Chapter 50

An Introduction to Ecology and the Biosphere

Biology, Seventh Edition
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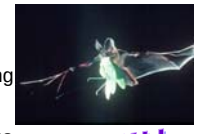
Lecture modified by Maria Morlin

The scope of ecology

- Ecology
  - Is a discipline of biology that studies the interactions between organisms and the environment
- These interactions
  - Determine both the distribution of organisms and their abundance

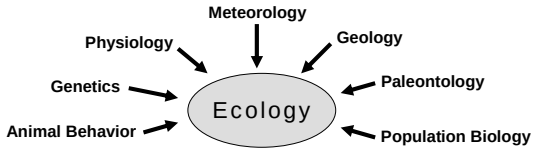
- Ecology
  - Is an enormously complex and exciting area of biology
  - Reveals the richness of the biosphere





WOW!

- Many disciplines of science contribute to the discipline of ecology



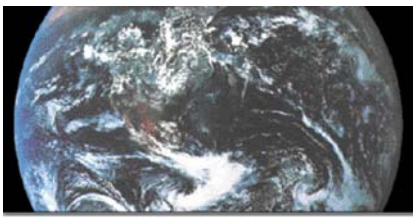
"Ecological Theater, Evolutionary Play"

- Environmental factors interacting with variation within populations could cause evolutionary change.



Why is understanding ecology important:

1) Ecology shapes selection and evolutionary divergence
2) Earth is a finite place with limited resources
3) Humans manage the planet's resources



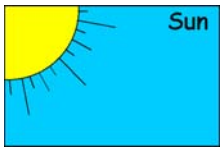
- Concept 50.1: Ecology is the study of interactions between organisms and the environment
- Ecology
  - Is a rigorous experimental science
  - It also has a long history as a descriptive science ("Discovery Science" from Ch. 1)
    - Records from Biblical times → Aristotle → Linnaeus → Audubon

Who will WIN – Native or Invasive Exotic

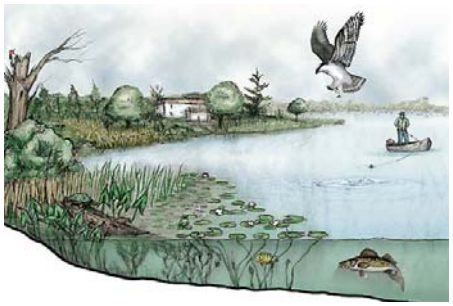
Environment

- Abiotic, or nonliving components
- Biotic, or living components
- Biota: all organisms living in environment
- Describe one of the tanks' biotic and abiotic variables

- **Abiotic factors**



- **Biotic factors**



- **Biota** = All the organisms living in the environment

- Environmental components
  - Affect the distribution and abundance of organisms

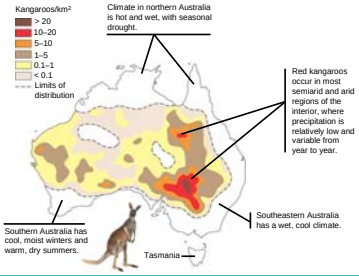


Figure 50.2

Subfields of Ecology

- Organismal ecology
  - Studies how an organism's structure, physiology, and (for animals) behaviour meet the challenges posed by the environment

Figure 50.3a

(a) Organismal ecology. How do humpback whales select their calving areas?

Polar bears: anatomy & physiology: adaptations

- Population ecology
  - Concentrates mainly on factors that affect how many individuals of a particular species live in an area
    - (A population is a group of organisms of the same species that live together in the same area at the same time)

(b) Population ecology. What environmental factors affect the reproductive rate of deer mice?

Figure 50.3b

- Community ecology
  - Deals with the whole array of interacting species in a community
    - (A community is all the populations of different species that are living together in the same area at the same time)

(c) Community ecology. What factors influence the diversity of species that make up a particular forest?

Figure 50.3c

- Ecosystem ecology
  - Emphasizes energy flow and chemical cycling among the various biotic and abiotic components
    - (An ecosystem is a community and its abiotic environment)

(d) Ecosystem ecology. What factors control photosynthetic productivity in a temperate grassland ecosystem?

