

1 ☐ Unit 2:

Terrestrial Ecosystems

EVSC 111

2 ☐ Four Units of Course

- ✓ Global Environments
- ✓ **Terrestrial Ecosystems**
- ✓ Aquatic Ecosystems
- ✓ Environmental management

3 ☐ Ecosystems

✓ Ecosystem

- a concept in which the physical and biological components of the environment are considered as a single, interactive system
- two main categories
 - **terrestrial** (unit 2)
 - **aquatic** (unit 3)

4 ☐ Ecosystems & Biomes

✓ Ecosystem

- similar physical environments lead to
 - the evolution of organisms similar in form and function
 - similar ecosystems
- this is known as the rule of climatic similarity
 - leads to the concept of the **biome**
 - which is a kind of ecosystem

5 ☐ Ecosystems & Biomes

✓ Biomes

- major communities of organisms that
 - have a characteristic appearance
 - are distributed over a wide land area
- defined largely by regional variations in **climate**

6 ☐ Ecosystems & Biomes

✓ Biomes

- the strong relationship between climate and life suggests that
 - if we know the climate of an area
 - we can predict what **biome** will be found there
 - » approximate biomass
 - » approximate productivity
 - » dominant types of organisms

7 ☐ Ecosystems and biomes

- ✓ distribution of biomes results from interaction of
 - physical features of the earth
 - two key physical factors
 - amount of solar heat
 - global atmospheric circulation
- ✓ together these factors dictate local climate
 - two most important climatic factors are
 - precipitation
 - temperature

8 ☐ Climate shapes the character of ecosystems

- ✓ why are there variations in the earth's climate?
 - different parts of the earth receive different amounts of energy from the sun
 - variations in the amount of energy received from the sun
 - responsible for
 - » many of the major climatic differences on the earth
 - » and, indirectly, for much of the diversity in the earth's biomes

9 ☐ Climate shapes the character of ecosystems

- ✓ why the tropics are warmer?
 - since the earth is a sphere, some parts receive more energy from the sun than others on a per unit area basis
 - tropics are warmer than temperate regions
 - because they receive more sun energy per unit area
 - poles are colder than other areas
 - because they receive less sun energy per unit area

10 ☐ Climate shapes the character of ecosystems

- ✓ key natural and physical elements
 - **precipitation**
 - all organisms require water
 - on land, water is often scarce
 - important aspects
 - total amount per year
 - form in which it arrives
 - seasonal distribution
 - ecosystem productivity increase with increased precipitation

11 ☐

12 ☐ Climate shapes the character of ecosystems

- ✓ key natural and physical elements
 - **precipitation**

- generally low near 30° N & S latitude
 - where air is descending & warming
- partly as a result of this, all the great deserts of world lie near 30° N or S latitude
- other major deserts are formed in the interiors of large continents
 - where precipitation is limited because of the great distance from the sea, the ultimate source of most moisture

13 ☐ Climate shapes the character of ecosystems

✓ key natural and physical elements

– **precipitation**

- precipitation is generally higher near equator and 60° north and south latitude
 - where air is rising & cooling
 - » releasing moisture it contains as its ability to hold the moisture decreases as temperature decreases

14 ☐

15 ☐ Climate shapes the character of ecosystems

✓ key natural and physical elements

– **precipitation**

- **rain shadow effect** can produce deserts
 - some mountains intercept moist winds from the sea
 - » air encounters mountains & then rises
 - » as air rises, its ability to hold moisture decreases
 - results in increased precipitation on the windward side of mountains (the side from which the wind is blowing)

16 ☐ Climate shapes the character of ecosystems

✓ key natural and physical elements

– **precipitation**

- **rain shadow effect** can produce deserts
 - air descends the other side of the mountains (the leeward side)
 - » is warmed & moisture-holding capacity increases
 - » which tends to inhibit precipitation
 - example, Sierra Nevada Mountains of CA
 - » eastern sides much drier than western sides & vegetation often very different

