

Chapter 10

Biodiversity

Section, 1 What is Biodiversity?

DAY ONE



Chapter 10

Biodiversity

Section 3, The Future of Biodiversity

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Preview 

Main 

Saving Species One at a Time

- When a species is clearly on the verge of extinction, concerned people sometimes make extraordinary efforts to save the last few individuals.
- These people hope that a stable population may be restored someday.
- Methods to preserve individual species often involve **keeping and breeding** the species in captivity.



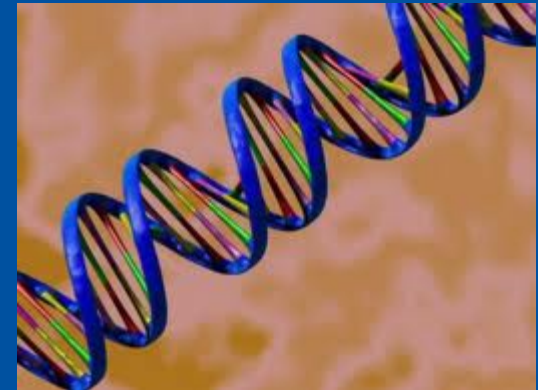
Captive-Breeding Programs

- Wildlife experts may attempt to restore the population of a species through **captive-breeding programs**.
- These programs involve breeding species in **captivity**, with the hopes of reintroducing populations to their natural habitats.
- This type of program has been used successfully with the **Californian condor**, for example. But the question remains whether or not these restored populations will ever reproduce in the wild.



Preserving Genetic Material

- One way to save the essence of a species is by preserving its genetic material.
- **Germ plasm** is hereditary material (chromosomes and genes) that is usually contained in the protoplasm of germ cells and may be stored as seeds, sperm, eggs, or pure DNA.
- Germ plasm banks store germ plasm in controlled environments for future use in research or species-recovery efforts.



Zoos, Aquariums, Parks, and Gardens

- In some cases, zoos now house the few remaining members of a species and are perhaps the species' last hope for survival.
- Zoos, wildlife parks, aquariums, and botanical gardens, are living museums of the world's biodiversity.
- But, these kinds of facilities rarely have enough resources or knowledge to preserve more than a fraction of the world's rare and threatened species.



More Study Needed

- Ultimately, saving a few individuals does little to preserve a species as captive species may not reproduce or survive again in the wild.
- Also, small populations are **vulnerable** to infectious diseases and genetic disorders caused by inbreeding.
- Conservationists hope that these strategies are a last resort to save species.



Preserving Habitats and Ecosystems

- The most effective way to save species is to **protect** their habitats.
- Small plots of land for a single population is usually not enough because a species confined to a small area could be wiped out by a single natural disaster. While other species require a large range to find adequate food.
- Therefore, protecting the habitats of endangered and threatened species often means **preserving or managing** large areas.

Conservation Strategies

- Most conservationists now give priority to protecting entire ecosystems rather than individual species.
- By doing this, we may be able to save most of the species in an ecosystem instead of only the ones that have been identified as endangered.
- The general public has now begun to understand that Earth's biosphere depends on all its connected ecosystems.



Conservation Strategies

- While conservationists focus on the hotspots discussed earlier to protect biodiversity worldwide, they also support additional strategies.
- One strategy is to **identify** areas of native habitat that can be preserved, restored, and linked into large networks.
- Another promising strategy is to **promote** products that have been harvested with sustainable practices.



More Study Needed

- Conservationists emphasize the urgent need for more serious study of the workings of species and ecosystems.
- Only in recent decades has there been research into basic questions as, How much fragmentation can a particular ecosystem tolerate?
- The answers to questions asked now may be years or decades away, but decisions affecting biodiversity continue to be made based on available information.

Legal Protection for Species

- Many nations have laws and regulations designed to prevent the extinction of species, and those in the United States are among the strongest.
- For example, in 1973, the U.S. Congress pass the Endangered Species Act.
- The **Endangered Species Act** is designed to protect any plant or animal species in danger of extinction.



U.S. Laws

- Under the first provision of the Endangered Species Act, the U.S. Fish and Wildlife Service (USFWS) must **compile** a list of all endangered and threatened species in the United States.
- As of 2002, **983** species of plants and animals were listed.
- The second main provision of the act **protects** listed species from human harm.
- The third provision **prevents** the federal government from carrying out any project that jeopardizes a listed species.

