MYP Biology
Community Ecology

Community Ecology

I.

Main Idea: Species living in close proximity will inevitably interact with each

Main Idea: These interactions can be positive, negative or have little to no effect.

COMMUNITY INTERACTIONS

- A ***community*** is a group of species living close together and interacting
- Some of these interactions affect the survival and reproduction of the two species interacting

Symbiosis

Note: Some define symbiosis narrowly as mutualism however the authors of your text use a broader definition to include *all* direct interactions between species

COMMUNITY INTERACTIONS

A. Competition (-/-)

- Limited resources cause species to compete for them and this lowers the fitness of both species

1. Competitive Exclusion

- In 1934, Russian Ecologist G.F. Gause concluded that two competing species could not coexist permanently in the same place

- One species will inevitably have a slight reproductive advantage and eventually eliminate the inferior competitor...***competitive exclusion principle***

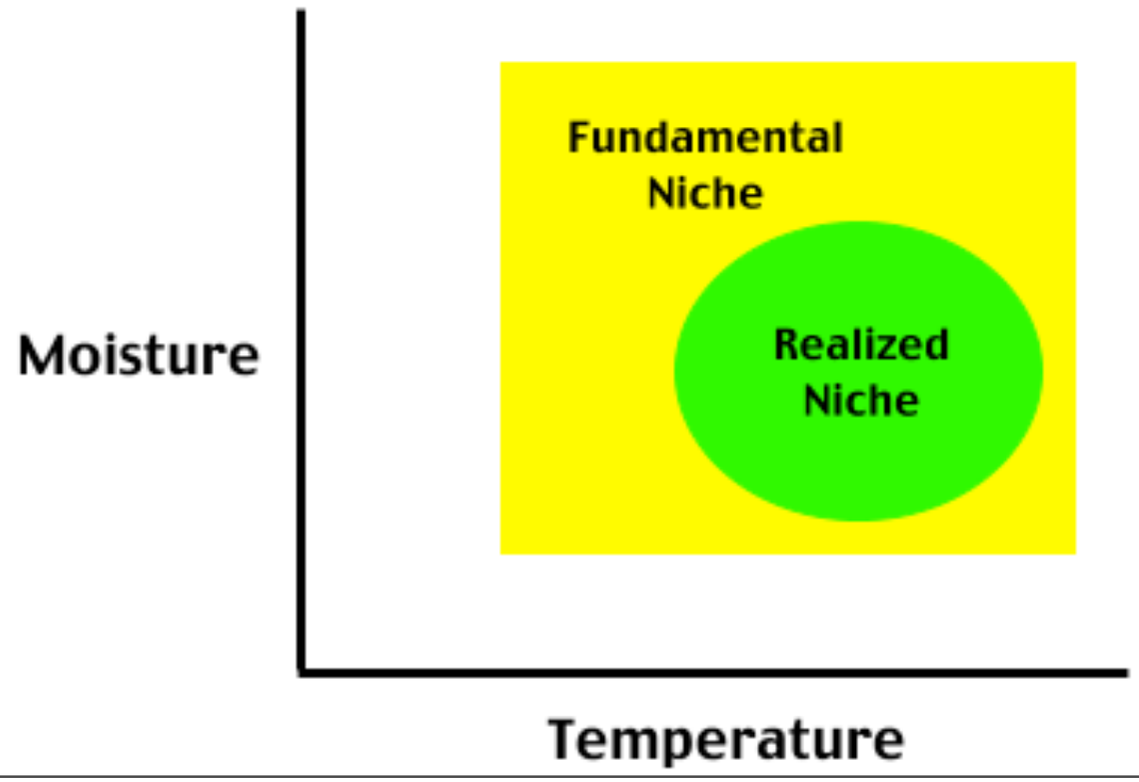
2. Ecological Niches & Evolution

- Sum use a species resources both abiotic and biotic in their environment...***niche***
- *Competitive exclusion principle* rephrased...no two species can occupy the same niche

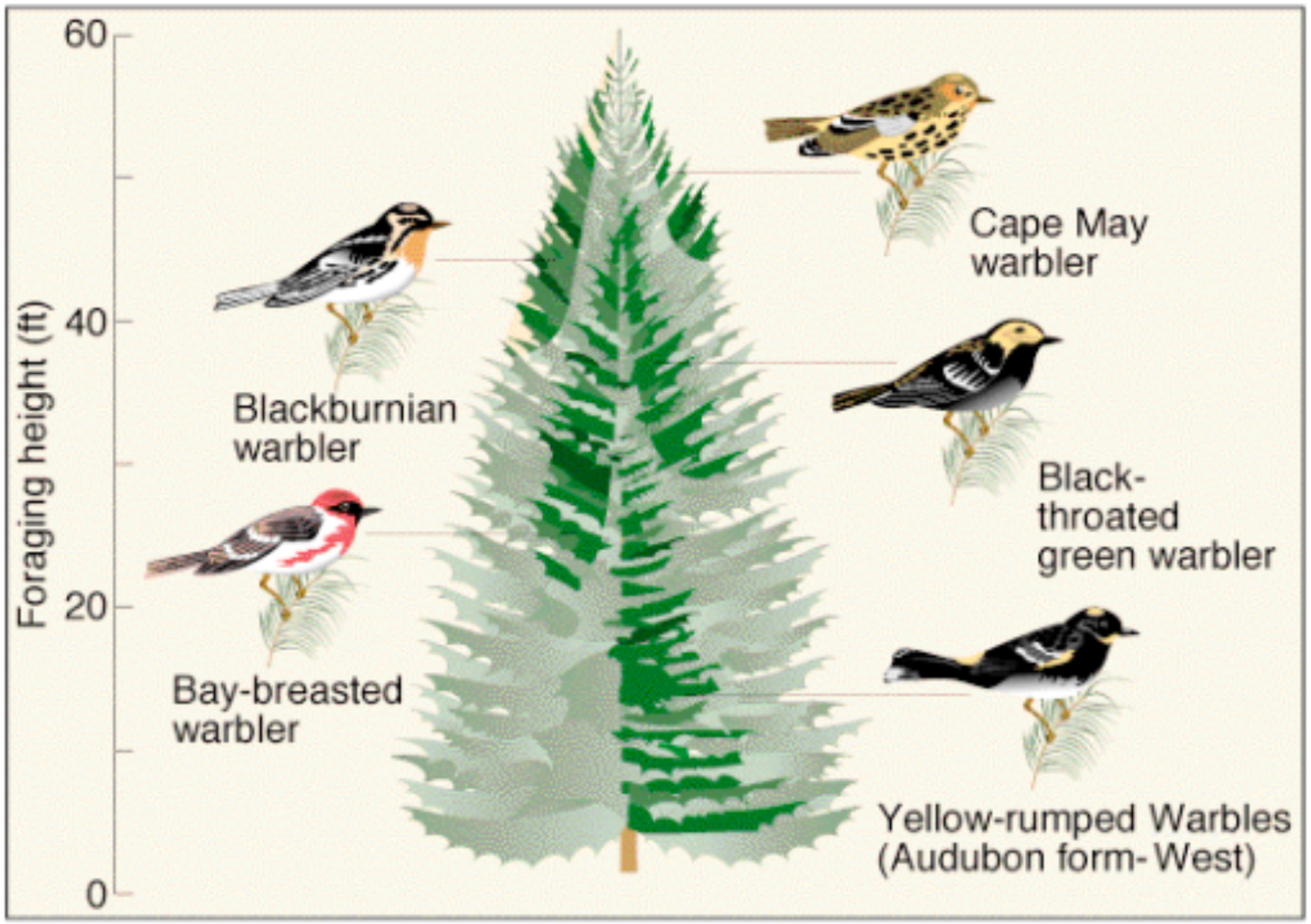
2. Ecological Niches & Evolution

- Since the two species can not occupy same niche one will use slightly different resources their by differentiating or partitioning the niche

- This resource partitioning allows two species to live in very similar niches



Resource Partitioning



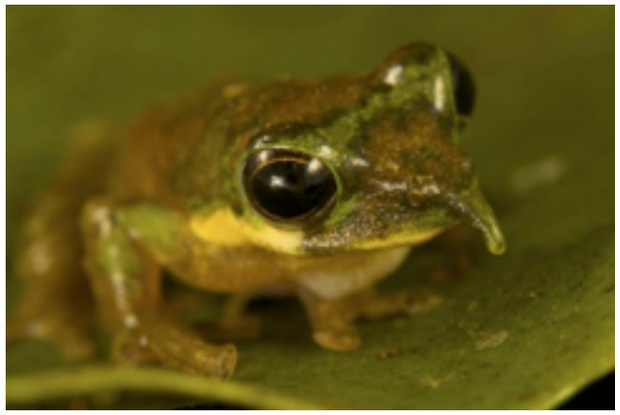
Note: species can partition their niches by *space* seen here or by *time*...think diurnal vs nocturnal

B. Predation (+/-)

- Natural selection has fine tuned both predator and prey with remarkable adaptations.
  - **Predators**:
    - acute senses, speed, agility, claws, teeth, fangs, stingers and venoms
  - **Prey**:
    - behavioral defenses; hiding, fleeing, forming herds or schools, alarm calls
    - morphological & physiological defenses; camouflage (cryptic coloration), warning colors (aposematic colorations), spines, poisons, toxins, chemicals, mimicry

Can you think of an example of each?

