# 22

# *Conservation Biology*

- *Case Study:* Can Birds and Bombs Coexist?
- Conservation Biology
- Declining Biodiversity
- Threats to Biodiversity
- Approaches to Conservation
- Ranking Species for Protection
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# Case Study: Can Birds and Bombs Coexist?

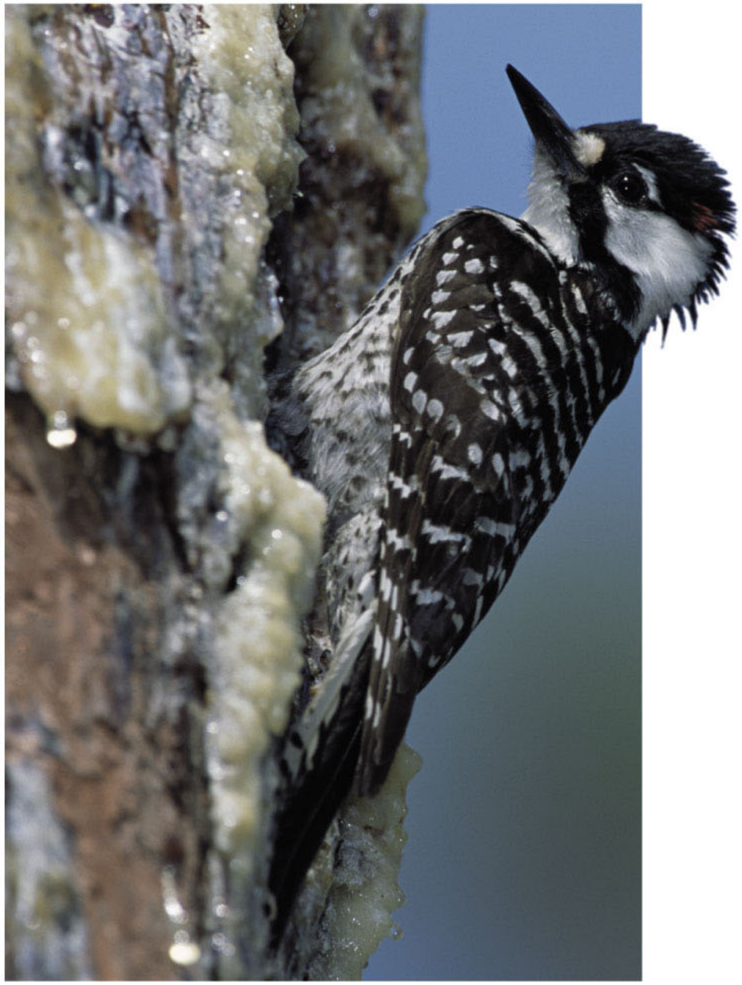


Figure 22.1 The Red-Cockaded Woodpecker: An Endangered Species

Decades of bombing at Fort Bragg have inadvertently protected thousands of acres of longleaf pine savanna, and helped save the endangered red-cockaded woodpecker.

## Case Study: Can Birds and Bombs Coexist?

The forests at Fort Bragg in North Carolina have been degraded by off-road vehicles, earth-moving equipment, and fires set by explosives.

This has ironically helped to preserve a now rare ecosystem—the longleaf pine savanna, which depends on fire.

Being a military base has prevented large blocks from being converted to farmland, forestry, and housing.

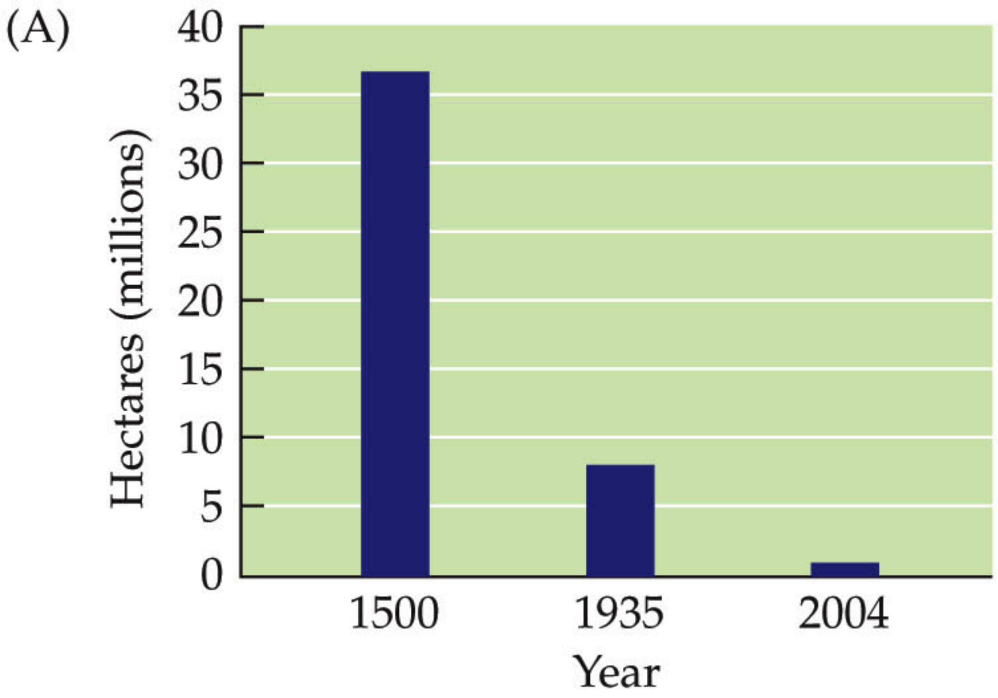
# Case Study: Can Birds and Bombs Coexist?

The longleaf pine savanna originally covered 30 million hectares, but has been reduced to only 3% of that.

Several factors caused the decline: Fire suppression, human population growth, and clearing for large plantations of other species, such as loblolly pine.

Species that depend on the longleaf pine ecosystem have also declined.

# Figure 22.2 Decline of the Longleaf Pine Ecosystem





ECOLOGY, Figure 22.2

# Case Study: Can Birds and Bombs Coexist?

The red-cockaded woodpecker (*Picoides borealis*) is adapted to large tracts of open pine savanna.

They require mature, living pines, especially longleaf pine, for nesting.

They are cooperative breeders—hatchlings are raised by a breeding pair and two to four nonbreeding helpers, generally males born to the pair in previous years.

## Case Study: Can Birds and Bombs Coexist?

Historically, periodic fires helped maintain the longleaf pine savanna by preventing succession.

If the understory of young oaks and other hardwoods grows up, red-cockaded woodpeckers abandon their nesting cavities, apparently due to a decrease in food resources.

Loss of habitat has reduced the woodpecker population size, making the population vulnerable to genetic drift, inbreeding, and extinction.

In 1989, Hurricane Hugo killed 70% of the birds in one population.

# Case Study: Can Birds and Bombs Coexist?

The story of the red-cockaded woodpecker reflects that of thousands of other imperiled species around the world.

Legal protection and extraordinary human effort have resulted in stabilization and slow recovery.

Do we have a responsibility to protect biodiversity? How can we allocate limited resources for conservation?

As the human population has grown, and we have cut, plowed, drained, and dammed, we have destroyed the habitat of many species.

These changes have given rise to a biodiversity crisis.

The Red List of Threatened Species, compiled by the World Conservation Union, lists 16,118 species as threatened with extinction.

# TABLE 22.1

## Global Summary of the Number of Documented Imperiled Species *(Part 1)*

| Group | Number of described species | Percentage of group evaluated in 2006 | Number of species evaluated in 2006 | Number of threatened species in 2006 | Number threatened in 2006, as percentage of described species |
|---|---|---|---|---|---|
| **VERTEBRATES** | | | | | |
| Mammals | 5,416 | 89.7 | 4,856 | 1,093 | 20 |
| Birds | 9,934 | 100.0 | 9,934 | 1,206 | 12 |
| Reptiles | 8,240 | 8.1 | 664 | 341 | 4 |
| Amphibians | 5,918 | 100.0 | 5,918 | 1,811 | 31 |
| Fishes | 29,300 | 9.9 | 2,914 | 1,173 | 4 |
| *Subtotal* | *58,808* | *41.3* | *24,286* | *5,624* | *10* |
| **INVERTEBRATES** | | | | | |
| Insects | 950,000 | 0.1 | 1,192 | 623 | 0.07 |
| Mollusks | 70,000 | 3.1 | 2,163 | 975 | 1.39 |
| Crustaceans | 40,000 | 1.3 | 537 | 459 | 1.15 |
| Others | 130,200 | 0.1 | 86 | 44 | 0.03 |
| *Subtotal* | *1,190,200* | *0.3* | *3,978* | *2,101* | *0.18* |

*Source*: Data from World Conservation Union Red List Summary 2007.

*Note:* Some groups have been completely evaluated (amphibians, birds) for conservation status, but for many groups, only a small percentage of described species have been evaluated. For those groups that have been only partially evaluated, there may be a bias toward completing assessments of imperiled species, with assessments of more common species a lower priority. That only 1% of species are shown as imperiled is an artifact of incomplete evaluation, as the percentage is believed to be much higher.

## TABLE 22.1

### Global Summary of the Number of Documented Imperiled Species *(Part 2)*

| Group | Number of described species | Percentage of group evaluated in 2006 | Number of species evaluated in 2006 | Number of threatened species in 2006 | Number threatened in 2006, as percentage of described species |
|---|---|---|---|---|---|
| **PLANTS** | | | | | |
| Mosses | 15,000 | 0.6 | 93 | 80 | 0.53 |
| Ferns and allies | 13,025 | 1.6 | 212 | 139 | 1 |
| Gymnosperms | 980 | 92.7 | 908 | 306 | 31 |
| Dicotyledons | 199,350 | 4.8 | 9,538 | 7,086 | 4 |
| Monocotyledons | 59,300 | 1.9 | 1,150 | 779 | 1 |
| *Subtotal* | *287,655* | *4.1* | *11,901* | *8,390* | *3* |
| **OTHERS** | | | | | |
| Lichens | 10,000 | > 0.1 | 2 | 2 | 0.02 |
| Mushrooms | 16,000 | > 0.1 | 1 | 1 | 0.01 |
| *Subtotal* | *26,000* | *> 0.1* | *3* | *3* | *0.01* |
| **TOTAL** | **1,562,663** | **2.6** | **40,168** | **16,118** | **1** |

*Source*: Data from World Conservation Union Red List Summary 2007.

*Note:* Some groups have been completely evaluated (amphibians, birds) for conservation status, but for many groups, only a small percentage of described species have been evaluated. For those groups that have been only partially evaluated, there may be a bias toward completing assessments of imperiled species, with assessments of more common species a lower priority. That only 1% of species are shown as imperiled is an artifact of incomplete evaluation, as the percentage is believed to be much higher.

## Introduction

Ecologists play an important role in observing, measuring, and communicating the changes in species abundances, distributions, and biological traits that have resulted from human activities.

Ecologists are part of a diverse team working to find ways to reverse these declines.

**Concept 22.1: Conservation biology is an integrative discipline that applies the principles of ecology to the conservation of biodiversity.**

Stabilization of red-cockaded woodpecker populations required expertise from several biological disciplines, as well as law, political science, and sociology.

Determining a successful management plan involved working with farmers, landowners, the U.S. military, and the business community.

Such an integrative approach is a characteristic of **conservation biology**—the scientific study of phenomena that affect the maintenance, loss, and restoration of biodiversity.

Protecting biodiversity is critically important on many levels.

People rely on biodiversity. We use hundreds of domesticated and wild species for food, fuel, fiber, medicines, building materials, spices, and decorative items.

We are dependent on ecosystem services—natural processes that sustain life, such as water purification, soil formation and maintenance, pollination of crops, climate regulation, and flood control.

For emotional health, most of us require time spent surrounded by nature's beauty and complexity.

Spiritually, we go to natural ecosystems for solace, wonder, and insight.

While some people view natural resources as simply there for the taking, as commodities awaiting human extraction, many others feel that we have a moral obligation to other species.

