Biogeographic Processes

Terrestrial Flora

July 19th, 2021

Ecosystem vs. Biome

Ecosystem—the totality of interactions among organisms and the environment in the area of consideration.

a) Encompasses both the living and nonliving portion and how energy flows among them.

b) Weakness—there is an almost infinite variety in the magnitude of ecosystems that can be studied:

- Range includes the whole Earth itself to a drop of water.

Biome: a large naturally occurring community of flora and fauna occupying a major habitat e.g.: forest or tundra

Food Chains

Food Chains

Food chain – sequential predation in which organisms feed upon one another, with organisms at one level providing food for organisms at the next level, and so on.

- Energy is **thus** transferred through the ecosystem.

Primary energy transformation mechanism

Food Chains

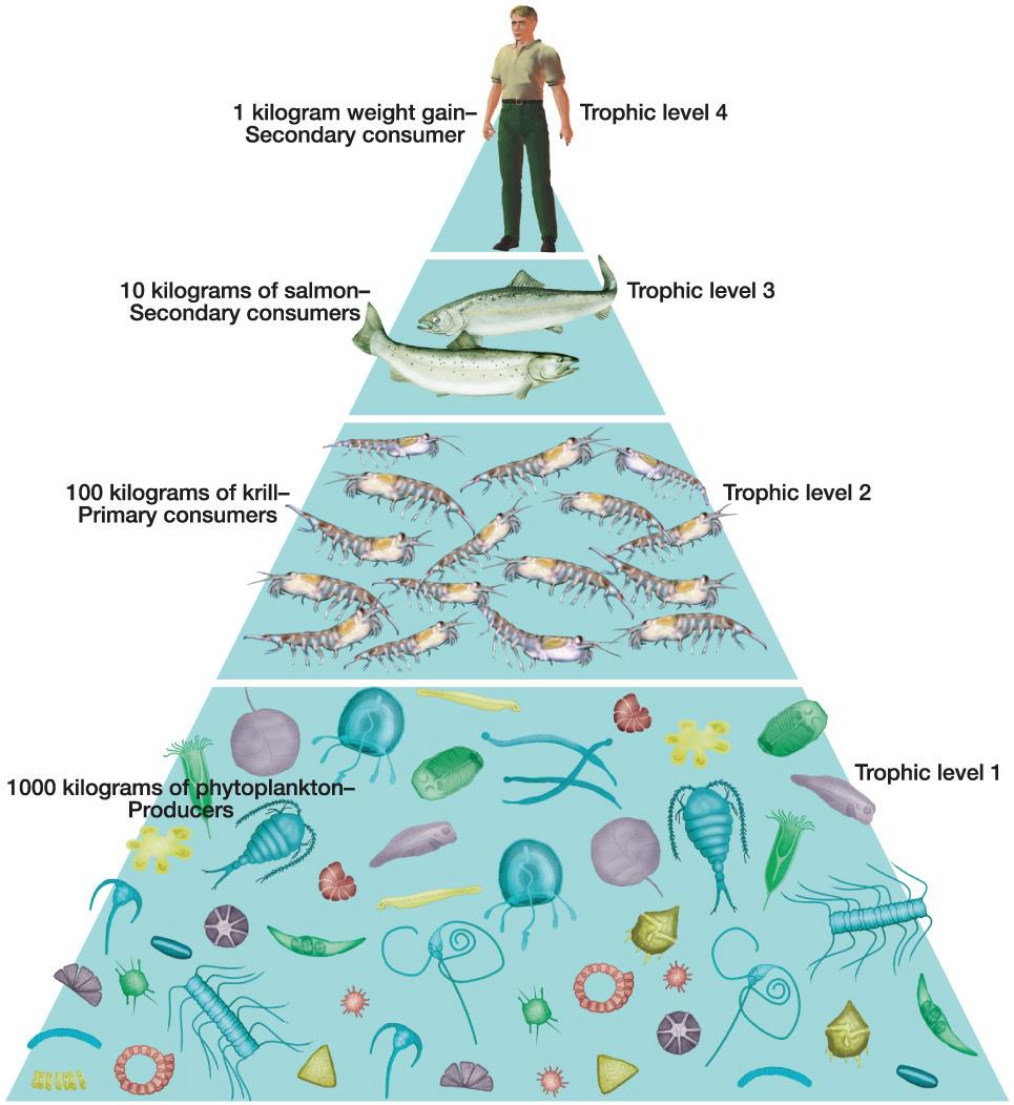
Fundamental unit – producers (autotrophs), self feeders

Producers eaten by consumers (heterotrophs)

- Primary consumers – herbivores
- Secondary consumers – carnivores

Food pyramid- another conceptualization of energy transfer through the ecosystem from large numbers of "lower" forms of life through succeedingly smaller numbers of "higher" forms, as the organisms at one level are eaten by the organisms at the next higher level.

Decomposers begin the food pyramid again

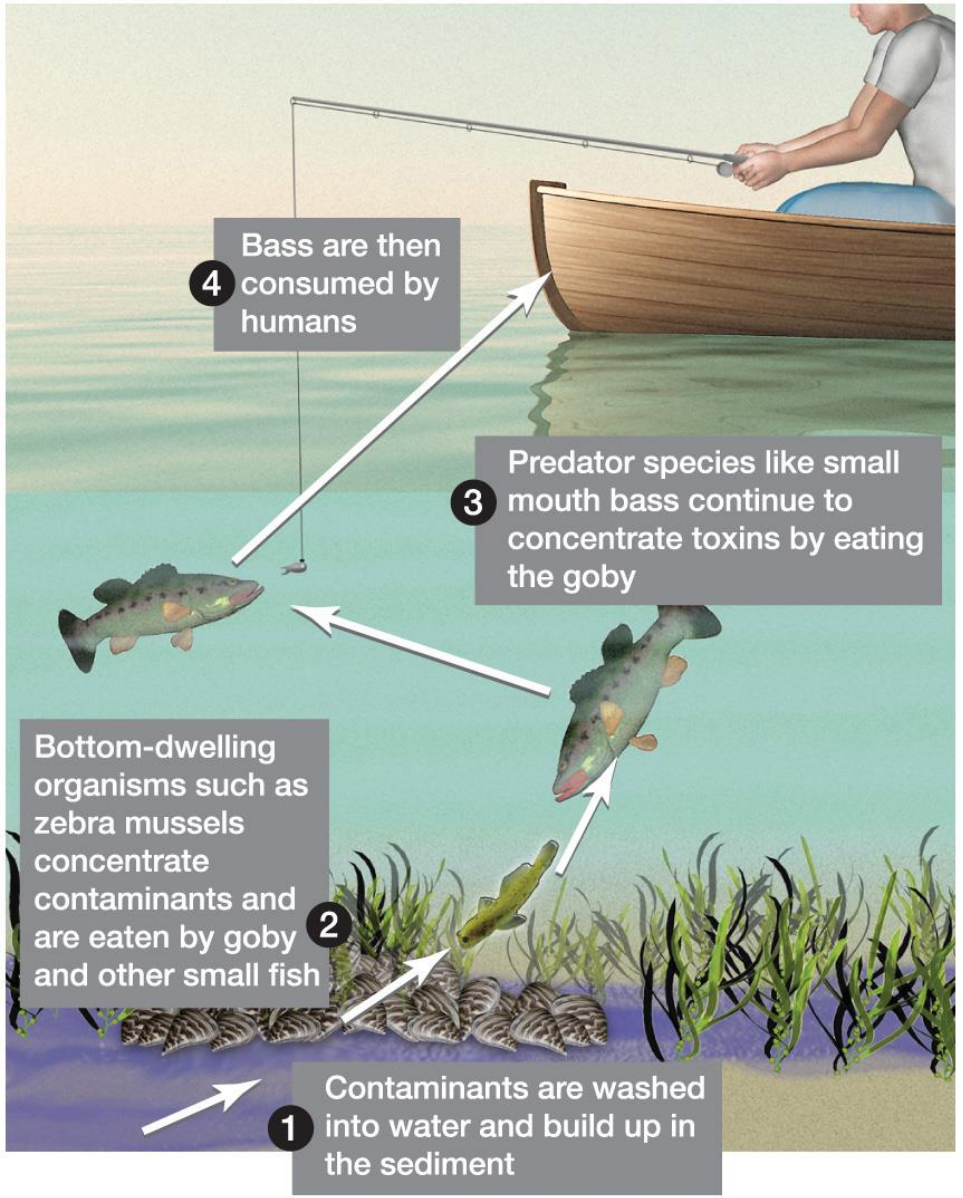


Food Chains

Pollutants in the food chain

- Biological amplification
- Chemical pesticides and heavy metals (mercury, lead)
- Irrigation-related issues

See bioaccumulation



Distribution

What is the range of a certain species or group of plants/animals?