U.S. Laws

Major Provisions of the Endangered Species Act

- The U.S. Fish and Wildlife Service (USFWS) must compile a list of all endangered and threatened species.
- Endangered and threatened animal species may not be caught or killed. Endangered and threatened plants on federal land may not be uprooted. No part of an endangered and threatened species may be sold or traded.
- The federal government may not carry out any project that jeopardizes endangered species.
- The U.S. Fish and Wildlife Service must prepare a species recovery plan for each endangered and threatened species.

Recovery Plans

- Under the fourth main provision of the Endangered Species Act, the USFWS must **prepare** a species recovery plan for each listed species.
- These plans often propose to protect or restore habitat for each species.
- However, attempts to restrict human uses of land can be controversial.
- Real-estate developers may be prohibited from building in certain areas, and people may lose income and may object when their interests are placed below those of another species.



Habitat Conservation Plans

- Battles between environmentalists and developers are widely publicized, and in most cases, compromises are eventually worked out.
- One form of compromise is a habitat conservation plan.
- A **habitat conservation plan** is a land-use plan that attempts to protect threatened or endangered species across a given area by allowing some tradeoffs between harm to the species and additional conservation commitments among cooperating parties.



International Cooperation

- At the global level, the International Union for the Conservation of Nature and Natural Resources (**IUCN**) facilitates efforts to protect species and habitats.
- The IUCN publishes **Red Lists** of species in danger of extinction around the world, advises governments on ways to manage their natural resources, and works with groups like the World Wildlife Fund to sponsor projects such as attempting to stop poaching in Uganda.



International Trade and Poaching

- One product of the IUCN has been an international treaty called **CITES** (the Convention on International Trade in Endangered Species).
- The CITES treaty was the first effective effort to **stop** the slaughter of African elephants being killed by poachers who would then sell the ivory tusks.
- In 1989, the members of CITES proposed a total worldwide ban on all sales, imports, and exports of ivory, hoping to put a stop the problem.

International Trade and Poaching

- Some people worried that making ivory illegal might increase the rate of poaching instead of decrease it.
- They argued that illegal ivory, like illegal drugs, might sell for a higher price.
- But after the ban was enacted, the price of ivory dropped, and elephant poaching declined dramatically.



The Biodiversity Treaty

- One of the most ambitious efforts to tackle environmental issues on a worldwide scale was the United Nations Conference on Environment and Development, also known as the first **Earth Summit**. An important result of the Earth Summit was the Biodiversity Treaty.
- The **Biodiversity Treaty** is an international agreement aimed at strengthening national control and preservation of biological resources.

The Biodiversity Treaty

- The treaty's goal is to **preserve** biodiversity and ensure the sustainable and fair use of genetic resources in all countries.
- However, the treaty took several years to be adopted into law by the U.S. government.
- Some political groups objected to the treaty, especially to the suggestion that economic and trade agreements should take into account any impacts on biodiversity that might result from the agreements.

Private Conservation Efforts

- Many private organizations work to protect species worldwide, often more effectively than government agencies.
- For example, the World Wildlife Fund encourages the sustainable use of resources and supports wildlife protection. The Nature Conservancy has helped purchase millions of hectares of habitat preserves in 29 countries. Conservation International helps identify biodiversity hotspots. And, Greenpeace International organizes direct and sometimes confrontational actions.

Balancing Human Needs

- Attempts to protect species often come into conflict with the interests of the world's human inhabitants.
- An endangered species might represent a source of food or income. Or a given species may not seem valuable to those who do not understand the species' role in an ecosystem.
- Many conservationists feel that an important part of protecting species is making the value of biodiversity understood by more people.

Ticket out the Door

1. What is a captive breeding program?
2. What is germ plasm?
3. What is the Endangered Species Act?
4. When was the Endangered Species Act passed?
5. What is a habitat conservation plan?
6. What is CITES?
7. What is the Biodiversity Treaty?

