ECOLOGY– PART 2
TERRESTRIAL ECOSYSTEMS – YEAR2 (2018)
Training Handout

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TRAINING MATERIALS:

- **Training Power Point** presents an overview of material in the training handout
- **Training Handout** presents introductory topic content information for the event
- **Sample Tournament** has sample problems with key
- **Event Supervisor Guide** has event preparation tips, setup needs and scoring tips
- **Internet Resource & Training Materials** are available on the Science Olympiad website at www.soinc.org under Event Information.
- **A Biology-Earth Science CD, an Ecology CD** as well as the **Division B and Division C Test Packets** are available from SO store at www.soinc.org

ECOLOGY CONTENT: - each section has a separate handout

- General Principles of Ecology (about 1/3)
  It is recommended that for State and Regional Tournaments the general Ecology principles be applied to the local and regional ecology.
- Terrestrial Ecosystems of North America (about 1/3)
- Human Impact on Terrestrial Ecosystems (about 1/3)

The Ecology event will concentrate on the US Terrestrial Ecosystems

YEAR 1 – 2017

- ***forests***
- ***taiga***
- ***tundra***

YEAR 2 - 2018

- ***grasslands***
- ***deserts***

North American Terrestrial Biomes

Ecological Principles applied to North American Biomes

Abiotic Factors of Biomes

Biotic Features of Biomes – Organisms

- Not intended to be a taxonomic event
- Emphasis on adaptations of common plants and animals for each biome
- Common members of food chains and food webs of each biome
- Limiting factors for each biome

