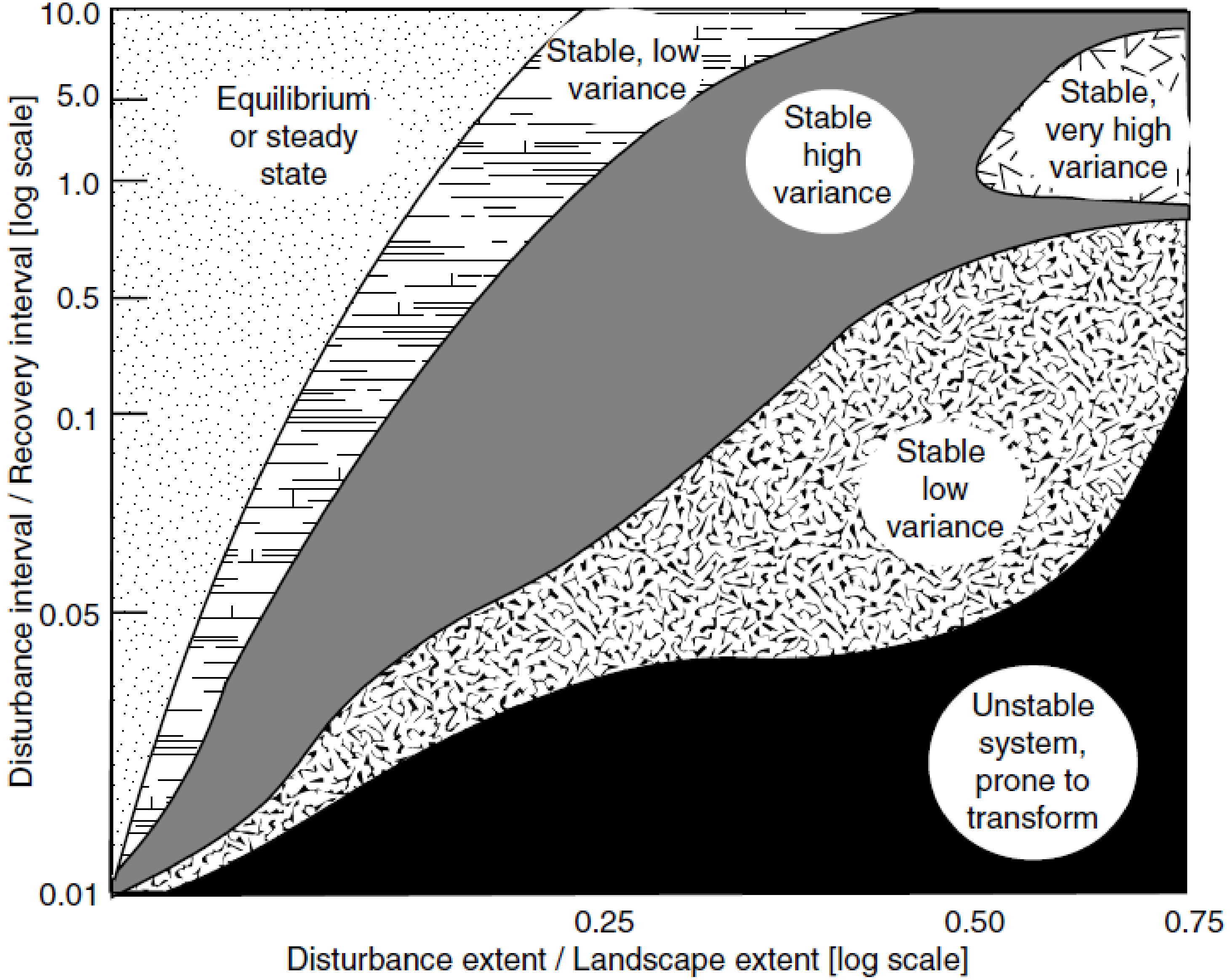


Estados alternativos de cobertura arbórea en función de la precipitación (mm/yr).

