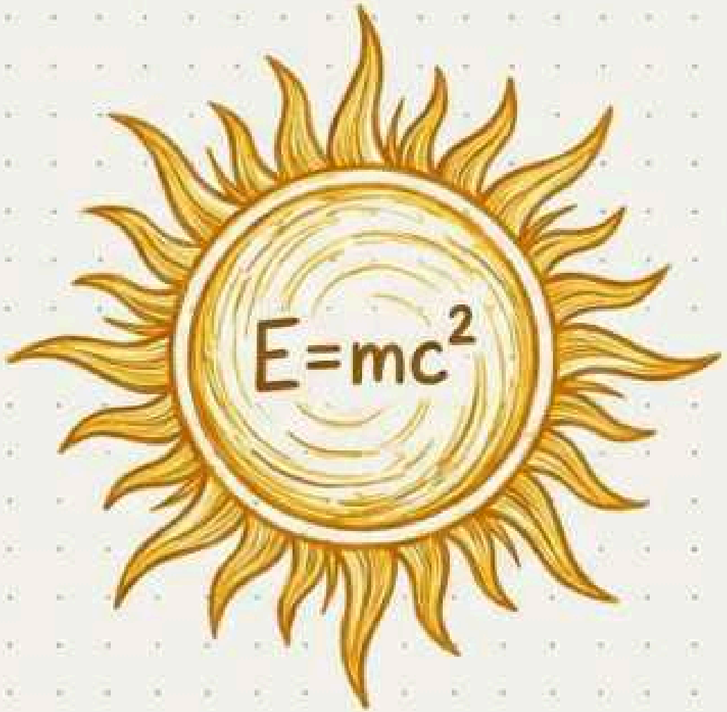
The Architecture of an Ecosystem

¶ 5.1



How does energy flow through living systems?



How are essential elements recycled?



How are ecosystems distributed?