17 ☐

18 ☐

19 ☐ Climate shapes the character of ecosystems

✓ key natural and physical elements

– **temperature**

- most organisms are adapted to live within a relatively narrow range of temperatures
 - won't survive if temperatures are significantly warmer or colder
 - » ex., growing season of plants is influenced by temperature
- ecosystem productivity increases with increased temperature

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21 Climate shapes the character of ecosystems

- ✓ key natural and physical elements
 - **temperature** is affected by **latitude**
 - **tropical latitudes**
 - temperatures higher in tropics
 - » more sunlight falls per unit area
 - highest mean global temperatures occur near equator
 - there are no seasons in the tropics
 - » there is little variation in mean monthly temperature in tropical ecosystems

22 Climate shapes the character of ecosystems

- ✓ key natural and physical elements
 - **temperature** is affected by **latitude**
 - **temperate latitudes**
 - temperatures decrease as you move from the equator toward temperate latitudes
 - » less sunlight strikes earth per unit area
 - temperature variations increase because of increasingly marked seasons

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24 Climate shapes the character of ecosystems

- ✓ key natural and physical elements
 - **temperature** is affected by **elevation**
 - higher altitudes become progressively colder
 - at a given latitude, air temperature falls about 6°C/1000m increase in elevation
 - ecological consequences of temp varying w/elevation = temp varying w/ latitude

25 Climate shapes the character of ecosystems

- ✓ key natural and physical elements
 - **temperature** is affected by **elevation**
 - higher altitudes become progressively colder
 - in North America, a 1000m increase in elevation results in a temp drop ~ to that of an 800 km increase in latitude
 - this is reason “timberline” (the elevation above which trees do not grow) occurs at progressively lower elevations as one moves farther from the equator

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27 Figure: Vegetation, Latitude, Altitude

28 Figure: Temperature and latitude

29 Succession

- ✓ **Succession**
 - concept that communities proceed through a series of regular, predictable changes in structure over time
 - results in a **climax community**
 - a stable, long lasting community

- type that results depends largely on climate
- occurs because activities of organisms cause changes in their surroundings
 - that make local environment suitable for other kinds of organisms

30 ☐ Succession

✓ Succession

- pace and direction affected by several factors
- two different kinds are recognized
 - **primary succession**
 - **secondary succession**

31 ☐ Succession

✓ Succession

- two different kinds are recognized
 - **primary succession**
 - begins with
 - » total lack of organisms
 - » bare mineral surfaces, or water
 - less frequently observed
 - usually takes a very long time
 - » because of lack of soil and few nutrients for plants
 - **secondary succession**

32 ☐ Succession

✓ Succession

- two different kinds are recognized
 - **primary succession**
 - **secondary succession**
 - more commonly observed
 - proceeds more rapidly
 - begins with destruction or disturbance of existing ecosystem
 - » some soil present
 - » some seeds or roots from which plants can begin growing

33 ☐ Succession

✓ Succession

- **terrestrial primary succession**
 - factors affecting rate and direction
 - **substrate type**
 - » will affect soil type that develops
 - availability of **reproductive structures**
 - » will determine species available to colonize the area
 - **regional climate**

34 ☐ Succession

✓ terrestrial primary succession

– pioneer community

- collection of organisms that first colonizes bare rock
- dominant organism is the **lichen**
 - a mutualistic relationship between
 - » a fungus
 - » an alga OR a photosynthetic bacterium

35 ☐ Succession

✓ terrestrial primary succession

– pioneer community

- **lichens**
 - develop slowly
 - accumulate debris
 - photosynthetic portion serves as a producer
 - » tiny consumer organisms live on them
 - acids produced by fungus
 - » cause breakdown of rock
 - contributes to accumulation of soil

36 ☐ Succession

✓ terrestrial primary succession

– pioneer community

• thin layer of soil

- can support variety of organisms
 - » bacteria
 - » protozoa
 - » fungi
 - » small worms, insects
 - » small annual plants
- as these organisms grow, reproduce, die
 - » they contribute additional organic matter for soil building process

