Species Abundance and Diversity

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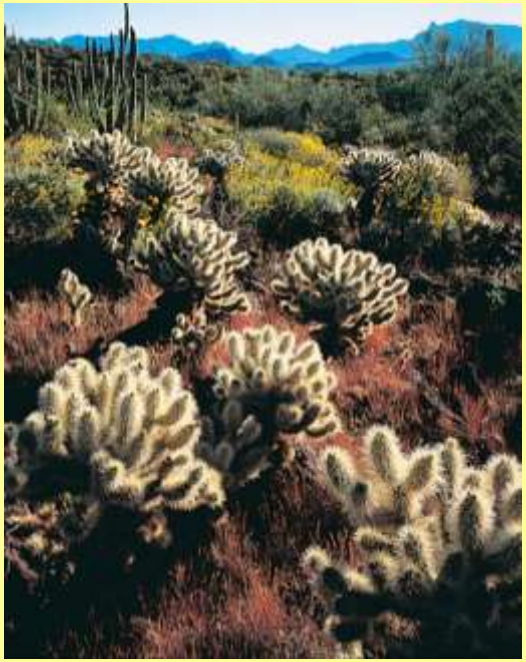
Introduction

- Community: Association of interacting species inhabiting some defined area.
  - Community Structure includes attributes such as number of species, relative species abundance, and species diversity.
- Guild: Group of organisms that all make their living in the same fashion.
  - Seed eating animals in the desert.
- Life Form: Combination of structure and growth dynamics.

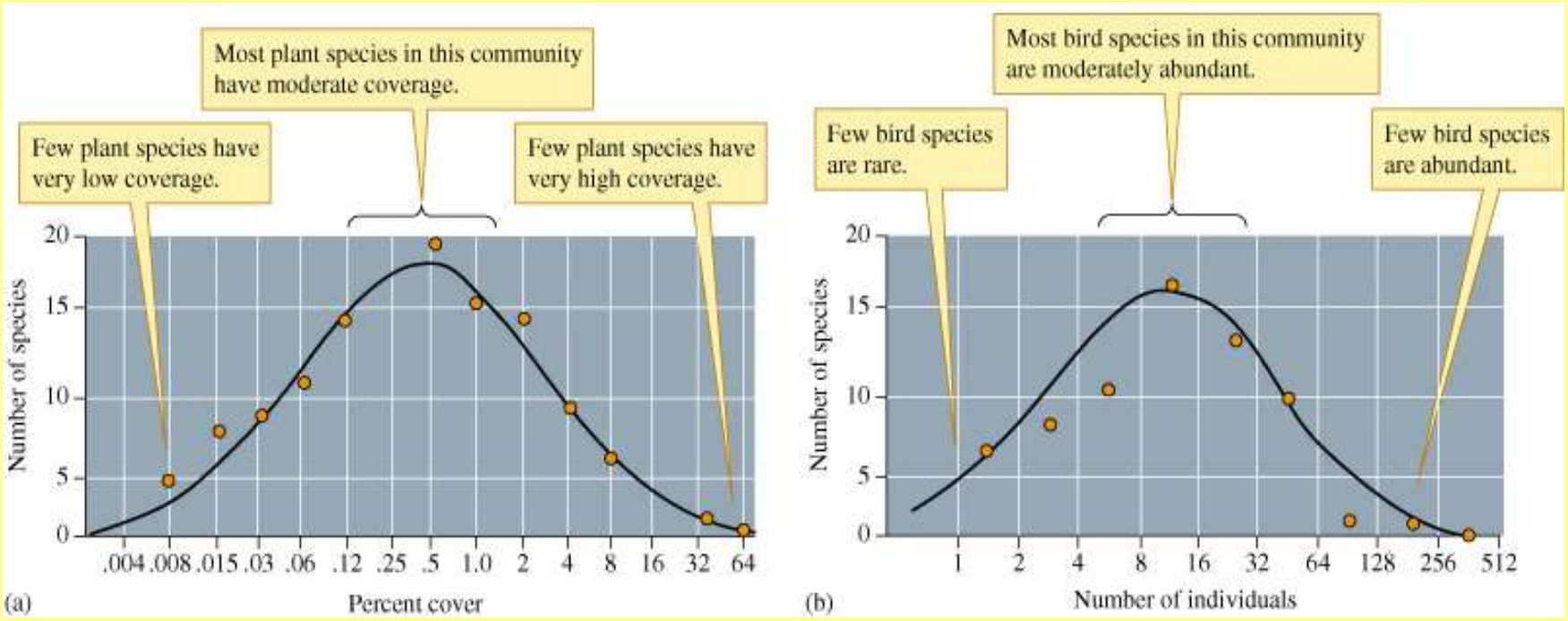
Species Abundance

- There are regularities in the relative abundance of species in communities that hold irregardless of the ecosystem.
- *Preston* developed a concept of distribution of commonness and rarity.