Chapter 10

Biodiversity

Section 2, Biodiversity at Risk

DAY ONE

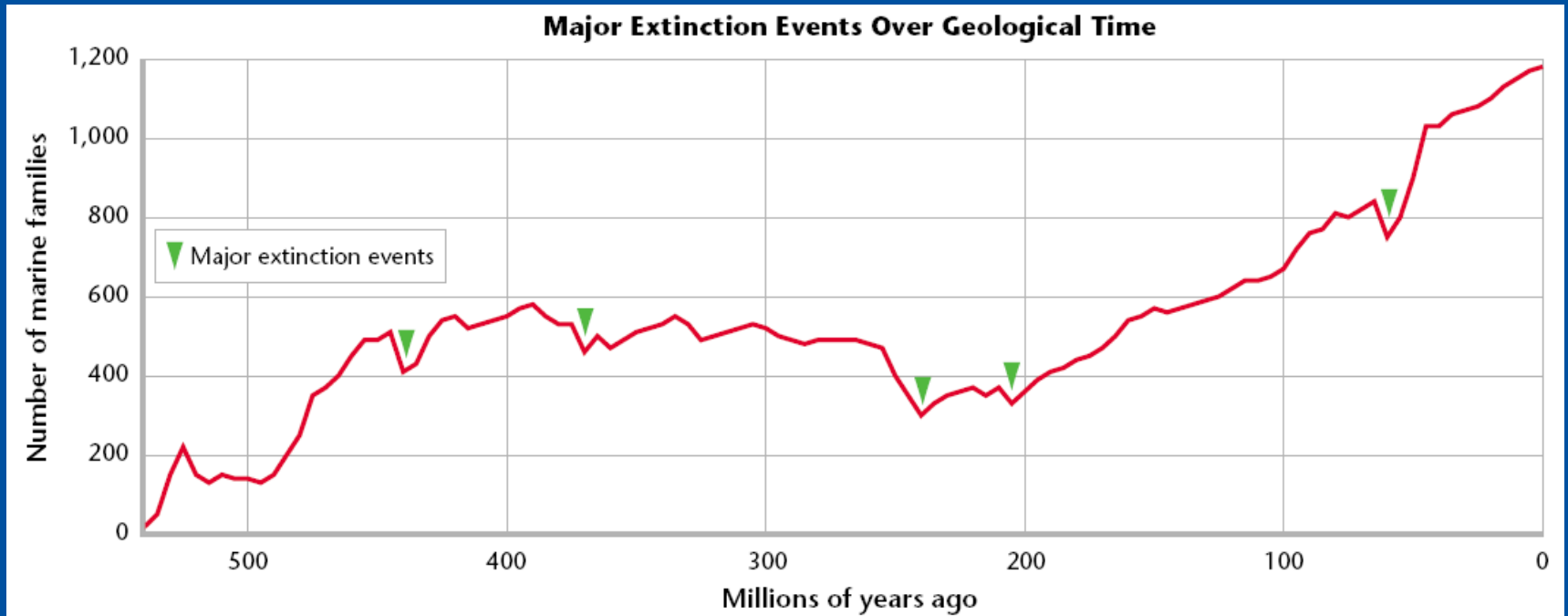


Biodiversity at Risk

- The extinction of many species in a relatively short period of time is called a **mass extinction**.
- Earth has experienced several mass extinctions, each probably caused by a global change in climate.
- It takes millions of years for biodiversity to rebound after a mass extinction.



Biodiversity at Risk



Current Extinctions

- Scientists are warning that we are in the midst of another mass extinction.
- The rate of extinctions is estimated to have increased by a multiple of **50** since 1800, with up to 25 percent of all species on Earth becoming extinct between 1800 and 2100.
- The current mass extinction is different from those of the past because humans are the **primary** cause of the extinctions.

Species Prone to Extinction

- Large populations that adapt easily to many habitats are **not likely** to become extinct.
- However, **small populations** in limited areas can easily become extinct.
- Species that are especially at risk of extinction are those that **migrate**, those that need large or special habitats, and those that are exploited by humans.

Species Prone to Extinction

- An **endangered species** is a species that has been identified to be in danger of extinction throughout all or a significant part of its range, and that is thus under protection by regulations or conservation measures.
- A **threatened species** is a species that has been identified to be likely to become endangered in the foreseeable future.



How Do Humans Cause Extinctions?