Defining the Engine of Ecology

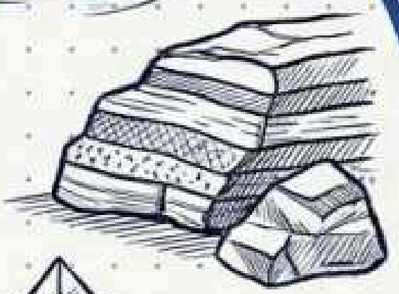
¶ 5.2

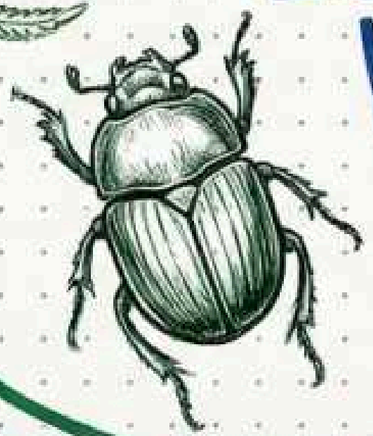
Biotic

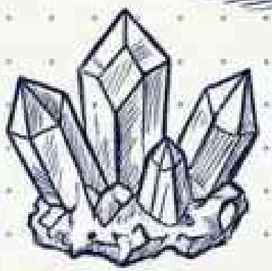
Abiotic











ECOSYSTEM

Arthur Tansley, 1935

Energy Flows

Matter Cycles

Sunlight is the Primary Driver

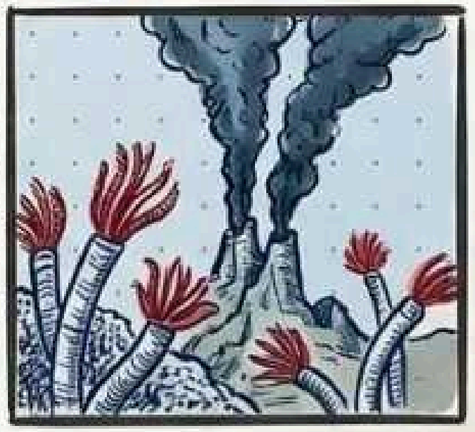
¶ 5.3