What are the reasons behind this distribution pattern?

What is the significance of the distribution?

Environmental Factors

Relationships between plants and animals depend on the environment

Influences depend on the area of interest

- Large area – seasonal characteristics, location
- Small area – localized terrain, topsoil

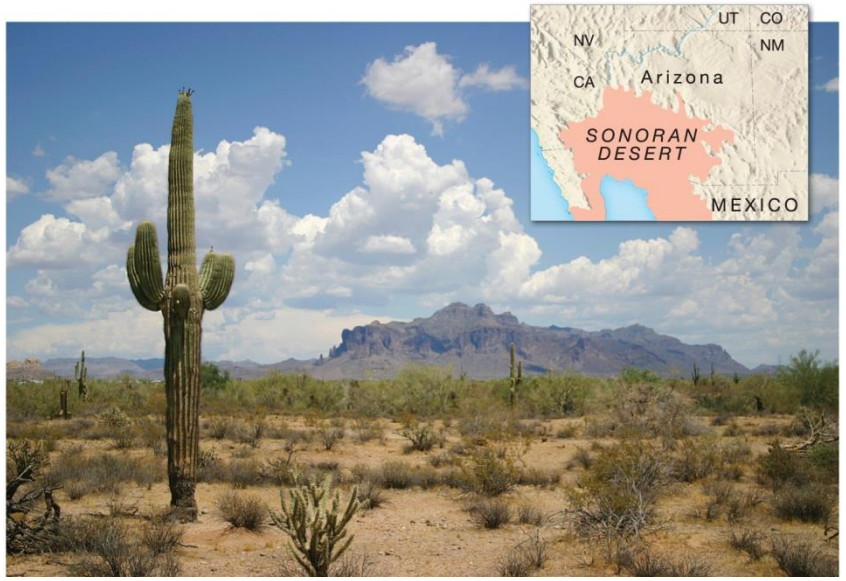
Interspecific versus intraspecific competition

Limiting factor – most important variable for the survival of an organism

Environmental Factors

The influence of climate

- Light
  - green plants need light to survive
  - Light changes shapes of plants
  - *Photoperiodism – stimulates seasonal plant behavior*
- Moisture
  - Distribution of biota governed more by moisture than any other factor
  - Biota evolution dictated by adaptation to moisture conditions



Environmental Factors

The influence of climate

- Temperature
  - Different species can survive in different temperatures
  - Plants have limited cold temperature tolerance
- Wind
  - Wind effects generally limited
  - Persistent winds can have limiting effects through increased drying
  - Strong winds can be destructive to biota

Environmental Factors

Topographic influences

- Plants and animals in a plains region vastly different from a mountainous region
- Slope and drainage

Wildfires

- Result in complete or partial devastation of plant life and death or driving away of animals
- Can be helpful for regrowth and maintaining of plant type

Environmental Factors

Example of selva (rainforest)

- Occurs when climate is warm and has abundant precipitation
- Abundance of precipitation and warmth leads to abundance of natural vegetation (flora), jungle
- Numerous plants allow for fauna
- Leaves, trees, branches decomposed by abundant fauna on floor, put into soil
- Water run off

Biological Factors and Natural Distributions

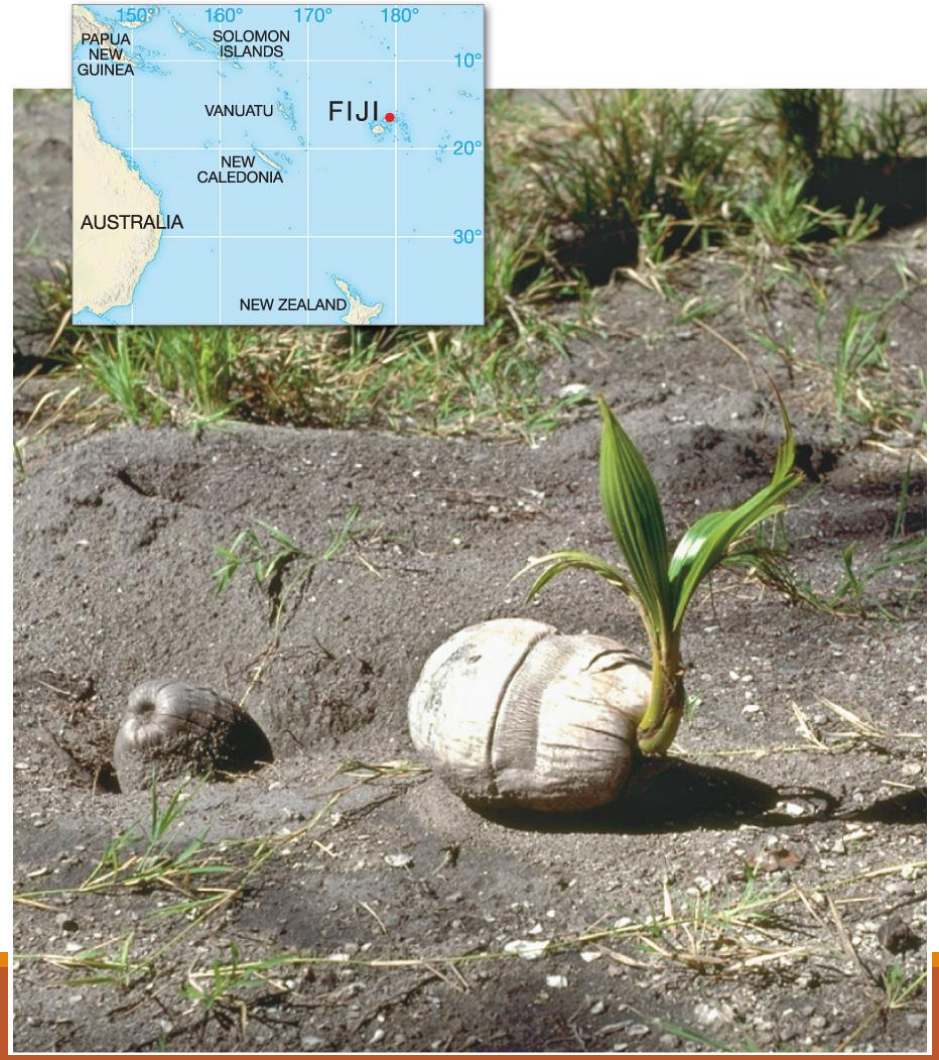
Four basic conditions

1. Origin of Species
   - Where did the genus (closely related organism group) come from ?
   - *Manilkara bidentata* (*balata/bulletwood*)
     - South America, Central America and the Caribbean
   - *Manilkara zapota (sapodilla)*
     - Southern Mexico, Central America and the Caribbean
   - Some localized -endemism
   - Several scattered localities of the same genus

