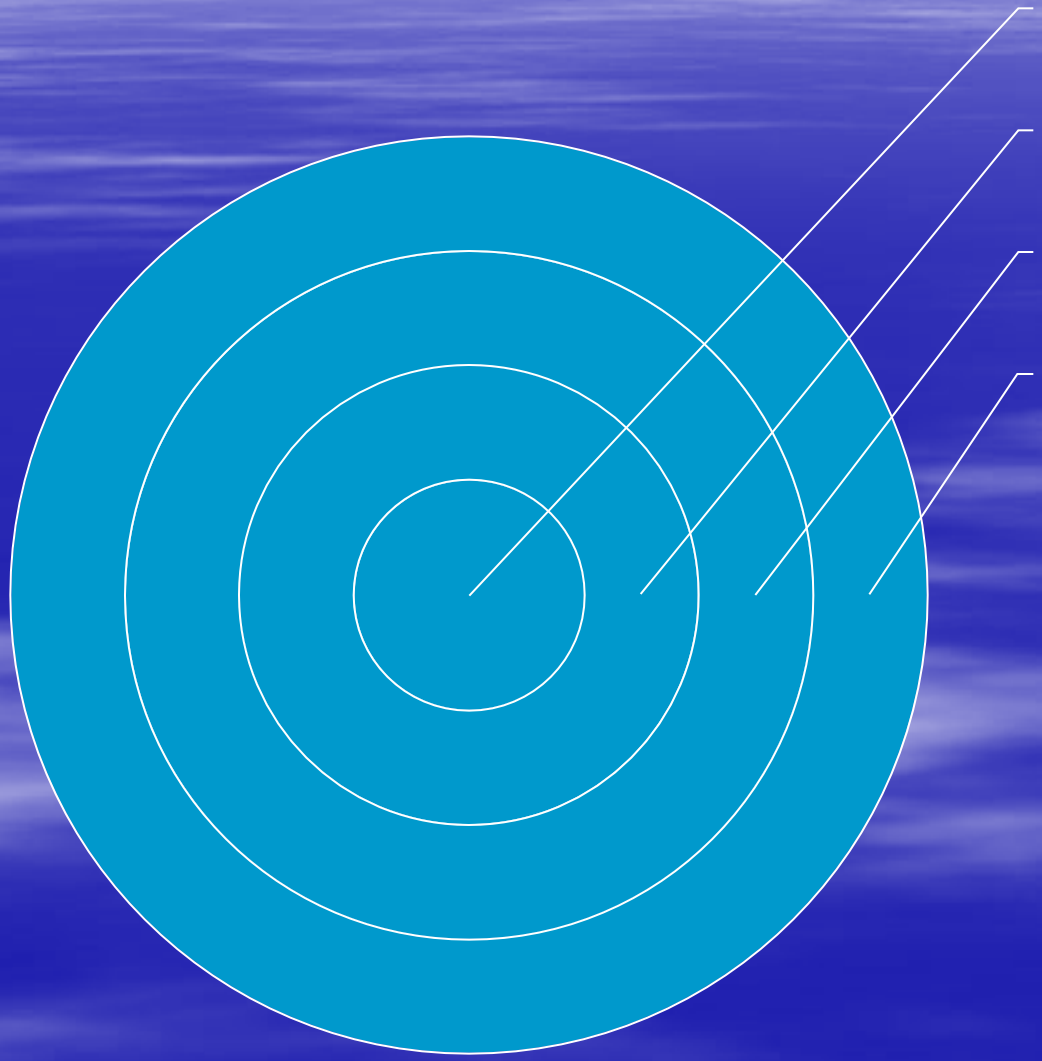
Chapter 3

Ecosystems and Their Diversity

Organisms and Their Environment

- Within the environment, organisms will interact with both biotic and abiotic factors
- Within an ecosystem, we can study any one of many interacting subsystems