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

Producer

Consumer

Decomposer

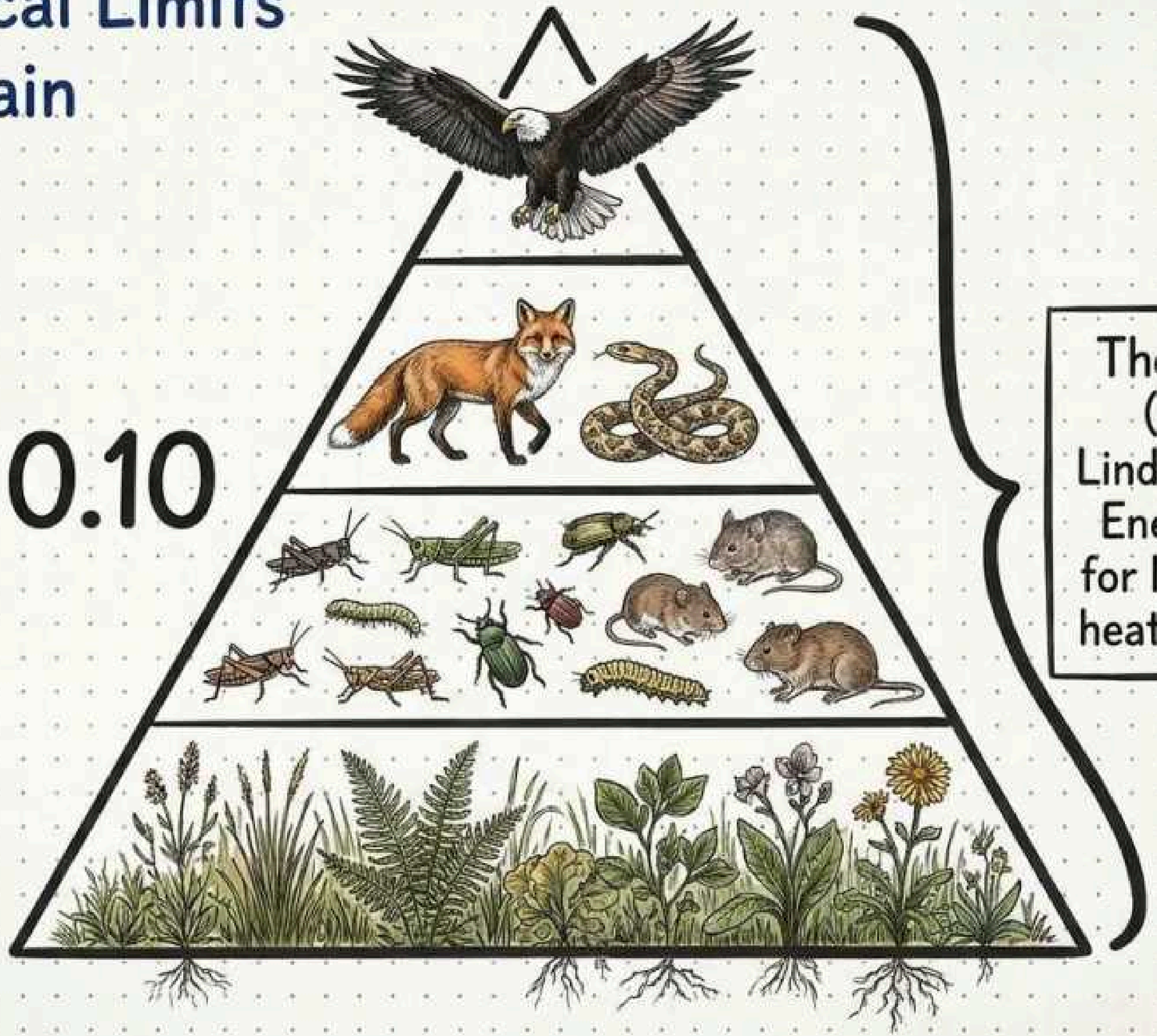


Alternative: Chemosynthesis

The Mathematical Limits of the Food Chain

¶ 5.4

$$E_n = E_{n-1} \times 0.10$$



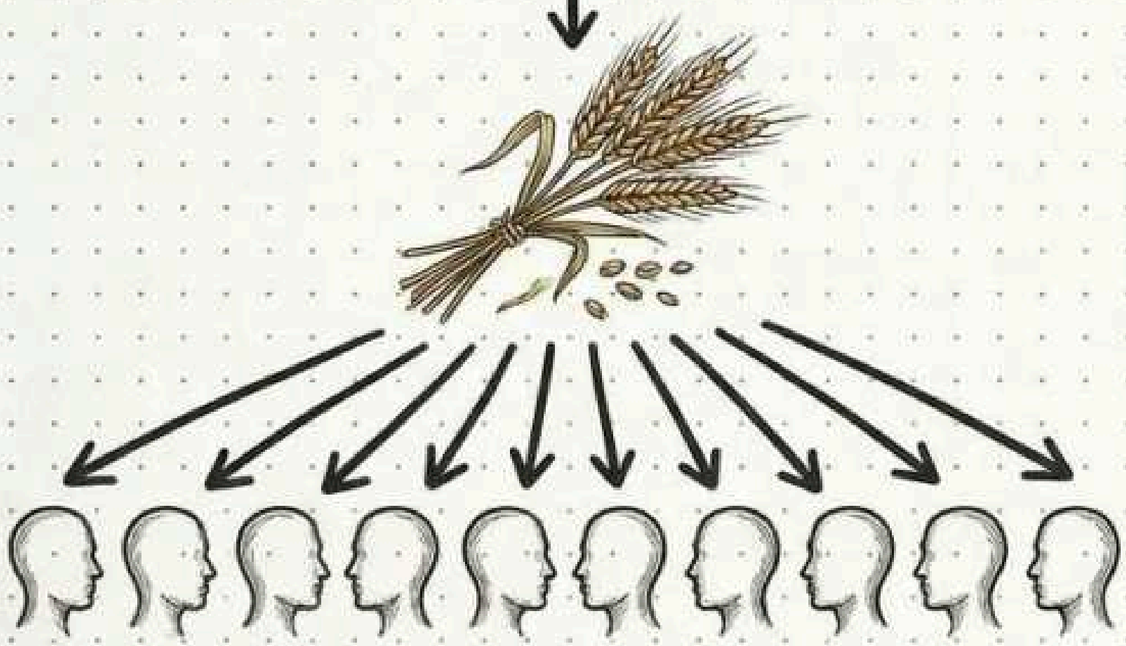
The 10% Rule (Raymond Lindeman, 1942). Energy is used for living, lost as heat, or uneaten.

