Ecology

Ecology Defined

What is essential difference between snake behind glass versus a wild animal?

Ecology Defined

- intact cells
- physiological properties
- genetics
- some extent behavior

Ecology Defined

- Caged animal is out of context
- Removed from natural surroundings
- Stripped of its natural history
- No loner interfaces with environment

Ecology

Discipline deals with myriad ways in which organisms

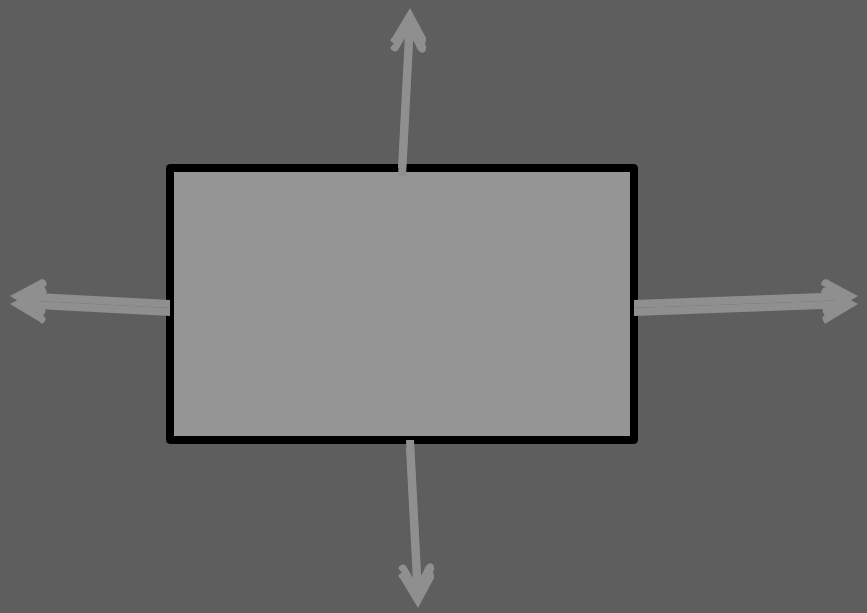
- interact with
- influence
- influenced by

Natural surroundings

Fundamental Difference

Difference from other disciplines

Focus is directed upward and outward from individual to environment



Fundamental Difference

Other disciplines in biology are reductionist

- Cell biology
- Physiology
- Anatomy
- Genetics

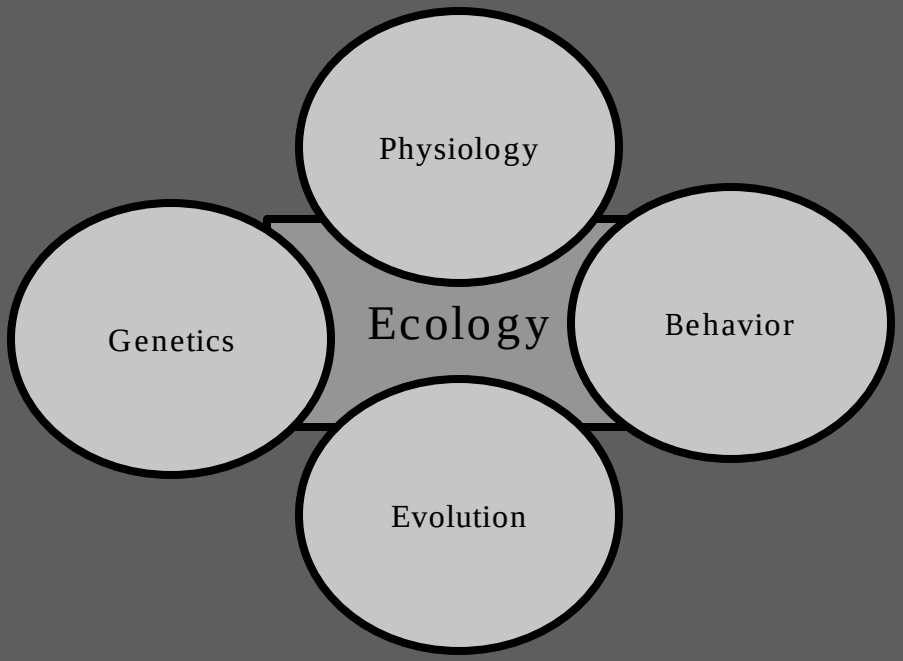
Fundamental Difference

Ecology is holistic

Ecology Definitions

- "Painful elaboration of the obvious"
  Cavitt's Mom
- "The total relations of the animal to its organic and inorganic environment"
  Haeckel 1869

