MILLER/SPOOLMAN

LIVING IN THE ENVIRONMENT

17TH

Chapter 9

Sustaining Biodiversity:
The Species Approach

Core Case Study: Polar Bears and Global Warming

- 20,000-25,000 in the Arctic
- Most calories in winter from seals on sea ice
- Environmental impact on polar bears
  - Less summer sea ice from global warming
  - Could be gone from wild by 2100
- 2008: Threatened species list

Polar Bear with Seal Prey

Fig. 9-1, p. 190

9-1 What Role Do Humans Play in the Extinction of Species?

- ***Concept 9-1*** *Species are becoming extinct 100 to 1,000 times faster than they were before modern humans arrived on the earth (the background rate), and by the end of this century, the extinction rate is expected to be 10,000 times the background rate.*

Extinctions Are Natural but Sometimes They Increase Sharply (1)

- **Biological extinction**
  - No species member alive
- **Background extinction**
  - Natural low rate of extinction
- **Extinction rate**
  - Percentage or number of species that go extinct in a certain time period

Extinctions Are Natural but Sometimes They Increase Sharply (2)

- **Mass extinction**
  - 3-5 events
  - 50-95% of species became extinct
  - From global changes in environmental conditions: major climate change, volcanoes, asteroid impacts

- Levels of species extinction
  - Local extinction
  - Ecological extinction
  - Biological extinction

Some Human Activities Are Causing Extinctions

- Human activity has disturbed at least half of the earth's land surface
  - Fills in wetlands
  - Converts grasslands and forests to crop fields and urban areas
  - Pollution of land and water

Extinction Rates Are Rising Rapidly (1)

- Current extinction rate is at least 100 times higher than typical background rate of .0001%

- Will rise to 10,000 times the background rate by the end of the century
  - Rate will rise to 1% per year
  - ¼ to ½ of the world's plant and animal species

Extinction Rates Are Rising Rapidly (2)

- Conservative estimates of extinction = 0.01-1.0%
  - Growth of human population will increase this loss
  - Rates are higher where there are more endangered species
  - Tropical forests and coral reefs, wetlands and estuaries—sites of new species—being destroyed

- Speciation crisis

Endangered and Threatened Species Are Ecological Smoke Alarms (1)

- **Endangered species**
  - So few members that the species could soon become extinct

- **Threatened species** (vulnerable species)
  - Still enough members to survive, but numbers declining -- may soon be endangered

Endangered and Threatened Species Are Ecological Smoke Alarms (2)

- Characteristics
  - Big
  - Slow
  - Tasty
  - Valuable parts
  - Behaviors that make them easy to kill

Endangered Natural Capital: Species Threatened with Premature Extinction

Fig. 9-2, p. 193

Endangered Natural Capital: Species Threatened with Premature Extinction

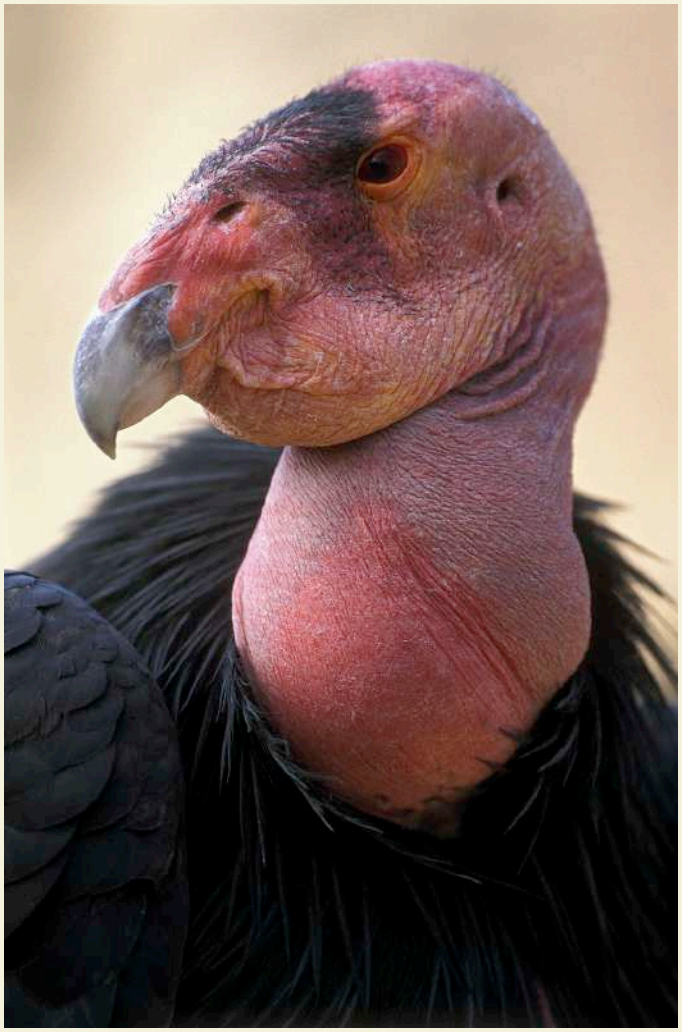

Fig. 9-2, p. 193

Characteristics of Species That Are Prone to Ecological and Biological Extinction

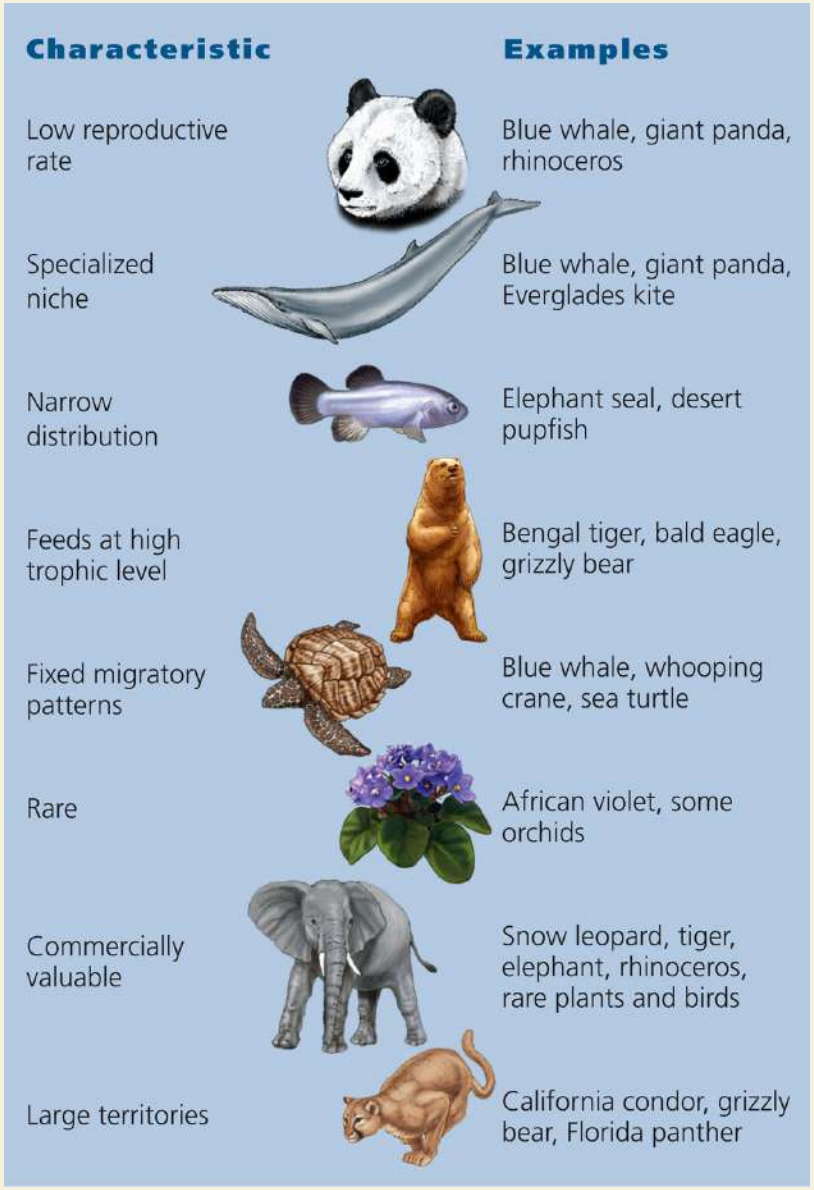

Fig. 9-3, p. 194

Characteristic	Examples
Low reproductive rate	Blue whale, giant panda, rhinoceros
Specialized niche	Blue whale, giant panda, Everglades kite
Narrow distribution	Elephant seal, desert pupfish
Feeds at high trophic level	Bengal tiger, bald eagle, grizzly bear
Fixed migratory patterns	Blue whale, whooping crane, sea turtle
Rare	African violet, some orchids
Commercially valuable	Snow leopard, tiger, elephant, rhinoceros, rare plants and birds
Large territories	California condor, grizzly bear, Florida panther