Figure 50.3d

Fire is an abiotic variable

- Landscape ecology
  - Deals with arrays of ecosystems and how they are arranged in a geographic region

Figure 50.3e

(e) Landscape ecology. To what extent do the trees lining the drainage channels in this landscape serve as corridors of dispersal for forest animals?

- The biosphere
  - Is the global ecosystem, the sum of all the planet's ecosystems
    - [All of the Earth's organisms and their interactions with each other, the land (lithosphere), the water (hydrosphere), and the atmosphere]

Ecology and Environmental Issues

- Ecology
  - Provides the scientific understanding underlying environmental issues
- Rachel Carson
  - Is credited with starting the modern environmental movement

Figure 50.4

- Rachel Carson (1907 – 1964) (Biologist)
  - In the 1960's, public concern about pollution and resource quality began to increase here in the USA.
  - Carson's most famous work, *Silent Spring,* was published in 1962. In it, she wrote:

"…Pesticide sprays, dusts, and aerosols are now applied almost universally to farms, gardens, forests, and homes – nonselective chemicals that have the power to kill every insect, the 'good' and the 'bad,' to still the song of birds and the leaping of fish in the streams, to coat the leaves with a deadly film, and to linger on in soil – all this though the intended target may be only a few weeds or insects. Can anyone believe it is possible to lay down such a barrage of poisons on the surface of the earth without making it unfit for all life? They should not be called 'insecticides,' but 'biocides.'

- Most ecologists follow the precautionary principle regarding environmental issues
- The precautionary principle
  - Humans need to be concerned with how their actions affect the environment
    - "An ounce of prevention is worth a pound of cure."
    - Manage resources within the confines of uncertainty

precautionary principle

- Fisheries management
- Wildlife management

Wildlife photography - Ecotourism

- Concept 50.2: Interactions between organisms and the environment limit the distribution of species
- Ecologists
  - Have long recognized global and regional patterns of distribution of organisms within the biosphere

- Many naturalists
  - Began to identify broad patterns of distribution by naming biogeographic realms
    - We now associate these patterns with continental drift, and barriers such as mountain ranges and deserts

Figure 50.5

- Biogeography
  - Provides a good starting point for understanding what limits the geographic distribution of species

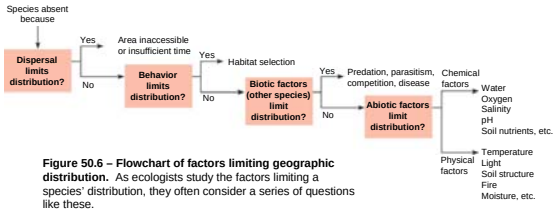


Figure 50.6 – Flowchart of factors limiting geographic distribution. As ecologists study the factors limiting a species' distribution, they often consider a series of questions like these.

Dispersal and Distribution

- Dispersal
  - Is the movement of individuals away from centers of high population density or from their area of origin
  - Contributes to the global distribution of organisms

Natural Range Expansions

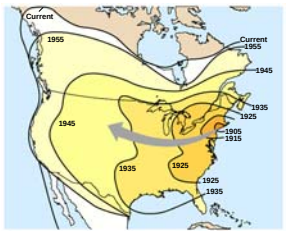
- Natural range expansions
  - Show the influence of dispersal on distribution

Example
(see page 1084)

Cattle egret

Starling expansion "acclimatization societies"

- Today, the starling range extends from Mexico to Alaska
- Their population is estimated at well over 100 million



Grizzly range: conflicts with livestock?

Figure 1. Current and Historic Grizzly Bear Distribution in North America

Species Transplants

•Species transplants (exotics, non-natives)

- Include organisms that are intentionally or accidentally relocated from their original distribution
- Can often disrupt the communities or ecosystems to which they have been introduced

Behavior and Habitat Selection

•Some organisms

- Do not occupy all of their potential range
- Species distribution in some cases
  - May be limited by habitat selection behavior – this kind of behavior is poorly understood but fairly well documented
    - E.g., European corn borer (insect) occur almost exclusively on corn because the egg depositing females are attracted by odors produced by the corn plant.

