

# Ecosystem

# Ecosystem

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- Terminologies related to ecosystems
- Human influence on ecosystems
- Energy and mass flow
- Bioaccumulation
- Nutrient cycle
- Population dynamics
- Lake ecosystem

# Some terminologies

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- **Ecosystems:** communities of organisms that interact with one another and with their physical environment
- **Habitats:** the place where a population of organisms lives
- **Population:** a group of organisms of the same species living in the same place at the same time

# Human influence on ecosystems

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- Destruction of environment (habitat)
  - deforestation, dam construction, road construction, etc.
- Changes in species population
  - can result in local and global extinction
  - release of toxic chemicals (ex: DDT, petroleum compounds, heavy metals)
  - shifting living conditions: acid rain, global warming, eutrophication, etc.
  - introduction of nonnative (exotic) species
  - excessive hunting

# DDT and Silent Spring

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1874: DDT first synthesized by O. Zeidler

1939: P. H. Müller discovered the insect killing ability and won Nobel Prize (1948)

1940s: Widely used as an insecticide (especially for lice-Typhus and mosquito-malaria)

1962: Rachel Carson published “Silent Spring” - described how DDT accumulates in organisms and affect wildlife

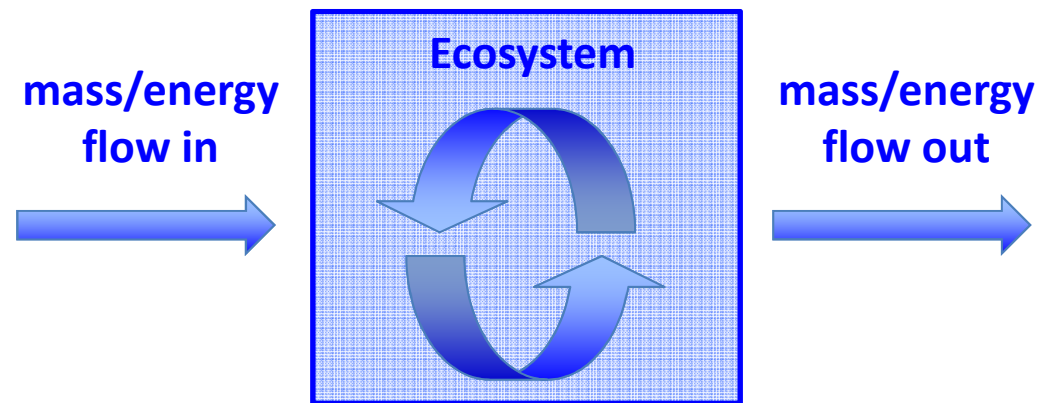
1960s: Environmental scientists published researches to support R. Carson’s argument (egg shell thinning by DDT)

1972: DDT banned in the U.S.