North American Biomes

1 Arctic Tundra

2 Boreal or Taiga

3 Rocky Mt. Evergreen

4 Pacific Coast Evergreen

5 Northern Mixed

6 Eastern Deciduous

7 Coastal Plain Evergreen

8 Mexican Montane

9 Rain Forest/Selva

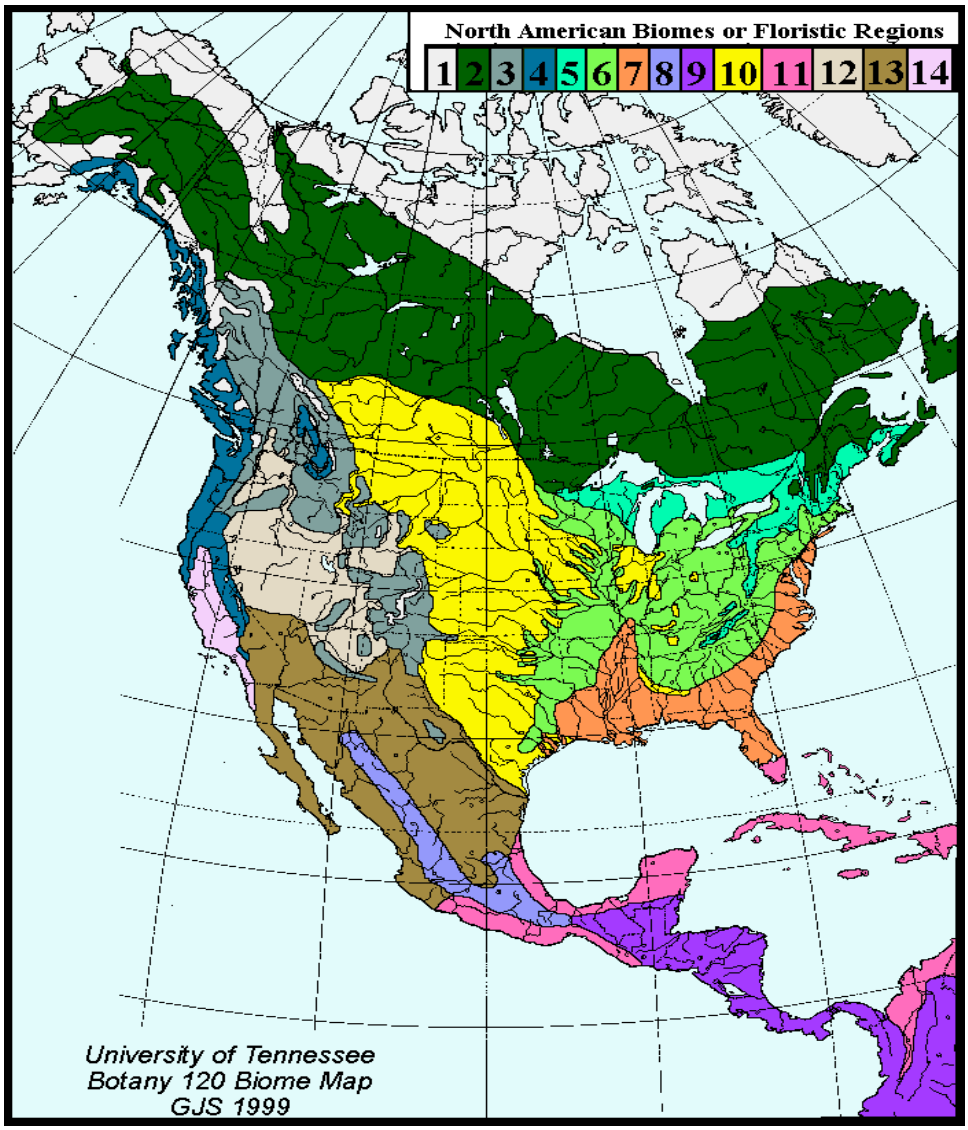
10 Prairie

11 Tropical Savanna

12 Cool Desert

13 Hot Desert

14 Mediterranean Scrub



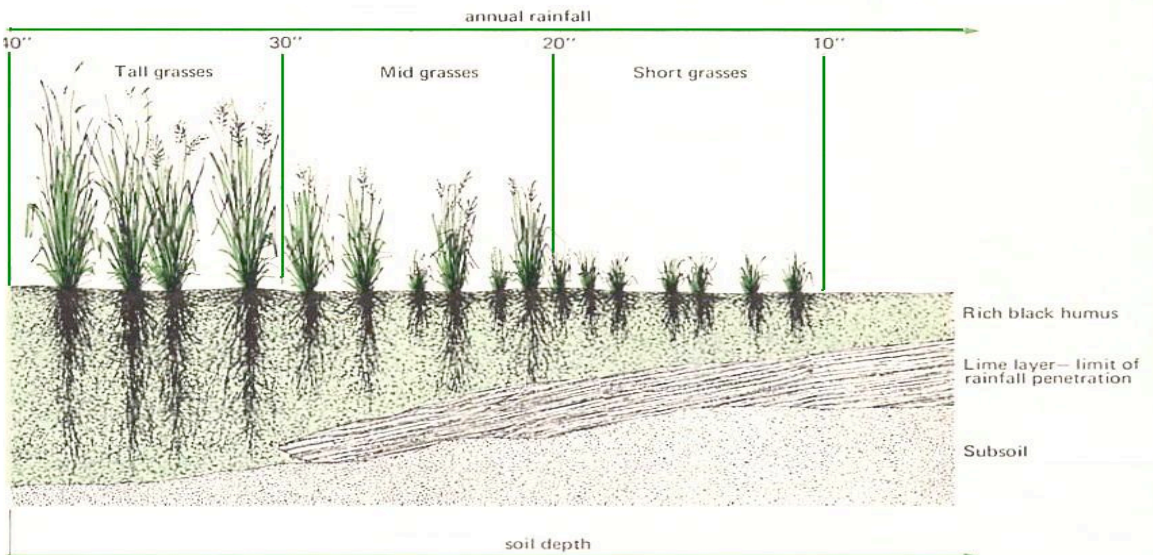
GRASSLANDS OR PRAIRIES

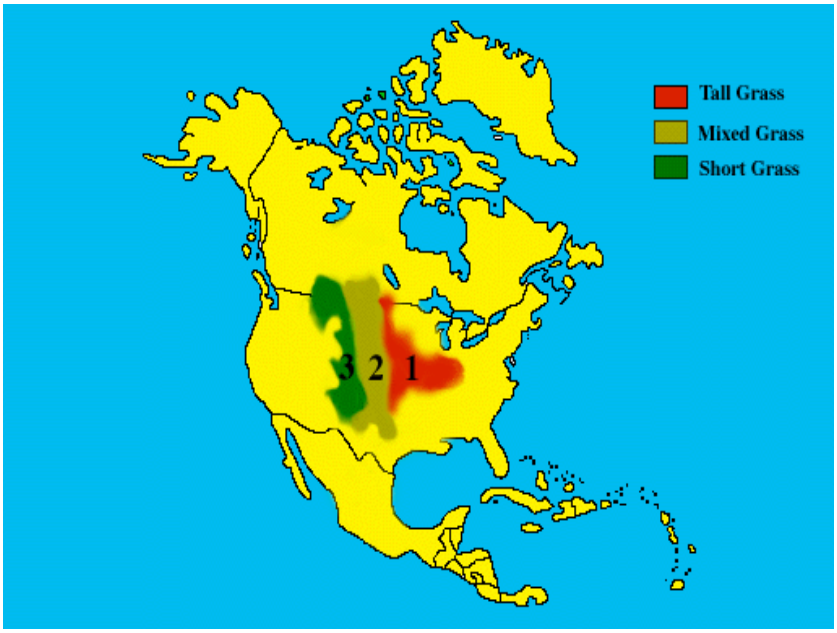
Characteristics of Prairies:

- Precipitation is too low to support trees but too great for deserts to form.
- Grasses are major producer with several genera and species common but usually with one or two dominate.
- Most grasses possess rhizomes and are wind pollinated.
- Moderate temperature with notable extremes: -20° F to 110° F common, and even colder temperatures in the north.
- Variable precipitation: 6-40 in (15-100 cm).
- Scattered rain and lightning common in summer months ("convection storms") with more general rains and snows in winter months.
- Soils generally fertile, deep and rich; variable
- Growing season of 120-200 days.
- Generally flat to rolling topography cut by stream drainages where there is a river-bank habitat.
- Fire a major factor in maintaining biome.
- Dominated by grazing animals (deer, antelope, buffalo - once common but now rarely native to the range), burrowing small animals, and song birds.

Three types of Grasslands or Prairies

- **Tall-grass Prairie**: eastern unit – nearest to Eastern Deciduous Forests
  - Tall grasses (3-4 ft or 1-1.5 m tall) with deep roots
  - 24-40 in (65-100 cm) precipitation annually.
- **Mid-grass Prairie**: central unit.
  - Grasses to 4 ft (1.5 m) tall
  - 14-25 in (35-65 cm) precipitation annually.
- **Short-grass Prairie**: western element, largest. Nearest to deserts of western US
  - Short grasses (less than 20 in or 50 cm tall)
  - About 10 in precipitation annually.





