

# **LECTURE I: INTRODUCTION TO GENERAL ECOLOGY**

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# Ecology

- ▶ oikos : household/ home/  
place to live
- ▶ logos : study

term promulgated by Ernst  
Haeckel (*oekologie*) in 1869  
and used by Darwin shortly  
thereafter



# Introduction to Ecology

- The meaning of the word ecology was given by German Biologist Hackle in 1869.
- The word ecology is derived from Greek words 'Oikos' meaning *house, habitat* or *place of living* and 'Logos' meaning *to study*.
- *Ecology* is defined as the study of interrelationship of different organisms with each other and with their environment. It is concerned with the general principles that apply to both animals and plants.



# Definition

- ▶ (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).”*



# Definition

- ▶ By ecology, we mean the body of knowledge concerning the economy of nature -- the investigation of the total relations of the animal both to its organic and to its inorganic environment; including above all, its relation with those animals and plants with which it comes directly or indirectly into contact -- in a word, *ecology is the study of all the complex interrelationships referred to by Darwin as the conditions of the struggle for existence.* Ernst Haeckel, 1870.

# Definition

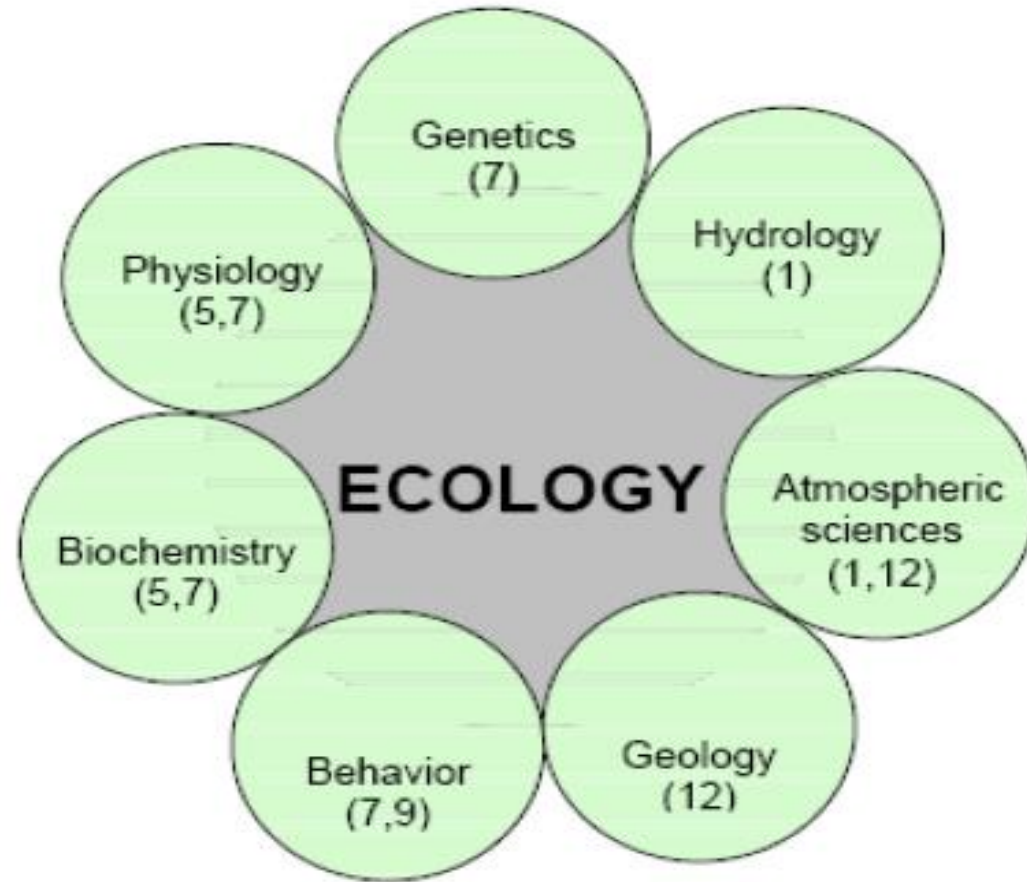


- ▶ parallel to *economy* (Haeckel)  
= *management of the household* many principles in common – resources allocation, cost–benefit ratios
- ▶ Burdon–Sanderson (1890s): Elevated Ecology to one of the three natural divisions of Biology: Physiology – Morphology – Ecology
- ▶ Andrewartha (1961): “The scientific study of the distribution and abundance of organisms.”
- ▶ Odum (1963): “The structure and function of Nature.”

