(Plant) Ecology

(Freeman Chs 50, 52-53)

09 March 2010

ECOL 182R UofA
K. E. Bonine

Videos
34.1, 34.3
browser

Lecture Schedule (middle third)

18 Feb KB – **Fungi**, Ch31

23 Feb KB – **Prokaryotes & Protists**, Ch28&29
25 Feb KB – **Plant Diversity, Form, Function**, Ch30&40

2 Mar KB – **Plant Form and Function**, Ch36&37
4 Mar KB – **Plant Function**, Ch38&39

9 Mar KB – **Plant Ecology**, Ch50,52,53
11 Mar KB – **Ecology**, Ch50,52,53

13-21 Mar Spring Break

23 Mar KB – **Biology of the Galapagos**
Wikelski 2000 and http://livinggalapagos.org/
25 Mar KB - Part 2. Discussion and Review.

30 Mar KB - **EXAM 2**

Video 34.3 Germination of soybean plants

Video 34.1 Time-lapse of bud burst in plants

What is Ecology?

- Study of the and of organisms.

- Study of the myriad ____________ among organisms and their environment.

- Includes both ____________ and ____________ interactions/components.

Ecosystem Components

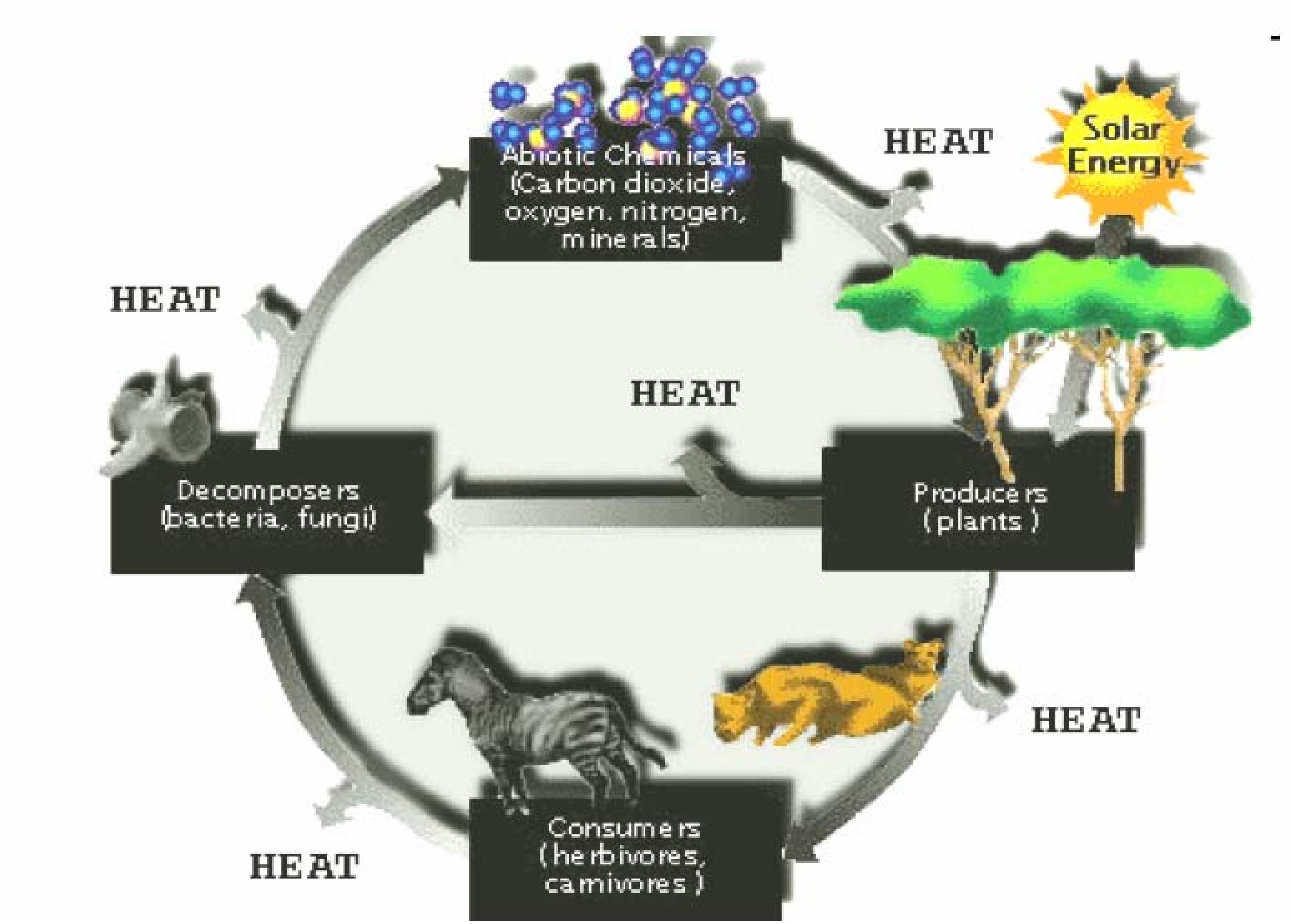
- Biotic Components
  - Autotrophs (inorganic to organic – reduce carbon compounds – fix energy – chemical or light)
  - Heterotrophs (rely on autotrophs or organic matter – macroconsumers (phagotrophs) – microconsumers (saprotrophs – decomposers)

- Abiotic Components
  - Inorganic molecules (C,H,N,P,S,Fe,Si,O - CO_2, H_2O)
  - Organic molecules (humus, non-bound carbon based molecules)
  - Substrate (parent material and age)
  - Climate (light, temp, precip)

What is Ecology?

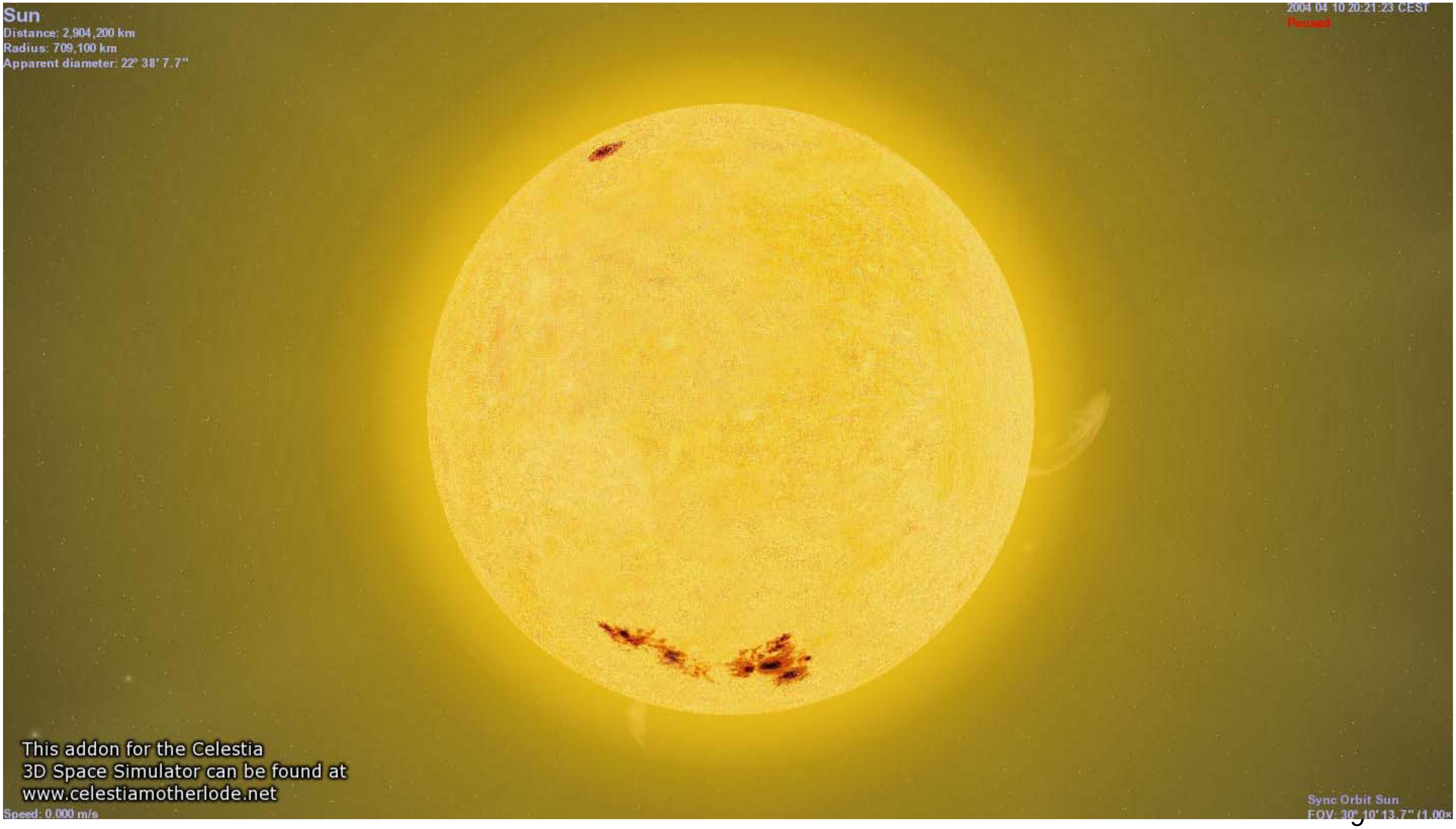
- It is NOT: an attempt to the or to save .

But ecology very often informs environmentalism

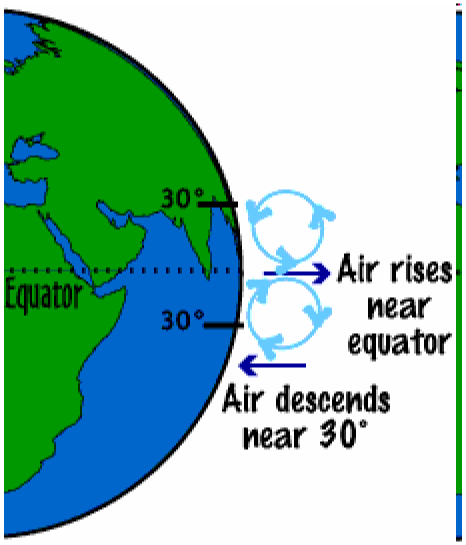


Energy flows and material cycles.

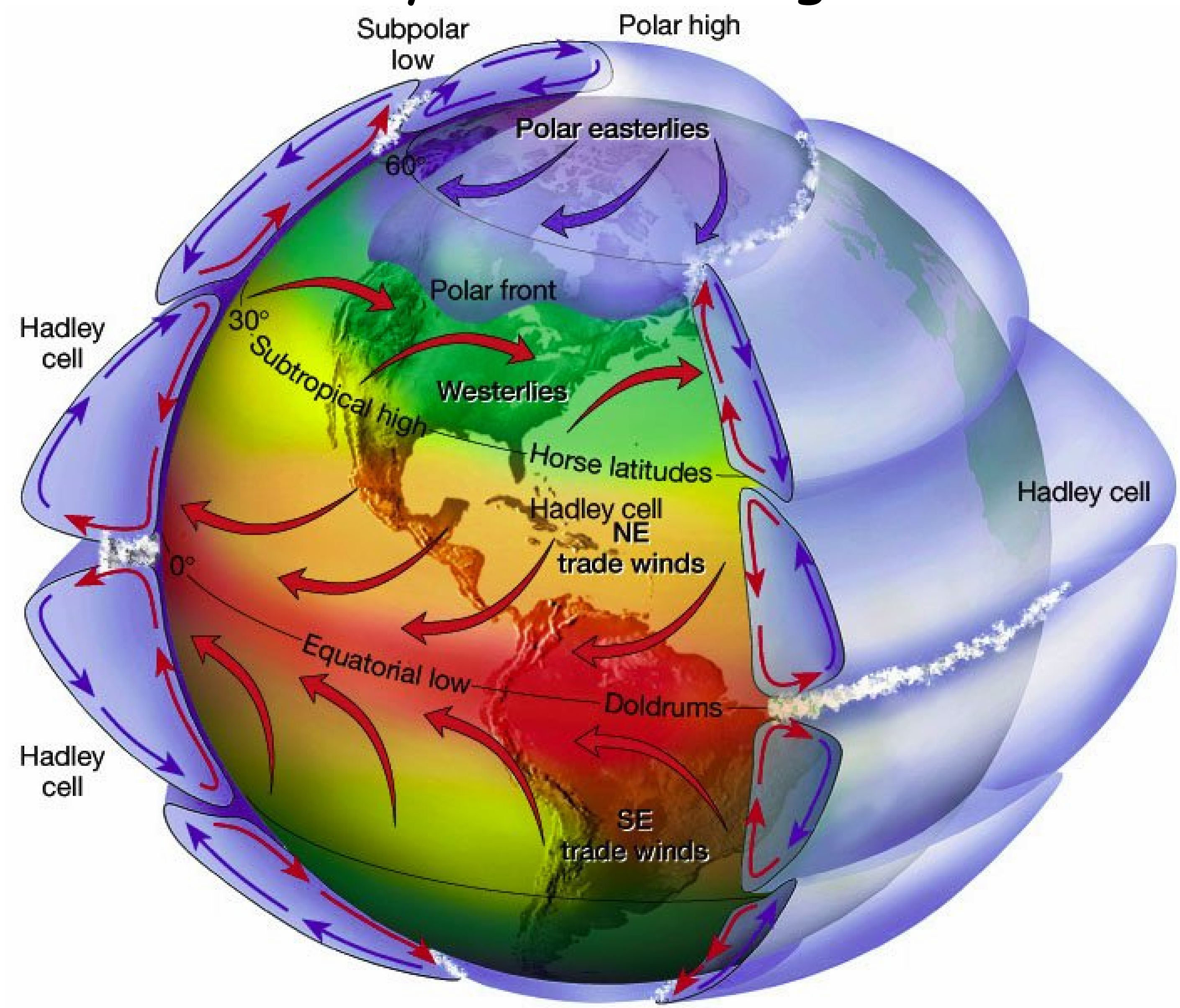
Energy


Sun
Distance: 2,904,200 km
Radius: 709,100 km
Apparent diameter: 22° 38' 7.7"
This addon for the Celestia
3D Space Simulator can be found at
www.celestiamotherlode.net
Speed: 0.000 m/s
Sync Orbit Sun

