

Climate and Biodiversity

Section 7-1

WHAT FACTORS INFLUENCE CLIMATE?

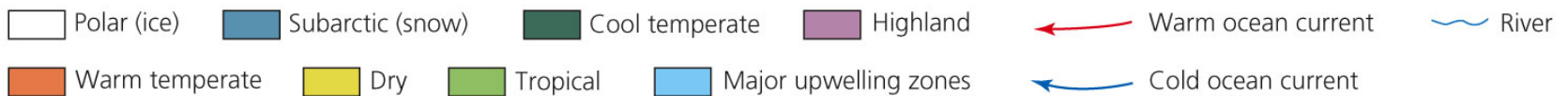
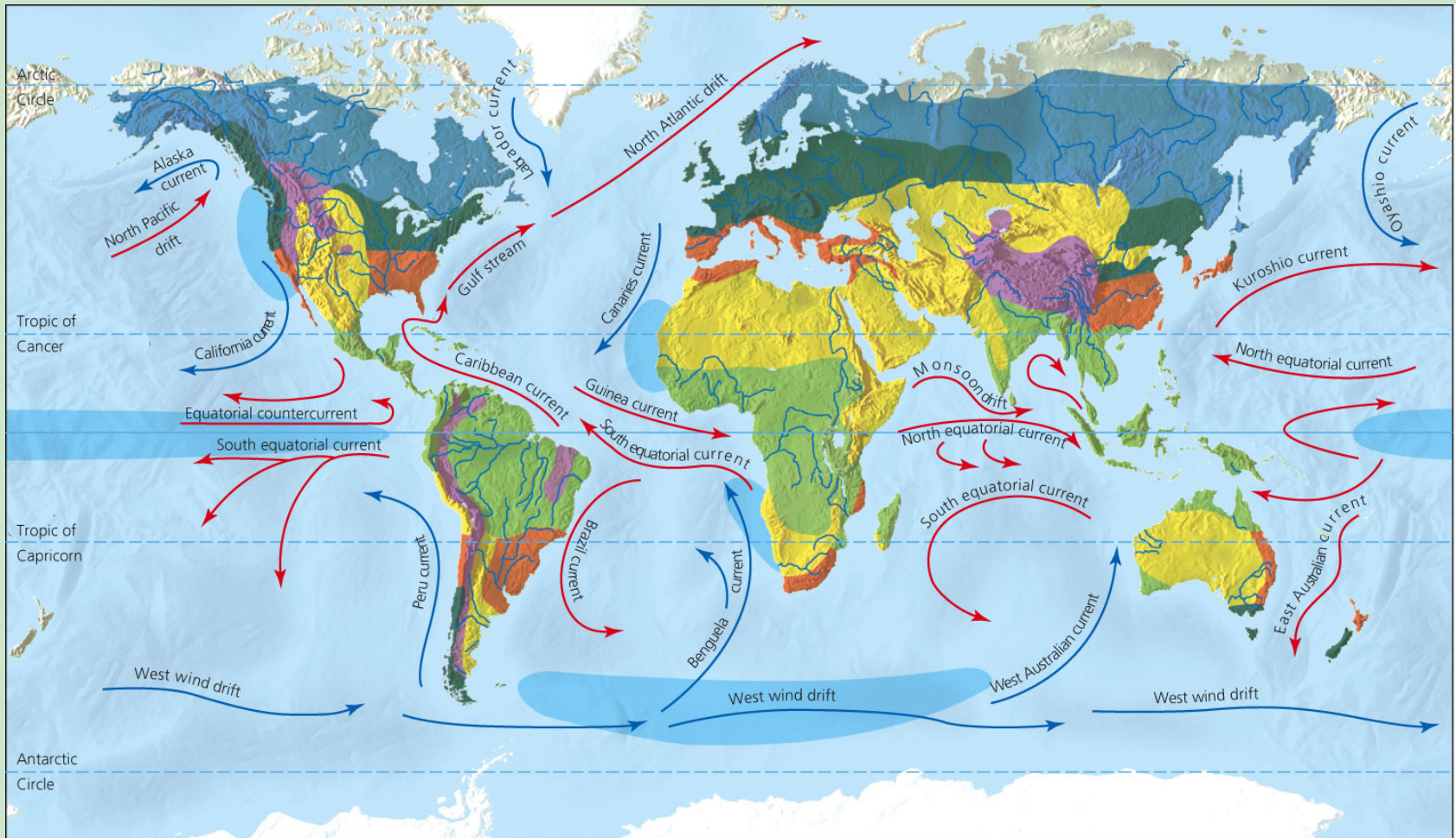
The earth has many different climates

- Weather is a set of physical conditions such as temperature, precipitation, humidity, wind, speed, cloud cover, and other factors in a given area for short periods of time.
- Climate is an area's general pattern of atmospheric conditions over periods ranging from 30 to thousands of years.
- Earth's current major climate zones and ocean currents are key components of the earth's natural capital.

The earth has many different climates

- Climate varies in different parts of the earth primarily because global air circulation and ocean currents distribute heat and precipitation unevenly between the tropics and other parts of the world.
- Three major factors determine how air circulates in the lower atmosphere:
 - Uneven heating of earth's surface by the sun.
 - Rotation of the earth on its axis.
 - Properties of air, water, and land.