The Human Consequences of the 10% Rule

¶ 5.5

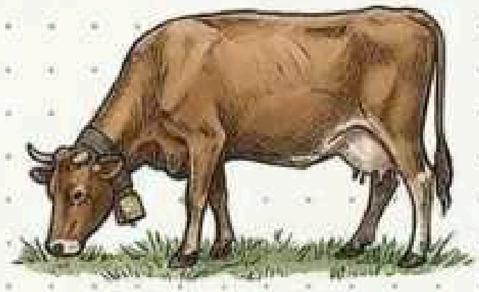
Direct

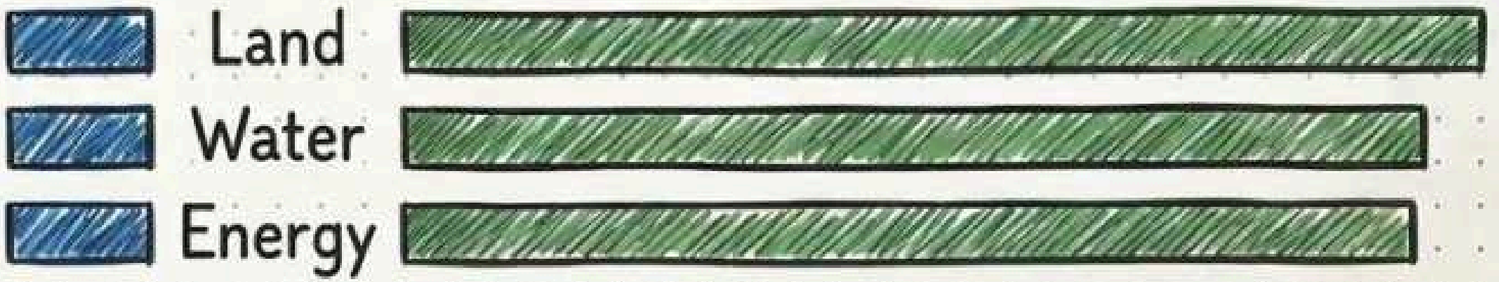
10,000 kcals



Indirect

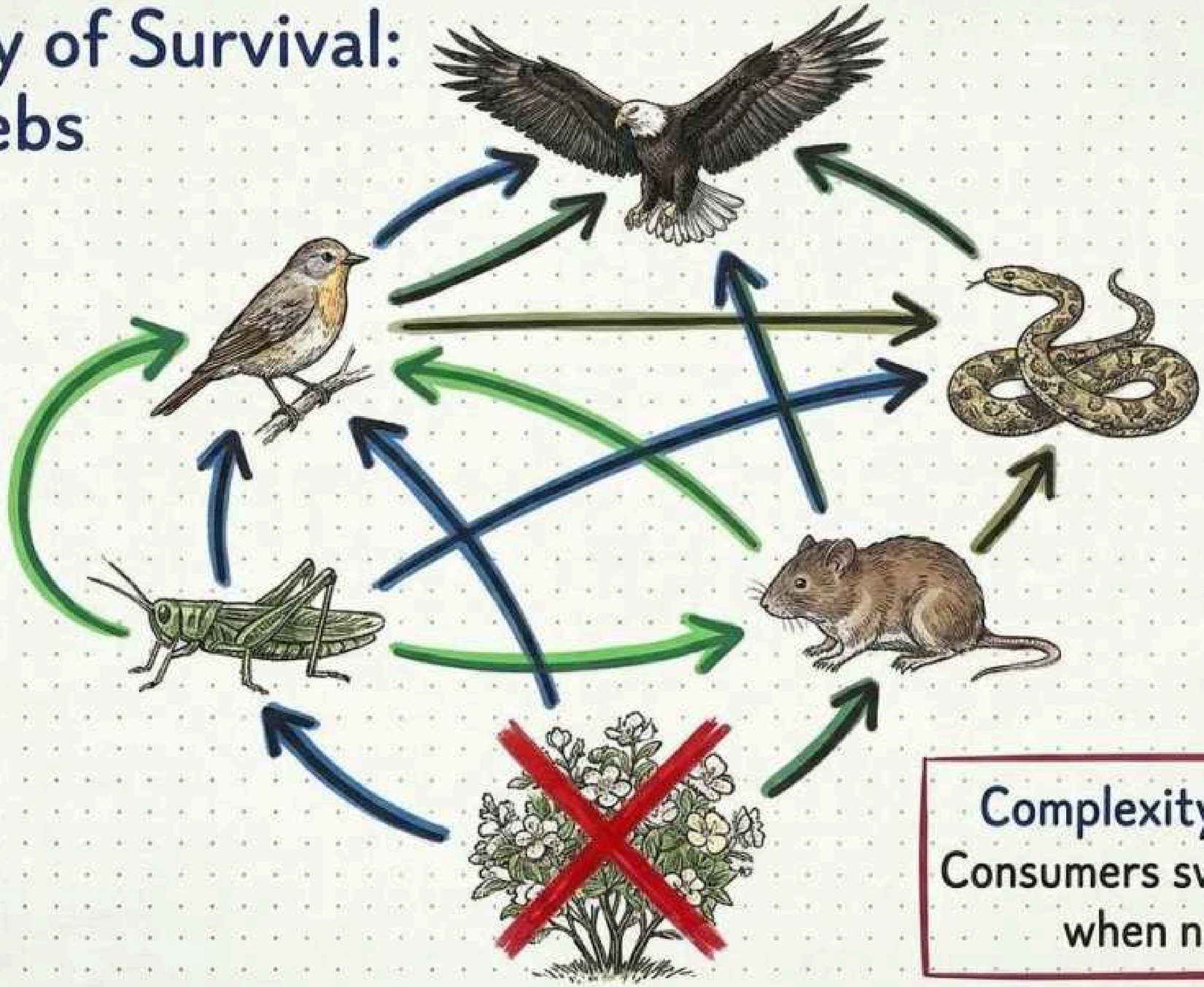