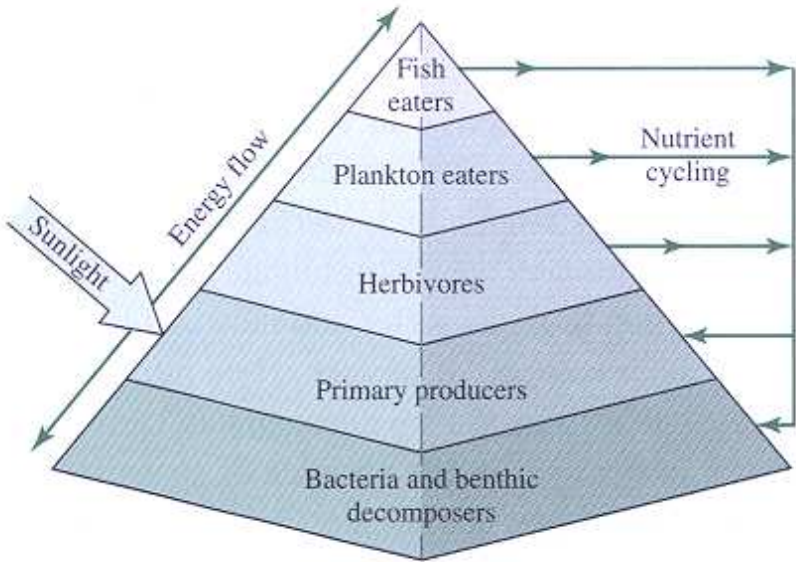
# Energy and mass flow

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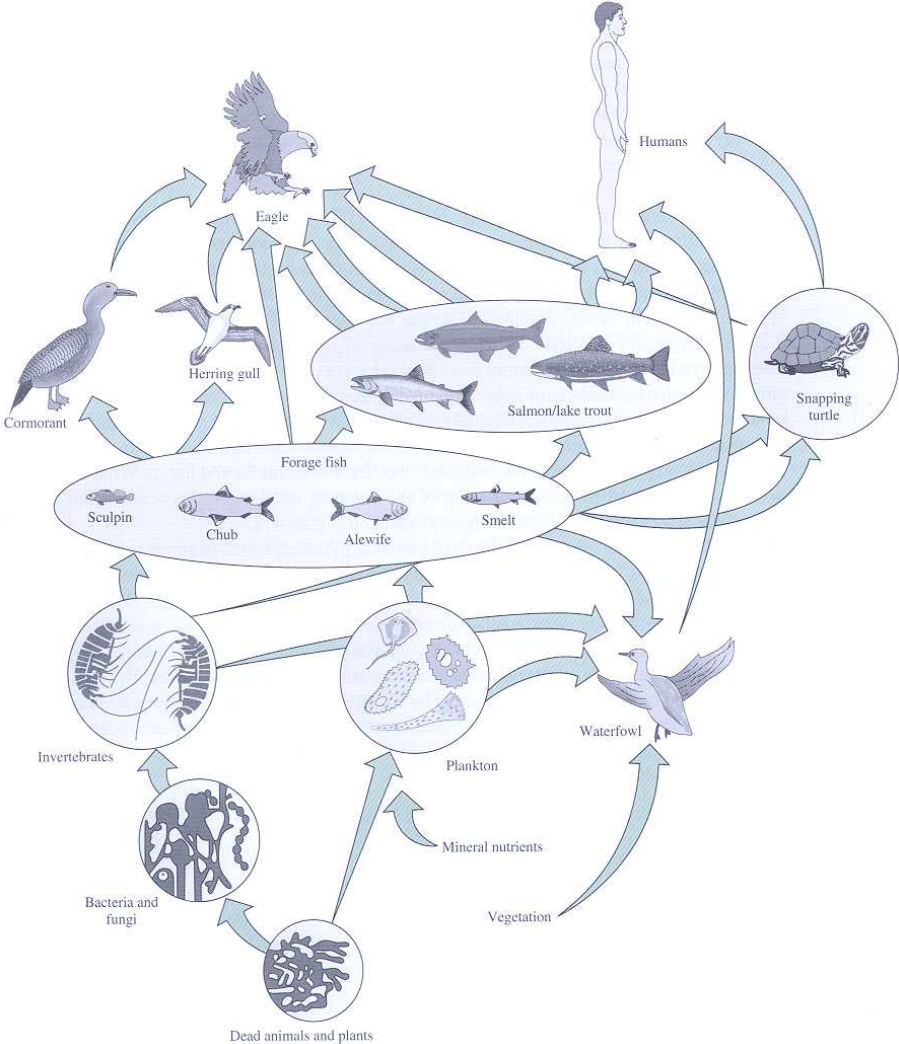
- Important feature of an ecosystem:
  - Flow of matter into, out of, and within the system



# Energy and mass flow



<Ecological pyramid example>



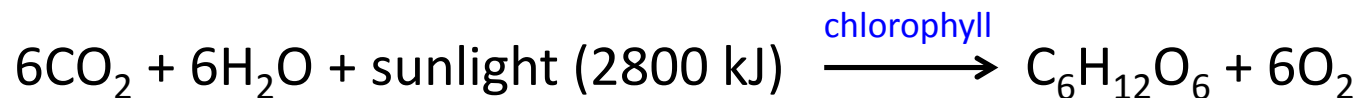
<Food web example>

# Energy and mass flow

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- Primary producers
  - Major source of energy for an ecosystem: sunlight
  - Major source of carbon (essential element for organic matter) for an ecosystem: CO<sub>2</sub>
  - Primary producers can use sunlight and CO<sub>2</sub> (or HCO<sub>3</sub><sup>-</sup>) to produce organic matter that contains energy in a chemical form:

## <Photosynthesis>



- Organisms that obtain carbon from inorganic sources and use sunlight as an energy source is called “*photoautotrophic*”



# Energy and mass flow

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- Classification of organisms based on energy / carbon source
  - Based on energy source
    - Phototrophs: light
    - Chemotrophs: organic or inorganic compounds
      - Chemolithotrophs: inorganic
      - Chemoorganotrophs: organic
  - Based on carbon source
    - Autotrophs: inorganic C ( $\text{CO}_2$  or  $\text{HCO}_3^-$ )
    - Heterotrophs: organic C

***Q: classification of (primary, secondary, tertiary, ...) consumers?***

***A: chemoorganotrophs, heterotrophs***

# Energy and mass flow

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- Respiration
  - A process of oxidizing organic compounds so that the chemical energy stored can be released
  - The energy released is used to derive other reactions (ex: cell metabolism and growth)

## <Aerobic respiration>



- Requires an oxidizing agent to oxidize an organic compound by the redox reaction: called “electron acceptors”
- Some organisms can use electron acceptors other than  $\text{O}_2$

# Energy and mass flow

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- Other electron acceptors: nitrate ( $\text{NO}_3^-$ ), nitrite ( $\text{NO}_2^-$ ), sulfate ( $\text{SO}_4^{2-}$ ), ferric ion ( $\text{Fe}^{3+}$ ),  $\text{CO}_2$ , organic compounds
- Classification of organisms based on living in the presence/absence of  $\text{O}_2$ 
  - : Aerobes / Anaerobes**
  - Obligate aerobes: can survive only in the presence of  $\text{O}_2$
  - Facultative (an)aerobes: can use  $\text{O}_2$  and other electron acceptor(s)
  - Aerotolerant anaerobes: cannot use  $\text{O}_2$ , but can survive in the presence of  $\text{O}_2$
  - Obligate anaerobes: cannot survive in the presence of  $\text{O}_2$