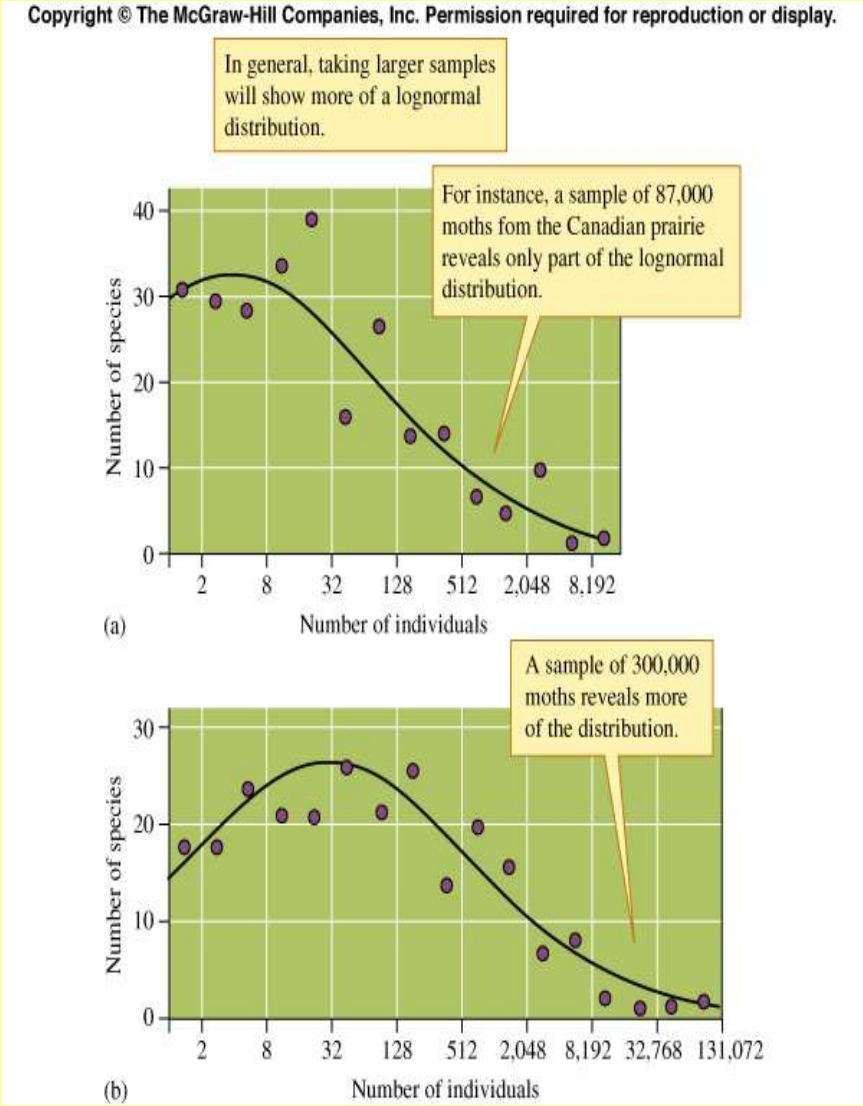
Lognormal Distribution

- *Preston* graphed abundance of species in collections as frequency distributions.
  - Lognormal Distributions
    - Bell-shaped curves.



Lognormal Distribution

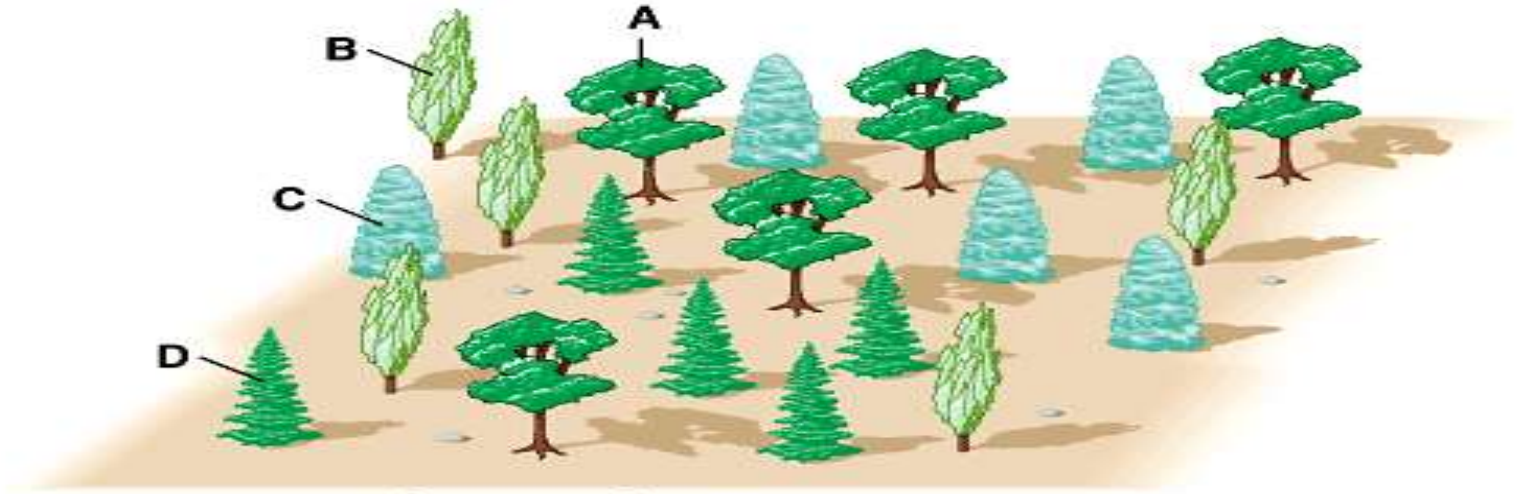
- In most lognormal distributions, only portion of bell-shaped curve is apparent.
  - Sample size has large effect.
  - Significant effort to capture rare species.



Species Diversity

- Two factors define species diversity:
  - Species Richness
    - Number of species in the community.
  - Species Evenness
    - Relative abundance of species.