Fig. 9-3, p. 194

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Stepped Art

Fig. 9-3, p. 194

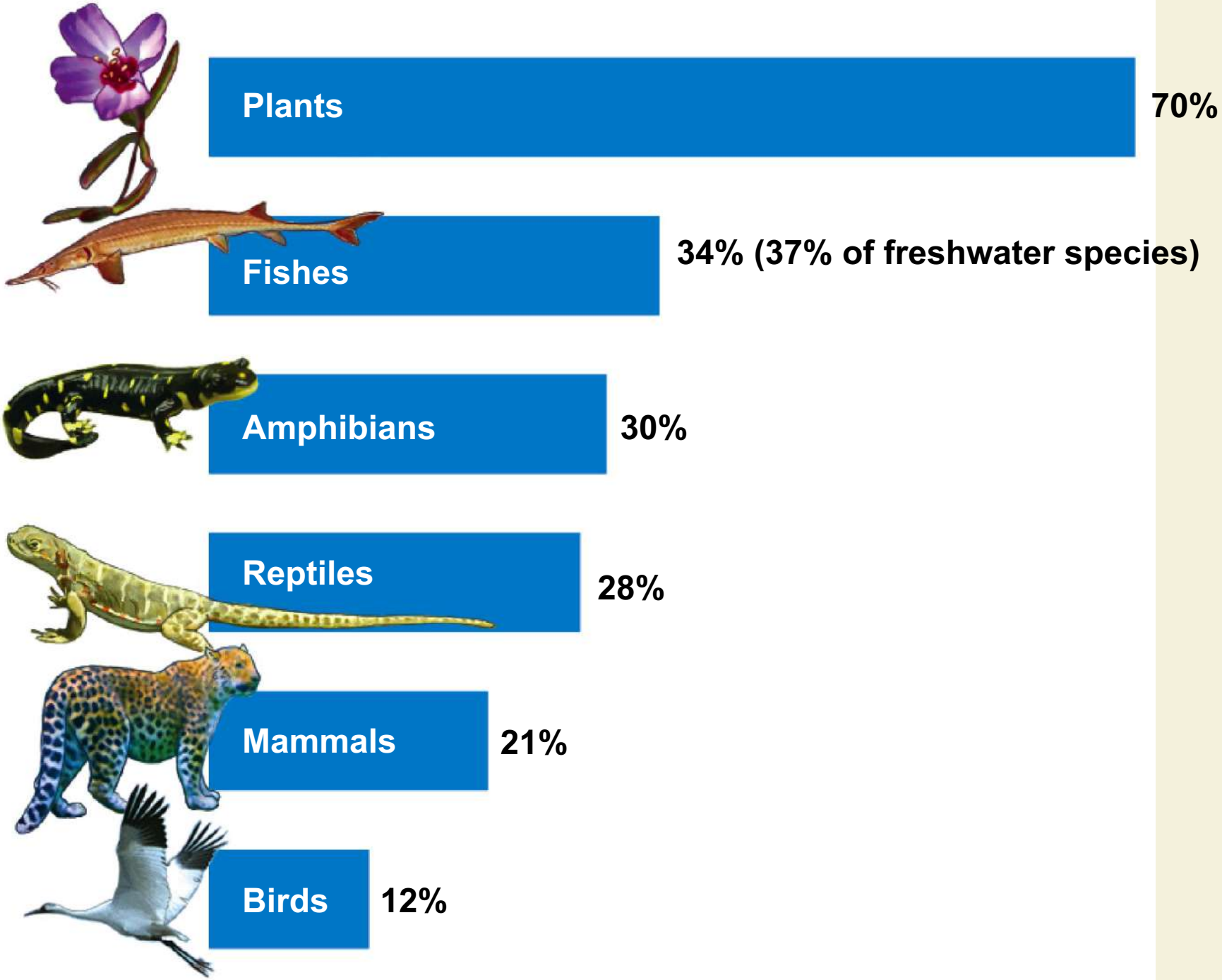

Plants
70%
Fishes
34% (37% of freshwater species)
Amphibians
30%
Reptiles
28%
Mammals
21%
Birds
12%

Fig. 9-4, p. 194

Percentage of Various Species Threatened with Premature Extinction

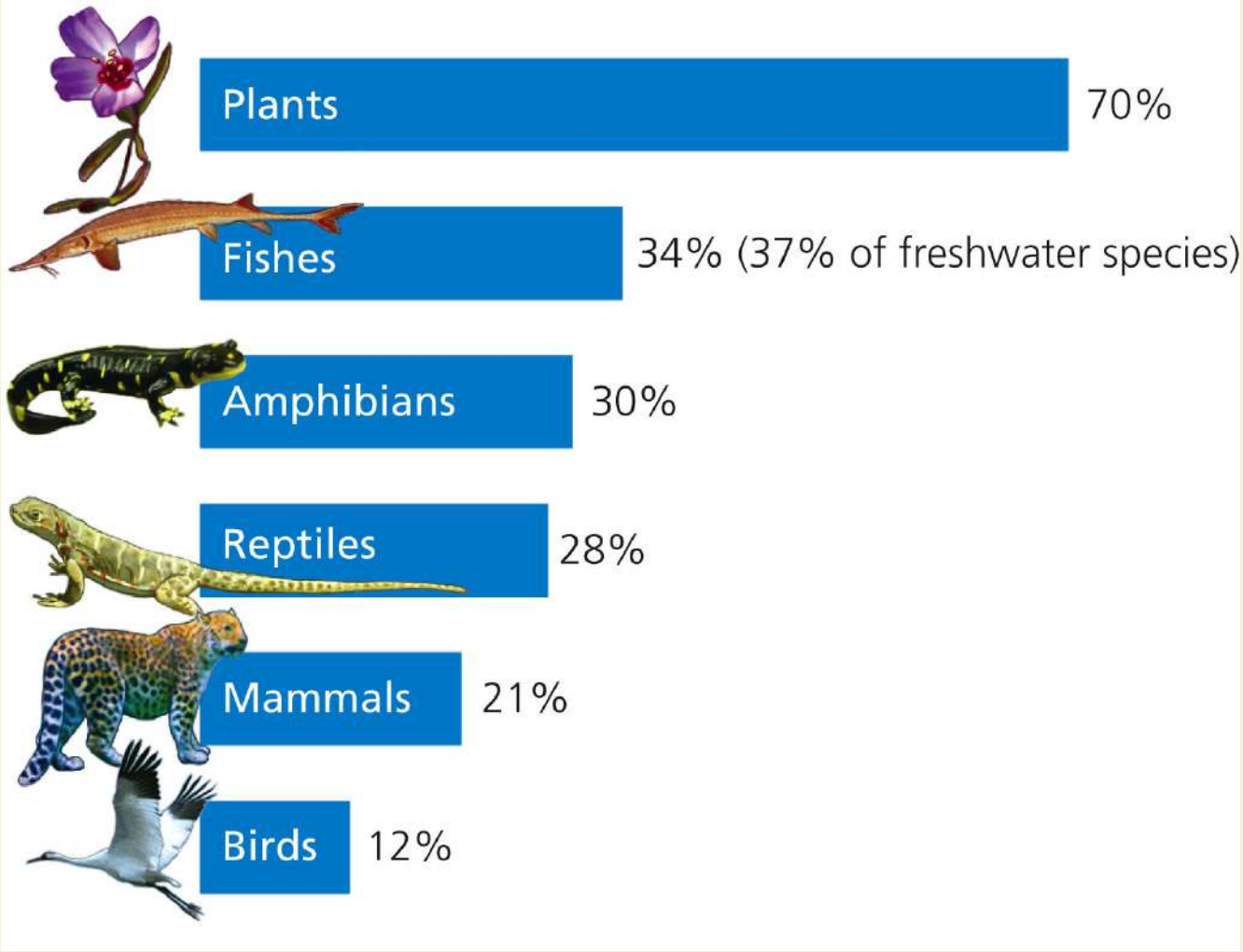


Fig. 9-4, p. 194

Science Focus: Estimating Extinction Rates

- Three problems
  1. Hard to document due to length of time
  2. Only 1.9 million species identified
  3. Little known about nature and ecological roles of species identified

- Approaches
  1. Study extinction rates over last 10,000 years and then compare with the fossil record
  2. Use species–area relationship
  3. Mathematical models

Case Study: The Passenger Pigeon: Gone Forever

- Once one of the world's most abundant birds
- Audubon: flock took 3 days to fly over
- Passenger pigeon hunted to extinction by 1900
  - Habitat loss
  - Commercial hunting
  - Easy to kill: flew in large flocks and nested in dense colonies

Passenger Pigeon

Fig. 9-5, p. 194

9-2 Why Should We Care about the Rising Rate of Species Extinction?

- ***Concept 9-2*** *We should prevent the premature extinction of wild species because of the economic and ecological services they provide and because they have a right to exist regardless of their usefulness to us.*

Species Are a Vital Part of the Earth's Natural Capital (1)

- 4 reasons to prevent extinctions

1. Species provide natural resources and natural services
   - Insects for pollination
   - Birds for pest control

2. Most species contribute economic services
   - Plants for food, fuel, lumber, medicine
   - Ecotourism

Species Are a Vital Part of the Earth's Natural Capital (2)

3. It will take 5-10 million years to regain species biodiversity

4. Many people believe species have an intrinsic right to exist

Natural Capital Degradation: Endangered Orangutans in a Tropical Forest

Fig. 9-6, p. 195

Natural Capital: Nature's Pharmacy

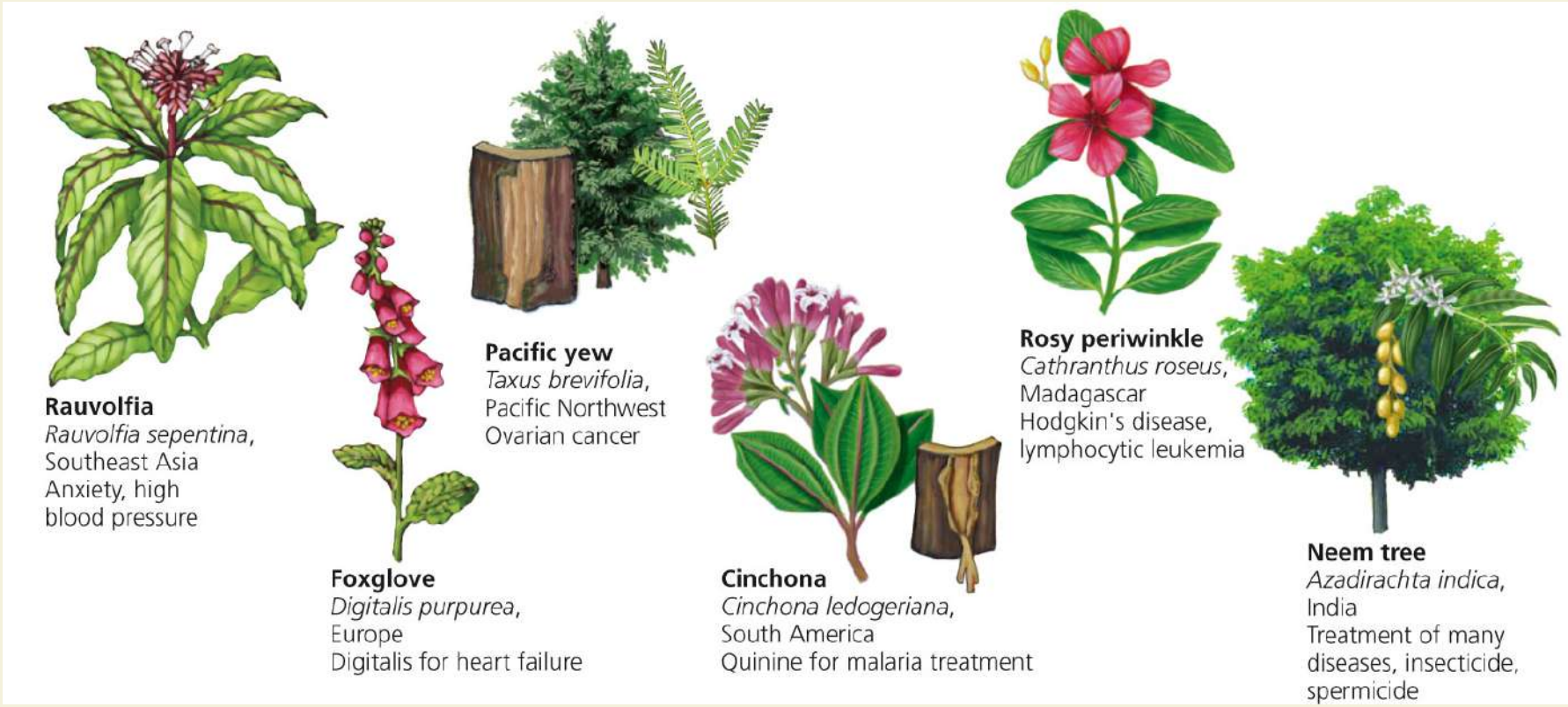
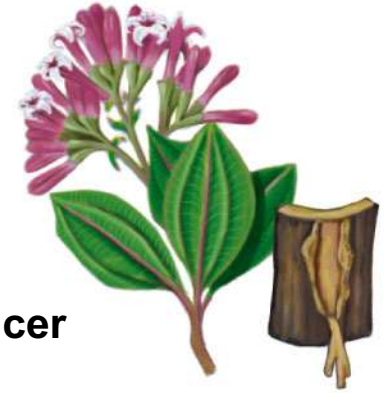


