APES – Chapter 3 – Ecosystem Ecology

Intro: Reversing the Deforestation of Haiti

Why is Haiti cutting down its trees?

What are the consequences of deforestation?

What are the solutions being put into play?

I. Ecosystem Components

A combination of BIOTIC and ABIOTIC factors.

Biotic –

Abiotic –

A. **Ecosystem Boundaries** – can be difficult to delineate the "edges" of many ecosystems.

From the standpoint of management the natural boundaries may not align with the administrative, municipal, state, national boundaries.

Ex: Yellowstone National Park and the Greater Yellowstone Ecosystem

B. **Ecosystem Processes** – energy and matter flow from one ecosystem to another.

II. Energy Flows Through Ecosystems

A. **Photosynthesis** – the activities of solar-powered producers

B. **Cellular Respiration** – unlocking the stored chemical energy from cells and organic molecules.

Note: Overall, because producers photosynthesize more than they respire, more (excess) oxygen is produced, and more carbon is stored in tissues.

C. **Trophic Levels** – (see fig. 3.5, page 61)

Producers (Autotrophs) – may be photosynthetic or chemosynthetic

Consumers (Heterotrophs) – have evolved to exploit numerous feeding strategies.

Primary Consumers – Herbivores

Secondary Consumers – Carnivores

Tertiary Consumers – Higher level carnivores, and so on…

Other Consumers:

Omnivores – generalist consumers such as bears, raccoons, humans, some fish, etc, that feed at various levels, based on necessity and opportunity.

Scavengers – specialized consumers that eat dead animals.

Detritivores – specialized consumers of detritus (dead plant matter and animal wastes) which is broken down into smaller particles.

Decomposers – fungi and bacteria that complete the breakdown and recycling of nutrients back into the ecosystem.

III. Ecosystem Productivity

A. **Gross Primary Productivity (GPP)** – the total amount of solar energy captured by producers in an ecosystem in a given amount of time.

B. **Net Primary Productivity (NPP)** – the gross primary productivity minus the energy that is lost as organisms respire (metabolize, grow, reproduce, etc.)

So that means: NPP = GPP – R

We can think of NPP as any new biomass* that is accumulated and stored during growth and reproduction.

As a rule, about **1%** of the incoming solar radiation is captured by Earth's producers during Photosynthesis…for GPP.

Most of that captured energy will be lost to Respiration (the cost of living).

The remainder can be stored, supporting growth, repair, reproduction, and is available as food to consumers (as carbos, lipids, proteins, etc.)...i.e. NPP

C. **Comparisons of NPP** for various ecosystems (See fig. 3.8, page 64)

Productivity is generally related to the availability of:

1.

2.

3.

4.

- **Biomass** = the total dry weight or organic matter in a defined area or organism.

  Standing crop = the amount of biomass present in ecosystem at any time.

	Slow-growing forest	Open Ocean algae
Productivity		
Standing Crop		

Changes in NPP are often used to assess the health of ecosystems.

D. **Energy Transfer Efficiency** – the proportion of consumed energy that can be passed from one trophic level to another.
Energy Efficiencies tend to range from 5 to 20% in ecosystems.
The average is about 10%, hence **"the 10% Rule"** (see fig. 3.9, p. 65)

Trophic Pyramids
In general, most of the Energy (and Biomass) is at producer level (base).

Often a **Pyramid of Numbers** (Populations) at each level will mirror Pyramid of Energy. There are exceptions:

Ecological Efficiency – implications for human diet…
Read the example on p. 65 about soybeans and beef…consider variations on this theme:

IV. Matter Cycles Through the Biosphere

Biosphere = combination of all ecosystems on Earth

Biogeochemical Cycles involve process that are…
Biological –

Geological –

Chemical –

Some basic terms:

Pools = components that contain matter such as air, water, organisms

Flows = processes that move matter between pools

Sinks = very long-term pools where nutrients remain nutrients remain "out of circulation".

A. **Hydrologic Cycle** – essential to the cycling of elements in the nutrient cycles.
See fig. 3.10, p. 67 – know all processes, trace a molecule thru cycle…
What human activities influence this cycle?
What are consequences of human changes to the natural cycling of water?

B. **Carbon Cycle** – (see fig. 3.11, p. 68)
Know all processes, trace a Carbon atom thru the cycle…
How does fast cycling of Carbon differ from slow cycling?
What are the major sinks for Carbon?
What forms does Carbon take?
What human activities disrupt the steady state of this cycle?
What are the consequences of these human-induced alterations?

C. **Nitrogen Cycle** – (see fig. 3.12, p. 70)
Know all processes, trace a Nitrogen atom thru the cycle…
In what ways is this cycle dominated by specialized bacteria?
Chemistry of these processes – describe role of oxidation and reduction.
What are the major sinks for Nitrogen?
What forms does Nitrogen take?
What human activities disrupt the steady state of this cycle?
What are the consequences of these human-induced alterations?

D. **Phosphorus Cycle** – (see fig. 3.13, p. 72)
Know all processes, trace a Phosphorus atom thru the cycle…
Why is P considered a limiting factor in ecosystems?
What are the major sinks for Phosphorus?
What forms does Phophorus take?
What human activities disrupt the steady state of this cycle?
What are the consequences of these human-induced alterations, especially with respect to aquatic ecosystems and terrestrial plant communities?

E. Other Nutrients: Calcium, Magnesium, Potassium, Sulfur

Importance of Ca, Mg, K?

Importance of S?

What human activities disrupt the steady state of Sulfur cycling?
What are the consequences of excess Sulfur in the atmosphere?

V. Ecosystems Respond to Disturbance

What is disturbance?

A. **Watershed Studies** – what is a watershed?

Ex: Hubbard Brook – where is it, and what is going on there?

B. Resistance vs. Resilience

C. **The Intermediate Disturbance Hypothesis** (see 3.19, p. 76)

VI. Ecosystems Provide Valuable Services

A. Instrumental Values:

1. Provisions
2. Regulatory Services
3. Support Systems
4. Resilience
5. Cultural Services

B. **Intrinsic Values** – stem from religious or philosophical convictions
Ecosystems / organisms have value independent of human benefit.
Ecosystems / organisms have inherent moral right to exist.
We (humans) have a moral obligation to protect ecosystems / organisms.

Working Toward Sustainability-
Can We Make Golf Greens Green? (p. 80-81)

List reasons why golf courses have had bad environmental reputation?
Bad practices:

Recommendations from Audubon Cooperative Sanctuary Program:

Challenges for the future?