- In the past 2 centuries, human population growth has accelerated and so has the rate of extinctions.
- The major causes of extinction today are
 - **the destruction of habitats**
 - **the introduction of nonnative species**
 - **pollution**
 - **the overharvesting of species**



How Do Humans Cause Extinctions?

Species Known to Be Threatened or Extinct Worldwide

Type of species	Number threatened (all categories of risk)	Number extinct (since ~1800)	Percent of species that may be threatened
Mammals	1,130	87	26
Birds	1,183	131	12
Reptiles	296	22	3.3
Amphibians	146	5	3.1
Fishes	751	92	3.7
Insects	555	73	0.054
Other crustaceans	555	73	1.03
Mollusks and worms	944	303	1.3
Plants	30,827	400	0.054

Habitat Destruction and Fragmentation

- As human populations grow, we use more land to build homes and harvest resources.
- In the process, we **destroy and fragment** the habitats of other species.
- It is estimated that habitat loss causes almost **75 percent** of the extinctions now occurring.



Habitat Destruction and Fragmentation

- For example, cougars, including the Florida Panther, require expansive ranges of forest and large amount of prey.
- Today, much of the cougars' habitat has been destroyed or broken up by roads, canals, and fences.
- In 2001, fewer than 80 Florida panthers made up the only remaining wild cougar population east of the Mississippi River.



Invasive Exotic Species

- An **exotic species** is a species that is not native to a particular region.
- Even familiar organisms such as cats and rats are considered to be exotic species when they are brought to regions where they never lived before.
- Exotic species can **threaten** native species that have no natural defenses against them.



Harvesting, Hunting, and Poaching

- Excessive hunting can also lead to extinction as seen in the 1800s and 1900s when 2 billion passenger pigeons were hunted to extinction.
- Thousands of rare species worldwide are harvested and sold for use as pets, houseplants, wood, food, or herbal medicine.
- **Poaching** is the illegal harvesting of fish, game, or other species.



Pollution

- Pesticides, cleaning agents, drugs, and other chemicals used by humans are making their way into food webs around the globe.
- The long term effects of chemicals may not be clear until after many years.
- The bald eagle was endangered because of a pesticide known as **DDT**. Although DDT is now illegal to use in the United States, it is still manufactured here and used around the world.



Areas of Critical Biodiversity

- An important feature of areas of the world that contain greater diversity of species is that they have a large portion of endemic species.
- An **endemic species** is a species that is native to a particular place and that is found only there.
- Ecologists often use the numbers of endemic species of plants as an **indicator** of overall biodiversity because plants form the basis of ecosystems on land.



Tropical Rain Forests

- Biologists estimate that over half of the world's species live in these forests even though they cover only **7 percent** of the Earth's land surface.
- Most of the species have never been described. Unknown numbers of these species are disappearing as tropical forests are cleared for farming or cattle grazing.
- Tropical forests are also among the few places where some native people maintain traditional lifestyles.



Coral Reefs and Coastal Ecosystem

- Reefs provide millions of people with food, tourism revenue, coastal protection, and sources of new chemicals, but are poorly studied and not as well protected by laws as terrestrial areas are.
- Nearly **60 percent** of Earth's coral reefs are threatened by human activities, such as pollution, development along waterways, and overfishing.
- Similar threats affect coastal ecosystems, such as swamps, marshes, shores, and kelp beds.