10,000 kcals





Topology of Survival: Food Webs

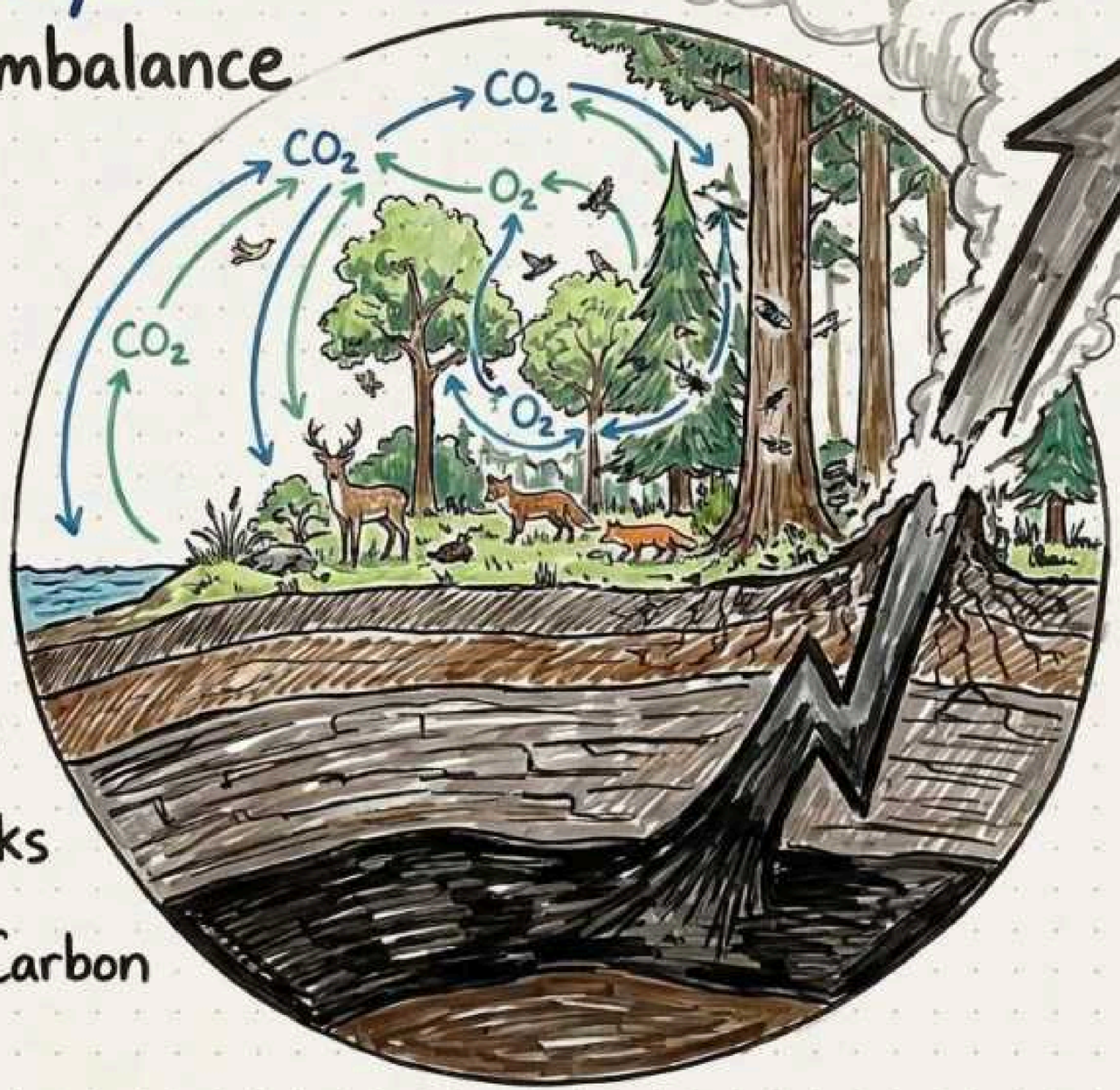
¶ 5.6



Complexity = Stability.
Consumers switch pathways when nodes fail.