Divisions Within the Ecosystem



Areas of Study

- Ecologists who study individuals are primarily concerned with how the environment affects the behavioural and physical characteristics of an organism
- Ecologists who study populations study why the size and composition of a population changes with time, and what factors drive those changes

- The ecologists who study communities look at the interactions between the many species and how these interactions affect the populations

Environments Change Over Time

- As abiotic factors change, the environment also changes
- As well, as one population within the ecosystem changes, those populations that interact with them will also change
- Populations are also able to change their environment over time, particularly after a major change to that environment

Ecosystems and the Biosphere

- An ecosystem encompasses all of the living and nonliving parts of an environment
- However, the environment can vary in size – the particular ecosystem studied depends on the individual researcher
- The biosphere is the largest possible ecosystem – it encompasses everywhere on Earth where living things can be found

- Every species has its own place or role in the biosphere (niche)
- The distribution of a species is related to the ways the abiotic and biotic components of the environment affect the ability of the species to survive

The Classification of Organisms

- Because of differences in language and culture, it became clear to scientists that a common method of classifying organisms was needed
- Taxonomy is the practice of classifying living things

Early Classification

- As early as 2000 years ago, Aristotle began to classify organisms into kingdoms (plants and animals)
- Of course, when more organisms were identified using the microscope, it was acknowledged that we needed more than two divisions

The Six Kingdoms

Archaea	Single-celled prokaryotic organisms that live in extreme environments
Bacteria	Single-celled prokaryotic organisms that live in a wide range of habitats
Protista	Consists of both single and multi-celled eukaryotic organisms
Fungi	Single and multi-celled eukaryotes that secrete enzymes to digest their food
Plantae	Eukaryotic multi-celled organisms that use photosynthesis
Animalia	Eukaryotic multi-celled organisms that are heterotrophs

Domains

- The six-kingdom system has recently been revised as we have developed a better understanding of the relationships between some organisms
- There are three major domains, which are large groups that encompass all of the kingdoms

Three Domains Diagram

3 Domains

1. Eukarya – unicellular or multicellular organisms that have cells that contain a nucleus. Reproduce sexually.
2. Archaea – unicellular prokaryotic organisms that reproduce asexually. Often have cell walls and are autotrophic by chemosynthesis.
3. Bacteria – unicellular prokaryotic organisms that reproduce asexually. Can be autotrophic (by chemo- or photosynthesis) or heterotrophic (by absorption).

The Levels of Classification

- There are 8 separate levels of classification
- These 8 levels are, from most inclusive to most exclusive:
- Domain, Kingdom, Phylum, Class, Order, Family, Genus, Species
- This system (minus the Domain classification) was developed by Carolus Linnaeus

Naming Systems

- We now use binomial nomenclature to identify and classify species
- Every organism is therefore referred to through its genus and species name
- These names are recorded in Latin and occasionally Greek (so that they are consistent regardless of the language of the scientist that classifies the organism)

Ex: Classifying the Human

- Domain: Eukarya
- Kingdom: Animalia
- Phylum: Chordata
- Class: Mammalia
- Order: Primates
- Family: Hominidae
- Genus: Homo
- Species: sapiens

Changing Names

- With the ability to genetically sequence the DNA of any organism, we can now verify whether or not a particular organism is correctly classified
- We can compare an organisms' DNA to other organisms that we suspect are related
- For instance, skunks have recently been removed from the family that contains the weasels and have been placed in their own family

Dichotomous Keys

- One of the easiest ways to classify an organism is to use its visible characteristics
- One way to accomplish this is through the use of a dichotomous key
- These keys use pairs of descriptions to simplify the identification of an organism

- Complex and specific keys would fill up many pages, and rely on very careful observations
- Therefore, keys are usually specific, and would not start at the phylum level, but most likely at the level of order or family