# History

- ▶ Draws upon need to control pests in agriculture, disease spread in humans
- ▶ Wildlife and fisheries management and harvesting
- ▶ Human population change–demography, important in insurance and government
- ▶ Mathematics and Computers–Equations describing systems and simulations

# Ecology: a multidisciplinary science



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



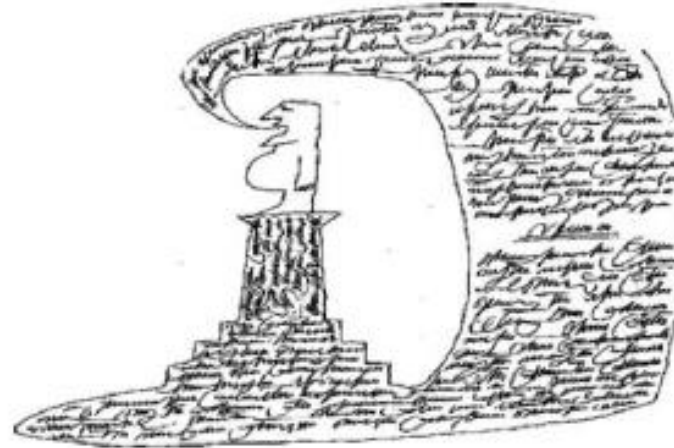
# Branches:

- ▶ Autecology = study of an individual organism/ species in relation to its environment and to other species
- ▶ Synecology = study of a community of organisms

Before you can describe an ecosystem, you must study the cause & effect interactions between species: Autecology.



Only when you understand key interactions of an area, can you ever really describe an ecosystem: the discipline of synecology (community ecology)



# *Classification of Ecology*

- **Based on study area :**
  1. Autecology : It deals with the study of an individual species of organisms and it's population. The ecologists study the behavior and adaptations of particular species to the environmental condition at every stage of that individual's life cycle. It is also called the Species ecology.
  2. Synecology : It deals with the study of communities, their composition, their behavior and relation with the environment. It is also called as Ecology of communities. It is further divided into 3 types :
    - 1) Population Ecology
    - 2) Community Ecology
    - 3) Ecosystem Ecology

# *Objectives of Ecological Studies*

- It is important for humanity to understand its environment because we have the ability to modify the environment through the use of technology, and through overexploitation of natural resources as a result of greed or sheer pressure of numbers. Therefore, ecology is more than just the understanding of the interrelationships between organisms and their environment; it also has social, political, economic and technological dimensions.
- It also is a study of evolutionary development of organisms, the biological productivity and energy flow in the natural system.
- To develop mathematical models to relate interaction of parameters and to predict the effects