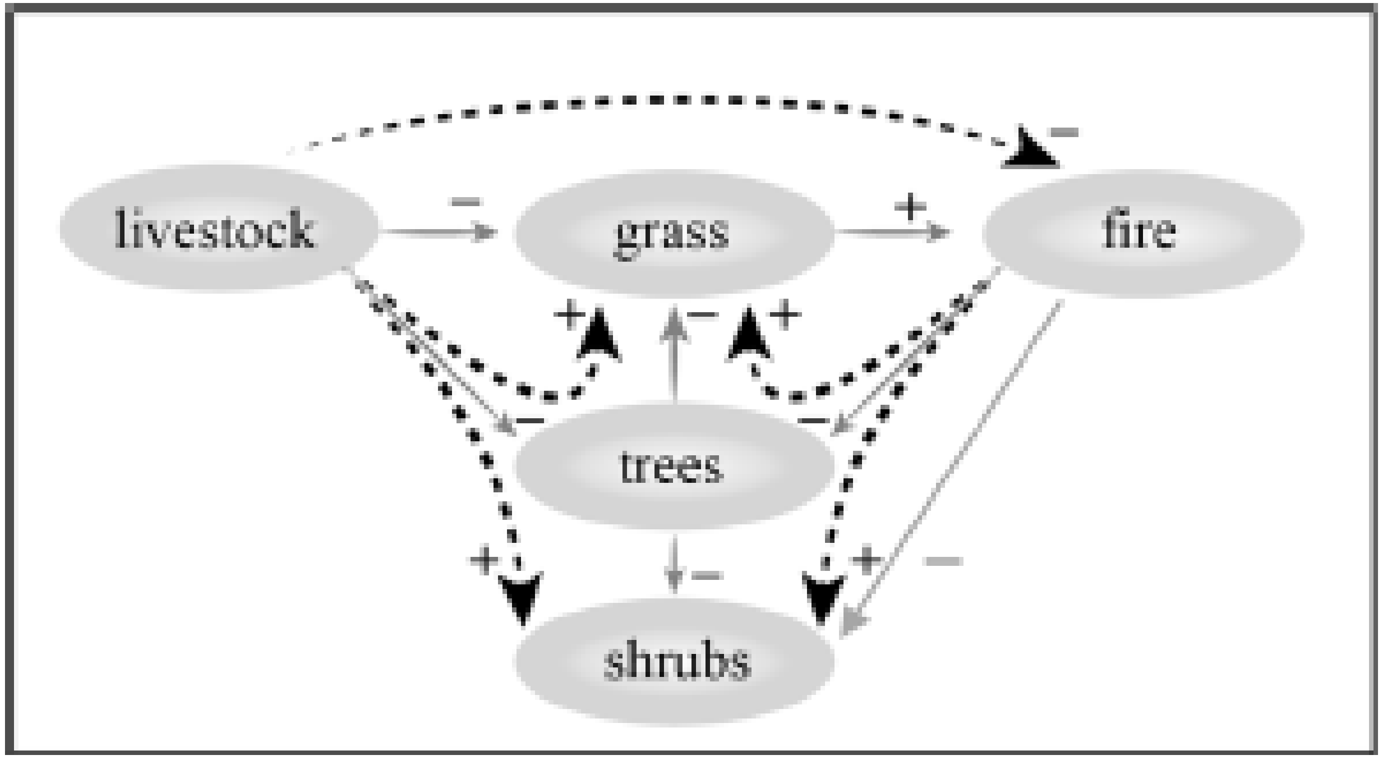


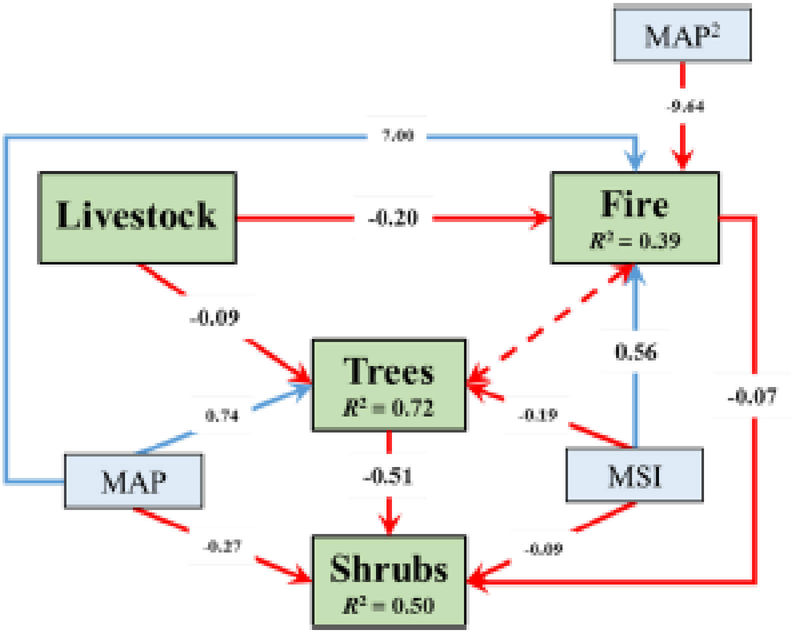
Hirota et al. 2011. Global Resilience of Tropical Forest and Savanna to Critical Transitions. Science.334.6053
Staver et **al. 2011 The global extent and determinants of savanna and forest as alternative biome states Science. 334.6053**
https://cmi.princeton.edu/annual-meetings/annual-reports/year-2021/future-fires-compromise-amazon-forest-resilience-to-climate-change/