Earth's climate zones, major ocean currents, and upwelling areas



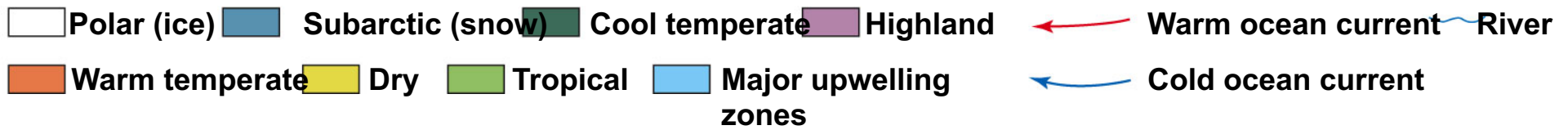
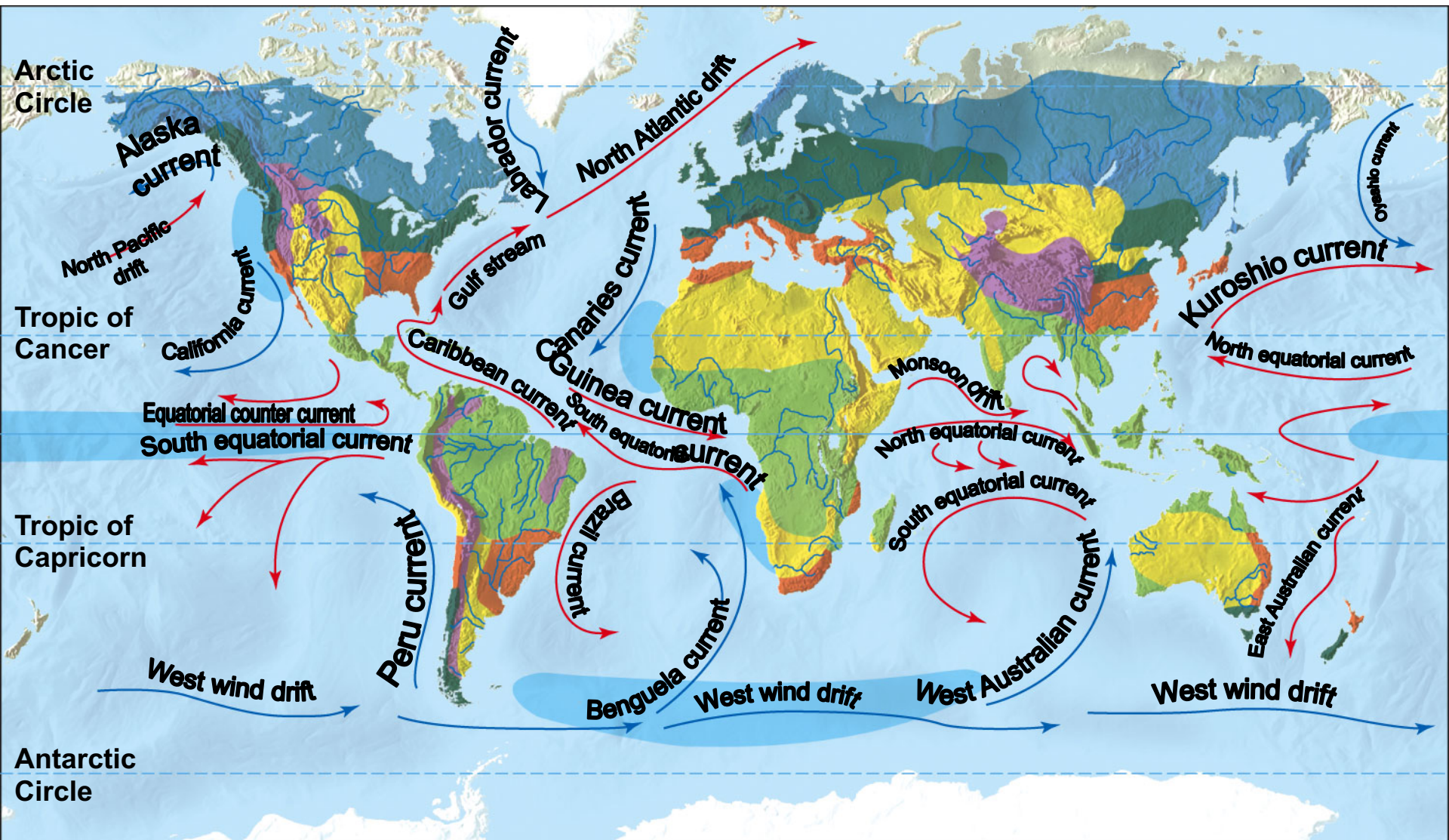
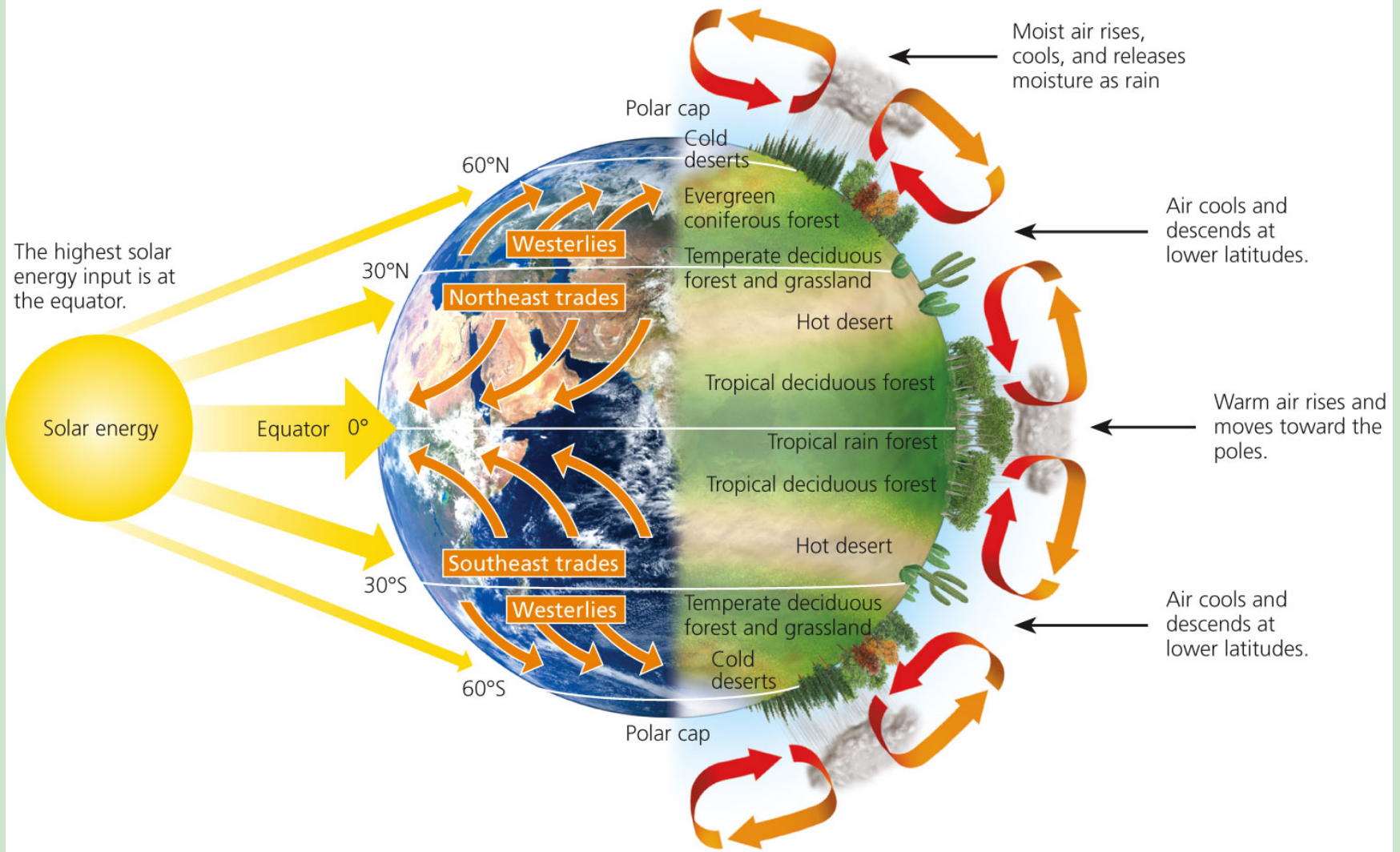


Fig. 7-2, p. 123

The earth has many different climates

- Prevailing winds blowing over the oceans produce mass movements of surface water called ocean currents. Major ocean currents help to redistribute heat from the sun, influencing climate and vegetation, especially near coastal areas.
- El Niño–Southern Oscillation, or ENSO—is an example of the interaction of land and air.
 - Large-scale weather phenomenon occurring every few years when prevailing winds in the tropical Pacific Ocean weaken and change direction.
 - Above-average warming of Pacific waters can affect populations of marine species by changing the distribution of plant nutrients.

Global air circulation



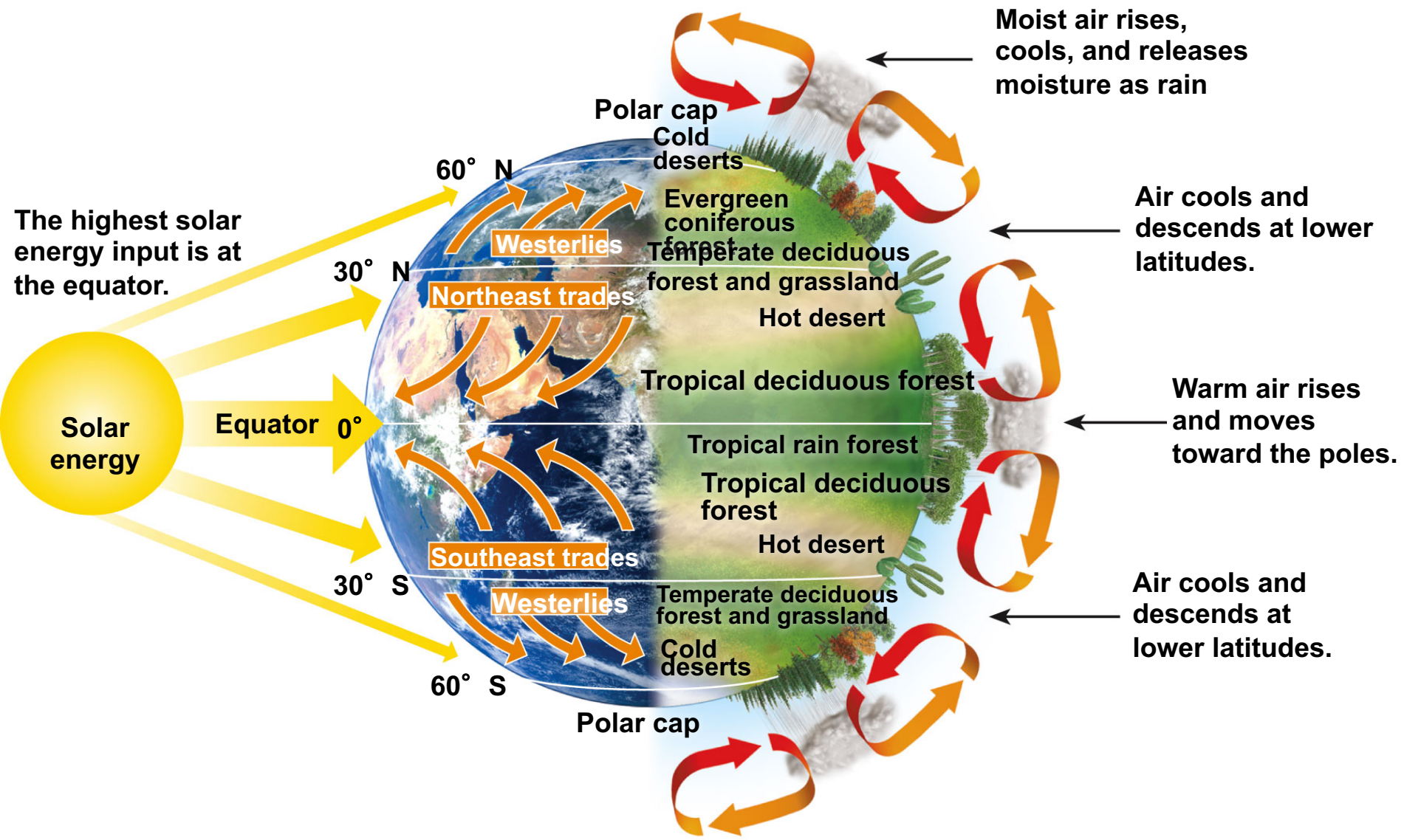
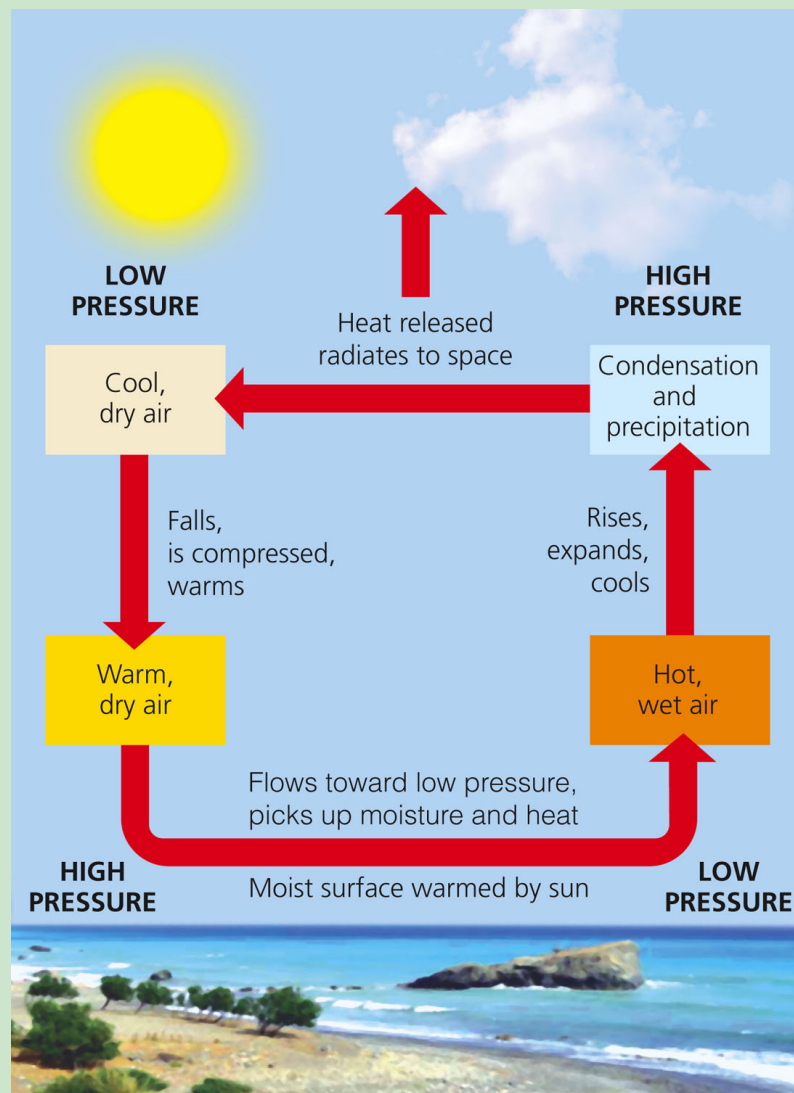