Sapodilla

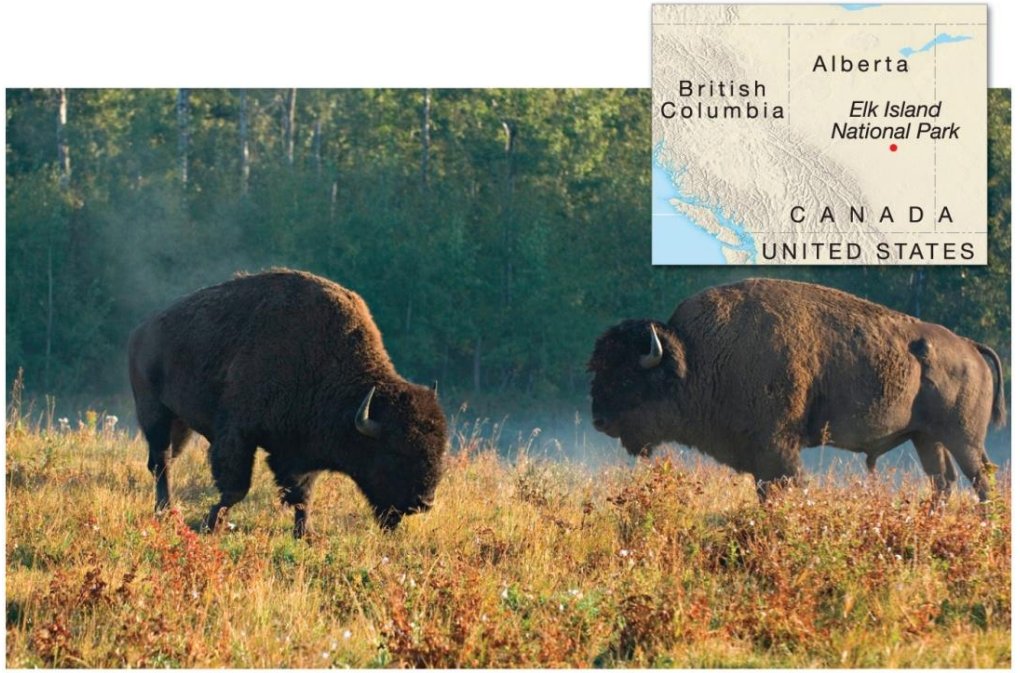
Biological Factors and Natural Distributions

2. Migration and dispersal
   - Animals move from one place to another
   - Plants move through seed dispersal
   - Distribution pattern of organisms results from natural migration or dispersal from the original development center



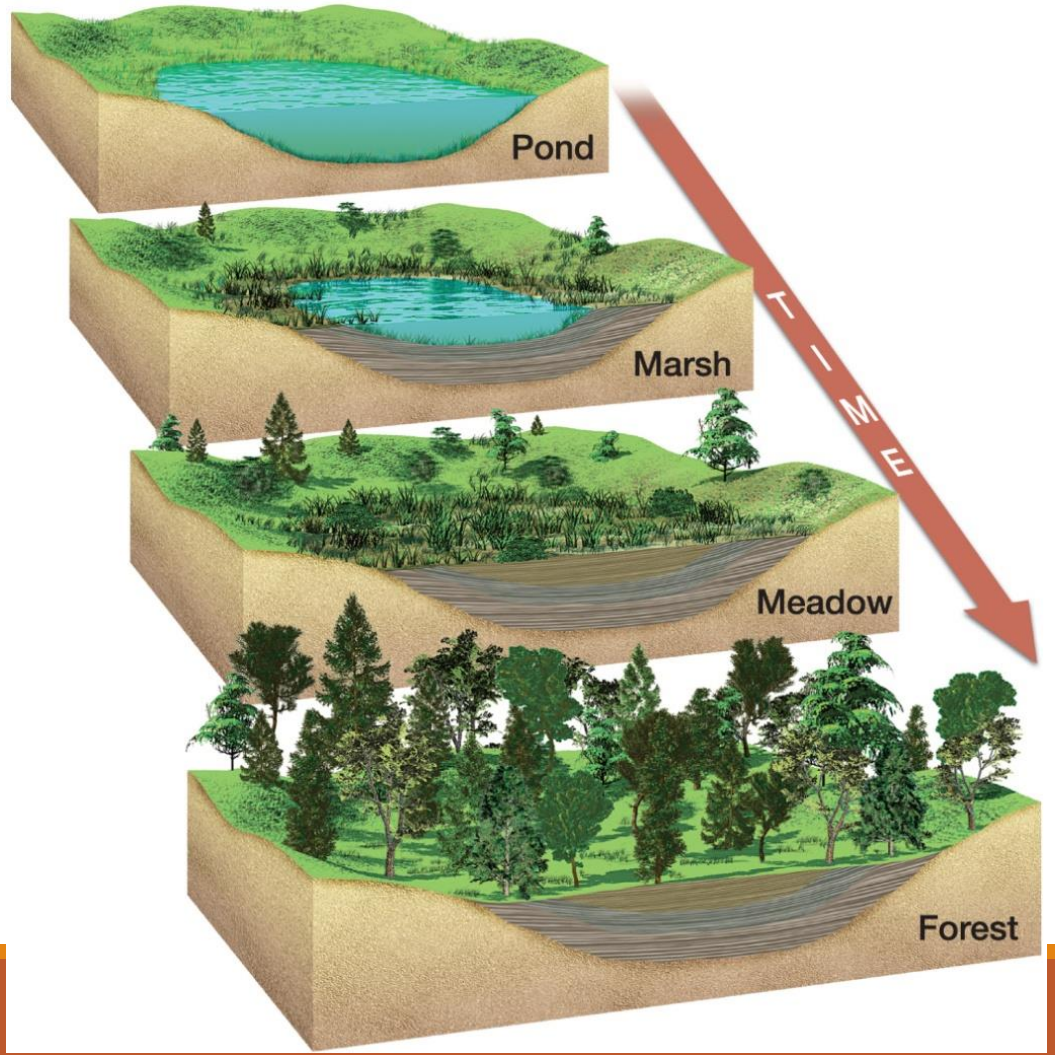
Biological Factors and Natural Distributions

3. Reproductive success
   - Ability of organisms to reproduce affects distribution
   - Factors resulting in poor reproductive success
     - Heavy predation
     - Climate change
     - Food supply failure
     - Changing environmental conditions



Biological Factors and Natural Distributions

4. Extinction and die-off
   - Range diminution
     - Small areal changes
     - Mass extinction
   - Plant succession – one vegetation type replaced by another
   - Occur after catastrophic events:
     - Primary succession – pioneer community
     - Secondary succession



Ecological Succession

Succession, Change, and Equilibrium

Secondary succession can occur after a disturbance alters an existing community. *Old-field succession,* on abandoned farmland, is an example of secondary succession