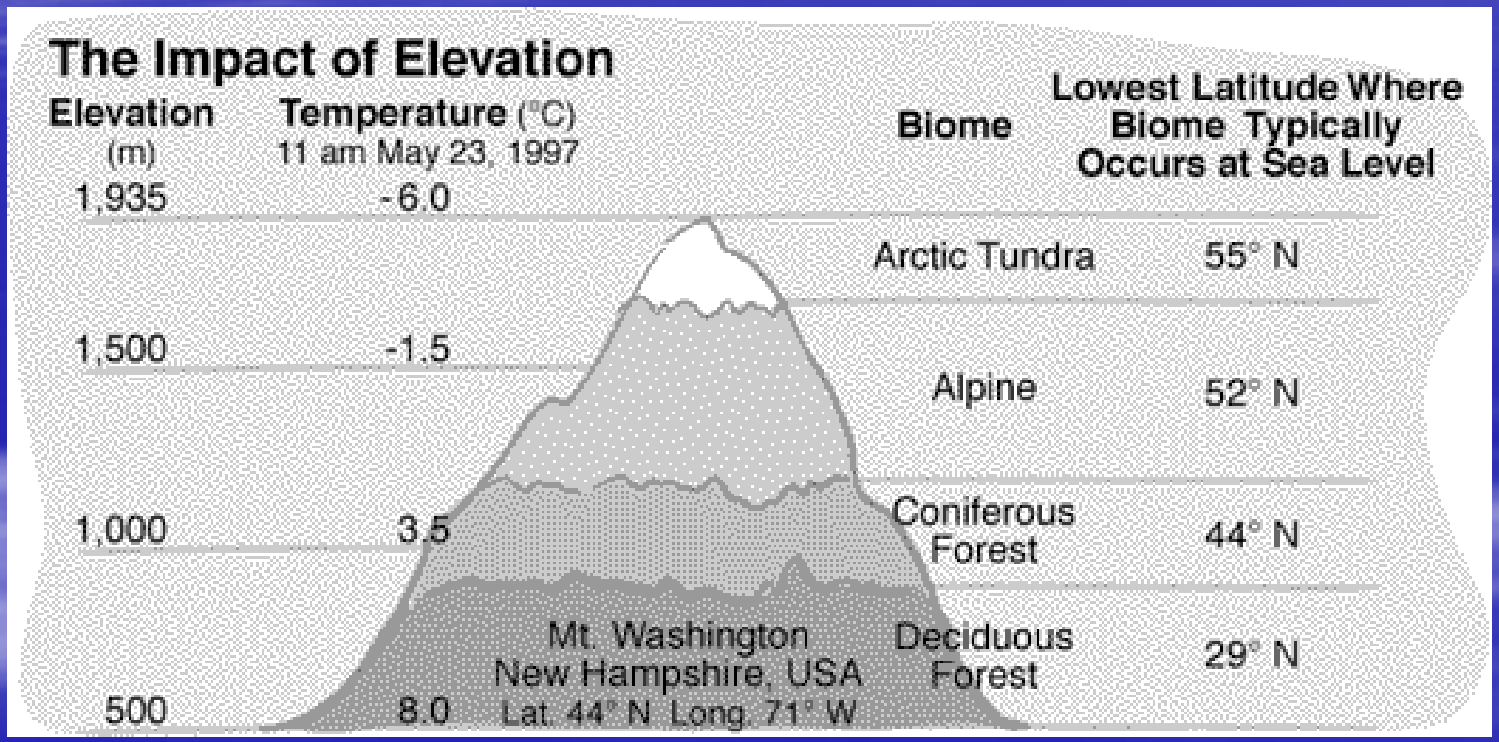
Studying Organisms in Ecosystems

- As previously mentioned, life on Earth is not evenly distributed
- The abiotic factors that dictate the productivity of an ecosystem will often have a major effect on the distribution of living things

Climate and Biomes

- Recall that the Earth heats unevenly
- This not only affects surface temperatures, but also the movement of ocean and atmospheric currents
- Both latitude and altitude have similar effects on the distribution of living things