Religious or spiritual beliefs lead many to feel a sense of stewardship, or that other species have an intrinsic right to exist.

Scientists have long been aware of the negative impacts of human activities.

Alfred Russel Wallace foresaw the current biodiversity crisis in 1869.

In the U.S. there was a rising public outcry over decline of buffalo, the excessive harvest of passenger pigeons that led to their extinction, and the flagrant use of bird feathers on ladies' hats.

# Figure 22.3 The Passenger Pigeon: From Great Abundance to Extinction

Early ecologists were divided on how strongly they could advocate for the preservation of nature while still maintaining scientific objectivity.

In 1948, the Ecologists' Union branched off from the Ecological Society of America, as an independent group focused on preservation.

The group changed its name in 1950 to The Nature Conservancy, a nonprofit organization that integrates science with advocacy and on-the-ground conservation work.

Conservation biology emerged as a discipline in the early 1980s, to apply science to the preservation of species and ecosystems.

The scientific method calls for objectivity —collection and interpretation of data without bias.

But it is not free of human values, and takes place within a larger social context.

Conservation biologists have had to come to terms with the implicit and explicit values that are part of their work.

Many ecologists, such as Dan Janzen, have chosen to speak up, and even refocus their research programs, as they have come to understand the irreversible consequences of the biodiversity crises.

E. O. Wilson began writing about biodiversity and its importance, to bring the issues into the public eye.

These biologists must still address the problems of biodiversity loss with sound and credible scientific analysis.

**Concept 22.2: Biodiversity is declining globally, and Earth's biota is becoming increasingly homogenized.**

Alwyn Gentry devoted his life to identifying, classifying, and mapping the immense diversity of plants in Central and South America.

He was an eyewitness to plant species extinctions as deforestation rapidly destroyed habitat.

## Figure 22.4 Loss of Forest Cover in Western Ecuador


**ECOLOGY, Figure 22.4**

# Declining Biodiversity

Gentry was one of many ecologists who have been finding and describing species on the one hand and watching their destruction on the other.

Extinctions of barely known tropical plant species continue throughout the tropics at a staggering pace despite our decades-long recognition of the problem.

## Declining Biodiversity

Rates of extinction are estimated using indirect measures.

Extinction rates determined from the fossil record are used as background rates against which to compare current rates.

For mammals and birds, the background rate is one species every 200 years.

This is equivalent to an average species life span of 1 million to 10 million years.

The current extinction rate for mammals and birds is one per year, equivalent to an average species life span of only 10,000 years.

Overall, the extinction rate in the twentieth century was 100 to 1,000 times higher than background.

Current extinction rate estimation relies on:

- The species–area relationship.
- Changes in the threat status of species (e.g., shift from endangered to critically endangered).
- Rates of population decline or range contraction of common species.

# Declining Biodiversity

It is sometimes difficult to know when a species is definitely, irrevocably extinct.

Many species are known from a single specimen or location; the logistics of relocating them may be insurmountable.

Declaring a species extinct can stimulate biologists' search efforts.

A flora of Hawaiian plants (1990) listed many extinct species. Thirty-five have since been found, though only a few individuals.

These extremely small populations cannot serve the same ecological functions as more substantial populations.

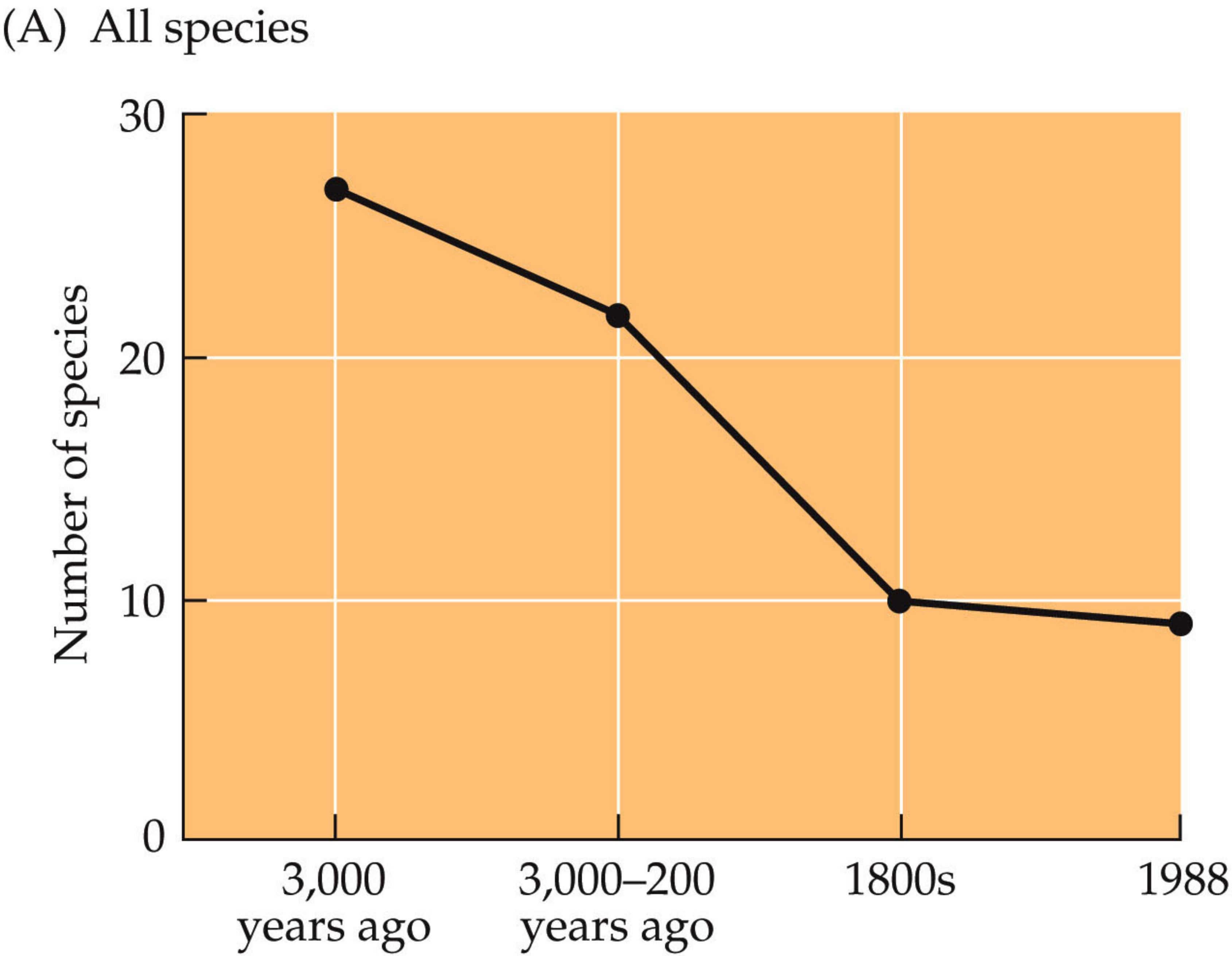
## Declining Biodiversity

Rates of biodiversity loss are accelerating, but humans have always had a large impact on other species.

Bones found on Pacific islands reveal the prehistoric extinction of up to 8,000 species of birds following colonization by Polynesians.

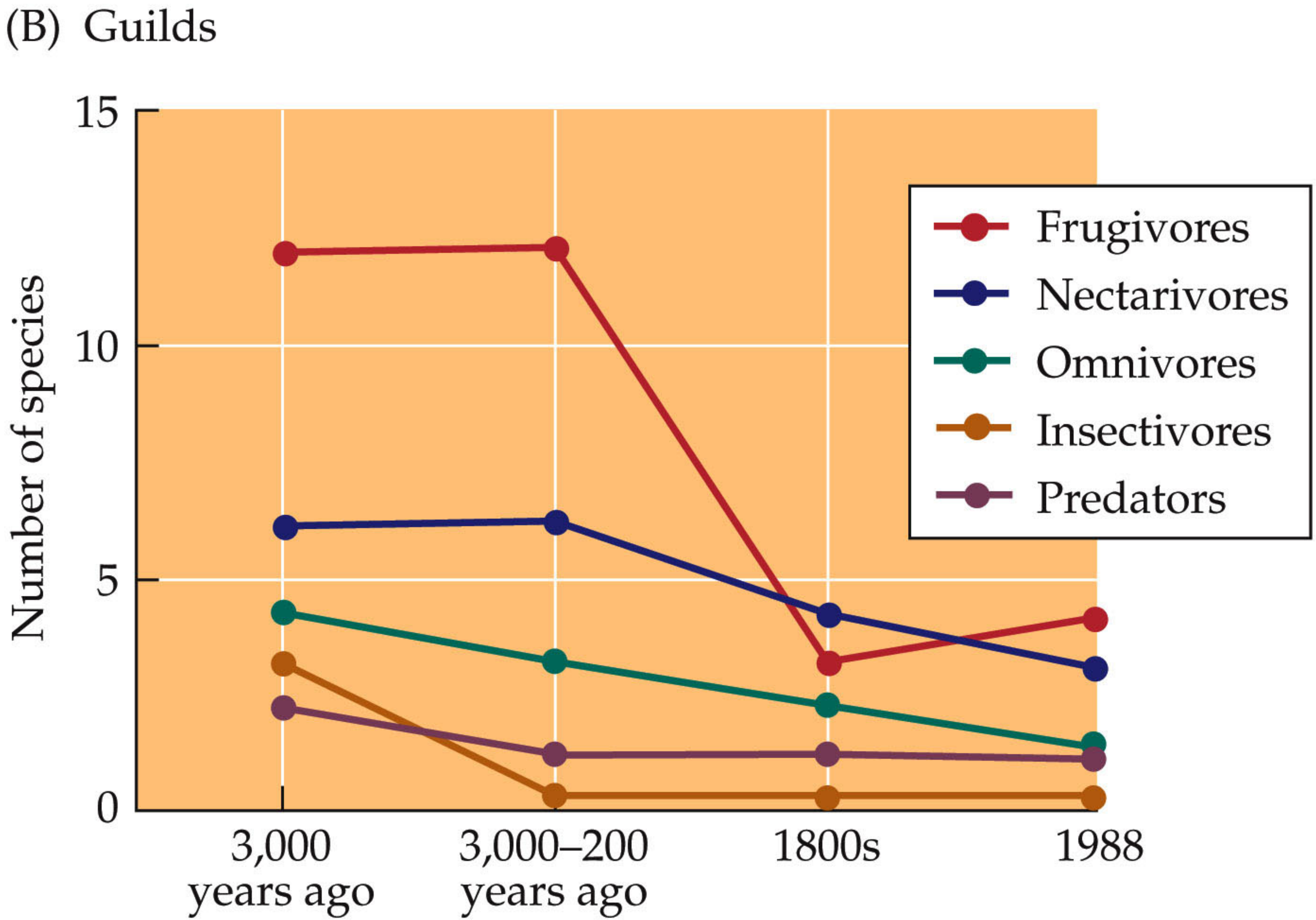
Most of the species were endemic. Some of the extinctions involved entire guilds.

Figure 22.5 Anthropogenic Extinctions Have Been Occurring for Millennia (Part 1)




ECOLOGY, Figure 22.5 (Part 1)

# Figure 22.5 Anthropogenic Extinctions Have Been Occurring for Millennia (Part 2)




**ECOLOGY, Figure 22.5 (Part 2)**

Early research on extinction focused on the problems of small populations, which are vulnerable to genetic, demographic, and environmental events that reduce the chance of persistence.

If a population drops below a certain size, it may become vulnerable to processes that act to reduce it even further (an **extinction vortex**).

Another approach is to determine the causes of population declines in particular species, with the aim of identifying actions that could counteract the declines before the extinction vortex was invoked.

A spatial approach tracks changes in species' ranges.

A study of 173 declining mammal species worldwide showed that, collectively, these species had lost half of their range area.