Fig. 7-3, p. 123

Energy is transferred by convection in the atmosphere



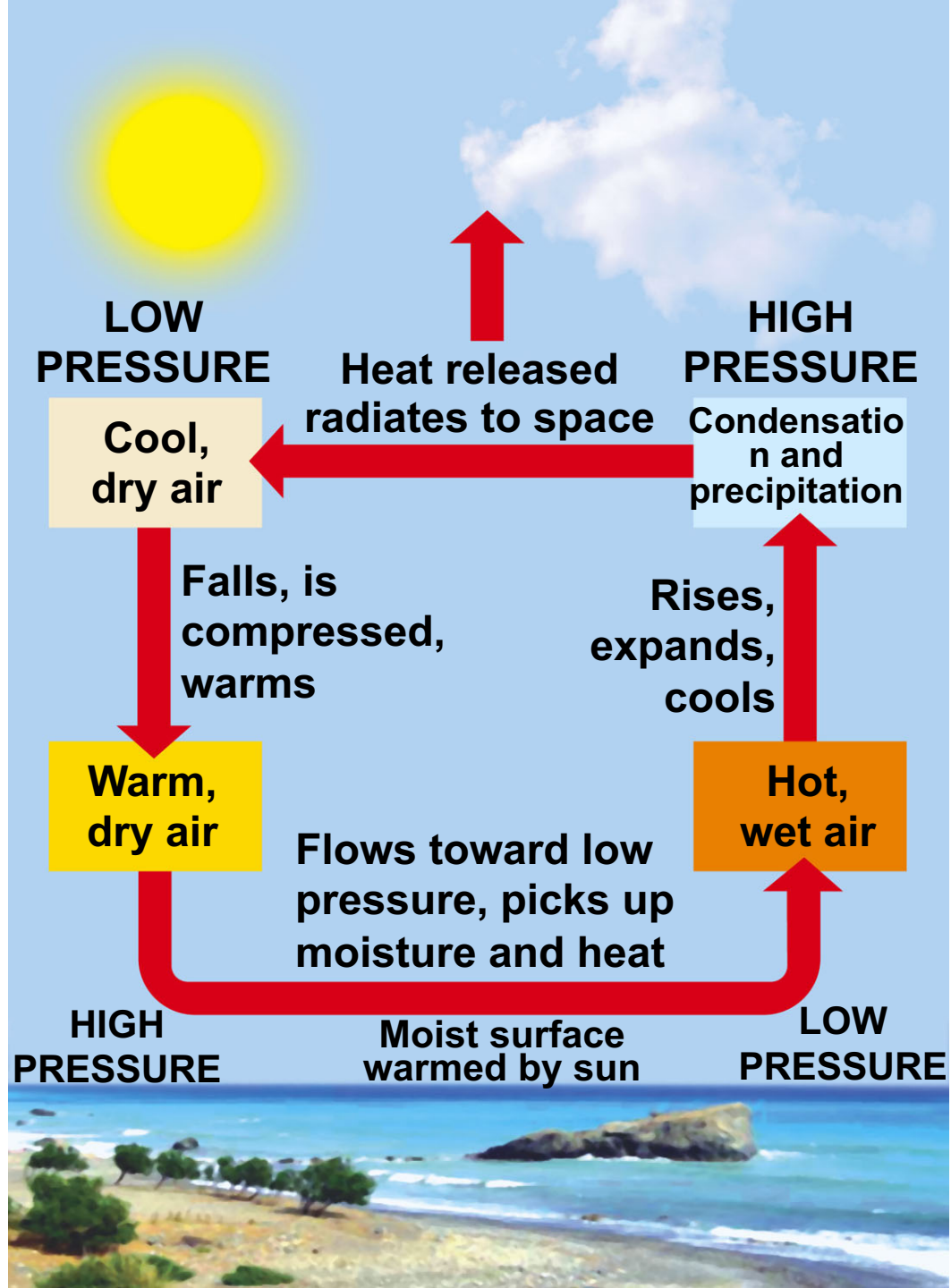
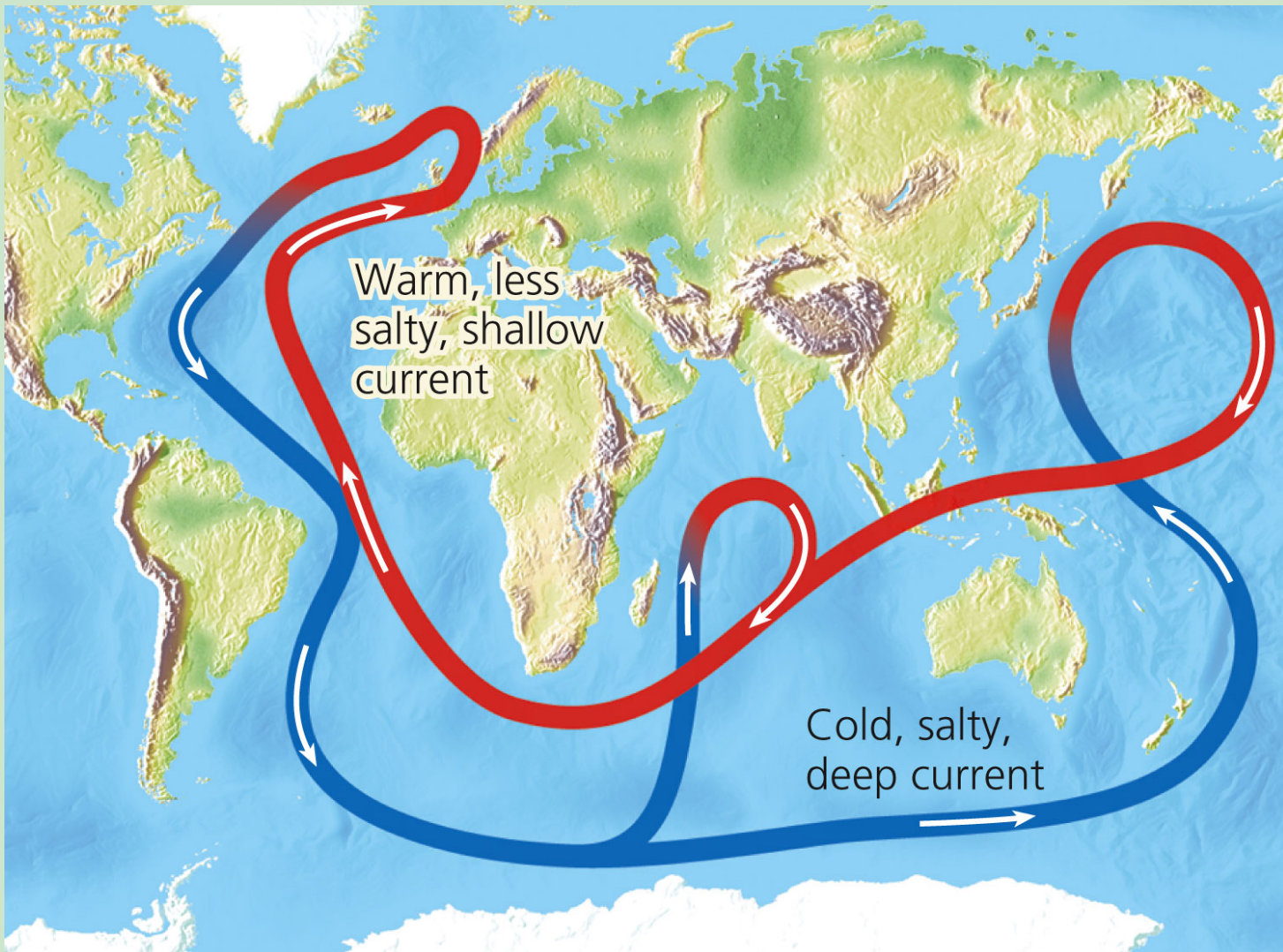


