EWCE 131
Ecology and Environmental Pollution

Lecture 2

Instructor

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Lecture outline

Ecology and Ecosystem

Topics

- Basic characteristics of ecosystem
- Ecosystem structure and components
- Types of ecosystem
- Ecological footprint

Ecosystem

"Ecosystem" - the term was

- ✓ first proposed by A.G. Tansley in 1935, and

- ✓ defined as "the system resulting from the integration of all living and non-living factors of environment".

- 'Eco' refers to environment

- 'System' implies an interacting, inter-dependent complex.

Ecosystem

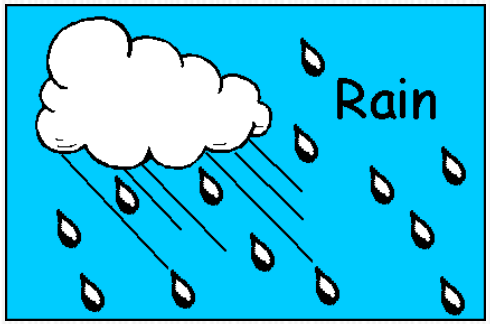
- An ecosystem is a biological environment –
- ✓ consisting of all living organisms in a particular area,
- ✓ as well as all non-living, physical components of the environment
- ✓ with which the organisms interact, such as air, soil, water and sunlight.

- There are many examples of ecosystems - a pond, a forest, an estuary, a grassland.

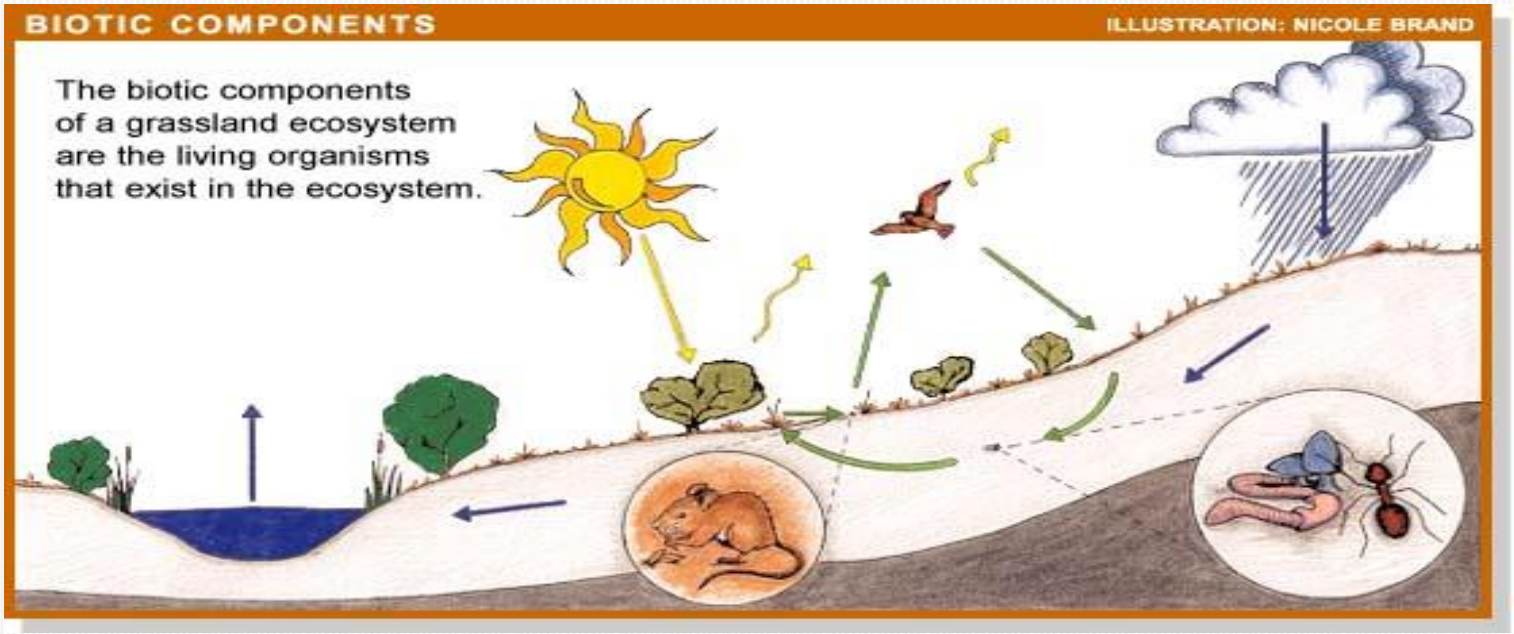
Ecosystem – Basic Terms

- **Abiotic**: Non–living components. Ex: water, air, sun





- **Biotic**: Living components. Ex: plants, animals, bacteria



- **Trophic level**: Feeding level for an organism

Characteristics of Ecosystem - **Structure**

- An ecosystem has two major parts:

(i) Nonliving (abiotic) and
(ii) Living (biotic).

- The **nonliving part** is the physical-chemical environment, including the local atmosphere, water, and mineral soil (on land) or other substrate (in water).

- The **living part**, called the ecological community, is the set of species interacting within the ecosystem.

Abiotic Components of Ecosystem

(i) Climatic Factors:

- Includes factors like sunlight, precipitation (rainfall, snowfall), humidity, wind etc.





Abiotic Components of Ecosystem

(ii) Inorganic Substances:

- Includes elements, such as – Carbon (C), Nitrogen (N_2), Oxygen (O_2) etc

- Used in synthesis of complex substances and involved in various material cycle, such as - carbon cycle, nitrogen cycle, oxygen cycle etc.

Abiotic Components of Ecosystem

(iii) Organic Substances:

- Includes lipids, proteins, carbohydrates.
- Formed by biotic components.
- Have a strong influence on structure, behavior and inter-relationship of various organisms in an ecosystem.