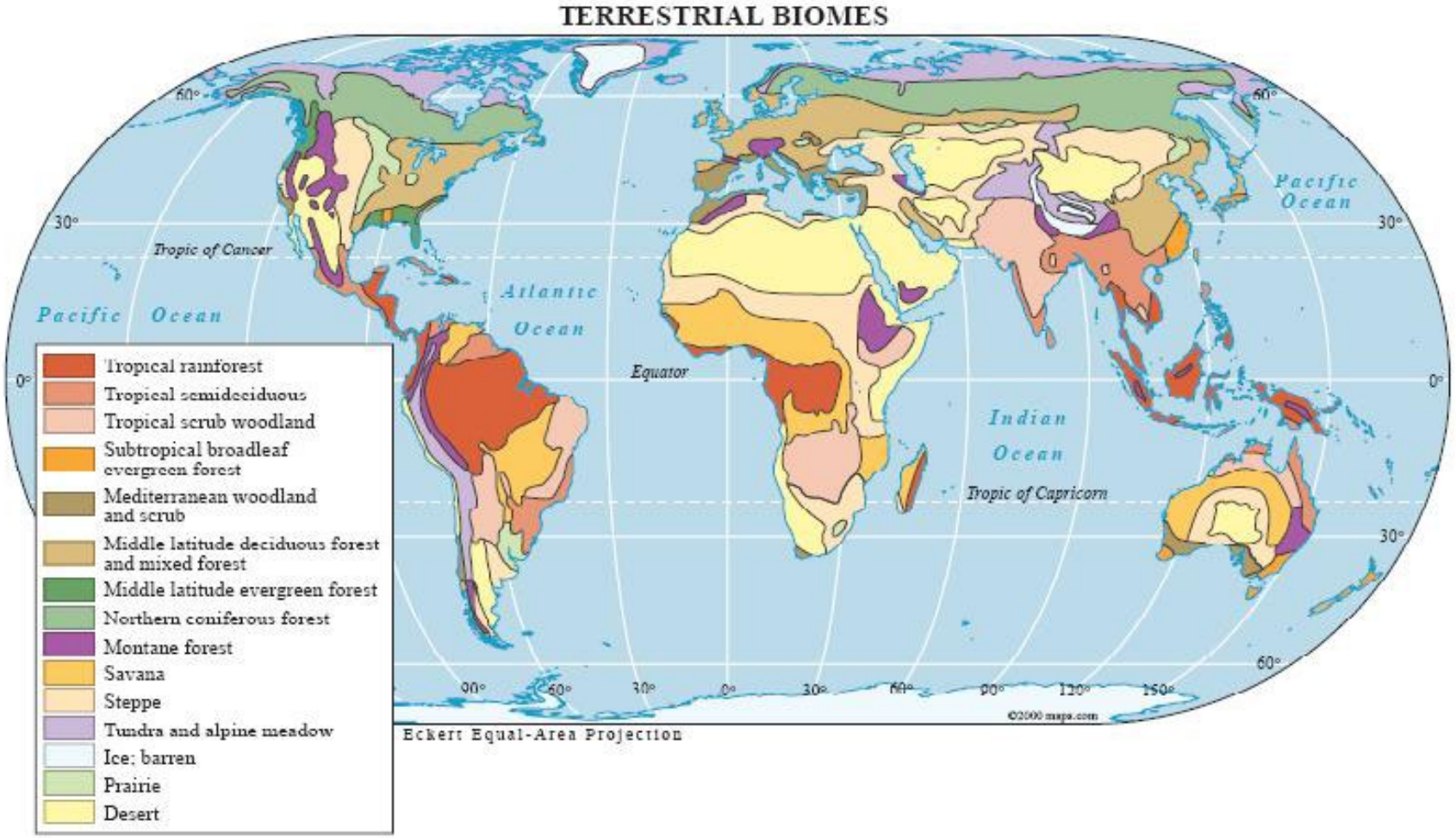
Effects of Latitude and Altitude



Biomes

- Biomes are identified based on their mean annual temperatures and precipitation levels
- In general, as temperature and precipitation both increase, the abundance of organisms will also increase
- It should be noted that biomes do not have set fixed barriers, but rather blend into other nearby biomes in most cases