Fig. 7-4, p. 124

Deep and shallow ocean currents



Greenhouse gases warm the lower atmosphere

- Greenhouse gases absorb and release heat, which warms the atmosphere, influencing the earth's average temperatures and its climates.
- The major greenhouse gases are:
 - Water vapor (H_2O).
 - Carbon dioxide (CO_2).
 - Methane (CH_4).
 - Nitrous oxide (N_2O).

Greenhouse gases warm the lower atmosphere

- The natural greenhouse effect is a warming of the lower atmosphere and the earth's surface.
 - Some of the energy that the earth's surface absorbs from the sun is radiated into the atmosphere as heat.
 - Greenhouse gases absorbed some of this heat which warms the lower atmosphere, causing the greenhouse effect.

The earth's surface features affect local climates

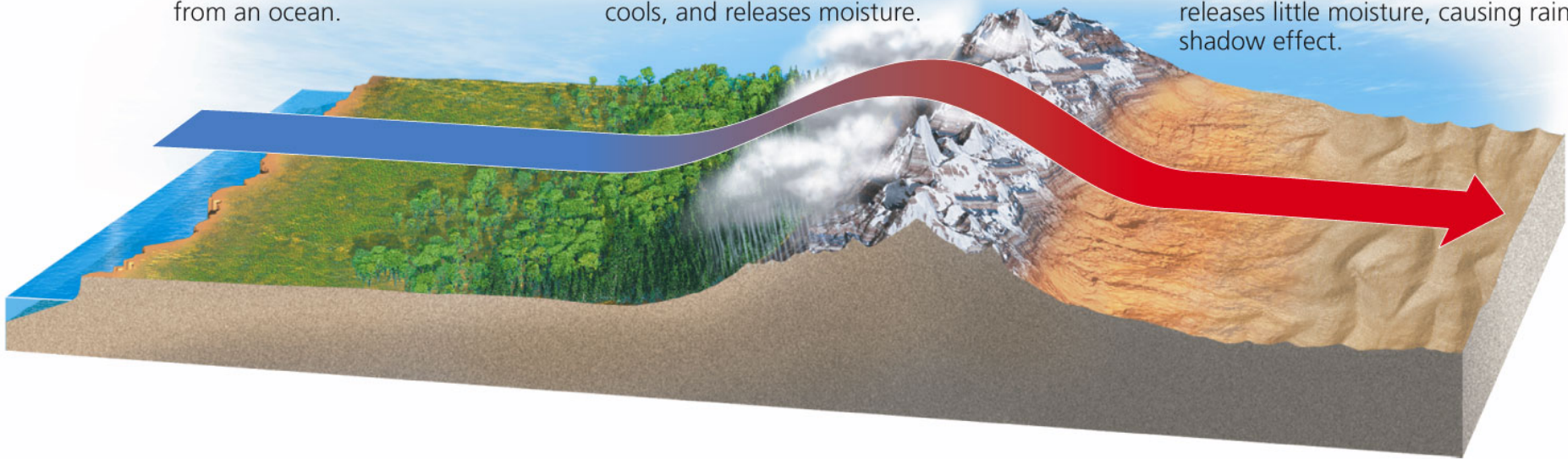
- Heat is absorbed and released more slowly by water than by land, creating land and sea breezes.
- Mountains interrupt the flow of prevailing surface winds and the movement of storms.
- High mountains create the rain shadow effect.
- Cities with bricks, asphalt, and traffic create distinct microclimates.

The rain shadow effect

Prevailing winds pick up moisture from an ocean.

On the windward side of a mountain range, air rises, cools, and releases moisture.

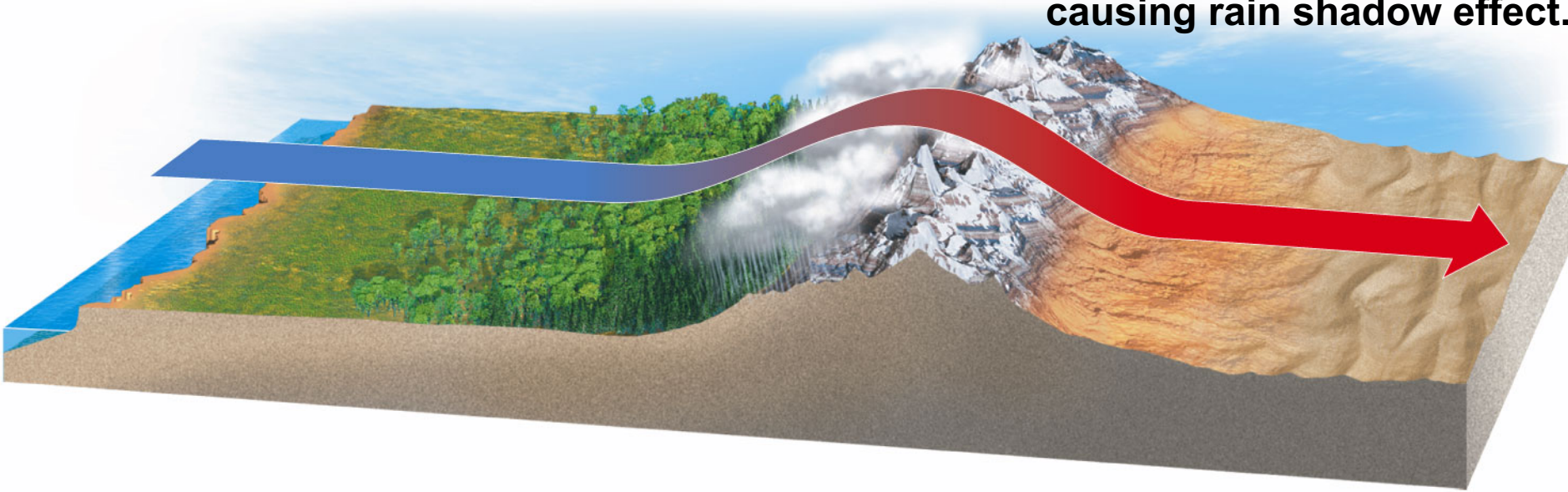
On the leeward side of the mountain range, air descends, warms, and releases little moisture, causing rain shadow effect.



Prevailing winds pick up moisture from an ocean.

On the windward side of a mountain range, air rises, cools, and releases moisture.

On the leeward side of the mountain range, air descends, warms, and releases little moisture, causing rain shadow effect.



**WHAT ARE THE MAJOR TYPES
OF AQUATIC SYSTEMS?**

Most of the earth is covered with water

- About 71% of the earth's surface is covered with salty ocean water.
- One global ocean, divided it into four large areas by geographers.
 - Atlantic Ocean.
 - Pacific Ocean.
 - The largest; contains more than half of the earth's water and covers one-third of the earth's surface.
 - Arctic Ocean.
 - Indian Ocean.