Abiotic Factors Limiting Population

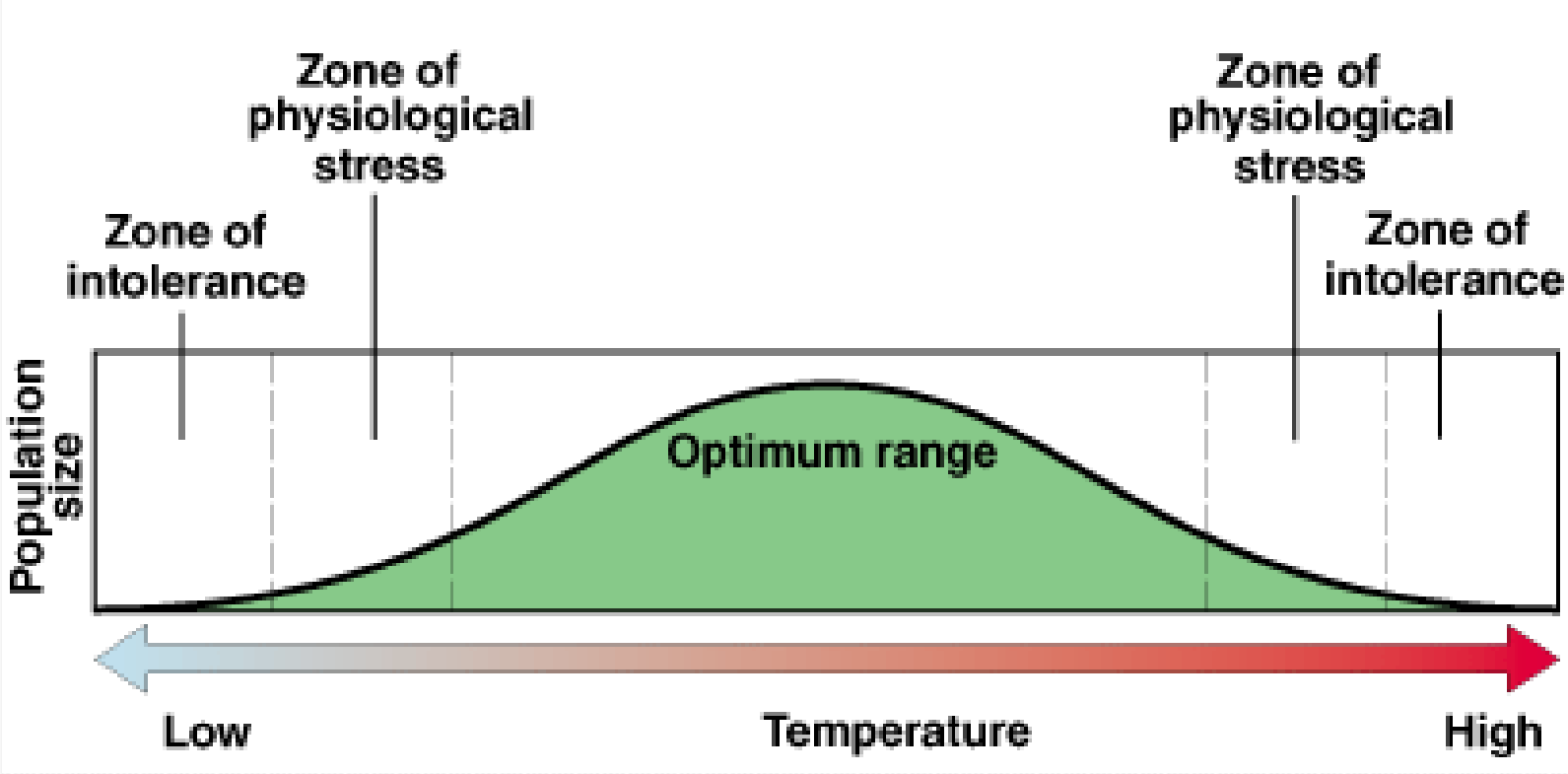
- **Law of Tolerance**: the ability of species to tolerate changes in their environment (physical or chemical factors). Pollution, global warming, habitat loss are some concerns associated with this.

- **Limiting Factor**: any environmental factor that reduces survival or reproduction within a population. Exp: predation, temperature.

- **Limiting Factor Principle**: too much or too little of any abiotic factor can limit or prevent growth of a population, regardless if all other factors are near optimum range of tolerance. Exp: too much fertilizer will kill plants.

Abiotic Factors Limiting Population

Range of Tolerance:



The survival, growth, and reproduction of organisms is determined, in part, by maximum & minimum tolerance limits for physical conditions such as temperature.

Biotic Components of Ecosystem

a. Producers (Autotrophs) (self-feeders)

- Make their own food from compounds that are obtained from their environment.
- Are the source of all food in an ecosystem.
- On land, most producers are green plants.



Biotic Components of Ecosystem - Producers

- In freshwater and marine ecosystems, algae and plants are the major producers near shorelines.

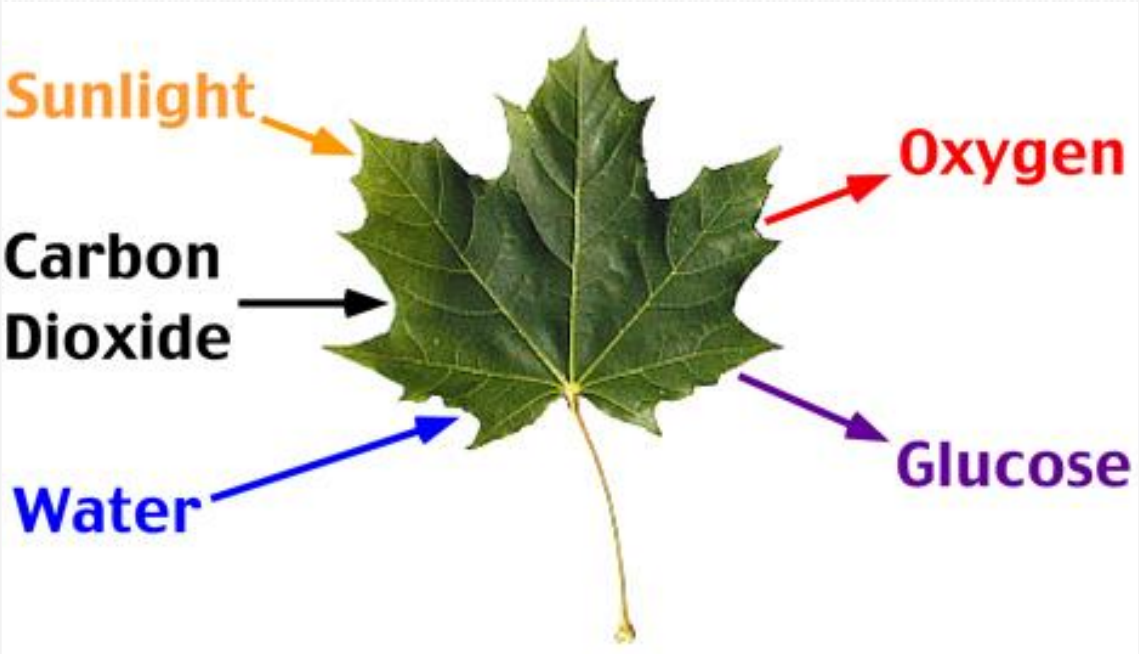
- In open water, the dominant producers are ***phytoplankton*** (most of them microscopic) that float or drift in the water.