Biotic Factors

- Biotic factors that affect the distribution of organisms may include
  - Interactions with other species (some of the behaviors that affect habitat selection may be associated with this)
  - Predation
  - Competition

- A specific case of an herbivore limiting distribution of a food species

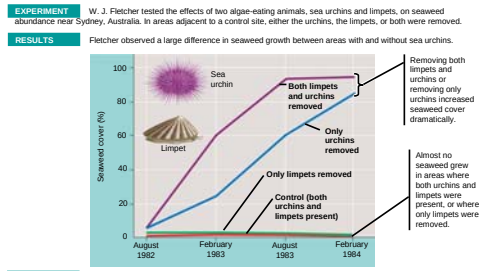


Figure 50.8

Abiotic Factors

- Abiotic factors that affect the distribution of organisms may include
  - Temperature
  - Water
  - Sunlight
  - Wind
  - Rocks and soil

Temperate and tropical rainforest nutrient cycling

Deforestation: logging in British Columbia

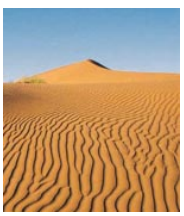
Deforestation: slash & burn agriculture - tropics

Temperature

- Environmental temperature
  - Is an important factor in the distribution of organisms because of its effects on biological processes
    - E.g., endothermic vs ectothermic organisms
    - E.g., mangroves vs salt marsh

Water

- Water availability among habitats
  - Is another important factor in species distribution



Sunlight

- Light intensity and quality
  - Can affect photosynthesis in ecosystems
- Light
  - Is also important to the development and behavior of organisms sensitive to the photoperiod

Peromyscus – white footed mouse

Regresses gonads during fall and regrows in spring – in response to photoperiod

Wind

- Wind
  - Amplifies the effects of temperature on organisms by increasing heat loss due to evaporation
  - Can change the morphology of plants

Figure 50.9

Rocks and Soil

- Many characteristics of soil limit the distribution of plants and thus the animals that feed upon them
  - Physical structure (e.g., sand, gravel, clay, loam, etc…)
  - pH
  - Mineral composition

Climate

- Climate
  - Is the prevailing weather conditions in a particular area
- Four major abiotic components make up climate
  - Temperature, water, sunlight, and wind

- Climate patterns can be described on two scales
  - ***Macroclimate***, patterns on the global, regional, and local level
  - ***Microclimate***, very fine patterns, such as those encountered by the community of organisms underneath a fallen log

Global Climate Patterns

- Earth's global climate patterns
  - Are determined largely by the input of solar energy and the planet's movement in space

- Sunlight intensity
  - Plays a major part in determining the Earth's climate patterns

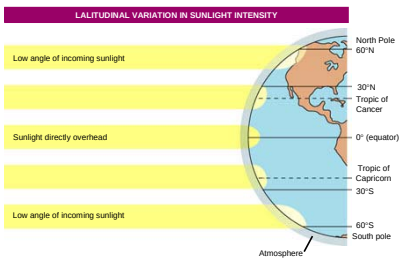


Figure 50.10

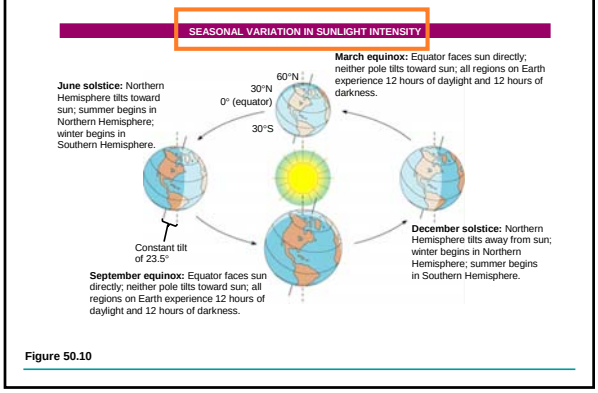
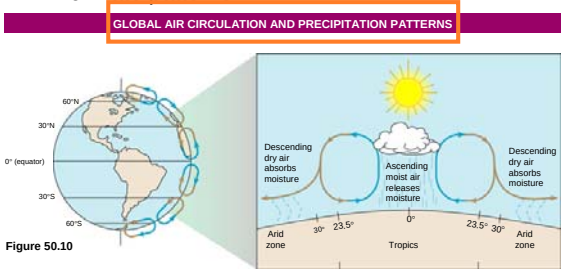


