**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

**Ecosystem Inputs**

- energy flows through

**Ecological Communities**

- **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
  - ~50% waste (feces)
  - energy lost to daily living
Ecological Pyramid
- Loss of energy between levels of food chain
  - can support fewer organisms at each level
    - 10^10 J
    - 10^7 J
    - 10^4 J
    - 10^2 J
    - 10^0 J

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 concentration: increase of 10 million times

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
  - Competitive Exclusion
    - If Species 2 is removed, then Species 1 will occupy whole tidal zone. But at lower depths Species 2 out-competes Species 1, excluding it from its potential (fundamental) niche.
Niche & Competition

- **Competitive Exclusion**
  - No two similar species can occupy the same niche at the same time

Interspecific Interactions

- **Symbiotic interactions**
  - *competition* (-/-)
    - compete for limited resource
    - competitive exclusion!
  - *predation / parasitism* (-/+)
  - *mutualism* (+/+)
    - lichens (algae & fungus)
  - *commensalism* (+/0)
    - barnacles attached to whale

Predation Drives Evolution

- **Predators adaptations**
  - locate & subdue prey
- **Prey adaptations**
  - elude & defend
    - horns, speed, coloration
  - spines, thorns, toxins
  - Predation provides a strong selection pressure on both prey & predator.

Resource Partitioning

- Reduce competition through microhabitats
  - "the ghost of competition past"
  - sympatric speciation!

Symbiosis

- **mutualism** +/+  
  - lichens (algae & fungus)
- **commensalism** +/0  
  - barnacles attached to whale
- **predation** +/-
- **competition** -/-

Defense Mechanisms

- **Camouflage**
  - *cryptic coloration*

Predation provides a strong selection pressure on both prey & predator.
Warning “Aposematic” Coloration
- Bright warning to predators

Batesian Mimicry
- Convergent evolution
  - Palatable or harmless species mimics a harmful model

Hawkmoth larva puffs up to look like poisonous snake

Convergent evolution
- Predators-prey relationships
- Parasite-host relationships
- Flowers & pollinators

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

Keystone Species
- Influential ecological role
  - Exert important regulating effect on other species in community
  - Keystone species increases diversity of habitat

Pisaster ochraceous
- Sea star
- Diversity increases
  - With Pisaster (control)
  - Without Pisaster (experimental)

Washington coast
Keystone Species
- Sea otter is a keystone predator in North Pacific
  - Focal chain before killer whale introduced in 1980
  - Focal chain after killer whale started preying on others

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
- Mt. St. Helens

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
  - Disturbance starts the process of succession over again
Succession of Species

- Pioneer species
  - lichens & mosses
  - grasses
- More shade tolerant species
  - bushes & small trees
- Shade tolerant species
- Climax forest

- Compete well in high sunlight
- More shade tolerant species

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

Disturbances as Natural Cycle

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

When people don’t learn ecology!

Building homes in fire climax zones

Deforestation

- Loss of habitat
- Loss of biodiversity
- Loss of stability
Effects of Deforestation

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

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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

Simpson’s Diversity Index

- Quantifiable measure of biodiversity

\[
\text{Diversity Index} = 1 - \sum \left( \frac{n}{N} \right)^2
\]

- \(n\) = total number of organisms of a particular species
- \(N\) = total number of organisms of all species

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