- Most producers capture sunlight to make carbohydrates (such as glucose) by **photosynthesis .**

Biotic Components of Ecosystem - Producers

Photosynthesis—use **light energy** to convert **carbon dioxide** and **water** into **oxygen** and **carbohydrates**

$$(6CO_2 + 6H_2O \rightarrow 6O_2 + C_6H_{12}O_6)$$



Chemosynthesis—performed by **bacteria**, use **chemical energy** to produce **carbohydrates**

Biotic Components of Ecosystem

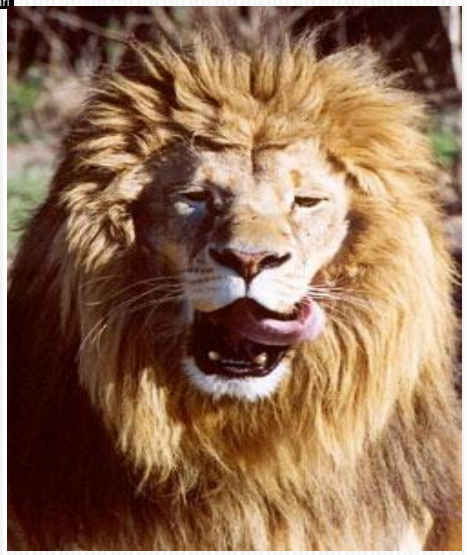
b. Consumers (Heterotrophs)

Get their energy and nutrients by feeding on other organisms or their remains.



i. **Primary consumers or herbivores :** Are those that eat producers (plants) as a source of food.

i. **Secondary consumers or carnivores :** Eat other animals.



Biotic Components of Ecosystem - Consumers

iii. Tertiary Consumers : Large Carnivores which feed on **secondary consumers.**

iv. Quaternary Consumers : Largest Carnivores that feed on tertiary consumers. They are not eaten by any animals.

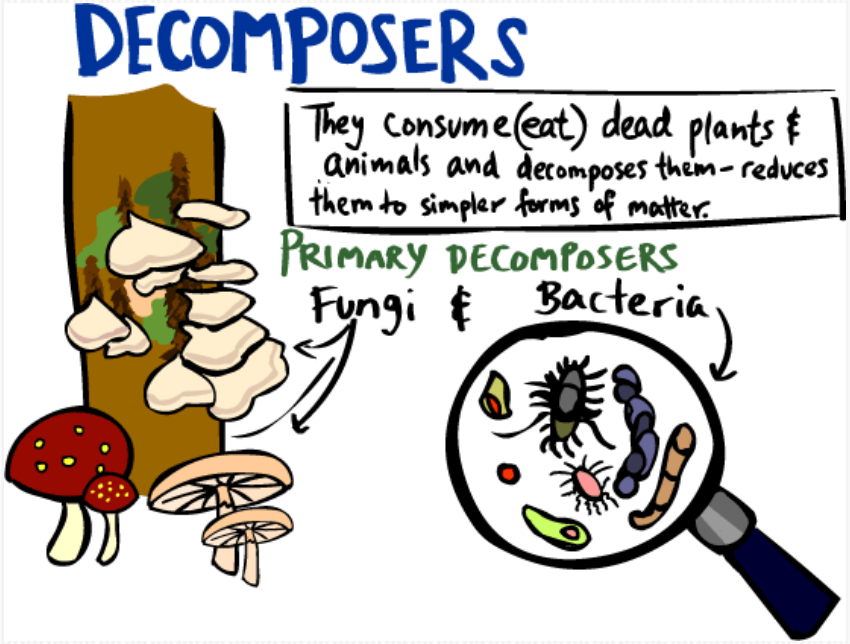
v. Omnivores : Have mixed diet that include both plants and animals.



Biotic Components of Ecosystem - Decomposers

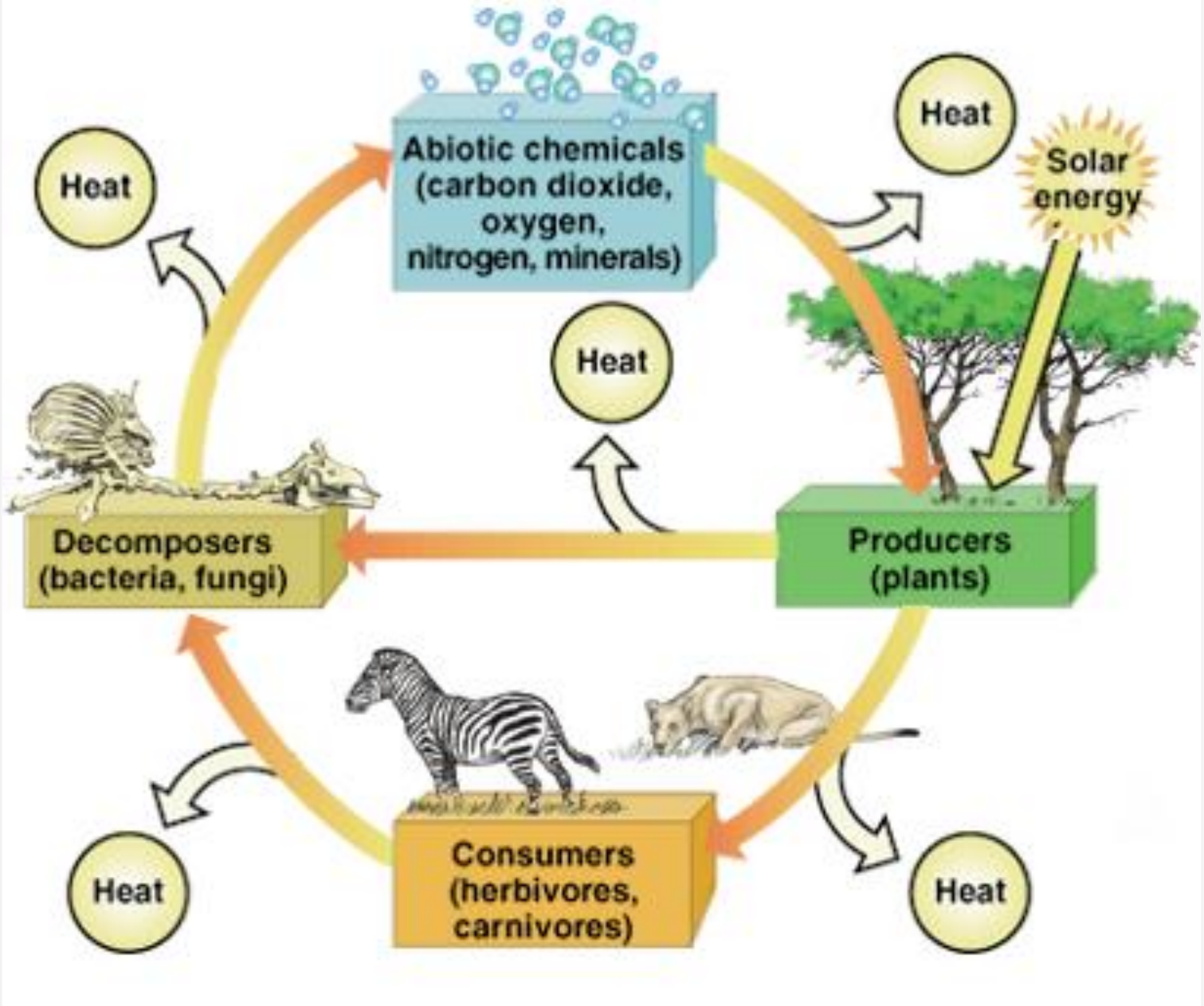
- Mostly certain types of bacteria and fungi are specialized consumers that recycle organic matter in ecosystems.

