

What is Ecology?

- Does ecology = environmentalism?
- Greek origin:
 - Oikos = home, household
 - Logos = study
- ...“the study of the household”?
- Economy = “management of the household”

What is Ecology?

- Many definitions...
 - “distribution and abundance of animals”
 - “relationship btw. organisms and habitat”
 - “patterns of nature”
 - “organism assemblages”
- **The scientific study of how organisms interact with their environment.**
 - Physical environment (abiotic)
 - Biological environment (biotic)

Ecology: Early Stages

- Ernst Haeckel (German) →
- (1866) “oekologie”
- “the economy of nature”



Ecology is a diverse science

- Plant Ecology
- Animal Ecology
- Physiological Ecology
- Population Ecology
- Community Ecology
- Landscape Ecology
- Ecosystem Ecology
- **Applied Ecology**
 - Conservation Ecology
 - Restoration Ecology

Plant Ecology

- Plant geographers traveled and described differences in plant communities



F. H. A. von Humboldt



Johannes Warming



Andreas Schimper

Plant Ecology

- In America, plant ecologists more interested in how communities developed rather than describing them



Frederic E. Clements



Henry C. Cowles (center)



Henry A. Gleason

Animal Ecology

- Developed later than Plant Ecology
- R. Hesse (Germany) and Charles Elton (England) were the pioneers
- In the USA, Charles Adams & Victor Shelford, (1913):
 - "A guide to the study of animal ecology"
 - "Animal communities in temperate America"

Animal Ecology

- The Great APPEs (University of Chicago):
 - W.C. Allee, Thomas Park, Orlando Park, A.E. Emerson, K.P. Schmidt
- Principles of Animal Ecology (1949)
 - Feeding relationships, energy budgets, population dynamics, natural selection and evolution

Animal Ecology

- Behavioral Ecology
 - Animals interact with their living and non living environments
 - Emphasis on natural selection
- Sociobiology (contrast) - E.O. Wilson:
 - Field observations of social groups of animals
 - Attempt to apply to humans

Physiological Ecology

- Ecophysiology
 - Responses of individual organisms to temp., moisture, light, nutrients, and other environmental factors
- Justus Leibig (1840)
 - Law of the minimum
- V.E. Shelford (1911)
 - Law of tolerance

Ecology taking shape

- In the beginning, a descriptive approach
 - Observational basis
 - Considered a weak discipline
- Ecology adopts mathematical basis approach
 - Experimental basis
 - Development of mathematical models
 - Prediction based, rather than "wait and see"

Population Ecology

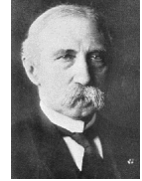
- Population growth, regulation, intraspecific and interspecific competition
- A. Lotka & V. Volterra (1926) established the foundation with mathematical models that tested population growth under limiting conditions
- Concepts create groundwork for the development of **Evolutionary Ecology** and **Community Ecology**

Ecosystem Ecology

- Holistic approach integrates ecological concepts that combined organisms and their physical environment into a system
- A.G. Tansley → refined "ecosystem"
- Limnologists already using "holistic" approach to the study of lakes

Ecosystem Ecology

- A. Thienemann → nutrient cycling, feeding levels, producers and consumers.
- S.A. Forbes → INHS
 - The Lake as a Microcosm (1887)
- Edgar Transeau (farmer)
 - "Accumulation of energy in plants" (1926)



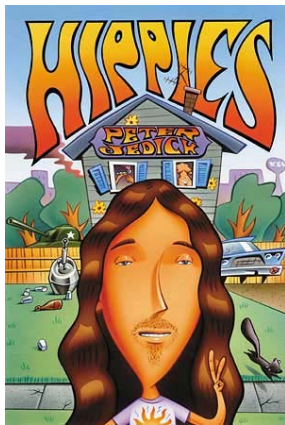
Ecosystem Ecology

- R.A. Lindeman → Univ of Minnesota
 - Studied plant succession in terms of energy
 - "The trophic dynamic aspect of ecology" (1942) - Cedar Bog Lake
 - Marked the beginning of ecosystem ecology
- G.E. Hutchinson, H.T. Odum and E.P. Odum → energy flow and nutrient budgets

Applied Ecology

- The use of ecological theory and models to understand the impact of humans on ecosystems
- Provides a basis for ecosystem and resource management, preservation and restoration
 - Around since the 1930's, but didn't gain visibility until the late 1960's - 1970's...why?