Steady state
Secondary succession
Primary succession
Herbivory
Fire
Agricultural clearing
Flooding
Mining and wars
Glaciers and volcanoes
0
100
Disturbance severity (% of organic material removed)

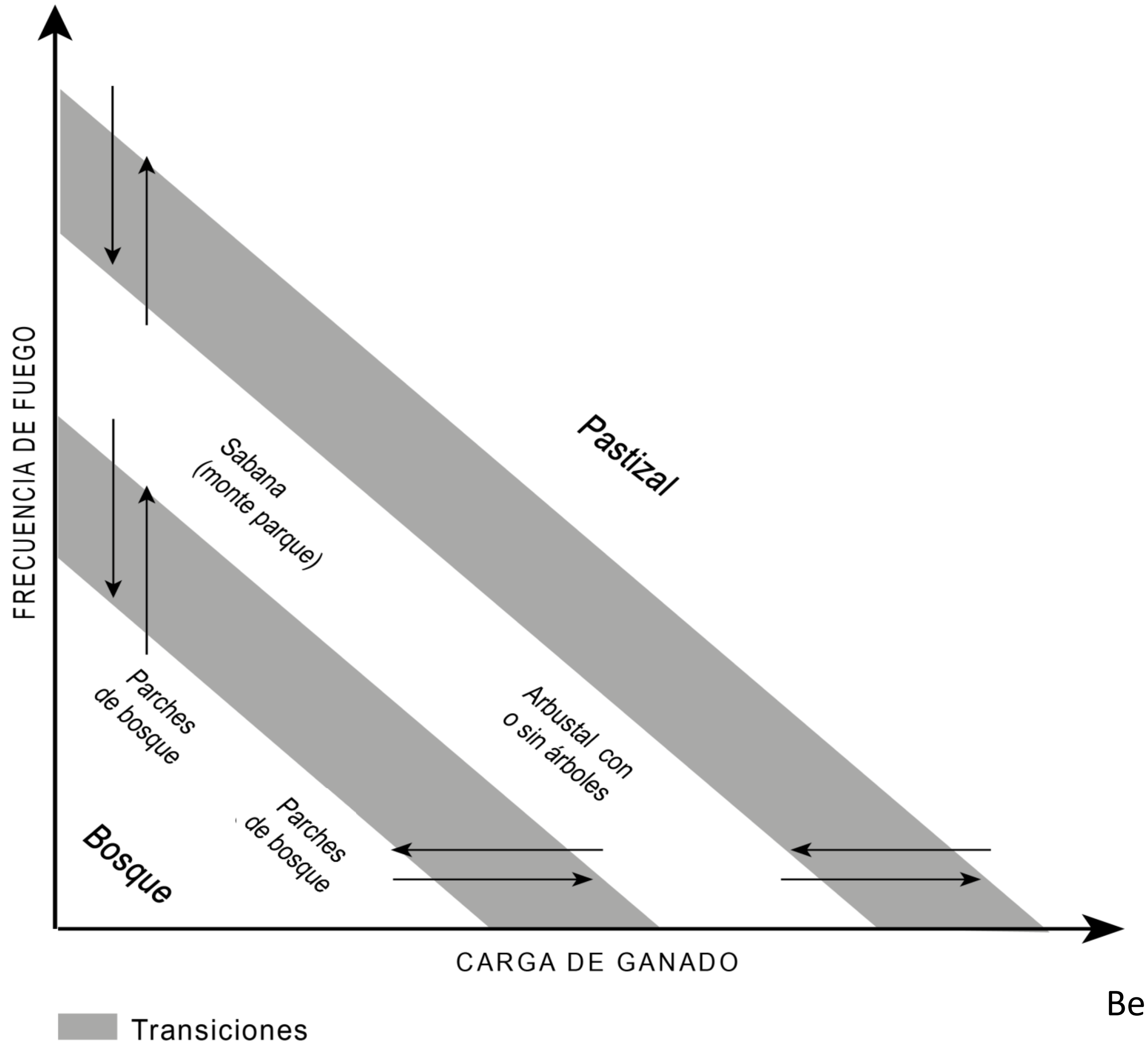


10.0
5.0
1.0
0.5
0.1
0.05
0.01
Disturbance interval / Recovery interval [log scale]
Equilibrium or steady state
Stable, low variance
Stable high variance
Stable, very high variance
Stable low variance
Unstable system, prone to transform
0.25
0.50
0.75
Disturbance extent / Landscape extent [log scale]