Typical Air Movement
-caused by solar heating

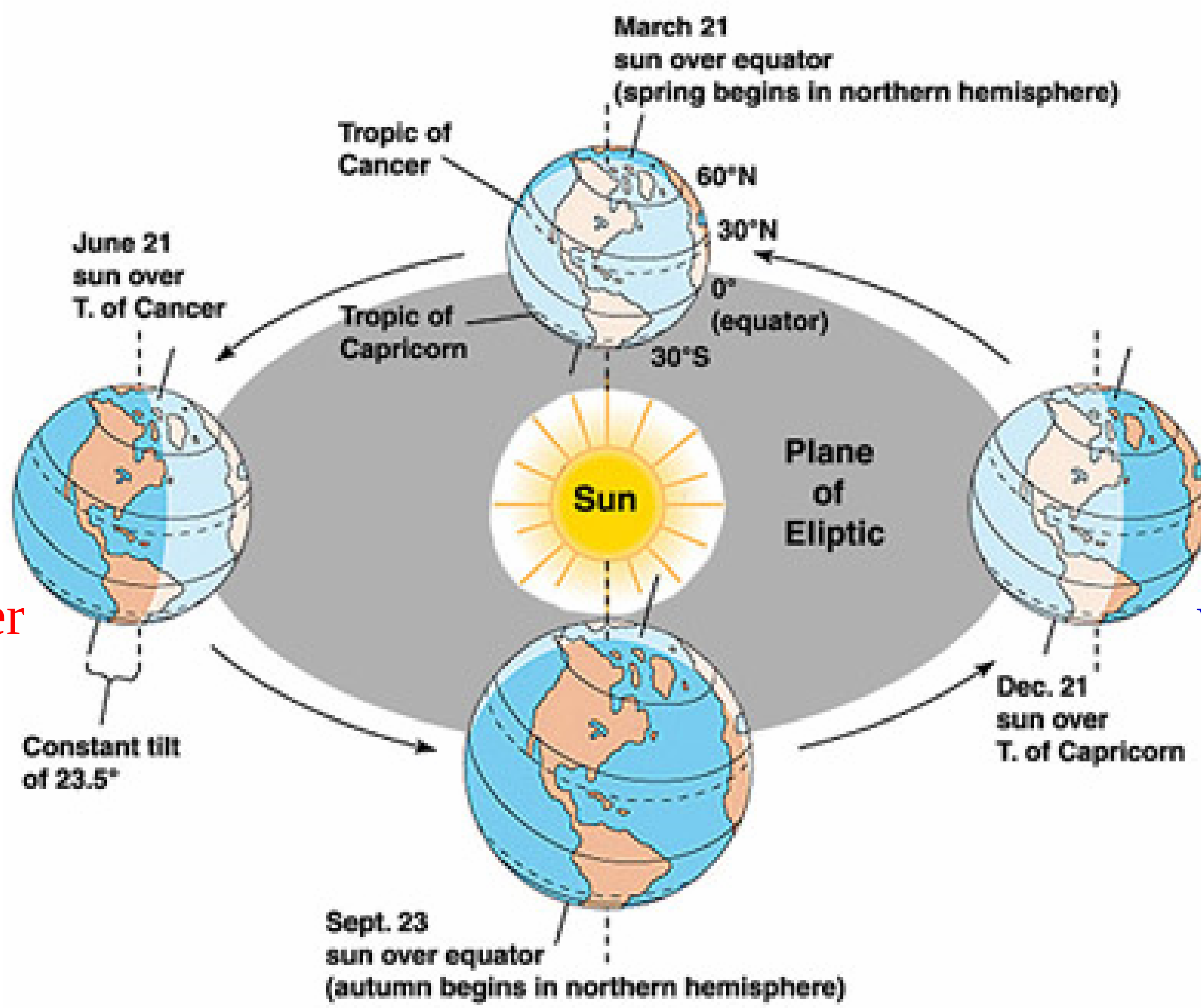


The ______ drives the weather!



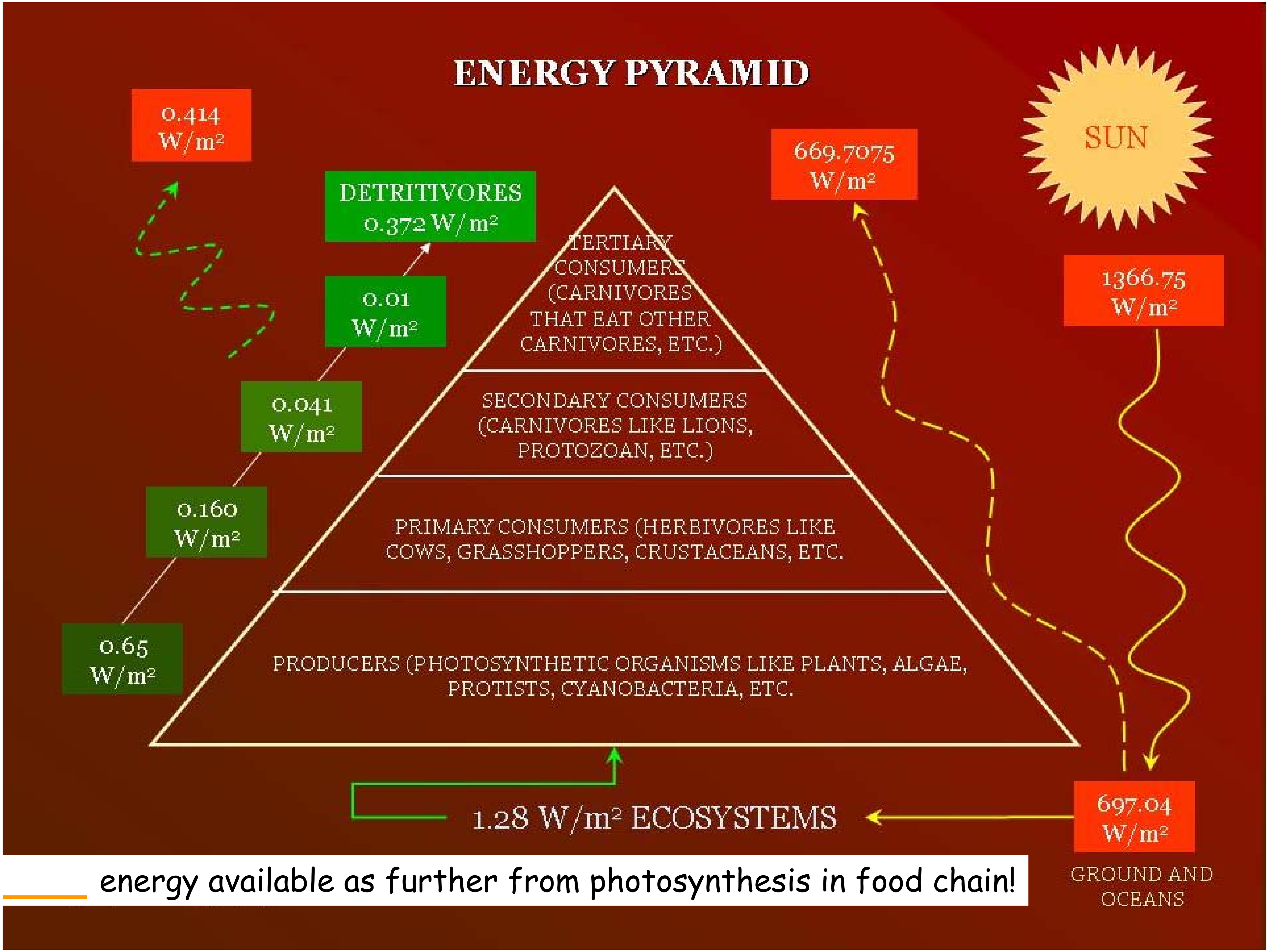
Why do we have seasons?

The earth is _____ and takes a year to go around the sun.

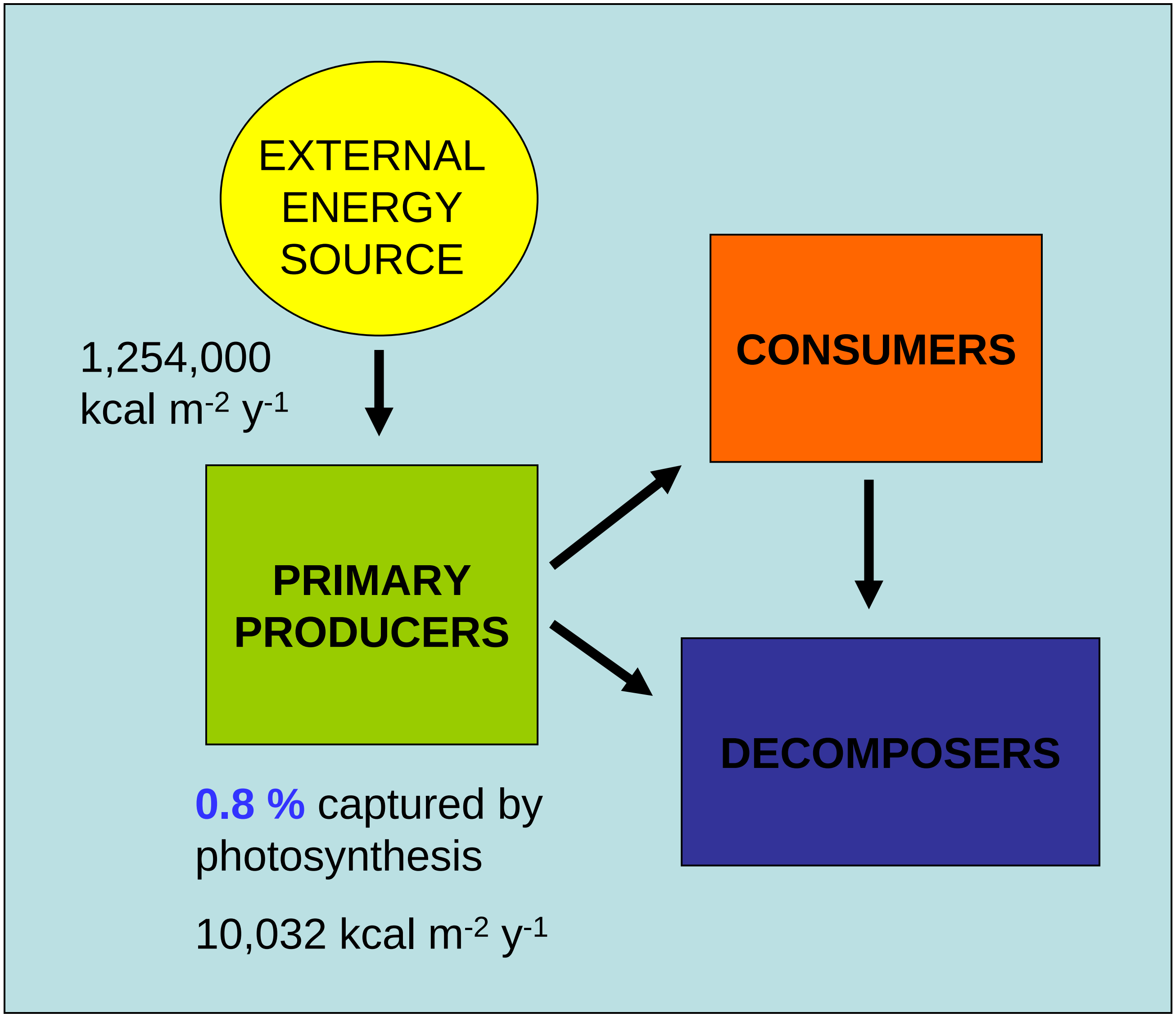


Our summer

Our winter



_____ energy available as further from photosynthesis in food chain!



Pattern of energy flow within ecosystem

(Hubbard Brook Forest)

Gross primary production
10,032 kcal m^{-2} y^{-1}

Net primary production
45 % (4,514 kcal m^{-2} y^{-1})

through respiration
55 % (5,176 kcal m^{-2} y^{-1})

