CHAPTER 12

SUSTAINING BIODIVERSITY: THE SPECIES APPROACH

Summary

1. Biologists estimate extinction rates in one of three levels. Local extinction occurs when a species in a specific area is lost, but the species is still found in other places. Ecological extinction describes a species that is so small that it cannot play out its ecological role where it is found. Biological extinction means that the species is gone from the Earth. Extinction-prone species have low reproductive rates, a specialized niche, a narrow distribution, feed at high trophic levels, have fixed migratory patterns, are commercially valuable, and have large territories.

2. Biodiversity and species extinction are important because they provide enormous economic and ecological services that we need to survive. In 100 years, humanity can destroy species that it would take 5 million years to rebuild. These species may provide genetic information, medicines, and information about natural processes that we need to discover. These wild plants and animals are economic, recreational, and health resources.

3. Scientists use measurements and models to estimate extinction rates: studying past records, identifying species-area relationships, and examining lists of threatened species. Current extinction rates are 1000 to 10 000 times greater now than they were before man's influence. Our growing population, and the degradation and elimination of species and ecosystems, are undermining biodiversity and contributing to growing extinction rates. Many human activities endanger wildlife including the degradation and loss of habitat, habitat fragmentation, the capture of wild animals thus preventing breeding, overfishing, oil spills, exposure to pesticides, and extinctions due to the introduction of non-native species.

4. To prevent the premature extinction of species, we must reduce threats from non-native species; end illegal poaching and hunting; provide means for people to survive economically without killing native animals for food; maintain predator species, not destroy them; reduce greenhouse emissions and deforestation throughout the world; develop governmental policies to support biodiversity; and protect wild species in sanctuaries.

5. CITES (Convention on International Trade in Endangered Species) helps protect endangered or threatened wild species. Canada's Species at Risk Act (SARA) helps to legally protect wildlife at risk. COSEWIC assesses the status of wildlife species and makes recommendations for species to be placed on the federal list. There are many criticisms of SARA, and co-operation between the federal government and provinces and territories needs to be strengthened. There are numerous volunteer organizations that help monitor and protect wildlife species.

6. Wildlife refuges and sanctuaries help protect habitat and wildlife. Gene banks, botanical gardens, and farms are also important, but many lack funding.

7. Reconciliation ecology develops methods to share the places man dominates with other species. It can be used to invent, establish, and maintain new habitats to conserve species diversity. Safe harbour agreements and voluntary conservation agreements among communities can support reconciliation efforts. Everyone must take part to save the Earth's biodiversity—individuals, governments, corporations, and groups.

Key Concepts and Learning Outcomes

After completing this chapter, students should be able to answer the following key questions.

12-1 What Are Three Types of Species Extinction? Local, Ecological, and Biological

A. The three levels of species extinction are local, ecological, and biological.
   1. Local extinction occurs when a species disappears from an area it once inhabited, but it is still found elsewhere in the world.
   2. Ecological extinction occurs when the number of members of a particular species is so low that they cannot fulfill their ecological roles in their biological communities.
   3. Biological extinction occurs when a species has disappeared from the Earth.

12-2 What Are Endangered and Threatened Species? Ecological Smoke Alarms

A. Species heading toward biological extinction are either endangered or threatened.
   1. Endangered species are so few in number that the species could soon become extinct over all or part of its natural range.
   2. Threatened or vulnerable species are still abundant in their natural range but, because of loss in numbers, are likely to become endangered in the near future.
   3. The first species to go tend to be the big, slow, and edible ones, and/or those whose valuable parts can be sold.
   4. Various studies show that plants, fishes, and amphibians tend to be in the most danger of premature extinction because of human activity.

12-3 How Do Biologists Estimate Extinction Rates? Peering into a Cloudy Looking Glass

A. Biologists use measurements and models to estimate extinction rates.
   1. Background extinctions, mass extinctions, and mass depletions account for a loss of 99.9% of all species that have ever existed.
   2. Extinction spasm describes the loss of a large number of species within a few centuries.
   3. Predicting extinctions is always difficult because of three factors.
      a. Extinction usually takes a long time and is difficult to document.
      b. Only a small percentage of the world's species have been identified.
      c. We know very little about most of the world's identified species.
   4. Various methods are used to estimate extinction rates.
      a. One approach is to study past records that document extinctions since man came on the scene.
      b. The World Conservation Union has kept *Red Lists* that are the world standard for listing threatened species throughout the world. They provide baseline information on changes in biodiversity over time.
      c. Another approach is to observe how the number of species increase as the size of an area increases (species-area relationship). When an area decreases by 90%, about 50% of the species there become extinct.

d. Models are used to estimate a species extinction risk by predicting population size, habitat changes/availability, and species interaction.

5. Estimates of future extinction vary due to different assumptions about the total species numbers found in the tropics, the rate of clearance of the tropics, and the reliability of methods.