37 ☐ Succession

✓ terrestrial primary succession

– pioneer community

• thicker layer of soil

- can support more organisms that are a little longer lived
 - » perennial herbs and grasses

– intermediate stages

- grasses, larger perennials, woody shrubs, shade intolerant trees

38 ☐ Succession

✓ terrestrial primary succession

– climax community

- relatively stable, long lasting
- complex and interrelated community

- bacteria, protista, fungi, plants, animals
 - shade tolerant trees
- specific types that occurs depends on climate, soil type
- **successional stage (seral stage)**
 - each step in process
- a **sere** is the entire sequence of stages

39 Figure 6.2: Primary succession on land

40 Succession

✓ aquatic primary succession

- main concepts of terrestrial primary succession can be applied to aquatic ecosystems
- except for oceans, over time, most aquatic ecosystems are replaced by terrestrial ecosystems
 - aquatic ecosystems receive continuous input of soil particles and organic matter
 - as sediment increases, water depth decreases
 - types of organisms change

41 Figure 6.3: Primary succession from a pond to a wet meadow

42 Succession

✓ Secondary succession

- driven by same processes as primary succession
- occurs when an existing community is destroyed
 - by forest fire, flood, conversion to agriculture
- but the destruction doesn't usually return the ecosystem to bare rock
 - much soil may remain, with its nutrients
 - some plants and other organisms may survive
- proceeds more rapidly than primary succession
- some communities exist only as successional stages
 - continually re-established after disturbances

43 Figure 6.5: Secondary succession on land

44 Figure 6.6: Secondary succession from a beaver pond

45 Succession

✓ Climax communities

- show certain characteristics when compared to successional communities
 - maintain their mix of species for a long time
 - are in energy balance
 - tend to have more types of organisms and types of interactions
 - trend is toward more complexity, energy efficiency

46 Succession

✓ Climax communities

- there doesn't appear to be a pre-ordained climax community for a given area
- specific community that develops depends on
 - climate
 - types of seeds present

- differentiated from a successional community by the time scale over which change occurs
 - climax communities do not change as rapidly as successional ones

47 Biomes

✓ Biomes

- are terrestrial climax communities with wide geographic distribution
- concept is useful for describing in broad terms
 - the general structure of the ecosystem
 - the types of niches present
- of the same type from different areas will exhibit variations in the exact species present
- affected by two nonbiological factors
 - temperature
 - precipitation

48 Biomes

✓ Biomes

- major biomes of the world
 - **desert**
 - **grassland**
 - **savanna**
 - **tropical rainforest**
 - **temperate deciduous forest**
 - **taiga or boreal forest**
 - **tundra**

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50 Biomes

✓ deserts

- dry places where rainfall is <25 cm/yr
 - so little that vegetation is sparse and survival depends on water conservation
 - world's great deserts are located in the interiors of continents
 - Sahara in Africa
 - Gobi in Asia
 - Great Sandy Desert in Australia


51 Biomes

✓ deserts

- organisms have evolved adaptations to help them survive
 - restricting activity to times of the year when water is present
 - avoiding high temperatures by living in deep, cool, & moist (sometimes) burrows
 - emerging only at night when temperatures are lower, especially if active year round
 - drinking large quantities of water when it is available (camels) & then survive long, dry periods

52 

53  Figure 6.10a: Climagraph for Cairo

54  Figure: Desert biome and climagraphs

55 

56  Biomes

✓ **Grasslands**

- also known as **temperate grasslands, prairies, steppes**
- widely distributed throughout temperate regions
 - ~ halfway between equator & poles
- rainfall is ~ 25cm -75cm per year
- tend to be windy with hot summers, cold to mild winters
- grasses make up 60%-90% of the vegetation

57  Biomes

✓ **Grasslands**

- once covered much of interior North America, were widespread in Eurasia & South America
 - often highly productive when converted to agricultural use
 - many of the agricultural lands of the US & Canada were originally occupied by grasslands (prairies)
 - » roots of perennial grasses characteristically penetrate far into soil
 - » grassland soils, therefore, tend to be deep and fertile