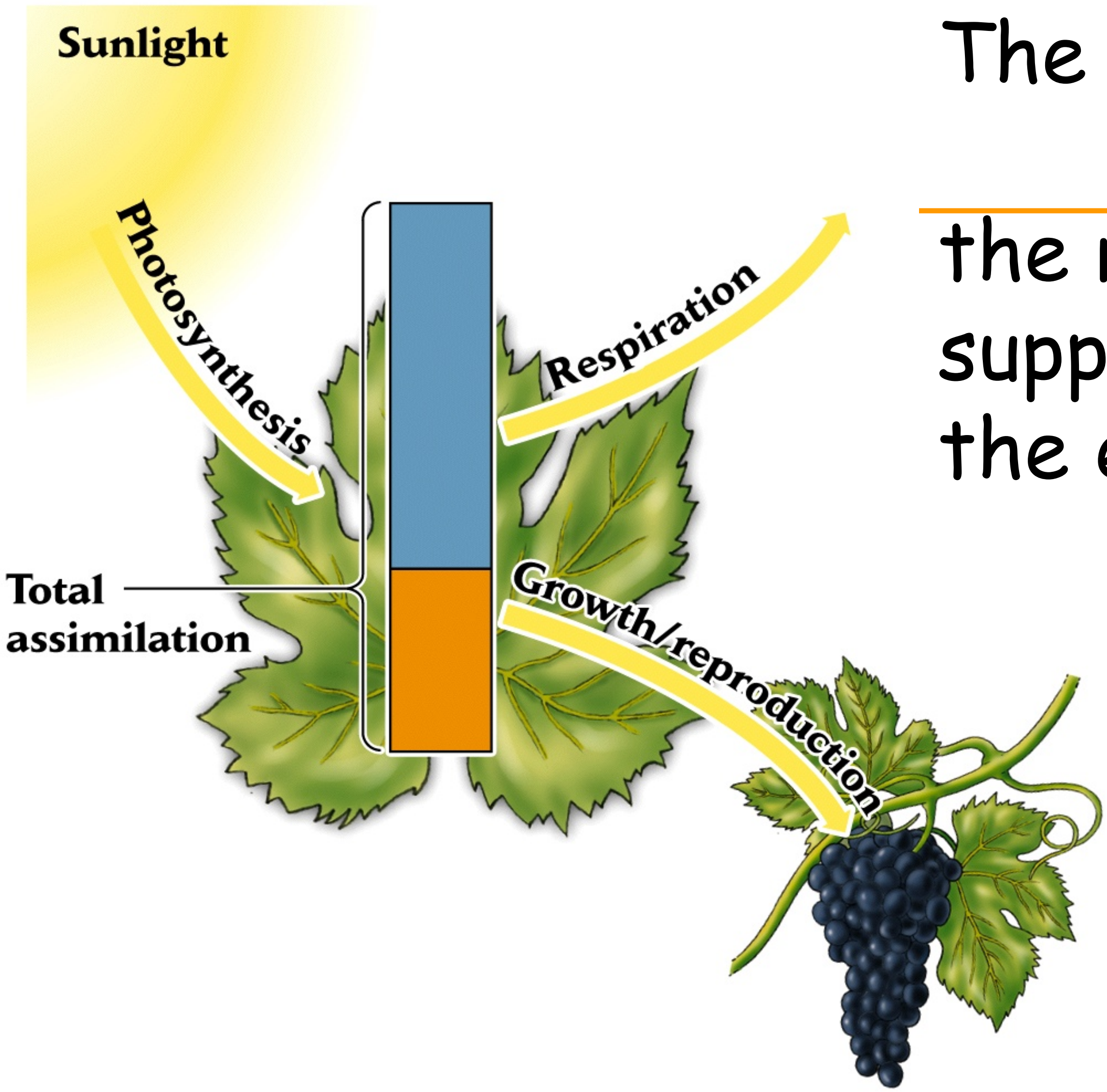
% entering consumers
11 % (1,103 kcal m^{-2} y^{-1})

% entering decomp.
34 % (3,411 kcal m^{-2} y^{-1})

Energy in Ecosystems

- Ecosystems =

  giant energy-transforming machines



The rate of **primary** ______________________ determines the rate of energy supply to the rest of the ecosystem

Components of Primary Production

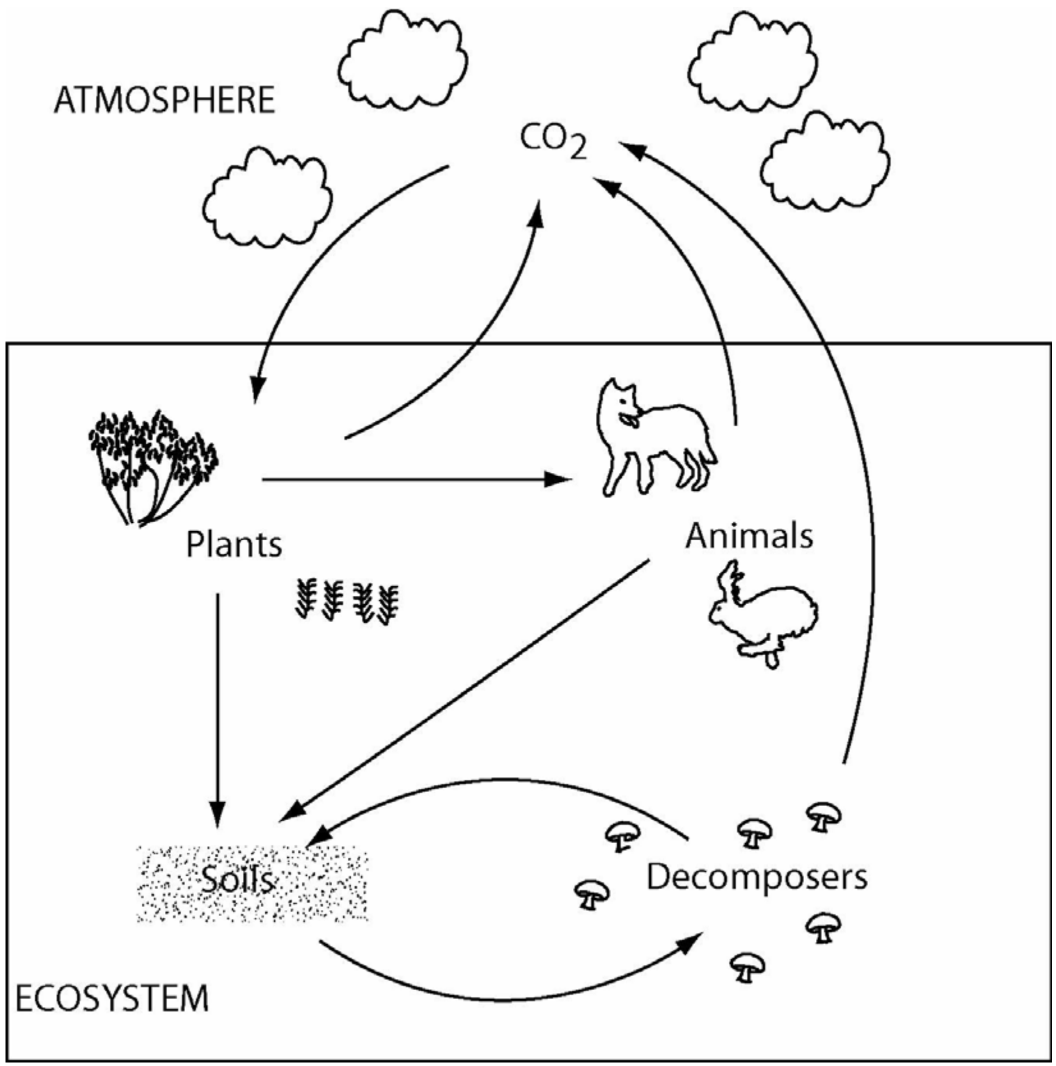
- **Gross primary production (GPP)** = total energy assimilated by primary producers

  _____ **primary production (NPP)** = energy accumulated (in stored form) by primary producers
- Gross - net = **respiration (R)**, the energy consumed by producers for maintenance and biosynthesis

Ecosystems support **two parallel food chains**:

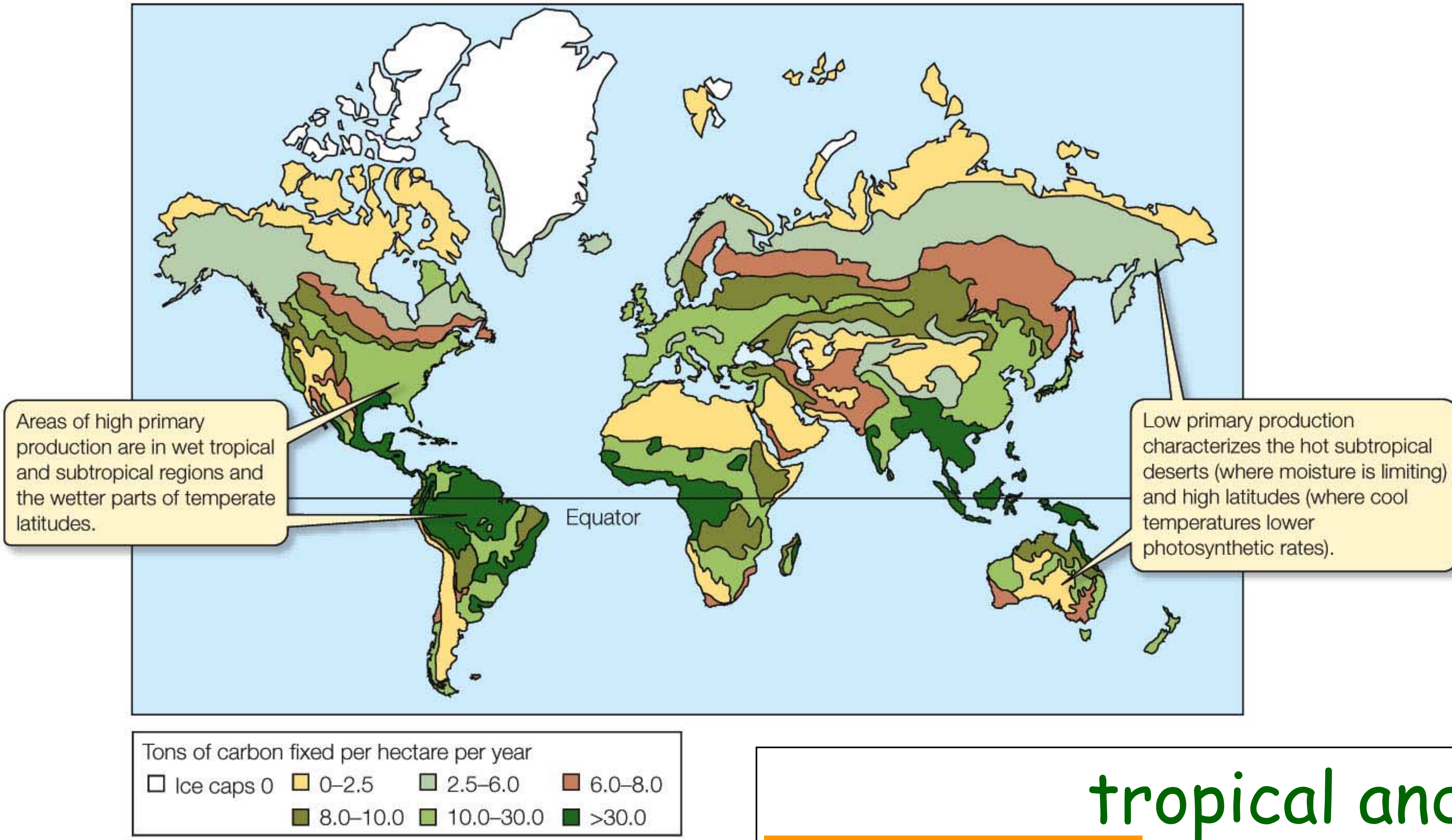
- **Herbivore-based** (large animals feed on leaves, fruits, seeds)
- ____________**-based** (microorganisms and small animals consume dead remains of plants and indigestible excreta of herbivores)
- herbivores consume:
  - 1.5-2.5% of net primary production in temperate forests
  - 12% in old-field habitats
  - 60-99% in plankton communities

Simple ecosystem model



Includes
biotic
and
abiotic

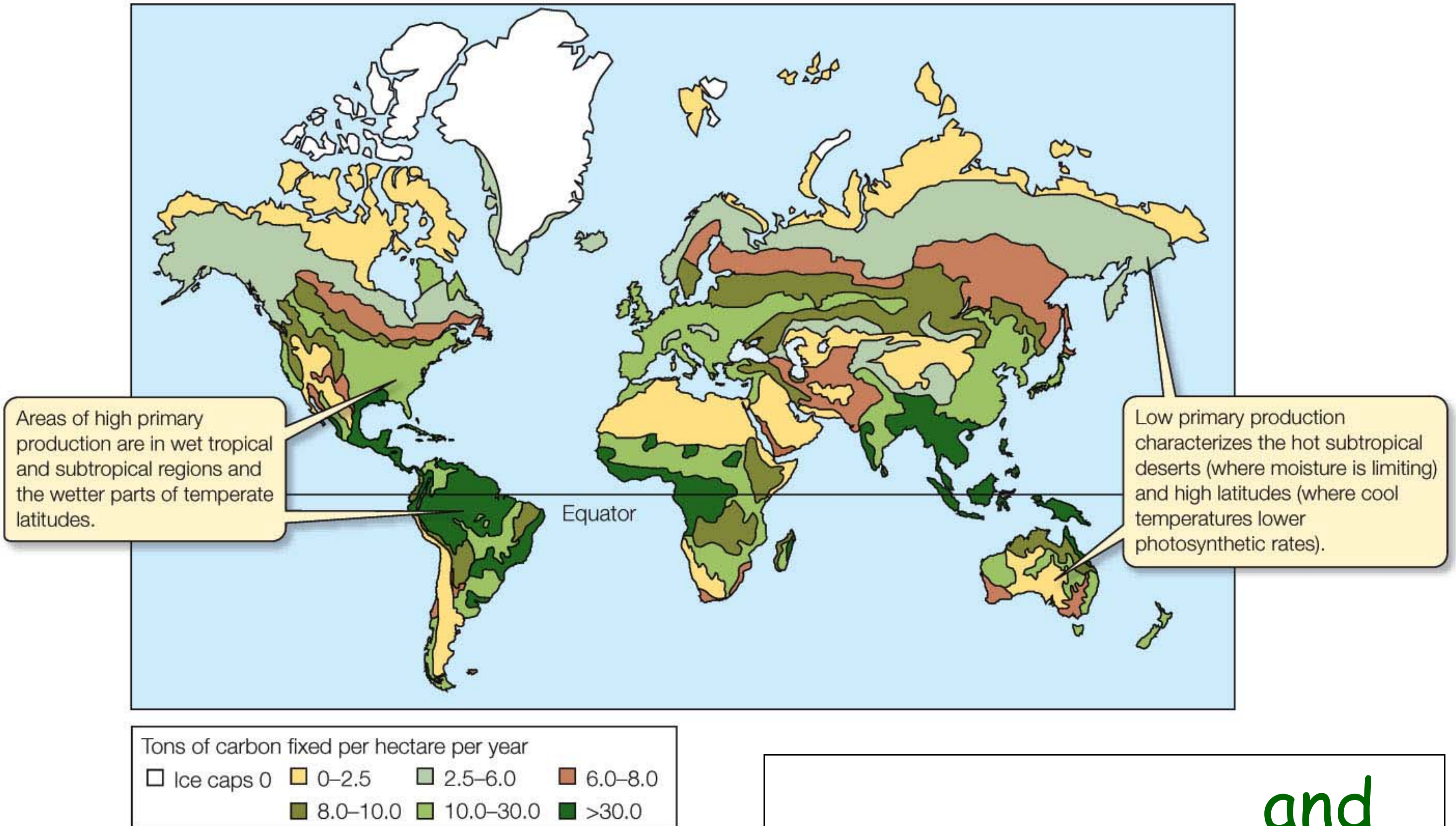
Where is biological production highest?



