What is Ecology?

- Study of the abundance of organisms.
- Study of the myriad interactions among organisms and their environment.
- Includes both biotic and abiotic interactions/components.

Ecosystem Components

- **Biotic Components**
  - Autotrophs (inorganic to organic – reduce carbon compounds – fix energy – chemical or light)
  - Heterotrophs (rely on autotrophs or organic matter – macroconsumers (phagotrophs) – microconsumers (saprotrophs – decomposers)

- **Abiotic Components**
  - Inorganic molecules (C, H, N, P, S, Fe, Si, O – CO₂, H₂O)
  - Organic molecules (humus, non-bound carbon based molecules)
  - Substrate (parent material and age)
  - Climate (light, temp, precip)
What is Ecology?

- It is NOT: an attempt to __________ or to save __________.

Energy

Why do we have seasons?
The earth is __________ and takes a year to go around the sun.

Energy flows and material cycles.
**Energy in Ecosystems**

- **Ecosystems** = giant energy-transforming machines

![Pattern of energy flow within ecosystem (Hubbard Brook Forest)](image)

- **Gross primary production** = total energy assimilated by primary producers
- **Net primary production** = energy accumulated (in stored form) by primary producers
- **Gross - net = respiration (R)**, the energy consumed by producers for maintenance and biosynthesis

**Components of Primary Production**

- **Herbivore-based** (large animals feed on leaves, fruits, seeds)
- **Detritivore-based** (microorganisms and small animals consume dead remains of plants and indigestible excreta of herbivores)

- *Herbivores consume:*
  - 1.5-2.5% of net primary production in temperate forests
  - 12% in old-field habitats
  - 60-99% in plankton communities

**Simple ecosystem model**

- Includes biotic and abiotic
Where is biological production highest?

- Tropical and temperate biomes

Where is biological production low?

- Poles (cold)

Biomes

- In terrestrial ecosystems, defined

Biome character driven by climate

Climate is what you expect.

_____ is what you get.
North American Biomes

Is everywhere in Brown the same vegetative community and climate?

Adiabatic Cooling

- As increase in altitude, atmospheric pressure decreases.
- As temperature decreases, air can hold less water.
- RESULT: At higher altitude get cooler, wetter conditions.

Rain Shadow

- When combine with prevailing winds...
Buffelgrass (Pennisetum ciliare) is a perennial, fire-adapted and fire-prone grass native to Africa that was first introduced to the United States in the 1930s. The idea was to create better forage for cattle: Slaughter the wolves, shoot the jaguars and then introduce buffelgrass, and you’ve got yourself cow heaven on Earth, went the thinking. By 1990, it was all over Southern Arizona and Sonora, and it continues its explosive march across the desert landscape.

Buffelgrass absolutely love fire. It invades an area and it burns hot, killing all of the native Sonoran Desert plants that never adapted to fire. (Ponderosa pine forests are perfectly adapted to fire. Saguaro forests definitely are not. Forest fire = good. Desert fire = bad.)

Buffelgrass absolutely love fire. It invades an area and it burns hot, killing all of the native Sonoran Desert plants that never adapted to fire. (Ponderosa pine forests are perfectly adapted to fire. Saguaro forests definitely are not. Forest fire = good. Desert fire = bad.)

Two or three burn episodes like this, and you’re left with something resembling an African savannah: the Sonoran Desert is gone for good. The grass is exponential in its growth, starting out slow when it first sneaks into an area, then quickly overwhelming everything in its path.

Vast areas of the Mexican state of Sonora might as well be African savannah: a monocultural grassland where once (just 10, 20 or 30 years ago) stood the diverse cacti, trees and other plants we associate with the Sonoran Desert.

The situation is now so critical that a fire could conceivably start down in the desert, work its way up into the foothills, and burn all the way up into the forest in the Santa Catalinas, or vice versa. The gap that traditionally separated the forest from the desert is being bridged by buffelgrass and is setting the stage for a massive, fiery conflagration on an unprecedented scale.

**Community:** all species living in the same place at the same time.

Communities include lots of populations.

