Chapter 6

Ecosystems and Ecosystem Management

Case Study- The Acorn Connection

This case study illustrates a very complex system of interactions involving mice, deer, ticks, gypsy moths, acorns and Lyme disease. In a study funded National Science Foundation, scientists discovered how population cycles of mice, deer, deer, and acorns interact to cause periodic outbreaks of Lyme disease. This case also highlights the need for long-term observations. These cycles were only discovered after years of careful measurements.

6.1 THE ECOSYSTEM: SUSTAINING LIFE ON EARTH

Sustained life on earth is a property of ecosystems. It is that level of organization that is required for sustained life, that is, sustained life requires a relatively stable community of species interacting with their environment and with each other. No species can survive in the absence of other species.

● Characteristics of ecosystems

- Structure: Ecosystems have structure consisting of living and nonliving parts. Ecosystems have organization. That is, the structural parts are arranged in a hierarchical fashion and the parts interact. The biological part of the structure is the **community**… the plants, microbes, and animals that live there. And an ecosystem has processes or functions. The plants and animals interact in a variety of ways, including the ways in which they feed on one another. A functional aspect of ecosystems is how energy and materials are transferred to one another along **food chains**. Food chains form a **food web**.
- Processes: biogeochemical cycling and energy flow
- Change: Ecosystem undergo continual change, some changes are predictable, e.g. **succession**, some are not.

● Communities, Food Webs, and Trophic Structure

The species that live in an ecosystem can be classified according to their function or the way they derive energy or trophic groups:

primary producers, also autotrophs (self feeders)
consumers
heterotrophs
carnivores
omnivores
decomposers

Put another way, the organisms in a food web can be parsed into **trophic levels**. The trophic level of an organism is its position in the food web relative to the primary

producers (the entry level for energy flow or **first trophic level**). Herbivores constitute the **second trophic level,** carnivores the third, and decomposers the fourth.
● Food web examples: terrestrial, oceanic. These examples are highly aggregated and simplistic. Real food webs are very complex, and if one includes all species of insects and microbes, the number of species in a food web is probably in the 1000s.

6.2 THE COMMUNITY EFFECT

● Every population or species in a food web is directly or indirectly connected to every other population or species.
● Some species, termed **keystone species**, exert a major control over all other species. The otter example is a classic. The presence or absence of this single species has a major impact on the structure of the community. These types of interactions are difficult to predict. We discover them through careful experimentation (e.g. Paine's star fish/rocky tidal example) or by accident (the otter example).

A CLOSER LOOK 6.1: Hot Spring Ecosystems in Yellowstone NP

●One of the simplest ecosystems is probably a hot springs where extreme conditions limit the number of organisms. The first trophic level is composed of photosynthetic bacteria and algae (Fig. 6.4). The second level is composed of several species of fly larvae. The third level consists of a carnivorous fly, dragonflies, wasps, spiders and birds. Then there are decomposers or saphrotrophs that make up a fourth level.

6.3 HOW DO YOU KNOW WHEN YOU HAVE FOUND AN ECOSYSTEM?

● An ecosystem is the minimal entity that has all the properties required to sustain life. But how do you know? In practice ecosystems are defined for practical reasons using geomorphological boundaries such as the boundary of a watershed or the boundaries of a pond. See Critical Thinking Issue: How Are the Borders of an Ecosystem Defined?

6.4 ECOSYSTEM MANAGEMENT

● With respect to the management of natural resources (forests, parks, defense properties, fisheries, etc.), ecosystem management is becoming the mantra. We have learned that you really cannot manage a population or other renewable natural resource without managing its ecosystem. The salmon fishery is a perfect example. The salmon population cannot be managed without managing the watersheds of the rivers in which it spawns, the logging, the quality of the water, the hydroelectric energy production, and the predator populations that feed on the salmon (including people).
● Ecosystems can be natural or artificial. Agroecosystems are examples of artificial ecosystems, but by our definition of an ecosystem as the minimal entity that sustains life, is a farm and ecosystem? Urban ecosystems are clearly not self-sustaining. They take inputs from all over the planet. Though ecosystems have a theoretical definition, they are practically defined.

CRITICAL THINKING

● How do you define the boundaries of an ecosystem?

● Could human life be sustained by converting the entire terrestrial surface of the earth into a few crops of one kind or another? The answer to this question will be revealed later on when we discuss biodiversity, but you can prime your students with this provocative question now.

● Can humans engineer a self-sustaining ecosystem? The answer to this question has practical importance. For example, if we are to send people on a long mission of space exploration, perhaps requiring years, it will may be necessary to send them in a ship that contains an ecosystem. The space ship ecosystem would provide the food, recycle the waste, and provide the oxygen. Biosphere II was an attempt to engineer an ecosystem. It failed, but much was learned from the failure.

WEB LINKS

http://www.iucn.org/themes/cem/ This web site of the World Conservation Union contains excellent case studies of ecosystem management.

http://www.epa.gov/ebtpages/ecosystems.html An EPA portal to ecosystems. EPA defines an ecosystem as a place having unique physical features, encompassing air, water, and land, and habitats that support plant and animal life. Ecosystems management is a philosophy the EPA embraces and this site contains examples of the practice of ecosystem management and links to ongoing research.

http://www.esa.org/science_resources/issues.php This site, maintained by the Ecological Society of America, provide some excellent and publicly accessible technical reports. In particular http://www.esa.org/science_resources/issues/FileEnglish/issue2.pdf is a link to the a publication by Gretchen C. Daily, Susan Alexander, Paul R. Ehrlich, Larry Goulder, Jane Lubchenco, Pamela A. Matson, Harold A. Mooney, Sandra Postel, Stephen H. Schneider, David Tilman, and George M. Woodwell "Ecosystem Services: Benefits Supplied to Human Societies by Natural Ecosystems" with an excellent summary of ecosystem services with references.

http://earthtrends.wri.org/updates/node/118 A site with information on the value of coastal ecosystems.