______ tropical and temperate biomes.

LIFE 8e, Figure 56.7

Where is biological production <u>low</u>?

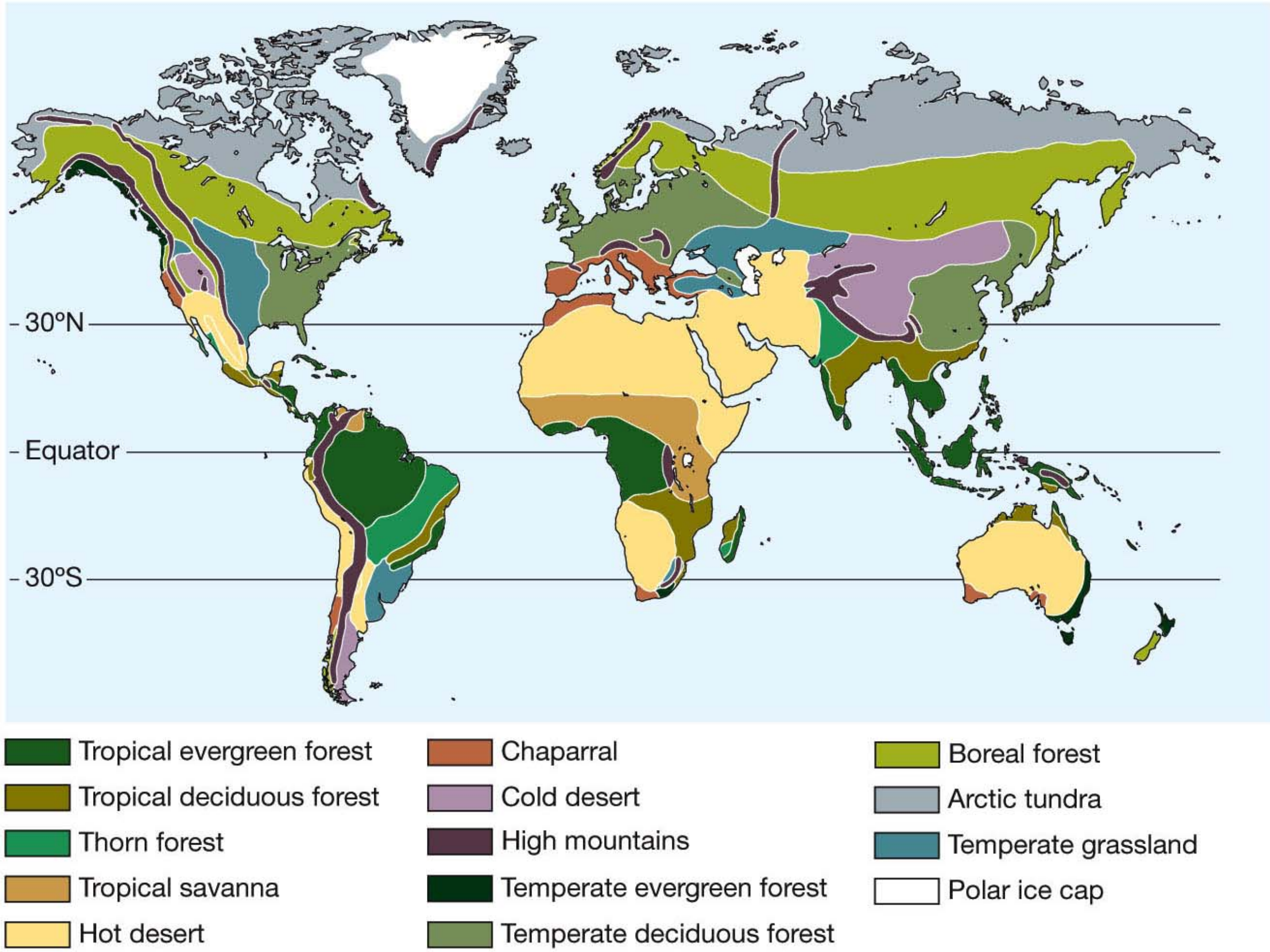


__________ and poles (cold).

LIFE 8e, Figure 56.7

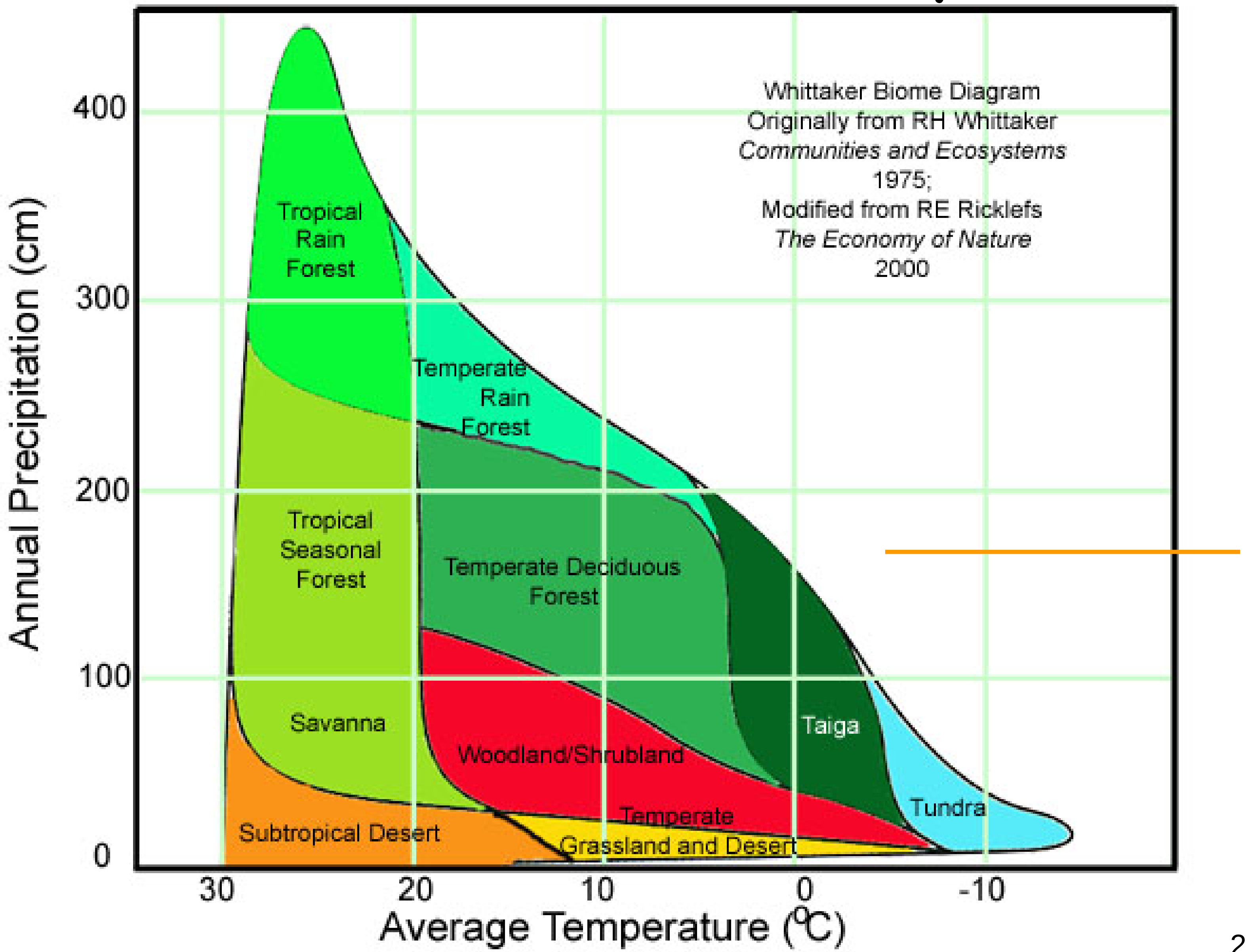
Biomes

- In terrestrial ecosystems, defined ______________.



LIFE 8e, Figure 52.5

Biome character driven by climate

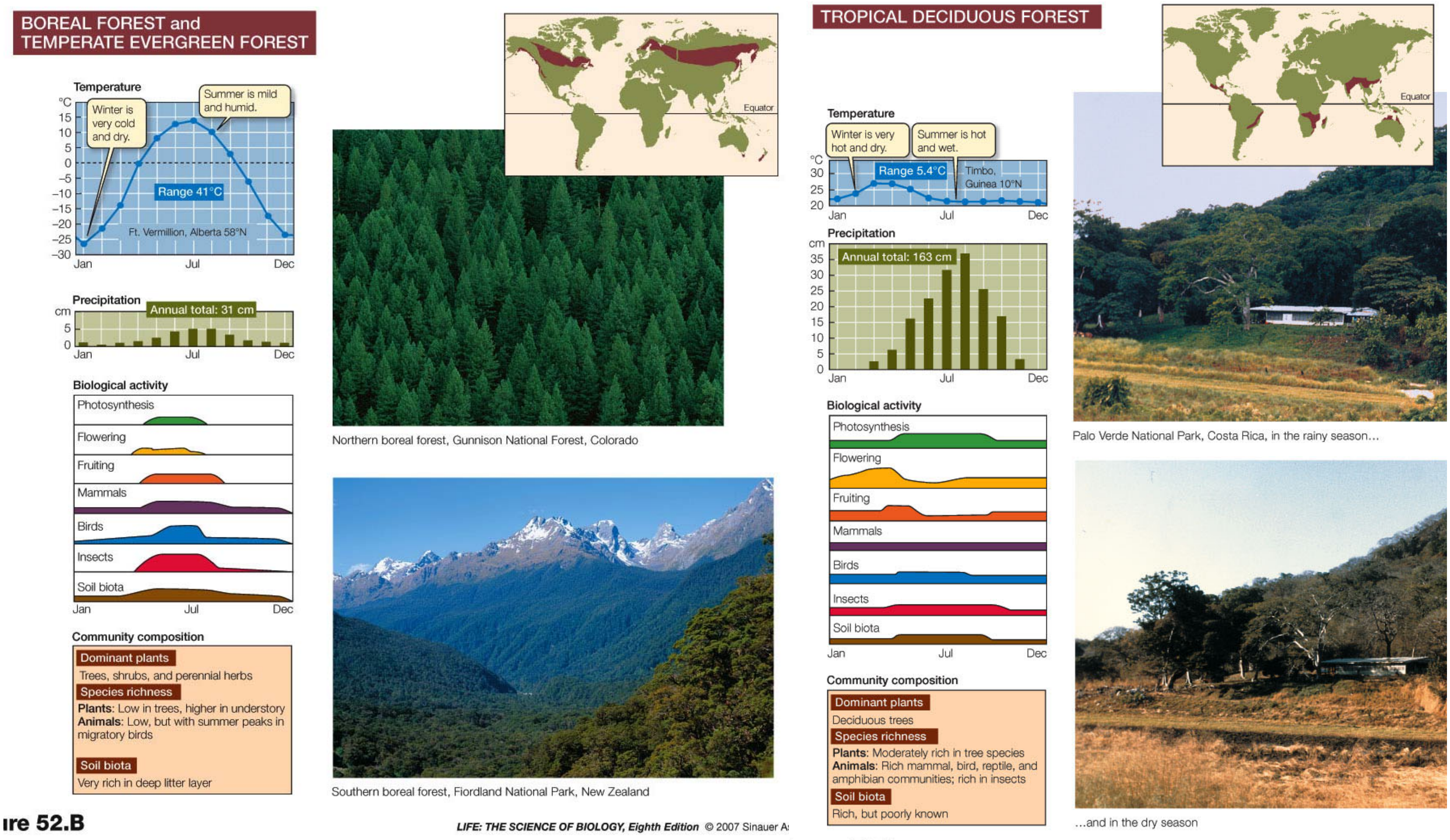


Climate is what you expect.