# Declining Biodiversity

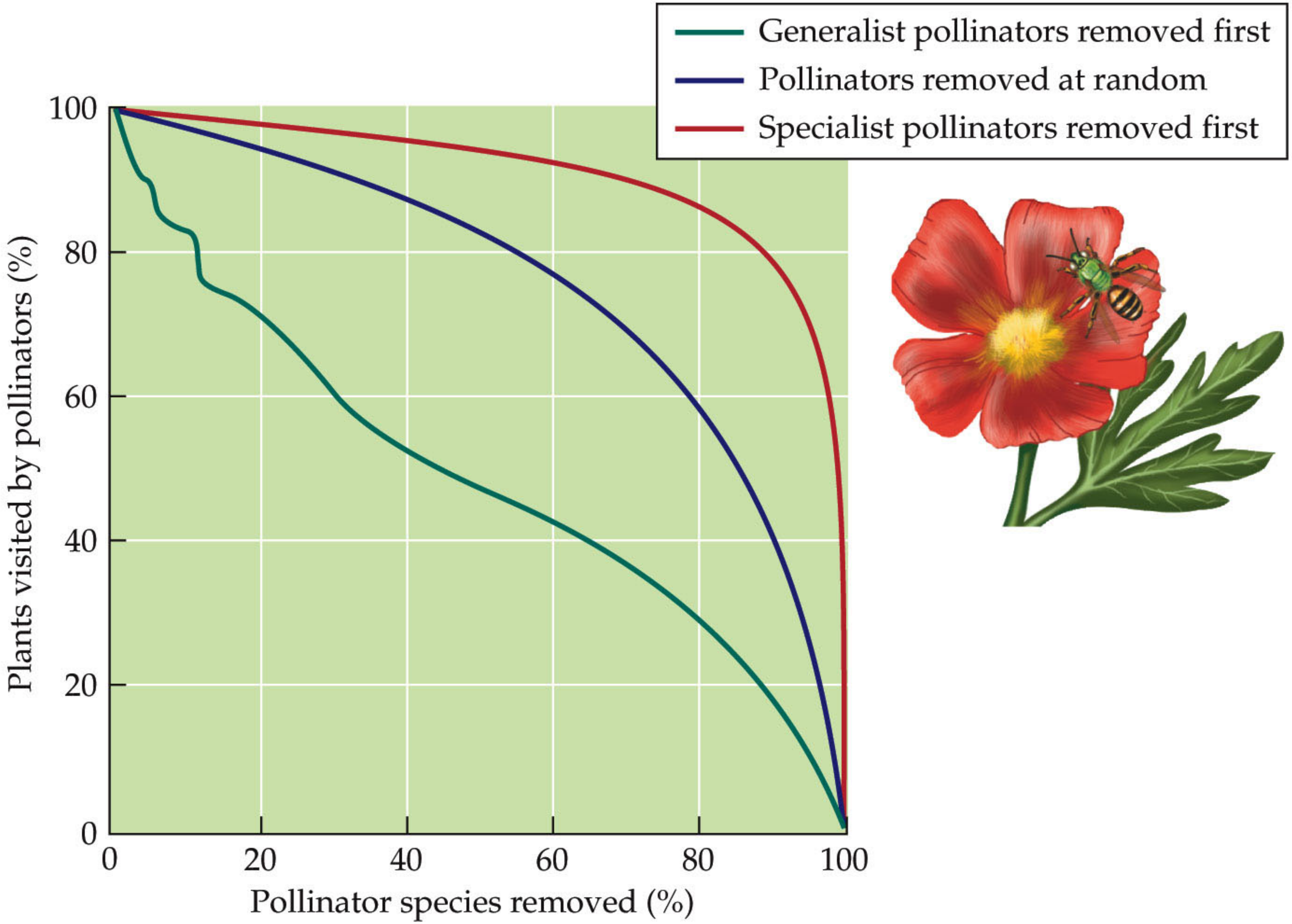
When populations are lost from an ecological community, there are consequences for that species' predators, prey, or mutualistic partners.

The resulting changes may bring about secondary extinctions and ultimately affect ecosystem function.

Generally, the stronger a species' interactions in the food web, the greater the effect of its removal.

In a study of plant–pollinator interaction webs, the effect of removing pollinators depended on whether they were specialists or generalists.

## Figure 22.6 Effects of Pollinator Losses on Plant Species Depend on Pollinator Specialization



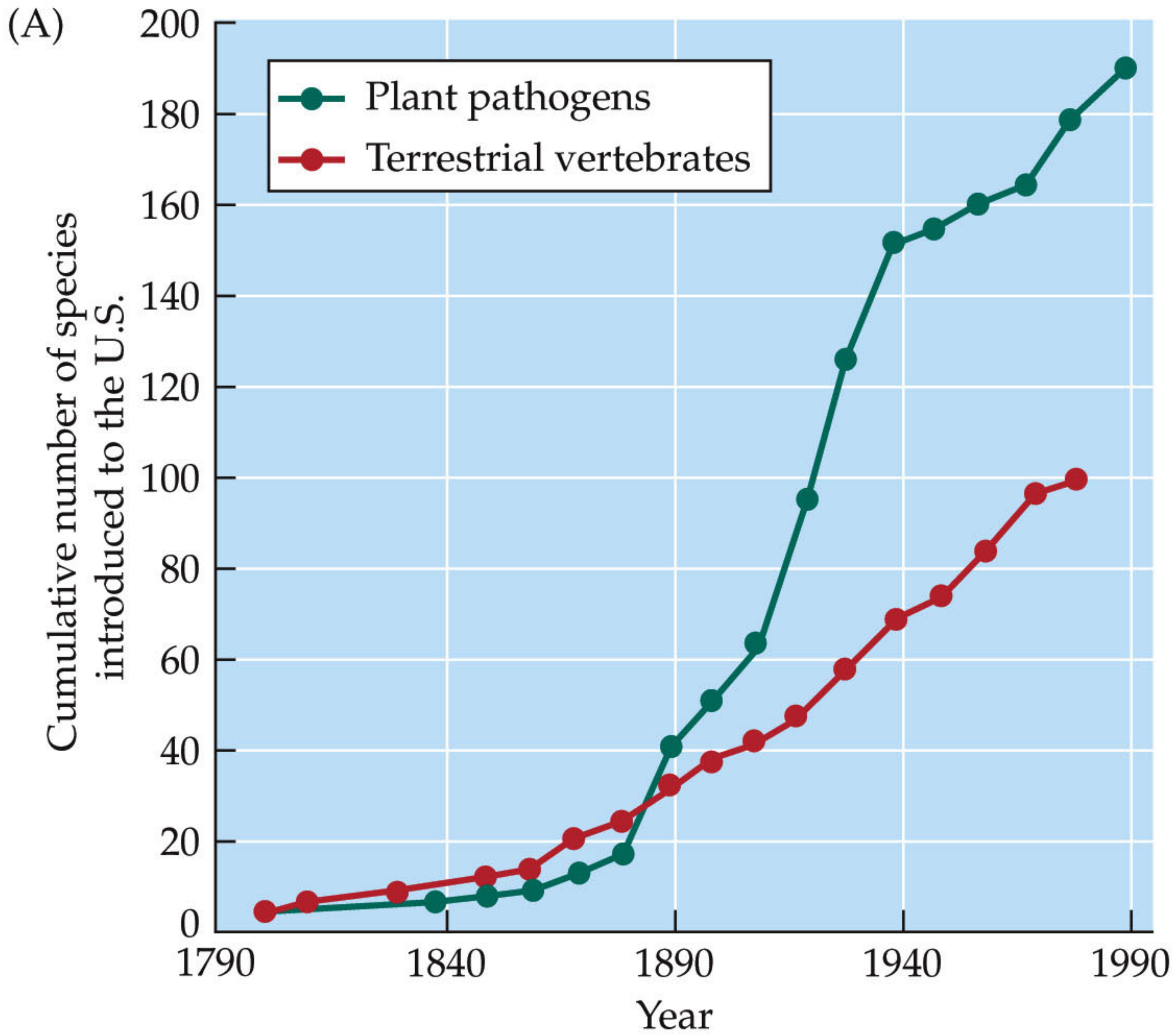

**_ECOLOGY_, Figure 22.6**

# Declining Biodiversity

The movement and introduction of species to all parts of the globe has increased over the last century.

The range expansion of some species has coincided with range contraction of many native species.

# Figure 22.7 Species Introductions Have Become a Growing Problem (Part 1)




**ECOLOGY, Figure 22.7 (Part 1)**

Figure 22.7 Species Introductions Have Become a Growing Problem (Part 2)