Species Diversity



Community 1

A: 25% B: 25% C: 25% D: 25%

Community 2

A: 80% B: 5% C: 5% D: 10%

Quantitative Index of Species Diversity

- Shannon Wiener Index:

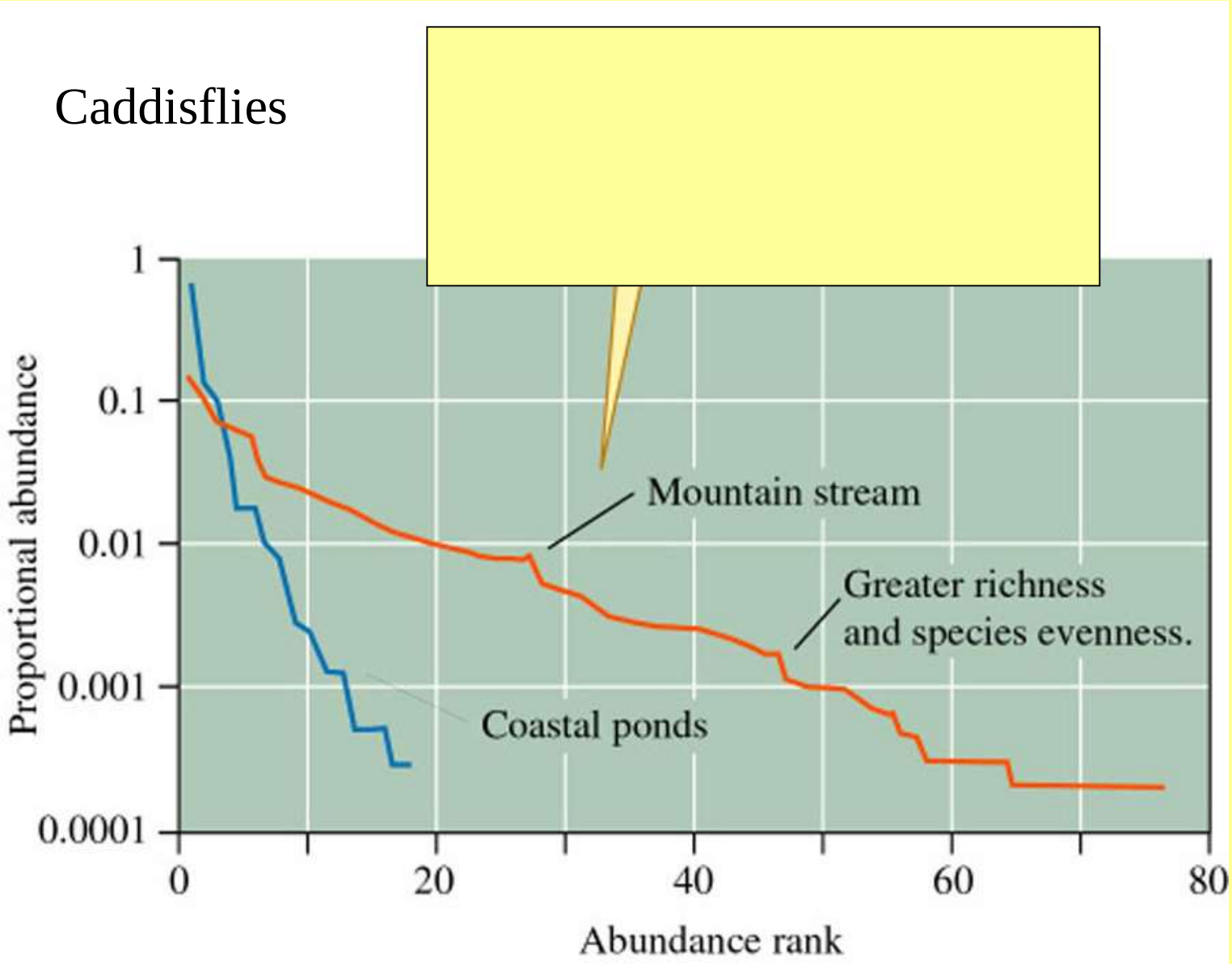
$$H' = -\sum_{i=1}^{s} p_i \log_e p_i$$

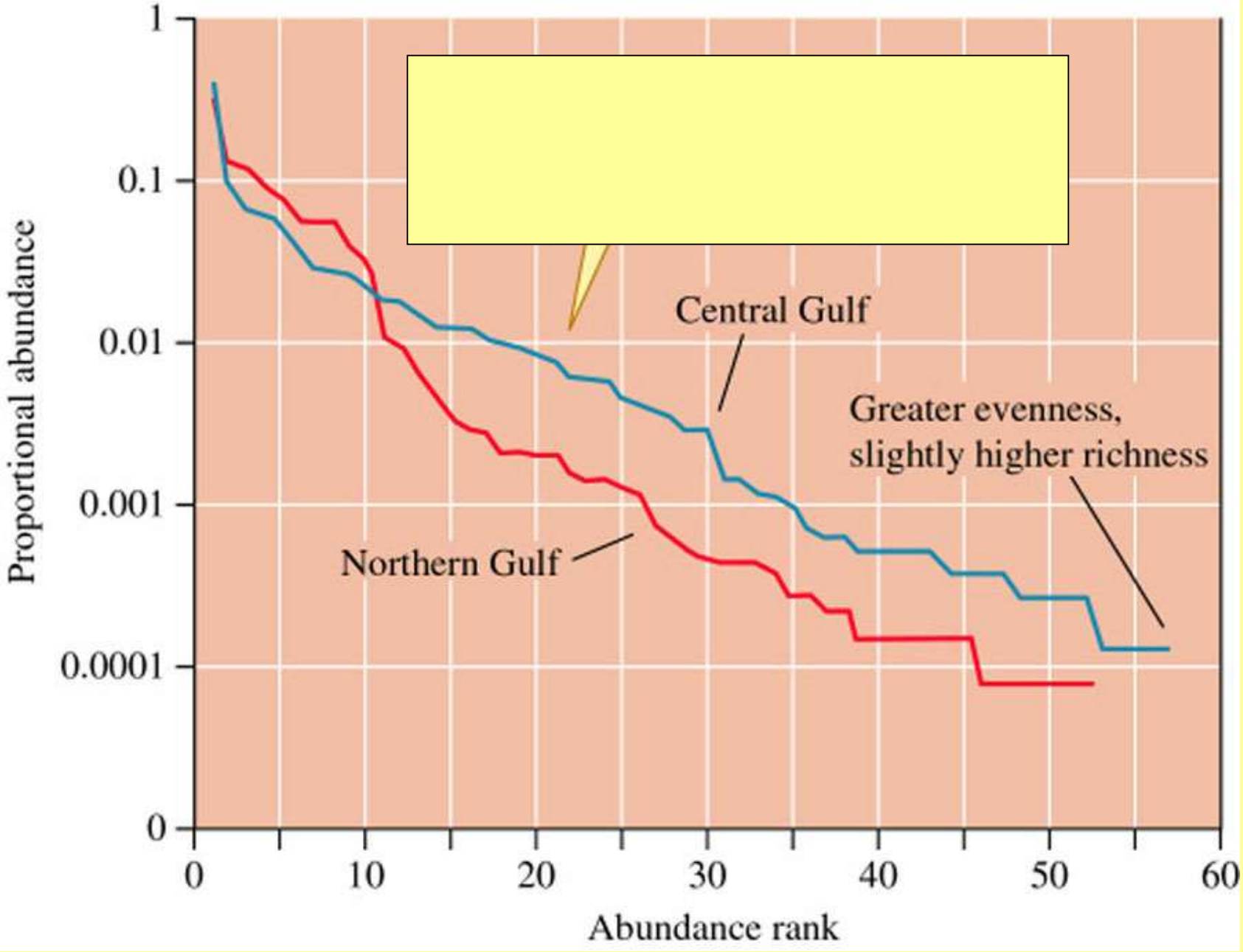
- H' = Value of SW diversity index.
- p_i = Proportion of the ith species.