- They do this by breaking down (**biodegrading**) dead organic material to get nutrients and releasing the resulting simpler inorganic compounds into the soil and water, where they can be taken up as nutrients by producers.





Summary of Ecosystem Structure



Characteristics of Ecosystem - **Processes**

- Two basic kinds of processes must occur in an ecosystem:
  (i) a cycling of chemical elements and
  (ii) a flow of energy.

- These processes are necessary for all life, but no single species can carry out all necessary chemical cycling and energy flow alone.

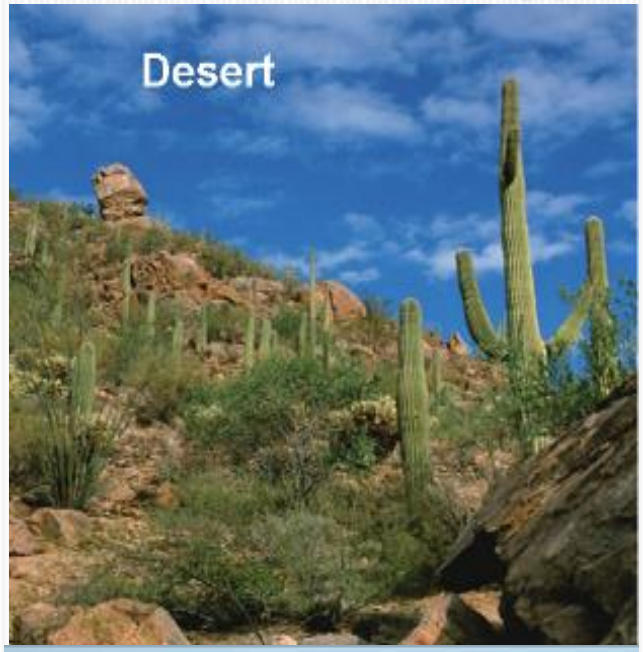
- That is why, it is said that sustained life on earth is a characteristic of ecosystems, not of individuals or populations.

Characteristics of Ecosystem - **Processes**

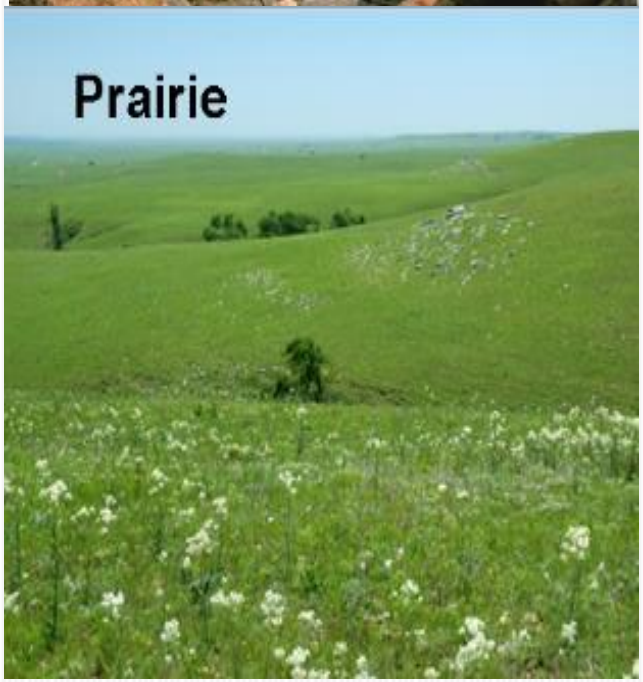
- At its most basic, an ecosystem consists of several species and a fluid medium—air, water, or both.

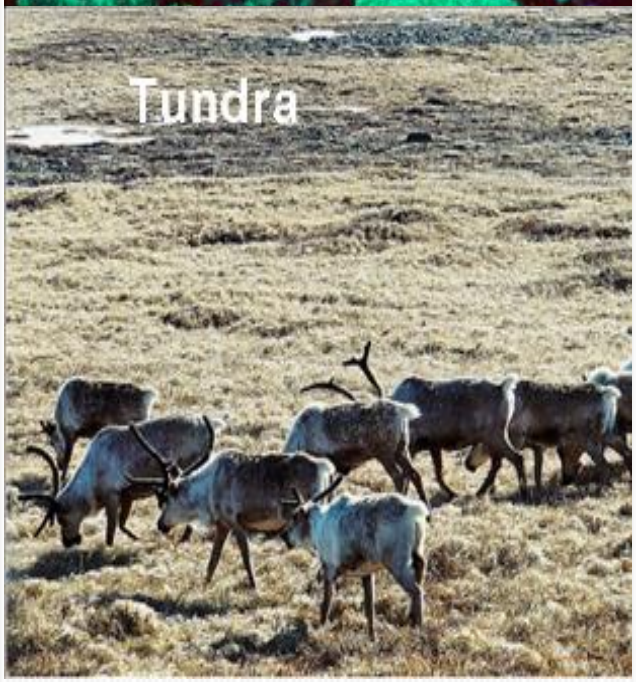
- Ecosystem energy flow places a fundamental limit on the abundance of life.

Types of Ecosystem









Types of Ecosystem

1. Natural Ecosystems : These operate under natural conditions without any major interference by man.

i. **Terrestrial Ecosystem :** Forest, grassland, desert, etc.

ii. **Aquatic Ecosystem :**

a. **Fresh water** : Lotic (running water like spring, stream, or rivers) or Lentic (standing water as lake, pond, pools, etc.)

b. **Marine water** : Such as deep bodies as ocean or shallow ones as Sea or an estuary.