Figure 50.10

- Air circulation and wind patterns
  - Play major parts in determining the Earth's climate patterns



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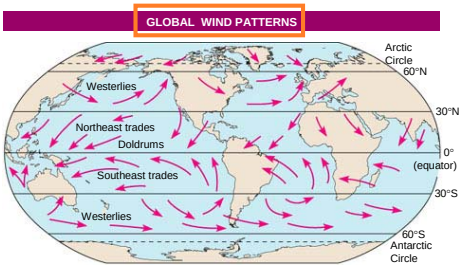


Figure 50.10

Regional, Local, and Seasonal Effects on Climate

- Various features of the landscape
  - Contribute to local variations in climate

Global climate is changing: the earth is warming

- Perennial sea ice decline

1979

2003

Credit: NASA Goddard Space Flight Center

Bodies of Water

- Oceans and their currents, and large lakes
  - Moderate the climate of nearby terrestrial environments

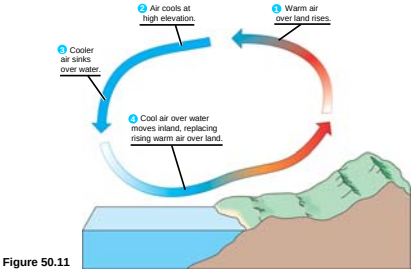


Figure 50.11

Mountains

- Mountains have a significant effect on
  - The amount of sunlight reaching an area
  - Local temperature
  - Rainfall

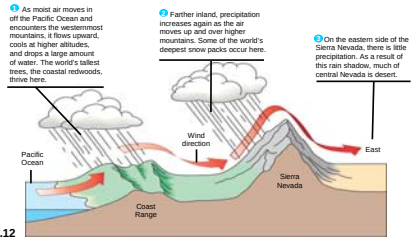
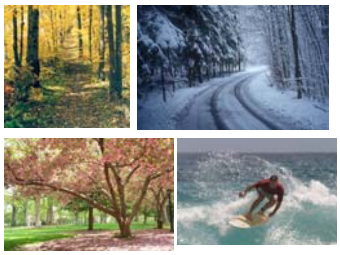
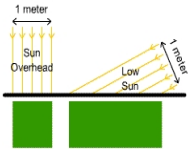


Figure 50.12

Seasonality

- The angle of the sun
  - Leads to many seasonal changes in local environments





The angle at which sunlight strikes the ground tells us how well it will heat the surface. Sunlight with a low angle (wintertime) spreads the same amount of energy over a much larger area, so it is not as efficient at heating the surface as when the Sun is higher in the sky.

- Lakes
  - Are sensitive to seasonal temperature change
  - Experience seasonal turnover
  - Thermoclines

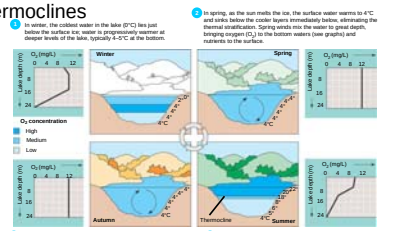


Figure 50.13

Microclimate

- Microclimate
  - Is determined by fine-scale differences in abiotic factors

Biomes

- Concept 50.3: Abiotic and biotic factors influence the structure and dynamics of aquatic biomes
- Varying combinations of both biotic and abiotic factors
  - Determine the nature of Earth's many biomes
- Biomes
  - Are the major types of ecological associations that occupy broad geographic regions of land or water