The Carbon Cycle and Industrial Imbalance

¶5.7



Oceans

Soils

Rocks

Ancient Carbon

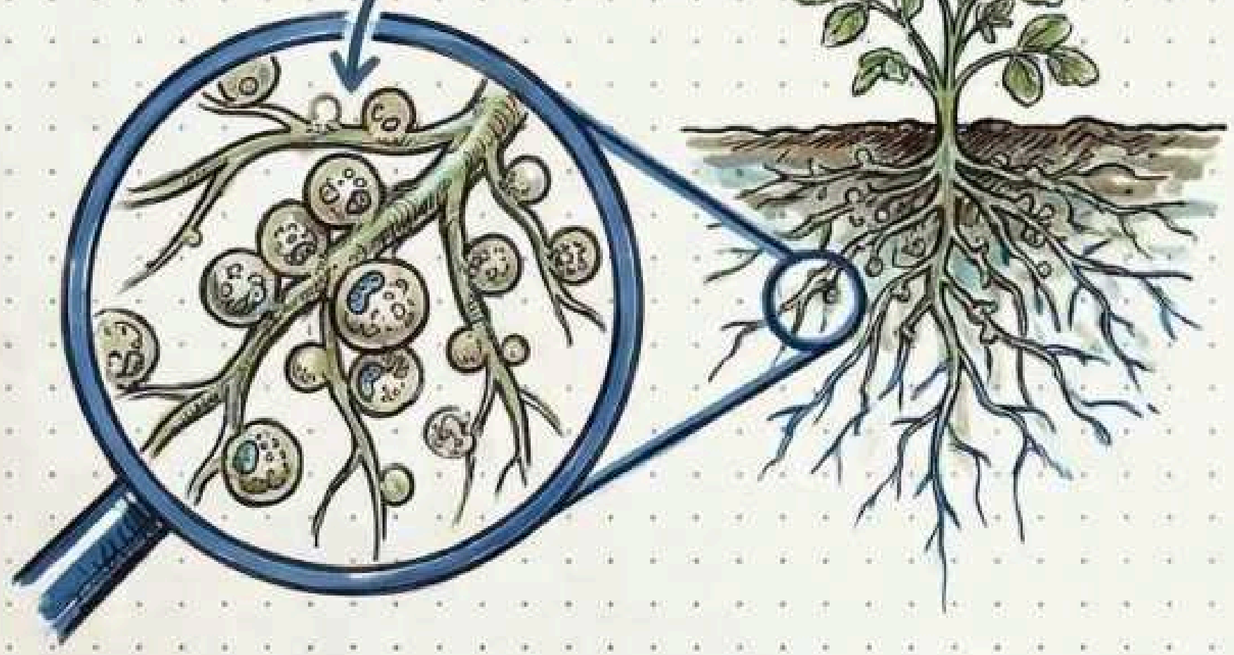
Rate of extraction
≫ Rate of natural removal.

Fixing Nitrogen:
Biology vs. Chemistry

¶ 5.8

78%
Atmospheric N_2
(Unusable)

Nitrogen
Fixation





$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

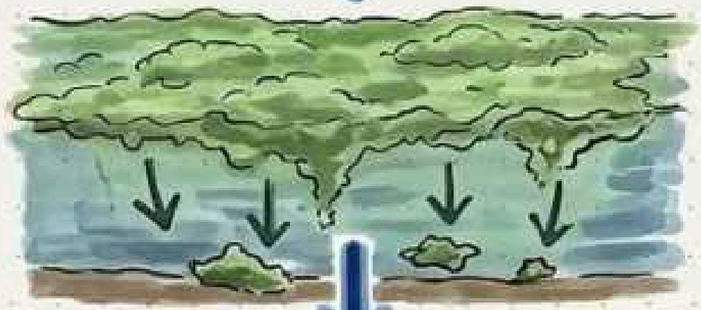
Feeds billions of people.

The Cascade of a Dead Zone

¶ 5.9



Excess N & P

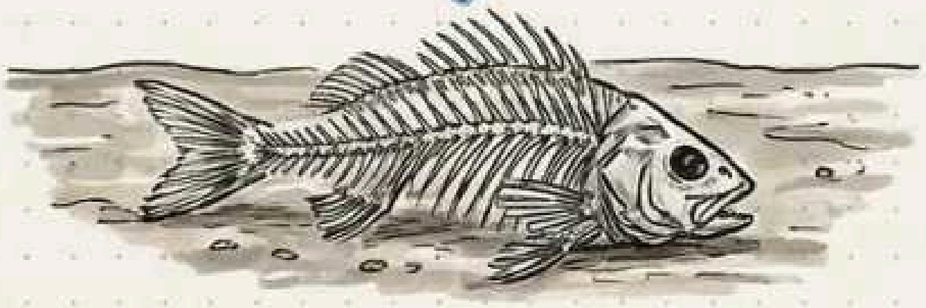


Algal bloom

Algae die & decompose



Oxygen Depletion ($O_2 = 0$)