**Coexistence**

There must be mechanisms that permit similar species to coexist.

1. **Resource partitioning**
   
   Splitting up of shared, limiting resources.
   
   Example: varying root depths

**Patterns in Time**

Communities change over time, as well as space.

**Succession:** (orderly?) Changes in species colonizing, dying out in a given habitat over time.

How might succession and disturbance be related?

Because environment changes predictably over time...

**1. Primary succession**

begins with ________ present.

1. **Succession:** (orderly?) Changes in species colonizing, dying out in a given habitat over time.
1. **Primary succession**
   a. Nothing present
   b. Pioneer species invade
   c. Buildup of organic material
   d. Other species can colonize.

2. **Secondary succession**
   begins with well-developed soil, some seeds, some plants.

**Species Diversity**
... another way to describe & compare communities:
What species are present? How many?

**Species richness**:

<table>
<thead>
<tr>
<th>Region</th>
<th># Plant sp.</th>
<th>Plant sp./sq. mi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costa Rica</td>
<td>8,000</td>
<td>0.45</td>
</tr>
<tr>
<td>Coastal Calif.</td>
<td>3,050</td>
<td>0.12</td>
</tr>
<tr>
<td>Baja Calif.</td>
<td>1,500</td>
<td>0.06</td>
</tr>
<tr>
<td>Great Britain</td>
<td>1,600</td>
<td>0.01</td>
</tr>
</tbody>
</table>

useful.  even more useful.
• Why are certain combinations of species found together as members of a community?

Interaction Hypothesis

• F.E. Clements (around 1936)
  • A community is an assemblage of closely linked species
  • Species are locked together by interactions that cause communities to function as integrated
  • Community composition is a function of strict “assembly rules”

 Interaction Hypothesis

• Clements focused on forests, evaluating communities of different age

• Gives rise to a xxxxx view of “succession”
  - Pattern of replacement of species through time, following a disturbance

Criticisms of Interaction Hypothesis

• “Super-organism” concept

• Forrest Shreve - Carnegie Desert Laboratory at Tumamoc Hill, Tucson
  - Shreve worked in dry tropical forests, eastern deciduous forests and deserts

Individualistic Hypothesis

• H.A. Gleason (late 1930’s, early 1940’s)

• Communities are - of species found in the same area simply because they happen to have similar abiotic requirements

• “Assembly rules” are weak interactions
Individualistic Hypothesis

- Then how can there be "assembly rules"?
  - finite # of "strategies" for dealing with abiotic extremes (low resources, etc).
  - Due to the inter-relatedness of species

Major consequence from an individualistic view
  events dictate the pattern of replacement of species through time following a disturbance

Testing the hypotheses

- Predictions - Interaction hypothesis
  - Species should be clustered into discrete communities with distinct boundaries,
  - presence / absence of a particular species A is determined by the presence / absence of species B

Testing the hypotheses

- Predictions - Individualistic hypothesis
  - Communities should generally discrete geographical boundaries
  - each species has an INDEPENDENT distribution along environmental gradients

Testing the hypotheses

- Robert Whittaker
  - Evaluation of plant species across elevation gradients within a latitudinal gradient
    - (aside - can this determine causation?)
  - Plotting species with respect to the resource gradients produced by this descriptive study

Graphical prediction of the interaction hypothesis

- Numbers of individuals per area
  - Wet to dry
Santa Mtns – Whittaker transects

Numbers of individuals per area

Wet to dry

- Supports the individualistic hypothesis
- Does NOT say that species interactions are un-important in ecology!

Why are some species found consistently in the same assemblages?

- The support is for the individualistic theory of community ecology
- Species are consistently found together because they have overlapping constraints

Testing the hypotheses

- Jenkins and Buikema
- Artificial ponds - chance establishment of communities versus strict assemblage characteristics
  - Artificial ponds filled with sterile water
  - After one year, evaluate who (which species) are in the ponds
  - A total of 60 different species found. No community had more than 39, and all had different combinations
  - Supports the individualistic hypothesis