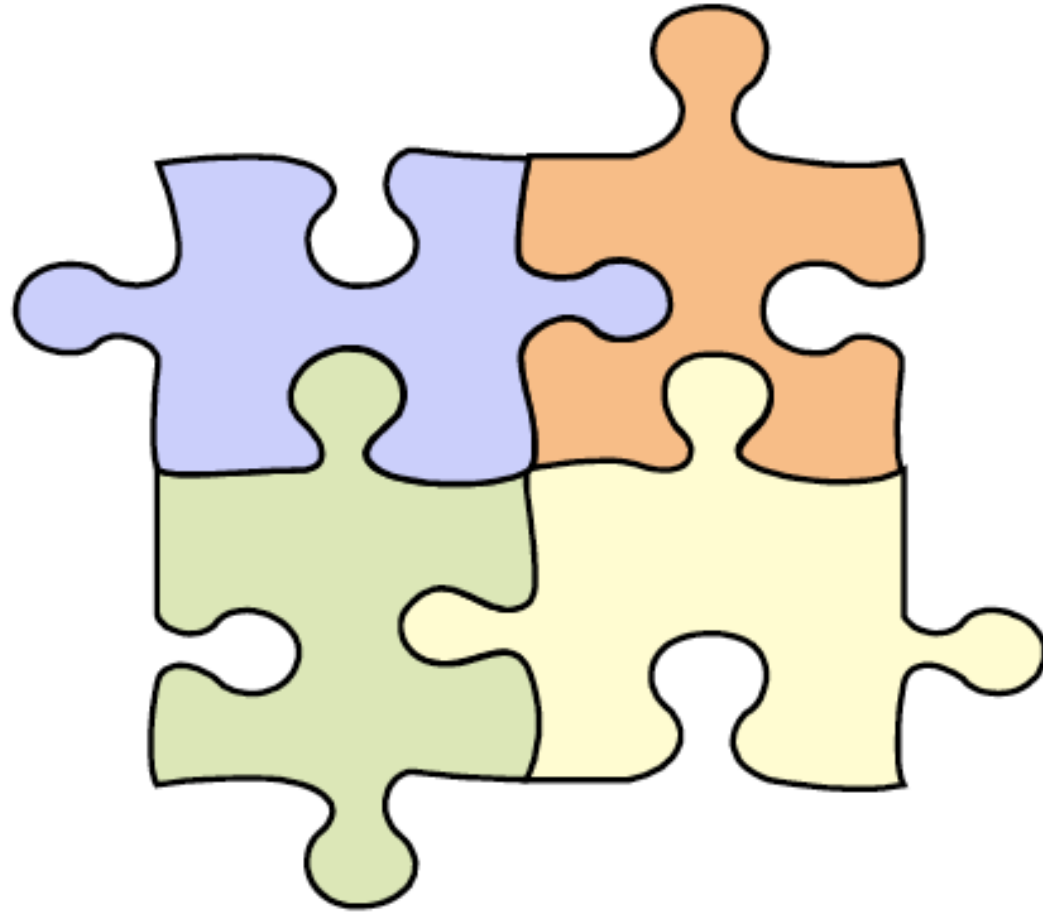


# Why study ecology?

- ▶ **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.**



# Ecology – A Science for Today

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



- ▶ We have a great need for ecological understanding:
  - what are the best policies for managing our environmental support systems -- our watersheds, agricultural lands, wetlands?
  - we must apply ecological principles to:
    - solve or prevent environmental problems
    - inform our economic, political, and social sectors on how to manage environmental concerns





# Ecology and Environmentalism

- ▶ Ecology provides the science behind many questions related to human impacts on the environment but it is not the same as environmentalism
- ▶ **Ecology** is a science
  - Seeking understanding of effects of
    - Organisms on environment
    - Environment on organisms.
- ▶ **Environmentalism** is a social & political movement concerned with the quality of the human environment.





# Classification of Ecology

## 2. Based on Environment or habitat

### 1) **Aquatic ecology** : The study of interaction of organisms in the water

#### 1) Marine water ecology

- i) Ocean
- ii) Deep Sea
- iii) Estuary

#### 2) Freshwater Ecology

- i) Lentic (Running water)
  - a) River
  - b) Stream
  - c) Spring
- ii) Lentic (Standing Water)
  - a) Pond
  - b) Lake



*Fresh water river*



*Coral reefs*

# Classification of Ecology

2) **Terrestrial Ecology** : The study of interaction of organisms on land :