Bernardi, R.E. et al. 2019, Ecosystems



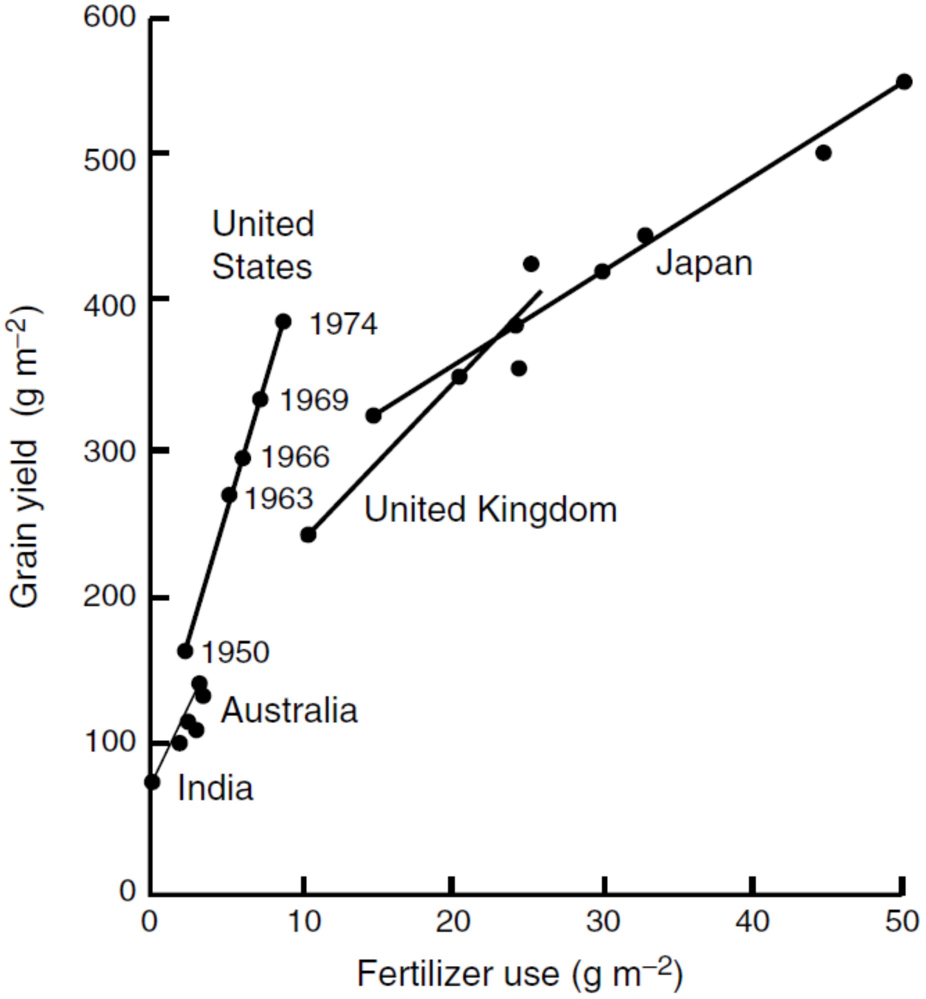
Bernardi et al., sometido