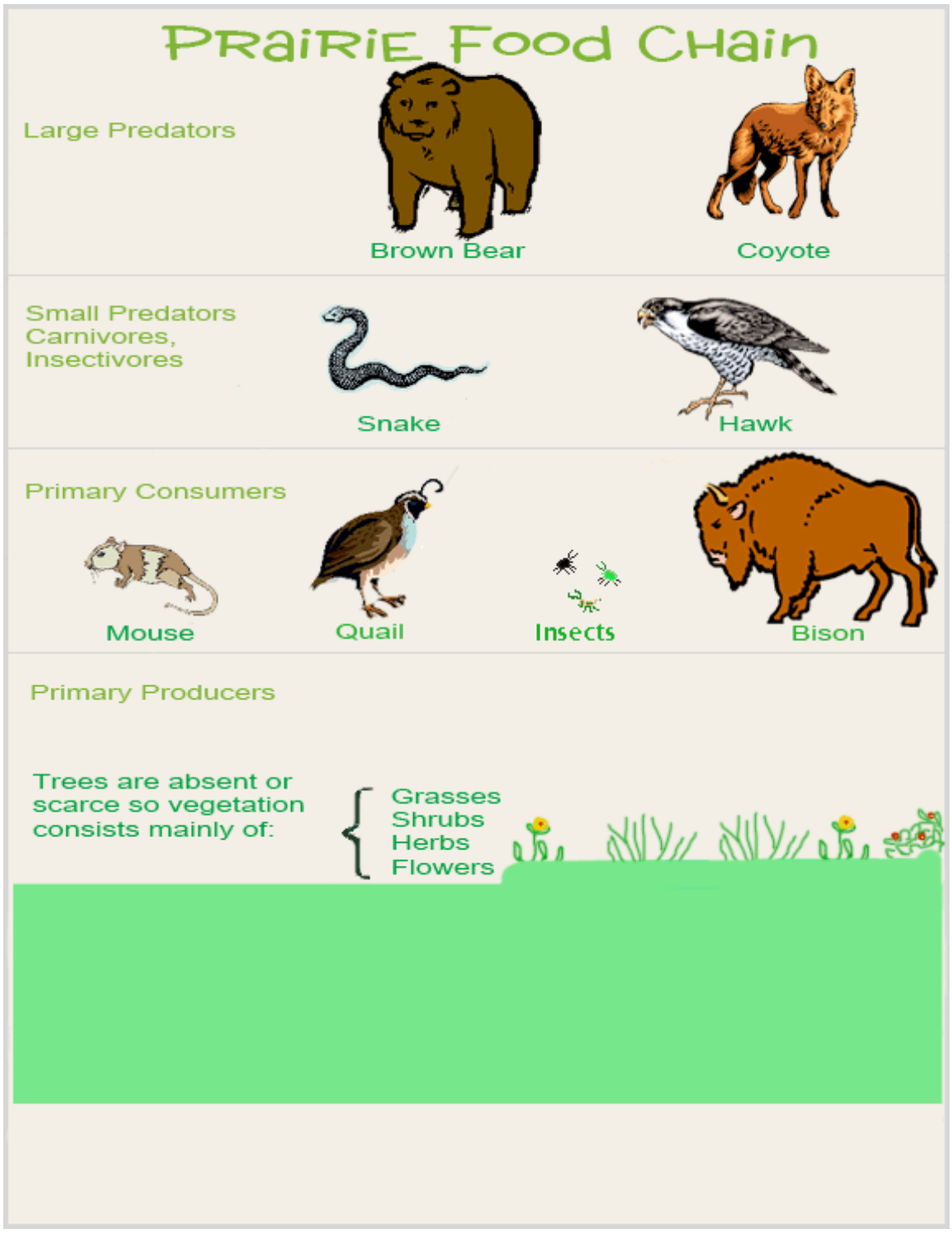
Types of Plants and Their Adaptations

- Grasses are major producer with several genera and species common but usually with one or two dominate
- Herbs and legumes (nitrogen fixing) among the grasses
- Many plants possess rhizomes (underground stems) and are wind pollinated
- Soils generally fertile, deep and rich in nutrients (Bread baskets of the world)
- Growing season of 120-200 days
- Generally flat to rolling topography
- Native plants are perennials while crop grains are annuals
- Grasses have three strata – roots, growth at ground level, and taller foliage
- Half of growth may be below ground
- Grazed taller foliage will grow back
- Taller foliage above ground adapted to withstand strong winds, fires, extreme temperature changes

Types of Animals and Their Adaptations

- Dominated by grazing animals (deer, antelope, buffalo - once common but now rarely native to the range)
- Herds (safety in numbers)
- Burrowing small animals (colonies as prairie dogs)
- Rodents and Jack Rabbits
- Flight song birds – strong fliers
- Insects esp. grasshoppers
- Long distance vision for predator & prey
- Eyes of grazing animals well above snout
- Many are built for speed – live in herds or colonies
- Small creatures can stand on haunches
- Some hop up and down or hop long distances
- Camouflage coloration
- Underground burrows
- Birds – strong fliers (strong winds), flight song birds to attract mates in air, nest in tall grass

GRASSLAND FOOD WEB



DESERTS

Characteristics of Deserts:

- **Cover 1/5 of earth's land surface**
- **Most occur at low latitudes but some are cold deserts**
- **Scarcity of water –** less than 25 cm (10 inches) of precipitation per year
- **Intense solar radiation** – strong tendency to lose water by evaporation
- **Water loss** – tendency for water loss may exceed annual rainfall
- **Temperature variation** – daytime over 120 degrees and drops as sun sets
- **Winters** – may be cold
- **Relatively poor soil quality** – high mineral content but little organic matter
- **Flooding problems during rains**
- **Special adaptations of desert organisms** – to withstand or avoid water stress
- **Desert expansion** – growth of deserts in parts of the world
- **Regions of low, sparse vegetation with minimal precipitation and humidity, high temperatures during some of the year and great daily temperature fluctuations**
- **Special adaptations of desert organisms** – to withstand or avoid water stress
- **Many endangered, rare and unusual plants and animals live in the desert**.
- **Slow to recover from habitat damage**
- **Desert expansion** – growth of deserts in parts of the world

Types of Deserts

- ***Hot*** - Arid regions with little or no annual precipitation, usually rain, no snow or frost; vegetation sparse and scattered, often limited to moist areas, or even lacking entirely except following periods of adequate regional moisture.
- ***Warm*** - Arid regions where precipitation falls seasonally principally as rain, some snow and frost each year; vegetation is xerophytic and sclerophyllous shrubs with scattered trees or arborescent
- ***Cold*** - Arid regions where precipitation falls sparingly principally as snow and permafrost is not a factor; vegetation is primarily xerophytic and sclerophyllous shrubs with scattered, low trees.