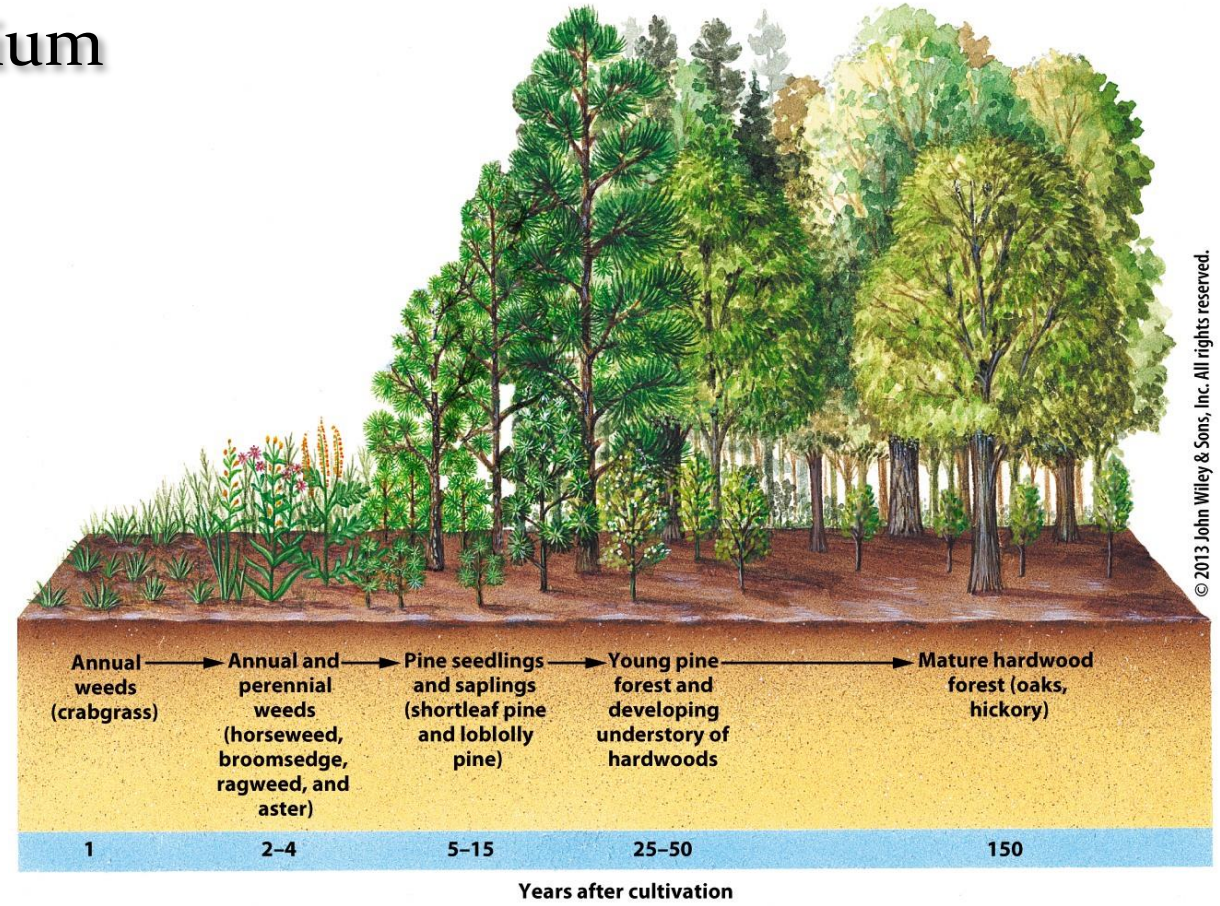


Figure 8.23

Vegetation Biogeography

Vegetation Biogeography

Terrestrial Flora

Why do we see the plants that we do, where we do?

Geographers are interested in natural vegetation of landscape for three reasons:

1. Plants are likely to dominate a landscape (except where terrain is rugged, climate is harsh, or humans have intervened);
2. Vegetation is a sensitive indicator of other environmental attributes (reflecting subtle variations in sunlight, temperature, precipitation, evaporation, drainage, slope, soil conditions, and other natural parameters);
3. Vegetation is often instrumental to human settlement and activities – some cases it is a barrier or hindrance to human endeavor, in other instances it provides an important resource to be exploited.

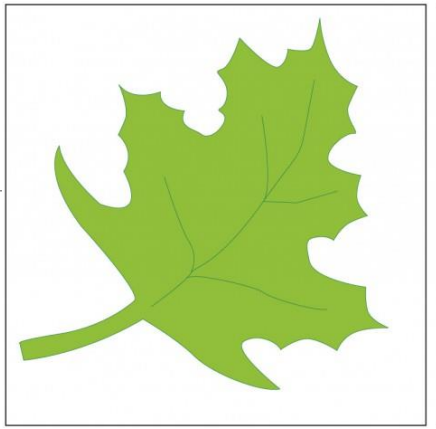
Vegetation Structure

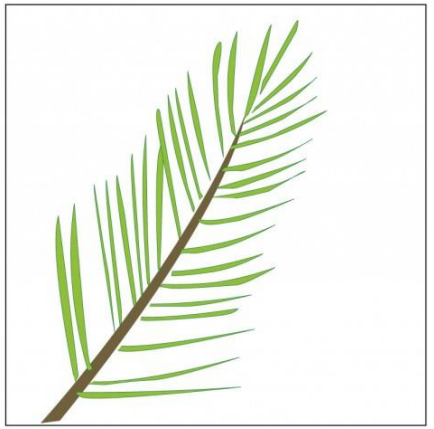
- Common characteristics – roots, stems, branches, leaves

There are two components that we describe:

1. **Life forms of the dominant plants**
    - plant that has stem composed of hard fibrous material
        - a single main woody stem = Tree
        - multiple woody stems = shrub
    - plants that have soft stems; mostly grasses, forbs, and lichens –
    - Non-Woody = **herb (herbaceous)**
    - In this class we will **NOT** look at a single plant, but a combination as they come together to form a community.