- a. Grassland Ecology
- b. Forest Ecology
- c. Desert Ecology

3. **Based on Advancement in the field of ecology**

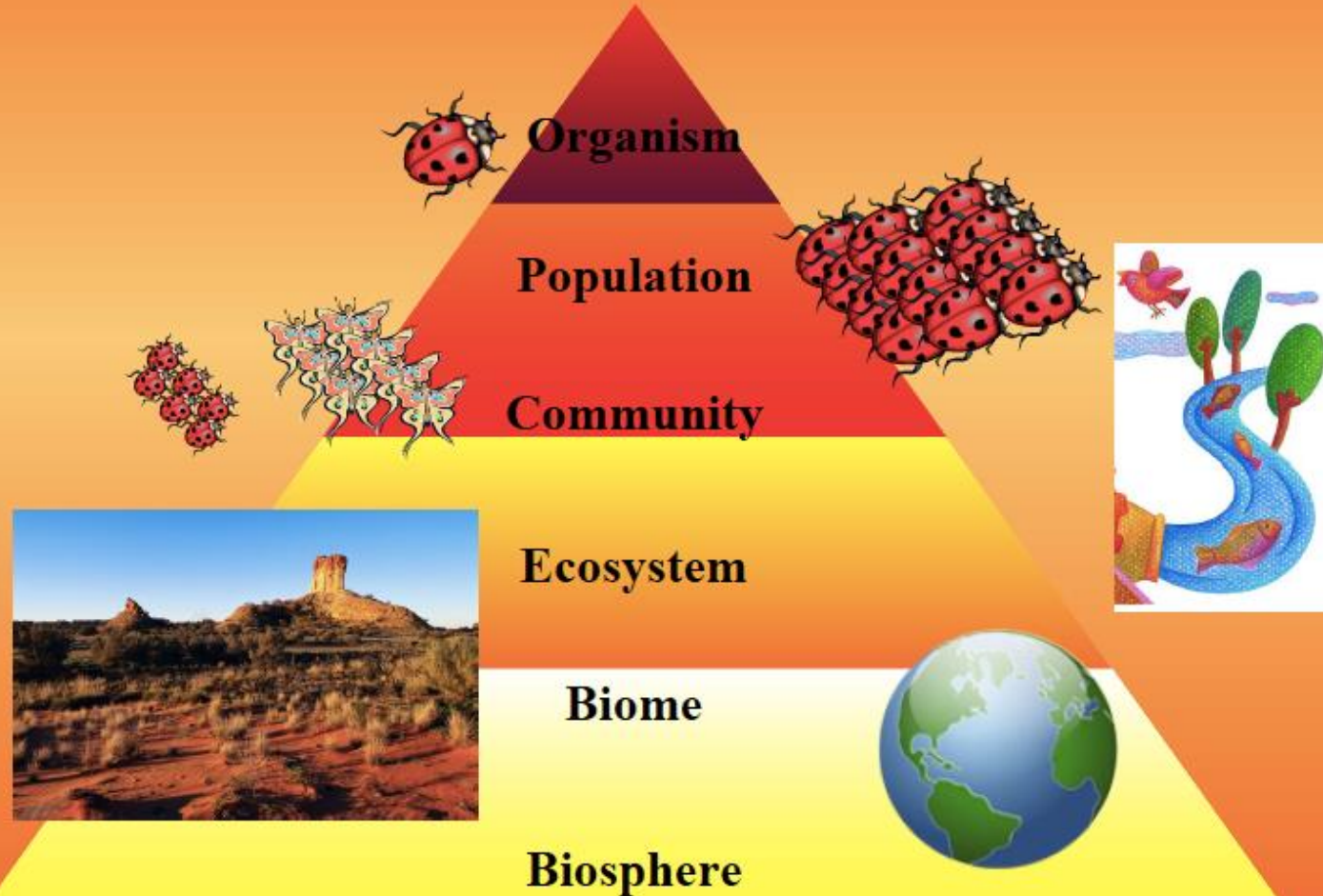
- a. Productive ecology
- b. Population ecology
- c. Community ecology
- d. Ecosystem ecology
- e. Microbial ecology
- f. Radiation ecology
- g. Pollution ecology
- h. Space ecology