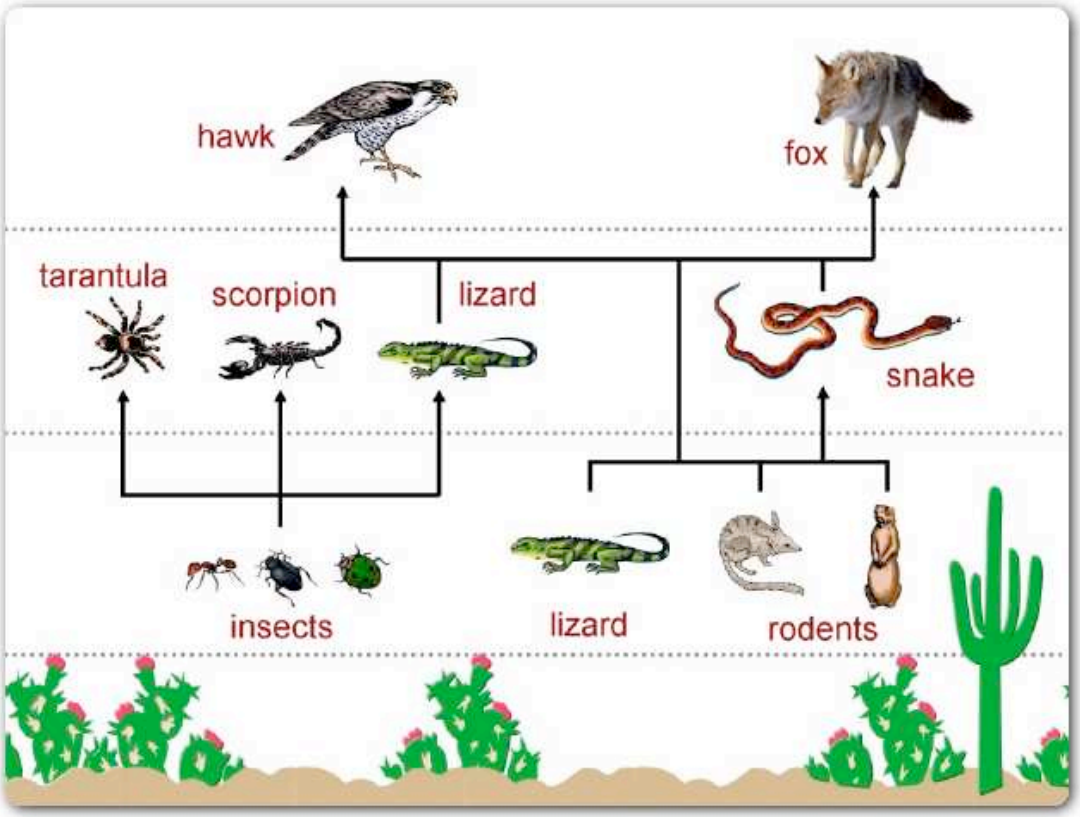
Desert Plants and their adaptations

- Succulent plants – "juicy plants" such as cacti store water, spines are remnants of leaves
- Annuals – dormant during dry season, germinate and grow rapidly to seed after rains
- Desert shrubs – have small thick leaves with sunken stomates
- Annuals have short life cycle of flower to seed after rain – seeds during dry times
- Shrubs have small thick leaves with sunken stomates with widely branching roots which rapidly collect moisture or deep tap roots to underground moisture as mesquite.
- Some depend upon animals' digestion for dispersal of seeds
- Succulents store water in stems – no stomates to lose water – green stems functions of leaves – spines thought to be remnant leaves

Desert Animals and their Adaptations

- Insects and scorpions
- Lizards and Snakes
- Birds – from hummingbirds to roadrunners and bats
- Small mammals as such rodents
- Larger mammals as such coyotes
- Burrow for protection from heat
- Conserve water loss from evaporation, exhalation, elimination of body waste
- Nocturnal activity when cooler or hide/burrow during day to protect from heat
- Many cold-blooded insects and reptiles
- Exoskeletons or scales

DESERT FOOD WEB



Deserts of North America

- Warm Desert – **Mojave Desert**
- Warm Desert – **Sonoran Desert**
- Warm Desert – **Chihuahuan Desert**

- Cold Desert – **Great Basin of the Intermountain West**

Biodiversity

Biodiversity- *"variability among living organisms"*

- The term Biodiversity is coined by **Walter Rosen**, 1985
- Biodiversity is the variety and variability of genus, species and ecosystem between and within
- It is the number of different organisms & their relative frequency in an ecosystem
- Biodiversity also includes: **Variability of genus, Variability of varieties, Variability of species, Variability of populations in different ecosystems, Variability in relative abundance of species**
- About 50 million species of plants, animals & microbes are existing in the world
- Among this only 2 million are identified so far
- Knowledge of biodiversity is essential for **sustainable utilization** of resources
- Biological resources provide us: **Nourishment, Clothing, House, Fuel, Medicine and Revenue**

Levels of Biodiversity:

- **Genetic diversity** – varies in the genetic make-up among individuals within a single species
- **Species diversity** – variety among the species or distinct types of living organisms found in different habitats of the planet
- **Ecological diversity** – variety of forests, deserts, grasslands, streams, lakes, oceans, wetlands, and other biological communities. Variations in the community in which the species lives. The ecosystem in which the community exists, Interaction within and between biotic and abiotic components

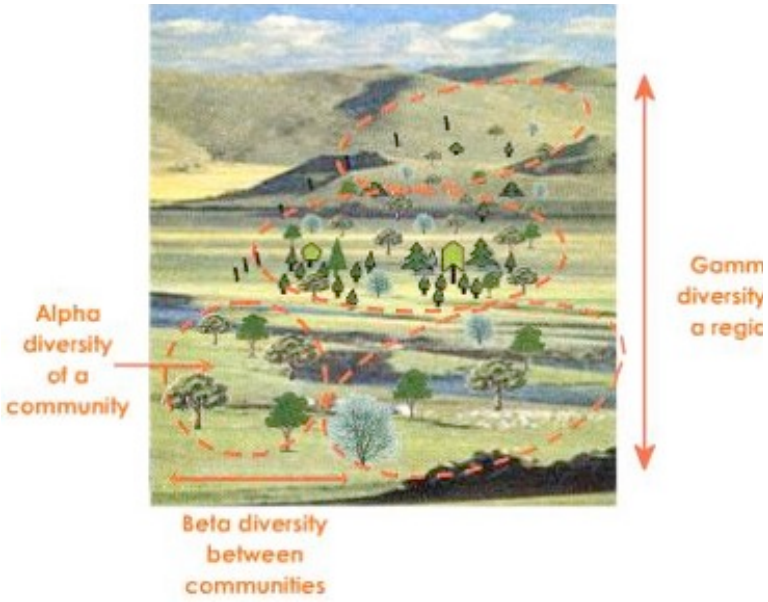
Types of biodiversity: different types of biodiversity can be observed in nature