Vegetation Structure



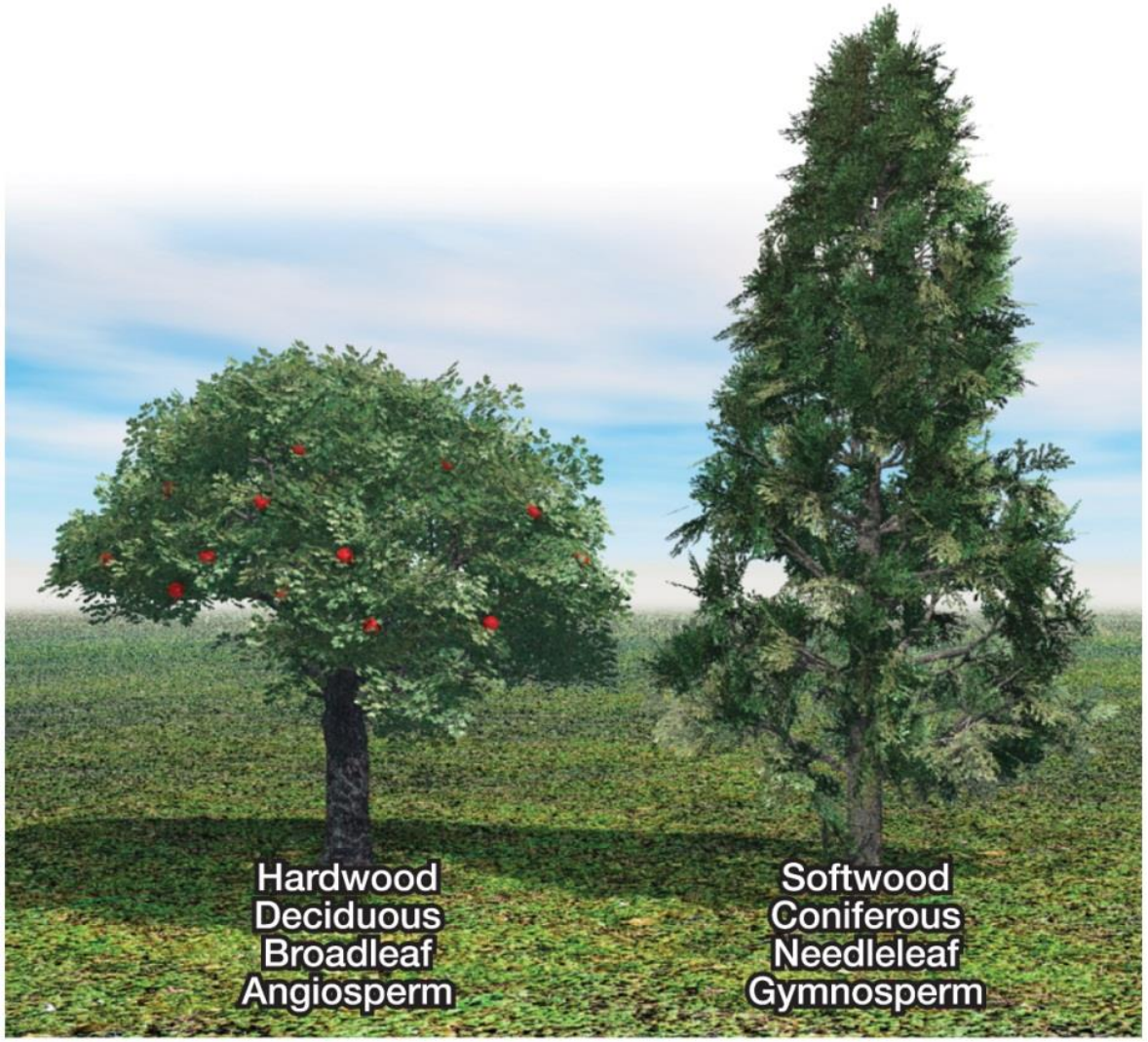


2. Leaf Characteristics of Woody Plants
    1. **Broadleaf or Needleleaf (shape)**
    - **Broadleaf**—tree that has flat and expansive leaves.
        - Majority are deciduous.
        - In rainy tropics, everything is evergreen.
    - **Needleleaf**—refers to trees adorned with thin slivers of tough, leathery, waxy needles rather than typical leaves.
        - Almost all are evergreen.
    2. **Evergreen or deciduous (timing)**
        - Evergreen means there is always some leaves on the plant, even though some does die and fall off
        - Deciduous means there are times when the plant has no leaves
        - There are more broadleaf evergreen worldwide than any other type.

Terrestrial Flora

But also, reproduction..

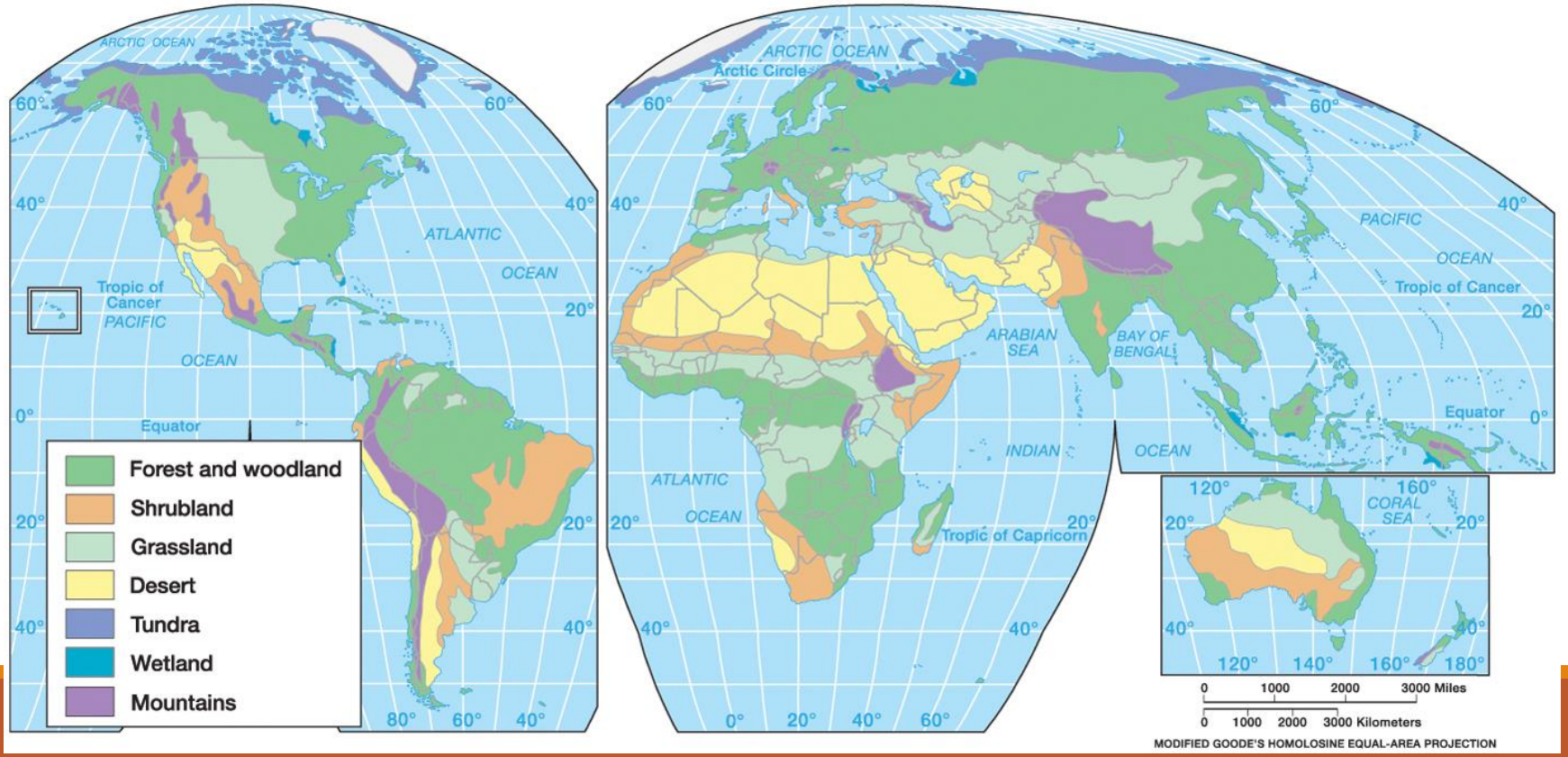
- Two types: seeds and spores
- Spore reproduction:
  - Bryophytes – mosses and liverworts
  - Pteridophytes – ferns, horsetails
- Seed reproduction:
  - Gymnosperms – seeds in cones, also called conifers
  - Angiosperms – seeds encased in protection, all other plant life is of this type



Terrestrial Flora

Spatial associations of plants

- Need generalization to interpret spatial flora patterns
- Human effects



Vegetation Structure: Life Form Combinations

1. Forest

An assemblage of trees growing closely together so that their individual leaf canopies generally overlap or a contiguous cover of trees

Likely to become climax association in any area where moisture is adequate and growing season is not very short.

Vegetation Structure: Life Form Combinations

2. Woodland

Tree-dominated association in which the trees are spaced more widely apart than those of forests and do not have interlacing canopies.

Ground not inhibited by sunlight

Drier than forest environments

Vegetation Structure: Life Form Combinations

3. Grassland

plant association dominated by grasses and forbs.

Includes Savanna (h), praire and steppe

scattered trees or shrub within a ground-cover of herbaceous plants

5. Shrubland

plant association dominated by relatively short woody plants (shrubs).

Wide latitudinal range but usually restricted to semiarid or arid areas

Vegetation Structure: Life Form Combinations

6. Tundra

a complex mix of very low-growing plants, including grasses, forbs, dwarf shrubs (tree-like), mosses, and lichens.

Only in the perennially cold climates of high latitudes or high altitudes.

Vegetation Structure: Life Form Combinations

7. Wetland

landscape characterized by shallow, standing water all or most of the year, with vegetation rising above the water level.

Have much more limited geographic extent than any other above associations.