Global Biomes

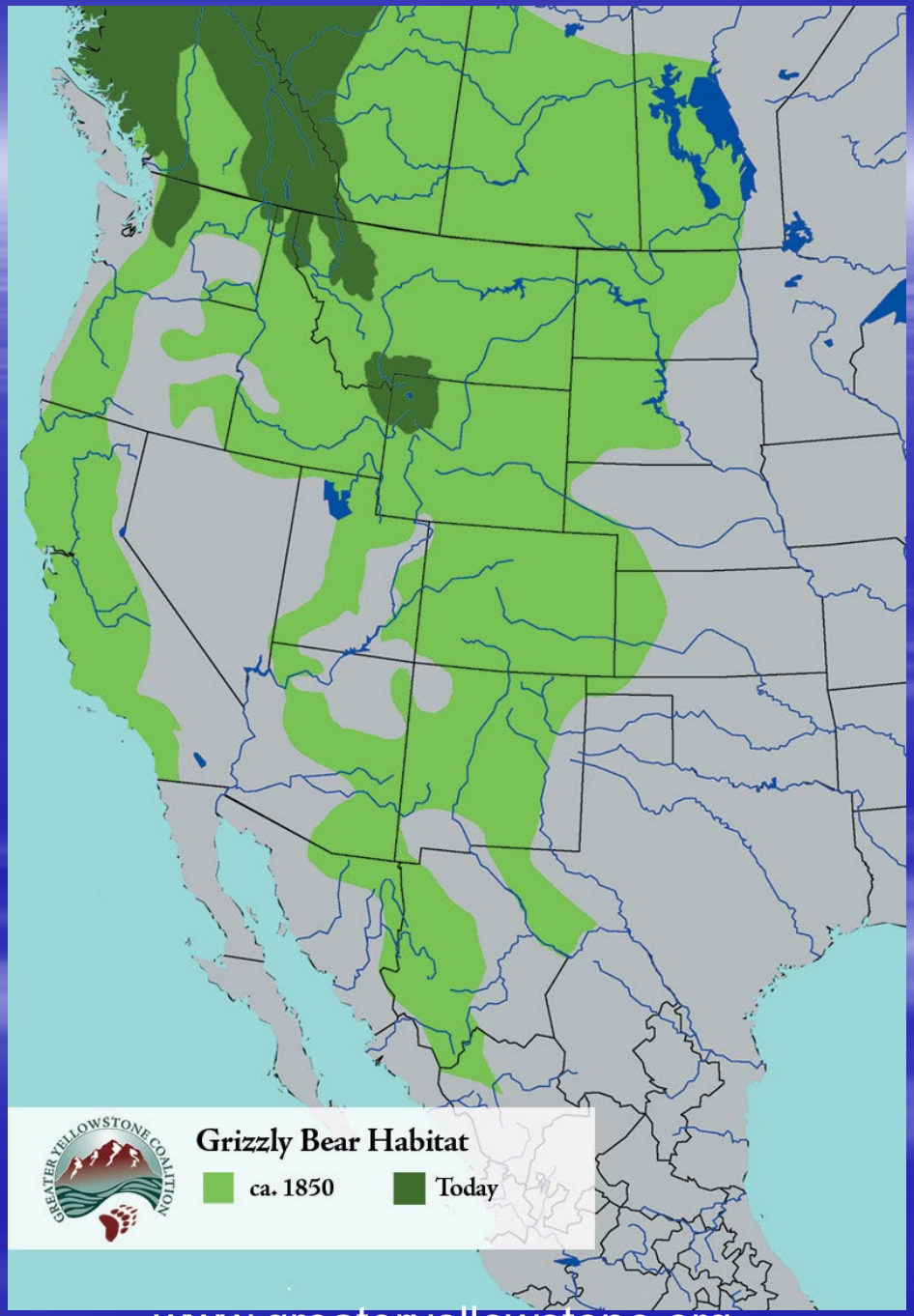


Habitat

- Within a biome, there is a huge amount of varied vegetation and terrain
- Therefore, a number of different habitats can be created that can suit the requirements of different organisms
- Related to a species' habitat is its range
- The range of a species refers to the geographical area in which the species can be found