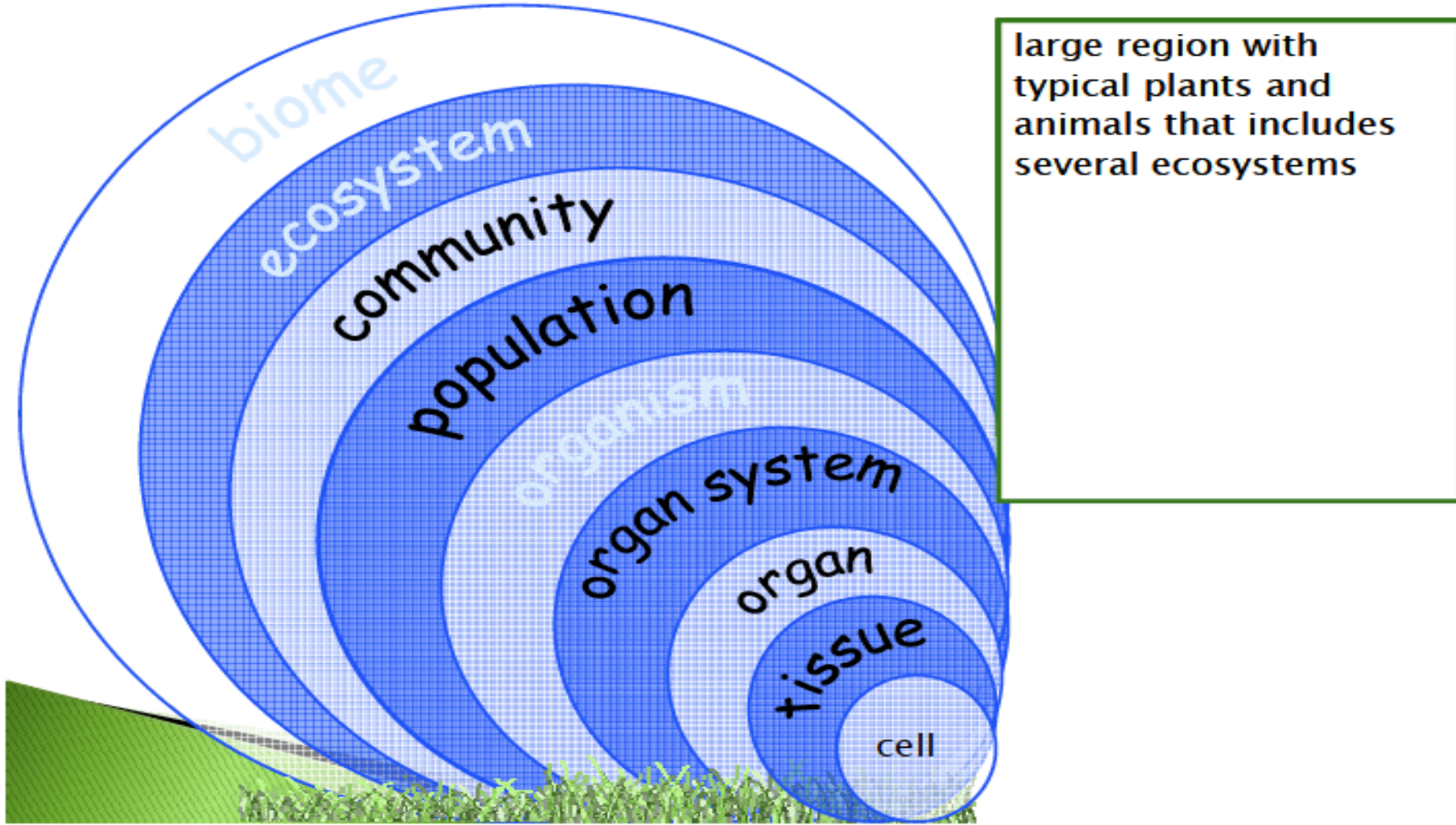
Forest  
Ecology



# Levels of Organization



# A Brief Review: Biological Levels of Organization





# Where to study Ecology?



**Biosphere:**  
Global processes



**Ecosystem:**  
Energy flux and cycling  
of nutrients



**Community:**  
Interactions among  
populations



**Population:**  
Population dynamics;  
the unit of evolution



**Organism:**  
Survival and reproduction;  
the unit of natural selection

Ecosystem level  
Community level  
Population level  
> Organismal level (individual)  
Organ system level  
Organ level  
Tissue level  
Cellular level  
Organelle level  
Macromolecular level  
Simple molecular level  
Atomic level

# 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



# Perspectives of Ecologists: Organism Approach



- ▶ How do form, physiology, and behavior lead to survival?
- ▶ Focus is on adaptations, modifications of structure and function, that suit the organism for life in its environment:
  - adaptations result from evolutionary change by natural selection, a natural link to population approach...