Fig. 9-7, p. 196

Rauvolfia
Rauvolfia sepentina,
Southeast Asia
Anxiety, high blood pressure

Foxglove
Digitalis purpurea,
Europe Digitalis
for heart failure

Pacific yew
Taxus brevifolia,
Pacific Northwest
Ovarian cancer



Cinchona
Cinchona ledogeriana,
South America
Quinine for
malaria treatment

Rosy periwinkle
Cathranthus roseus,
Madagascar
Hodgkin's disease,
lymphocytic leukemia

Neem tree
Azadirachta indica, India
Treatment of many diseases,
insecticide,
spermicides

Fig. 9-7, p. 196

Endangered Hyacinth Macaw is a Source of Beauty and Pleasure

Fig. 9-8, p. 197

9-3 How do Humans Accelerate Species Extinction?

- ***Concept 9-3*** *The greatest threats to any species are (in order) loss or degradation of its habitat, harmful invasive species, human population growth, pollution, climate change, and overexploitation.*

Loss of Habitat Is the Single Greatest Threat to Species: Remember HIPPCO

- **H**abitat destruction, degradation, and fragmentation
- **I**nvasive (nonnative) species
- **P**opulation and resource use growth
- **P**ollution
- **C**limate change
- **O**verexploitation

Habitat Fragmentation

- **Habitat fragmentation**
  - Large intact habitat divided by roads, crops, urban development
  - Leaves habitat islands
  - Blocks migration routes
  - Divides populations
  - Inhibits migrations and colonization
  - Inhibits finding food

- National parks and nature reserves as habitat islands

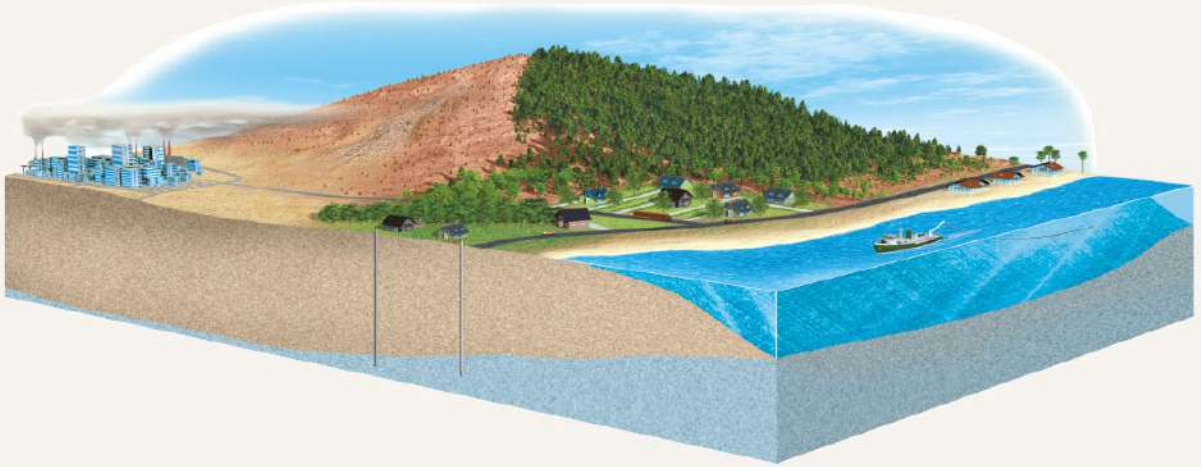
Causes of Depletion and Premature Extinction of World Species

Natural Capital Degradation

Causes of Depletion and Extinction of Wild Species

Underlying Causes

- Population growth
- Rising resource use
- Undervaluing natural capital
- Poverty



Direct Causes

- Habitat loss
- Habitat degradation and fragmentation
- Introduction of nonnative species
- Pollution
- Climate change
- Overfishing
- Commercial hunting and poaching
- Sale of exotic pets and decorative plants
- Predator and pest control

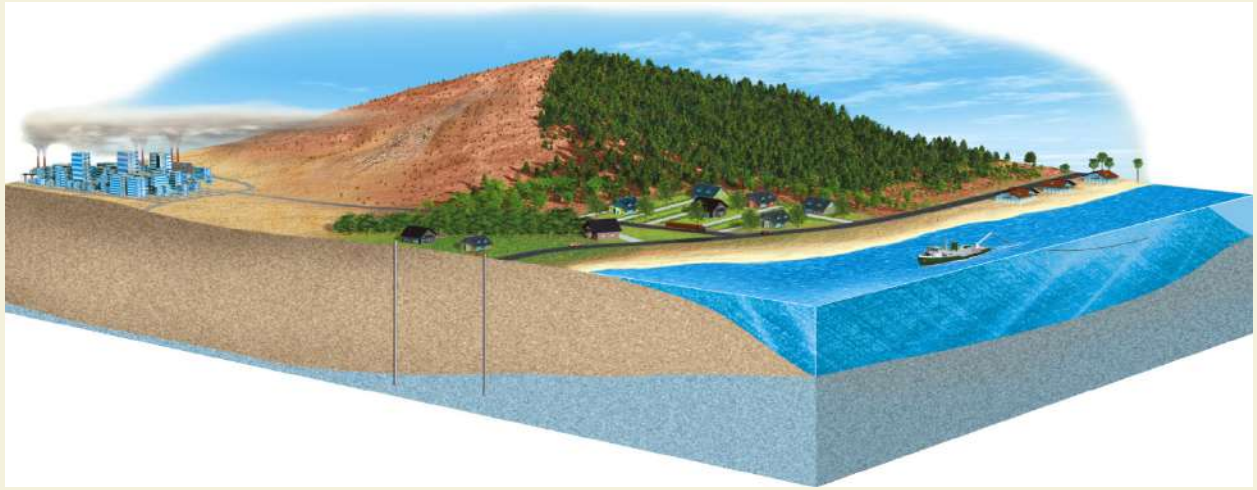
Fig. 9-9, p. 198

Natural Capital Degradation

Causes of Depletion and Extinction of Wild Species

Underlying Causes

- Population growth
- Rising resource use
- Undervaluing natural capital
- Poverty



Direct Causes

- Habitat loss
- Habitat degradation and fragmentation
- Introduction of nonnative species
- Pollution
- Climate change
- Overfishing
- Commercial hunting and poaching
- Sale of exotic pets and decorative plants
- Predator and pest control