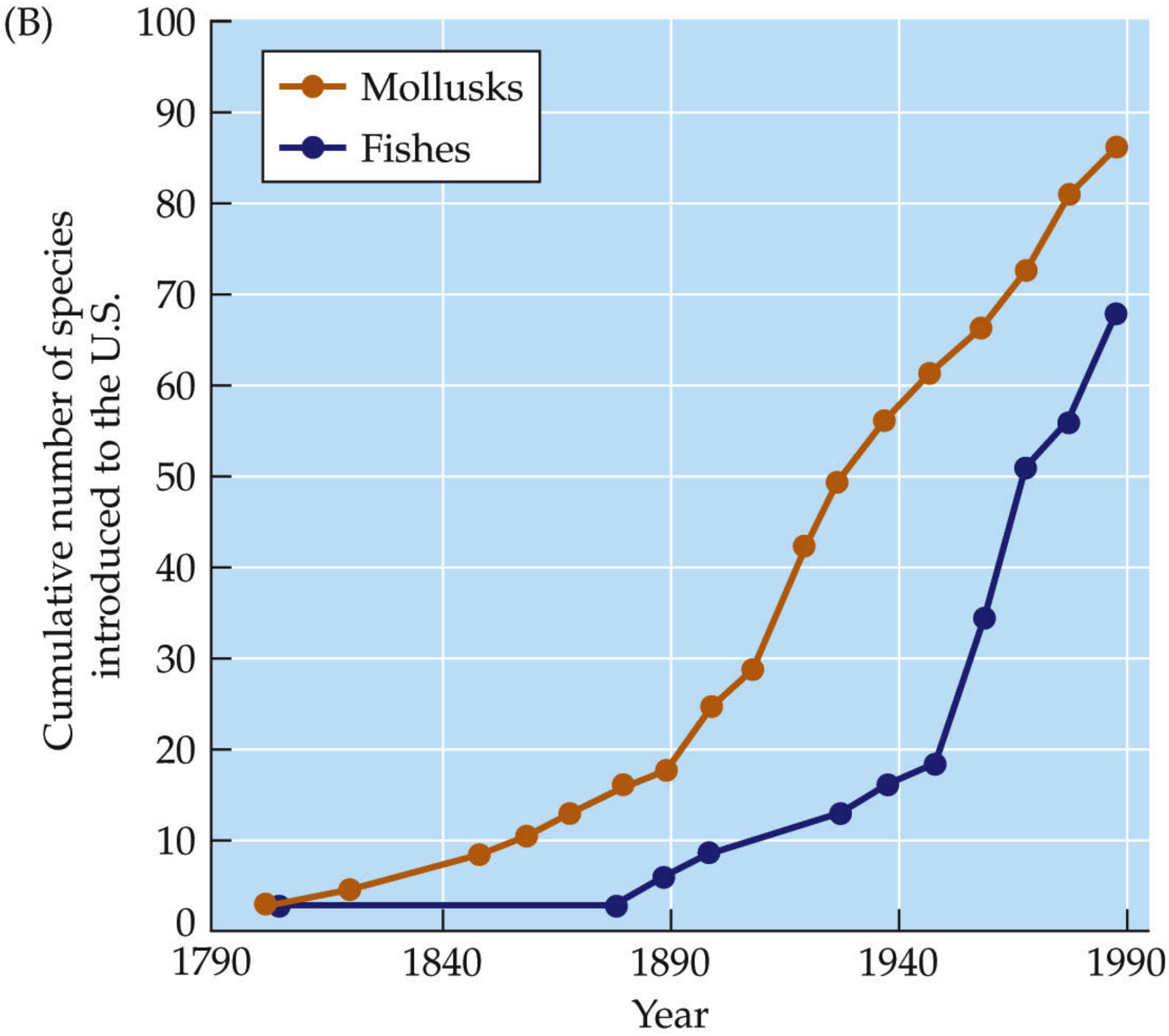
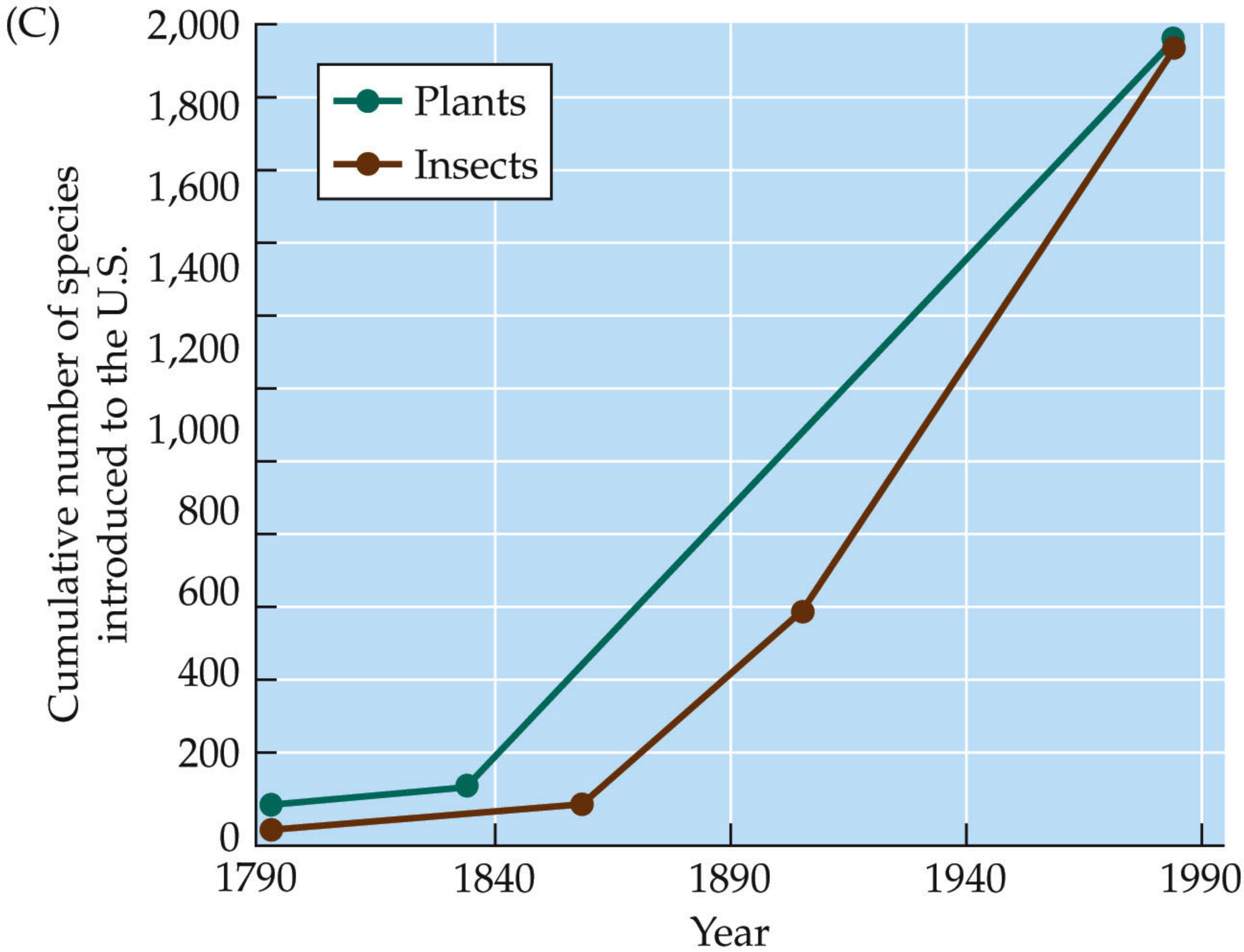


Figure 22.7 Species Introductions Have Become a Growing Problem (Part 3)




ECOLOGY, Figure 22.7 (Part 3)

# Declining Biodiversity

The greatest “losers” among native species tend to be specialists with adaptations that resulted from evolution in a particular place.

The “winners” tend to be generalists with less stringent habitat requirements.

## Declining Biodiversity

The spread of introduced species and native generalists, coupled with decline of native specialists, is leading to **taxonomic homogenization** of Earth's biota.

## Declining Biodiversity

Island biotas are particularly vulnerable to invasions and extinctions.

A survey of American Samoa found 19 of the 42 species of land snails that were historically known, plus 12 non-native species (Cowie 2001).

The non-native species occurred at high abundances.

# Declining Biodiversity

The predators contributing to decline of native land snail species were also non-natives, such as a predatory snail and the house mouse.

This trend toward homogenization of land snail faunas is widespread among Pacific Islands.

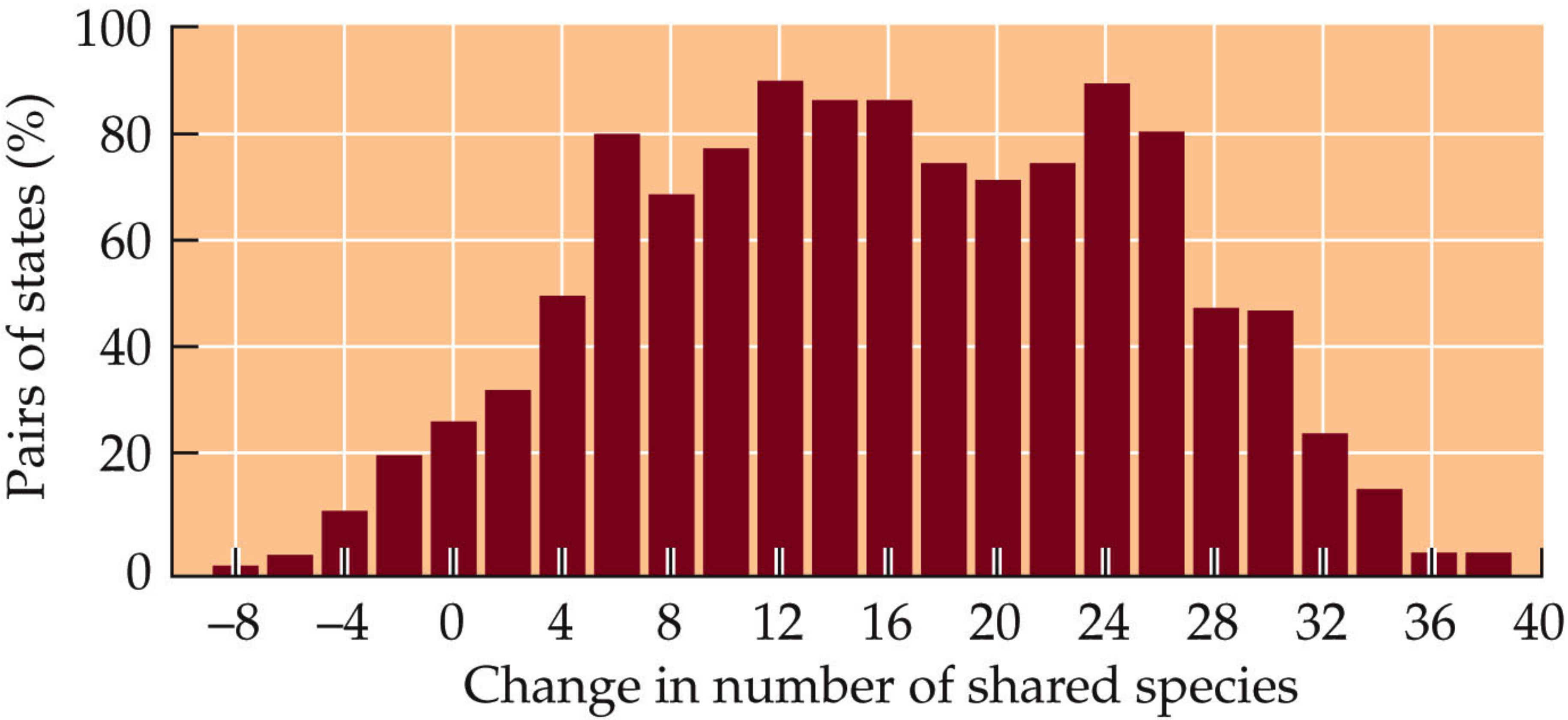
# Declining Biodiversity

Widespread introduction of game fishes has resulted in homogenization of freshwater fish in the U.S.

Rahel (2000) examined the change in number of species shared between all possible pairs of the lower 48 states.

On average, pairs of states shared 15 more species than they did at the time of European colonization.

## Figure 22.8 U.S. Fish Faunas Are Undergoing Taxonomic Homogenization



Interspecific genetic homogenization is occurring through hybridization between native and non-native species.

Example: The California tiger salamander, a threatened endemic, has hybridized with another species of tiger salamander introduced from the Midwest 50 years ago as fish bait.

## Declining Biodiversity

Homogenization is also suspected to be occurring at the level of ecosystem function.

Lower diversity and greater proportions of generalists will result in a lower number of functional groups in natural communities.

**Concept 22.3: The primary threats to biodiversity are habitat loss and degradation, invasive species, and overexploitation.**

Understanding the causes of biodiversity losses is the first step toward reversing them.

For any given species, multiple factors are likely to contribute to decline and extinction.

Example: The Pyrenean ibex was endemic to the Pyrenees in Spain and France and was abundant in the fourteenth century.

Its numbers declined gradually due to hunting, climate change, disease, and competition with domesticated livestock and non-native ungulate species such as chamois.

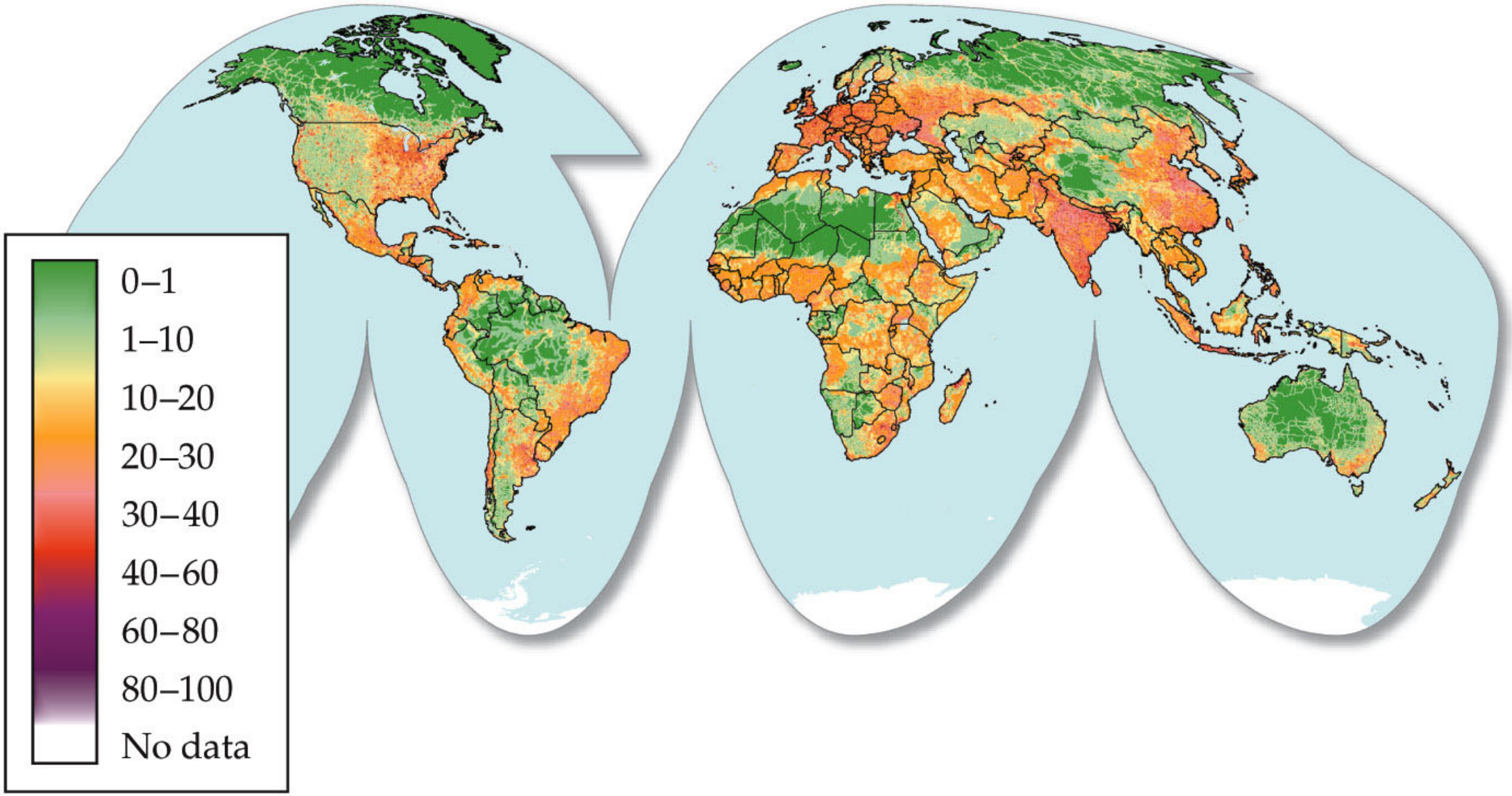
For the past century, no more than 40 animals had been counted, and the problems of small populations also contributed to the ibex's extinction.