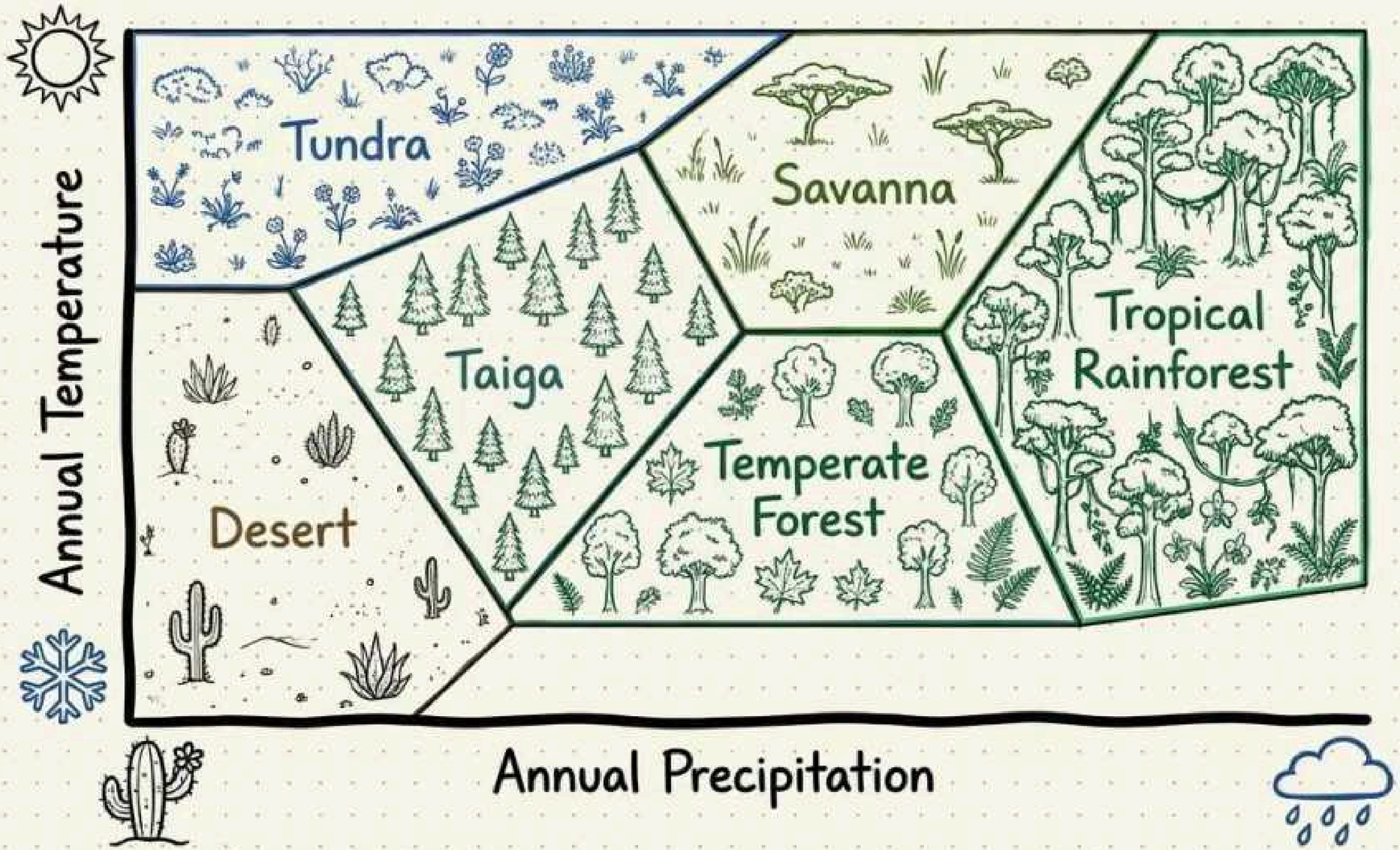


Seasonal Dead Zone near the Mississippi



Mapping Biomes by Temperature and Rainfall

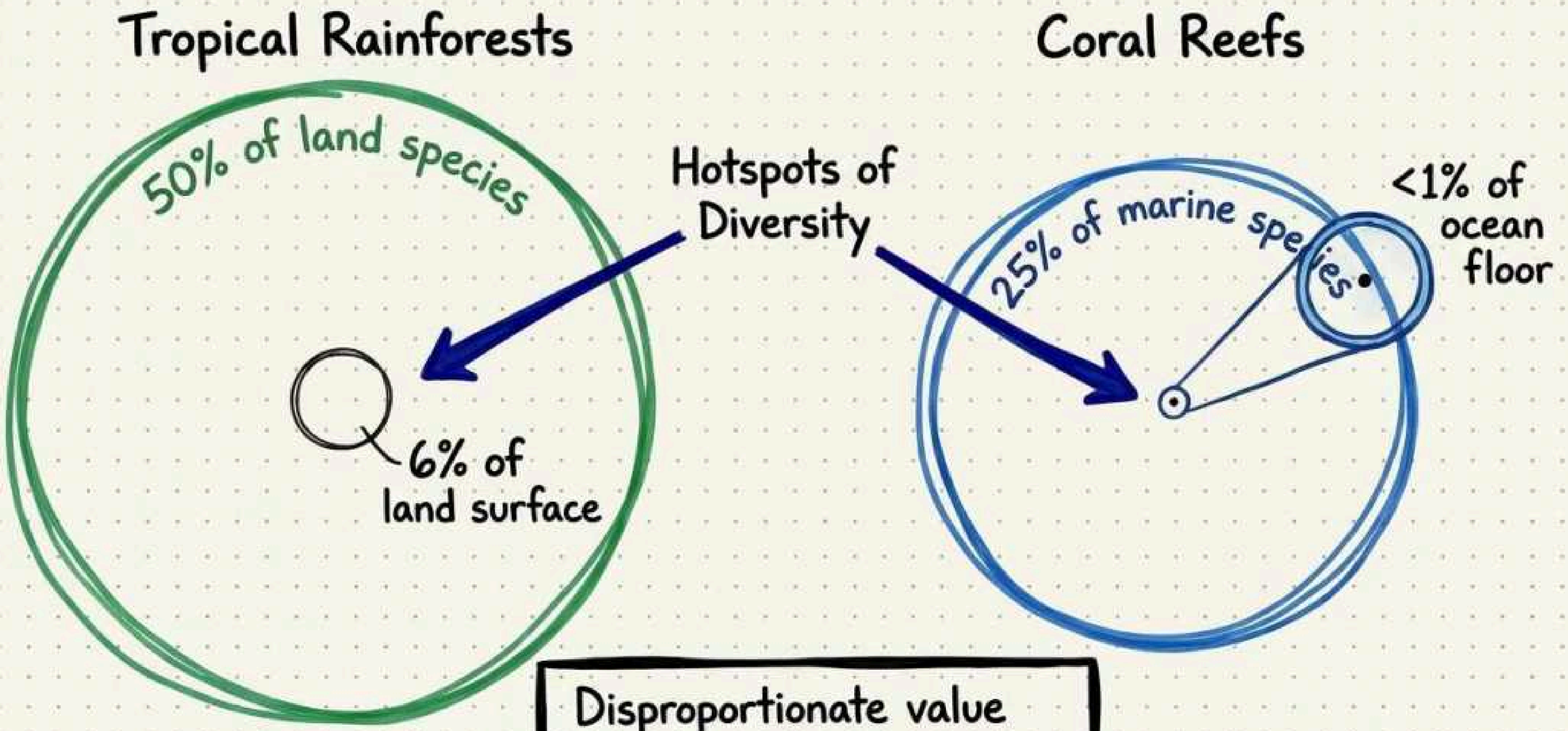
¶ 5.10



Note: Marine and freshwater systems exist outside this terrestrial matrix.

The Geometry of Biodiversity Hotspots

¶ 5.11



Disproportionate value demands priority protection.