- However, not all places within a range will have a suitable habitat for those organisms
- Therefore, organisms do not live throughout their range, but rather in its particular habitat within that range
- However, the range of a particular species may change as humans interfere or modify the environment

- This map shows the historical and current range of the Grizzly bear in the western United States and Canada
- As you can see, the range of the bear has greatly decreased since 1850



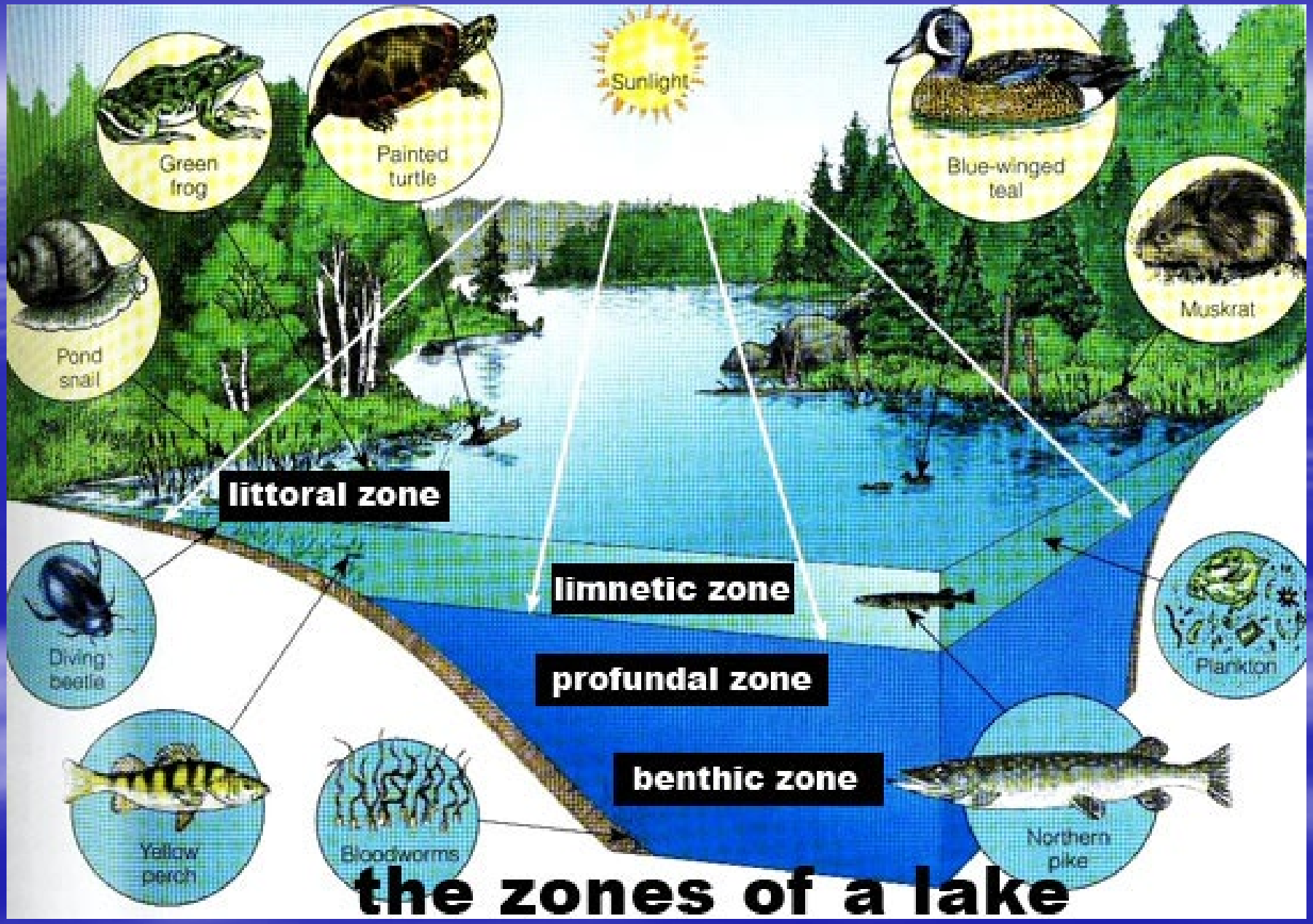
www.greateryellowstone.org

Ecological Niches

- Although many species may share the same ranges, they often have different niches
- Often trouble occurs when one organism either occupies another organisms' niche, or destroys its niche (such as the mountain pine beetle destroying pine trees)

Niches in Aquatic Environments

- Niches are determined by the available biotic and abiotic factors
- In aquatic environments, the amount of available light is often the main determining factor in the available niches
- Therefore, each zone of a lake will have distinct groups of organisms


Sunlight
Green frog
Painted turtle
Blue-winged teal
Muskrat
Pond snail
littoral zone
limnetic zone
profundal zone
benthic zone
Diving beetle
Plankton
Yellow perch
Bloodworms
Northern pike
the zones of a lake

Lake Zones

Zone	Abiotic Factors	Organisms
Littoral	-shallow, warm water -lots of light	-rooted plants, insects, small fish
Limnetic	-open water -lots of light	-algae, small and large fish
Profundal	-dark, cold water	-mostly decomposers
Benthic	-mud & sand -little or no light	-decomposers, filter feeders, worms

Overturn vs. Stagnation

- **Spring/Fall Overturn:**
  - Refers to the overall mixing of the layers of the lake during these seasons
  - We know that water's density properties change when the temperatures range from +4-0°C. Due to this change, the water thermal layers begin to mix.
  - This allows for more oxygen and other nutrients to be dissolved into the lake.
  - This is good because during winter/summer, there is NO mixing!

Overturn vs. Stagnation

- **Summer/Winter Stagnation:**