Fig. 9-9, p. 198

Natural Capital Degradation: Reduction in the Ranges of Four Wildlife Species

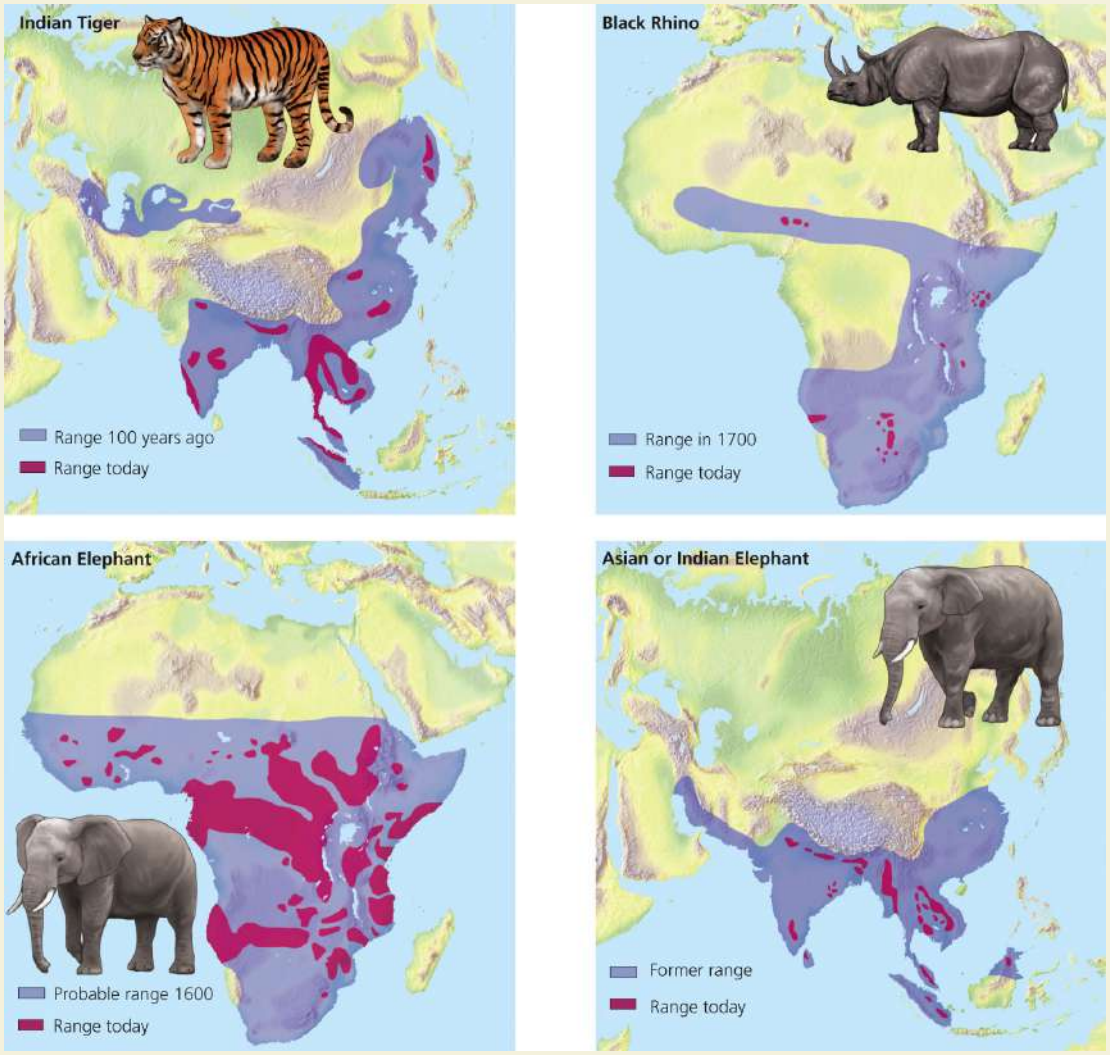


Fig. 9-10, p. 199

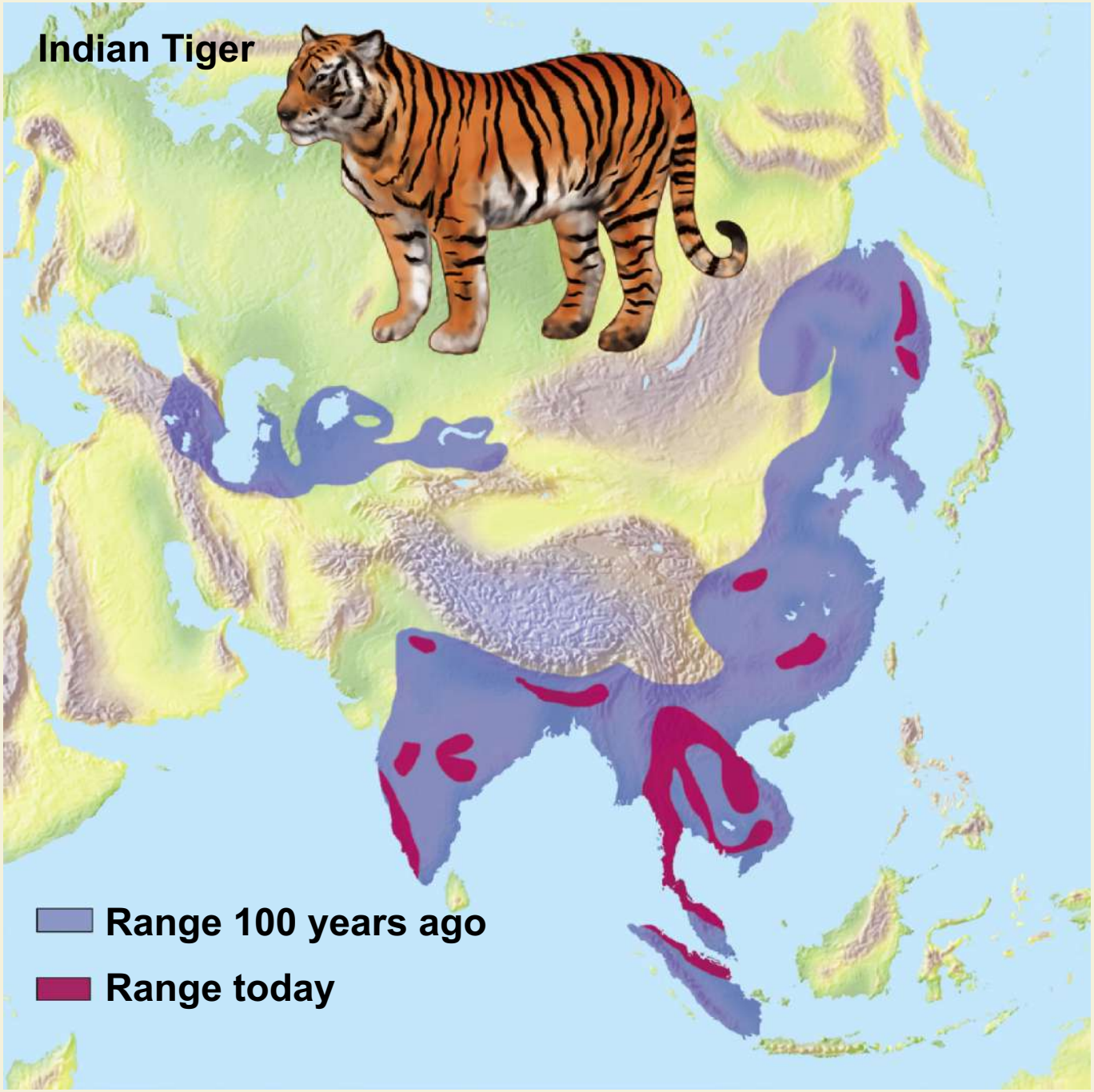


Fig. 9-10a, p. 199

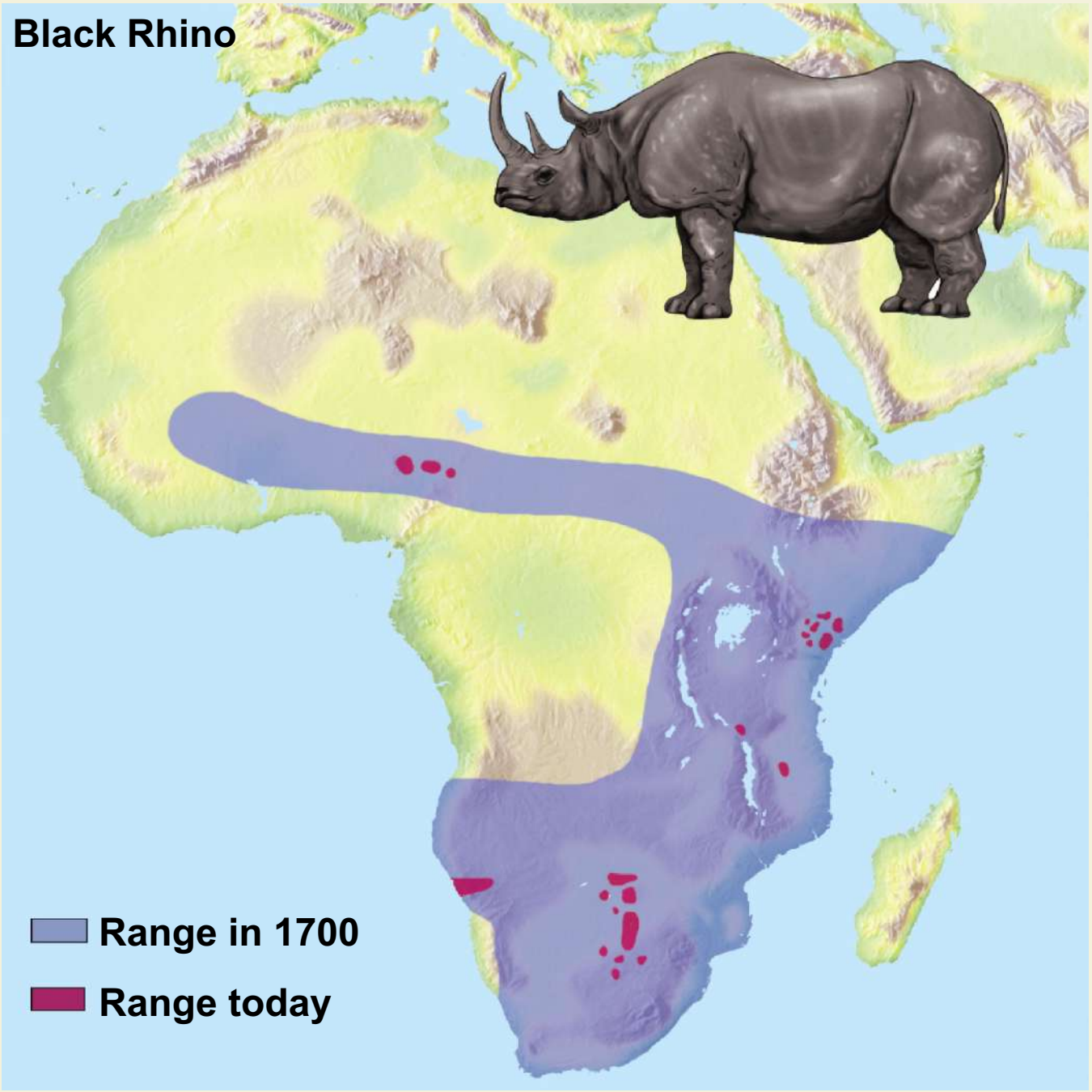