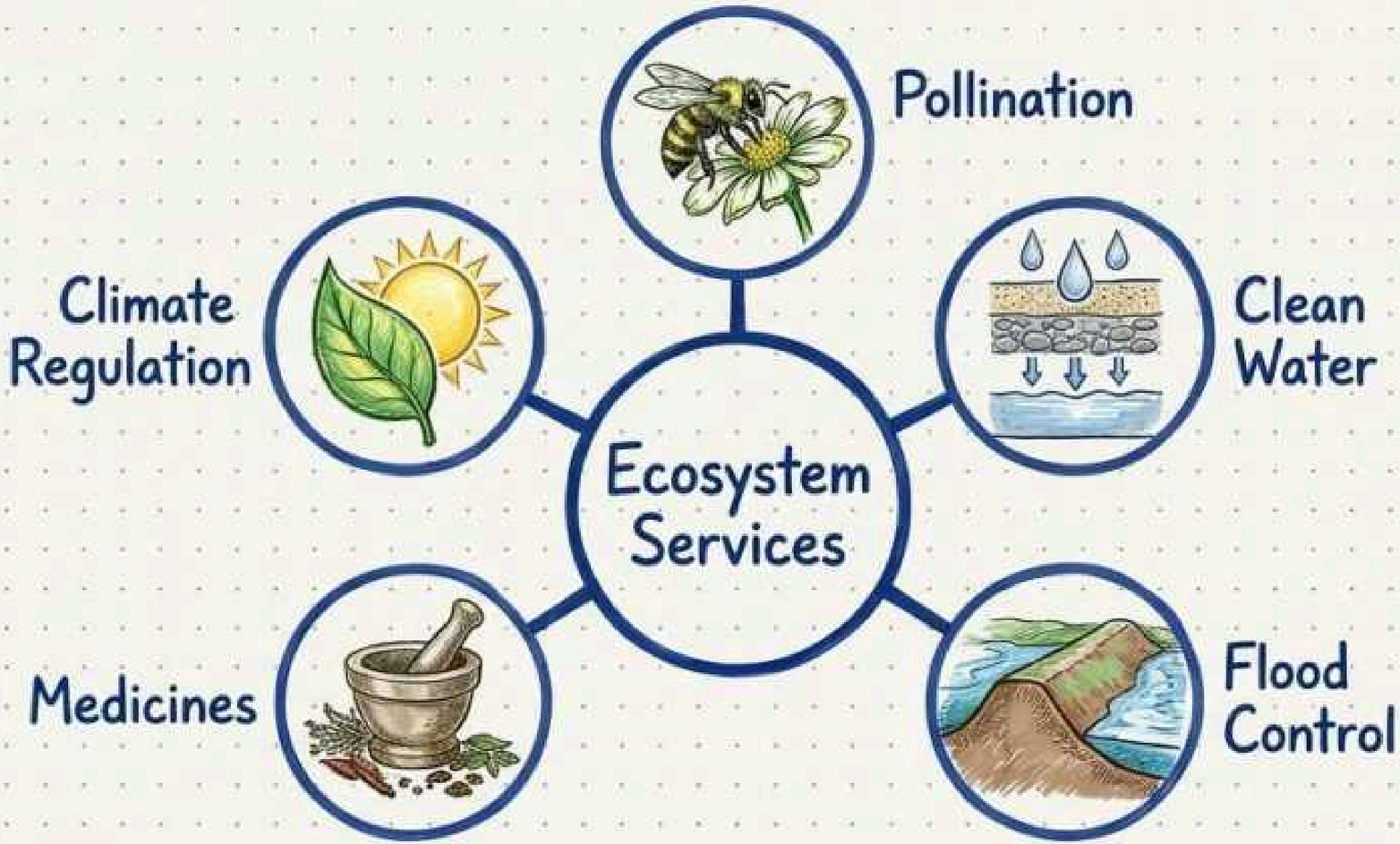
Succession: Ecosystems Change Over Time

¶ 5.12



The Economic Synthesis: Ecosystem Services

¶ 5.13

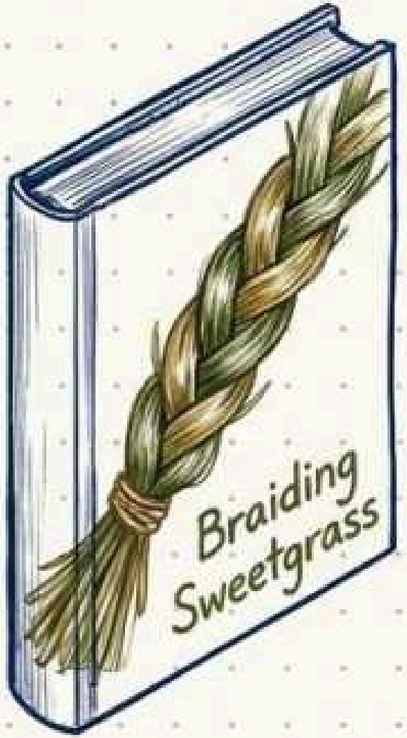


$$\sum (\text{Global Ecosystem Services Value}) > \text{Total Global GDP}$$

(Costanza, 1997)

The Master Ecologist's Library

¶ 5.14



Braiding Sweetgrass, Robin Wall Kimmerer, 2013

- Blends ecology with Indigenous knowledge.



The Diversity of Life, E.O. Wilson, 1992

- A foundational classic on biodiversity.

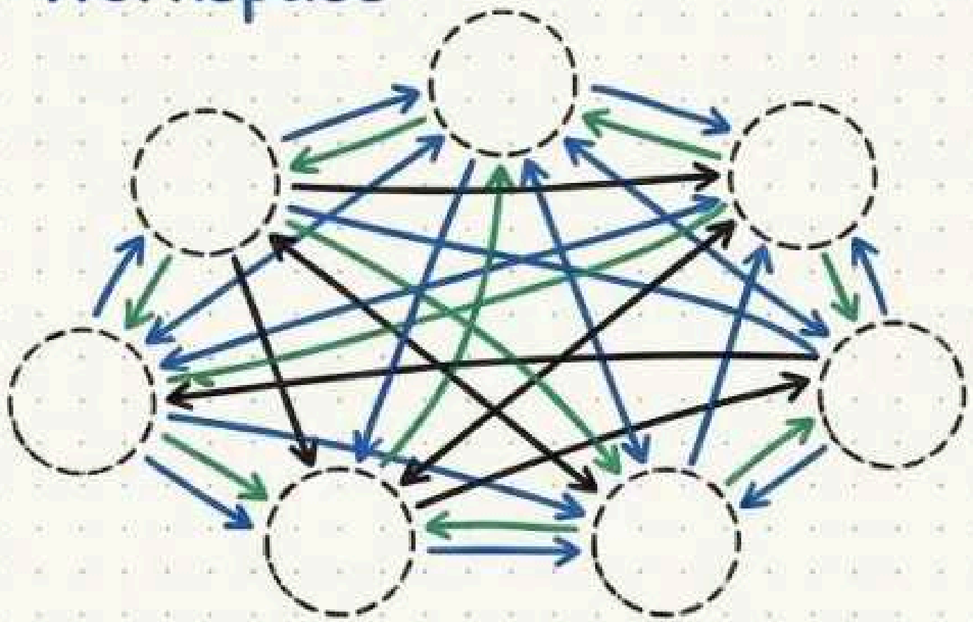


NASA Earth Observatory

- Tracks cycles from space.

Applied Ecology: Your Workspace

¶ 5.15



Producers Herbivores Carnivores Decomposers

Closing Exercise: Map a local habitat. Apply the 10% rule.

10,000 → [ ] → [ ] → [Top Predator]

Next: Humans & The Biosphere (Lecture 6)