Lentic (standing water) lake ecosystem



Lotic (flowing water) river ecosystem

Types of Ecosystem

2. Artificial (Man Engineered) Ecosystems :

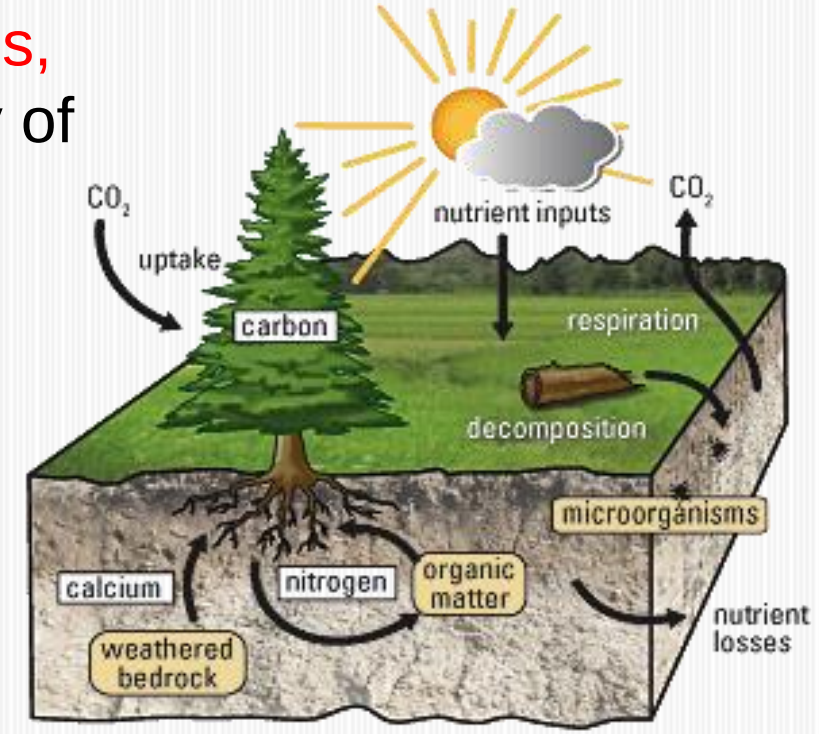
- These are maintained artificially by man.
- Due to addition of energy and planned manipulation, natural balance is disturbed regularly.
- Exp: crop land ecosystem.



Crop land ecosystem

Forest Ecosystem

- They have a predominance of trees that are interspersed with large number of species of herbs, shrubs, climbers, lichens algae & a variety of wild animals & birds.



- Depending upon the climatic conditions forests can be of different types :

1. Tropical Rain Forest
2. Tropical Deciduous forests
3. Tropical Scrub Forests
4. Temperate Rain Forests
5. Temperate Deciduous Forests
6. Evergreen Coniferous Forests

Desert – Ecosystem with very little rainfall.

- They occur in regions where evaporation exceeds precipitation (rainfall, snow, etc.)

- Mainly two kinds of deserts:
  - Hot deserts
  - Cold deserts

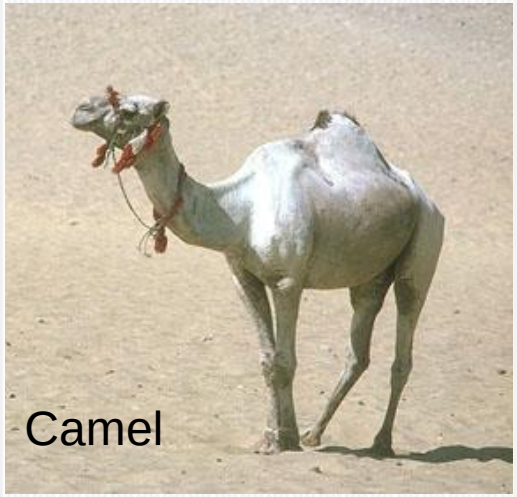
- Hot deserts
  - Temperatures are very warm all year round
  - The summers are very hot

- Cold deserts
  - Short, warm summers
  - Long, cold winters
  - Found in places near the north and south poles

Desert Ecosystem

Main Components :

1. Desert Plants
2. Desert Animals



Camel

Gila monster (lizard)









Roadrunner

Grass Land Ecosystem

- A grassland ecosystem is an ecological unit that has physical factors like water, soil and air, which help to establish that animals live there.
- The plants, animals, microbes along with the water, soil and air they live in help to create the ecosystem.
- About 1.2×10^8 mi^2 (4.6×10^7 km^2) of the Earth's surface is covered with grasslands, which make up about 32% of the plant cover of the world.
- Grasslands occur in regions that are too dry for forests but that have sufficient soil water to support a closed herbaceous plant canopy (cover) that is lacking in deserts.

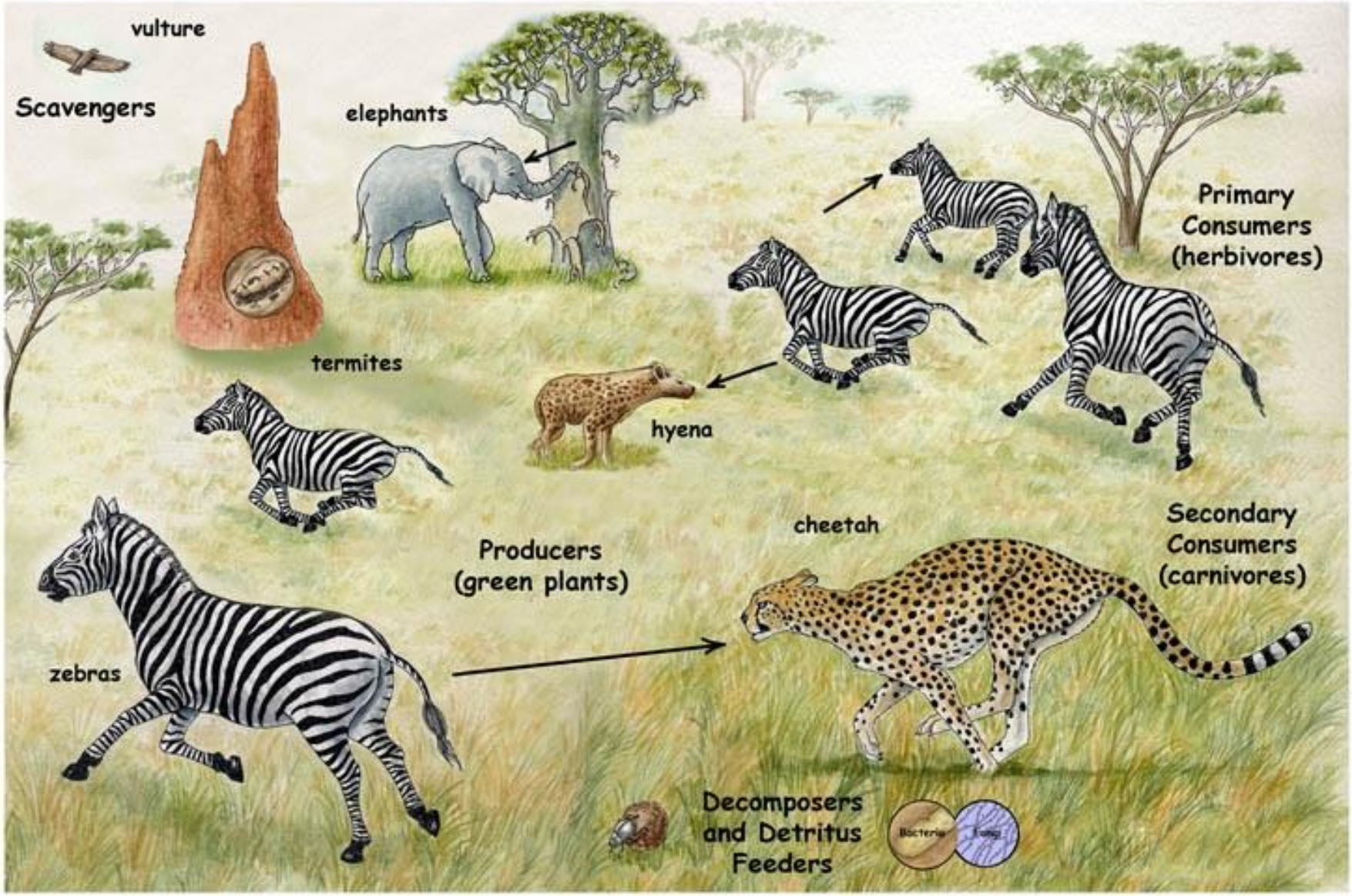
Grass Land Ecosystem

- Different kinds of grasslands develop within continents, and their classification is based on similarity of dominant vegetation, presence or absence of specific dominant species, or prevailing climate conditions.