- **Genetic diversity:** diversity in the alleles of a single gene
- **Organismal diversity:** differences in morphology, anatomy, behavior of organisms
- **Population diversity:** variations observed quantitative ecological parameters such as frequency, density, abundance etc.
- **Species diversity:** Measures the species number variations in different genera at a particular habitat
- **Community diversity:** variability among community composition of and ecosystem and variations in the ecological interactions
- **Ecosystem diversity:** deals with the variations of interdependence of biotic and abiotic factors in the ecosystem
- **Landscape diversity:** measures the species composition in different landscapes
- **Biogeographic diversity:** diversity observed in geological and geographic history over a large period of time

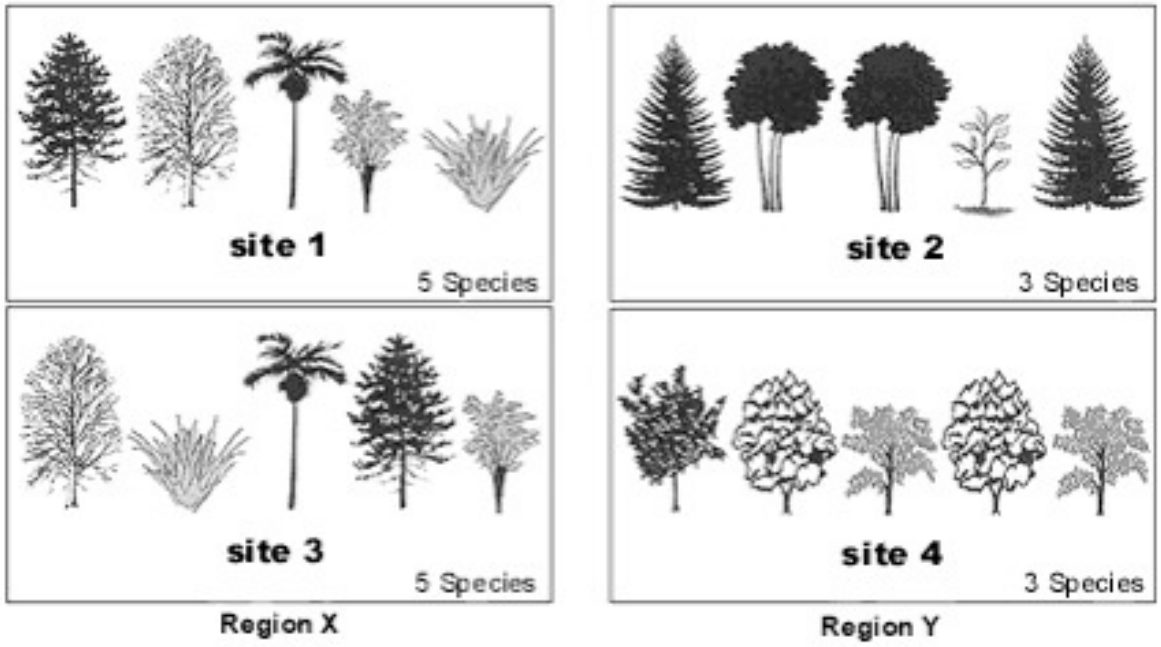
Species diversity and ecosystem stability

- higher diversity = higher stability
- minimum threshold of species diversity needed to maintain stability

Diversity Levels - Progress from local to regional levels



- ***Alpha*:** within habitat diversity - refers to a group of organisms interacting and competing for the same resources or sharing the same environment. Measured as # of species within a given area.
- ***Beta*:** species diversity along transects & gradients - refers to the response of organisms to spatial heterogeneity. High beta-diversity implies low similarity between species composition of different habitats. It is usually expressed in terms of similarity index between communities (or species turnover rate) between different habitats in same geographical area (often expressed as some kind of gradient). High Beta indicates number of species increases rapidly with additional sampling sites along the gradient
- ***Gamma*:** diversity of a larger geographical unit (island) - Geographical diversity



ALPHA-, BETA- AND GAMMA-DIVERSITY.
Alpha diversity is measured locally, at a single site, as at sites 1 and 2. Site 1 has higher alpha-diversity than site 2.

