**Community Ecology**

- **Community**
  - all the organisms that live together in a place = interactions

- **Community Ecology**
  - study of interactions among all populations in a common environment

**To answer:** In what way do the populations interact?

**Energy Transfer**

- **Energy in**
  - from the Sun
  - captured by autotrophs = producers (plants)

- **Energy through**
  - food chain
    - transfer of energy from autotrophs to heterotrophs (herbivores to carnivores)
    - heterotrophs = consumers
      - herbivores
      - carnivores

**Food Chains**

- **Trophic levels**
  - feeding relationships
  - start with energy from the sun
  - captured by plants
    - 1st level of all food chains
  - food chains usually go up only 4 or 5 levels
  - inefficiency of energy transfer
  - all levels connect to decomposers (detritivores)

**Inefficiency of Energy Transfer**

- **Loss of energy between levels of food chain**
  - To where is the energy lost? The cost of living!
    - 17% growth
    - only this energy can move on to the next level in the food chain
    - 33% cellular respiration
    - energy lost to daily living
    - 50% waste (feces)

**Ecological Pyramid**

- **Loss of energy between levels of food chain**
  - can feed fewer animals in each level

- Numbers

```
<table>
<thead>
<tr>
<th>Level</th>
<th>Numbers</th>
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</thead>
<tbody>
<tr>
<td>Tertiary consumers</td>
<td>1</td>
</tr>
<tr>
<td>Secondary consumers</td>
<td>100</td>
</tr>
<tr>
<td>Primary consumers</td>
<td>1,000</td>
</tr>
<tr>
<td>Primary producers</td>
<td>1,000,000,000</td>
</tr>
</tbody>
</table>
```

- 1,000,000 J of sunlight
Humans in Food Chains
- Dynamics of energy through ecosystems have important implications for human populations
  - how much energy does it take to feed a human?
    - if we are meat eaters?
    - if we are vegetarian?

Food Webs
- Food chains are linked together into food webs
- Who eats whom?
  - a species may weave into web at more than one level
    - bears
    - humans
    - eating meat?
    - eating plants?

BioMagnification
- Energy pyramid
  - toxins concentrate as they move up the food chain
    - DDT is good for me!?

BioMagnification
- PCBs
  - General Electric manufacturing plant on Hudson River
  - PCBs in sediment
  - striped bass nesting areas

Niche
- An organism’s niche is its ecological role
  - habitat = address vs. niche = job

Niche & Competition
- Competitive Exclusion
  - No two similar species can occupy the same niche at the same time
Resource Partitioning
Reduce competition through microhabitats

“the ghost of competition past”

A. nicolli
A. distinctus
A. cristata
A. cypsela
A. etheridgei

Interspecific Interactions

Symbiotic interactions

- competition (-/−)
  - compete for limited resource
  - competitive exclusion
- predation / parasitism (-/+)
- mutualism (+/+)
  - lichens (algae & fungus)
- commensalism (+/0)
  - barnacles attached to whale
- amensalism (+/-)
  - animals killing plants while drinking water

Predation Drives Evolution

Predators adaptations
- locate & subdue prey
Prey adaptations
- elude & defend
  - horns, speed, coloration

Defense Mechanisms

Camouflage
- cryptic coloration

Warning “Aposematic” Coloration

Bright warning to predators

Predation provides a strong selection pressure on both prey & predator.

spines, thorns, toxins
Mimicry

Batesian mimicry
palatable or harmless species mimics a harmful model

Hawkmoth larva puffs up to look like poisonous snake

Mullerian mimicry
two or more protected species look like each other

- group defense?
- predators may evolve innate avoidance

Characterizing a Community

Community structure
- species diversity
  - how many different species
- composition
  - dominant species
  - most abundant species or highest biomass (total weight)
- keystone species
  - key role
  - strong effect on composition of the community

Coevolution in Community

- Predator-prey relationships
- Parasite-host relationships
- Flowers & pollinators

Long term evolutionary adjustments between species

Keystone Species

Influential ecological role
- exert important regulating effect on other species in community
- keystone species increases diversity of habitat

With Pisaster (control)
- diversity increases
- diversity decreases
- mussels out-compete other species

Without Pisaster (experimental)
- diversity decreases
- mussels out-compete other species

Pisaster ochraceous
Sea star
Washington coast
Keystone Species
Sea otter is a keystone predator in North Pacific

Keystone Species
Beaver is a keystone species in Northeast and West

dams transform flowing streams into ponds creating new habitat

Ecological Succession
- Sequence of community changes
  - transition in species composition over time
    - years or decades
  - usually after a disturbance

What causes succession?
- Tolerance
  - early species are weedy r-selected
  - tolerant of harsh conditions
- Facilitation & Inhibition
  - early species facilitate habitat changes
    - change soil pH
    - change soil fertility
    - change light levels
  - allows other species to out-compete

Primary Succession
- Begins with virtually lifeless area without soil, then...
  - bacteria
  - lichens & mosses
  - grasses
  - shrubs
  - trees

Secondary Succession
- Existing community cleared, but base soil is still intact
  - burning releases nutrients formerly locked up in the tissues of tree
  - the disturbance starts the process of succession over again
Succession of Species

- Pioneer species
- Lichens & mosses
- More shade tolerant species
- Grasses
- Bushes & small trees
- Trees
- Compete well in high sunlight
- Climates forest
- Shade tolerant species
- Stable community

Climax Forest

- Plant community dominated by trees
- Representing final stage of natural succession for specific location
- Stable plant community
- Remains essentially unchanged in species composition as long as site remains undisturbed
  - Birch, beech, maple, hemlock
  - Oak, hickory, pine

Disturbances

- Most communities are in a state of non-equilibrium due to disturbances
  - Fire, weather, human activities, etc.
  - Not all are negative

- Before a controlled burn
- During the burn
- After the burn

Disturbances as Natural Cycle

- Disturbances are often necessary for community development & survival
- Release nutrients
- Increases biodiversity
- Increases habitats
- Rejuvenates community

Deforestation

- Loss of habitat
- Loss of biodiversity
- Loss of stability

Effects of Deforestation

- 40% increase in runoff
- Loss of water
- 60x loss in nitrogen
- 10x loss in calcium

Concentration of nitrate (mg/l)

- Nitrate levels in runoff
- Loss into surface water
- Loss out of ecosystem

Year

1965 1966 1967 1968
Fragmented Habitat

- Loss of habitat
- Loss of food resource for higher levels on food chain
- Loss of biodiversity
- Loss of stability

Species Diversity

- greater diversity = greater stability
  - Greater biodiversity offers:
    - more food resources
    - more habitats
    - more resilience in face of environmental change

The Impact of Reduced Biodiversity

compare these communities

- agricultural "monoculture"
- "old field"

- Irish potato famine
- 1970 US corn crop failure

Loss of Diversity

- 3 levels of biodiversity
  - genetic diversity
    - inbreeding with shrinking populations
  - community diversity
    - mix of species
  - ecosystem diversity
    - different habitats across landscape
  - All decreased by human activity

Driven to Extinction

Biodiversity hot spots

Restoration projects