1. Temperate grasslands
2. Tropical grasslands
3. Polar grasslands

- Grassland soils are highly fertile and contain large amount of exchangeable bases and organic matter.

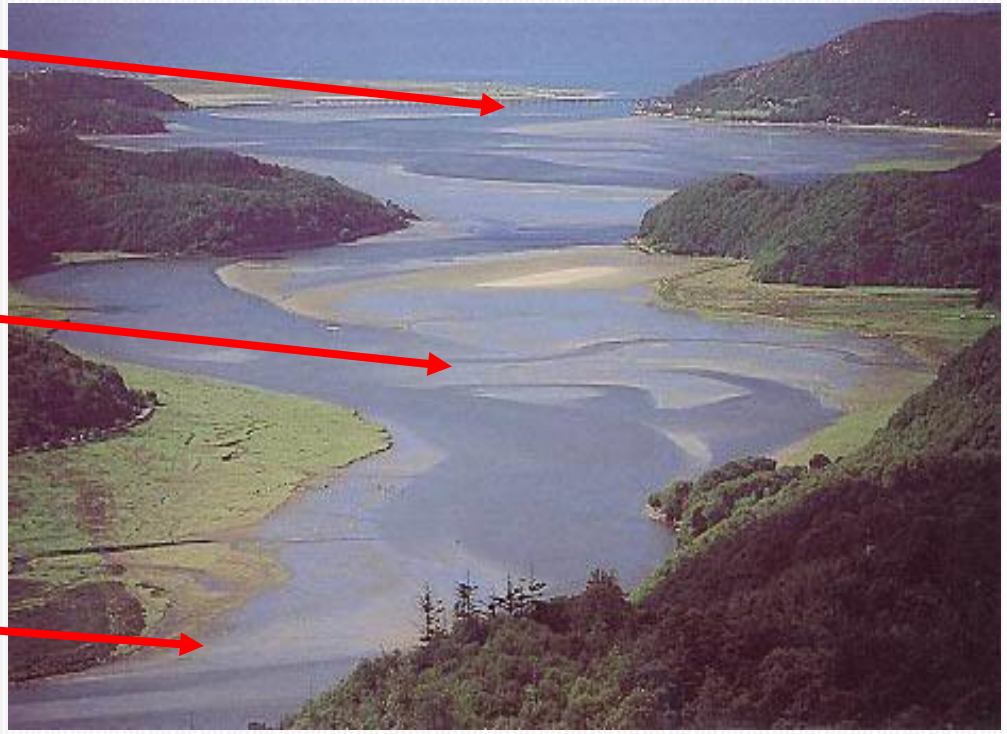
Grassland Food Web



Estuaries

- An estuary is a semi closed coastal body of water that has free connection with sea.

- An area in which fresh water from a river mixes with salt water from the ocean; a transition area from the land to the ocean. Other names: bay, sound, lagoon, harbor etc.



Characteristics of Estuaries

- Very nutrient rich ecosystems → leads to high productivity and high biodiversity.
- There is a gradual increase in salinity as you go from the river (0-5ppt) to the middle of the estuary (5-25ppt), to the ocean (>25 ppt). (ppt = parts per thousand)
- Sediment settles out in the estuary when the water slows down.
- Nutrients accumulates on the bottom (benthic zone).
- Pollutants are absorbed in estuaries.

Aquatic Ecosystem

- An **aquatic ecosystem** is an ecosystem in a body of water. Communities of organisms that are dependent on each other and on their environment live in aquatic ecosystems

- Aquatic Ecosystem can be further classified into :

  1. **Fresh water Ecosystem**

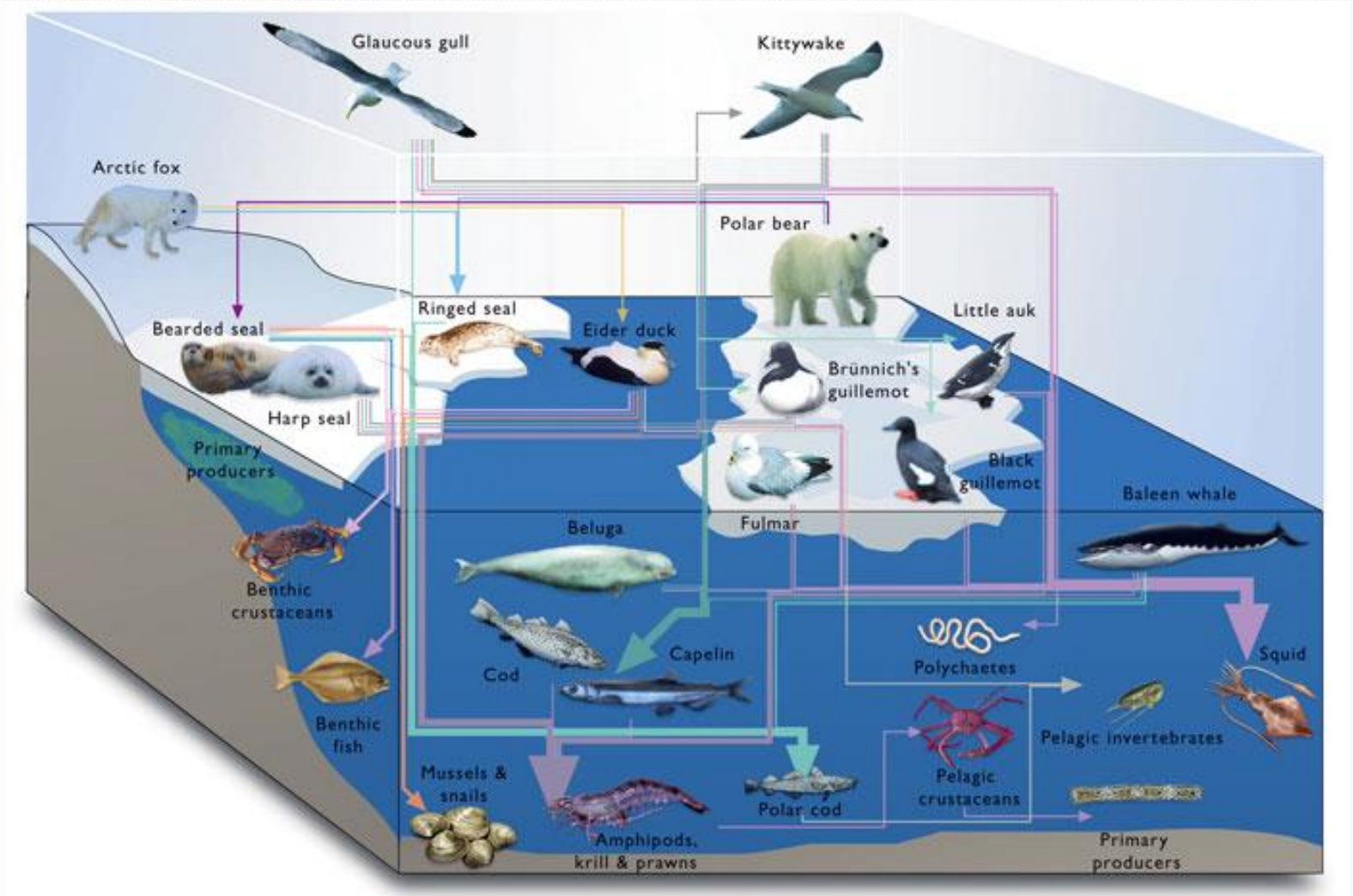
     - Pond Ecosystem : small bodies of freshwater with shallow and still water, marsh, and aquatic plants