Smell

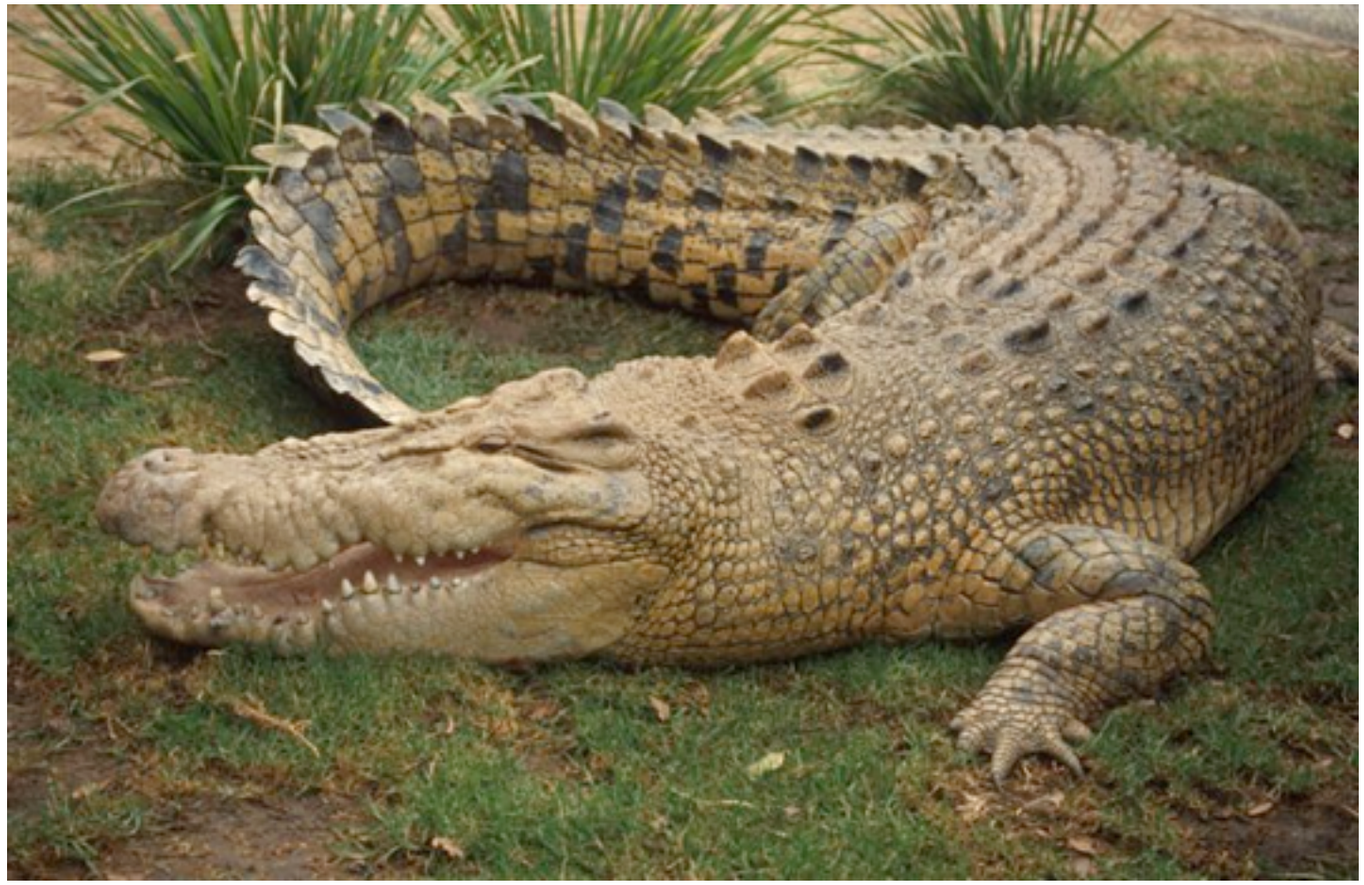


Hearing

Vision

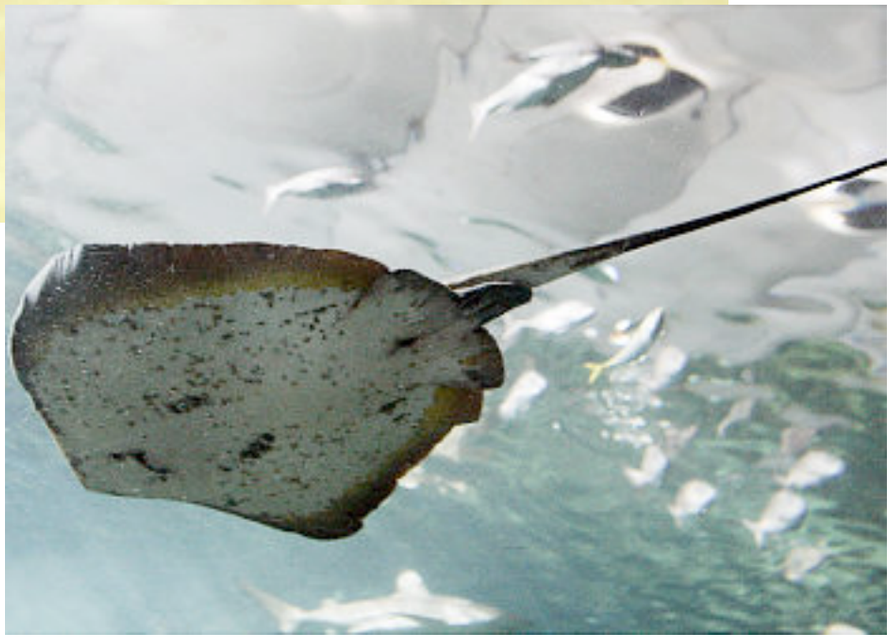
Taste

Touch

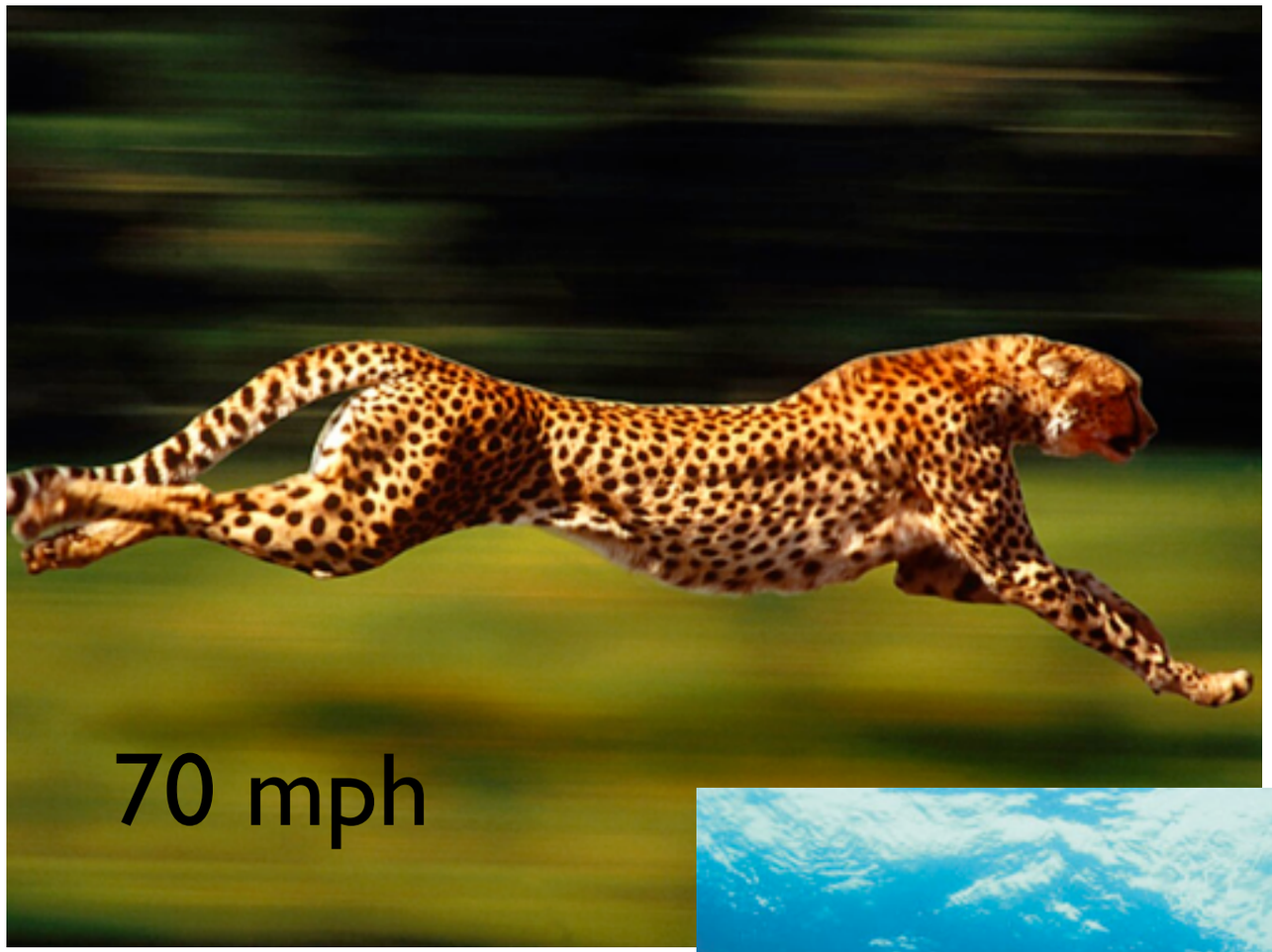


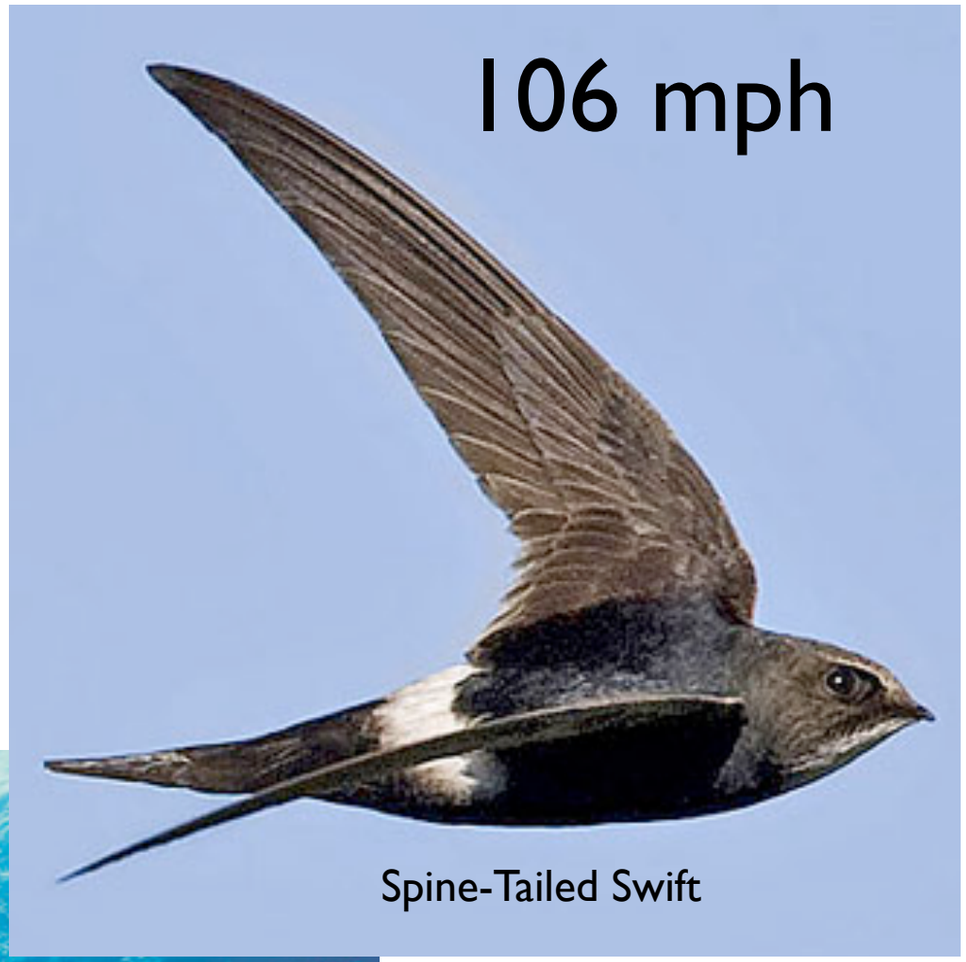
Claws, Teeth & Fangs

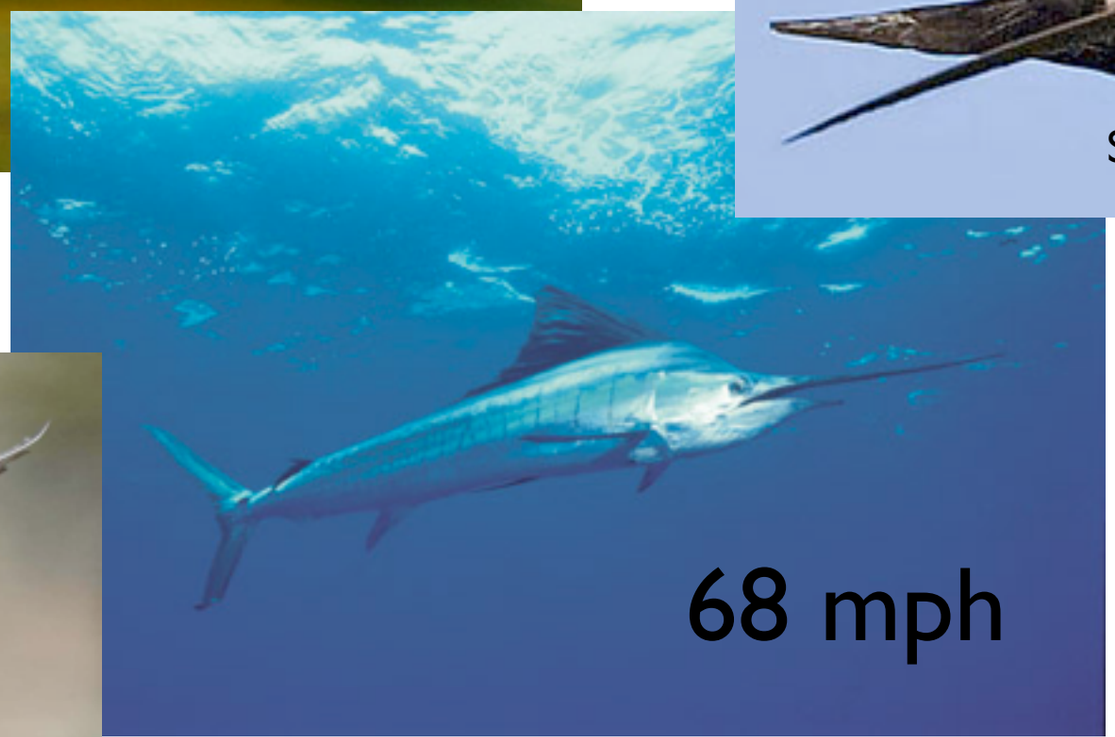