  - During these seasons the water is either higher than 4 °c or lower than 0 °c (usually lower than -5 °c in the winter)
  - At these temperatures, water's density properties revert to NORMAL
  - As a result, there is NO mixing (and thus no oxygen or nutrients dissolving) during these seasons.
  - Whatever nutrients/oxygen is present during these seasons, it must last the whole season until it can be replenished in the fall/spring.

Thermal Zones of a Lake

There are 3 thermal zones in a lake:

1. Epilimnion: the highest temperature zone (located at the top of the lake)

2. Thermocline: medium temperature zone located in the middle of the lake (profundal)

3. Hypolimnion: the coldest temperature zone located at the bottom of the lake (benthic)

Types of Lakes

1. Oligotrophic: young lakes, cold lakes, deep lakes. As well very little vegetation or detritus.

2. Eutrophic: older lakes, warmer lakes (lots of productivity and decomposing action), shallow lakes. Contain lots of vegetation and detritus.

**Note: Eutrophication is the process in which lakes go from being oligotrophic to eutrophic. (Also refers to the filling in of a lake with vegetation and detritus)

Niches in Terrestrial Environments

- There is a great amount of diversity among terrestrial ecosystems
- The biodiversity in these ecosystems also depends on the biotic and abiotic factors present
- The greater the number and variety of organisms in an ecosystem, the greater the number of niches

Growth-Limiting Factors

- Consider the following scenario:
- If a small population of bacteria doubled in size every few hours, then at the end of 20 hours there would be about 1×10^{12} bacteria
- Within 4 days, the mass of the bacterial colony would be greater than the mass of the Earth
- Obviously, this does not happen because there are limiting factors to their growth

Abiotic Limiting Factors

- Some limiting factors are the abiotic factors present in the environment
- Producers, in particular are limited by the abiotic factors of their environment
- Many producers rely on changes in the abiotic factors of their environment to initiate different phases of their life cycle

