Lecture 1 – Introduction to Ecology

READINGS FOR NEXT LECTURE:

- ☐ Krebs Chapter 1: Introduction to the Science of Ecology
- ☐ Redox Handout (please work through the example problems). (H, W)
- ☐ Vernadskii (1926). The Biosphere. (H, W)
- ☐ Rowe (1992). Biological Fallacy: Life Equals Organisms. (H, W)
- ☐ Remmert (1980). Ecology: The Basic Concept. (H, W)

Outline for today:

I. What is ecology?
II. Why study ecology?
III. How to study ecology?
IV. Where to study ecology?
V. How will we learn about ecology?

RECITATIONS NEXT WEEK (9/8 and 9/11):

I. What is ecology?

origin of word:

oikos = the family household
logy = the study of

interesting parallel to *economy* = management of the household
many principles in common – resources allocation, cost-benefit ratios

definitions:

Haeckel (German zoologist) 1870: "By ecology we mean the body of knowledge concerning the economy of Nature - the investigation of the total relations of the animal to its inorganic and organic environment."

Burdon-Sanderson (1890s): Elevated Ecology to one of the three natural divisions of Biology: Physiology - Morphology – Ecology

Andrewartha (1961): "The scientific study of the distribution and abundance of organisms."

Odum (1963): "The structure and function of Nature."

Definition we will use (Krebs 1972):

"Ecology is the scientific study of the processes regulating the distribution and abundance of organisms and the interactions among them, and the study of how these organisms in turn mediate the transport and transformation of energy and matter in the biosphere (i.e., the study of the design of ecosystem structure and function)."

The goal of ecology is to understand the principles of operation of natural systems and to predict their responses to change.

What ecology is not

Ecology is not environmentalism, nor "deep ecology." Ecology is science, based on biological, physical and chemical principles, and should be value-free. Environmentalism advocates for certain actions and policy positions.

II. Why study ecology?

Curiosity – How does the world around us work? How are we shaped by our surroundings?

Responsibility – How do our actions change our environment? How do we minimize the detrimental effects of our actions? Overfishing, habitat destruction, loss of biodiversity, climate change.

Nature as a guide – The living world has been around much longer than we have and has solved many problems with creative solutions. Ecological systems are models for sustainability. How can we feed our growing population? Where will we live?

Sustainability – a property of human society in which ecosystems (including humans) are managed such that the conditions supporting present day life on earth can continue.

Ecology helps us understand complex problems.

Examples:

- Cane toads in Australia
- Feral pigs in Hawai'i
- Nile Perch in Lake Victoria
- Wolves in Yellowstone

III. How to study ecology?

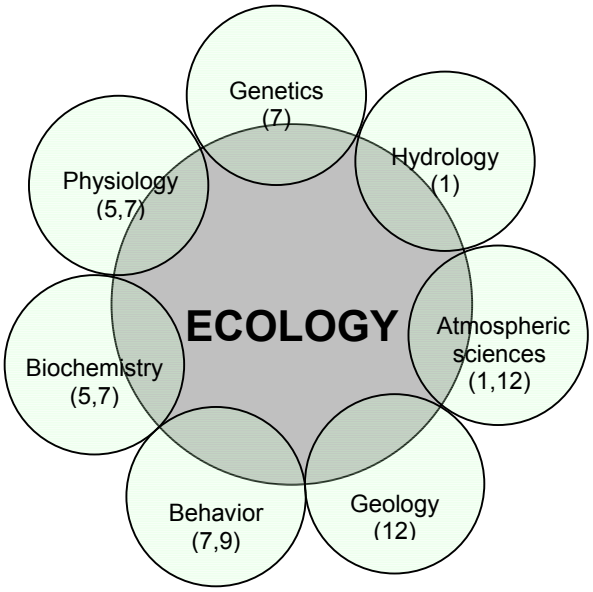
What kinds of experiments do ecologists perform?

Observations – Go into the field and see what's happening

Microcosms – Isolate a portion, limit factors, manipulate conditions.

Mathematical models – Describe ecosystems interactions as equations.

Connections to other disciplines :



adapted from *Elements of Ecology*, R.L. Smith and T.M. Smith, 4th Ed.

IV. Where to study ecology?

Organism ⇐ **(Tissues)** ⇐ **Organelle** ⇐ **Molecule** ⇐ **Atom**

⇓

Population: Group of interacting and interbreeding organisms.

⇓

Community: Different populations living together and interacting.

⇓ Populations can interact as competitors, predator and prey, or symbiotically.

Ecosystem: Organisms and their physical and chemical environments together in a particular area.

⇓ "The smallest units that can sustain life in isolation from all but atmospheric surroundings."

Biome: Large scale areas of similar vegetation and climatic characteristics.

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Biosphere: Thin film on the surface of the Earth in which all life exists, the union of all of the ecosystems. This is a highly ordered system, held together by the energy of the sun.

When is an organism not an organism?

Populations are shaped by their abiotic surroundings, and, in turn, change their abiotic surroundings.
For example, O_2 in atmosphere from photosynthesis. Others?

These levels of organization do not exist in isolation. There are feedbacks between the largest and smallest scales.

Interactions among different levels lead to emergent properties.

Principle of hierarchical control (Odum): "As components combine to produce larger functional wholes in hierarchical series, new properties emerge. That is, one cannot explain all the properties at one level from an understanding of the components at the one below."

V. How will we learn about ecology?

Start with energy flows
- At the individual level, how do organisms "make a living"?
- At the ecosystem level, how does energy move around?

Move on to nutrients
- How does nutrient availability limit organism growth?
- On an ecosystem and global scale, how do organisms fit in to global nutrient cycles?

Then focus on populations and communities
- Numerical models of the growth of individual populations
- Then apply these to model competition between populations for the same resources
- Metrics of species diversity and responses of communities to changes

Study questions

- Give an example of organisms modifying their surroundings (not mentioned in class).
- What is the relationship between ecology and environmentalism? Where does Remmert see ecology fitting in to broader societal problems?
- Why does Remmert call green plants “the first great polluters of the environment”?
- What is an invasive species? Why do they pose such a serious problem for ecologists?
- Give an example of an ecosystem, and explain what the associated community would consist of.
- What kinds of experiments do ecologists perform? What are the advantages and disadvantages of each?
- According to Vernadskii, in what ways does life change the surface of the earth. If all forms of life became extinct, what would happen? What does he mean by “the biosphere is the creation of the sun?” and “Under the thermodynamic conditions of the biosphere, water is a powerful chemical agent...” but on a dead Earth, water is “...a compound of weak chemical activity?”
- Rowe’s “Biological Fallacy” calls in to question using an organism-level perspective on life. Describe how energy flows would look different if you were a) inside a cell or b) in a space ship looking down on earth. Without prior knowledge, what would you call life?