__________ is what you get.

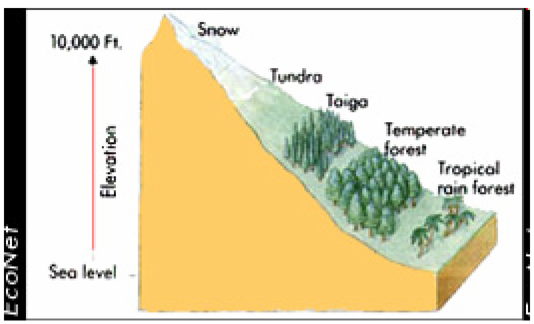
Seasonal Activity

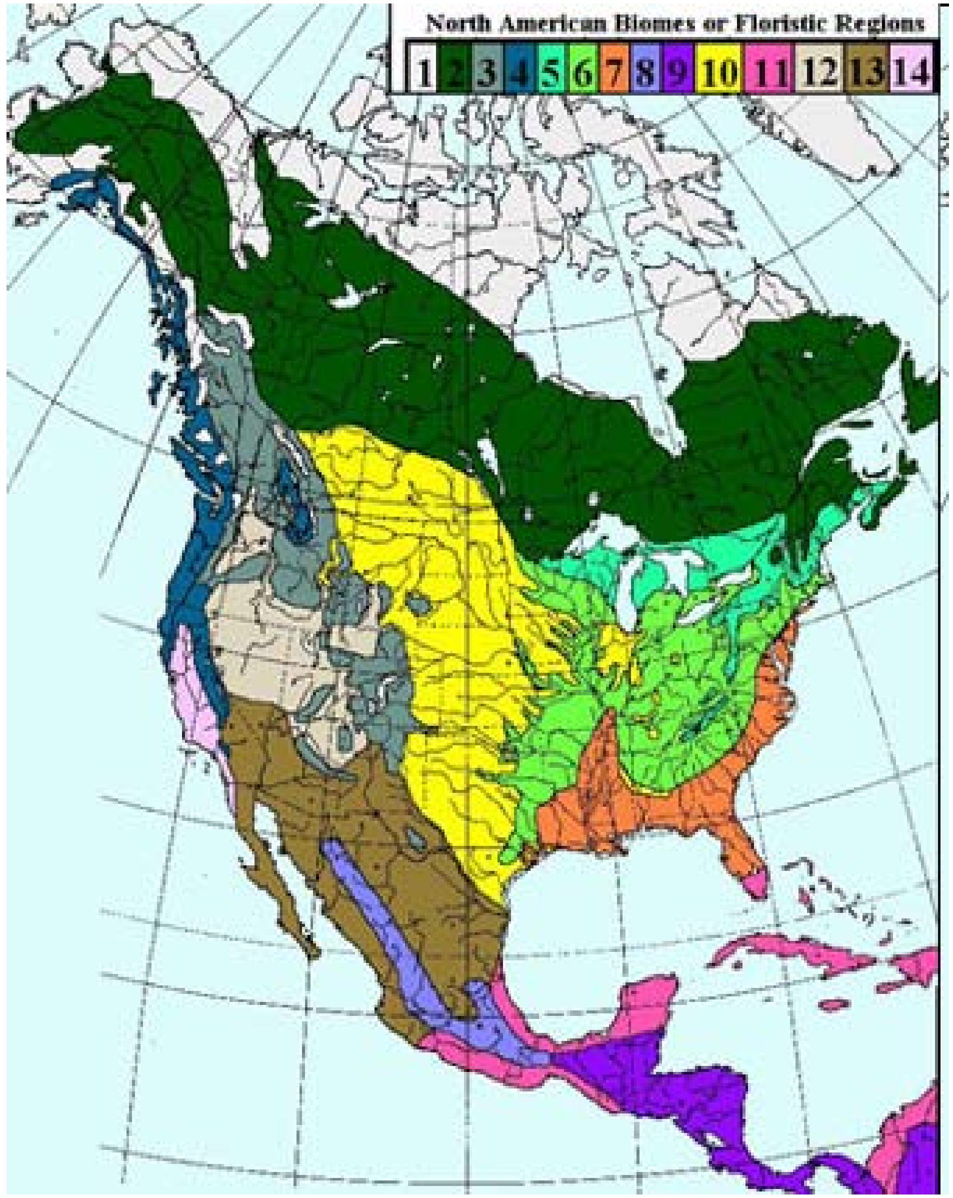
Boreal Forest vs. Tropical Forest



North American Biomes

Is everywhere in Brown the same vegetative community and climate?

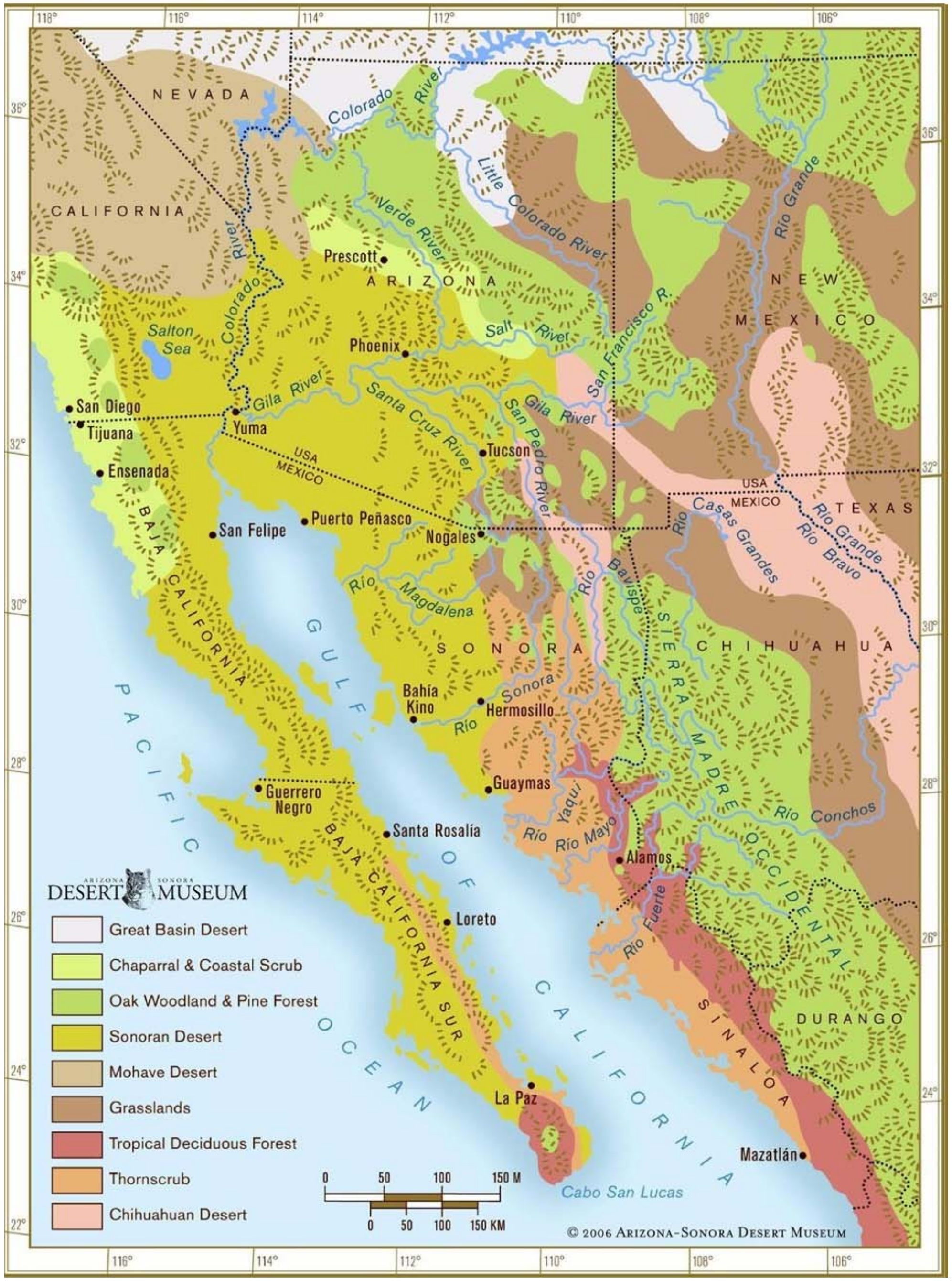




http://rst.gsfc.nasa.gov/Sect3/biome1999a.jpg

Sonoran Desert Region

The Sonoran Desert Region consists of the Sonoran Desert itself plus the surrounding biological communities, including the Sea of Cortez (Gulf of California) and its islands



12″ precip/year

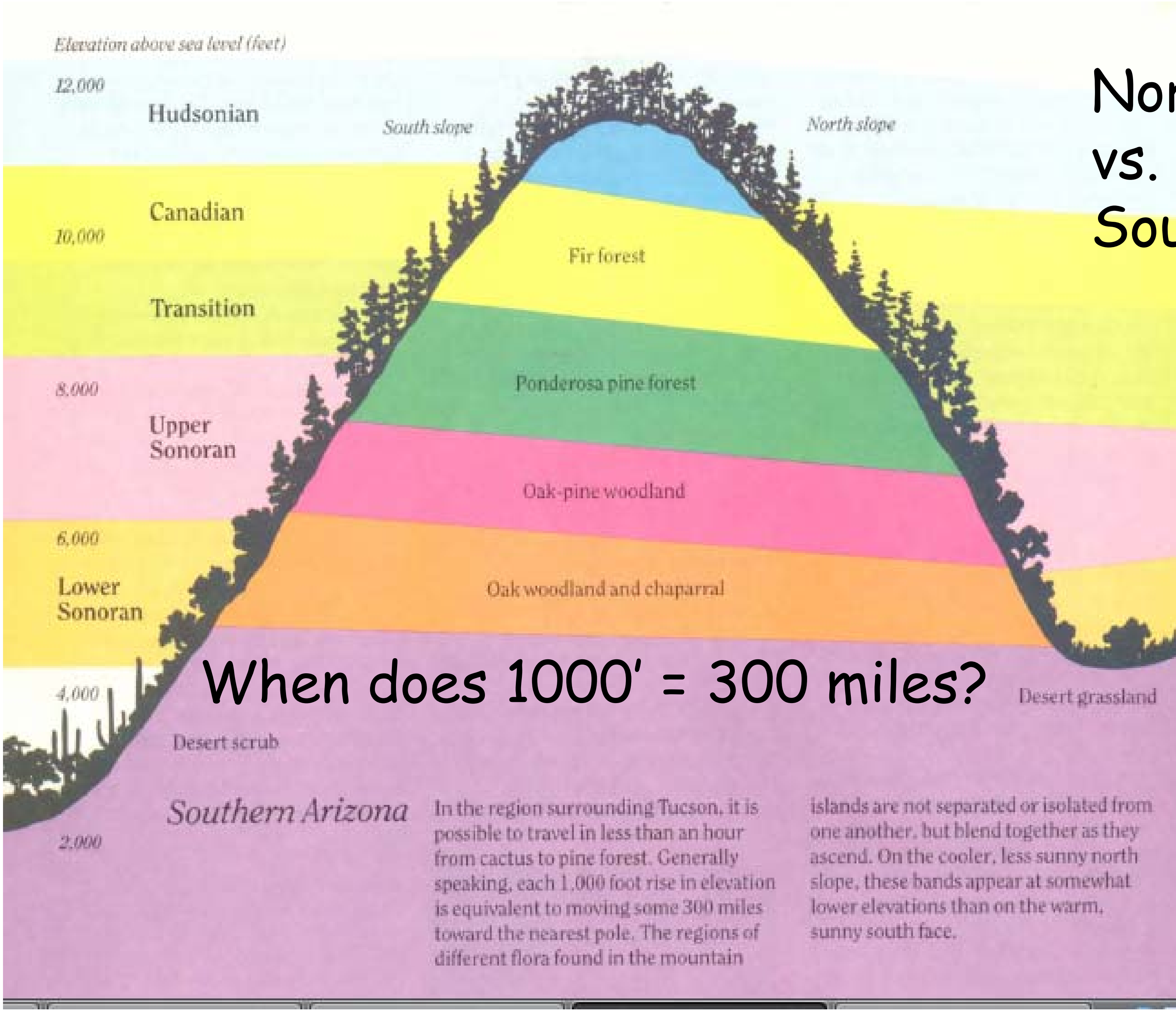
28″ precip/year

30 miles!

~3 months > 100F

~3 months < 50F

North vs. South



When does 1000' = 300 miles?

Adiabatic Cooling

- As increase in altitude, atmospheric pressure decreases.

decreases

(PV=nRT)

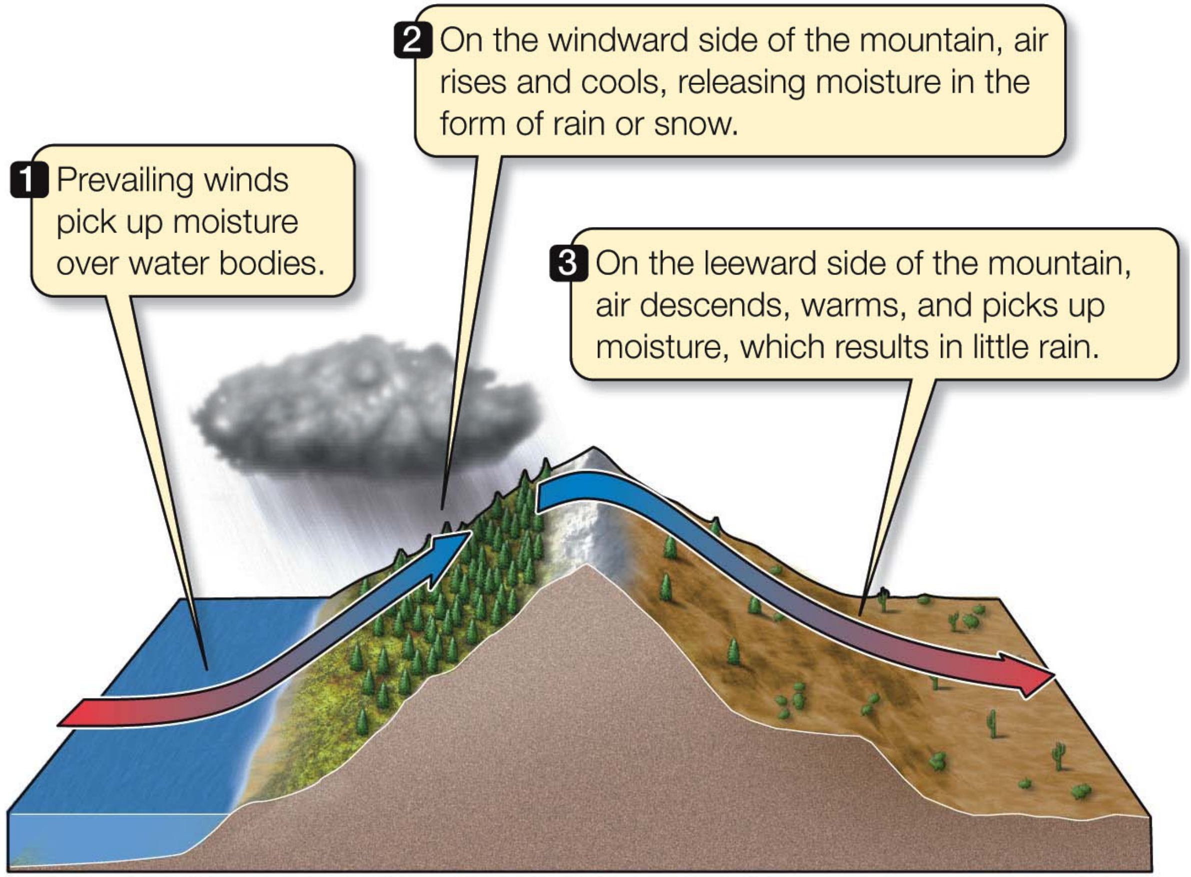
decreases.