The ocean planet



Ocean hemisphere



Land-ocean hemisphere



Ocean hemisphere



Land-ocean hemisphere

Most of the earth is covered with water

- Aquatic life zones are the aquatic counterparts of biomes
- Distribution of aquatic organisms is determined largely by the water's salinity—the amounts of various salts such as sodium chloride (NaCl) dissolved in a given volume of water.
- Zones are classified into two major types:
 - Saltwater or marine life zones: Oceans and their bays, estuaries, and other coastal systems.
 - Freshwater life zones: Lakes, rivers, streams, and inland wetlands.

Most of the earth is covered with water

- Four major types of aquatic organisms:
 - Plankton are weakly swimming and free-floating. Types include:
 - Phytoplankton: photosynthesizers, includes many types of algae.
 - Zooplankton: plankton that feed on other plankton.
 - Ultraplankton: huge populations of photosynthetic bacteria.
 - Nekton are strong-swimming consumers such as fish, turtles, and whales.

Most of the earth is covered with water

- Benthos are bottom dwellers. Examples include:
 - Oysters, which anchor themselves to one spot.
 - Clams and some worms, which burrow into the bottom.
 - Lobsters and crabs, which walk on the sea floor.
- Decomposers (mostly bacteria), which break down organic compounds in the dead bodies and wastes of aquatic organisms.

Most of the earth is covered with water

- Key factors determining the type and number of organisms at various depths include:
 - Water temperature.
 - Dissolved oxygen content.
 - Availability of food.
 - Availability of light and nutrients required for photosynthesis.

Section 7-5

WHY ARE MARINE AQUATIC SYSTEMS IMPORTANT AND HOW HAVE WE AFFECTED THEM?

Marine ecosystems

Natural Capital

Marine Ecosystems

Ecological Services

Climate moderation

CO₂ absorption

Nutrient cycling

Waste treatment

Reduced storm impact
(mangroves, barrier islands,
coastal wetlands)

Habitats and nursery areas

Genetic resources and
biodiversity

Scientific information



Economic Services

Food

Animal and pet feed

Pharmaceuticals

Harbors and
transportation routes

Coastal habitats for
humans

Recreation

Employment

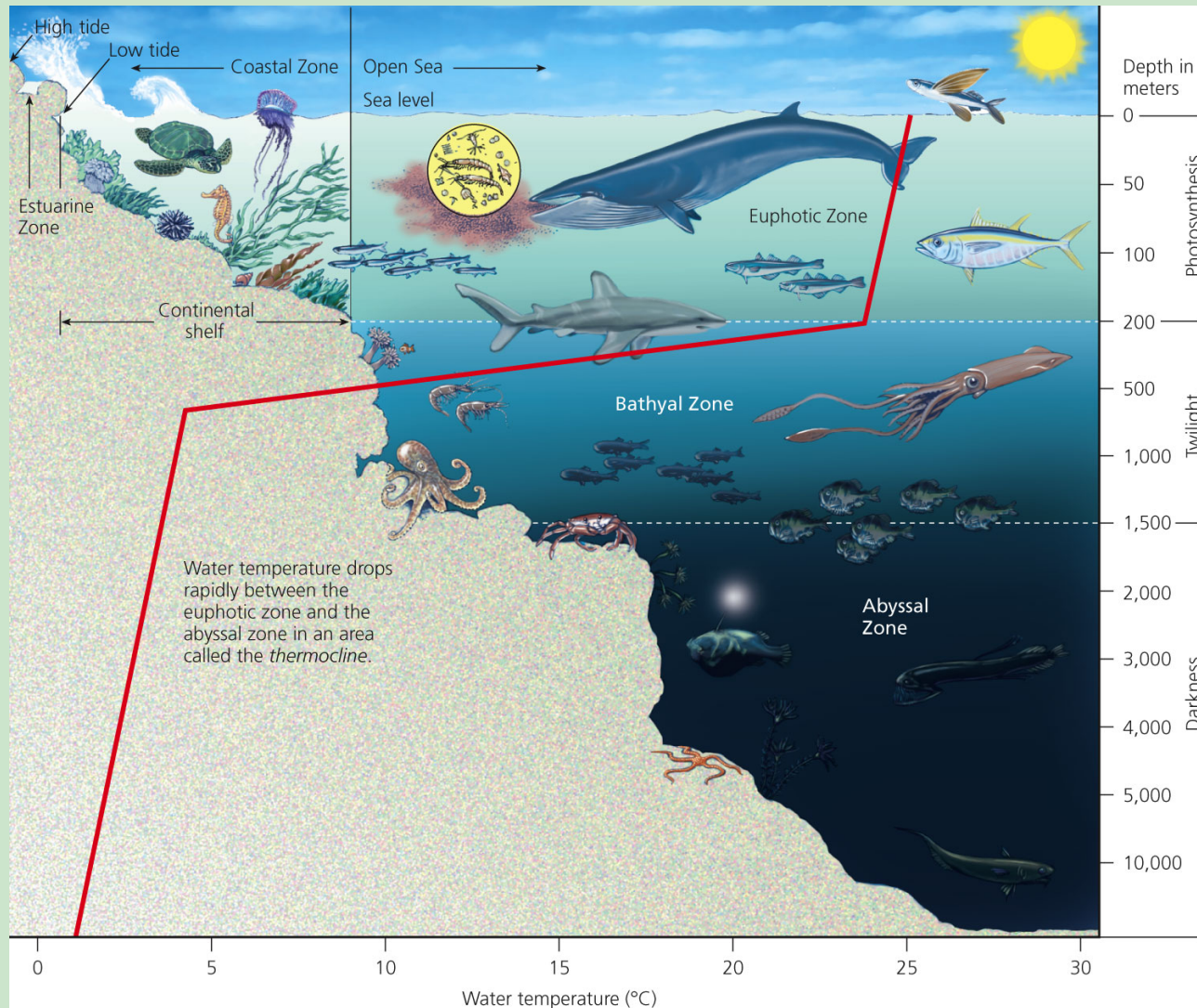
Oil and natural gas

Minerals

Oceans provide vital ecological and economic services

- Enormous reservoirs of biodiversity with three major life zones: The coastal zone, open sea and ocean bottom.
- The coastal zone
 - Warm, nutrient-rich, shallow water that extends from the high-tide mark on land to the edge of the continental shelf.
 - Makes up less than 10% of the world's ocean area while containing 90% of all marine species and is the site of most large commercial marine fisheries.
 - Have high net primary productivity due to ample sunlight and plant nutrients that flow from land.