Islands

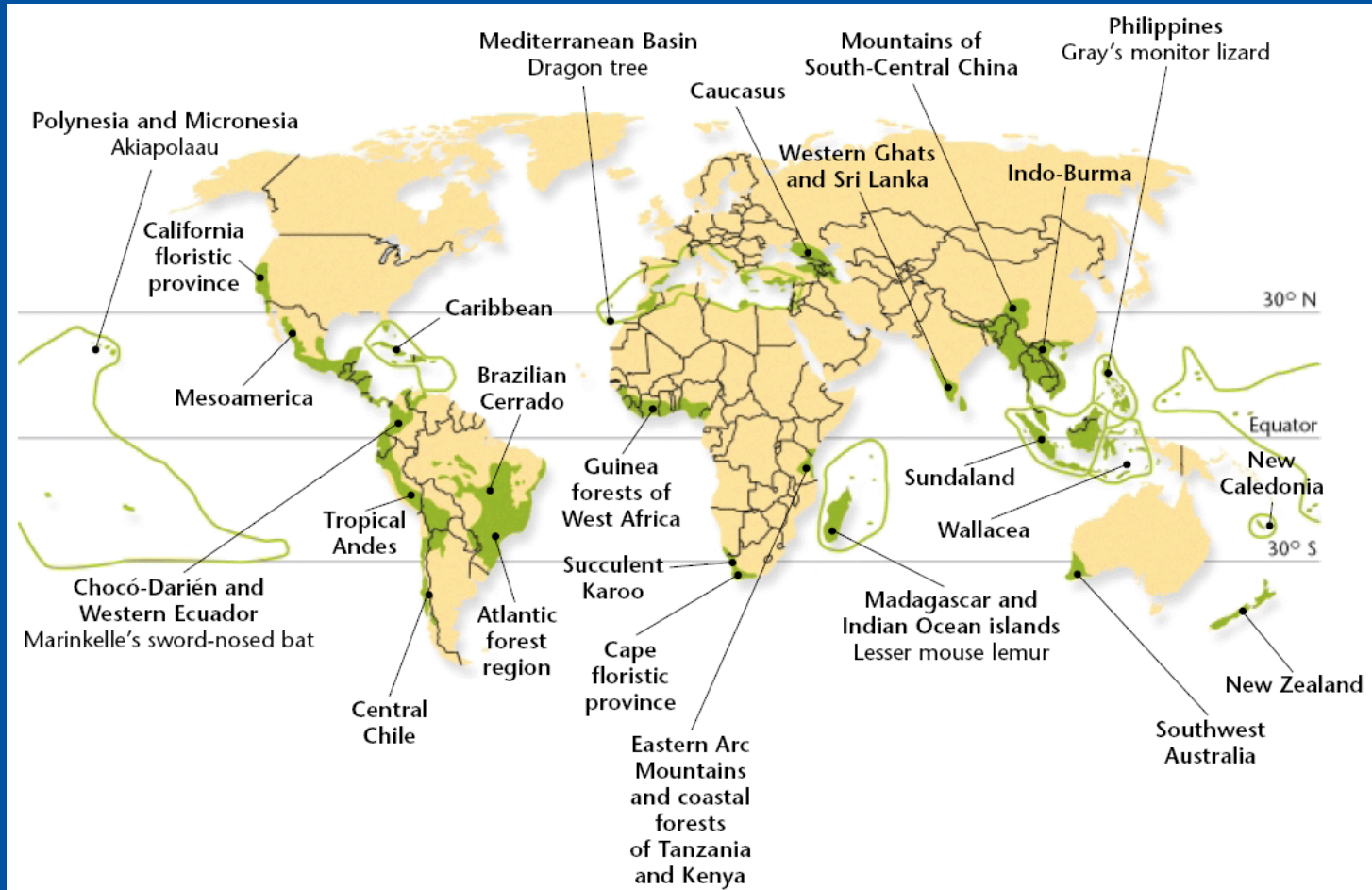
- When an island rises from the sea, it is colonized by a **limited number** of species from the mainland. These colonizing species may then evolve into several new species.
- Thus, islands often hold a very distinct but limited set of species.
- Many island species, such as the Hawaiian honeycreeper, are endangered because of invasive exotic species.



Biodiversity Hotspots

- The most threatened areas of high species diversity on Earth have been labeled **biodiversity hotspots** and include mostly tropical rainforests, coastal areas, and islands.
- The hotspot label was developed by an ecologist in the late 1980s to identify areas that have high numbers of endemic species but that are also threatened by human activities.
- Most of these hotspots have lost at least **70 percent** of their original natural vegetation.

Biodiversity Hotspots



Biodiversity in the United States

- The United States includes a wide variety of unique ecosystems, including the **Florida Everglades**, the California coastal region, Hawaii, the Midwestern prairies, and the forests of the Pacific Northwest.
- The United States holds unusually high numbers of species of freshwater fishes, mussels, snails, and crayfish.
- Diversity is also high among groups of the land plants such as pine trees and sunflowers.



Biodiversity in the United States

- The **California Floristic Province**, a biodiversity hotspot, is home to 3,488 native plant species.
- Of these species, 2,124 are endemic and 565 are threatened or endangered.
- The threats to this area include the use of land for agriculture and housing, dam construction, overuse of water, destructive recreation, and mining.
- All of which stem from local human population growth.