Stingers



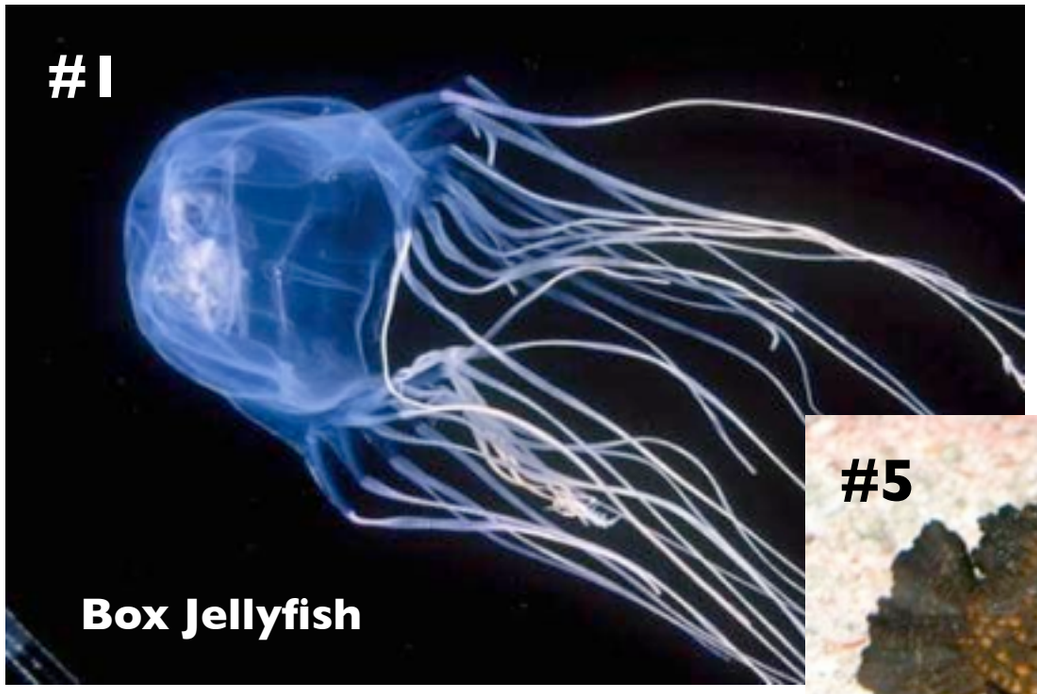
Speed & Agility







Venoms (Top 5?)


#1
Box Jellyfish


#5
Stonefish


#3
Taipan


#2
Brazilian Wandering Spider


#4
Blue Ringed Octopi

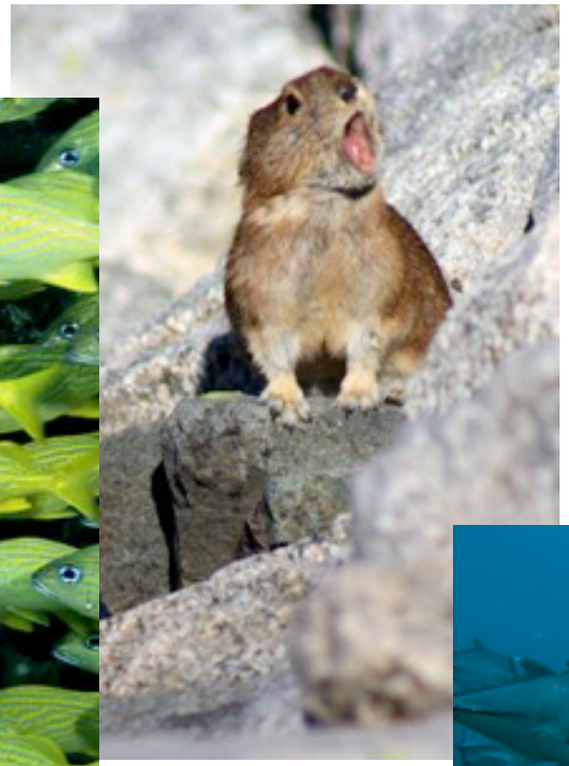
Should have made the list?