???



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Peter Jedick

Applied Ecology

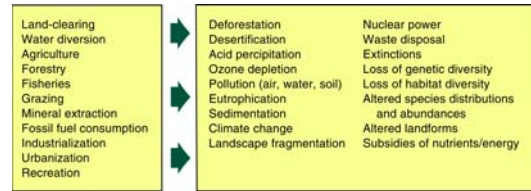
- Social, political, and economic issues
 - Public awareness to pollution, toxic waste, overpopulation, degraded environment
- Although ecologist had been dealing with conservation issues for years
 - Nature Conservancy founded by Charles Elton et al. in Great Britain
 - British Ecological Society founded by A.G. Tansley
 - G.P. Marsh (USA) → "Man and Nature" (1885)

Applied Ecology

- Aldo Leopold → "A Sand County Almanac" (1949) – ecological land ethic
- Rachel Carson → "Silent Spring" (1962)



Applied Ecology



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Fig. 1.4 - Human activities lessen the sustainability of the biosphere

Applied Ecology

- Lead to the development of:
 - Conservation Biology
 - Restoration Ecology
 - Landscape Ecology
- ...and subsequently the development of many related journals:
 - *Environmental Management, Journal of Applied Ecology, Ecosystems, Ecological Applications, Conservation Biology, Restoration Ecology, etc.*

Applied Ecology

- Endangered Species Act (1973)
 - Amended 1982, 1994
- Clean Water Act (1977)
 - Amended 1981, 1987, 1994
- Clean Air Act (1970)
 - Amended 1977
- ...among others

Ecology: An Empirical and Experimental Approach

- G.E. Hutchinson, Robert MacArthur, Richard Levins, Robert May
 - Mathematical approach → Ecology as a highly predictive science
 - Understand the patterns and processes related to life on earth
 - Hypothesis testing
- Hypothesis = a statement about an observation that can be tested. Possible explanation to observed phenomena

Ecology: An Empirical and Experimental Approach

- **Inductive method**
 - Scientist gathers empirical data and from it arrives at a generalization
- **Deductive method**
 - Scientist develops a general idea about a phenomenon, performs experiments, and from them makes specific predictions that can be tested again.

Experimental Approach

- The response of one variable to variation in some other variable or set of variables
- **Dependent variable**
- **Independent variable** → controlled by the investigator
- **Treatment** → manipulation of the independent variable by investigator

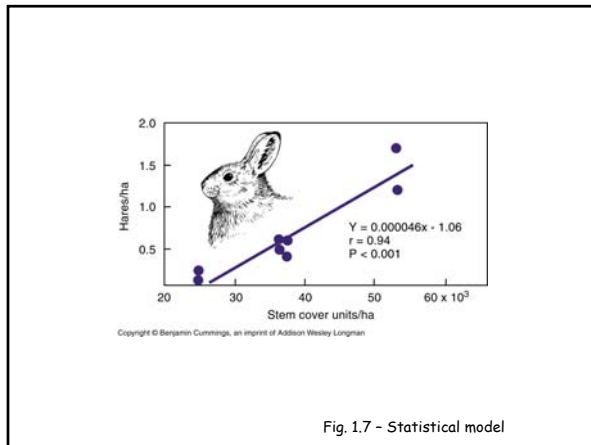
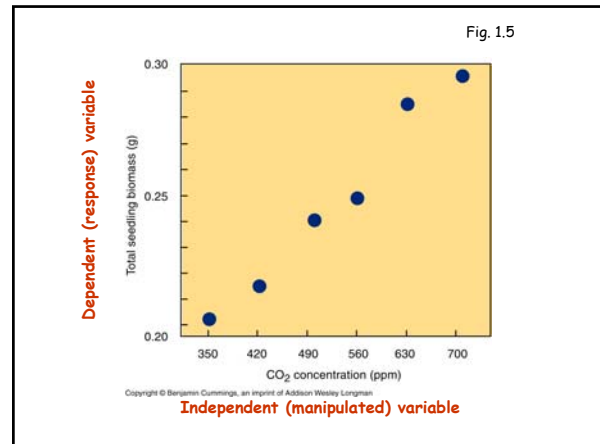