Ticket Out The Door

1. What is an endangered species?
2. What is a threatened species?
3. What is poaching?
4. What is an endemic species?
5. What is a biodiversity hotspot?
6. What is habitat fragmentation?
7. What is a mass extinction?

A World Rich in Biodiversity

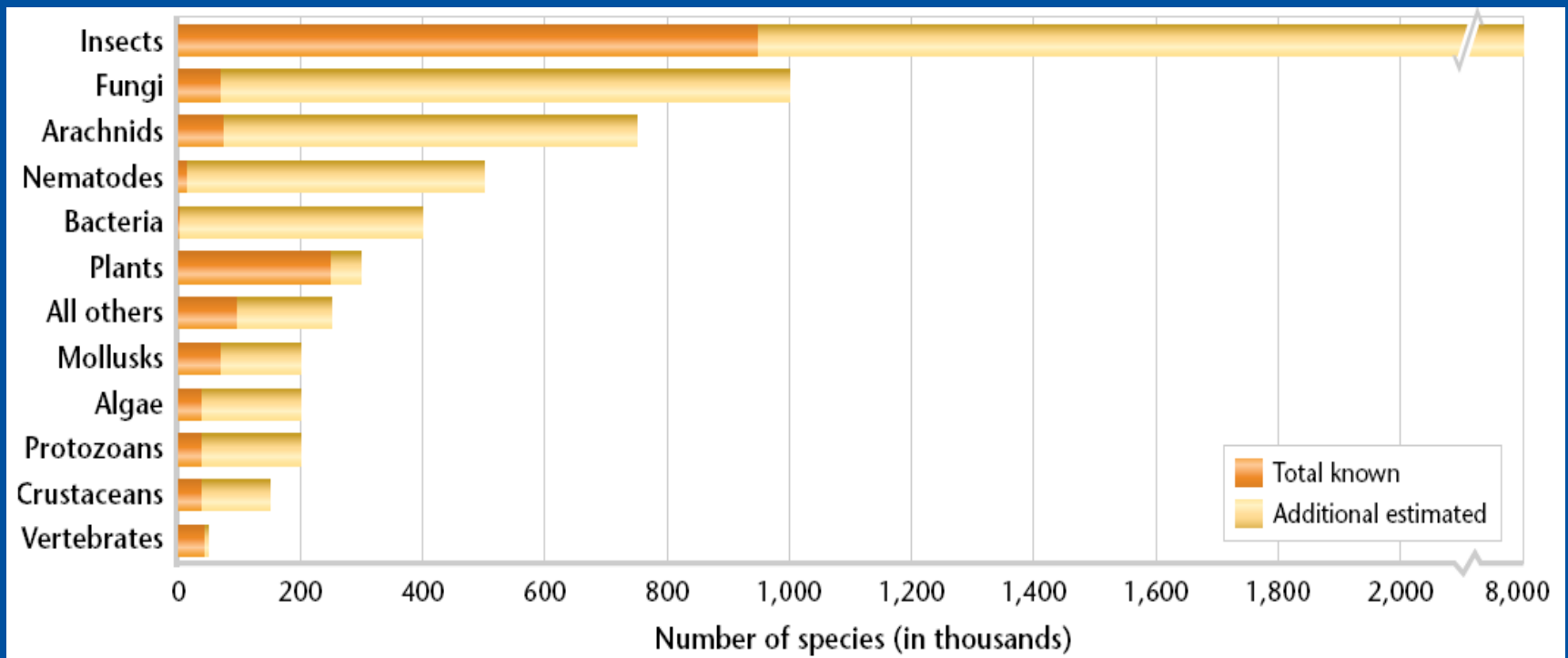
- **Biodiversity**, short for biological diversity, is:
 - the **variety** of organisms in a given area
 - the **genetic variation** within a population
 - the variety of **species** in a community
 - the variety of **communities** in an ecosystem.
- Certain areas of the planet, such as **tropical rainforests**, contain an extraordinary variety of species.
- Humans need to understand and preserve biodiversity for our own survival.