Fig. 9-10b, p. 199

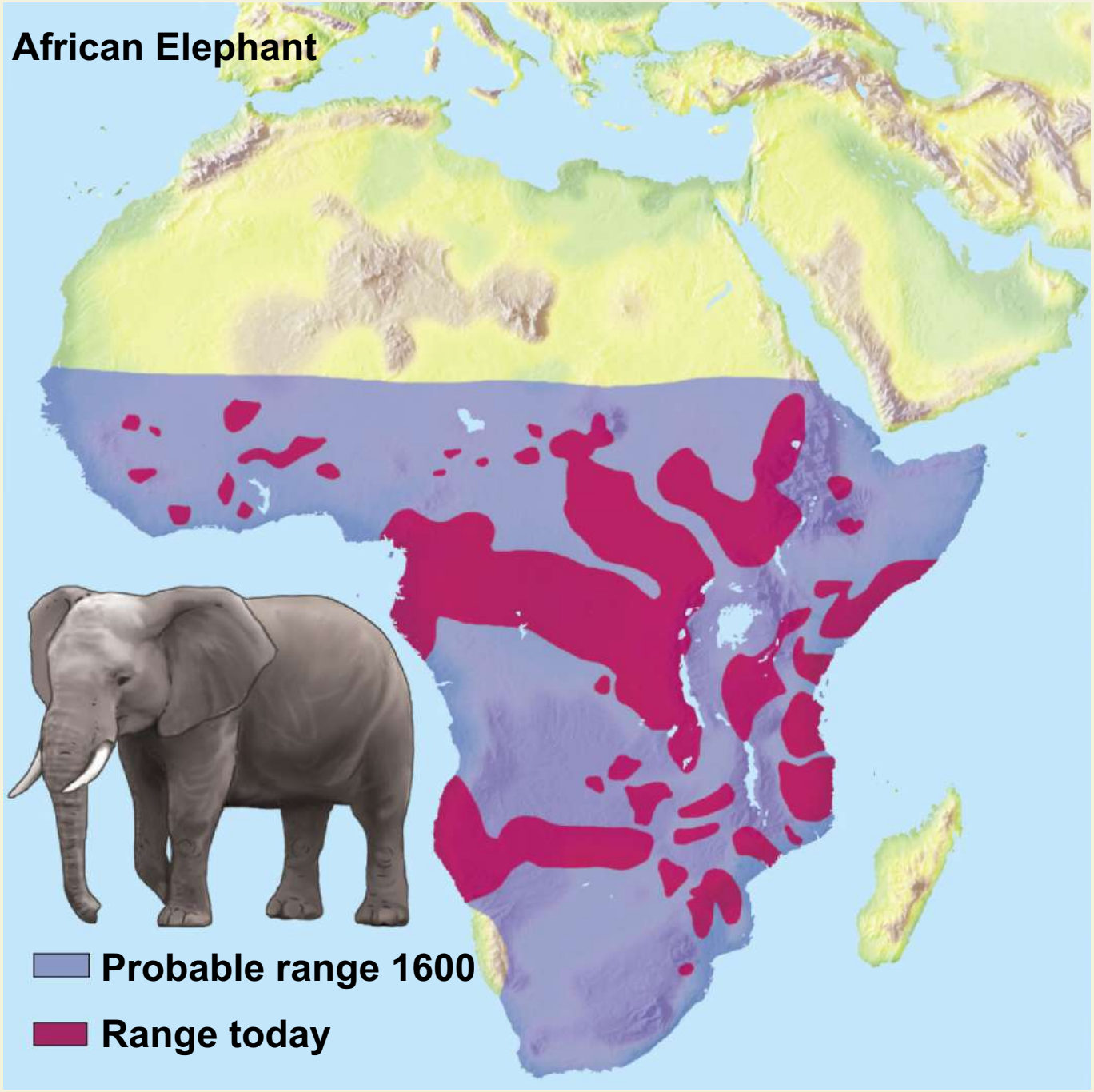


Fig. 9-10c, p. 199

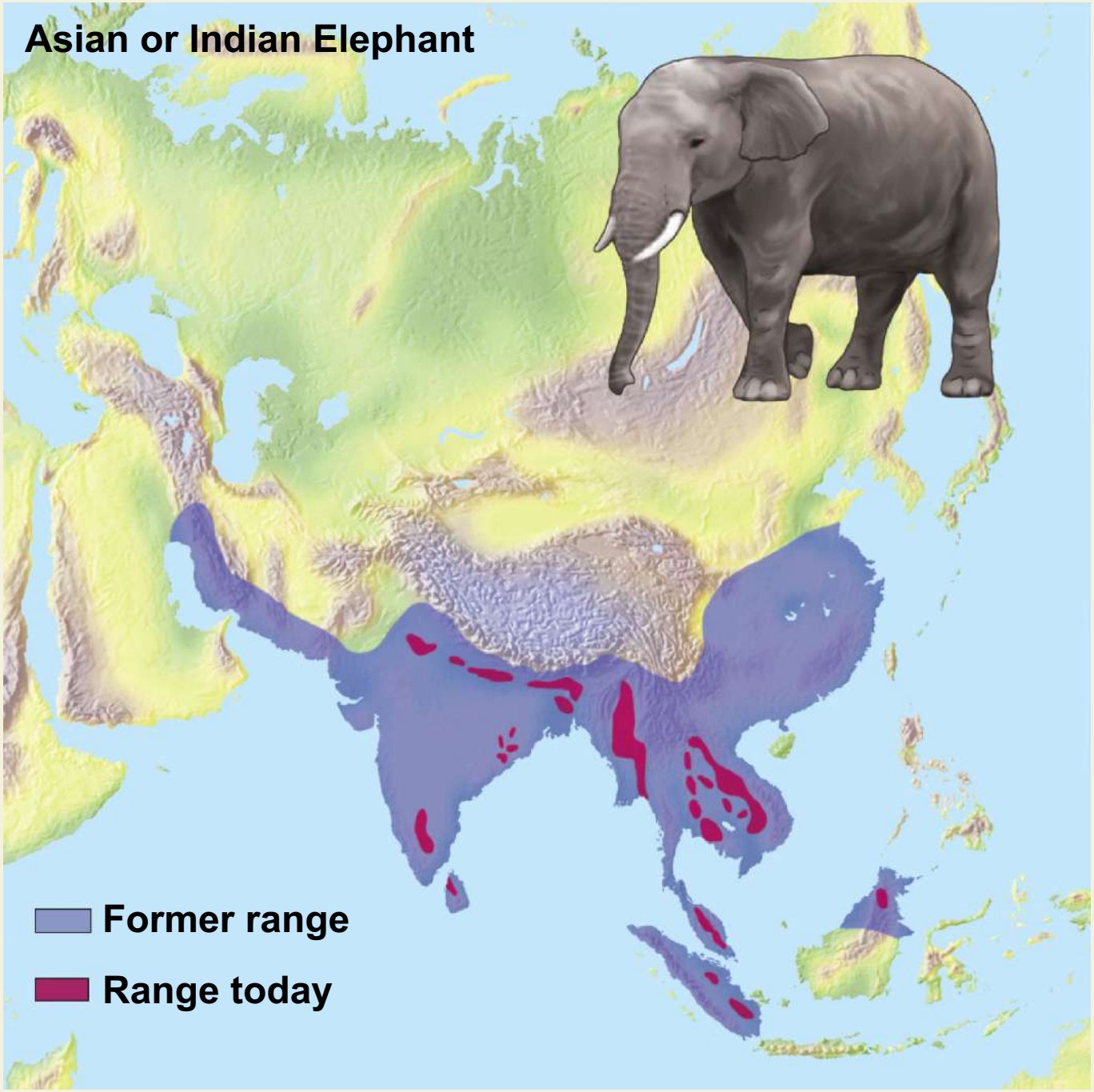
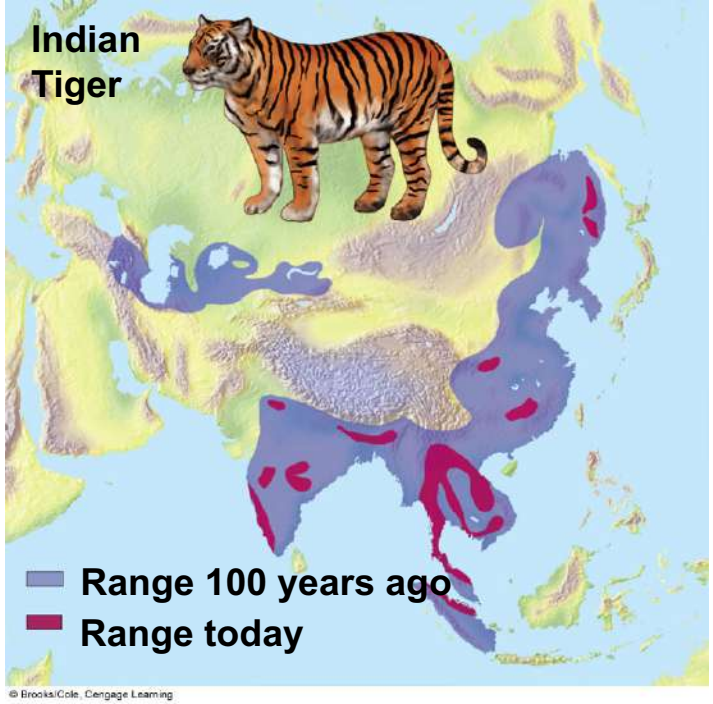
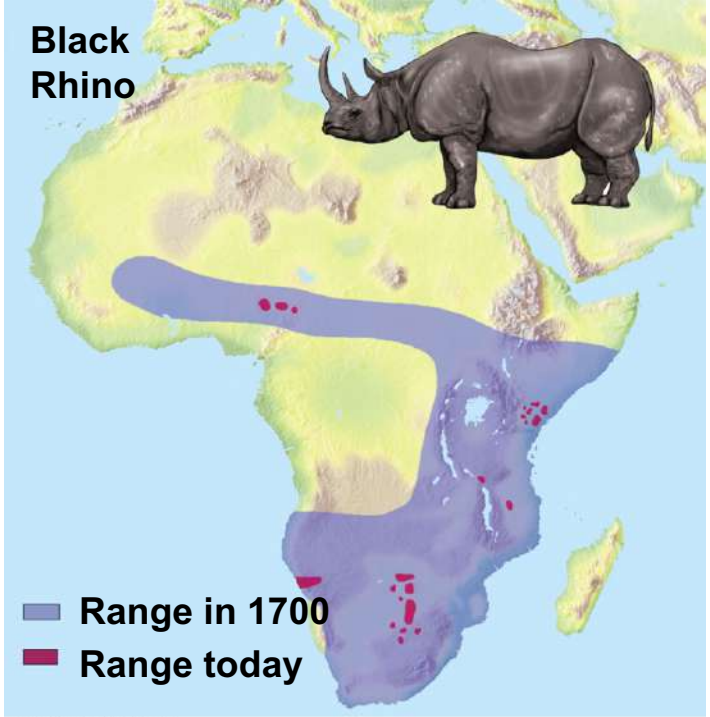
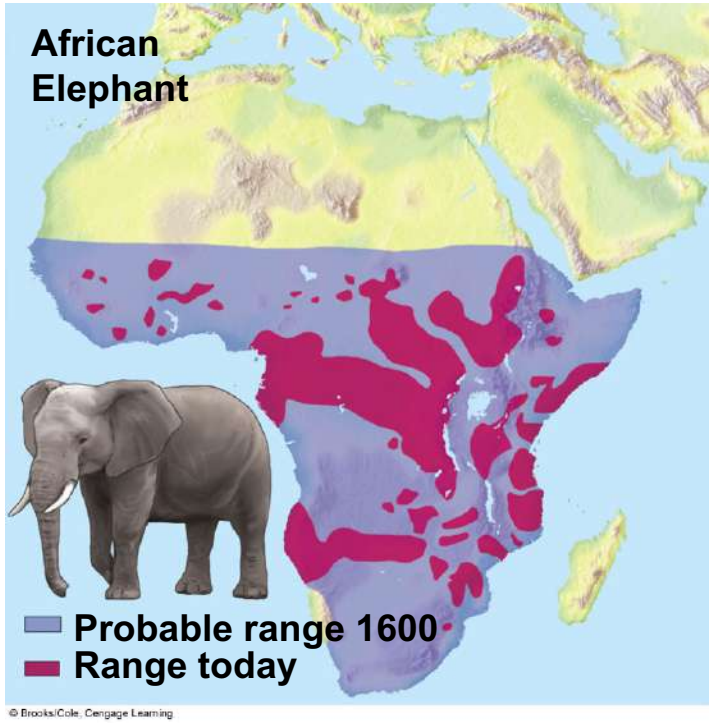