The ecological footprint of humanity on Earth is large and rapidly increasing.

83% of the land surface has been modified in some way.

*Homo sapiens* is now appropriating 10%–55% of Earth's primary production and has appropriated 98% of the area where wheat, corn, or rice can be grown.

Figure 22.9 Habitat Loss Results from a Growing Human Footprint




ECOLOGY, Figure 22.9

## Threats to Biodiversity

This human footprint is by far the most important factor contributing to global declines in biodiversity.

Thus, addressing the degradation, fragmentation, and loss of habitat is central to conservation work.

**Habitat degradation**—changes that reduce quality of the habitat for many, but not all, species.

**Habitat fragmentation**—breaking up of continuous habitat into habitat patches amid a human-dominated landscape.

**Habitat loss**—conversion of an ecosystem to another use.

## Threats to Biodiversity

The Atlantic Forest of Brazil has suffered large losses. Its location coincides with 70% of Brazil’s human population.

More than 92% has been cleared for agriculture and urban development, and what remains is highly fragmented.

This moist tropical forest has many endemic species, many threatened with extinction.

# Figure 22.10 The Atlantic Forest of Brazil Has Been Significantly Reduced in Area


**ECOLOGY, Figure 22.10**

## Threats to Biodiversity

Habitat degradation is even more widespread than habitat loss.

It can have many causes, such as overgrazing, vegetation harvesting, agriculture, and pollution.

Example: Sand dune habitat in the Sinai Peninsula had been degraded by grazing and agriculture.

Percentage of plant cover and height of the vegetation was lower, compared to undisturbed habitat.

Degraded habitats had fewer individual lizards as well as a lower diversity of lizard species.

**Invasive species**—non-native, introduced species that sustain growing populations and have large effects on communities.

Of particular concern are invasive species that impact native endangered species.

# Threats to Biodiversity

Example: Zebra mussels have had negative impacts on the freshwater mussels in the order Unionoida.

North America has a third of the world's Unionoida.

Many species are endemic, and rare, and were already threatened by poor water quality and habitat loss.

After the zebra mussel introduction, competition brought about steep declines in native freshwater mussels (60%–90%), including some regional extinctions.

Whether the invasion will bring some species to complete extinction remains to be seen.

## Threats to Biodiversity

In many ecosystems, habitat fragmentation is followed by habitat degradation, which increases vulnerability to invasive species.

Example: Tropical dry forests of Hawaii have been reduced by 90%. This habitat has 25% of Hawaii's threatened plant species.

An invasive species of fountain grass has led to further ecosystem degradation.

It has outcompeted and displaced native plants, and increased fire frequency.

Presence of grazing animals facilitates invasion by fountain grass.

## Threats to Biodiversity

The Nile perch was introduced into Lake Victoria in Africa in the early 1960s.

After about 15 years, population size increased, as the native endemic cichlid species declined. As many as 200 cichlid species may have gone extinct.

Before the introduction, cichlids made up 80% of the biomass in the lake; the Nile perch now accounts for 80% of the biomass.

# Figure 22.11 Invasive Species Can Reduce Native Populations

## Threats to Biodiversity

As human population increases and natural habitat shrinks, the harvesting of many species from the wild has become unsustainable.

Globally, overexploitation is contributing to the imperilment of many species.

The effect of overhunting on tropical forests has removed large vertebrate faunas.

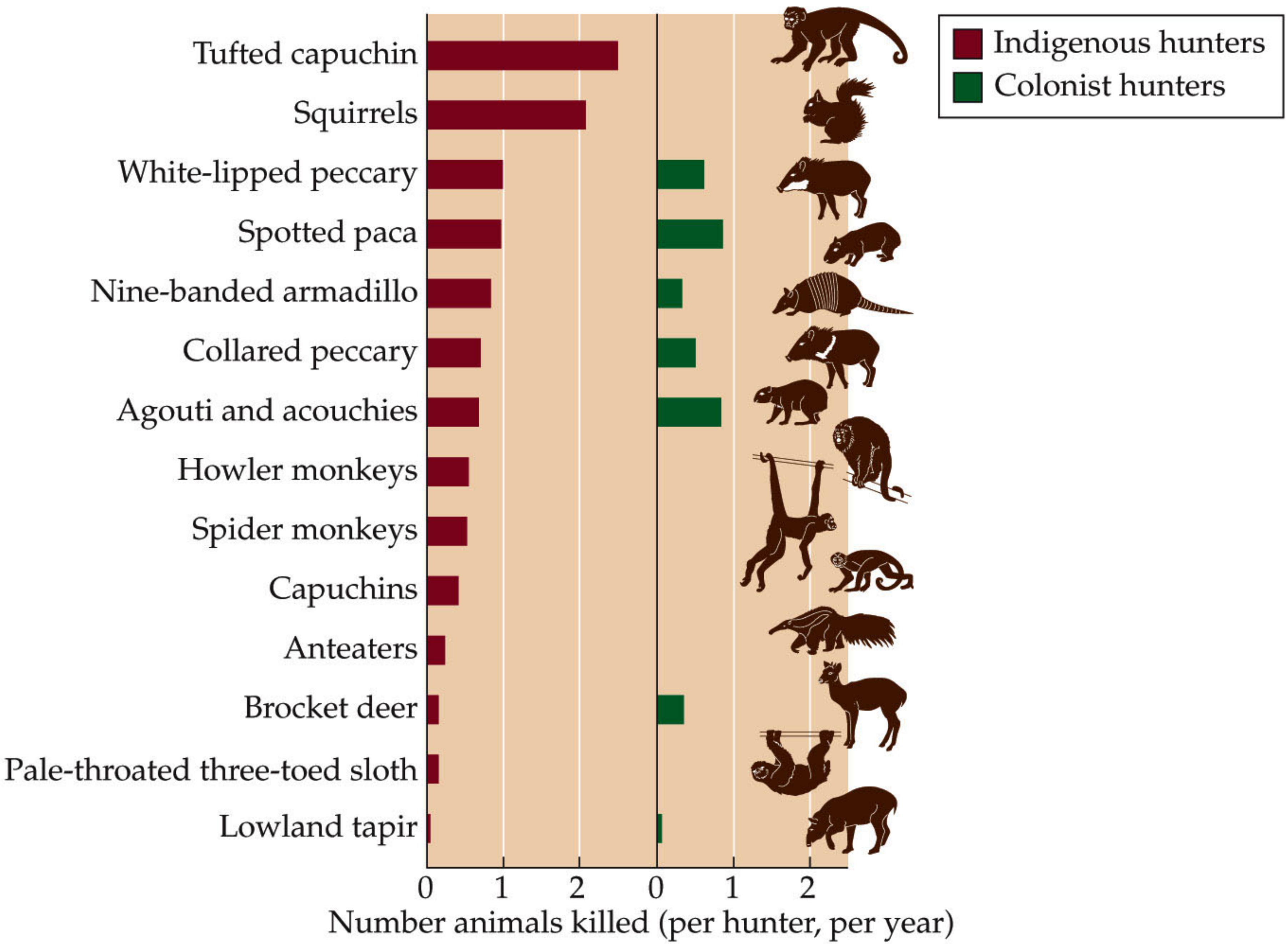
The ecological consequences of the loss of frugivores and top predators from these biological communities have been examined for only a few cases.

## Threats to Biodiversity

Road-building increases accessibility and facilitates overharvesting, as does the widespread availability of guns.

13 million mammals are killed each year in the Amazon rainforests by hunters.

# Figure 22.12 Unsustainable Hunting is Defaunating Tropical Forests




ECOLOGY, Figure 22.12

Overfishing in the oceans has led to declines in top predators, and other species.

For every ton of fish caught by commercial trawlers, 1 to 4 tons of other marine life may be brought aboard, called bycatch.

The bycatch includes species of conservation concern, including marine mammals, birds, and turtles.

# Threats to Biodiversity

Repeated trawling also degrades benthic habitat and impacts species such as corals and sponges.

Some studies have indicated that habitat recovery following trawling is very slow.

Other species have suffered from overharvesting.

All three species of mahogany are threatened by overharvesting and habitat loss.

The growth in interest in herbal medicine has threatened wild populations of many medicinal plants.

Whenever a species has market value, it is likely to be overharvested.

As desirable species become more rare, increased economic value drives ever more aggressive searches and harvest.

The best approach to protecting overexploited species is to determine sustainable levels of harvest and establish regulatory mechanisms to achieve those levels.

Some species may be maintained by developing systems to propagate them in captivity.

## Threats to Biodiversity

Other anthropogenic factors contribute to declining populations—air and water pollution, climate change, and diseases.