- $\log_e$ = Natural logarithm of p_i.
- s = Number of species in community.

Rank Abundance Curves

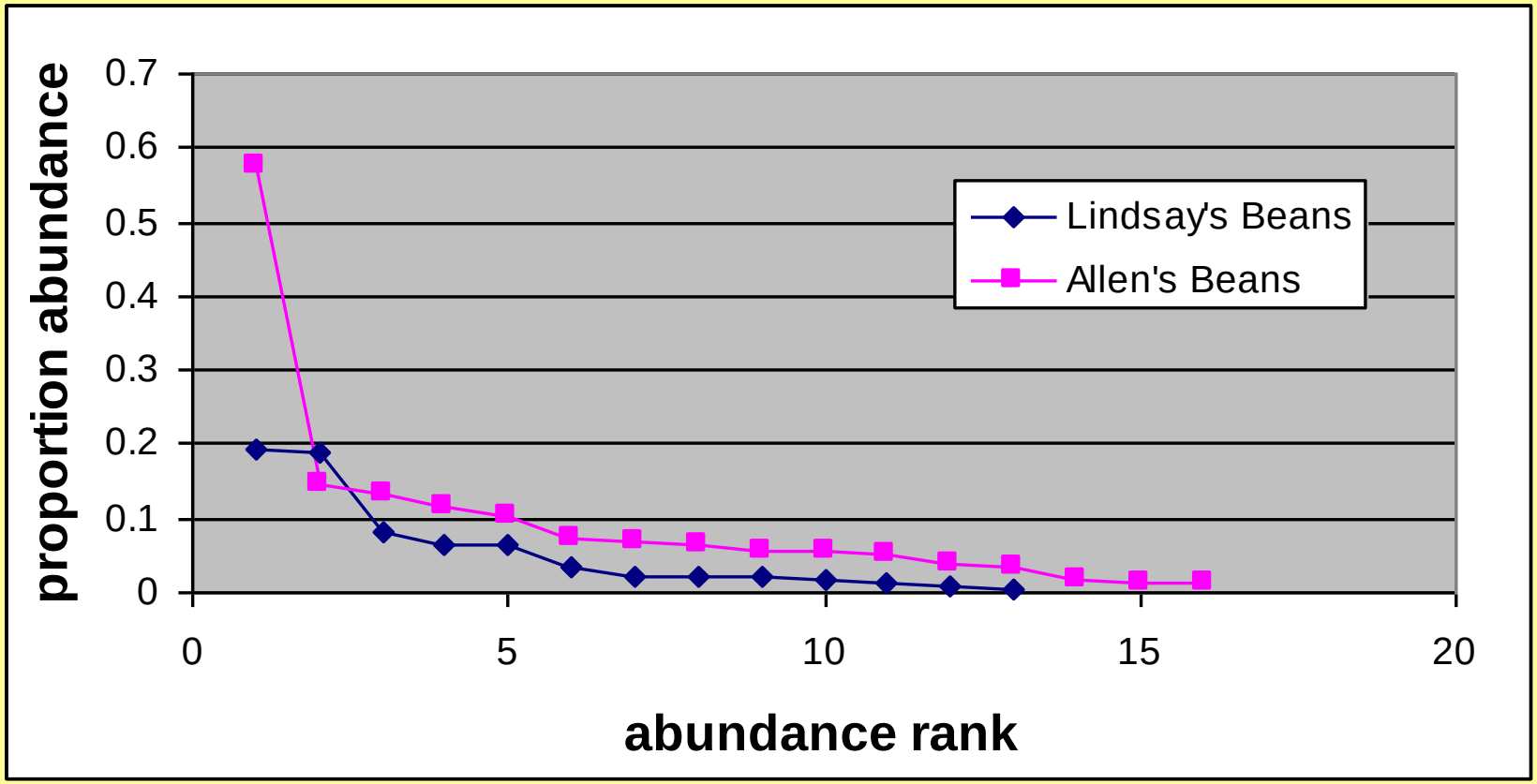
- Can also portray relative abundance and species diversity within a community by plotting relative abundance of species against their rank in abundance.
  - Greater evenness indicated by lower slope.