8. **Deserts**

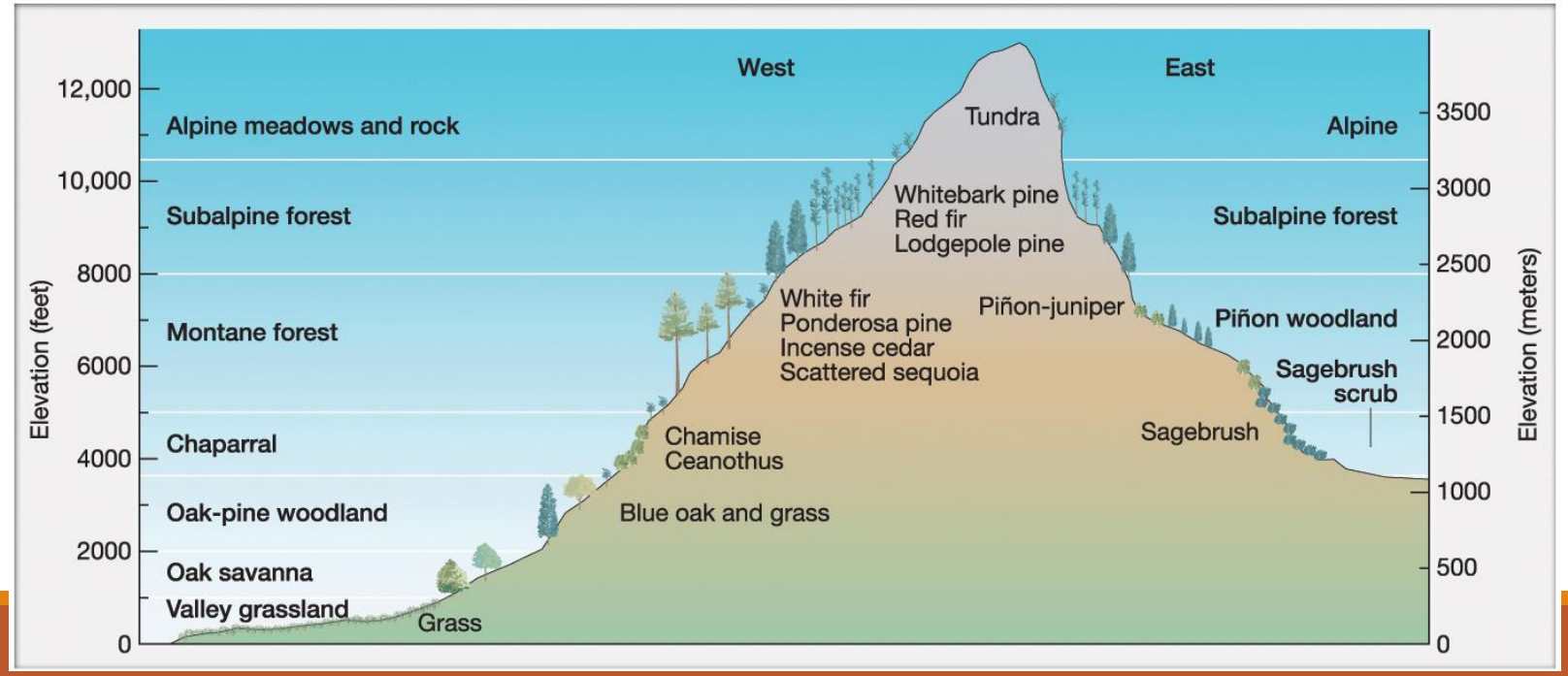
Widely scattered plants with much bare ground

Great variety of vegetation

Terrestrial Flora

Vertical zonation

- Distinct pattern of vegetation patterns in mountainous areas
- Elevation – latitude relationship
- Upper treeline



What factors determine vegetation presence and type?

Environmental Controls on Vegetation

1. **Climate**: describes the availability of the two most important resources for plants:
    1. Energy from the sun: temperature and daylength
    2. Water or Moisture (precipitation) – how important are things such as Physiological drought – ground water is unavailable as its frozen

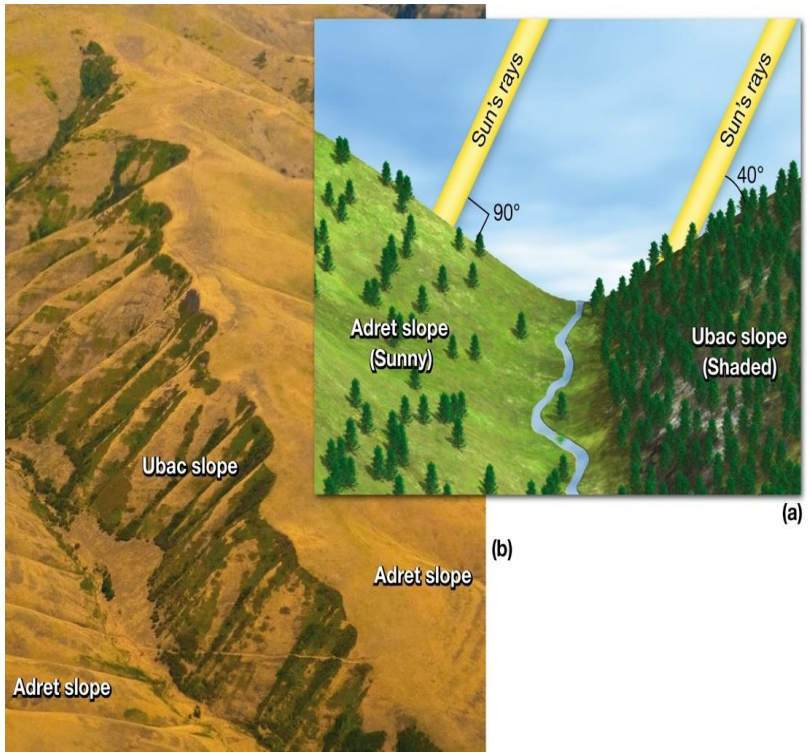
Environmental Controls on Vegetation

2. Topography: the shape of the land surface upon which a plant is growing.

Topography affects:

a. Microclimate: Controls the climate a plant experiences at a very local scale (e.g. via slope aspect)

- South facing or ***adret*** slopes are warmer and drier --higher evaporation, lower plant growth
- North facing or ***ubac*** slopes are cooler and moister – less heating = more growth
- Slope aspect is particularly important in the **Mid-latitudes, not so much so in the low latitudes**
- Affects delivery of groundwater to the plant and drainage



3. Soil

Soil holds moisture and provides nutrients to the plant

Environmental Controls on Vegetation

4. Biota interactions

Large animals: Some interactions can be negative e.g. grazing. Some are positive – seed dispersal.

Insects: provide pollination, or can be pests

Competition: with other plants. There is a fixed amount of resources available in a place, plants compete for these.

Allelopathy – plant versus plant chemical warfare. Some plants release chemicals into the soil that prevent the seeds of competitors from growing. In effect trying to reduce competition