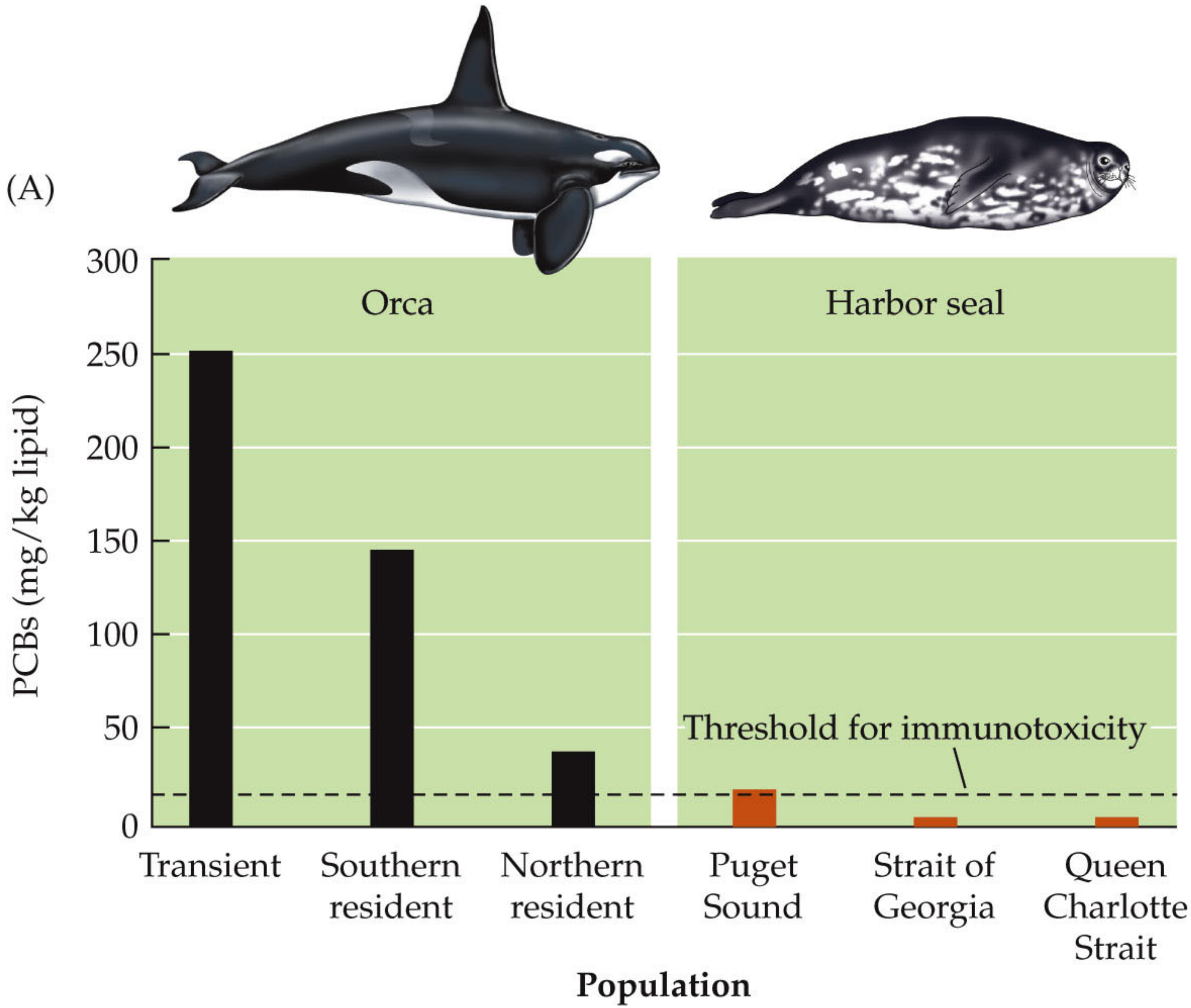
An emerging pollution threat is persistent endocrine-disrupting contaminants (EDCs).

Persistent organic pollutants such as DDT and PCBs can enter marine food webs and undergo bioaccumulation and biomagnification.

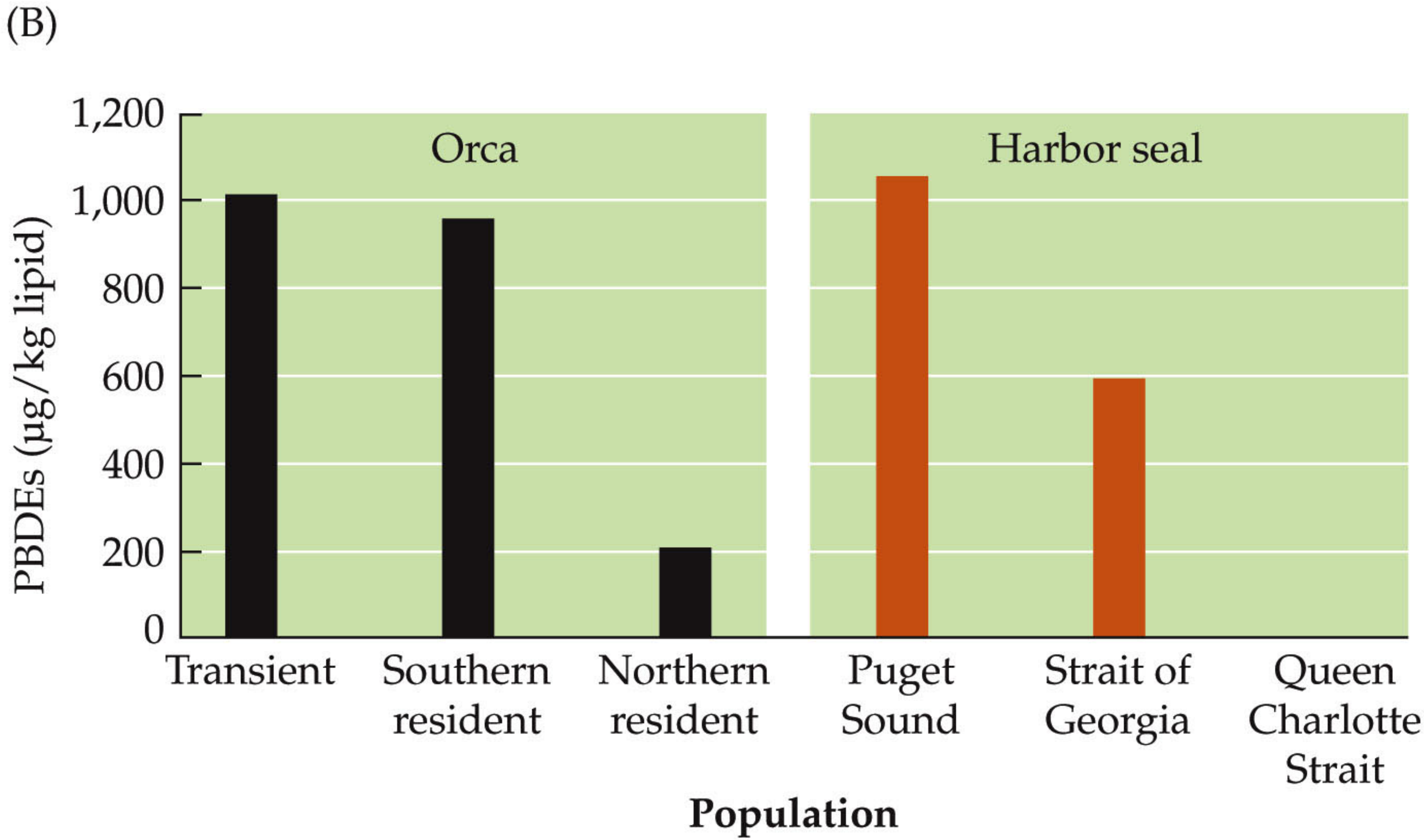
The number and concentration of chemicals in marine organisms has increased markedly in the past 40 years.

Many of these chemicals are EDCs that interfere with reproduction.

# Figure 22.13 Persistent Synthetic Chemicals Are a Growing Threat to Marine Mammals (Part 1)



## Figure 22.13 Persistent Synthetic Chemicals Are a Growing Threat to Marine Mammals (Part 2)



Specific cases of a change in conservation status due to climate change have been few in number.

The extinction of the golden toad from the cloud forests of Costa Rica has been attributed in part to shifts in fog regimes due to climate change (Pounds et al. 1999).

## Threats to Biodiversity

Of utmost concern is the possibility that the pace of warming will exceed the capacity of species to migrate to new ranges or adapt to changing conditions.

The protected areas we establish today may prove less effective over time as their physical environments change.

Disease can also contribute to species declines.

Extinction of the Tasmanian wolf in the 1930s was hastened by a disease; The Tasmanian devil now faces a similar threat.

In North America, decline of the black-footed ferret is made worse by canine distemper.

# Threats to Biodiversity

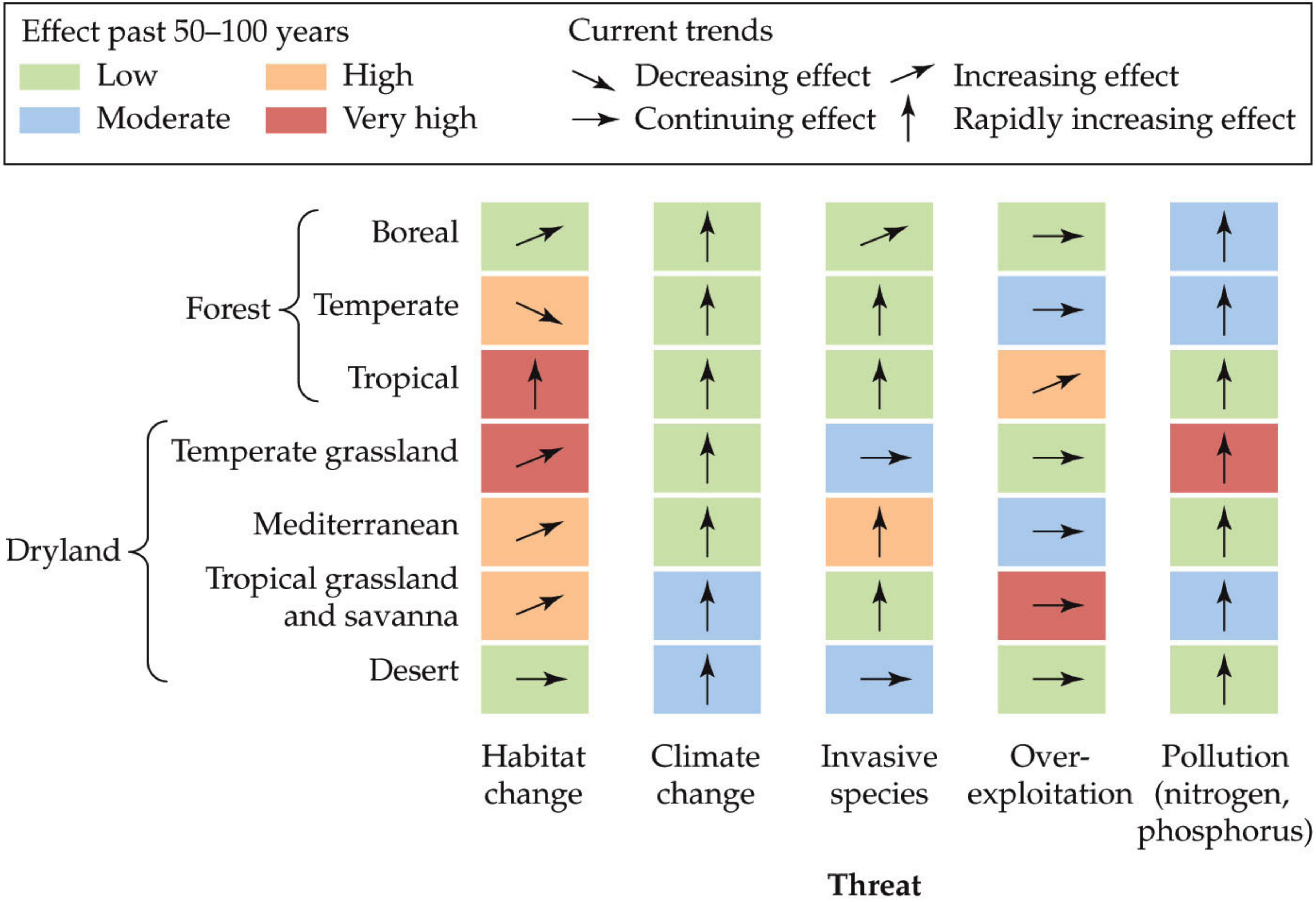
Increased contact between domesticated and wild animals has contributed to the crossing over of diseases such as rabies and rinderpest into wild populations.

# Threats to Biodiversity

The importance of the different threats varies among biomes.