- The examination of biomes will begin with Earth's aquatic biomes

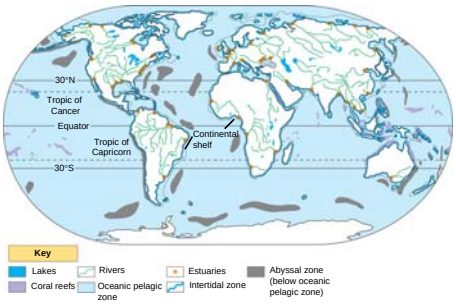
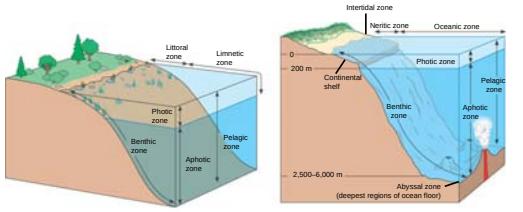


Figure 50.15

- Aquatic biomes
  - Account for the largest part of the biosphere in terms of area
  - Can contain fresh or salt water
- Oceans
  - Cover about 75% of Earth's surface
  - Have an enormous impact on the biosphere

- Many aquatic biomes
  - Are stratified into zones or layers defined by light penetration, temperature, and depth



(a) **Zonation in a lake.** The lake environment is generally classified on the basis of three physical criteria: light penetration (photic and aphotic zones), distance from shore and water depth (littoral and limnetic zones), and whether it is open water (pelagic zone) or bottom (benthic zone).

(b) **Marine zonation.** Like lakes, the marine environment is generally classified on the basis of light penetration (photic and aphotic zones), distance from shore and water depth (intertidal, neritic, and oceanic zones), and whether it is open water (pelagic zone) or bottom (benthic and abyssal zones).

Figure 50.16a, b

- Lakes

Oligotrophic lake - describes a lake or river with low productivity, deficient in plant nutrients, rich in oxygen throughout its depth and with good water clarity.

Eutrophic lake – lake or river is characterised by high productivity and biomass. It is rich in dissolved nutrients, often shallow and seasonally deficient in oxygen. This fertilization can be a natural process or one brought on by human activity, the latter often having a negative impact on the ecosystem.

LAKES

An oligotrophic lake in Grand Teton, Wyoming

A eutrophic lake in Okavango delta, Botswana

Figure 50.17

- Wetlands

"Wetlands" is a general term used to describe areas which are neither fully terrestrial nor fully aquatic. These areas range in character from the majestic cypress swamps of the southern United States to shallow, unimpressive depressions which hold water at most only a few weeks out of the year.
Wetlands are important for many reasons. Some provide critical habitat for migratory waterfowl, while others check flooding and siltation on our waterways. Some act as filters - removing and sequestering contaminants that might otherwise find their way into our drinking water, while others provide us with recreational opportunities such as fishing and boating.

WETLANDS

Figure 50.17 Okefenokee National Wetland Reserve in Georgia

- Streams and rivers

STREAMS AND RIVERS

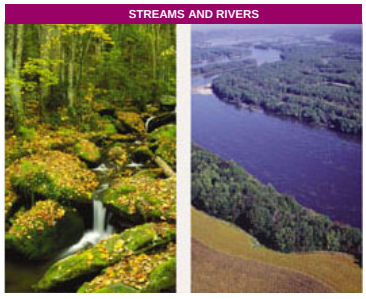


Figure 50.17 A headwater stream in the Great Smoky Mountains

The Mississippi River far form its headwaters

- Estuaries

ESTUARIES

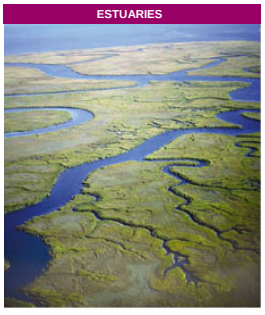


Figure 50.17 An estuary in a low coastal plain of Georgia

Where fresh and salt water mix!

How are estuaries valuable?

Can you name some estuaries in Florida?