Beta-diversity measures the amount of change betwen two sites or along a gradient, as in regions X and Y. Region Y has higher beta-diversity than region X, as there is a higher turnover of species among the sites in region Y.

Gamma-diversity is similar to alpha-diversity, only measured over a large scale. Both alpha- and beta-diversity contribute to gamma-diversity. Region X has high alpha-diversity at its sites, but they are all fairly similar; the region thus has low beta-diversity and only moderate gamma-diversity. Region Y has low alpha-diversity at its sites, but the sites differ from each other; the region therefore has high beta-diversity, and higher gamma-diversity than region X.

Measuring Biodiversity – Div. C

Biodiversity is defined and measured as an attribute that has two components — **richness** and **evenness**.

- **Richness** = The number of groups of genetically or functionally related individuals. In most vegetation surveys, richness is expressed as the number of species and is usually called **species richness**.
- **Evenness** = Proportions of species or functional groups present on a site. The more equal species are in proportion to each other the greater the evenness of the site. A site with low evenness indicates that a few species dominate the site.

The most common measures of biodiversity are species richness, Simpson's index, and Shannon's index. Although it's good to know what each test helps you understand, software programs have been designed to do the math for you. The most commonly used program for measuring biodiversity is **EstimateS**. The count of the species coupled with these tests, summarizes most of the information on biodiversity.

- **Species richness:** This is the simplest measure of species diversity. Simply count the number of species found in your sample area. Since the larger the sample, the more species we would expect to find, the number of species is divided by the square root of the number of individuals in the sample. This particular measure of species richness is known as D, the Menhinick's index.

$$D = \frac{s}{\sqrt{N}}$$

where s equals the number of different species represented in your sample, and N equals the total number of individual organisms in your sample.

- **Species Diversity:** Species diversity differs from species richness in that it takes into account both the ***numbers of species*** present and the dominance or ***evenness of species*** in relation to one another. **Shannon-Weomer index is used.** Interestingly Shannon, a physicist, developed the index as a formula for measuring the entropy of matter in the universe. It turns out that the mathematical relationships hold true whether one is dealing with molecules in solution or species in an ecological community.

$$H = \sum (pl) \, |\ln pl|$$

Where (pl) is the proportion of the total number of individuals in the population that are in species "l" in the community.

- Should only be used on random samples taken from a large community where the total number of species is known.
  - Measures the order, or disorder, observed within a specific community.
  - Can be used to determine evenness, a measure of abundance similarity among the various species in the community.

Advantages and Disadvantages Shannon-Wiener's Index

- All species must be represented
- Relatively easy to calculate
- Sensitive to changes in rare species

Simpson's Index: The probability of picking two different organisms at random.

- **Simpson's Index** = D.

$$D = \frac{\Sigma n(n - 1)}{N(N - 1)}$$

where N = the total number of organisms of all species
n = the total number of organisms of a particular species.
The value of D ranges between 0 and 1. 0 represents infinite diversity and 1 represents no diversity

- **Simpson's Diversity Index** = 1 – D
- **Simpsons Reciprocal Index** = 1/D

Advantages and Disadvantages of Simpson's Index

- Aids in understanding the biodiversity across communities.
- Gives more attention to common species rather than rare species.
- Works very well with small samples.
- Does not require all species be represented
- Measures chance that two individuals are from same species
- Sensitive to changes in common species
- Weighted towards most abundant species
- Opposite of dominance

Biodiversity Calculator - http://www.alyoung.com/labs/biodiversity_calculator.html

SEE THE HANDOUT ON BIODIVERSITY CALCULATIONS