If true then what isn't ecology


Physiology
Genetics
Ecology
Behavior
Evolution

Ecology Definitions

Ecology overlaps all these disciplines thus need stricter definition

Ecology Definitions

- "Scientific natural history" Charles Elton, *Animal Ecology*
- "Study of structure and function of nature" Eugene Odum
- "Scientific study of the distribution and abundance of organisms" H.G. Andrewartha

Ecology Definitions

- The science of how organisms interact with their living and non-living environment

- "The scientific interactions that determine the distribution and abundance of organisms" Charles Krebs

Ecology Definitions

Definition is

- Specific
- Workable
  - Where are organisms found
  - How many are there
  - Why

- Perhaps the **oldest** of the natural sciences

Ecology is not synonymous with environmental problems

- Ecology is a basic science
- Applied sciences use the knowledge generated by basic sciences to solve problems
- Ecology is hierarchical

Hierarchy

- **Individuals**
  - (organisms)
- **Populations**
  - (groups of individuals of 1 species)
- **Communities**
  - (species that interact)
- **Ecosystems**
  - (community + abiotic environment)

Ecology can be studied from multiple perspectives

- Evolutionary - investigating adaptive aspects of ecological phenomena
- Distribution & Abundance - investigating the contemporary processes that determine
  - where an organism occurs **(distribution**)
  - how many organisms (**abundance**)
  - how numbers of organisms change (**dynamics**)

The same system can be studied at multiple levels

- **Example:** Bluegill sunfish (*Lepomis macrochirus*)
- Large individuals
  - found in open water
  - feed mostly on zooplankton
- Small individuals
  - found in vegetation
  - feed mostly on benthic insect

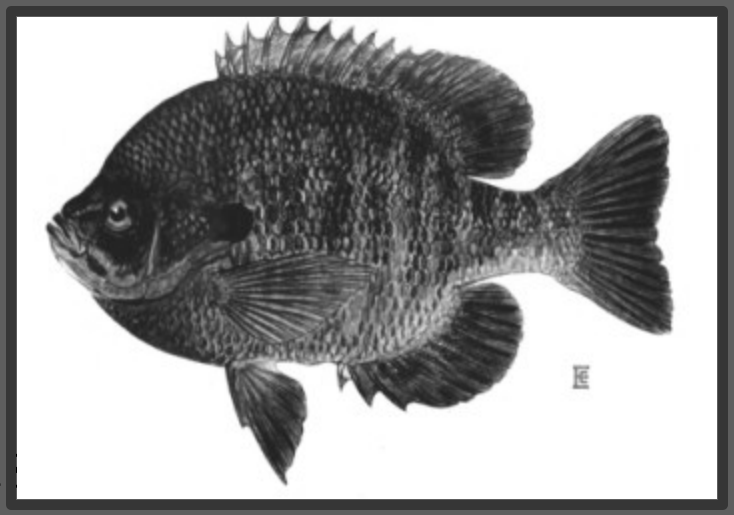


Image from Conrell Univ. Dept. of Natural Resources

Why the difference in location?

- **Hypothesis:** bluegill choose habitat with most profitable prey
- **Hypothesis:** small bluegill are safer from predation in the vegetation
- **Hypothesis:** large bluegill aggressively exclude small bluegill from open water
- **Evolutionary hypotheses** -- advantageous for **individuals** to choose certain locations

What determines the number of bluegill in each size class?

- **Hypothesis:** bass predation on young bluegill
- **Hypothesis:** human predation on older bluegill
- **Hypothesis:** limited nest sites
- **Ecological hypotheses** -- contemporary **population** level effects

Additional questions…..

- How do bluegill affect populations of pumpkinseed sunfish?
- How do bluegill affect populations of *Daphnia*?
- What would be the effect of a 2^{o}C increase in water temperature on bluegill populations?
- **Ecological questions --** contemporary processes affecting distribution and abundance

Methods of Approach

Ecologists utilize scientific method

2 approaches to answering questions and testing hypotheses in ecology

Methods of Approach

Observation and Experimentation

1. Observation

Not all ecological phenomena are amenable to experimentation

Methods of Approach

- Natural events can not be manipulated
- Scale of question can be important
- Ethics of experimentation can be important