- Intertidal zones

Figure 50.17 Rocky intertidal zone on the Oregon coast

- Oceanic pelagic biome

Figure 50.17 Open ocean off the island of Hawaii

- Coral reefs

Figure 50.17 A coral reef in the Red Sea

- Marine benthic zone

Figure 50.17 A deep-sea hydrothermal vent community

- Concept 50.4: Climate largely determines the distribution and structure of terrestrial biomes
- Climate
  - Is particularly important in determining why particular terrestrial biomes are found in certain areas

Climate and Terrestrial Biomes

- Climate has a great impact on the distribution of organisms, as seen on a climograph

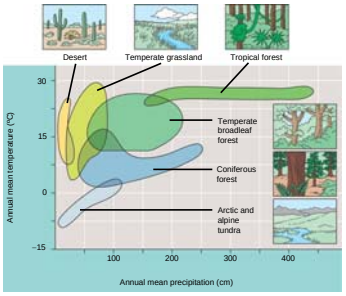


Figure 50.18

- The distribution of major terrestrial biomes

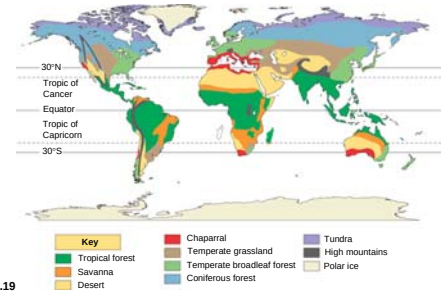


Figure 50.19

General Features of Terrestrial Biomes

- Terrestrial biomes
  - Are often named for major physical or climatic factors and for their predominant vegetation
- Vertical Stratification (plant life)
  - Is an important feature of terrestrial biomes

- Tropical forest
  - ~200-400 cm rain annually
  - Warm temps year around

Figure 50.20 A tropical rain forest in Borneo

- Desert
  - Generally <30 cm rain annually
  - Temp varies seasonally and daily

Figure 50.20 The Sonoran Desert in southern Arizona

- Savanna
  - ~30-50 cm rain annually
  - Warm temps year around

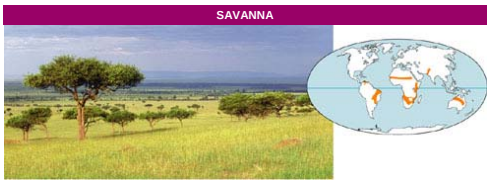


Figure 50.20 A typical savanna in Kenya

- Chaparral
  - ~30-50 cm rain annually…BUT long, dry summers
  - Cool winters, warm summers

Figure 50.20 An area of chaparral in California

- Temperate grassland
  - ~30-100 cm rain annually, with dry winters and wet summers
  - Very temperate

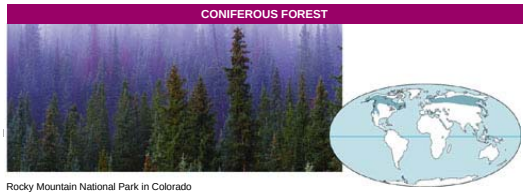
TEMPERATE GRASSLAND

Figure 50.20

Sheyenne National Grassland in North Dakota

- Coniferous forest
  - ~30-70 cm rain annually
    - Temperate Rain Forest = up to 300 cm annual rainfall
  - Very temperate

CONIFEROUS FOREST

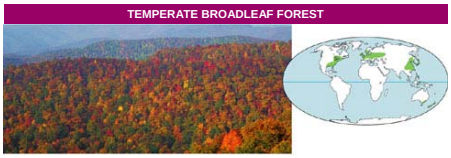


Rocky Mountain National Park in Colorado

- Temperate broadleaf forest
  - ~70-200+ cm rain annually
  - Very temperate

TEMPERATE BROADLEAF FOREST

Figure 50.20



Great Smoky Mountains National Park in North Carolina

- Tundra
  - ~20-60 cm annually…with over 100 cm in alpine tundra
  - Temps cold to cool

TUNDRA

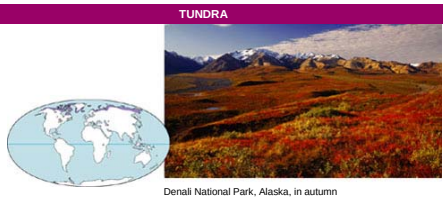


Figure 50.20

Denali National Park, Alaska, in autumn