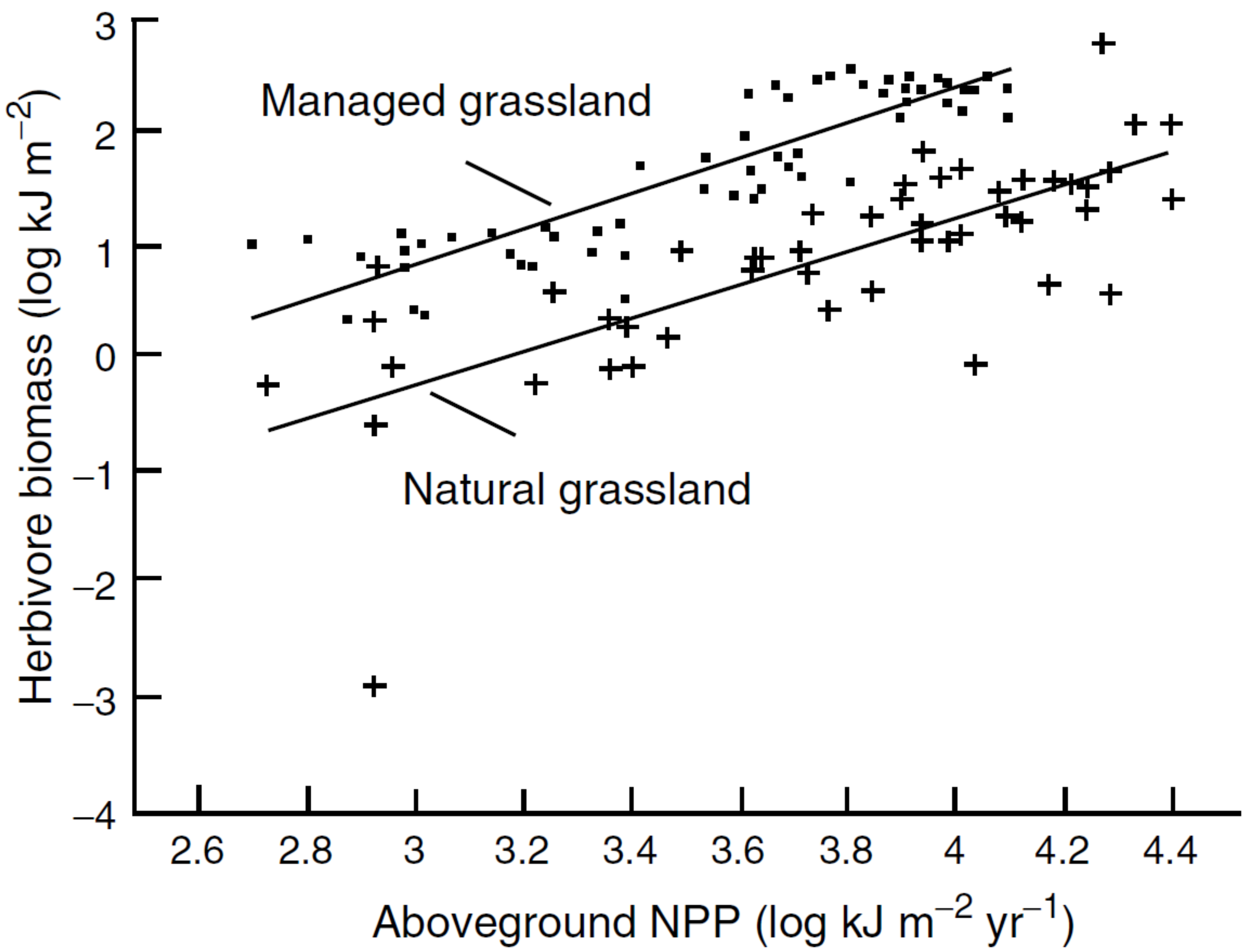
Condiciones locales

(Holmgren *et al.*, 2006, Carlucci et al. 2011, Brazeiro et al. 2018)