Major life zones and vertical zones in an ocean



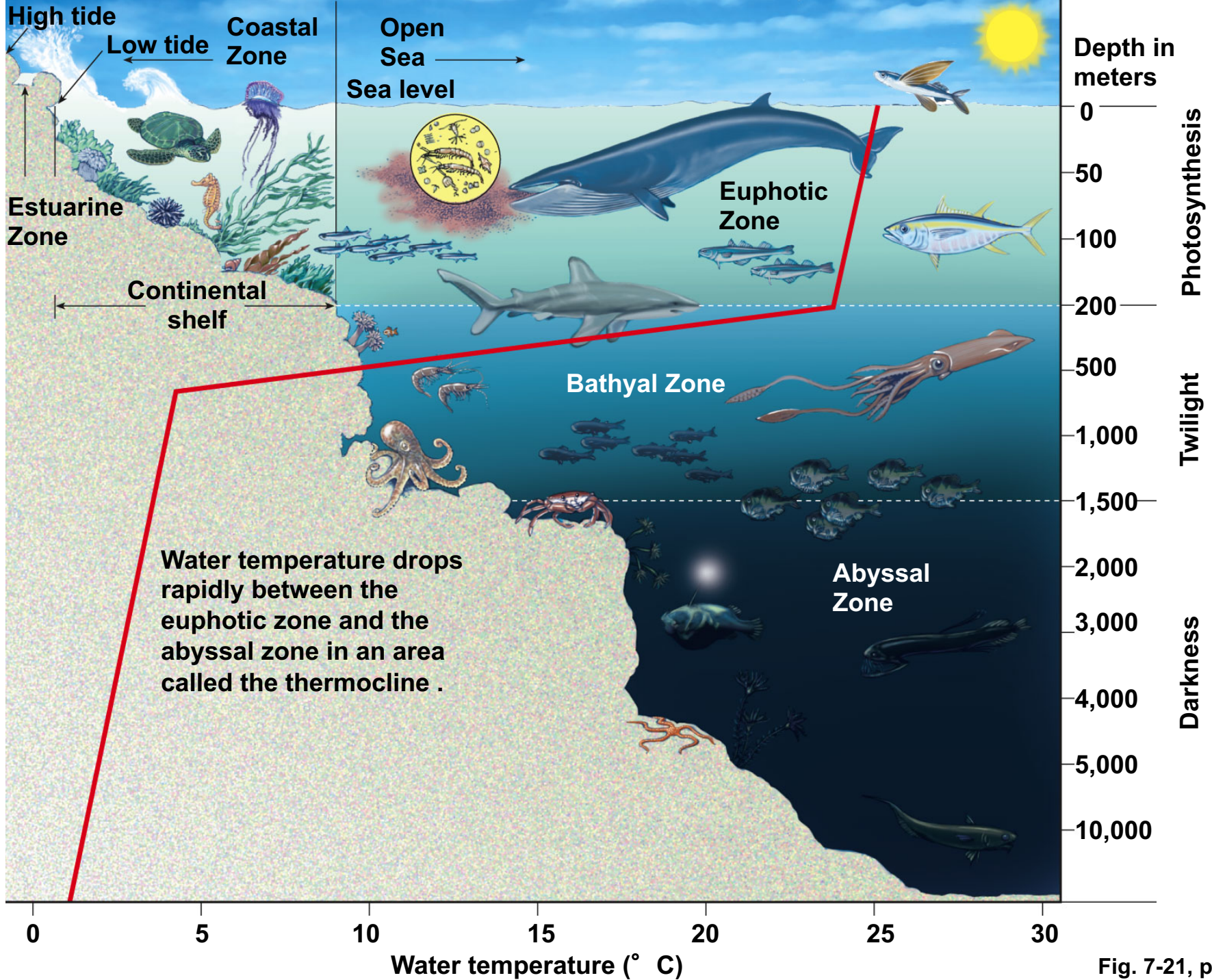


Fig. 7-21, p. 141

Estuaries and coastal wetlands are highly productive

- Estuaries are where rivers meet the sea, forming partially enclosed bodies of water where seawater mixes with freshwater as well as nutrients and pollutants from streams and runoff from the land.
- Associated coastal wetlands are areas covered with water all or part of the year.
 - Coastal wetlands are in temperate zones.
 - Mangrove forests are in tropical zones.
- Some of the earth's most productive ecosystems.

Estuaries and coastal wetlands are highly productive

- Sea grass beds consist of plants that grow underwater in shallow marine and estuarine areas along most continental coastlines.
- Coastal aquatic systems provide vital ecological and economic services such as:
 - Help maintain water quality in tropical coastal zones by filtering toxic pollutants, excess plant nutrients, and sediments, and by absorbing other pollutants.
 - Provide food, habitats, and nursery sites for a variety of aquatic and terrestrial species.
 - Reduce storm damage and coastal erosion by absorbing waves and storing excess water produced by storms and tsunamis.

Estuary in Madagascar



Coral reefs are storehouses of biodiversity

- Underwater structures that are built primarily of limestone and form in the clear, warm coastal waters of the tropics and subtropics.
- Highly productive ecosystems that are dazzling centers of biodiversity.
- Reefs form from massive colonies of polyps that secrete limestone.
- Coral reefs result from a mutually beneficial relationship between the polyps and single-celled algae called zooxanthellae that live in the tissues of the polyps.

Coral reefs are storehouses of biodiversity

- Ecological services provided by coral reefs include:
 - Act as natural barriers that help to protect 15% of the world's coastlines from erosion caused by waves and storms.
 - Provide habitats for about 25% of all marine organisms.
 - Produce about 10% of the global fish catch.
 - Provide fishing and ecotourism jobs for some of the world's poorest countries.

Coral reefs are storehouses of biodiversity

- Coral reefs are easily damaged because they grow slowly, are disrupted easily and require specific water conditions.
- Coral bleaching occurs when stresses such as increased temperature cause the symbiotic zooxanthellae to die. Without food, the coral polyps die, leaving behind a white skeleton of calcium carbonate.

A healthy coral reef and a bleached one



Coral reefs are storehouses of biodiversity

- Ocean water is becoming more acidic as it absorbs some of excess carbon dioxide from the atmosphere. The CO_2 reacts with ocean water to form a weak acid, which can slowly dissolve the calcium carbonate that makes up the corals.
- Almost 45–53% of the world's shallow coral reefs have been destroyed or degraded by coastal development, pollution, overfishing, warmer ocean temperatures, increasing ocean acidity, and other stresses.

The open sea and the ocean floor host a variety of species

- The open sea occurs beyond the edge of the continental shelf and is divided into three vertical zones largely on the basis of the penetration of sunlight.
 - The euphotic zone is the brightly lit upper zone, where drifting phytoplankton carry out about 40% of the world's photosynthetic activity.
 - The bathyal zone is the middle zone, which gets little sunlight and therefore does not contain photosynthesizing producers.
 - The lowest zone, called the abyssal zone, is dark and very cold; it has little dissolved oxygen.

Human activities are disrupting and degrading marine ecosystems

- About 45% of the world's population and more than half of the U.S. population live along or near coasts.
- Major threats to marine systems from human activities include:
 - Coastal development, which destroys and pollutes coastal habitats.
 - Runoff of nonpoint source pollution such as fertilizers, pesticides, and livestock.
 - Point-source pollution such as sewage from passenger cruise ships and spills from oil tankers.

Human activities are disrupting and degrading marine ecosystems

- Overfishing, which depletes populations of commercial fish species.
- Use of trawler fishing boats, which drag weighted nets across the ocean bottom and destroy habitats.
- Invasive species, some introduced by humans, that can out compete populations of native aquatic species and cause economic damage.
- Climate change which is warming the oceans and making them more acidic; this could cause a rise in sea levels during this century that would destroy coral reefs and flood coastal marshes and coastal cities.

Major threats to marine ecosystems by humans

Natural Capital Degradation

Major Human Impacts on Marine Ecosystems and Coral Reefs

Marine Ecosystems



Half of coastal wetlands lost to agriculture and urban development

Over one-fifth of mangrove forests lost to agriculture, development, and shrimp farms since 1980

Beaches eroding because of coastal development and rising sea levels

Ocean bottom habitats degraded by dredging and trawler fishing

At least 20% of coral reefs severely damaged and 25–33% more threatened

Coral Reefs



Ocean warming

Rising ocean acidity

Soil erosion

Algae growth from fertilizer runoff

Bleaching

Rising sea levels

Increased UV exposure

Damage from anchors

Damage from fishing and diving

Section 7-6

**WHAT ARE THE MAJOR TYPES
OF FRESHWATER SYSTEMS AND
HOW HAVE HUMAN ACTIVITIES
AFFECTED THEM?**

Water stands in some freshwater systems and flows in others

- Freshwater life zones include standing bodies of freshwater such as lakes, ponds, and inland wetlands, and flowing (lotic) systems such as streams and rivers.
- Lakes are large natural bodies of standing freshwater formed when precipitation, runoff, streams and rivers, and groundwater seepage fill depressions.
- Oligotrophic (poorly nourished) lakes have a small supply of plant nutrients, causing them to look crystal clear.

Water stands in some freshwater systems and flows in others

- Eutrophic (well-nourished) lakes have a large supply of nutrients needed by producers, causing them to have high productivity and look murky brown or green.
- Cultural eutrophication occurs when human inputs of nutrients from the atmosphere and from nearby urban and agricultural areas accelerate eutrophication.

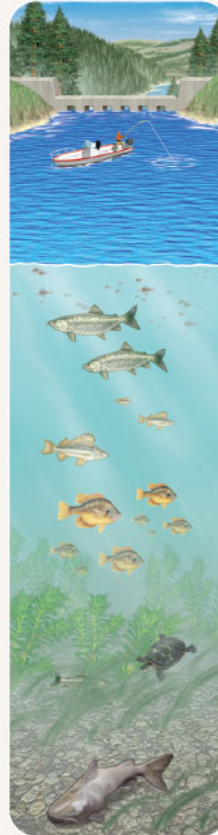
Freshwater systems provide many important services