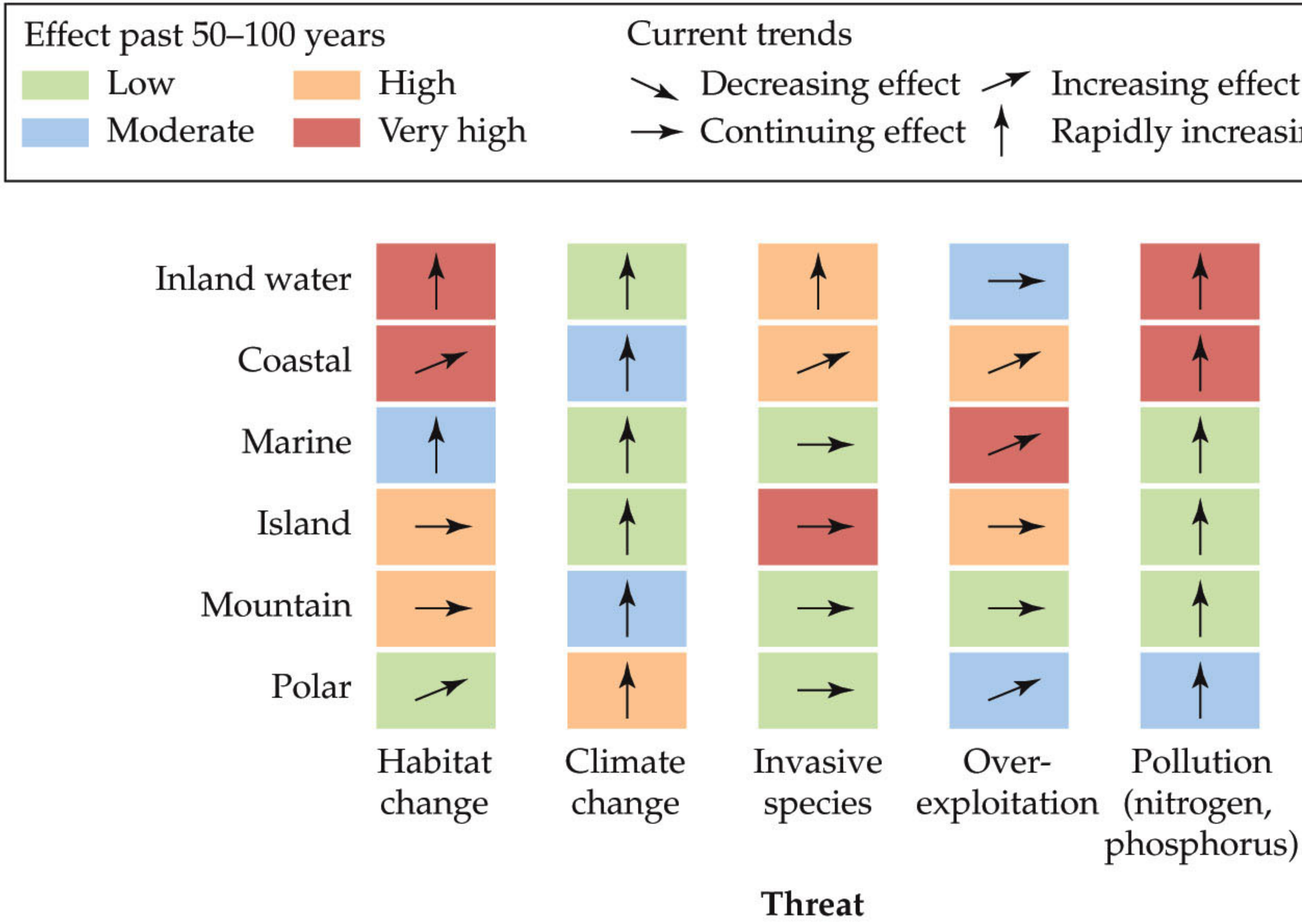
Example: Habitat loss is greater in the tropics than in the polar zones, but climate change is having more of an effect in the polar zones.

# Figure 22.14 Different Biomes Face Different Principal Threats (Part 1)




**ECOLOGY, Figure 22.14 (Part 1)**

# Figure 22.14 Different Biomes Face Different Principal Threats (Part 2)




*ECOLOGY*, **Figure 22.14 (Part 2)**

**Concept 22.4: Conservation biologists use many tools and work at multiple scales to manage declining populations.**

Should conservation focus on habitat preservation or understanding the biology of threatened species?

The U.S. Endangered Species Act mandates the identification and protection of critical habitat.

# Approaches to Conservation

There are two approaches to conservation planning:

**Fine-filter** (genes/populations/species).

**Coarse-filter** (landscape/ecosystem/habitat)—emphasis on maintaining ecosystem processes; protects many species at once.

The choice of where to focus efforts on a landscape scale must of course be dictated by a certain amount of fine-filter information.

Small populations are vulnerable to the effects of genetic drift and inbreeding, which can result in the loss of genetic variability and the fixation of deleterious alleles.

This is an important issue in conservation biology.

A genetic analysis of cheetahs revealed extremely low diversity.

They also had low sperm counts and poor reproductive success, both in the wild and in captivity.

Biologists attributed this phenomenon to a genetic bottleneck in the Pleistocene (an event that reduced the population to only a few individuals).

The role of genetics in species extinctions remains unclear.

Spielman et al. (2004) analyzed several studies that show threatened species generally have lower heterozygosity than their more common relatives, but whether this contributed to their threatened status is not clear.

Inbreeding is also a problem for small populations.

Genetic analyses are also being used to identify **evolutionarily significant units**—appropriate targets for management within species (subspecies or populations).

Example: Salmon populations in the Pacific Northwest are studied to distinguish populations warranting protection under the Endangered Species Act.

Molecular genetic techniques are also used to identify the source of illegal wildlife products.

Example: Identification of illegally harvested whale species in Japanese meat that was labeled as either dolphin or Southern Hemisphere minke whale, which are legal to hunt.

## Figure 22.15 Molecular Genetic Can Identify the Origin of Organisms Intercepted in Illegal Trade

Demographic models are also used to guide management of populations.

**Population viability analysis** (**PVA**) allows ecologists to assess extinction risks and evaluate management options.

The probabilities of population persistence are calculated under various scenarios.

The models range from simple to complex, and allow prediction of outcomes given certain assumptions about future conditions.

PVA is used to:

- Assess risk of extinction of a population.
- Identify particularly vulnerable age or stage classes.
- Determine how many animals to release or how many plants to propagate to establish a new population.
- Determine what might be a safe number of animals to harvest.

Example: Demographic models were used for for loggerhead sea turtles to determine that protection of mature individuals would be key to slowing declines in populations.

In Florida, the fire regime that would best serve population growth in a rare plant was determined through PVA simulations of burns at different times of year and at different intervals.

Models are not without problems:

There is not much demographic information for many threatened species, and unknown critical factors can be left out.

Models need to be constantly refined and revisited to check their validity against field observations, just as management strategies must be checked and adjusted for effectiveness.

When a population becomes extremely small, direct intervention may be called for.

The only hope may be to remove the species from its habitat—ex situ—and allow it to multiply in sheltered conditions.

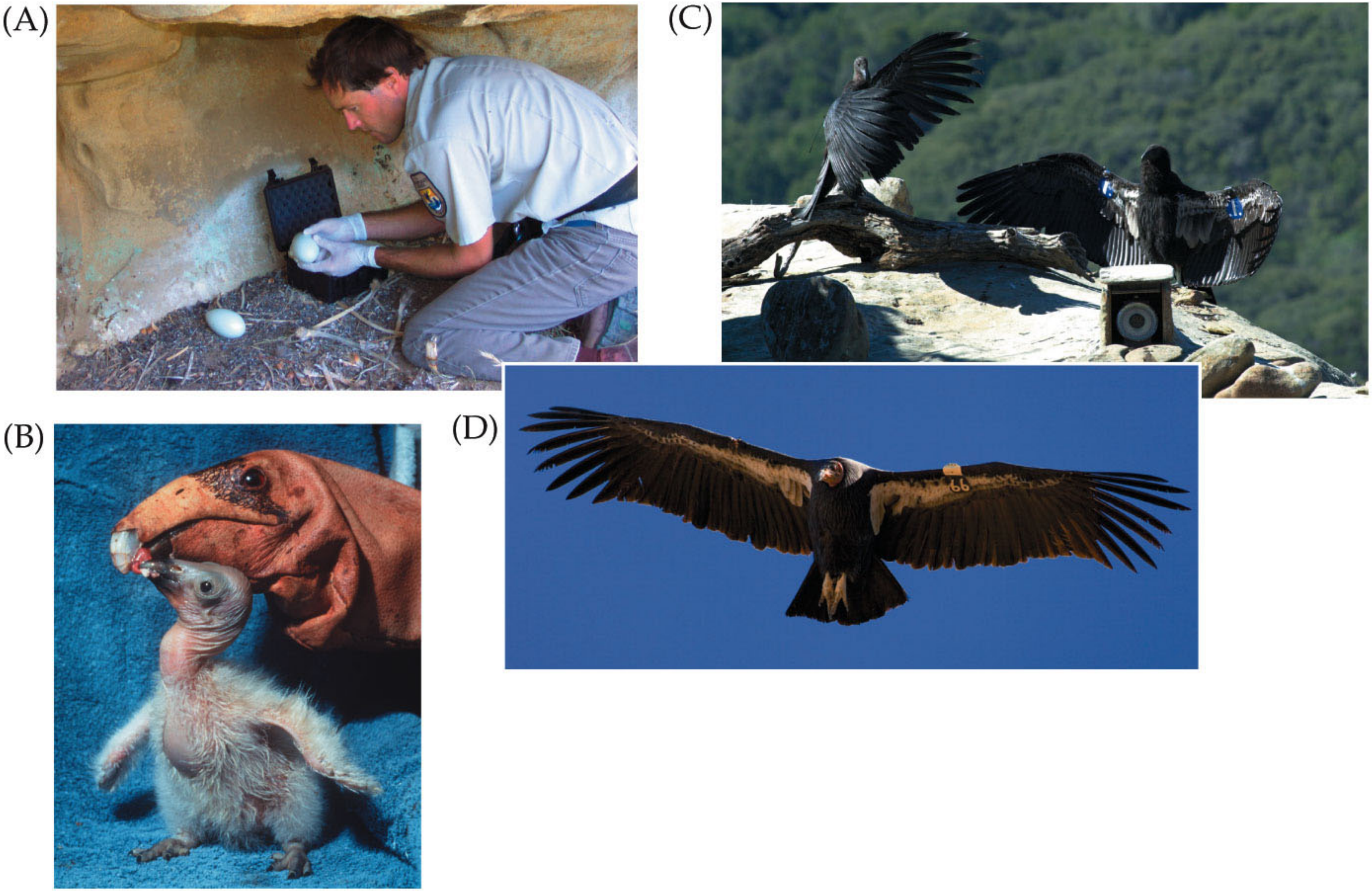
This was done for the California condor, whose population had dropped to 22 by 1982.

In 1987, the last birds were captured and brought to an ex situ facility for breeding.

There are now more than 200 birds, and some have been released to the wild.

It has taken a tremendous amount of effort, and many threats to condors still exist in the wild.

# Figure 22.16 Ex Situ Conservation Efforts Can Rescue Species from the Brink of Extinction




**ECOLOGY, Figure 22.16**

Ex situ programs play an important role for some species, but they are very expensive and have had limited success in restoring wild populations.

Could the money be better spent for things such as land protection, for in situ efforts?

Sometimes the answer is no, especially for critically small populations.

Many of the decisions that impact ecosystems fall into the realm of public policy.

In the U.S. the Endangered Species Act (ESA) is the main legislation to protect threatened species.

The U.S. Fish and Wildlife Service and the National Marine Fisheries Service are charged with listing threatened and endangered species, identifying critical habitat for each species, drafting recovery plans, and carrying out actions necessary to increase abundances to target numbers.

The ESA currently protects 1,300 native species.

It also regulates trade in endangered species as a result of an international treaty, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

The CITES treaty has been in place for 35 years, and mandates total prohibition of trade of endangered species, or their parts (e.g., furs).

Other species must be monitored in their home countries for indications that trade should be restricted.

But, international trade in wild species is worth billions of dollars, and much of it is illegal.

Enforcement of CITES regulation is often difficult, but the treaty has been a key instrument in protecting species worldwide.

Another international agreement, The Convention on Biological Diversity, acknowledges that declining biodiversity is a problem shared by all the world’s people.

This agreement serves as a framework for nations to develop conservation plans, and to work together to address biodiversity loss.