- As temperature decreases, air can hold less water.

- RESULT: At higher altitude get cooler, wetter conditions.

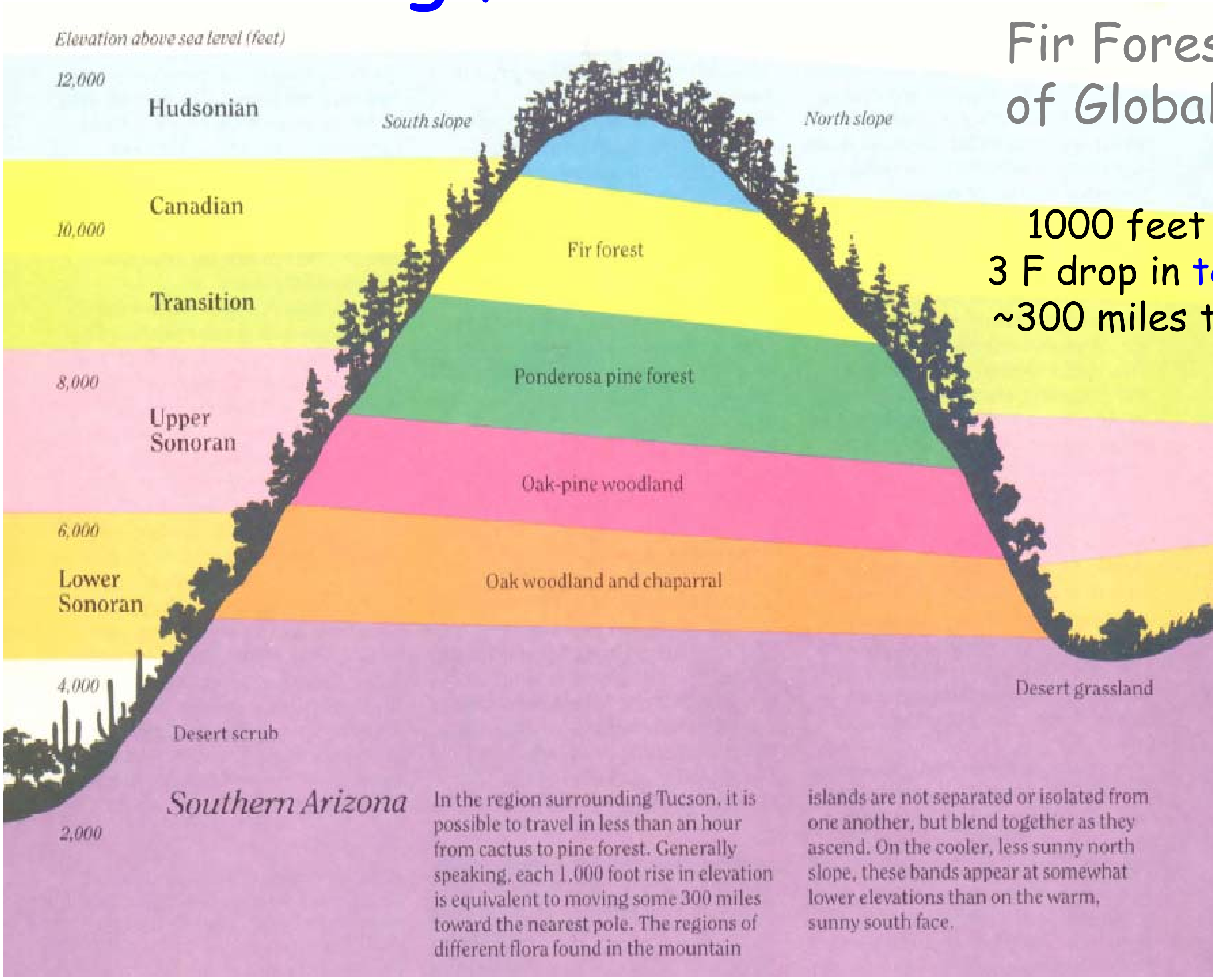
Rain Shadow

- When combine ____________ with prevailing winds…




SOUTH AMERICA
PHYSICAL MAP
Coast Ranges
Llanos
Guyana Highlands
Amazon Basin
Andes
Campos Catinga
Mato Grosso Plateau
Bolivian Plateau
Brazilian Highlands
Gran Chaco
Atacama Desert
Cordoba Ra.
Pampas
Patagonia
Cocos Ridge
Panama Basin
Carnegie Ridge
Gulf of Guayaquil
Parinas Point
Peru Chile Trench
Chile Basin
SOUTH PACIFIC OCEAN
Chile Rise
Corcovado Gulf
Cape Verde Fracture
Vema Fracture
Cape Verde Basin
Guyana Basin
Mouths of the Amazon
C. Sao Roque
SOUTH ATLANTIC OCEAN
Rio Grande Rise
River Plate
Blanca Bay
Gulf of San Matias
Gulf of San Jorge
Argentine Basin
Strait of Megallen
Scotia Ridge
Scotia Sea
Cape Horn
Cotopaxi 5896
Chimborazo 6267
Nevado Huascaran 5748
Ancohuma 6550
L. Titicaca
Aconcagua 6960
Acarai Mts.
L. Maracaibo
Angel Falls
HEIGHT (in Metres)
4000
2000
1000
500
200
0 (Sea Level)
DEPTH (in Metres)
0
200
3000
5000
6500
Map not to Scale
Copyright © 2008-09 www.mapsofworld.com
www.mapsofworld.com

e.g., Mt Lemmon



Fir Forest in age of Global Heating?

1000 feet elevation →
3 F drop in temperature →
~300 miles toward Canada

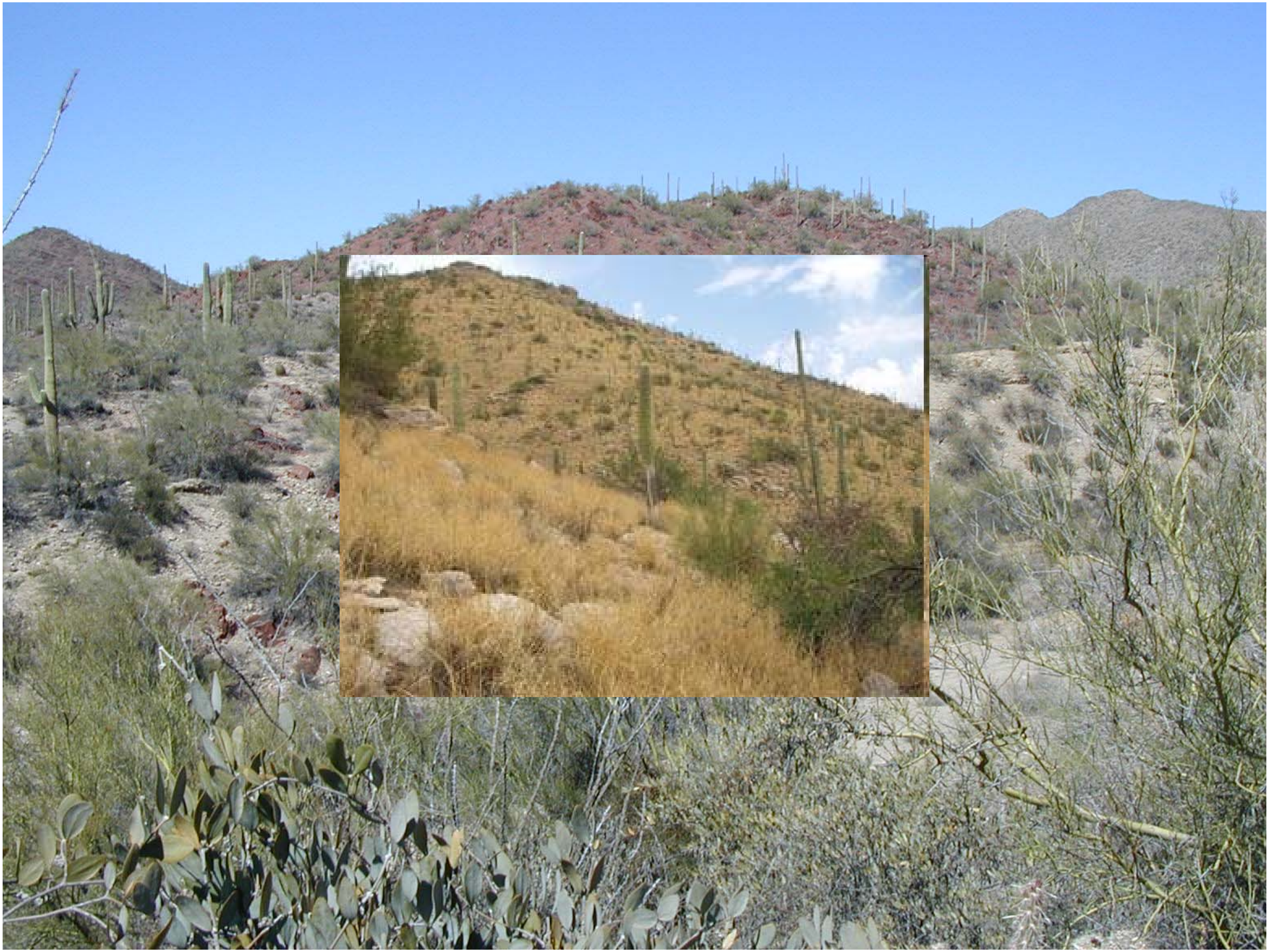
grasslands

deserts

tundra

forests

Etc.



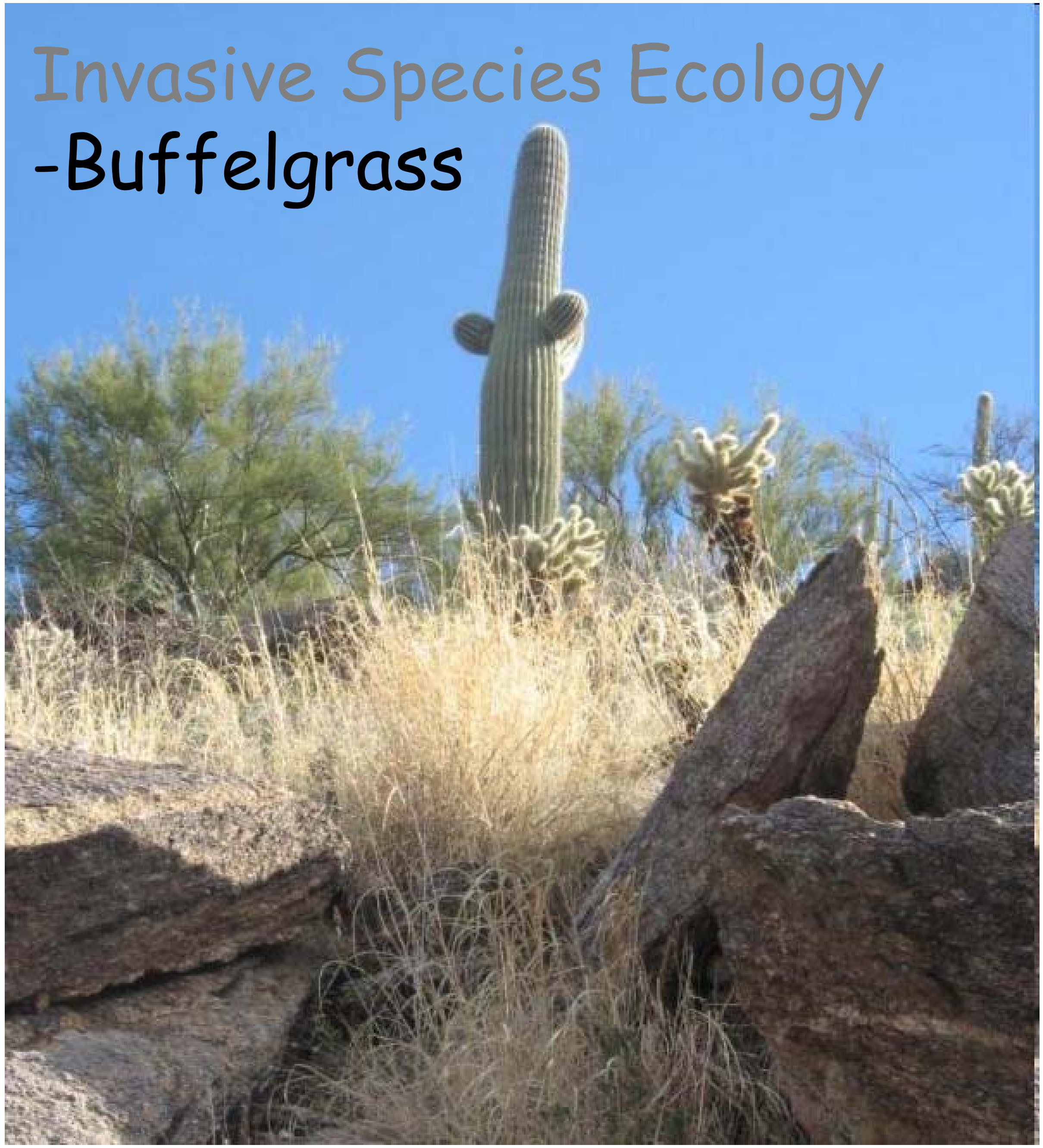
Buffelgrass (*Pennisetum ciliare*) is a perennial, fire-adapted and fire-prone grass native to Africa that was first introduced to the United States in the 1930s. The idea was to create better forage for cattle: Slaughter the wolves, shoot the jaguars and then introduce buffelgrass, and you've got yourself cow heaven on Earth, went the thinking. By 1990, it was all over Southern Arizona and Sonora, and it continues its explosive march across the desert landscape.