Environmental Controls on Vegetation

5. Disturbance:

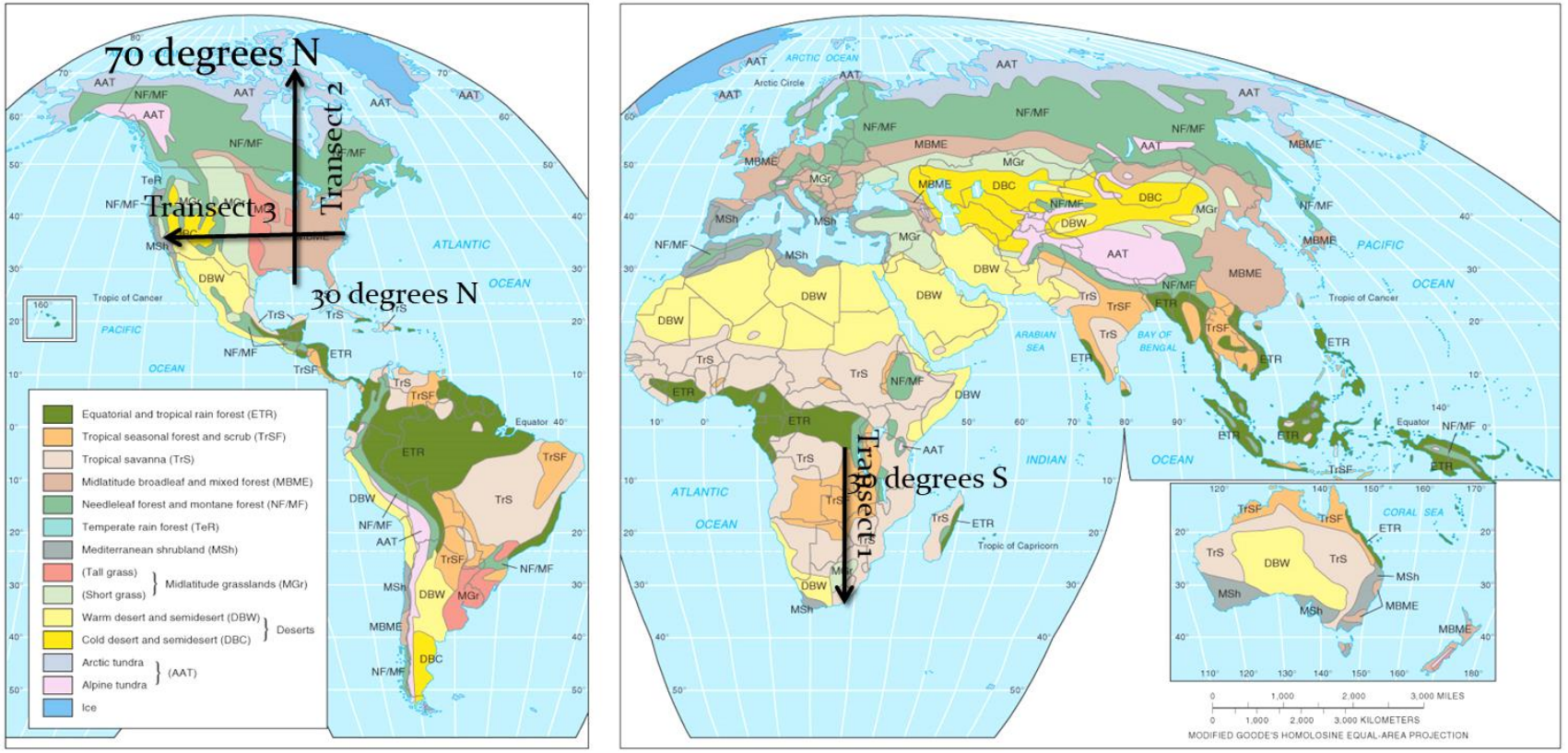
abrupt removal, destruction or death of vegetation at a site.

- Natural disturbances: Fire, wind throw, floods, landslides & avalanches, insect and pest outbreaks.
- Anthropogenic (Human) disturbances: clearing of land, transport of invasive species, climate change, acid rain.

Note: On a global scale, climate is the primary control of vegetation

Vegetation Distribution

Vegetation Distribution



Transect 1


ETR
10°
0°
ETR
Transect 1
AAT
TrS
ATLANTIC
OCEAN
TrSF
TrS
TrS
MGr
DBW
30 degrees S
MSh
40°

Transect 1: Equator to 30° Latitude

Tropical Wet Climate (0° - 10°) : Tropical Broadleaf Evergreen Forest (Rainforest)

- Warm all year round
- **Forest**: lots of energy and water to support biomass
- **Evergreen**: no reason **NOT** to be, no stressful season during the year.
  - So there is no reason for the plant to shutdown.
  - If they Shutdown, they will lose out to other plants that are continuing to grow.
  - So there is an advantage in NOT shutting down.
- **Broadleaf**: most efficient shape

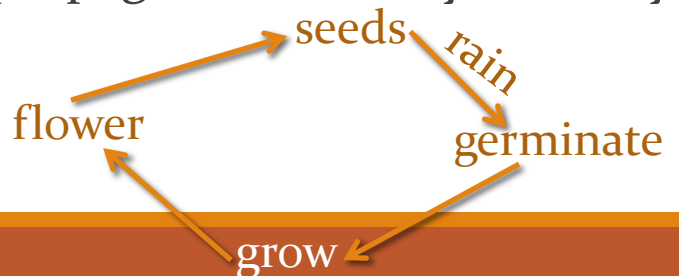
Transect 1: Equator to 30° Latitude

Tropical Wet and Dry Climate (10° -15° latitude): Tropical Savanna(h) and Grassland

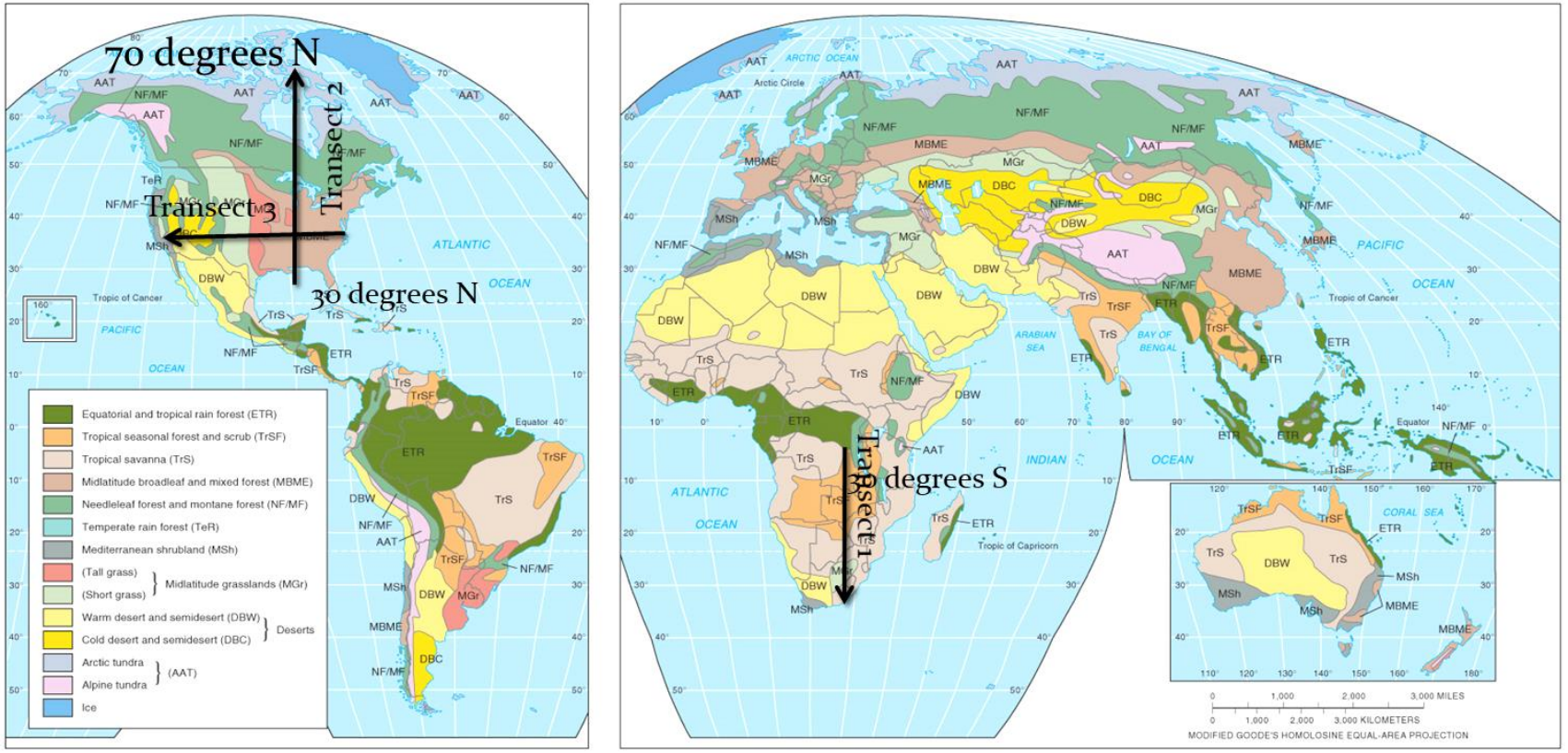
- Why not Forest?
  - Climate : lack of moisture in the dry season to support big trees
  - Fire: High fire frequency favors herbaceous vegetation
  - Soils: dry season and clayey soils = "hard-pan"

Sub-Tropical Desert (15°- 30°)

- **Scattered shrubs** with drought coping characteristics, succulents (e.g. cacti), small-leaved shrubs to reduce water loss, hairy leaves which traps humid air next to leaves surface, hence leaves dry out slower. There is not enough water to support contiguous growth
- **Herbaceous annuals**: plant life is short, but leaves propagules for next year. They may live only for a few weeks.