Most Poisonous Plants

Spines

Thorns

Alarm Calls, Herds & Schools



- **Batesian Mimicry:** a harmless/palatable species copying a harmful/unpalatable species

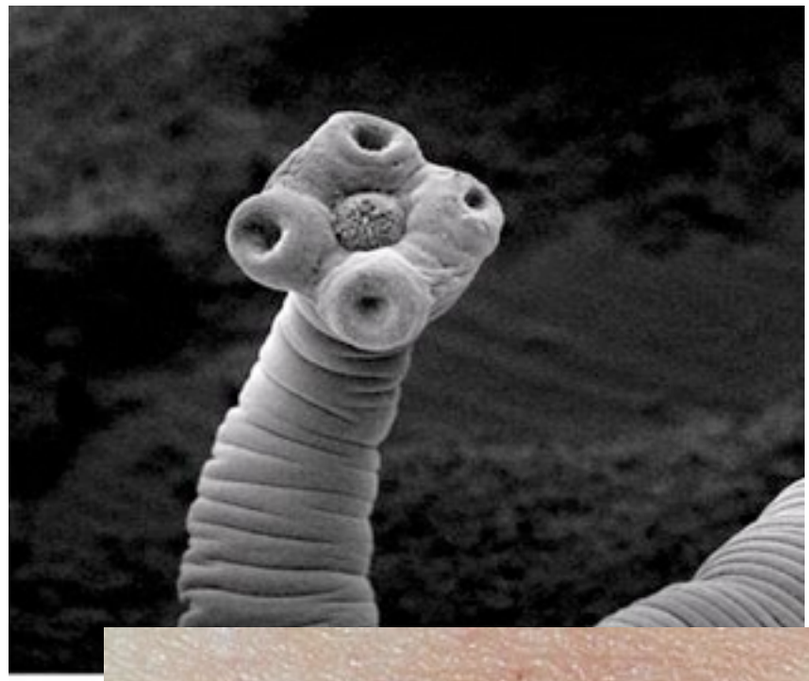
- **Mullerian Mimicry:** two or more harmful/unpalatable species resembling each other

C. Herbivory (+/-)

- Natural selection has fine tuned herbivores (and the plants) with remarkable adaptations.
  - **Herbivores**:
    - insects can detect toxic chemicals with their feet
    - mammals
      - use smell to assess plants,
      - mammals also have specialized teeth (molars) for grinding plant matter,
      - mammals have specialized digestive tracts to breakdown cellulose
  - **Plants**:
    - Spines and Thorns
    - Toxins: strychnine, nicotine, selenium, peppermint, cloves,

I. Parasitism (+/-)

- *Parasites* are organisms that derive nourishment from a host, the *host* is the organism that is harmed in the process.
  - Endoparasites feed/live within their host (tapeworms)
  - Ectoparasites feed/live on their host (ticks)



2. Mutualism (+/+)

- These interactions benefit both species involved.
- Many important mutualistic relationships exist in nature.
  - ***#1. Nitrogen Fixation (bacteria and plants-legumes)***
  - ***#2. Mycorrhizae (fungi and plants)***
  - *#3. Cellulose Digestion in Ruminants (herbivores and bacteria)*

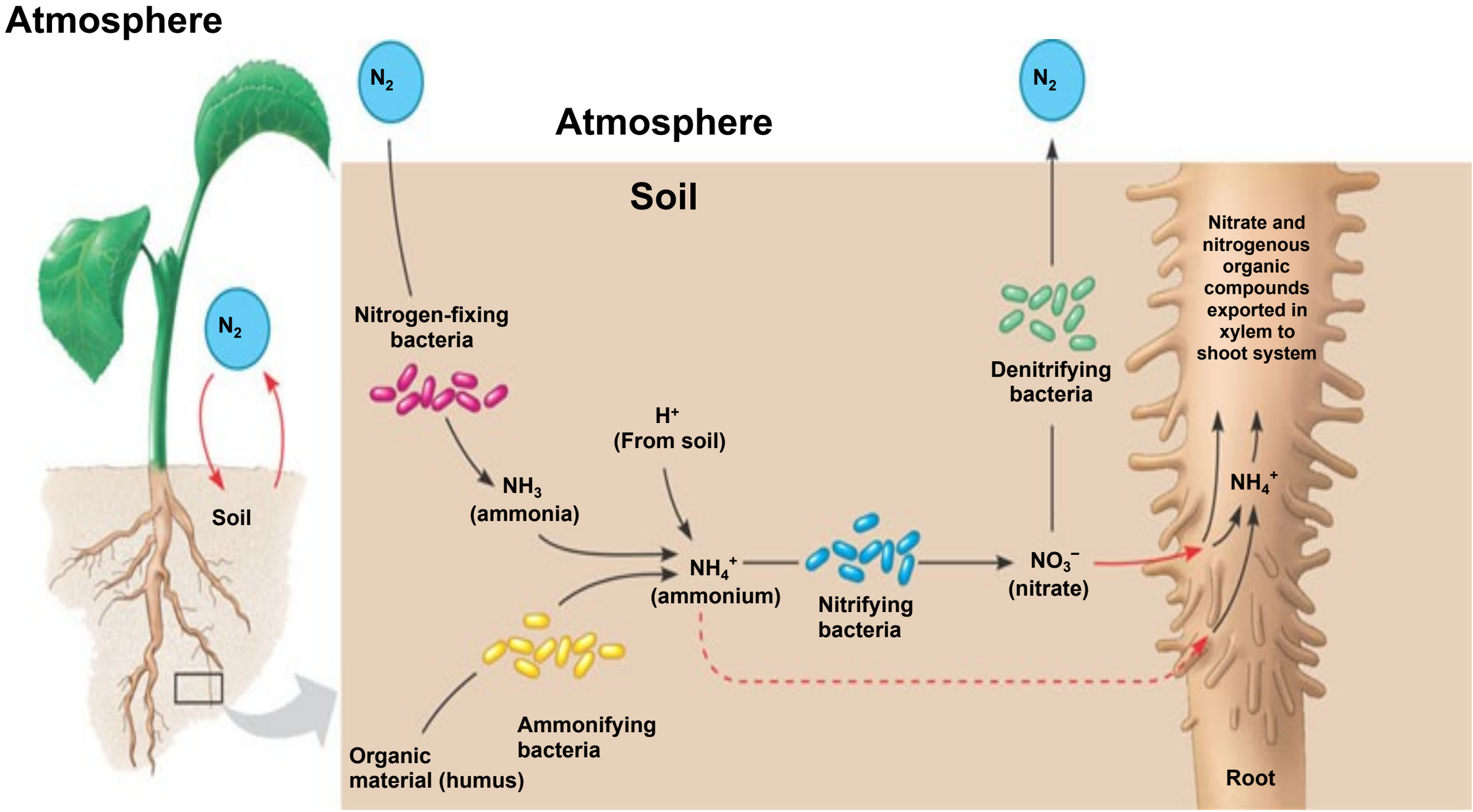
#1. Nitrogen Fixation (bacteria and plants-legumes)

An Introduction

- Atmospheric nitrogen is abundant however it is biologically unavailable. Most organisms are unable to break the triple covalent bonds between nitrogen atoms.
- It is imperative that these bonds are broken because **"life" needs nitrogen atoms** to build amino acids and nucleotides.
- This reaction requires ***nitrogenase*** the enzyme cable of fixing nitrogen gas.
- This reaction is **energetically costly**.

#1. Nitrogen Fixation (bacteria and plants-legumes)

Overview



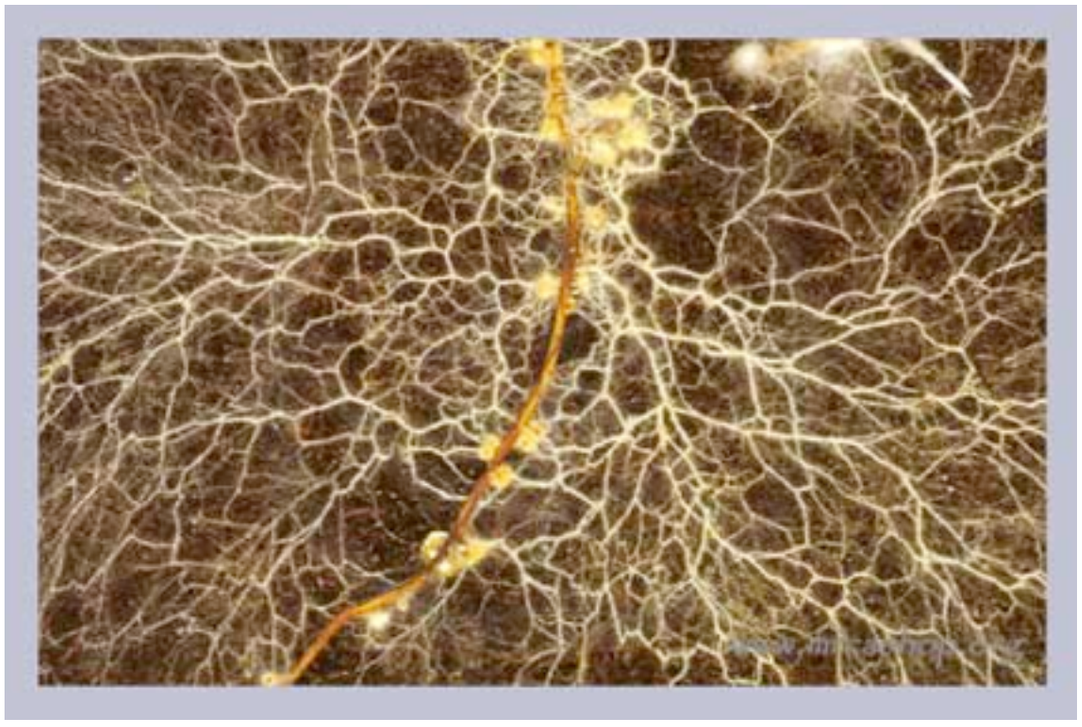
#3. *Mycorrhizae (fungi and plants)*

Overview

- This relationship is both *ancient* and *extensive*. Fossil evidence suggests that this relationship is over 400 million old and may have contributed to plants colonizing land. Furthermore this relationship is found in roughly 80% of all plant species.