Biotic Factors

- Biotic factors also affect the rate of growth
- In general, these factors may be classified as one of the following:
- Competition
- Predation
- Parasitism

Competition

- There are finite amounts of each resource available in each ecosystem
- Therefore, there is competition for these resources
- Competition may be classified as intraspecific (within a species) or interspecific (between two different species)

Intraspecific Competition

- A number of resources may be required by all of the individuals of a species
- However, there is not enough resources to ensure the survival of all of these individuals

http://www.nhptv.org

Interspecific Competition

- Competition between species occurs when two different species occupy the same niche
- If these niches are the same, the stronger species will become dominant and eventually the weaker species will disappear (either through extinction or migration)
- If humans introduce a new species to an ecosystem, it can often disrupt the niche of another native species, often causing extinction

http://hyenas.zoology.msu.edu

Predation

- Predation naturally limits the population of prey species
- The change in the numbers of prey will affect trophic levels beneath the prey species
- Predators that feed on multiple prey types will affect numerous food chain relationships

http://lib.colostate.edu

Parasitism

- Parasitism differs from predation as the parasite often does not kill its host when feeding
- If there is an increase in the density of the host population, parasites can more easily pass between those hosts
- Often parasitic infestations will limit the reproductive and survival ability of the host

http://www.histopathology-india.net/Ascar.htm

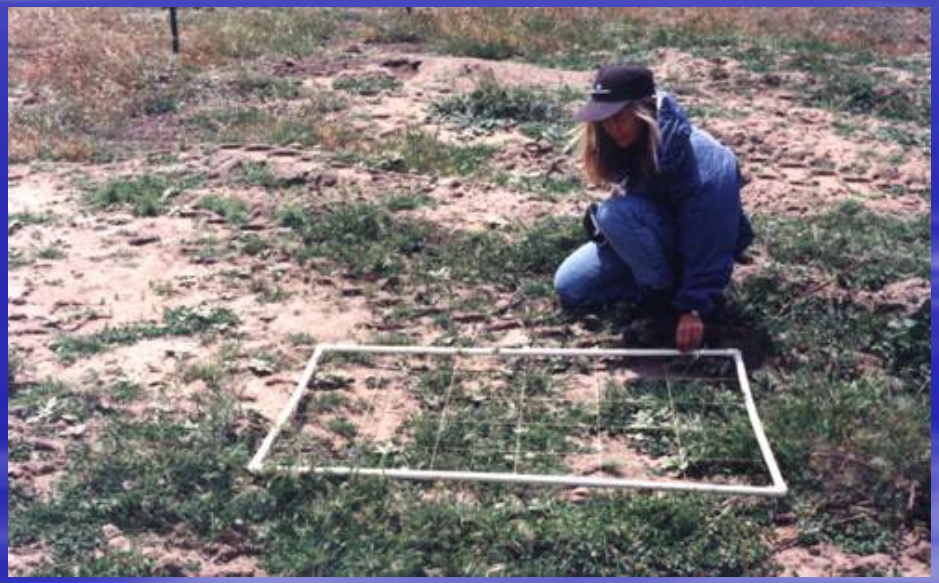
Population Sampling

- Population samples are often used to determine population sizes
- When sampling an area, transects or quadrats are used to divide the study area into smaller areas

Transect vs. Quadrat Sampling

Transect Method

http://biodiversity.science.oregonstate.edu



Quadrat Sampling Method

http://www.sci.sdsu.edu

Estimating Population Densities

- The density of organisms is determined by calculating the average number of individuals per unit of area
- This assumption then could be applied to a larger area to determine the total population of an area
- The important thing to keep in mind regarding sampling is that the samples should be random to avoid groupings of organisms that may occur in small areas

End of Chapter

www.sfrc.ufl.edu

http://www.wnps.org

http://biology.usgs.gov

http://www.geography.learnontheinternet.co.uk