Rank Abundance Curves





Bean Soup



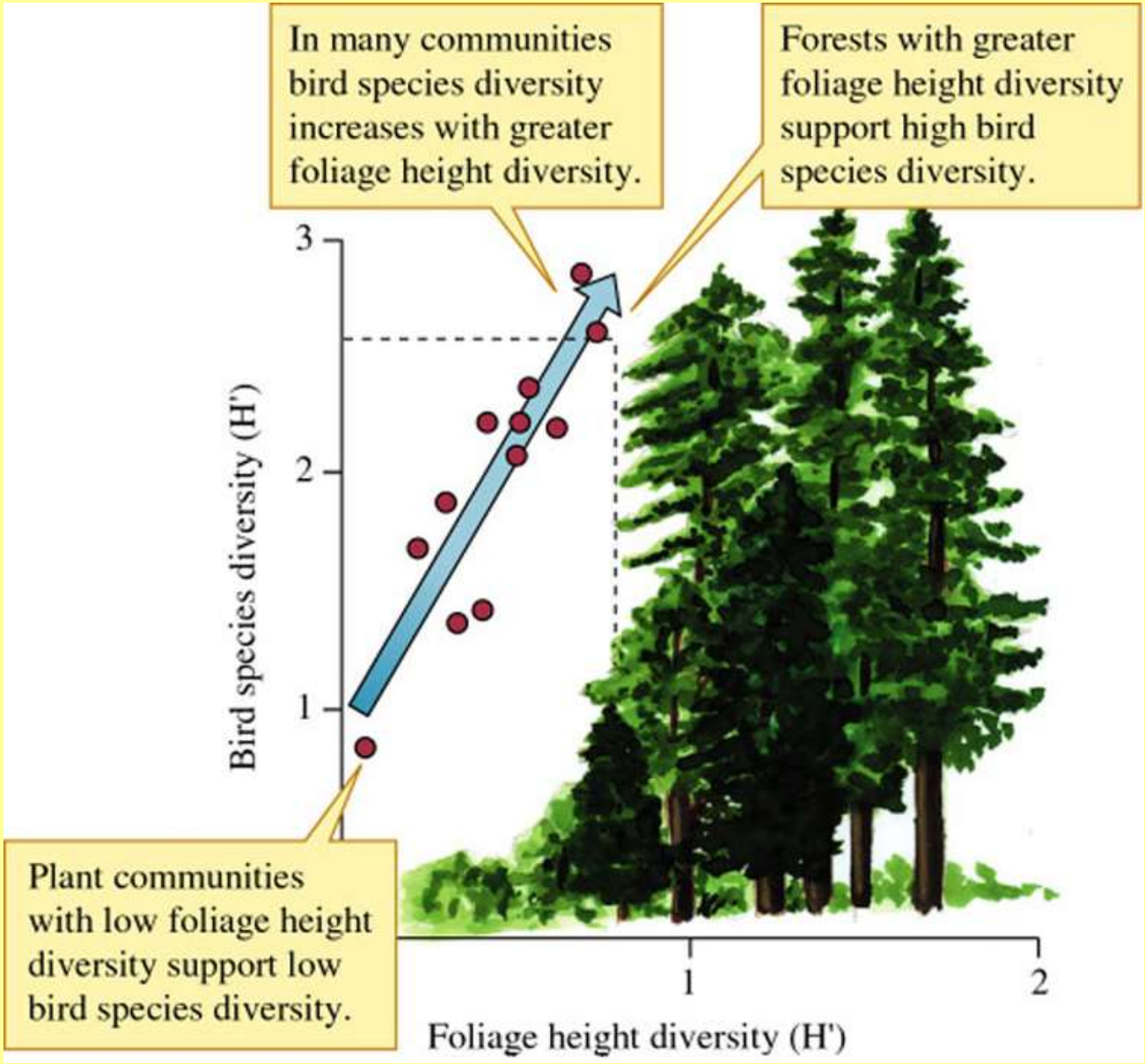
Lindsay's
H= 1.7
E = 0.7

Allen's
H= 2.8
E = 1.0

Environmental Complexity

- In general, species diversity increases with environmental complexity or heterogeneity.
- *MacArthur* found warbler diversity increased as vegetation stature increased.
  - Measured environmental complexity as foliage height.
- Many studies have shown positive relationship between environmental complexity and species diversity.