Unknown Diversity

- The study of biodiversity starts with the unfinished task of cataloging all the species that exist on Earth.
- The number of species known to science is about **1.7 million**, most of which are **insects**.
 - Actual number of species on Earth is **unknown**.
- Scientists accept an estimate of greater than 10 million for the total number of species.



Unknown Diversity



Unknown Diversity

- New species are considered known when they are **collected and described** scientifically.
- Unknown species exist in remote wilderness, deep oceans, and even in cities.
- Some types of species are harder to study and receive less attention than large, familiar species.

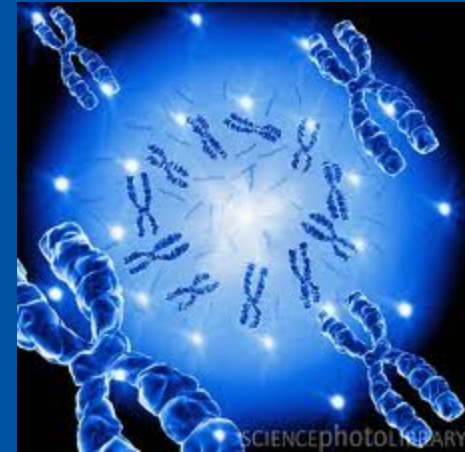


Levels of Diversity

- Biodiversity can be studied and described at three levels:
 - **species diversity**
 - **ecosystem diversity**
 - **genetic diversity**
- Species diversity refers to all the **differences** between populations of species, as well as between different species.
- Ecosystem diversity refers to the **variety** of habitats, communities, and ecological processes within and between ecosystems.

Levels of Diversity

- Genetic diversity refers to all the **different genes** contained within all members of a population.
- A **gene** is a segment of DNA that is located in a chromosome and that codes for a specific hereditary trait.



Benefits of Biodiversity

- Biodiversity can affect the **stability** of ecosystems and the **sustainability** of populations.
- We depend on healthy ecosystems to ensure a healthy biosphere that has balanced cycles of energy and nutrients.
- Species are part of these cycles.



Species Are Connected to Ecosystems

- When scientists study any species closely, they find that it plays an important role in an ecosystem.
- Every species is probably either **dependent on or depended** upon by at least one other species in ways that are not always obvious.
- When one species disappears from an ecosystem, a strand in a food web is removed.

Species Are Connected to Ecosystems

- Some species are clearly critical to the functioning of an ecosystem.
- A **keystone species** is a species that is critical to the functioning of the ecosystem in which it lives because it affects the survival and abundance of many other species in its community.
- An example is the **sea otter**.
 - The loss of the sea otter populations led to an unchecked sea urchin population, which ate all the kelp leading to the loss of kelp beds along the U.S. Pacific Coast.