There are many other national, state, and local regulations and policies designed to restrict development, manage harvests, and protect species and habitats.

Not all land can be protected, so private landowners must also be encouraged to protect biodiversity. There must also be a legal framework that applies to private lands.

# Ranking Species for Protection

**Concept 22.5: Prioritizing species helps maximize the biodiversity that can be protected with limited resources.**

How do we allocate limited resources for species protection?

Do we protect all threatened species, or only ones with large ecological roles?

Which habitats are most critical to protect?

# Ranking Species for Protection

Some species may be naturally rare.

Rarity depends on geographic range, habitat specificity, and population sizes.

This results in seven different types of rarity. Conservation of these different types of rare species requires different approaches.

## TABLE 22.2

**Seven Forms of Rarity**

| Local population size | Geographic distribution: WIDE — Habitat specificity BROAD | Geographic distribution: WIDE — Habitat specificity RESTRICTED | Geographic distribution: NARROW — Habitat specificity BROAD | Geographic distribution: NARROW — Habitat specificity RESTRICTED |
|---|---|---|---|---|
| SOMEWHERE LARGE | Common | **RARE:** Widely distributed in an uncommon specific habitat | **RARE:** Narrow endemic, but with a broad ecological tolerance and locally abundant | **RARE:** Endemic, with narrow ecological requirements, but locally abundant |
| EVERYWHERE SMALL | **RARE:** Never abundant, but distributed over a wide geographic and habitat range | **RARE:** Small populations in a specific habitat, but over a wide geographic area | **RARE:** Endemic, broad ecological tolerance, small populations | **RARE:** Endemic, narrow ecological tolerance, small populations |

*Source:* Rabinowitz et al. 1986.

# Ranking Species for Protection

The World Conservation Union began assessments of conservation status in 1963 with the red-listing process.

The Nature Conservancy established the Natural Heritage Program (now NatureServe) in the early 1970s to assess conservation status of American species.

## Ranking Species for Protection

Assessment protocols take into account population size, the total geographic area that the species occupies, the rate of its decline, and its risk of extinction.

Different sets of criteria are used for different kinds of organisms (e.g., birds or butterflies, or trees).

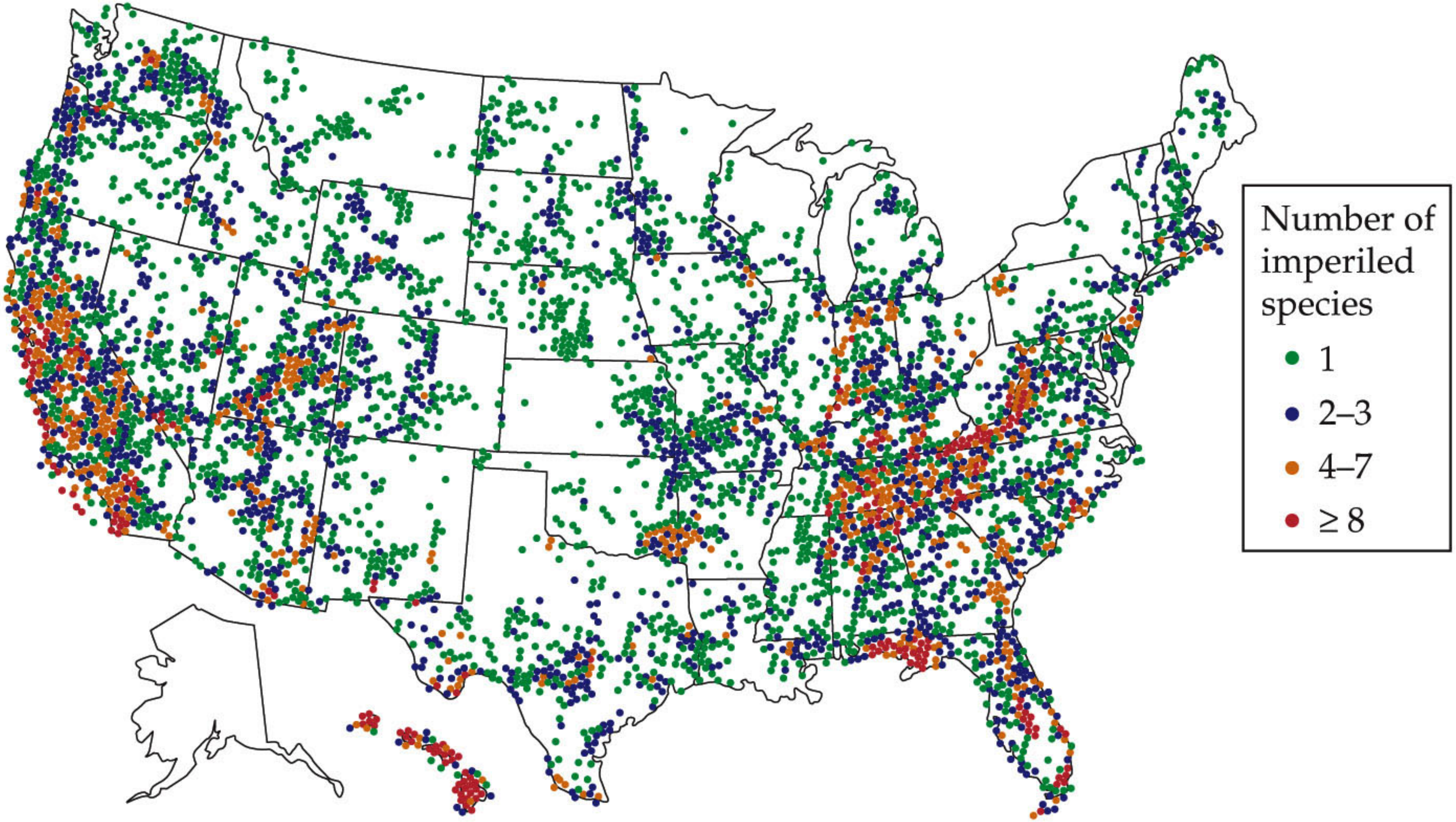
## Ranking Species for Protection

Assessments of conservation status can play a role in conservation planning.

Areas with clusters of threatened species can be identified for protection.

The assessments are consulted before development projects go through, and they keep the threatened species in the public eye.

# Figure 22.17 Areas of the U.S. Have Higher Concentrations of Imperiled Species than Others




ECOLOGY, Figure 22.17

# Ranking Species for Protection

Protecting habitat for one species, such as the red-cockaded woodpecker, can result in protection of other species as well. These are called **surrogate species**.

This can be a shortcut when there is a lack of information about many species in an area.

# Ranking Species for Protection

A **flagship species** is a charismatic organism that people will want to give protection to, such as the giant panda.

# Figure 22.18 A Flagship Species, the Giant Panda

**Umbrella species**—selected with the assumption that protection of its habitat will serve as an "umbrella" to protect many other species with similar habitat requirements.

They usually have large ranges (grizzly bear) or specialized habitats (red-cockaded woodpecker), or are easy to count (butterflies).

## Ranking Species for Protection

Several **focal species** are selected for their different ecological requirements or susceptibility to different threats.

By thus casting a broader net, we improve the chances of protecting regional biodiversity.

# Case Study Revisited: Can Birds and Bombs Coexist?

The cooperative breeding system of red-cockaded woodpeckers evolved in response to a shortage of suitable breeding and nesting sites.

The woodpeckers excavate nests in living trees, which takes a year or more. The chance of a young bird finding a vacant cavity is very small.

# Case Study Revisited: Can Birds and Bombs Coexist?

Under these circumstances, it is advantageous for young birds to remain with their parents and help them rear their younger siblings until one of them inherits a breeding site rather than dispersing into territory that is already occupied to capacity.

## Case Study Revisited: Can Birds and Bombs Coexist?

Trees suitable for cavity excavation must be sufficiently large (at least 90 years old) and have some heart rot fungus, which facilitates excavation. These trees are in short supply.

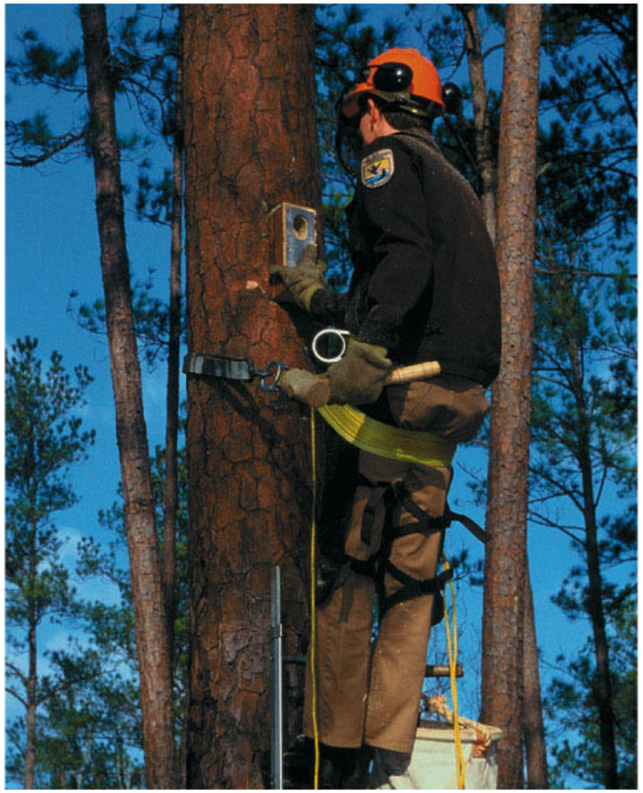
Studies of the woodpecker's nesting behavior led to the idea of building clusters of nesting cavities that would be suitable.

# Figure 22.19 Artificial Nest Cavities Have Allowed Red-Cockaded Woodpeckers to Increase

(A)

(B)


(C)



## Case Study Revisited: Can Birds and Bombs Coexist?

Hurricane Hugo was devastating to red-cockaded woodpeckers in Francis Marion National Forest, SC.

Within 2 years of the storm, National Forest workers had installed 443 artificial cavities. By 1992 the population had recovered to 332 breeding groups.

## Case Study Revisited: Can Birds and Bombs Coexist?

Research on this woodpecker has utilized all the tools:

- Models of population dynamics helped identify vulnerable stages in the woodpecker’s life cycle.
- Genetic studies focused attention on the threat of inbreeding.

## Case Study Revisited: Can Birds and Bombs Coexist?

- Field studies demonstrated the need for prescribed burning and protection of the mature trees favored by the woodpeckers.
- Economic and sociological analyses led to a "safeharbor" program that makes endangered species management easier for private landowners.

## Case Study Revisited: Can Birds and Bombs Coexist?

- Managers reached into an actual toolbox to build nesting cavities.

Much of this work has been dictated by the U.S. Endangered Species Act.

## Connections in Nature: Some Burning Questions

Fire is the key to managing the longleaf pine system.

Prescribed burning is used as a management tool for conserving species in many ecosystems where fire has historically been a regular disturbance.

# Figure 22.20 Prescribed Burning Is a Vital Management Tool in Some Ecosystems

## Connections in Nature: Some Burning Questions

But prescribed burning can have unintended consequences.

In some Florida longleaf pine forests, burning left openings that allowed cogongrass, an invasive plant from Asia, to become established.

This grass causes fires to burn hotter, higher, and more evenly on a horizontal plane.

# Connections in Nature: Some Burning Questions

Hotter fires cause increased mortality of longleaf pine seedlings and native wiregrass, favorable conditions for further infiltration of cogongrass.

Should managers burn or not? The timing and frequency of the prescribed burns can be crucial.

# Connections in Nature: Some Burning Questions

In the Animas Mountains, NM, fire maintains the native grassland that serves as habitat for several rare and endangered species.

But it is a threat to the New Mexico ridge-nosed rattlesnake, another threatened species. Fires that are too hot can kill the snakes.

Again, timing and frequency are important.

## Connections in Nature: Some Burning Questions

People are also part of the landscape that is managed by burning.

Education and outreach is necessary, as well as carefully controlled burning and safety measures.