Environmental Complexity

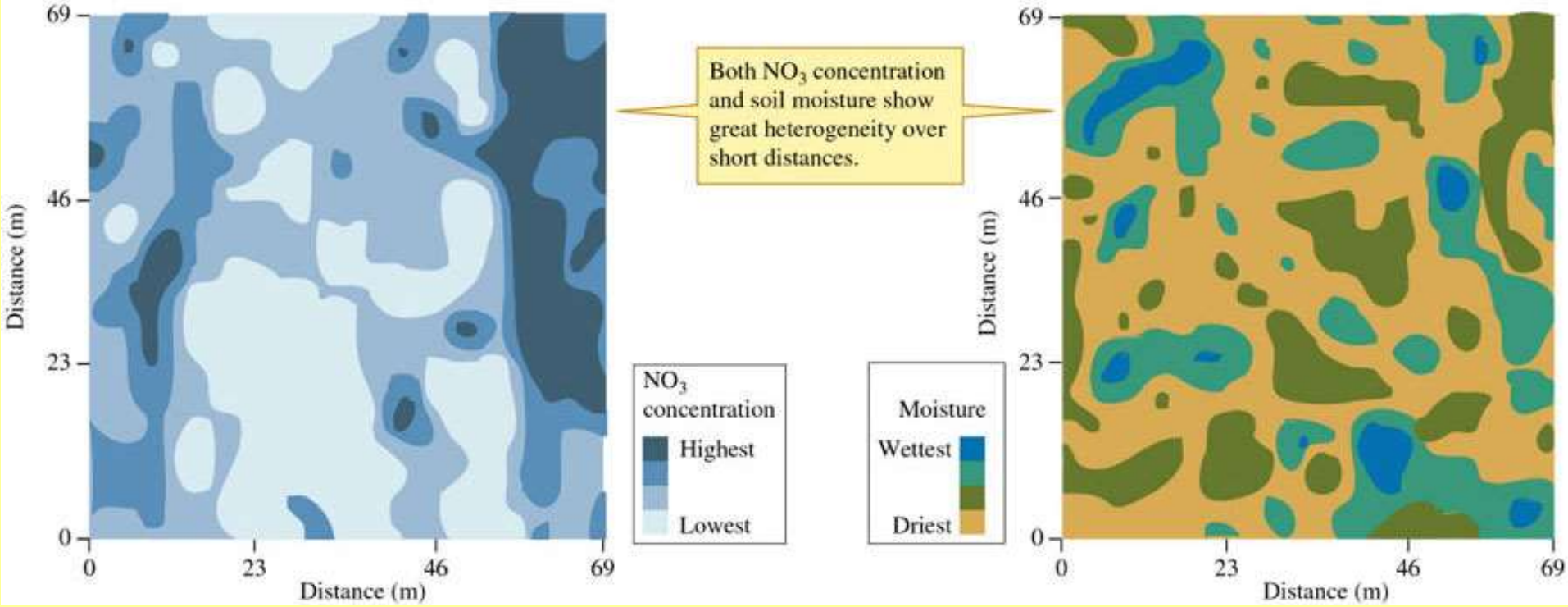


Niches and Diversity of Algae and Plants

- *Hutchinson*:
  - Phytoplankton communities present a paradox because they live in relatively simple environments and compete for the same nutrients, yet many species coexist without competitive exclusion.
    - Environmental complexity may account for significant portion of the diversity.

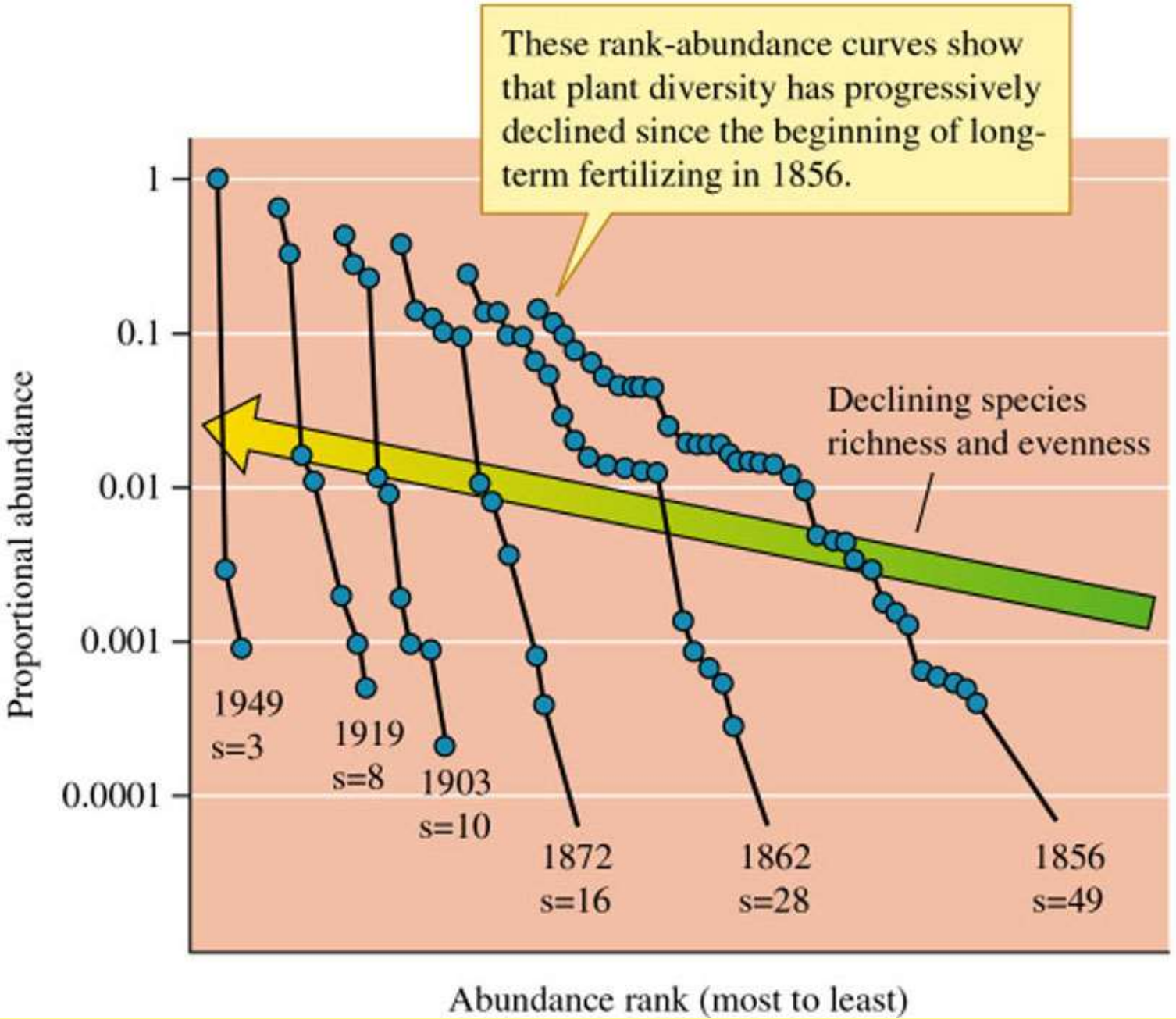
Niches and Diversity of Algae and Plants