Natural Capital

Freshwater Systems

Ecological Services

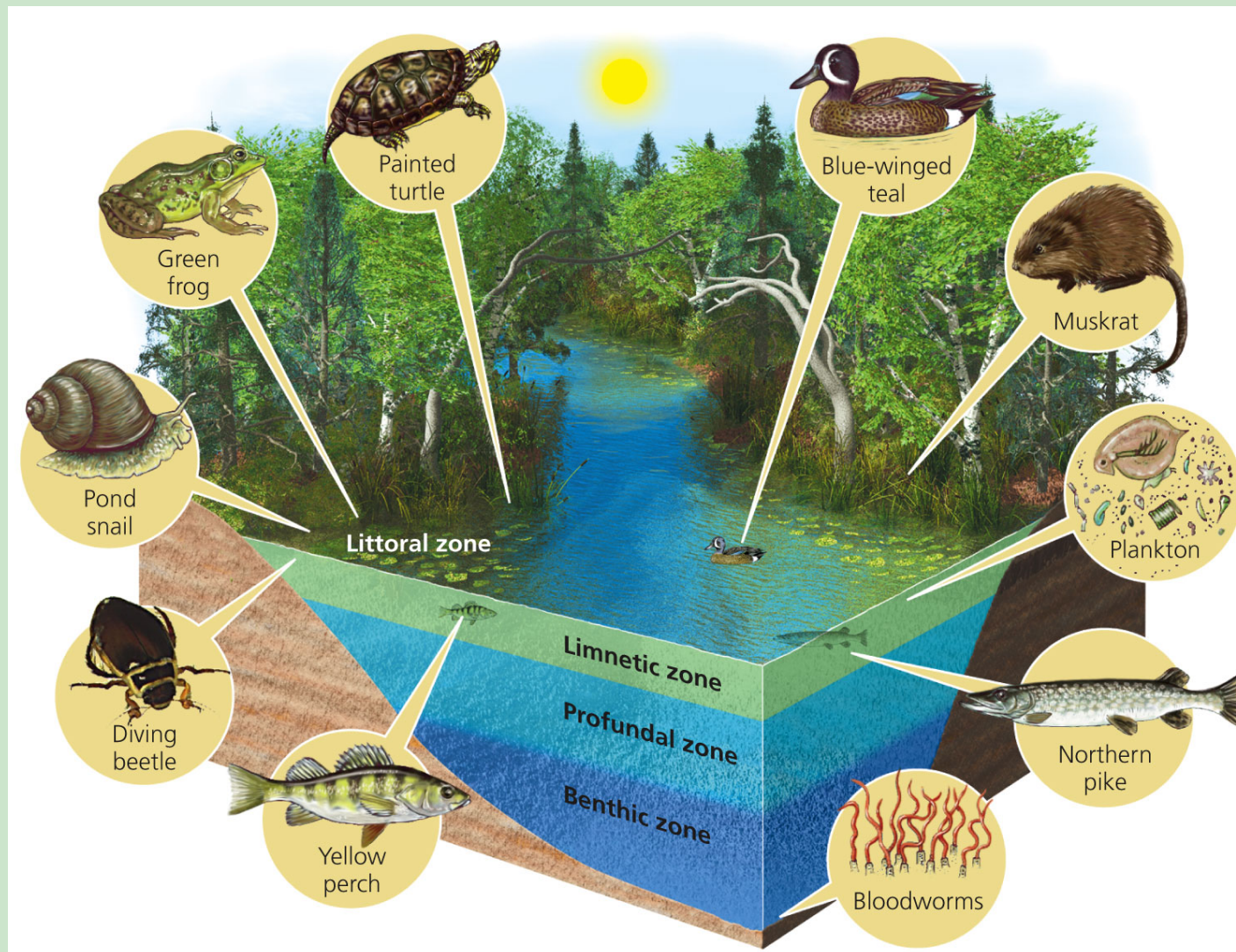
Climate moderation
Nutrient cycling
Waste treatment
Flood control
Groundwater recharge
Habitats for many species
Genetic resources and biodiversity
Scientific information



Economic Services

Food
Drinking water
Irrigation water
Hydroelectricity
Transportation corridors
Recreation
Employment