# Perspectives of Ecologists: Population Approach



- ▶ What determines the numbers of individuals and their variations in time and space?
- ▶ Focus is on processes of birth and death, immigration and emigration, influenced by:
  - the physical environment
  - evolutionary processes
  - interactions with other populations, a natural link to community approach...



# Perspectives of Ecologists: Community Approach



- ▶ How are communities structured from their component populations?
- ▶ Focus is on the diversity and relative abundance of different kinds of organisms living together, affected by:
  - population interactions, promoting and limiting coexistence
  - feeding relationships, responsible for fluxes of energy and materials, a natural link to ecosystem approach...

## Perspectives of Ecologists: Ecosystem Approach

- ▶ How can we account for the activities of populations in the common “currencies” of energy and materials?
- ▶ Focus is on movements of energy and materials and influences of:
  - organisms large and small
  - climate and other physical factors, including those acting on a global scale, a natural link to biosphere approach...



## Perspectives of Ecologists: Biosphere Approach

- ▶ How can we understand the global movements of air and water, and the energy and chemical elements they contain?
- ▶ Focus is on the global circulation of matter and energy, affecting:
  - distributions of organisms
  - changes in populations
  - composition of communities
  - productivity of ecosystems





### (a) Organismal ecology



How do individuals interact with each other and their physical environment?

Male and female salmon fight over females during the breeding season

### (c) Community ecology



How do species interact, and what are the consequences?

Salmon are prey as well as predators

### (b) Population biology



How and why does population size change over time?

Each female salmon produces thousands of eggs. Only a few will survive to adulthood. On average, only two will return to the stream of their birth to breed

### (d) Ecosystem ecology



How do energy and nutrients cycle through the environment?

When salmon die and decompose, the nutrients that are released are used by bacteria, archaea, plants, protists, young salmon, and other organisms



**(a) Organismal ecology.**  
How do humpback whales select their calving areas?



**(b) Population ecology.**  
What environmental factors affect the reproductive rate of deer mice?



**(e) Landscape ecology.**  
To what extent do the trees lining the drainage channels in this landscape serve as corridors of dispersal for forest animals?



**(d) Ecosystem ecology.**  
What factors control photosynthetic productivity in a temperate grassland ecosystem?



**(c) Community ecology.**  
What factors influence the diversity of species that make up a particular forest?

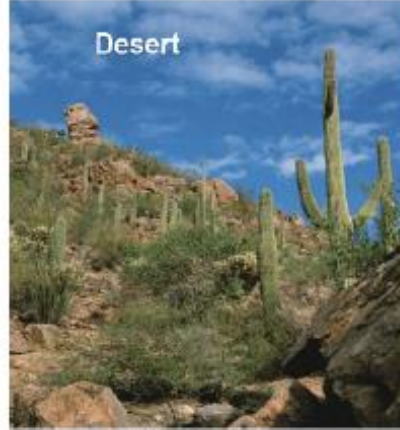
# Other branches:

- ▶ Ecophysiology examines how the physiological functions of organisms influence the way they interact with the environment, both biotic and abiotic.
- ▶ Ecomechanics uses physics and engineering principles to examine the interaction of organisms with their environment and with other species.
- ▶ Behavioral ecology examines the roles of behavior in enabling an animal to adapt to its environment.
- ▶ Systems ecology is an interdisciplinary field focusing on the study, development, and organization of ecological systems from a holistic perspective.
- ▶ Evolutionary ecology studies ecology in a way that explicitly considers the evolutionary histories of species and their interactions.
- ▶ Political ecology connects politics and economy to problems of environmental control and ecological change.
- ▶ according to the species/ fields of interest



# Ecosystem

- The term Ecosystem was first proposed by A.G. Tansley in 1935. he defined it as “the system resulting from the interaction of all the living and non living factors of the Environment.
- An ecosystem consists of the biological community that occurs in some locale, and the physical and chemical factors that make up its non-living or abiotic environment. There are many examples of ecosystems - a pond, a forest, an estuary, a grassland.



*Various types of Ecosystem*

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**THANK YOU.**