Fig. 9-10d, p. 199







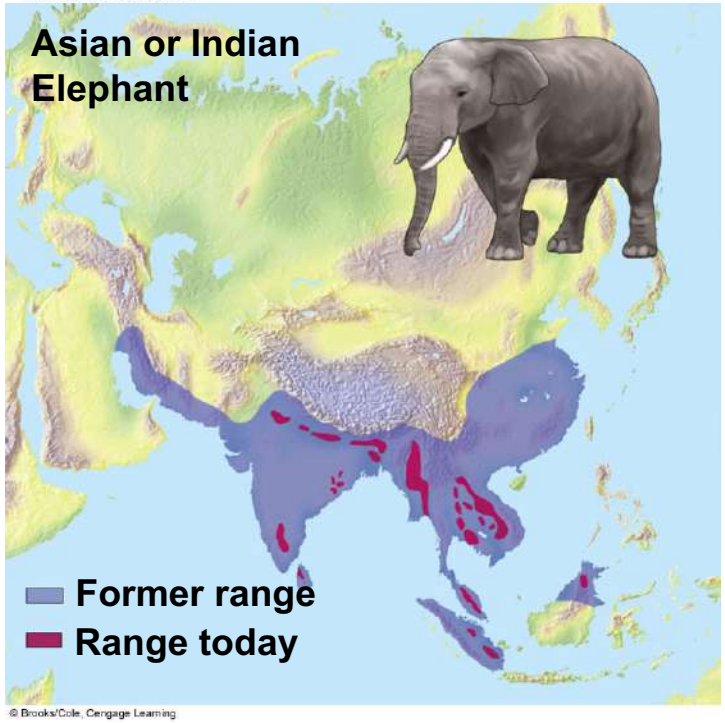


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Fig. 9-10, p. 199

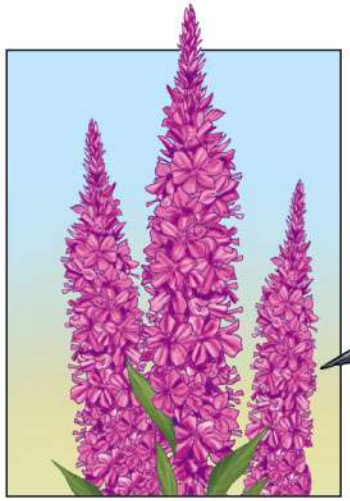
Some Deliberately Introduced Species Can Disrupt Ecosystems

- Most species introductions are beneficial
  - Food
  - Shelter
  - Medicine
  - Aesthetic enjoyment
- Nonnative species may have no natural
  - Predators
  - Competitors
  - Parasites
  - Pathogens

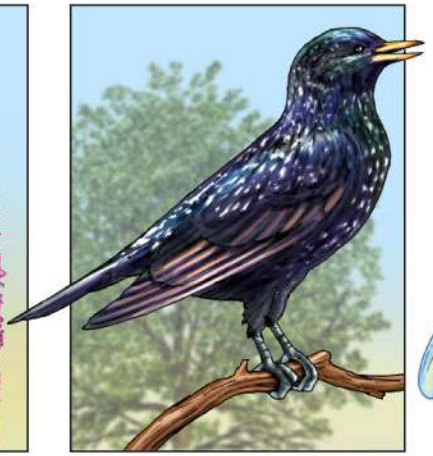
Some Harmful Nonnative Species in the United States

Fig. 9-11, p. 200

Deliberately Introduced Species



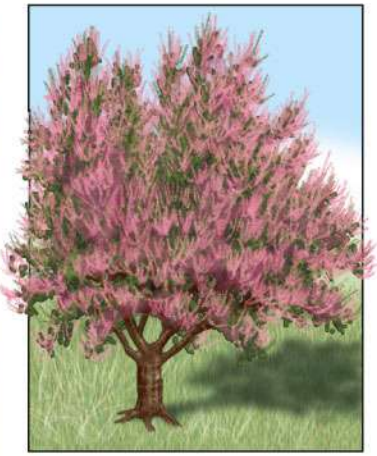
Purple loosestrife



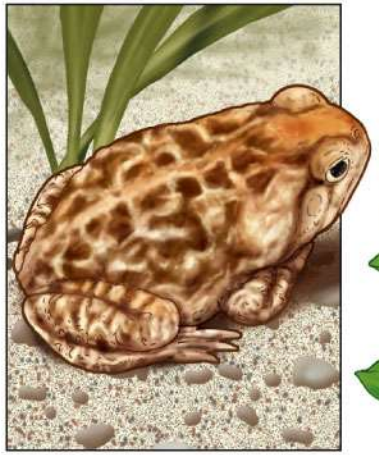
European starling

African honeybee ("Killer bee")

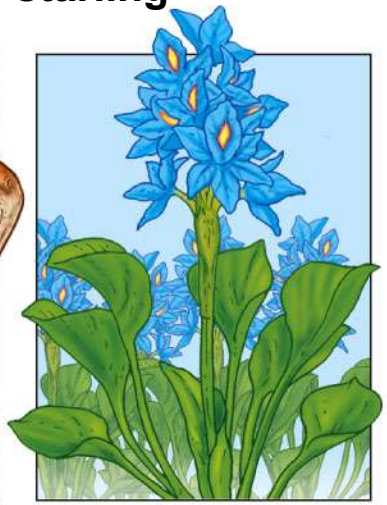
Nutria



Salt cedar (Tamarisk)



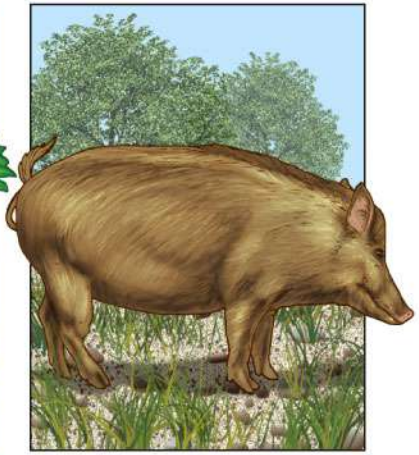
Marine toad (Giant toad)



Water hyacinth

Japanese beetle

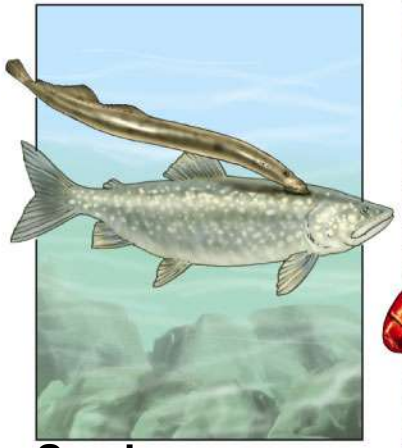
Hydrilla



European wild boar (Feral pig)

Fig. 9-11a, p. 200

Accidentally Introduced Species



Sea lamprey (attached to lake trout)

Argentina fire ant

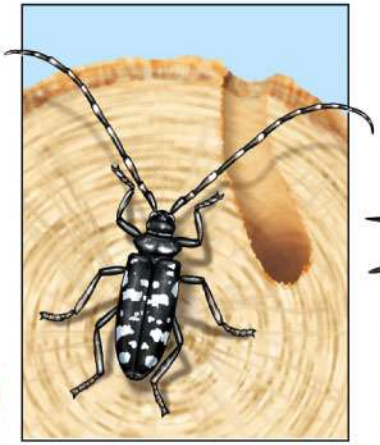
Brown tree snake

Eurasian ruffe

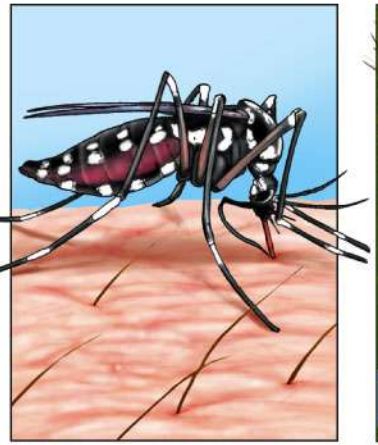
Common pigeon (Rock dove)

Formosan termite

Zebra mussel



Asian long-horned beetle



Asian tiger mosquito

Gypsy moth larvae

Fig. 9-11b, p. 200

Deliberately introduced species

Purple loosestrife

European starling

African honeybee ("Killer bee")

Nutria

Salt cedar (Tamarisk)

Marine toad (Giant toad)

Water hyacinth

Japanese beetle

Hydrilla

European wild boar (Feral pig)

Accidentally introduced species

Sea lamprey (attached to lake trout)

Argentina fire ant

Brown tree snake

Eurasian ruffe

Common pigeon (Rock dove)

Formosan termite

Zebra mussel

Asian long-horned beetle

Asian tiger mosquito

Gypsy moth larvae

Stepped Art

Fig. 9-11, p. 200

Case Study: The Kudzu Vine

- Imported from Japan in the 1930s
- “ The vine that ate the South”
- Could there be benefits of kudzu?
  - Fiber for making paper
  - Kudzu powder reduces desire for alcohol

Kudzu Taking Over an Abandoned House in Mississippi, U.S.