Methods of Approach

- Observation or comparative studies often rely on correlation

Methods of Approach

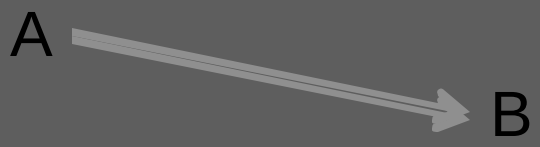
Major Goal

Want to understand causality

A

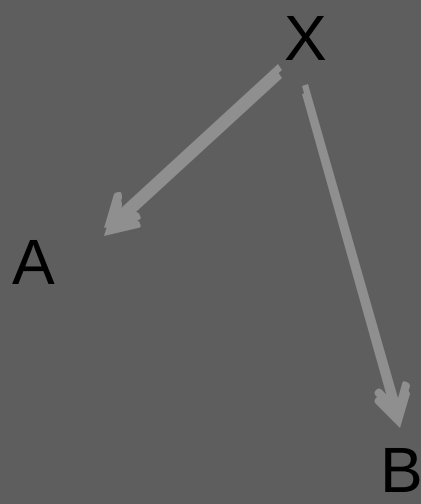
B

Leads us to infer that A “causes” B



Problem with correlation

Some other unknown event could be “causing” both to occur



Methods of Approach

So what's the problem with correlation?

Taverns in Wisconsin Counties

Baptist Ministers

Methods of Approach

- The problem is -

What can infer from correlation?

“Correlation does not prove causation”

Methods of Approach

The number of Baptist Ministers is not causing an increase in the number of Taverns in Wisconsin.

History of Ecology

Roots of Ecology lie in natural history so technically it is as old as humans

Balance of Nature

1. Primitive peoples relied on
   a. Hunting
   b. Fishing
   c. Food gathering

so needed detailed information on when/where to find food

2. Agriculture – increased need for knowledge of relationships of plants and animals to their environments

Balance of Nature

3. Plagues attracted early writers attention
   a. Exodus
   b. Aristotle – explained plagues of mice and locusts.

Balance of Nature

4. Principle of Ecological Harmony

Greeks established

term “Balance of Nature” – idea that nature is designed to benefit and preserve each species

Balance of Nature

Each species had a special place in nature and extinction does not occur because it would upset the balance of nature.

Balance of Nature

Today you can still find subscribers to this principle.

Why?

17th and 18th Century

1. Graunt 1662

Described human population change quantitatively (father of demography)

- Birth rate
- Death rate
- Sex ratio
- Age structure

17th and 18th Century

2. Leeuwenhoek 1687

Studied reproductive rate of grain beetles, carrion flies and human lice.

Counted # eggs laid by flies and extrapolated (746,496 in 3 months)

1st attempt to calculate theoretical rates of increase for an animal

17th and 18th Century

3. Buffon – *Natural History* 1756

First to recognize all organisms are subject to same processes

4. Malthus – *Essay on Populations* 1798

Caluculated organisms can increase geometrically

Reproductive rate held in check by food supply

17th and 18th Century

During this time

What prevents populations from reaching a point where they deplete their food supply?

What checks operate against a tendency toward geometric increase?

3 Centuries later ecologists are still asking these same questions

19th Century

1. Doubleday – "*True Law of Population*" 1841

Questioned Malthus

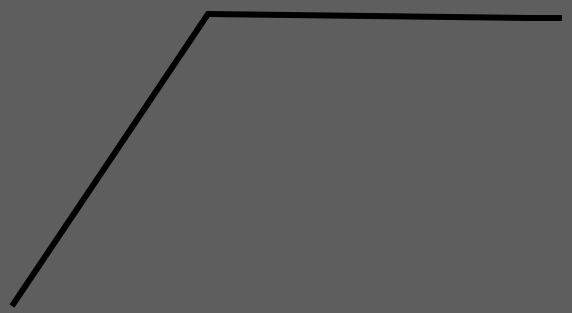
Whenever species threatened with extinction, nature made a corresponding effort to increase fertility

Used humans in less developed countries

19th Century

Verhulst 1838 – Derived equation to describe rapid increase and stabilization of populations

Called logistic growth curve



19th Century

During most of time thinking hadn't changed from idea of Plato

2 ideas during this time undermined "Balance of Nature"

1. Many spp becoming extinct
2. Resources are limiting and competition is important

19th Century

Consequences became clear

- Malthus
- Lyell
- Darwin

"Providential Ecology" and "Balance of Nature" replaced with Natural Selection

19th Century

"Balance of Nature" continues to persist in modern ecology

- natural systems are stable
- systems in equilibrium unless disturbed

20th Century

Ecology as Science

Roots

- Natural History
- Human Demography
- Biometry
- Applied problems in Agriculture, Medicine

20th Century

Struggle to understand how nature works

Alfred Lotka – Metropolitan Life Insurance Co

Laid groundwork for mathematical ecology

20th Century

Until 1960's ecology not considered important science

What happened?

20th Century

- Increase in human population
- Destruction of natural environment

Caused public outcry and realization of problems