- Plants (through photosynthesis) provide fungi a constant supply of sugar (food) while the fungi provides plants with increased water and mineral absorption (through their vast surface area and unique cell chemistry).

- Mycorrhizal plants are more resistant to disease, toxins and drought.



3. Commensalism (0/+)

- These interactions benefit one species and the other is effected no way positive or negative. Some argue that this can not exist, that all interactions have some effect no matter how small.

  - ex. barnacles on whales, algae on turtle shells

What do you think? Can argue both ways?

Homework

On your own checkout the story of the Honey Badgers & Honey Guides. As well as the relationship between the Acacia and Ants

Community Ecology

II.

Main Idea: Diversity is important for healthy communities.

Main Idea: Each community has unique feeding relationships.

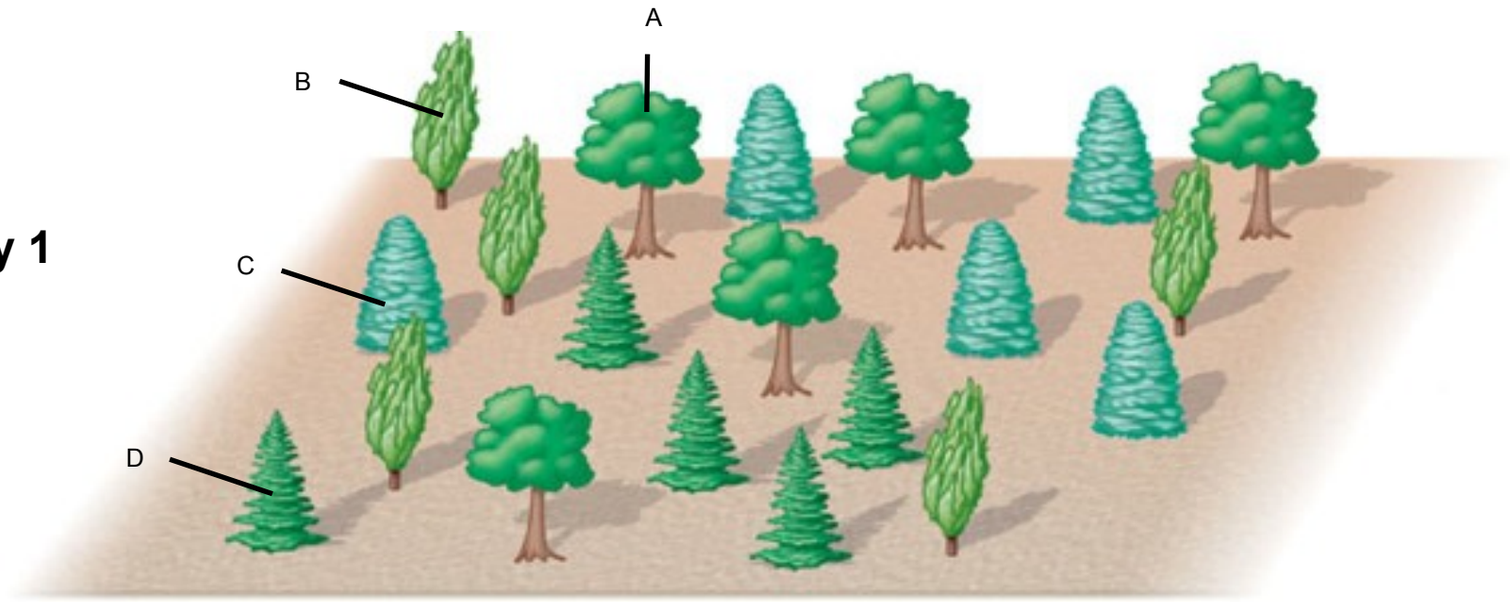
DIVERSITY & TROPHIC STRUCTURE

A. Species Diversity

- Diversity has two components
  - 1. **Richness** = number of different species
  - 2. **Relative Abundance** = the proportion that each species represents of all individuals in the community

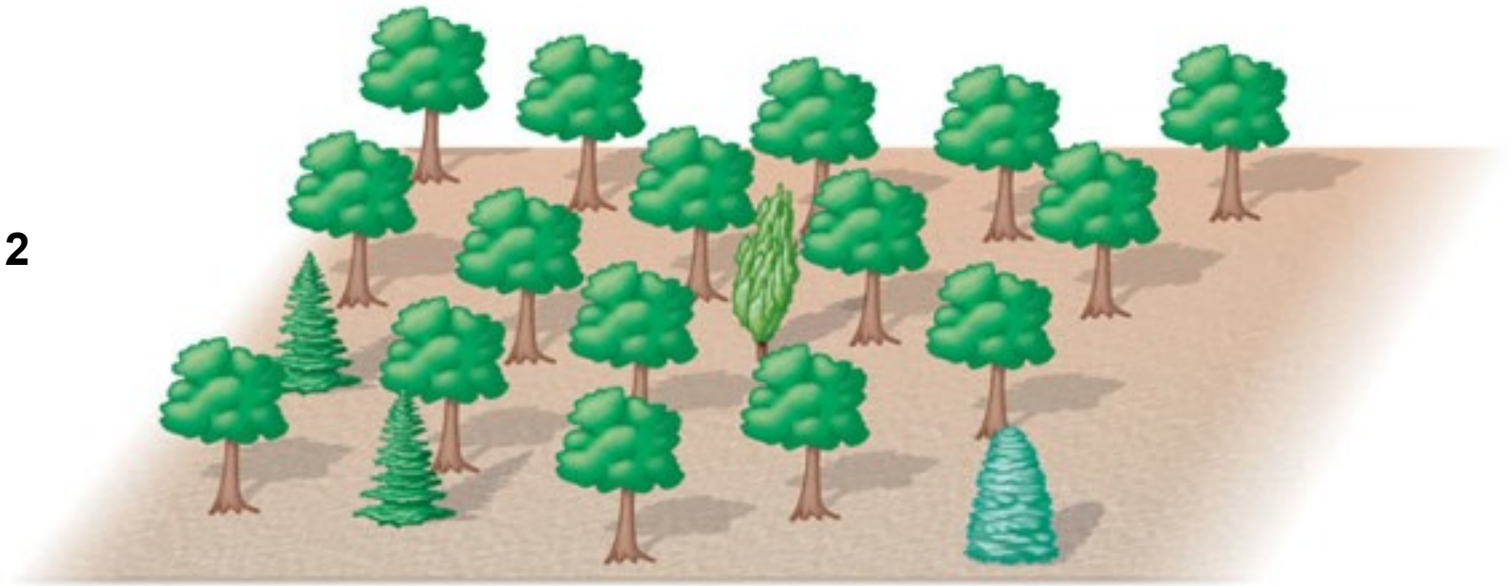
Which community below is more diverse? Use your gut.

Community 1



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

Community 2



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

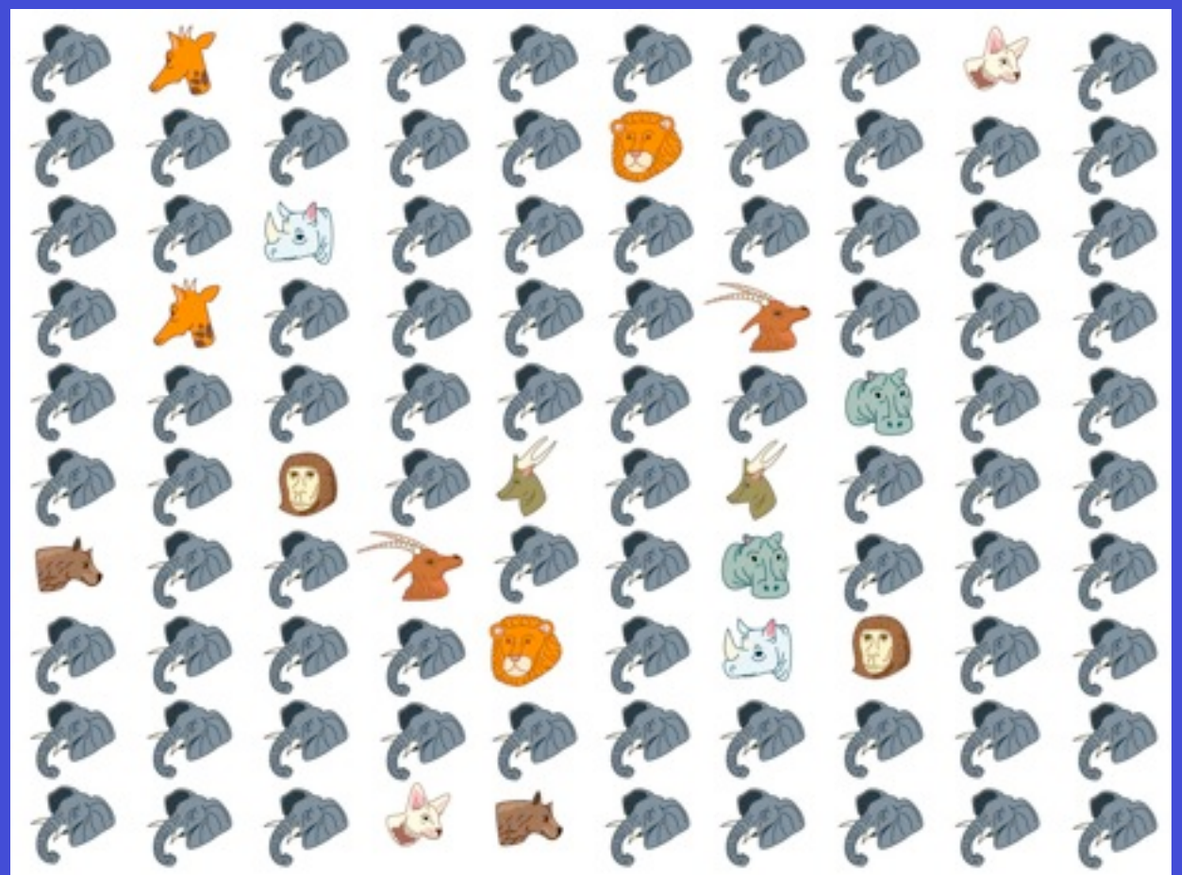
Ecologists use a mathematical expression called Shannon diversity, to more objectively calculate diversity.