Fig. 9-12, p. 201

Some Accidentally Introduced Species Can Also Disrupt Ecosystems

- Argentina fire ant: 1930s
  - Reduced populations of native ants
  - Painful stings can kill
  - Pesticide spraying in 1950s and 1960s worsened conditions
  - 2009: tiny parasitic flies may help control fire ants

- Burmese python
  - Florida Everglades

Fight Between a Python and Alligator

Fig. 9-13, p. 202

Prevention Is the Best Way to Reduce Threats from Invasive Species

- Prevent them from becoming established
- Learn the characteristics of the species
- Set up research programs
- Try to find natural ways to control them
- International treaties
- Public education

What Can You Do? Controlling Invasive Species

Fig. 9-14, p. 203

Other Causes of Species Extinction (1)

- Human population growth
- Overconsumption
- Pollution
- Climate change

Other Causes of Species Extinction (2)

- Pesticides
  - DDT: Banned in the U.S. in 1972
- Bioaccumulation
- Biomagnification

Bioaccumulation and Biomagnification

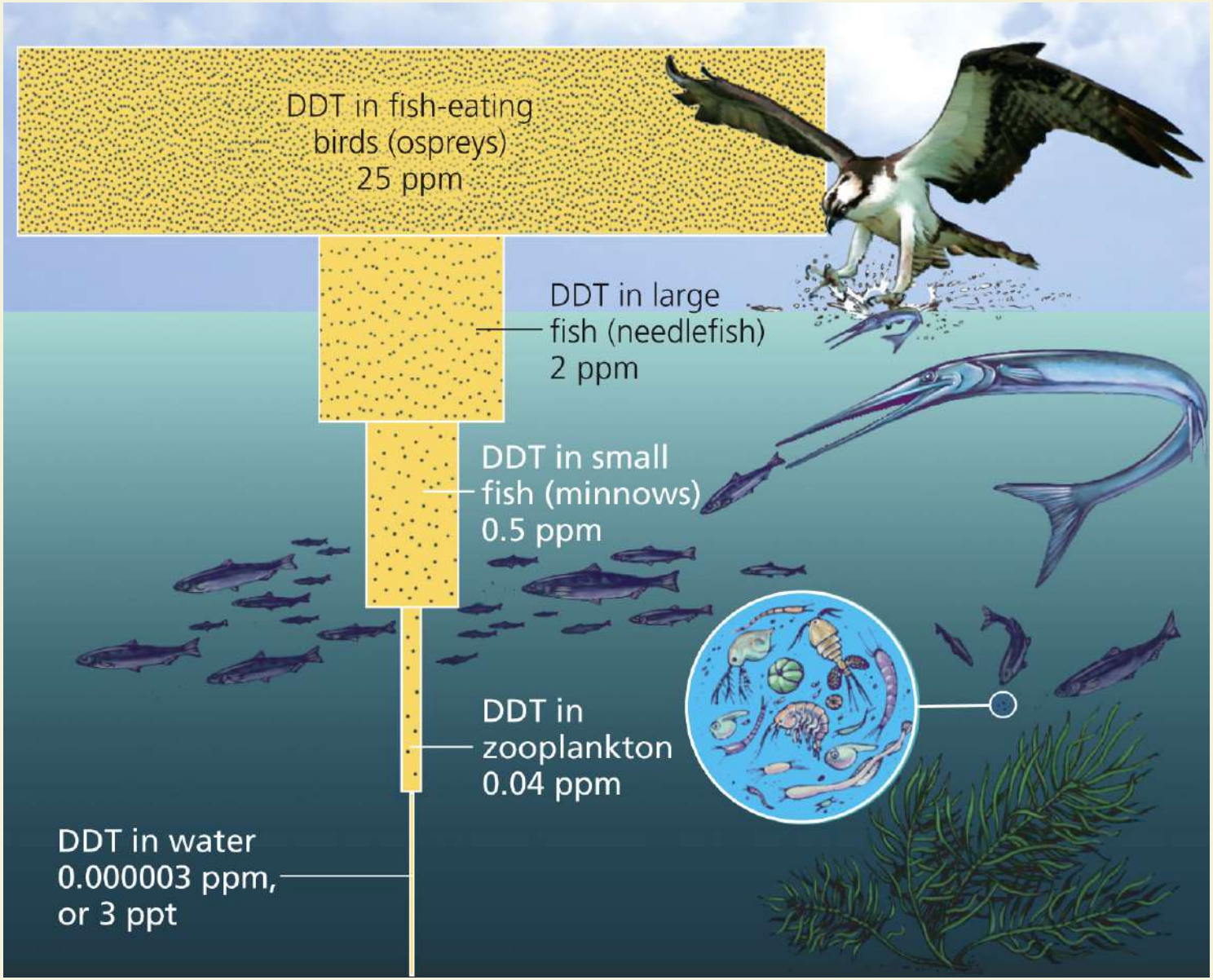


Fig. 9-15, p. 203

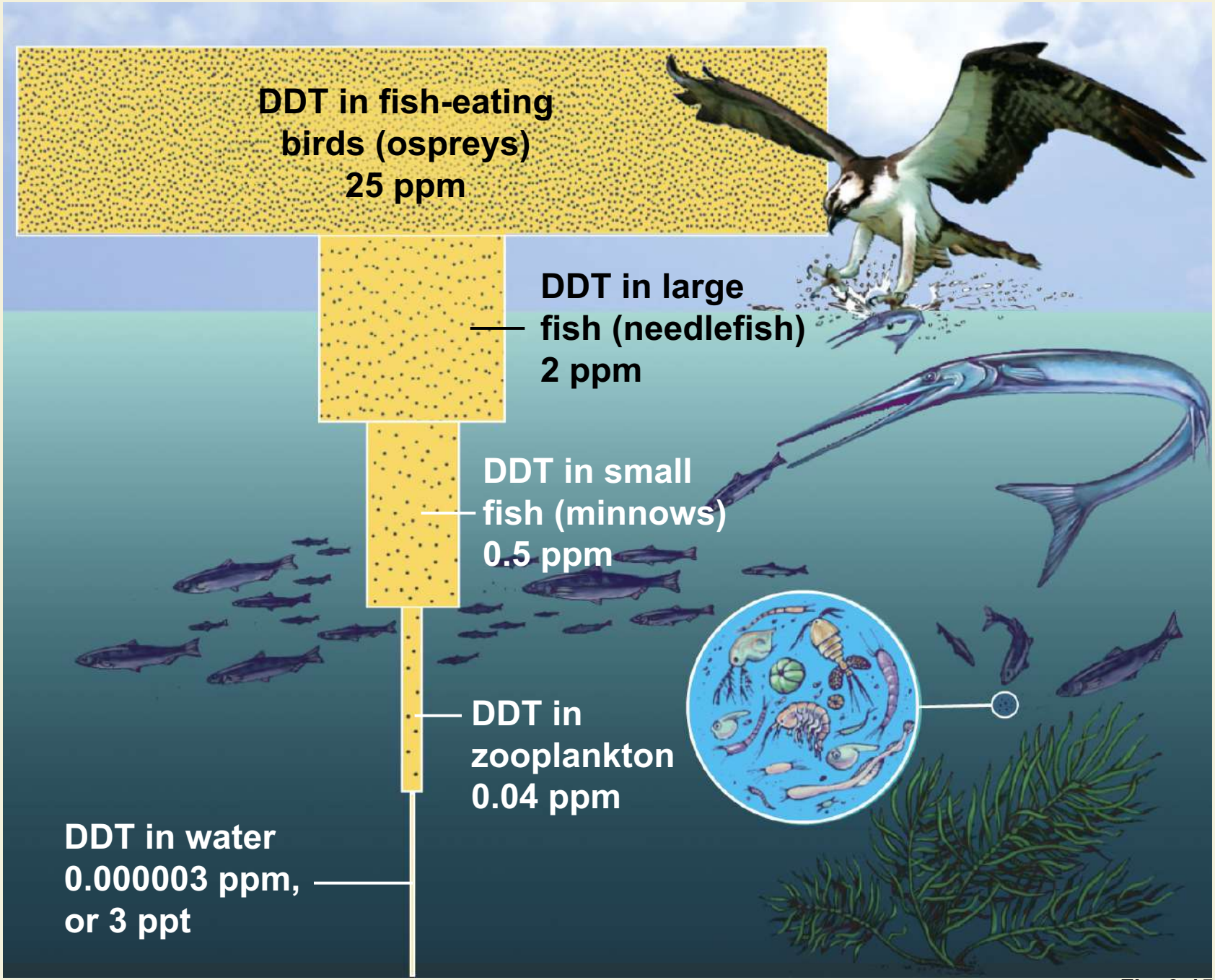
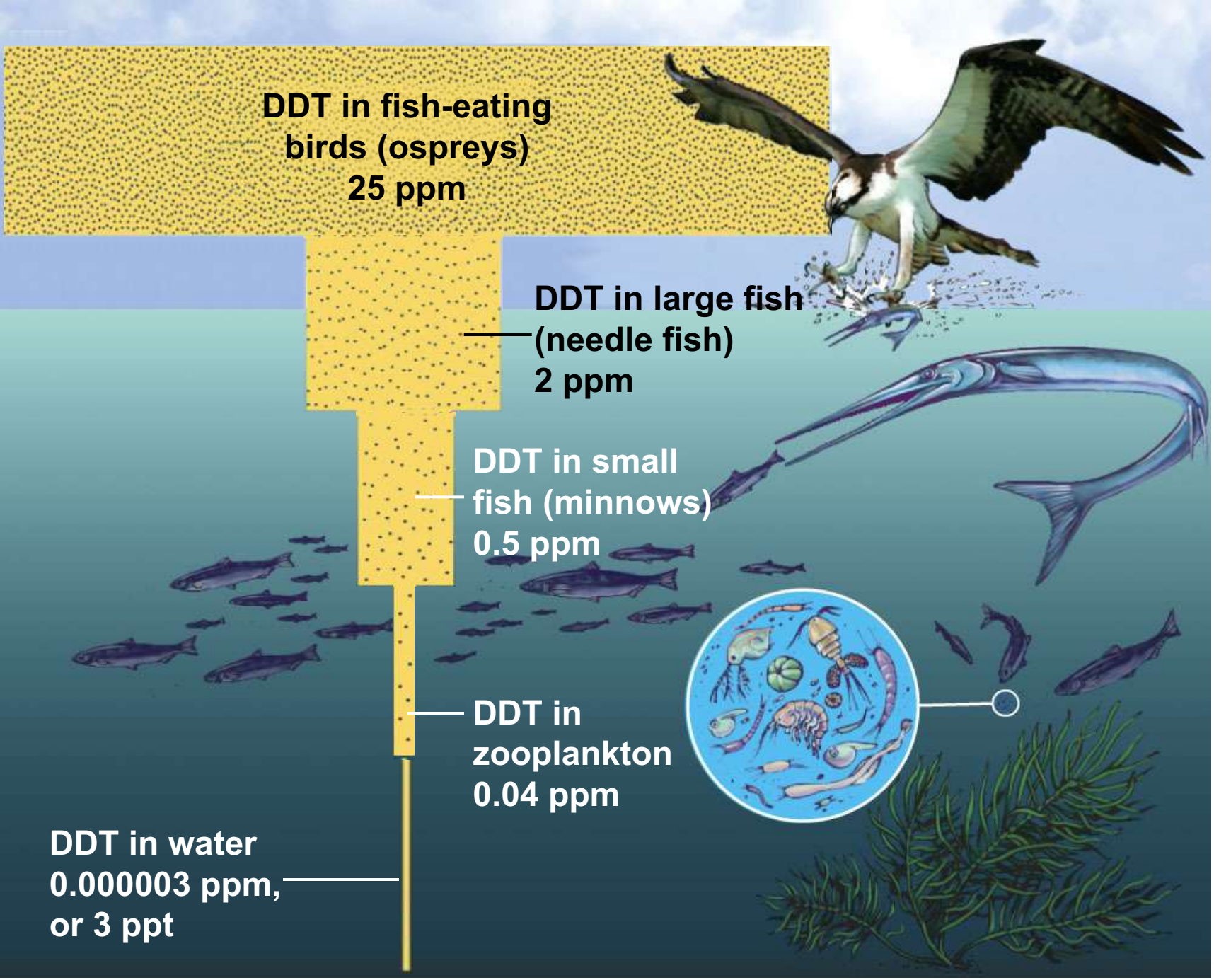

DDT in fish-eating birds (ospreys) 25 ppm
DDT in large fish (needlefish) 2 ppm
DDT in small fish (minnows) 0.5 ppm
DDT in zooplankton 0.04 ppm
DDT in water 0.000003 ppm, or 3 ppt

Fig. 9-15, p. 203



Stepped Art

Fig. 9-15, p. 203

Case Study: Where Have All the Honeybees Gone?