     - Lake Ecosystem : slow moving water like pools, ponds, and lakes.

     - River Ecosystem : large streams flowing downwards from the mountain highlands into the sea

Aquatic Ecosystem

2. **Marine Ecosystem** : cover approximately 71% of the Earth's surface and contain approximately 97% of the planet's water.



Ecological Footprint

- The **Ecological Footprint** has emerged as the world's premier measure of humanity's demand on nature.
- It measures the amount of biologically productive land and water a given population requires to produce all the resources they consume and take in all the waste they make using prevailing technology (Onisto et al. 1998).
- Ecological footprints measure the extent to which humans are using the Earth's bio-productive capacity.
- Unit of ecological footprint is global hectares.

Ecological Footprint

- Biologically productive land and sea includes area that –

  1) supports human demand for food, fiber, timber and space for infrastructure, and

  2) absorbs the emitted waste.

- Examples of Biologically productive areas include cropland, grazing land, forest and fishing grounds, and do not include deserts, glaciers and the open ocean.

- The Ecological Footprint is compared to available **biocapacity**, that is, the planet's or a region's biological capacity to provide the products and services people demand.

Ecological Footprint

- By measuring the **footprint** of a population — an individual, city, business, nation, or all of humanity —

  ✓ we can assess our pressure on the planet

  ✓ which helps us manage our ecological assets more wisely and take personal and collective action in support of a world, where humanity lives within the Earth's bounds.

The Ecological Footprint

MEASURES

how fast we consume resources and generate waste



Energy



Settlement



Timber & paper



Food & fibre



Seafood

COMPARED TO

how fast nature can absorb our waste and generate new resources.



Carbon Footprint

Built-up land



Forest

Cropland & pasture

Fisheries

Global Footprint Accounts
(in global hectares/ person, 1999)

Ecological Demand *(Ecological Footprint)*		**Ecological Supply *(Biocapacity)***	
Footprint Areas for:		**Biocapacity Areas:**	
Growing Crops	0.53	Crop land	0.53
Grazing Animals	0.12	Grazing land	0.27
Settlements & infrastructure	0.10	Built-up area	0.10
Producing timber & fuelwood	**0.33**	**Forest**	**0.86**
Absorbing excess CO_2	**1.07**		
Harvesting Fish	0.14	Fishing Grounds	0.14
Total Global Demand	**2.29**	**Total Global Supply**	**1.90**