Typical distinct zones of life in fairly deep temperate-zone lakes



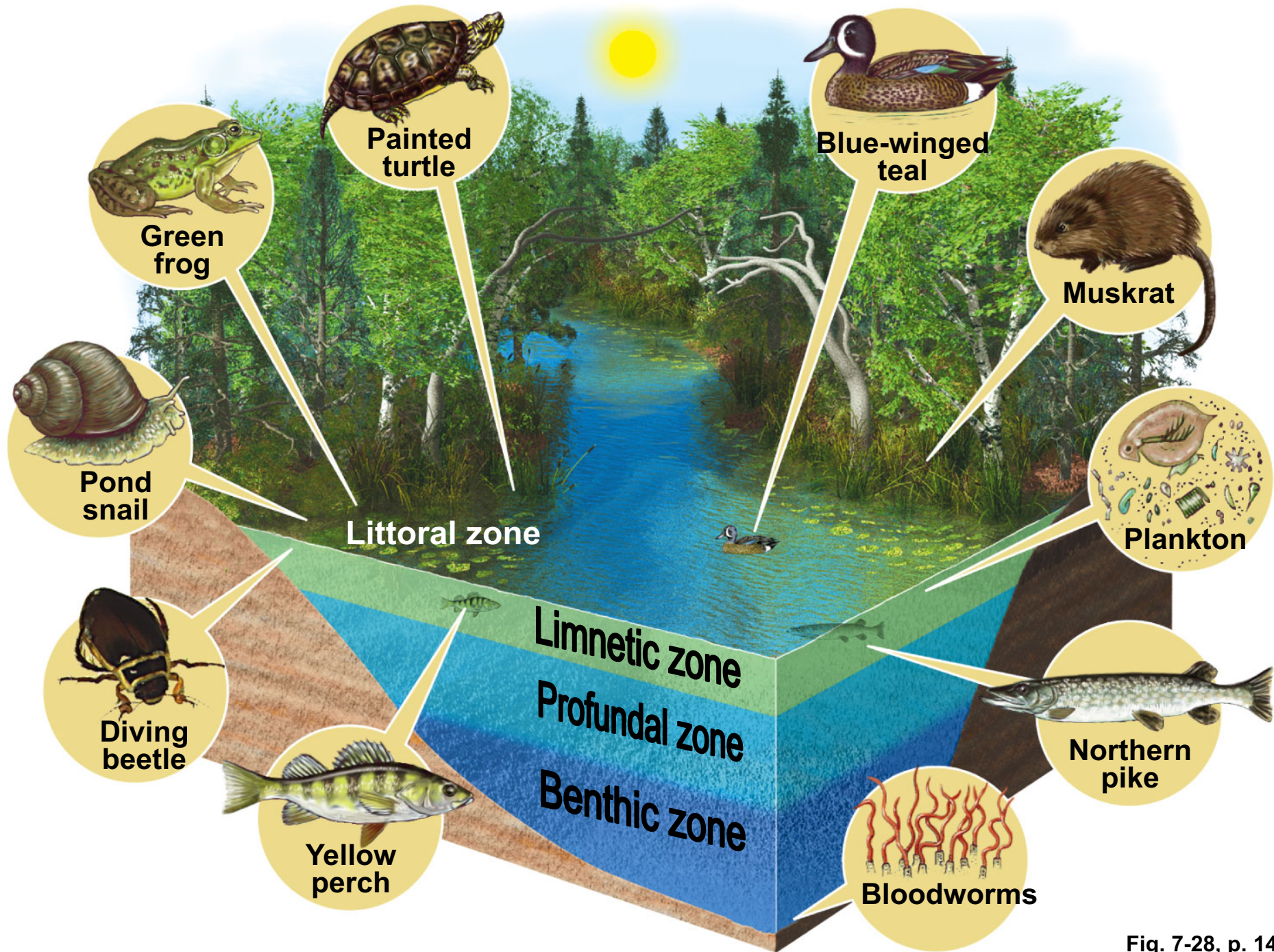


Fig. 7-28, p. 146

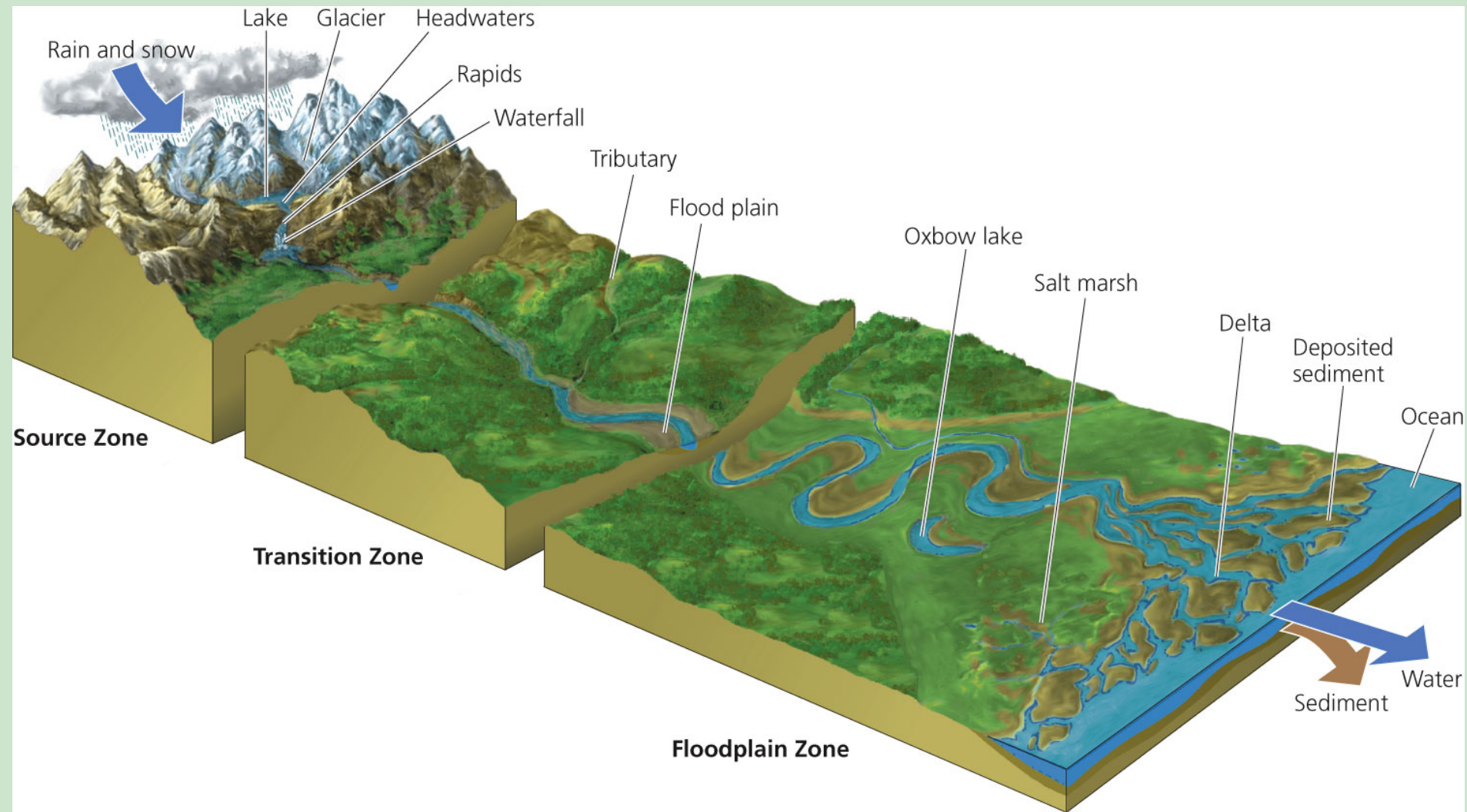
The effect of nutrient enrichment on a lake



Freshwater streams and rivers carry water from the mountains to the oceans

- Surface water becomes runoff when it flows into streams or lakes.
- A watershed, or drainage basin, is the land area that delivers runoff, sediment, and dissolved substances to a stream or lake.
- The downward flow of water from mountain highlands to the sea typically takes place in three aquatic life zones characterized by different environmental conditions:
 - The source zone, the transition zone, and the floodplain zone.

Three zones in the downward flow of water



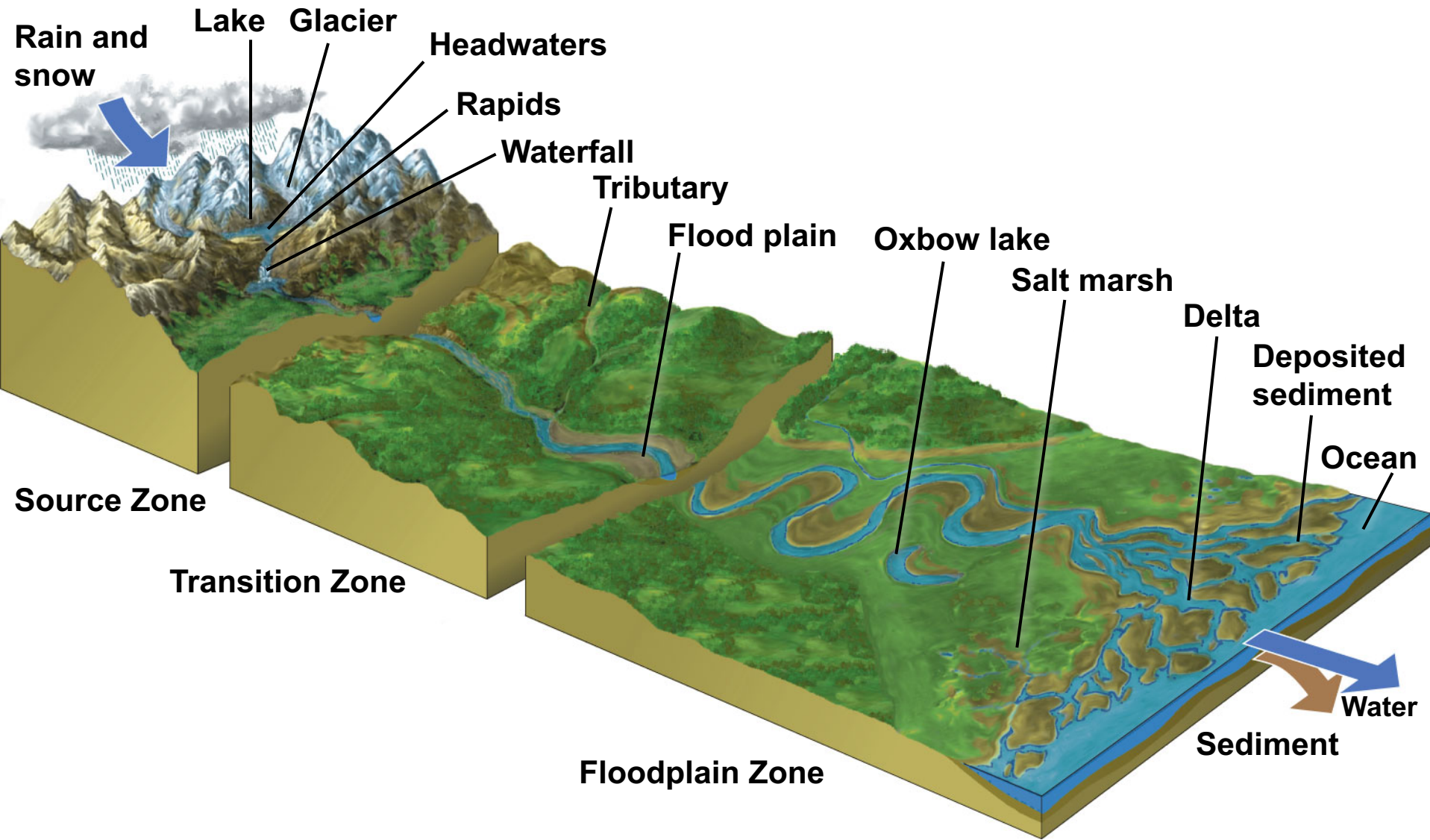


Fig. 7-30, p. 147

Freshwater inland wetlands are vital sponges

- Inland wetlands are lands covered with freshwater all or part of the time and located away from coastal areas.
 - Marshes (mainly grasses, reeds, and few trees).
 - Swamps (dominated by trees and shrubs).
 - Prairie potholes (depressions carved out by ancient glaciers).
 - Floodplains (receive excess water during heavy rains and floods).
 - Seasonal wetlands (remain under water or are soggy for only a short time each year).
 - Arctic tundra (wet in summer).

Freshwater inland wetlands are vital sponges

- Inland wetlands provide a number of free ecological and economic services, which include:
 - Filtering and degrading toxic wastes and pollutants.
 - Reducing flooding and erosion by absorbing storm water and releasing it slowly, and by absorbing overflows from streams and lakes.
 - Maintaining stream flows during dry periods.
 - Helping to recharge groundwater aquifers

Freshwater inland wetlands are vital sponges

- Helping to maintain biodiversity by providing habitats for a variety of species,
- Supplying valuable products such as fishes and shellfish, blueberries, cranberries, wild rice, and timber, and
- Providing recreation for birdwatchers, nature photographers, boaters, anglers, and waterfowl hunters.

Human activities are disrupting and degrading freshwater systems

- Dams and canals alter and destroy terrestrial and aquatic wildlife habitats along rivers and in their coastal deltas and estuaries by reducing water flow and increasing damage from coastal storms.
- Flood control levees and dikes built along rivers disconnect the rivers from their floodplains, destroy aquatic habitats, and alter or reduce the functions of nearby wetlands.
- Cities and farms add pollutants and excess plant nutrients to nearby streams, rivers, and lakes. This can cause explosions in the populations of algae and cyanobacteria, which deplete the lake's dissolved oxygen. Fishes and other species may then die off, which causes a major loss in biodiversity.

Human activities are disrupting and degrading freshwater systems

- Many inland wetlands have been drained or filled to grow crops or have been covered with concrete, asphalt, and buildings.
- More than 50% of the inland wetlands in the continental United States have been lost which has increased flood damage in the United States.

Three big ideas

- Differences in climate, based mostly on long-term differences in average temperature and precipitation, largely determine the types and locations of the earth's deserts, grasslands, and forests.
- Saltwater and freshwater aquatic systems cover almost three-fourths of the earth's surface, and oceans dominate the planet.
- The earth's terrestrial and aquatic systems provide important ecological and economic services, which are being degraded and disrupted by human activities.