58  Biomes

✓ **Grasslands**

- temperate grasslands are often populated by herds of grazing mammals
 - in North America, huge herds of bison and pronghorns once inhabited the prairies
 - herds are almost all gone now
 - most of the prairies have been converted into the richest agricultural region on earth

59 

60  Figure 6.11a: Climagraph for Tehran

61  Figure: Temperate grassland biome and climagraph

62  Biomes

✓ **Savanna**

- great grasslands located in dry climates that border the tropics
- transitional between tropical rainforest and desert (on global scale)
- rainfall is 50cm-150cm /yr & occurs seasonally
 - period of heavy rainfall followed by prolonged drought
- predominant plants are grasses
 - with widely spaced, drought resistant trees
- landscape is open

63 Biomes

✓ Savanna

- many of its animals and plants are active only during the rainy season
- fire is common and trees tend to be fire-resistant
- savannas are increasingly being converted to agricultural use
 - causing the inhabitants of savannas to struggle to survive

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65 Figure 6.12a: Climagraph for Rangoon

66 Figure: Savanna biome and climagraph

67 Biomes

✓ Tropical rainforest

- rainfall is >200cm/yr
- temperatures are warm and relatively constant, no frost
- richest ecosystems on earth
 - contain ~ half of all species of terrestrial plants and animals
 - in 1sq mi of tropical forest in Rondonia, Brazil there are 1200 species of butterflies
 - » which is twice the number found in the U.S. and Canada combined

68 Biomes

✓ Tropical rainforest

- communities are diverse
 - each kind of organism is often represented in a given area by only a few individuals
- located near the equator
 - South America, Africa, southeast Asia
- are being destroyed
 - many of the species in rainforests have never been seen by humans
 - during our lifetime, a quarter of the world's species will disappear with the rainforests

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70 Figure 6.13a: Climagraph for Singapore

71 Figure: Tropical rain forest biome and climagraphs

72 Biomes

✓ temperate deciduous forests

- rainfall is 75cm-100cm per year
- in areas with warm climates (warm summers and cool winters)
 - plants grow actively for ~1/2 year
- found in northeastern US, eastern Canada, Eurasia
- often populated by deer, beaver, bear, raccoon
- generally have a lower number of species but a higher number of individuals per species
- trees are the major producers

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74  Figure 6.14: Climagraph for Chicago

75  Figure: Temperate deciduous forest

76  Biomes

✓ **Taiga**

- rainfall is 25cm-100cm per year
 - climate is humid due to low evaporation resulting from generally low temperatures
- winters are long and cold
 - soil freezes in winter
- northern forests of coniferous trees such as hemlock, spruce, fir
 - needle-shaped leaves limit moisture loss
 - pyramid shapes accommodate snow
- is one of the largest ecosystems on earth

77  Biomes

✓ **Taiga**

- has very short growing season for farming so few people live there
- populated by many types of large mammals and carnivores such as moose, elf, deer, wolves, bear, lynx
- has been used for fur trapping and lumber production
- located in a ring that extends across vast areas of Asia and North America
- also known as **boreal forest, northern coniferous forest**

78 

79  Figure 6.15a: Climagraph for Moscow

80  Figure: Taiga biome and climagraphs

81  Biomes

✓ **tundra**

- located in the far north of the taiga and south of the polar ice
- rainfall is <25cm/yr
- soil layer is known as **permafrost**
 - it is permanently frozen
- extremely cold and windy
- open, grassland that is often boggy
- enormous ecosystem that covers 1/5th of the earth's land area


82  Biomes

✓ **tundra**

- no trees grow in the area
- herbs are perennials that grow rapidly during the brief summer
- populated by large grazing mammals such as musk-oxen, caribou, reindeer and carnivores such as wolves, foxes, lynx

83 

84  Figure 6.16a: Climagraph for Fairbanks

85  Figure: Tundra biome and climagraphs

86  Figure: World Biomes

87  Figure 6.8: Influence of precipitation and temperature on vegetation

88  The End