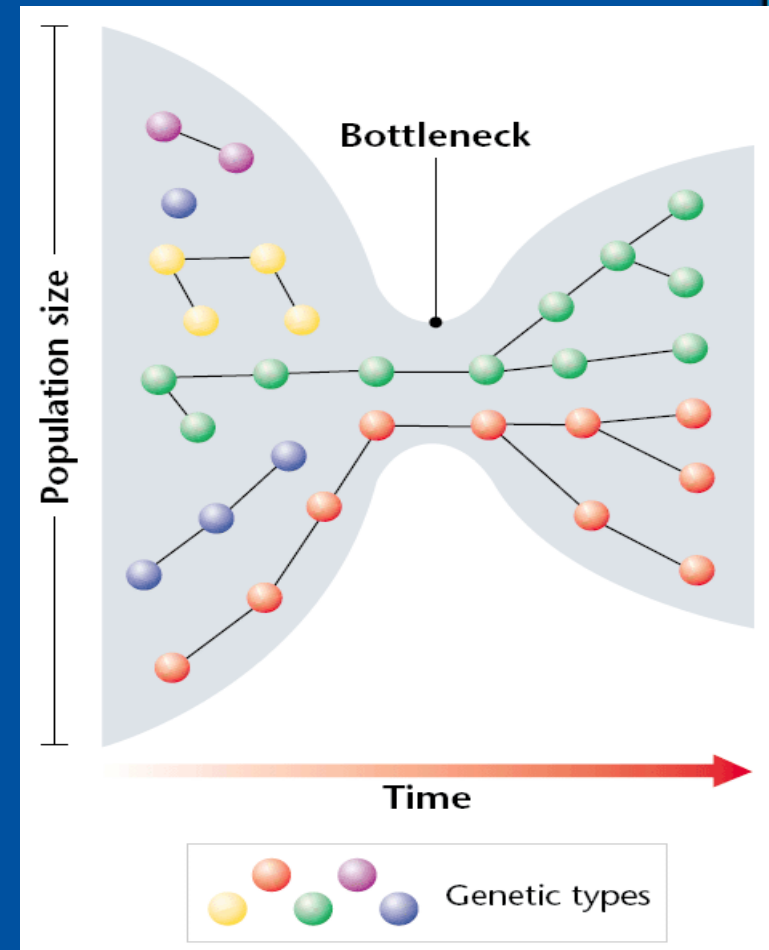
Species and Population Survival

- The level of genetic diversity within populations is a critical factor in species survival.
- **Genetic variation** increases the chances that some members of the population may survive environmental pressures or changes.
- **Small and isolated populations** are less likely to survive such pressures.



Species and Population Survival

- When a population shrinks, its genetic diversity **decreases** as though it is passing through a bottleneck.
- Even if such a population is able to increase again, there will be inbreeding within a smaller variety of genes.
- The members of the population may then become more likely to **inherit** genetic diseases.



Medical and Industrial Uses

- About **one quarter** of the drugs prescribed in the United States are derived from plants, and almost all of the antibiotics are derived from chemicals found in **fungi**.
- New chemicals and industrial materials may be developed from chemicals discovered in all kinds of species.
- The scientific community continues to find new uses for biological material and genetic diversity.



Medical Uses

Common Medicines Derived from Plants		
Medicine	Origin	Use
Neostigmine	calabar bean (Africa)	treatment of glaucoma and basis for synthetic insecticides
Turbocurarine	curare vine (South America)	surgical muscle relaxant; treatment of muscle disorders; and poison for arrow tips
Vincristine, vinblastine	rosy periwinkle (Madagascar)	treatment of pediatric leukemia and Hodgkin's disease
Bromelain	pineapple (South America)	treatment to control tissue inflammation
Taxol	Pacific yew (North America)	anticancer agent
Novacaine, cocaine	coca plant (South America)	local anesthetic and basis for many other anesthetics
Cortisone	wild yam (Central America)	hormone used in many drugs
L-dopa (levodopa)	velvet bean (tropical Asia)	treatment of Parkinson's disease
Reserpine	Indian snakeroot (Malaysia)	treatment to reduce high blood pressure

Agricultural Uses

- Most of the crops produced around the world originated from a few areas of **high** biodiversity.
- Most new crop varieties are **hybrids**, or crops developed by combining genetic material from other populations.
- History has shown that depending on too few plants for food is risky.
- Famines have resulted when an important crop was wiped out by disease. But some crops have been saved by crossbreeding them with wild plant relatives.

Agricultural Uses

Origins of Some Foods

North America, Central America, and South America

- corn (maize), tomato, bean (pinto, green, and lima), peanut, potato, sweet potato, avocado, pumpkin, pineapple, cocoa, vanilla, and pepper (green, red, and chile)

Northeastern Africa, Central Asia, and Near East

- wheat (several types), sesame, chickpea, fig, lentil, carrot, pea, okra, date, walnut, coffee, cow, goat, pig, and sheep

India, East Asia, and Pacific Islands

- soybean, rice, banana, coconut, lemon, lime, orange, cucumber, eggplant, turnip, tea, black pepper, and chicken

Ethics, Aesthetics, and Recreation

- Some people believe that we should preserve biodiversity for ethical reasons.
- They believe that species and ecosystems have a right to exist whether or not they have any other value.
- People also value biodiversity for aesthetic or personal enjoyment such as keeping pets, camping, picking flowers, or watching wildlife.
- **Ecotourism** is a form of tourism that supports the conservation and sustainable development of ecologically unique areas.

Wild Classroom: Biodiversity

Wild Classroom - Biodiversity



Ticket Out The Door

1. What is biodiversity?
2. What biome has the largest biodiversity?
3. How many species are known to man currently?
4. What is species diversity?
5. What is ecosystem diversity?
6. What is genetic diversity?
7. What is a keystone species?