Revolución Verde

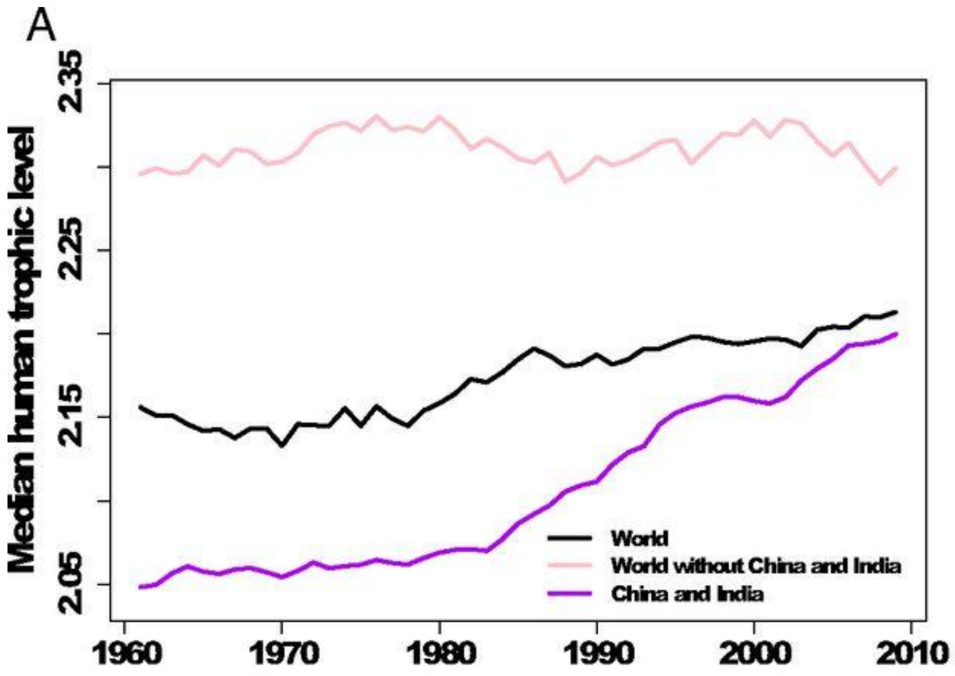
Fig. 8.1 Response of grain yield of cereal crops to fertilizer addition. These studies were conducted during the green revolution. Yield is most responsive to nutrient addition at low nutrient addition rates; it often saturates with further nitrogen additions. Redrawn from Evans (1980)

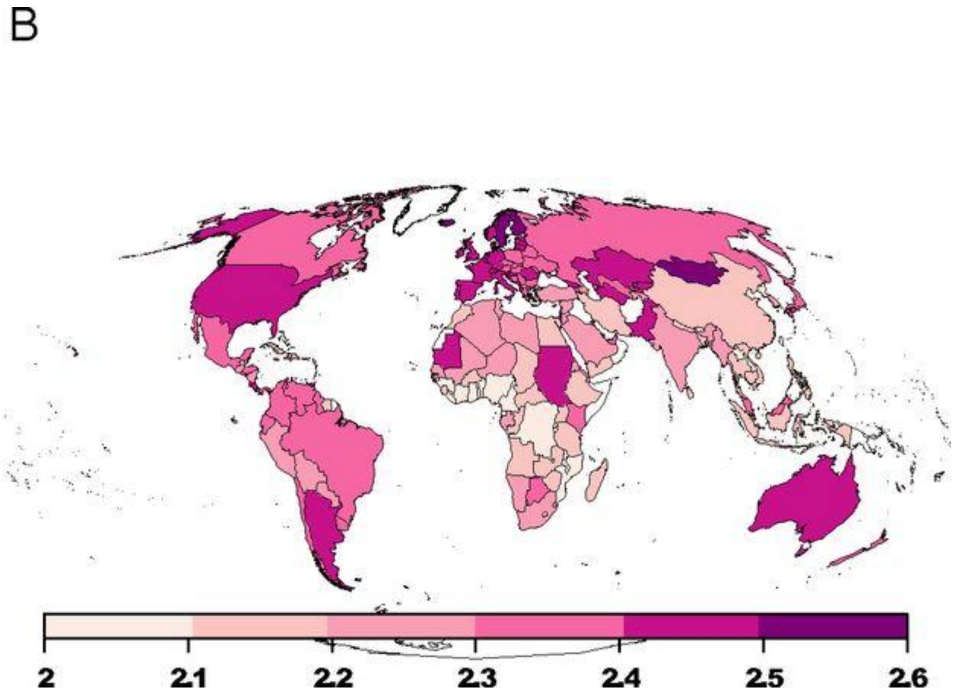




Managed grassland
Natural grassland
Herbivore biomass (log kJ m^{-2})
3
2
1
0
−1
−2
−3
−4
2.6
2.8
3
3.2
3.4
3.6
3.8
4
4.2
4.4
Aboveground NPP (log kJ m^{-2} yr^{-1})

Nivel trófico humano





Bonhommeau et al. 2013

Agroecosistemas