Try again...

10 species; 100 ind, 87 elephants, 9 sp w/ 2 ind each

10 species; 100 ind, 10 ind each species

Species Diversity



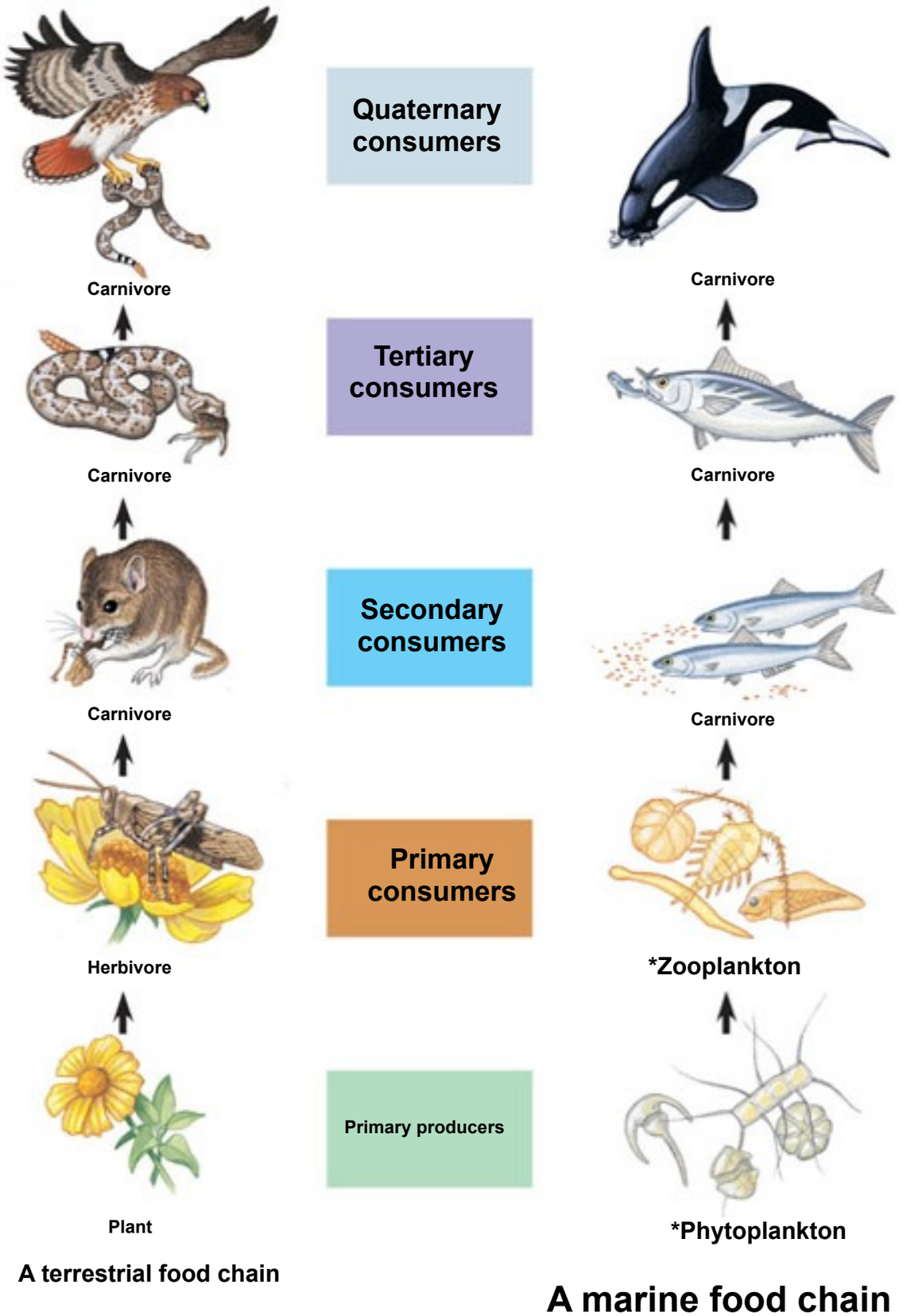
Merely counting the number of species is not enough to describe biological diversity.

B. Diversity & Stability

- Diversity has its benefits
  - 1. **Productive**, higher diversity communities are more productive
  - 2. **Resilient**, higher diversity communities are more stable during times of environmental stress
  - 3. **Stable**, higher diversity communities are more stable (consistent) year to year in their productivity
  - 4. **Resistant**, higher diversity communities are more resistant against *invasive species*.

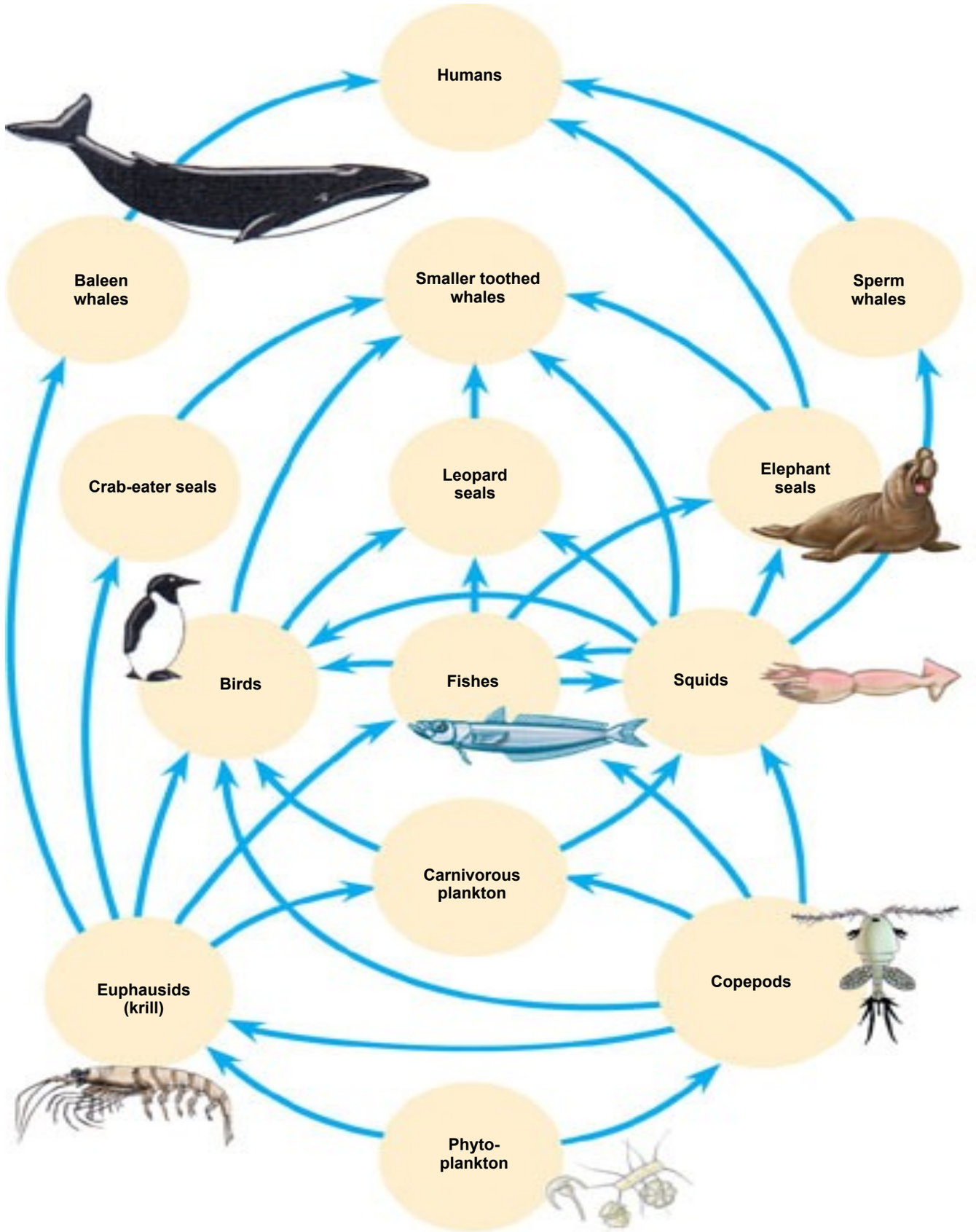
C. Trophic Structure

- **Trophic Structure**...feeding relationships within the community.
- The movement of food energy from autotrophs through and up to the largest consumers...**food chains**.