- Algal niches appear to be defined by their nutrient requirements.
  - *Tilman* found coexistence of freshwater diatoms depended upon ratio of silicate and phosphate.
    - Found conditions allowing coexistence.
      - Diatoms held different trophic niches.
        - Thus different diatoms would dominate different areas.



Algal and Plant Species Diversity and Increased Nutrient Availability

- Repeatedly observed negative relationship between nutrient availability and algal and plant species diversity.
- Adding nutrients to water or soils generally reduces diversity of plants and algae.
  - Reduces number of limiting nutrients.



Disturbance and Diversity

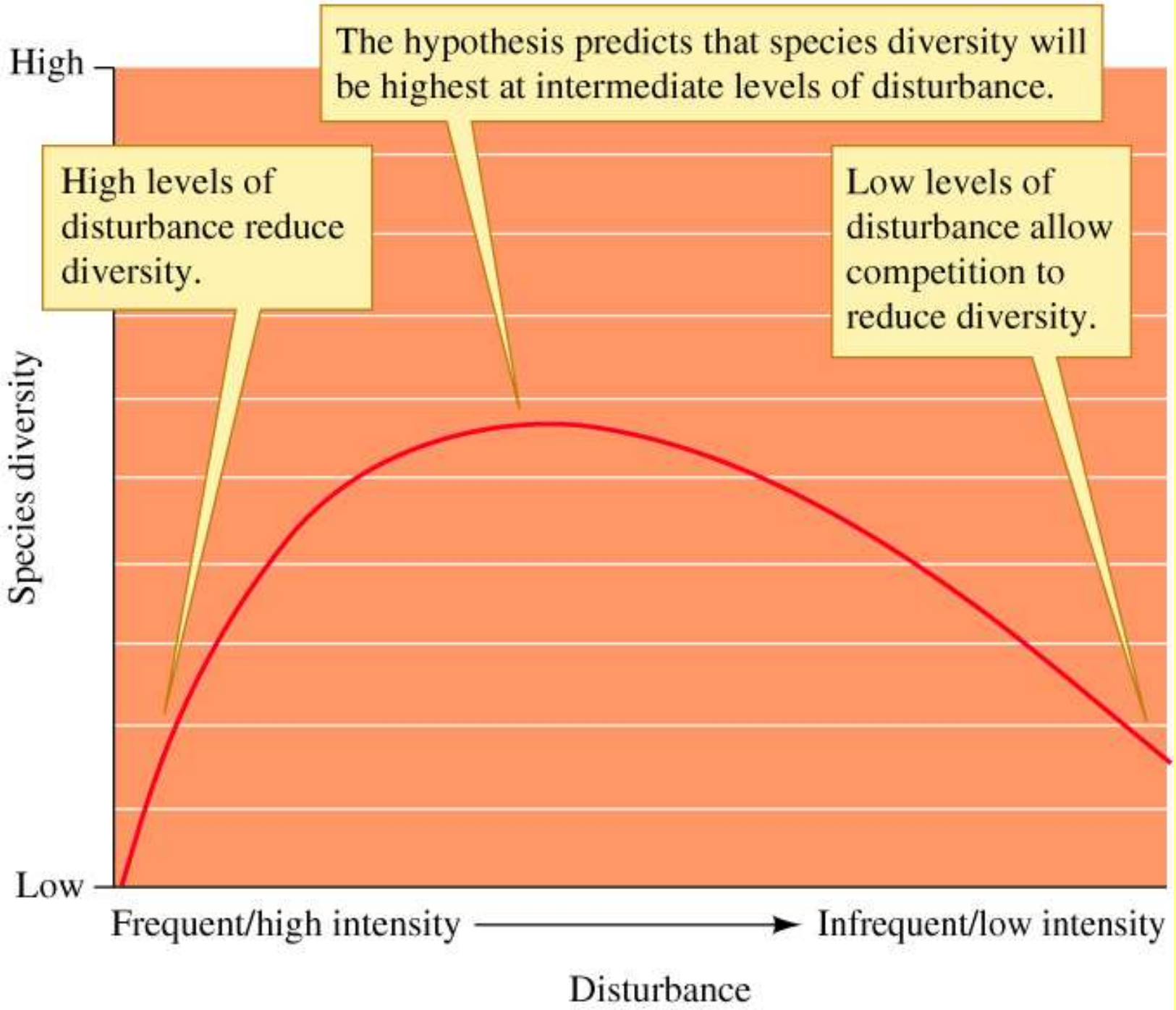
- Disturbance difficult to define as it involves departure from “average conditions.”
  - Average conditions may involve substantial variation.
- *Sousa* defined disturbance:
  - Discrete, punctuated, killing, displacement, or damaging of one or more individuals that directly or indirectly creates an opportunity for new individuals to be established.