Fig. 1.7 - Statistical model

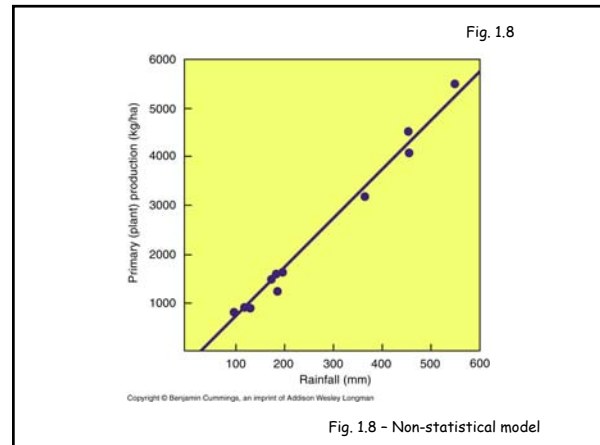


Fig. 1.8 - Non-statistical model

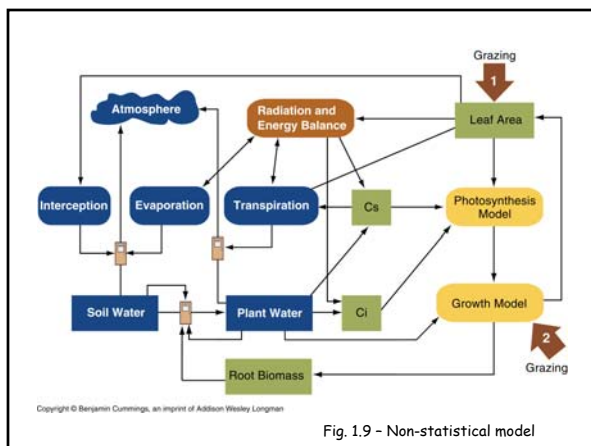
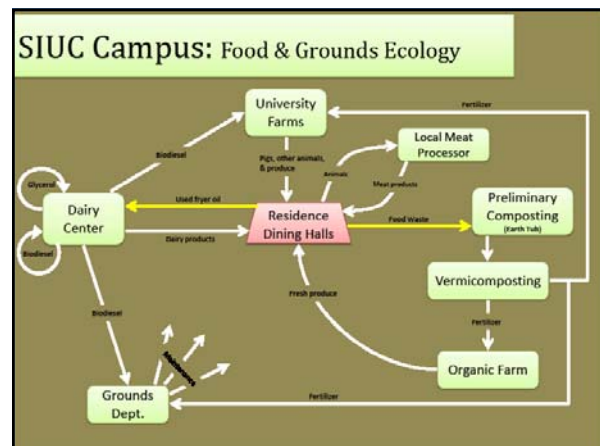


Fig. 1.9 - Non-statistical model



Hypothesis Testing

- Requires the collection of data:
 - Direct observation
 - Experimentation
- Experimentation involves the manipulation of one or more variables while holding others constant
- Based on laboratory or field experiments

Models and predictions

- Simplifications of natural settings
- Provide insight (predict) on new or existing phenomena

- Abstract representation of the real system
 - (i.e., statistical, non statistical, analytical, conceptual, simulation)