***Q: classification of human?***

***A: obligate aerobe***

# Bioaccumulation

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- Some chemicals have significantly higher affinity to some part of organisms than to the environment (water, air, soil, etc.)
  - ex) hydrophobic compounds have very high affinity to lipids than to water
- If chemical gain > loss for an organism, then the chemical may be accumulated within the body
- The chemical accumulation may occur more significantly for higher trophic level organisms

# Terminologies related to bioaccumulation

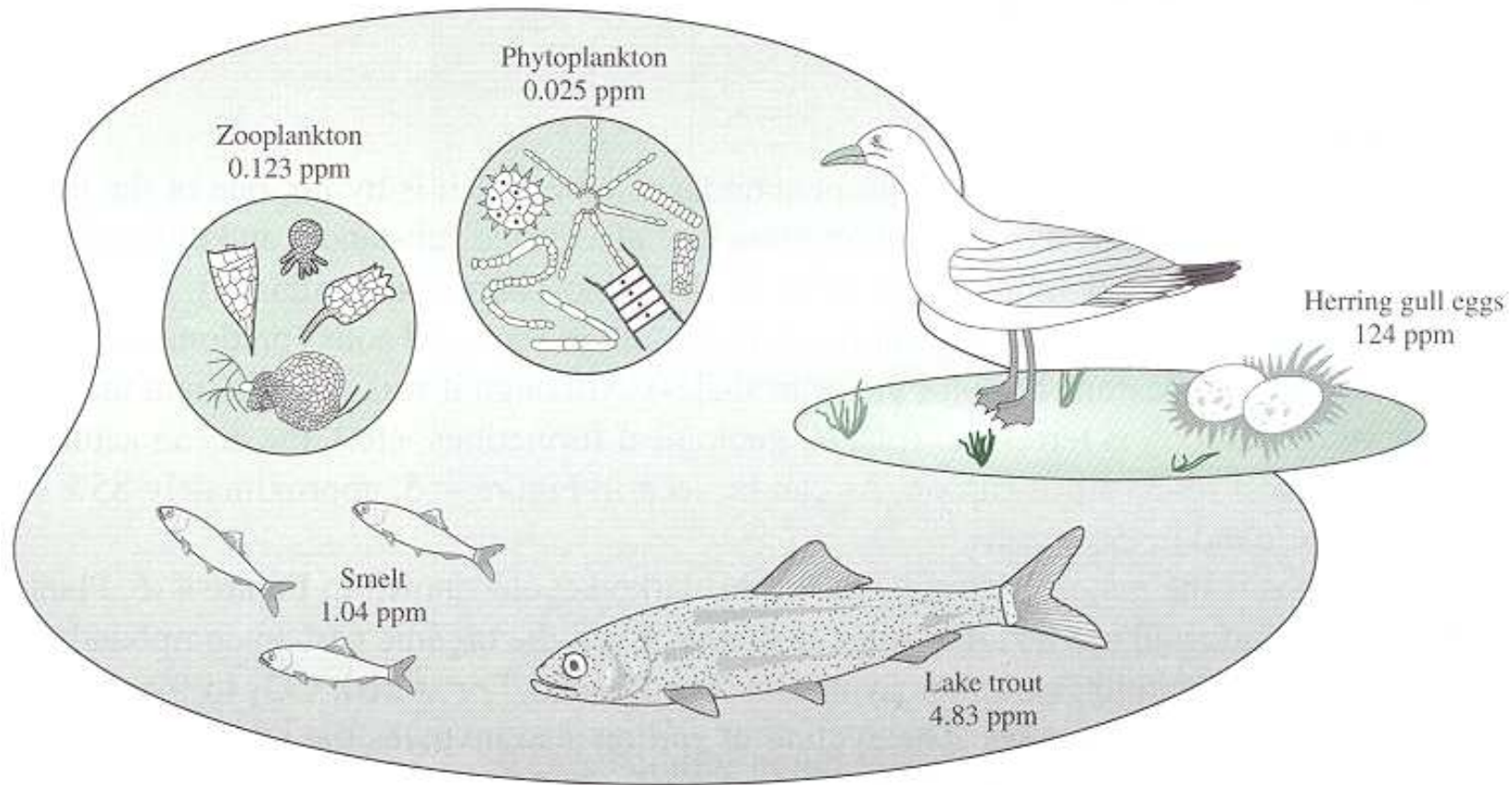
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- **Bioaccumulation:** total uptake of chemicals by an organism from either water or food
- **Biomagnification:** a process that results in accumulation of a chemical in an organism at higher levels than are found in its own food
- **Bioconcentration:** the uptake of chemicals from the dissolved phase

# Biomagnification in aquatic food web

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<PCBs in Great Lakes aquatic food web>



# Reading assignment

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- Textbook Ch5 p. 190-199