Buffelgrass absolutely loves fire. It invades an area and it burns hot, killing all of the native Sonoran Desert plants that never adapted to fire. (Ponderosa pine forests are perfectly adapted to fire. Saguaro forests definitely are not. Forest fire = good. Desert fire = bad.) Two or three burn episodes like this, and you're left with something resembling an African savannah; the Sonoran Desert is gone for good. The grass is exponential in its growth, starting out slow when it first sneaks into an area, then quickly overwhelming everything in its path. Vast areas of the Mexican state of Sonora might as well be African savannahs, a monocultural grassland where once (just 10, 20 or 30 years ago) stood the diverse cacti, trees and other plants we associate with the Sonoran Desert.

The situation is now so critical that a fire could conceivably start down in the desert, work its way up into the foothills, and burn on up into the forest in the Santa Catalinas. Or vice versa. The gap that traditionally separated the forest from the desert is being bridged by buffelgrass and is setting the stage for a massive, fiery conflagration on an unprecedented scale.

http://www.tucsonweekly.com/tucson/state-of-the-desert/Content?oid=1149226

Invasive Species Ecology
-Buffelgrass



www.buffelgrass.org
9 minute video

ECOLOGICAL

____

Community: all species living in the place at the ______________

Communities include lots of populations.

Coexistence

There must be mechanisms that permit similar species to __________

1. **Resource partitioning**

Splitting up of shared, limiting resources.

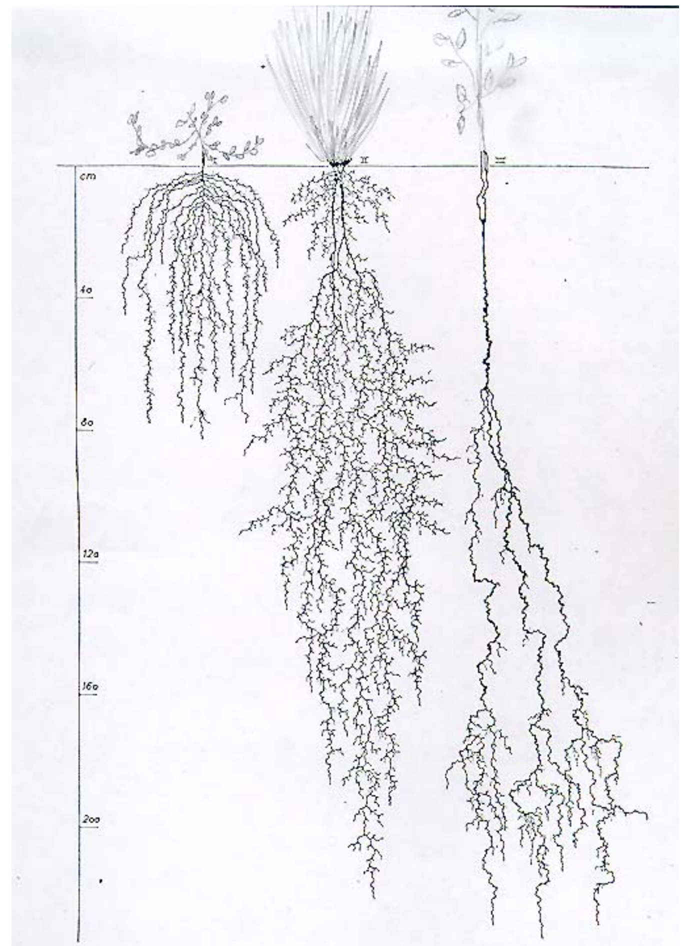


Abb. 7. Primärwurzelsysteme mit verschiedener Stärke und Verteilung der Seitenwurzeln erster Ordnung. I *Adonis aestivalis*, II *Medicago sativa*, III *Chondrilla juncea*

Example: varying root depths

Patterns in Time

Communities change over time, as well as space.

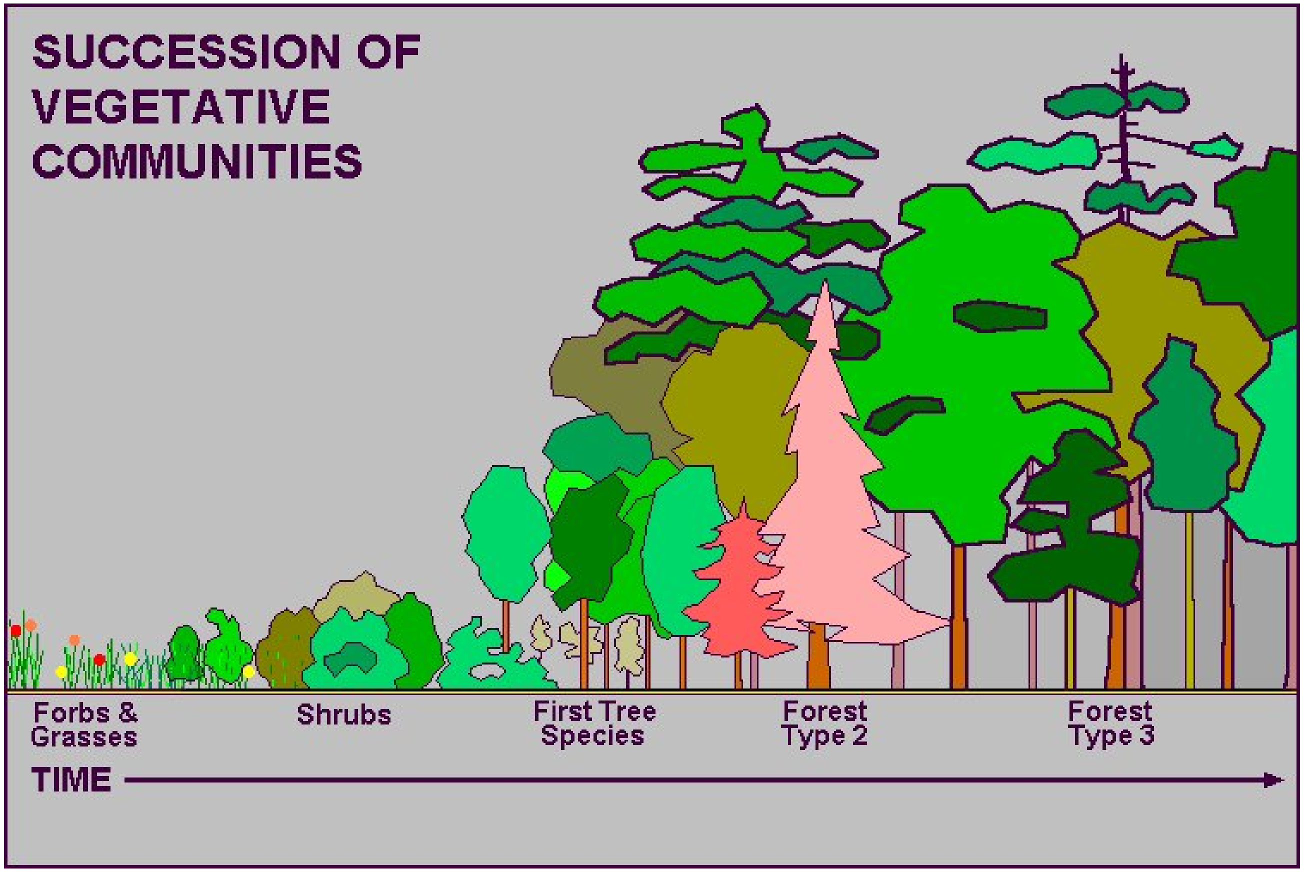
Patterns in Time

Communities change over time, as well as space.

Succession: (orderly?) ________ of species colonizing, dying out in a given habitat over time.

How might succession and disturbance be related?

Because environment changes predictably over time...

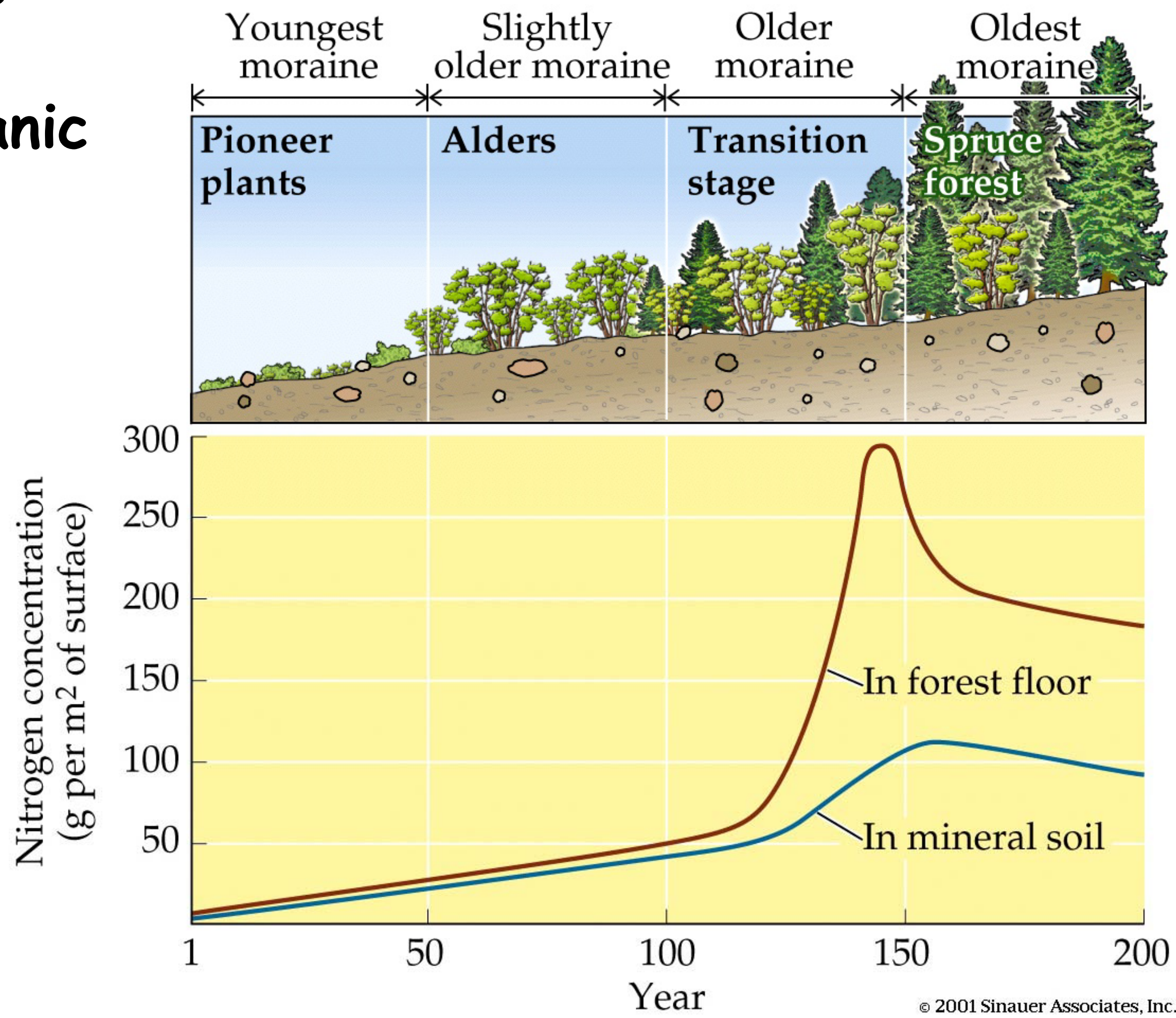


1. Primary succession

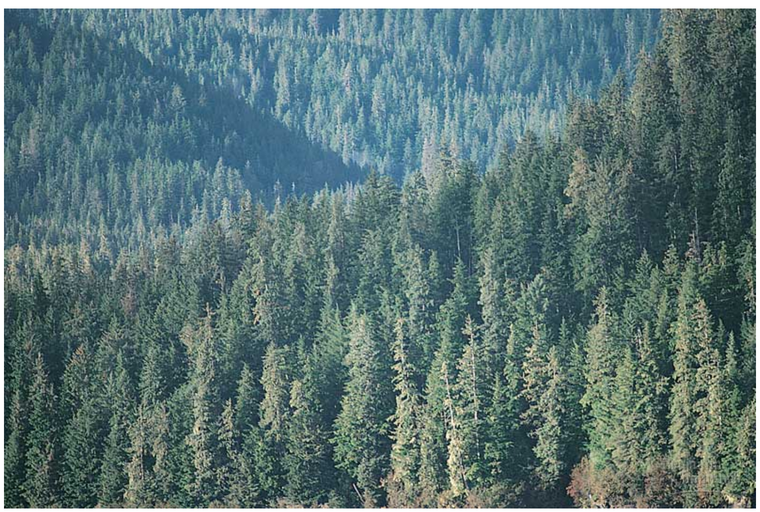
begins with __________ present.

1. Primary succession

a. Nothing present
b. Pioneer species invade
c. Buildup of organic material
d. Other species can colonize.