1. Food Webs

- Interconnected and linked food chains make up **food webs**.
- The arrow points in the direction of foods movement. In other words A ⟶ B indicates that B is eating A. Many students reverse this so be careful



Could you interpret these feeding relationships IF...

1. the pics were removed?
2. the pics and names were removed?
3. What if I removed all pics, names and turned in upside down?

Phytoplankton

1. Food Chain Lengths

- Food chains are limited in their lengths.
  - The *Energetic Hypothesis* states that the energy transfer one one trophic level to another is inefficient (about 10-20%) and after 3 - 5 transfers there is not enough energy to support another level.

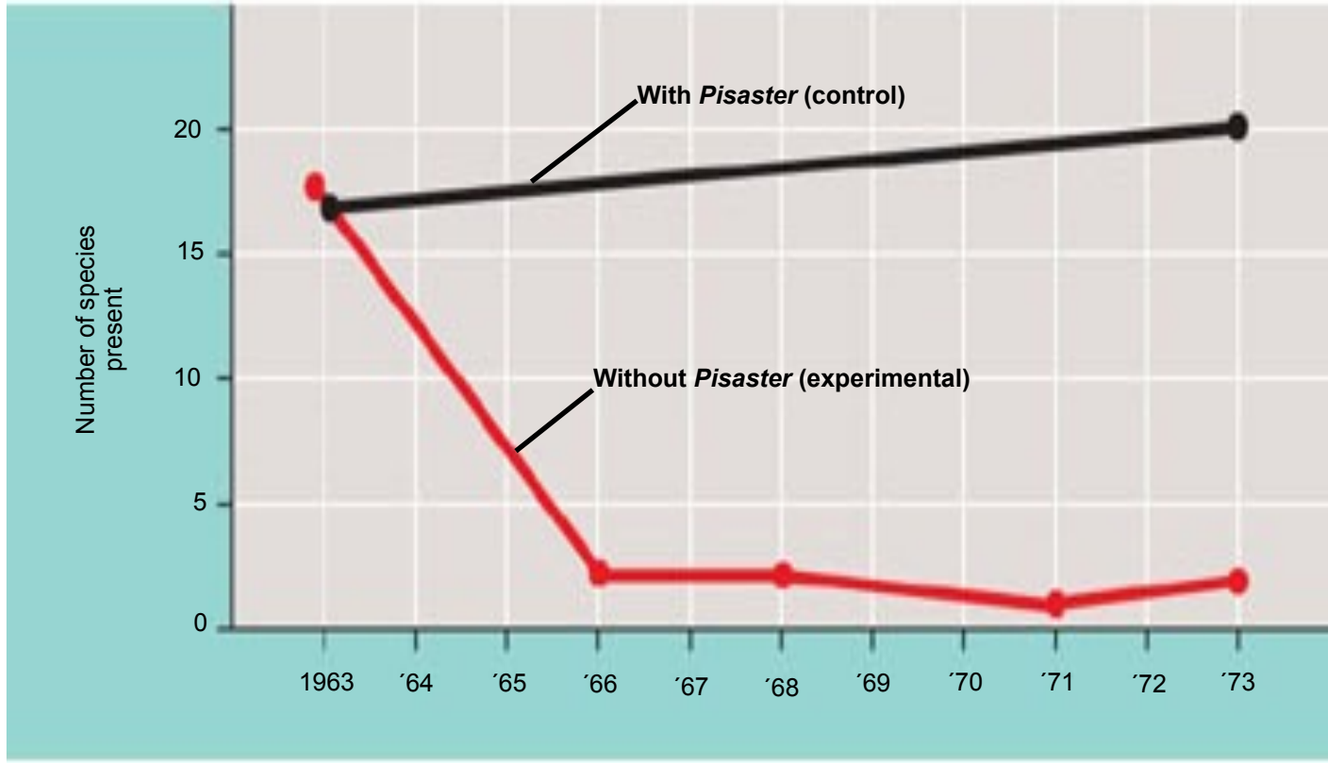
D. Dominant Species

- Certain species have a proportionally larger impact in the community due to their abundance or a key role that they play in community interactions
  - 1. **Dominant Species**; are the most abundant or have the highest biomass.

E. Keystone Species

- 2. **Keystone Species**; are the most abundant but they exert strong control on community dynamics due their unique role or niche.

(a) The sea star *Pisaster ochraceous* feeds preferentially on mussels but will consume other invertebrates.



(b) When *Pisaster* was removed from an intertidal zone, mussels eventually took over the rock face and eliminated most other invertebrates and algae. In a control area from which *Pisaster* was not removed, there was little change in species diversity.

What is a "keystone"?

Community Ecology

III.

Main Idea: Disturbances play an important role in communities.

Main Idea: Disturbances influence the diversity of species and the composition of species found in a community.

DISTURBANCES INFLUENCE SPECIES DIVERSITY AND COMPOSITION

- **Disturbance-** an event that changes a community by removing organisms from it or altering resource availability.
  - Ex. storms, fire, floods, droughts, freezing, overgrazing, human activities

A. Disturbances

- Vary in frequency and severity in each community.
  - *high level disturbance* results from high intensity & frequency
  - *low level disturbance* result from low intensity or frequency

- **Intermediate Disturbance Hypothesis-** moderate levels of disturbance result in greater biodiversity than either high or low level disturbances.
  - high level disturbances exceed the tolerance of organisms
  - low level disturbances allow more competitive species to dominate
  - moderate level disturbances are rarely exceed the tolerance of organisms but may be great enough to create new niches for less competitive species

FIRE

(a) Before a controlled burn. A prairie that has not burned for several years has a high proportion of detritus (dead grass).

(b) During the burn. The detritus serves as fuel for fires.

(c) After the burn. Approximately one month after the controlled burn, virtually all of the biomass in this prairie is living.

B. Ecological Succession

- *Ecological Succession* occurs when a disturbed area is colonized by a group of species who are later replaced by other species, who are in turn replaced by other species and so on.
  - *Primary succession* begins in a lifeless area where soil has not even formed (exposed bare rock, volcanic islands)
  - This takes a *long time* to complete...on the order of hundreds to thousands of years
    - "First on the scene"... Prokaryotes and Protists
    - Second...Lichens and Moss (important in creating soil)
    - Third...Grasses, Fourth...Shrubs and Last to arrive...Trees

Mt. Hood, Oregon
Soil was washed away during flood exposing bare rock.

Because gravel/sand is loose lichens and moss do not colonize yet. Instead pioneer plants like *lupines* (nitrogen fixers)begin to build soil and retain moisture.

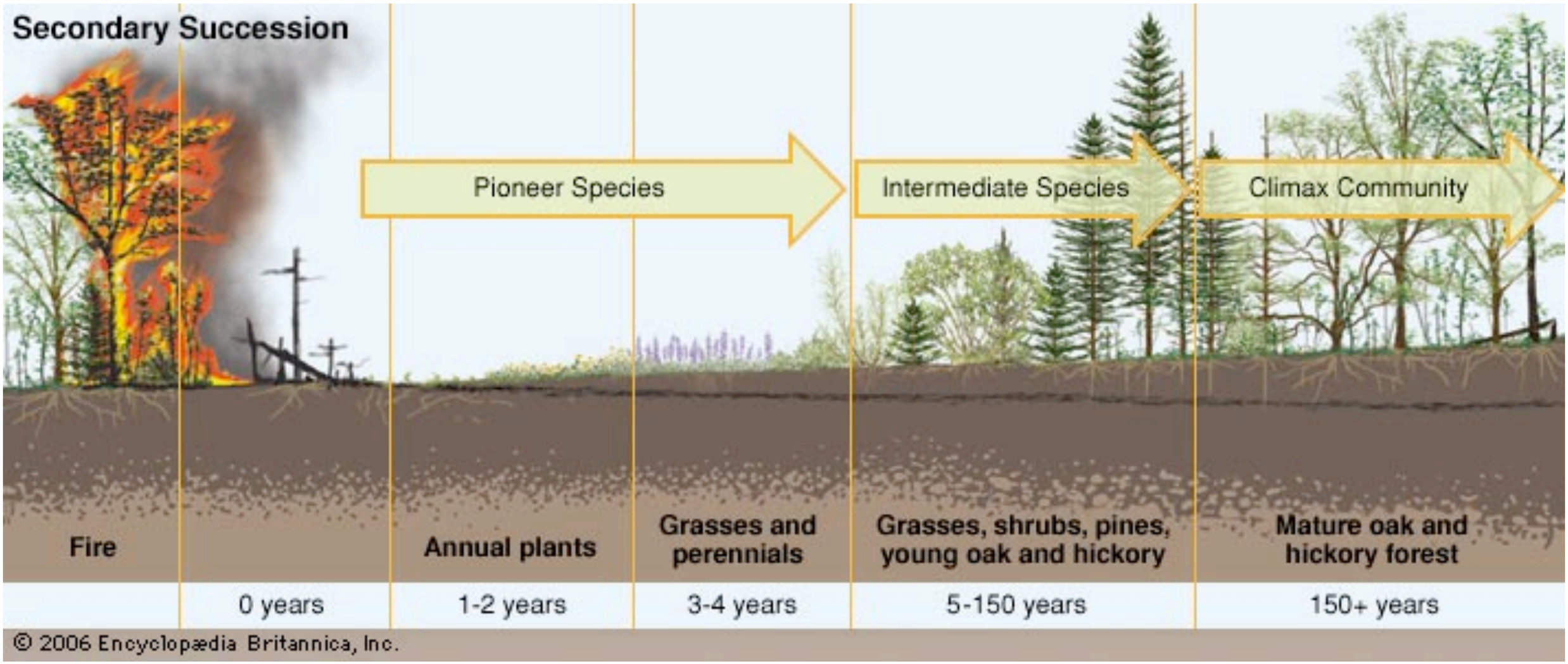
With some soil established and increased shade and moisture the moss and lichens move in and continue create soil.

