**Ecosystem Ecology**

- One-way flow of energy through the trophic levels
- A cycling of materials from abiotic to biotic and back

**Ecosystem**

**Primary Production**

- Initial capture of energy into the ecosystem
- Photosynthesis
- Two types of PP
  - Gross
  - Net

<table>
<thead>
<tr>
<th>Community</th>
<th>Net PP (g/m²)</th>
<th>Total Area (mill. Km²)</th>
<th>World NPP (bill. tons/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desert</td>
<td>90</td>
<td>18</td>
<td>1.6</td>
</tr>
<tr>
<td>Temperate Forest</td>
<td>1240</td>
<td>12</td>
<td>14.8</td>
</tr>
<tr>
<td>Trop. Rain Forest</td>
<td>2200</td>
<td>17</td>
<td>37.8</td>
</tr>
<tr>
<td>Lakes/ Streams</td>
<td>250</td>
<td>2</td>
<td>0.5</td>
</tr>
<tr>
<td>Open Ocean</td>
<td>125</td>
<td>332</td>
<td>41.5</td>
</tr>
<tr>
<td>Reefs/ Algal Beds</td>
<td>2500</td>
<td>0.6</td>
<td>1.6</td>
</tr>
</tbody>
</table>

**Bottom-up Model**

Increased Productivity:
- increased trophic levels supported
- higher biomass at all trophic levels

**What limits primary production in ecosystems?**

- Marine: light and nutrients
- Freshwater: light, nutrients, pollution
- Terrestrial: light, water
Secondary Production

- Energy flow
- Rate
- Ecological efficiency

Three hundred trout are needed to support one person for a year. The trout, in turn, must consume 90,000 frogs, that must consume 27 million grasshoppers that live off of 1,000 tons of grass.

— G. Tyler Miller, Jr., American Chemist (1971)
Where does this energy/biomass go?

For example: CATERPILLAR

Digest/Absorb: 1/2 of what they eat. Of this:

- 2/3 absorbed goes to cellular respiration (CO₂, H₂O, heat)
- 1/3 absorbed is added BIOMASS at that level

Energy pyramid

Energy lost
Biogeochemical cycles

- Water, nitrogen, carbon, phosphorous, etc...
- Involve geological (atmosphere, lithosphere, hydrosphere) and biological (trophic levels) components
Direct values
- Private goods or commodity values
- Harvested
  - Meat
  - Fuelwood/timber
  - Edible/medicinal plants
- Consumptive and productive use

Indirect values
- Public goods, nonconsumptive use value
- Benefits from biodiversity not involving harvesting or destroying
  - Ecosystem productivity
  - Water quality
  - Soil protection
  - Climate
  - Flood control
  - Waste treatment and nutrient retention

Example: River vegetation

<table>
<thead>
<tr>
<th>Table 1. Benefits from river corridor vegetation (after Pettis, 1999)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Regulation of flow by wetland vegetation</td>
</tr>
<tr>
<td>2 Regulation of water quality: example and riparian wood</td>
</tr>
<tr>
<td>3 wood are efficient sinks for N and P</td>
</tr>
<tr>
<td>4 Input of organic food for the aquatic community</td>
</tr>
<tr>
<td>5 Stabilising of channels and bank</td>
</tr>
<tr>
<td>6 Creation of habitats for aquatic wildlife: natural</td>
</tr>
<tr>
<td>7 Ecosystem productivity</td>
</tr>
<tr>
<td>8 Production of timber products from riparian forest</td>
</tr>
<tr>
<td>9 Creation of habitats for terrestrial wildlife</td>
</tr>
<tr>
<td>10 Enhanced landscape quality</td>
</tr>
</tbody>
</table>

Ecosystem productivity
- Primary productivity-energy
- Terrestrial and aquatic
- Diversity-productivity relationship

Soil and water resources
- Buffering ecosystems
  - Flood
  - Drought
  - Water quality
- Logging, farming, development affect soil erosion
  - Useless for farming
  - Kill aquatic life
  - Water undrinkable
  - Loss of electrical output
Climate regulation
- Local: shade, water transpiration, windbreaks
- Regional: deforestation → lower rainfall, lower uptake of CO2 (global warming)

Waste treatment/nutrient retention
- Aquatic communities (fungi and bacteria)
- Break down/immobilize pollutants (2.4 trill)
- Store sewage and nutrient runoff for photosynthetic organisms & nitrogen fixing
- New York Bight

Species relationships
- Predation (bottom-up and top-down)
- Pollination
- Microorganisms

Recreation and ecotourism
- Enjoyment!
- Hiking, fishing, camping, rock climbing, bird watching
- Ecotourism- to experience unusual communities

Option value
- Future potential to provide an economic benefit to human society
- Genetic improvement to crops- disease resistance, harvest increase…
- Biological control
- Medicinal

Existence value
- Value attached to preventing extinction of species, habitat destruction, genetic degradation
- Use of flagship species (charismatic megafauna)