Disturbance and Diversity

- *White* and *Pickett* defined disturbance:
  - Any relatively discrete event in time that disrupts ecosystem, community, or population structure and changes resources, substrate availability, or the physical environment.
  - Two major characteristics:
    - Frequency
    - Intensity

Intermediate Disturbance Hypothesis

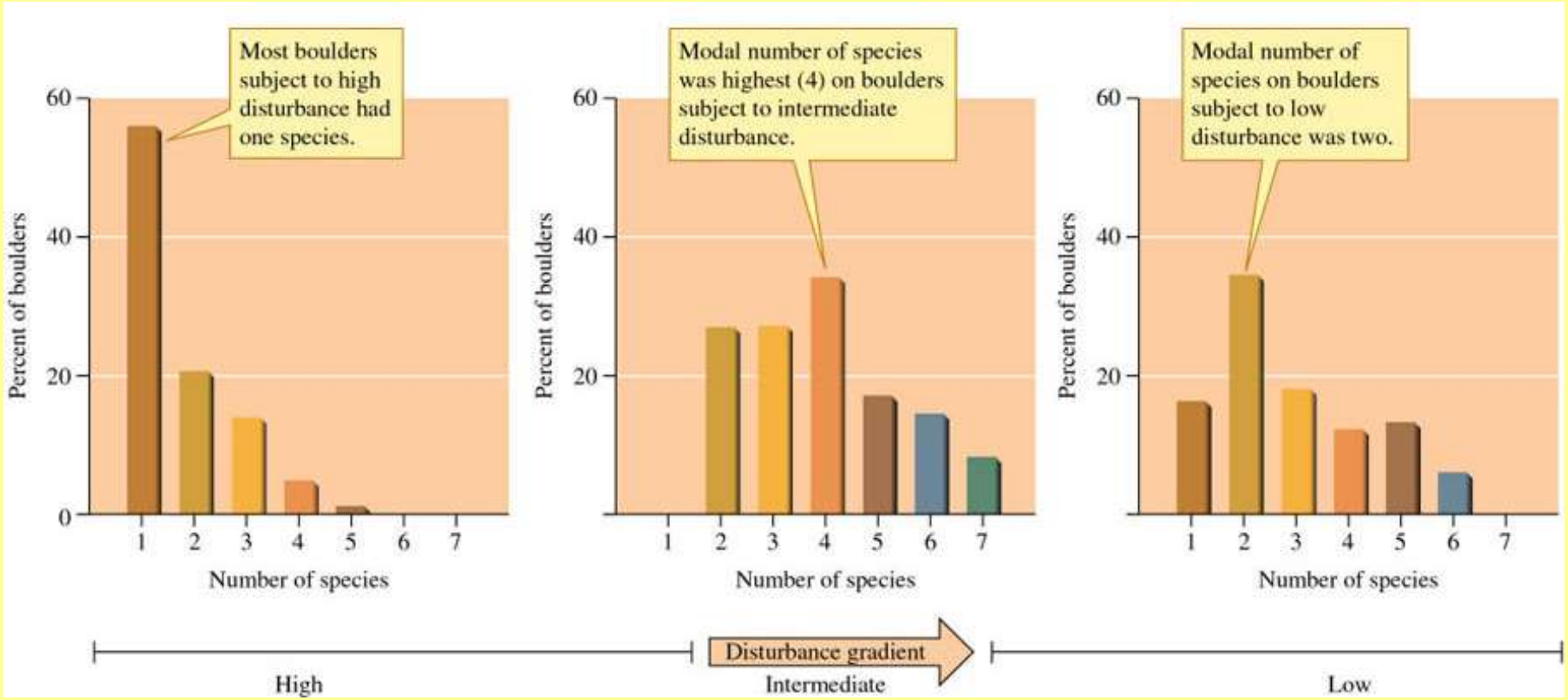
- *Connell* proposed disturbance is a prevalent feature that significantly influences community diversity.
  - Proposed both high and low levels of disturbance would reduce diversity.
    - Intermediate levels promote higher diversity.
      - Sufficient time between disturbances allows wide variety of species to colonize, but not long enough to allow competitive exclusion.



Disturbance and Diversity in the Intertidal Zone

- *Sousa* studied effects of disturbance on diversity of algae and invertebrates growing on boulders in the intertidal zone.
  - Predicted level of disturbance depends on boulder size.
    - Large boulders require more force to move.
      - Boulders supporting greatest diversity of species were those subject to intermediate levels of disturbance.

Disturbance and Diversity in the Intertidal Zone



Disturbance and Diversity in Temperate Grasslands

- *Whicker* and *Detling*: Prairie dogs (Cynomys spp.) source of disturbance on N. A. prairies.
  - Build extensive burrow systems.
    - Remove vegetation around burrows.
      - Area opens to colonization.
        - Pest control programs reduced prairie dog populations 98%.
        - Eliminated dynamic influences on plant communities.