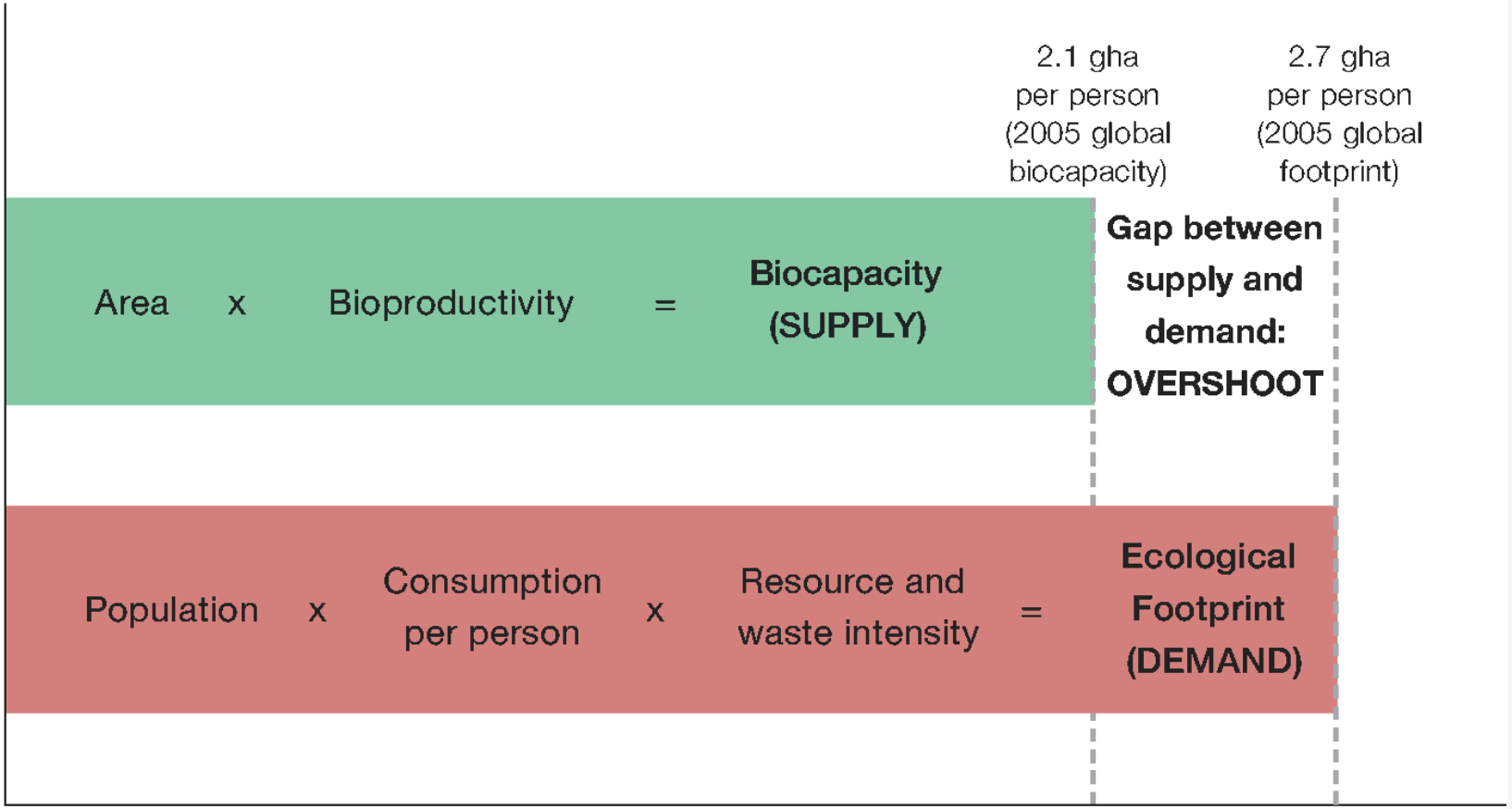
Demand Exceeds Supply By 20%

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Overshoot

Ecological Footprint

Fig. 33: **FOOTPRINT AND BIOCAPACITY FACTORS THAT DETERMINE OVERSHOOT**



Global Footprint Accounts

Data for 1999	***Eco-Footprint*** [global ha /cap]	***Biocapacity*** [global ha/cap]
Australia	7.6	14.6
China	1.6	1.1
Germany	4.7	1.8
Italy	3.8	1.3
Japan	4.6	0.8
Russia	4.2	5.1
South Africa	4.0	2.5
US	9.6	5.8
WORLD	**2.3**	**1.9**

Ecological Footprint

- Ecological footprints measure Earth's carrying capacity for humans
- In 2010, the biosphere had about 11.5 billion hectares of biologically productive surface (about 1/4 of the total planet)
  - ✓ 2 billion ha of ocean
  - ✓ 9.5 billion ha of land
- Current estimates indicate that humans are over-shooting the Earth's carrying capacity by 25-50%
  - ✓ To sustain the current carrying capacity, we could need 1.5 Earths!

Ecological Footprint

Overstepping Ourselves

As our Ecological Footprint continues to exceed Earth's biocapacity, we overdraw from our future.



1961

74%
of biocapacity

1985

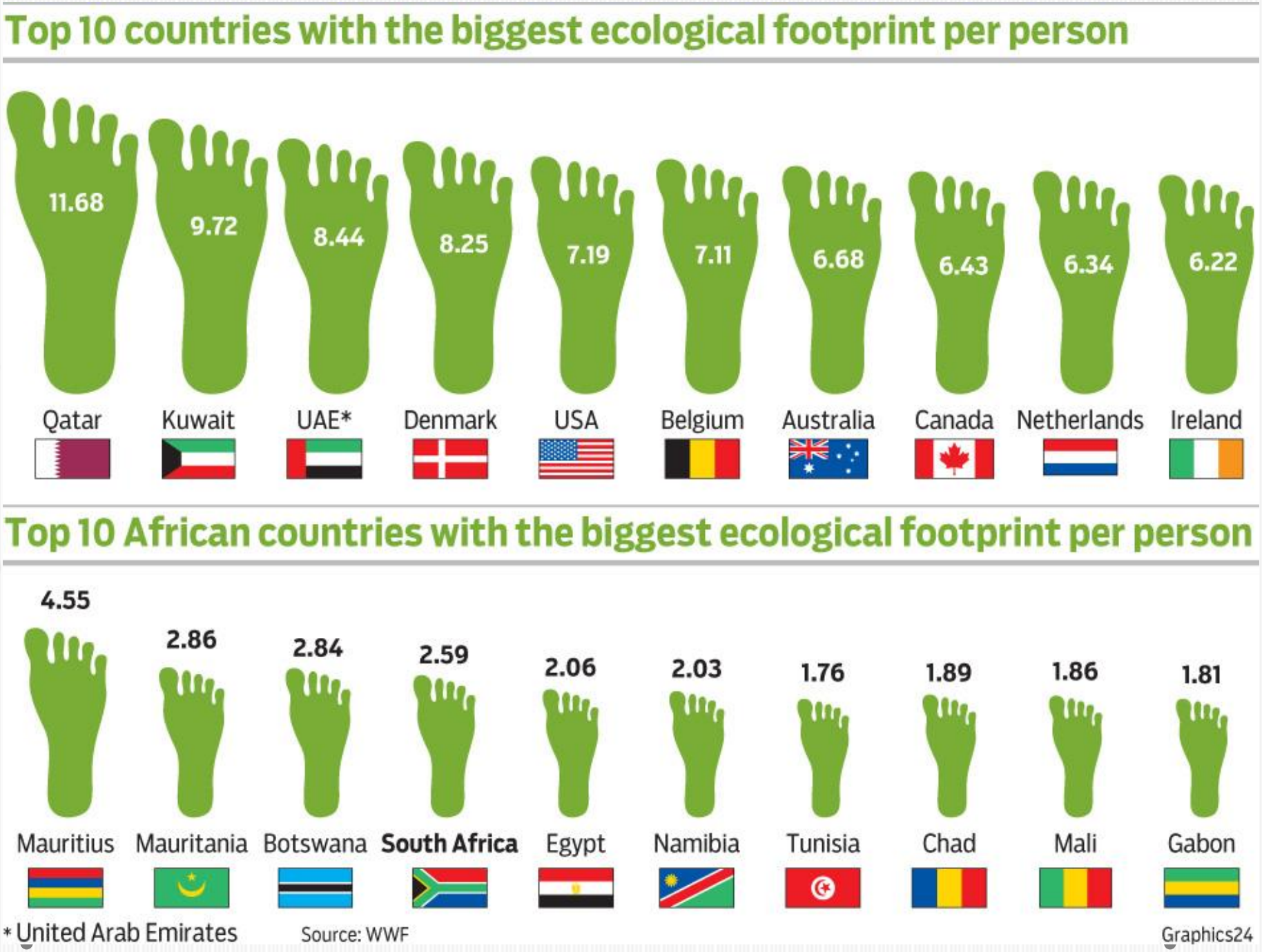
114%
of biocapacity

2012

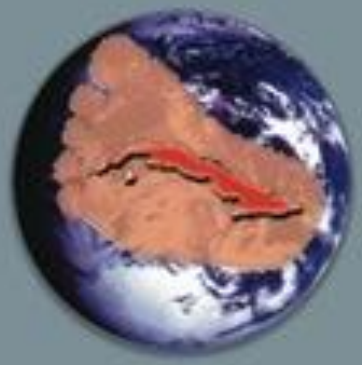
156%
of biocapacity

Source: Global Footprint Network, Earth Overshoot Day, 2012

Ecological Footprint



Ecological Footprint



If everyone lived like a Cuban we could sustain current population with the resources of one planet earth

If everyone lived like an Australian we'd need **3.7 planets**