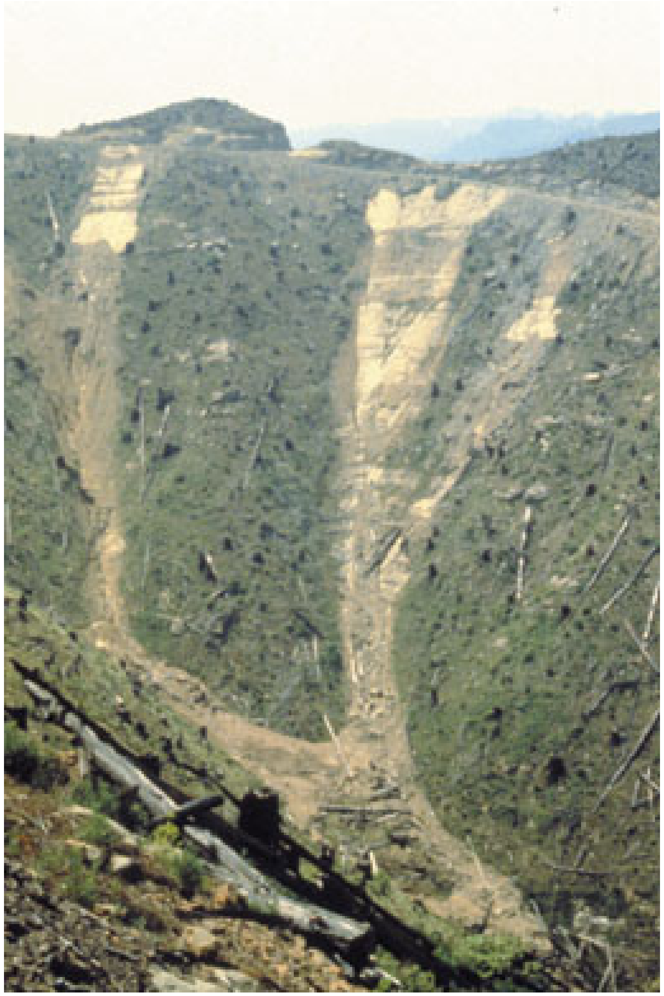


Glacier Bay, Alaska; 200 yrs



2. Secondary succession

begins with well-developed soil, some seeds, some plants.



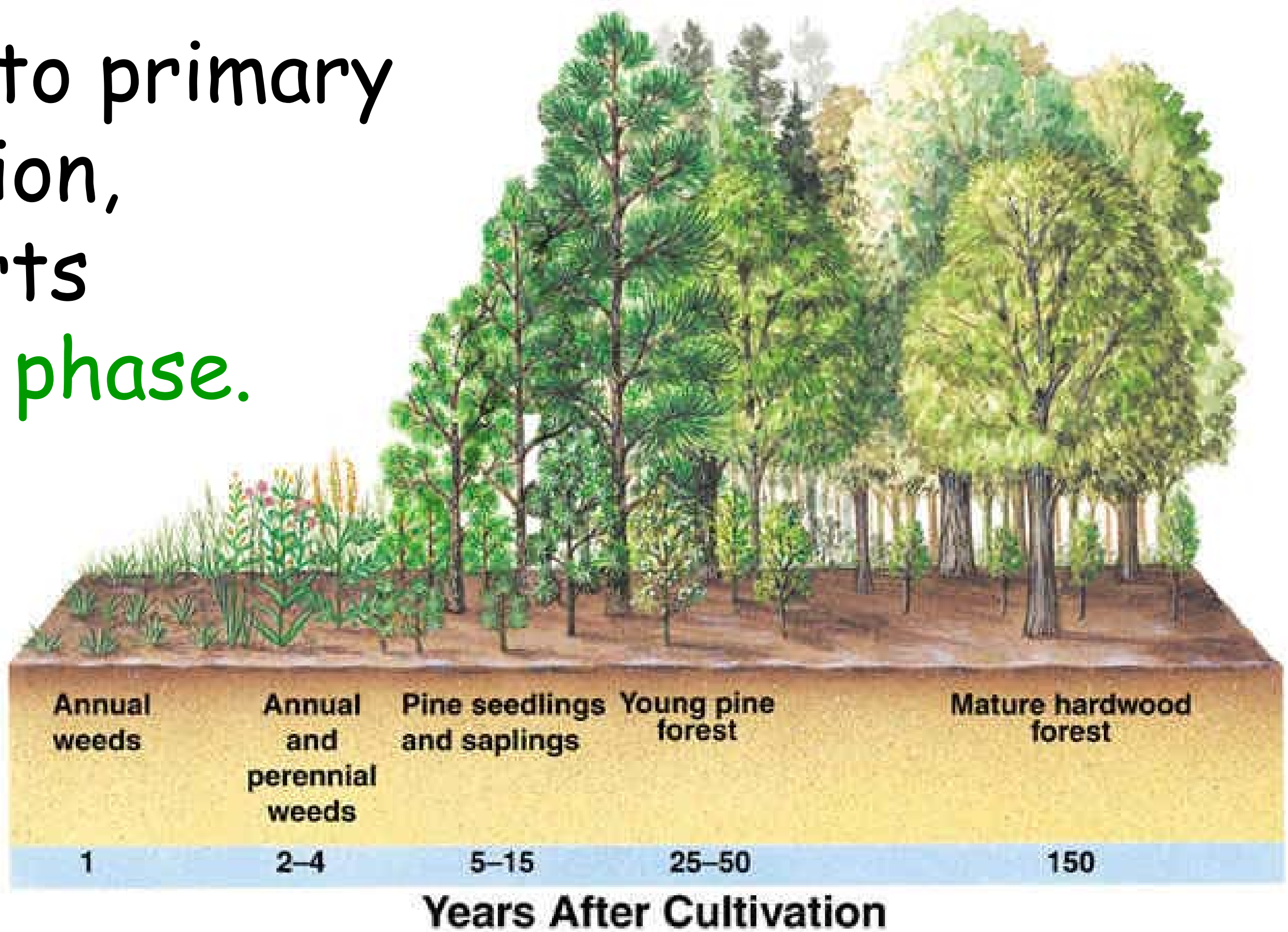
Results of indiscriminate clearcutting in Russian forests

2. Secondary succession

begins with ____________________

Raven/Berg, Environment, 3/e
Figure 5.17

Similar to primary succession,
but starts
at later phase.



Species Diversity

… another way to describe & compare communities:

What species are present? How many?

Species richness: ________________

Region	# Plant sp.	Plant sp./sq. mi
Costa Rica	8,000	0.45
Coastal Calif.	3,050	0.12
Baja Calif.	1,500	0.06
Great Britain	1,600	0.01

useful. even more useful.

- Why are certain **combinations** of species found together as members of a community?

Interaction Hypothesis

- F.E. Clements (around 1936)

- A community is an assemblage of closely linked species
- Species are locked together by interactions that cause communities to function as integrated ____

- Community composition is a function of strict "assembly rules"

Interaction Hypothesis

- Clements focused on forests, evaluating communities of different age
- Gives rise to a __________ view of "succession"
  - Pattern of replacement of species through time, following a disturbance

Criticisms of Interaction Hypothesis

- "Super-organism" concept
- Forrest Shreve – Carnegie Desert Laboratory at Tumamoc Hill, Tucson

over species distributions is

  - Shreve worked in dry tropical forests, eastern deciduous forests and deserts

Individualistic Hypothesis

- H.A. Gleason (late 1930's, early 1940's)

- Communities are – ______________________ of species found in the same area simply because they happen to have similar abiotic requirements

- "Assembly rules" are weak interactions

Individualistic Hypothesis

- Then how can there be "assembly rules" ?
  - finite # of "strategies" for dealing with abiotic extremes (low resources, etc).
  - Due to the inter-relatedness of species

Major consequence from an individualistic view

__________ events dictate the pattern of replacement of species through time following a disturbance

Testing the hypotheses

- Predictions – Interaction hypothesis

- Species should be clustered into discrete communities with distinct boundaries,
  - presence / absence of a particular species A is determined by the presence / absence of species B

Testing the hypotheses

- Predictions – Individualistic hypothesis
- Communities should generally ____ discrete geographical boundaries
  - each species has an INDEPENDENT distribution along environmental gradients

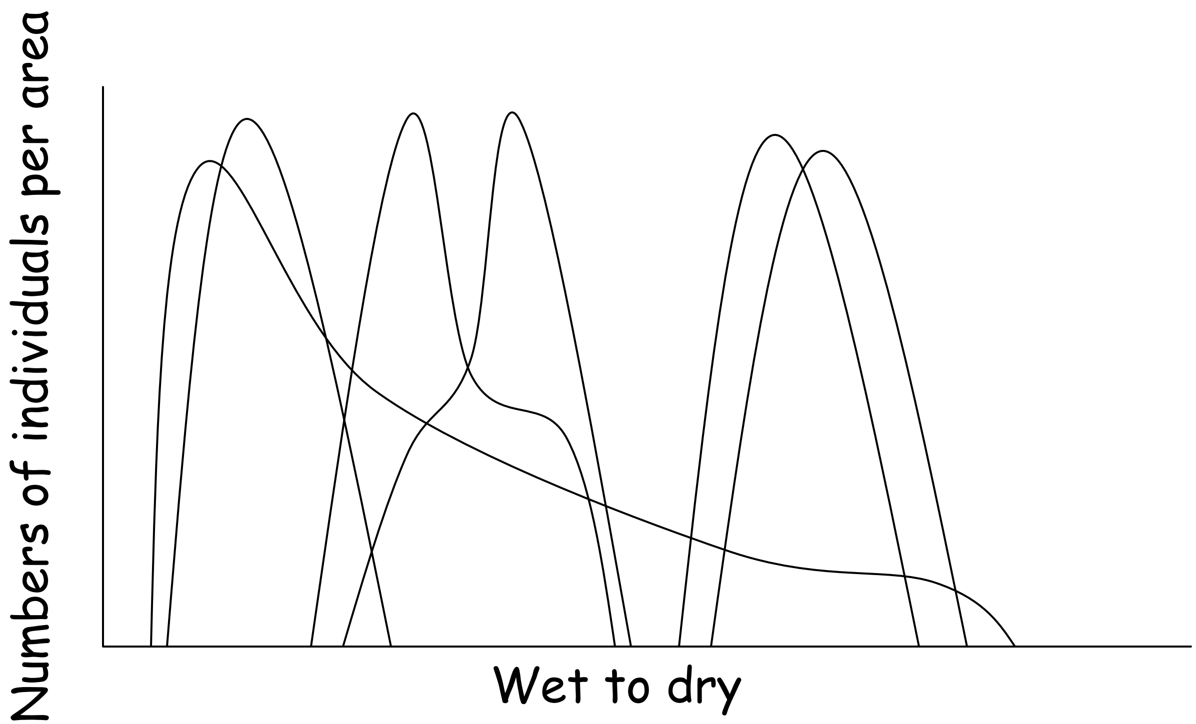
Testing the hypotheses

- Robert Whittaker

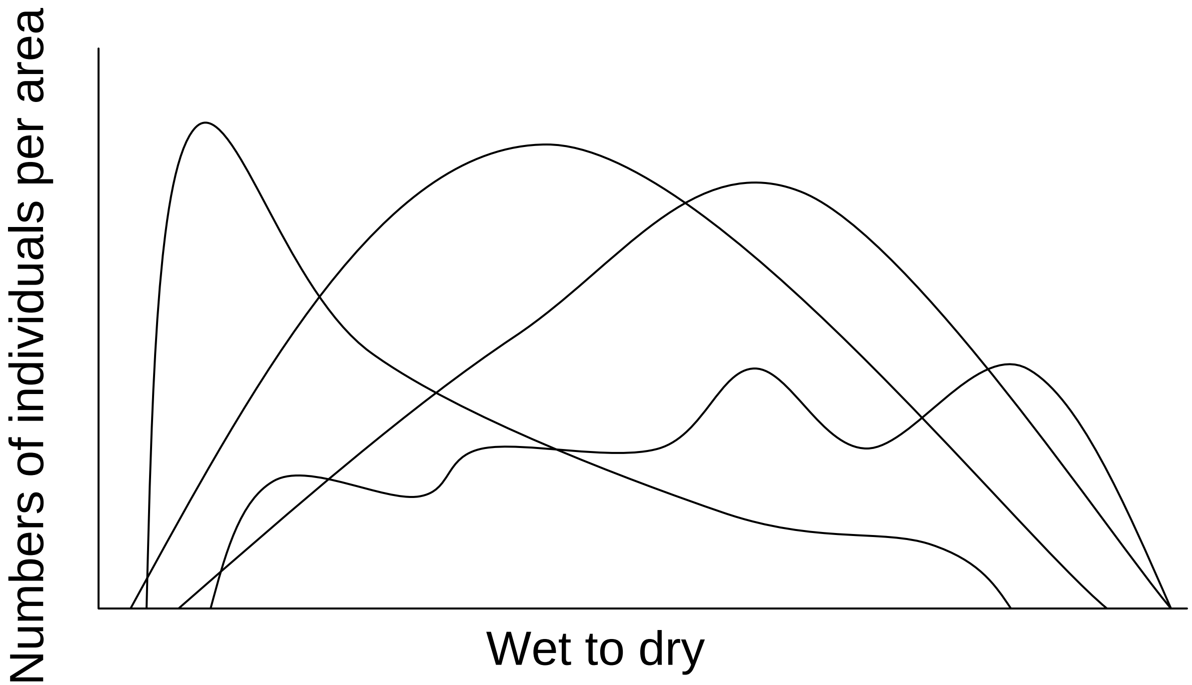
- Evaluation of plant species across elevation gradients within a latitudinal gradient
  - (aside – can this determine causation?)

- Plotting species with respect to the resource gradients produced by this descriptive study

Graphical prediction of the interaction hypothesis



Santa ________________ Mtns – Whittaker transects



- Supports the individualistic hypothesis
- Does NOT say that species interactions are un-important in ecology!

Testing the hypotheses

- Jenkins and Buikema
- Artificial ponds – chance establishment of communities versus strict assemblage characteristics

  ________________ filled with sterile water

  - After one year, evaluate who (which species) are in the ponds
  - A total of **60** different species found. No community had more than **39**, and all had different combinations
  - Supports the individualistic hypothesis

Why are some species found consistently in the same assemblages?

- The support is for the individualistic theory of community ecology
- Species are consistently found together because they have overlapping constraints