- Honeybees responsible for 80% of insect-pollinated plants and nearly 1/3 human food
- 2006: 30% drop in honeybee populations

- Dying due to
  - Pesticides?
  - Parasites?
  - Viruses, fungi, bacteria?
  - Microwave radiation – cell phones?
  - Bee colony collapse syndrome

Illegal Killing, Capturing, and Selling of Wild Species Threatens Biodiversity

- Poaching and smuggling of animals and plants
  - Animal parts
  - Pets
  - Plants for landscaping and enjoyment

- Prevention: research and education

Mountain Gorilla in Rwanda

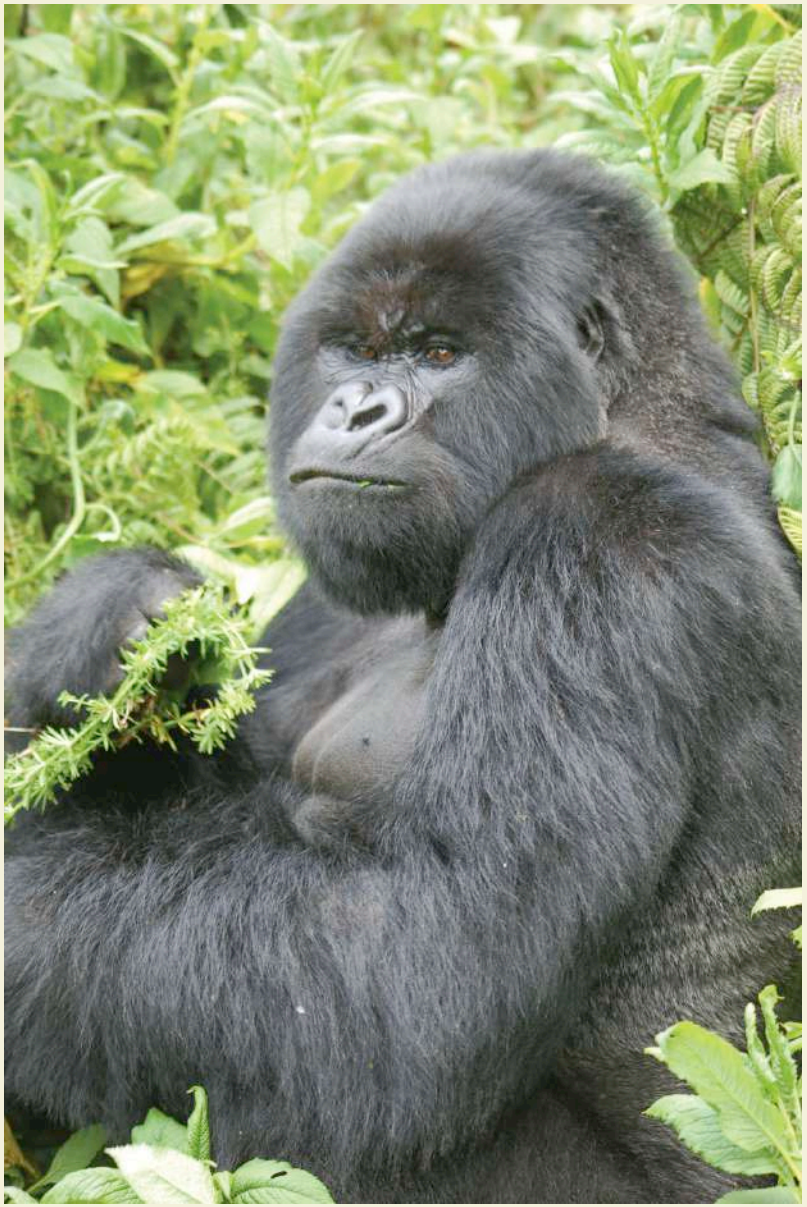


Fig. 9-16, p. 205

White Rhinoceros Killed by a Poacher

Fig. 9-17, p. 205

Individuals Matter: Pilai Poonswad

- Biologist in Thailand
- Visited poachers of rhinoceros hornbill bird and convinced them to protect the bird instead
- Many former poachers now lead ecotourism groups to view the birds

Professor Pilai Poonswad

Fig. 9-A, p. 206

The Rare Rhinoceros Hornbill

Fig. 9-B, p. 206

Rising Demand for Bush Meat Threatens Some African Species

- Indigenous people sustained by **bush meat**
- More hunters leading to local extinction of some wild animals
- West and Central Africa
- Helps spread HIV/AIDS and Ebola from animals to humans

Bush Meat: Lowland Gorilla

Fig. 9-18, p. 207

Case Study: A Disturbing Message from the Birds (1)

- 1/3 of 800 bird species in U.S. are endangered or threatened
- Habitat loss and fragmentation of the birds' breeding habitats
  - Forests cleared for farms, lumber plantations, roads, and development
- Intentional or accidental introduction of nonnative species
  - Eat the birds

Case Study: A Disturbing Message from the Birds (2)

- Seabirds caught and drown in fishing equipment
- Migrating birds fly into power lines, communication towers, and skyscrapers
- Other threats
  - Oil spills
  - Pesticides
  - Herbicides
  - Ingestion of toxic lead shotgun pellets

Case Study: A Disturbing Message from the Birds (3)

- Greatest new threat: Climate change
- Environmental indicators
- Economic and ecological services

Endangered Black-Browed Albatross

Fig. 9-19, p. 208

Science Focus: Vultures, Wild Dogs, and Rabies: Unexpected Scientific Connections

- Vultures poisoned from *diclofenac* in cow carcasses in India
- More wild dogs eating the cow carcasses
- More rabies spreading to people

9-4 How Can We Protect Wild Species from Premature Extinction?

- ***Concept 9-4*** *We can reduce the rising rate of species extinction and help to protect overall biodiversity by establishing and enforcing national environmental laws and international treaties, creating a variety of protected wildlife sanctuaries, and taking precautionary measures to prevent such harm.*

International Treaties and National Laws Help to Protect Species

- 1975: Convention on International Trade in Endangered Species (CITES)
  - Signed by 172 countries

- Convention on Biological Diversity (BCD)
  - Focuses on ecosystems
  - Ratified by 190 countries (not the U.S.)

Endangered Species Act

- Endangered Species Act (ESA): 1973 and later amended in 1982, 1985, and 1988
- Identify and protect endangered species in the U.S. and abroad
- National Marine Fisheries Service for ocean species
- U.S. Fish and Wildlife Service for all others

Endangered Species Act (2)

- Forbids federal agencies (except Defense) from funding or authorizing projects that jeopardize endangered or threatened species
- 2010: 1,370 species officially listed
- USFWS and NMFS prepare recovery plans
- Incentives for private property owners

Science Focus: Accomplishments of the Endangered Species Act (1)

- Four reasons ESA not a failure for removing only 46 species from endangered list
  1. Species listed only when in serious danger
  2. Takes decades to help endangered species
  3. Conditions for more than half of listed species are stable or improving
  4. 2010: spend only 9 cents per American

Science Focus: Accomplishments of the Endangered Species Act (2)

- Three ways to improve ESA

1. Greatly increase funding
2. Develop recovery plans more quickly
3. When a species is first listed, establish the core of its habitat that's critical for survival

- New law needed to focus on sustaining biodiversity and ecosystem health

Confiscated Products Made from Endangered Species

Fig. 9-20, p. 210

We Can Establish Wildlife Refuges and Other Protected Areas

- 1903: Theodore Roosevelt

- Wildlife refuges
  - Most are wetland sanctuaries
  - More needed for endangered plants
  - Could abandoned military lands be used for wildlife habitats?

Pelican Island National Wildlife Refuge

Fig. 9-21a, p. 211

Gene Banks, Botanical Gardens, and Wildlife Farms Can Help Protect Species

- Gene or seed banks
  - Preserve genetic material of endangered plants
- Botanical gardens and arboreta
  - Living plants
- Farms to raise organisms for commercial sale

Zoos and Aquariums Can Protect Some Species (1)

- Techniques for preserving endangered terrestrial species
  - Egg pulling
  - Captive breeding
  - Artificial insemination
  - Embryo transfer
  - Use of incubators
  - Cross-fostering

Zoos and Aquariums Can Protect Some Species (2)

- Goal of ultimately releasing/reintroducing populations to the wild

- Limited space and funds

What Can You Do? Protecting Species

Fig. 9-22, p. 213

Case Study: Trying to Save the California Condor

- Largest North American bird
- Nearly extinct
  - Birds captured and breed in captivity
- By 2009, 180 in the wild
  - Threatened by lead poisoning

The Precautionary Principle

- **Precautionary principle**: act to prevent or reduce harm when preliminary evidence indicates acting is needed
- Species: primary components of biodiversity
- Preservation of species
- Preservation of ecosystems

Three Big Ideas

1. We are greatly increasing the extinction of wild species by destroying and degrading their habitats, introducing harmful invasive species, and increasing human population growth, pollution, climate change, and overexploitation.

2. We should avoid causing the extinction of wild species because of the ecological and economic services they provide and because their existence should not depend primarily on their usefulness to us.

Three Big Ideas

3. We can work to prevent the extinction of species and to protect overall biodiversity by using laws and treaties, protecting wildlife sanctuaries, and making greater use of the precautionary principle.