Vegetation Distribution



Transect 2: Gulf Coast to Arctic

1. **Eastern and South Eastern United States**:
   - Humid sub-tropical climate; cool to cold winters, warm summers, no dry season
   - Temperate broadleaf deciduous forest (usually)
     - Forest: sufficient energy and moisture
     - Deciduous:
       - cool/cold winter – trees shutdown to avoid physiological drought - lose their leaves in stressful winter season.
       - Broadleaf can collect snow and injure the plant. Thus it makes sense to become dormant
   - There are two exceptions to this pattern on the Gulf Coast:
     - Broadleaf evergreens (e.g. Magnolia trees)
     - Needleleaf evergreens (e.g. pines on sandy soils) – these are also caused by Anthropogenic disturbance such as fire.

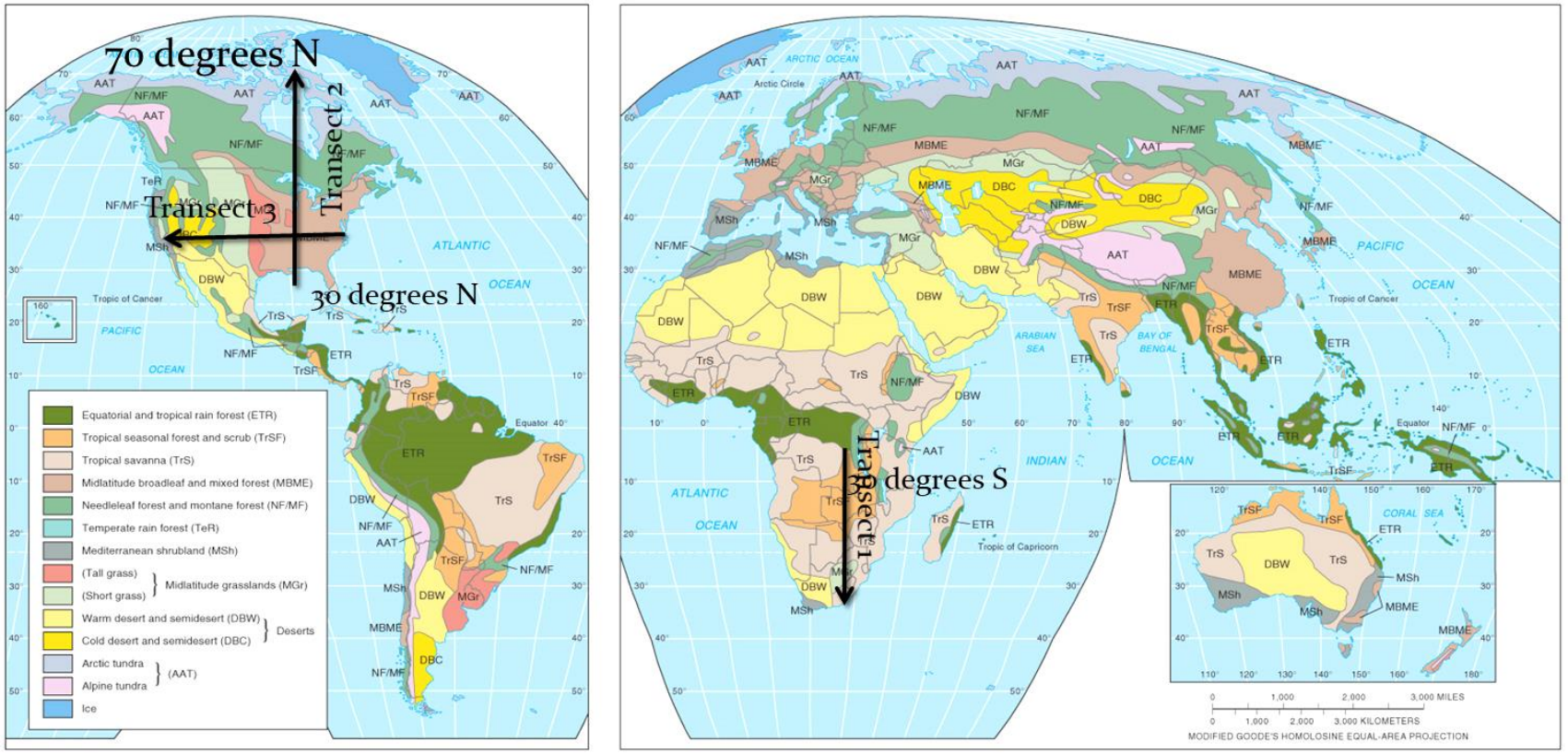
Transect 2: Gulf Coast to Arctic

2. **Southern Canada and Alaska**: Needleleaf Evergreen Forest (aka Boreal or Taiga)
    - Winter long and severe, summers short and mild
    - Forest: enough energy and moisture.
    - Trees are smaller as there is less available moisture
    - **Evergreen**: the long severe winter does not allow deciduousness. The growing season is too short. No time to loose leaves and store energy.
        - At the start of spring when it gets warmer, trees can begin photosynthesis.
    - Needleleaf: more sturdy and smaller surface area for snow to collect.
    - There is little of this in the Southern Hemisphere as there is little land mass at this latitude.

Transect 2: Gulf Coast to Arctic

3. **Arctic Coast**
   - **Tundra**: herbaceous perennials, small woody “trees” and shrubs
   - Very long severe winter and short mild summer
   - Low plants: covered by snow in winter, slow growth, low productivity
   - Everything is small because plants do not have enough time to grow
   - **Low productivity**: not enough energy to support bigger trees and their small size allow snow to insulate from cold.

Transect 3



Transect 3: East to West Coast

Driven by precipitation rather than latitude

Eastern US – see Transect 2 - 1

Mid-Continent: Midlatitude grassland – Prairie/Steppe

- Climate is drier – seasonal precipitation and winter drought

Grassland: it's grassland rather than forest because there is a lack of moisture.

- But the most important reason is the **frequent fires** (Dry enough)
- Tall to short grass Prairie to the East, short grass to the West

Intermountain West Rocky Mountains and Sierra Nevada

Transect 3: East to West Coast

General region of high elevation mountain ranges and low elevation valleys. This gives two main areas:

1. **Mountains**: needleleaf forest, higher elevation alpine tundra
2. **Basins (valleys)** Midlatitude Desert Shrubland
    1. No bare ground
    2. Contiguous Shrubland – enough moisture in the soil to support shrubs
    3. Less extreme adaptation to dry conditions than subtropical desert.
        - But there are small leaves.

Transect 3: East to West Coast

West of Sierra Nevada – Mediterranean Climate (mild, wet winters and hot dry summers)

- This climate is problematic for plants as there is not enough energy and moisture levels available at the same time
- The energy and moisture are out of sync.
- Maximum growth season is the spring when there is still enough moisture in the soil
- **Evergreen Sclerophyllous Shrubland – Chaparral**
  - Small waxy leaves to prevent moisture loss in the summer

http://en.wikipedia.org/wiki/Mediterranean_forests,_woodlands,_and_scrub#mediaviewer/File:Mediterranean_forests_1.JPG

Transect 3: East to West Coast

Marine West Coast- Oregon, Washington, BC

Needleleaf Evergreen Forest

- This vegetation type does not make sense because the winters are not severe enough demanding the plants be needleleaf.