As soil gets deeper small shrubs begin to appear.

Grasses and larger shrubs begin to appear. On addition saprotrophs (decomposers) continue to decompose dead organic matter and the soil becomes deeper or more nutrient rich.

With enough time the process above continues, soil gets deeper and more nutrient rich until it can one day support a climax community like this one.

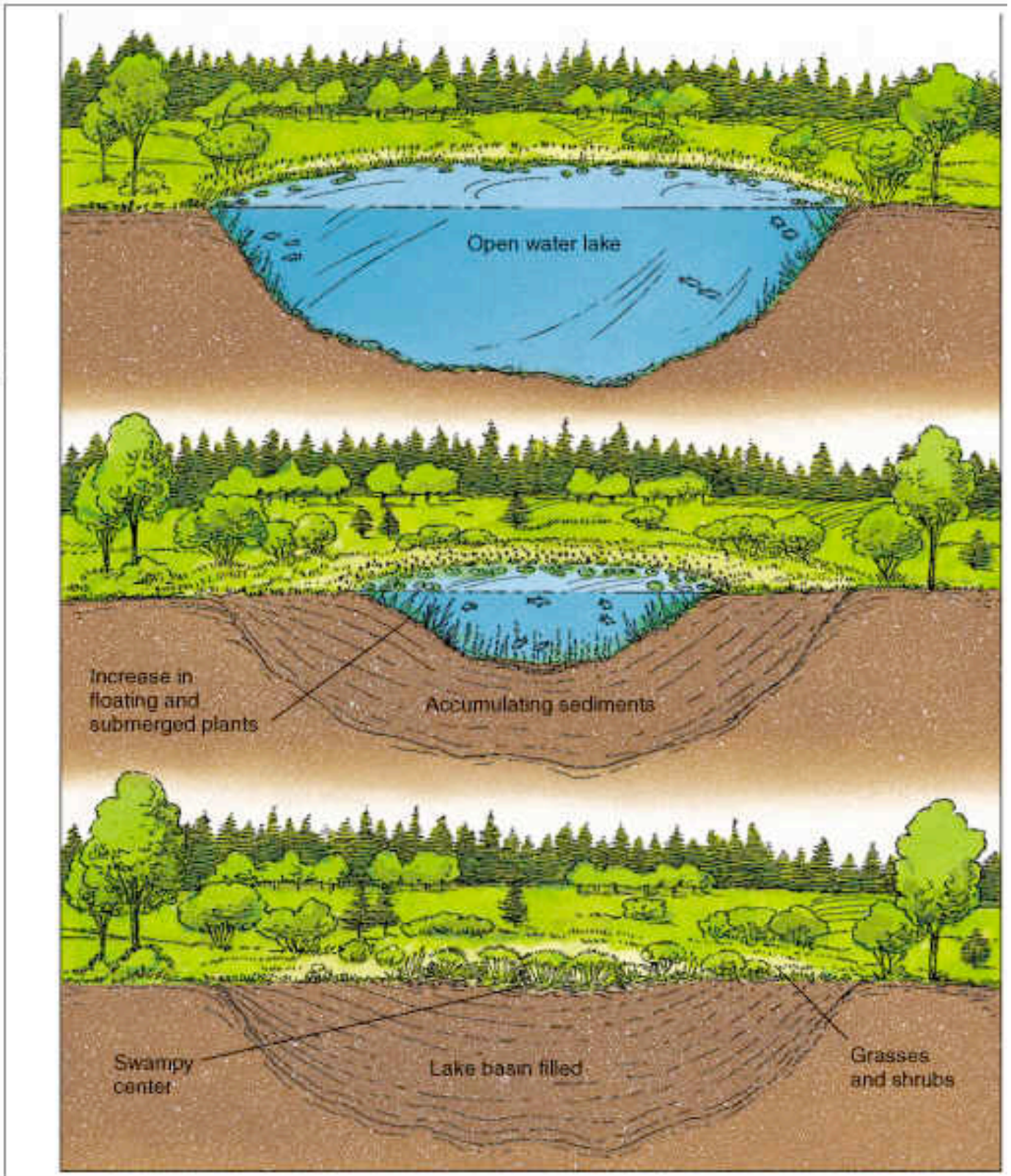
- *Secondary Succession* begins after an existing community (soil is present) has been cleared as a result of some disturbance.
- Time frame here is on the order of months to decades



Yellowstone 1988

Yellowstone 2009

Succession also occurs in aquatic communities



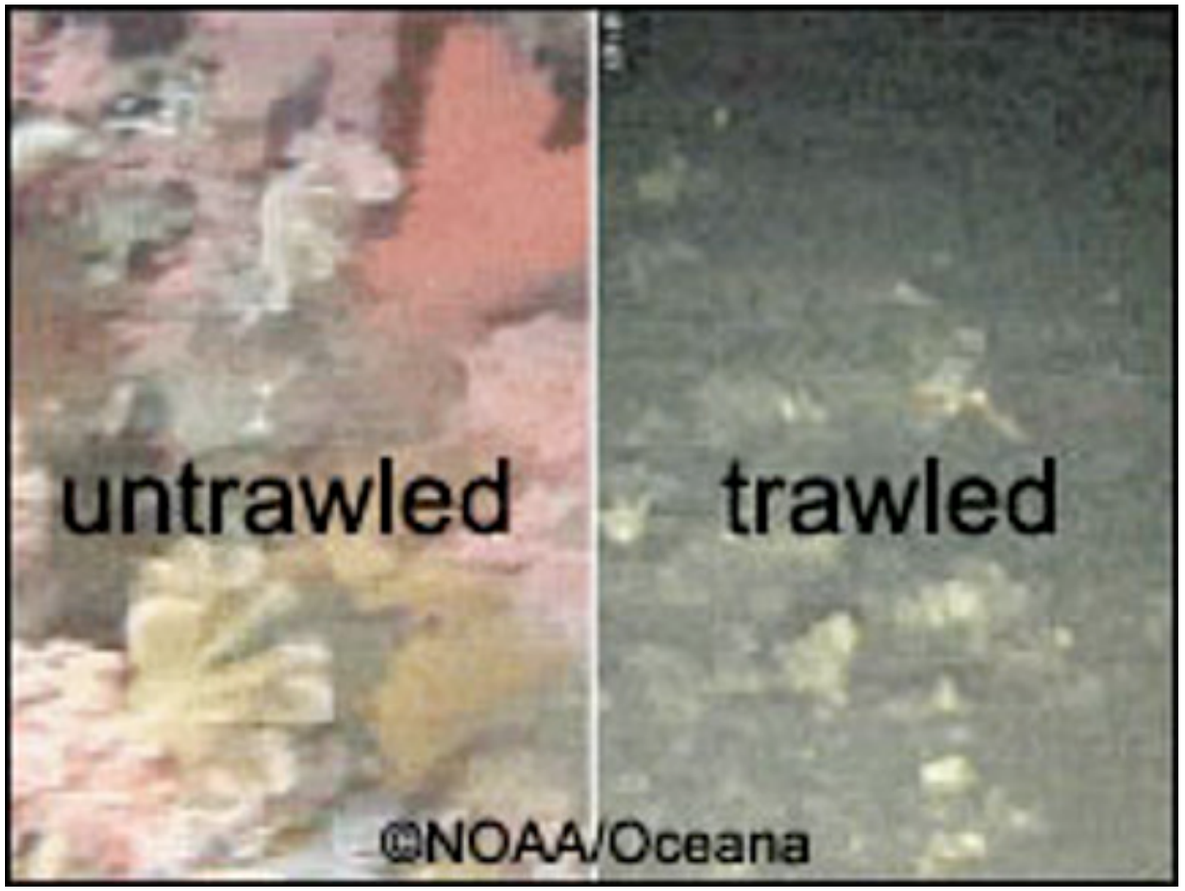
Caption

(a) What begins as a lake gradually fills with organic and inorganic sediments, which successively shrink the area of the pond. A bog forms, then a marshy area, and finally a meadow completes the successional stages. (b) Aquatic succession in a mountain lake. [Photo by Bobbé Christopherson.]

C. Human Disturbances

- The strongest agent of change today is...US.
  - Reasons include: agricultural development, urban development, logging, mining, trawling, and farming.

Case in Point- Ships can trawl over 15 million km^2 of ocean floor (annually). This is roughly the size of South America and 150x more than clear cut forests per year.



Community Ecology

IV.

Main Idea: Latitude and land area effect community diversity.

BIOGEOGRAPHIC FACTORS AFFECT COMMUNITY DIVERSITY

- Here we consider larger scale factors that affect biodiversity.

A. Latitude

- *Biodiversity is generally greater at the equator and decreases as you move towards the poles.*
  - **Climate**: Tropical climates receive more *solar energy* and *water* than polar communities

B. Area

- *All factors equal the greater the geographical area, the greater the biodiversity.*
  - more area = more habitats and niches