12-4 How Are Human Activities Affecting Extinction Rates? Taking Out More Species

A. Human activities affect extinction rates.

1. Currently, the rate of extinction is estimated to be 1000 to 10 000 times greater than the rate of species extinction prior to the emergence of human beings.
2. Using estimated extinction rates, 20% of the world's present plant and animal species will be gone by 2030; 50% will vanish by 2099.
3. Greater extinction rates than predicted are likely because of three main factors.
   a. Species loss and biodiversity loss will likely increase because of exponential human population growth.
   b. Biologically diverse areas (hot spots) have rates of extinction that may be as high as 50%. The extinction rate in these hot spots deserves special attention.
   c. Possible colonization sites for new species are being eliminated, degraded, and simplified by human activities so that new species cannot arise. By reducing the rate of speciation, we are creating a speciation crisis. Such a crisis may contribute to dominance of the world by species with survival power (cockroaches, rats and weeds) and contribute to the permanent decline of Earth's biodiversity.
4. A precautionary strategy is necessary to prevent a significant decrease in the genetic, species, ecological, and functional diversity of the Earth.

12-5 Why Should We Preserve Wild Species? They Have Value

A. Wild species have important value, both economic and ecological.

1. We are reducing species biodiversity more quickly than new species can evolve.
2. It will take 5 million years for speciation to rebuild the animals and plants human beings will destroy in 100 years.
3. We should preserve species for their instrumental value.
4. Some of the economic and ecological benefits (instrumental value) of present species have not even been identified; we are destroying our chance for future discoveries.
   a. Medicinal properties are found in many plants and some animals.
   b. Genetic information in species helps them adapt and produce new species. This information can be used to develop food and medicines for people. Wild species provide a bank of genetic information.
   c. Recreational value is provided by plants and animals.
   d. Ecotourism generates money to help poor countries; preserving plants and animals is much more economically wise than destroying them.
      1) A male lion skin is worth $1000; a male lion living for seven years produces $515 000 in tourist dollars.
      2)

12-6 What Is the Intrinsic Value of Species? Existence Rights

A. Some people believe that each species has a right to live, that is, an intrinsic (existence) value, even if it is not useful to humans.

1. Biologist E. O. Wilson believes that humans have an innate affinity for the natural world (biophilia). Some people may have a fear of wildlife (biophobia), probably stemming from a lack of understanding.
2. We must remember that all species, including microorganisms, have important roles to play in keeping ecosystems in balance.

12-7 What Is the Role of Habitat Loss and Degradation? Creating Homeless Species

A. The loss, degradation, and fragmentation of habitat are the greatest threat to a species.
   1. There are several causes of depletion and premature extinction of wild plants and animals.
   2. The acronym HIPPO (**h**abitat destruction and fragmentation, **i**nvasive species, **p**opulation growth, **p**ollution, and **o**verharvesting) describes these causes.
      a. Deforestation in tropical forests is the greatest species eliminator, followed by loss of wetlands and ploughing of grasslands.
      b. Temperate biomes have been compromised by widespread development over the last 200 years. Emphasis is now shifting to the tropics.
      c. Major habitat disturbance factors are, in order of importance, agriculture, commercial development, water development, outdoor recreation, livestock grazing, and pollution.
      d. Island species, frequently endemic, are particularly vulnerable to extinction.

12-8 What Is the Role of Habitat Fragmentation? Isolating and Weakening Populations of Species

A. Habitat islands are a habitat surrounded by a different one, such as a national park surrounded by logging, mining, and other activities.
   1. Habitat fragmentation leads to species vulnerability to predators, disease, etc.
   2. Species are limited in their ability to colonize new areas and find mates and food.

12-9 What Is the Role of Introduced Species? Good and Bad News

A. Many non-native species provide us with food, medicine. and other benefits.
   1. Invasion of alien species may also lead to extinctions, disrupt ecosystems, and cause economic losses. Alien species can be introduced accidentally or deliberately.
   2. Some of these species threaten and endanger native species.
      a. They have no natural predators, competitors, or pathogens in their new habitat.
      b. They can trigger ecological disruptions (e.g., purple loosestrife or zebra mussels).
      c. European wild boars were deliberately introduced into some parts of the United States and caused all sorts of damage. Feral cats and domestic cats kill about 570 million birds per year.

12-10 How Can We Reduce Threats from Non-native Species? Prevention Pays

A. The best control is to prevent non-native species from being introduced.
   1. Identify the types of ecosystems that are vulnerable to invaders, and identify the characteristics that allow the non-native species to become successful invaders.
   2. Inspect imported goods.
   3. Identify harmful invader species, and pass international laws that prohibit their transfer from one country to another.

12-11 How Serious Is the Illegal Taking or Killing of Wild Species? Making Big Money

A. Some protected species are killed for their valuable parts or are sold live to collectors.
   1. Smuggling wildlife, including many endangered species, is the third largest and most profitable illegal cross-border activity after arms and drugs.
   2. At least two-thirds of all live animals smuggled around the world die in transit.
   3. Poverty contributes to illegal smuggling of wild species as poachers make enough money to survive and feed their families.
   4. Tiger populations have declined drastically since 1950, mostly because of habitat loss and poaching for fur and bones.
   5. Black market demand has increased as animals become endangered.

12-12 What Is the Effect of Predator Control? Unintended Consequences

A. People try to exterminate species that compete with them for food and game animals.
   1. Each year farmers and ranchers shoot, poison, or trap thousands of coyotes, prairie dogs, wolves, bobcats, and other species because they prey on livestock, game species, or aquaculture ponds.
   2. Many of the prairie dogs in North America have been eradicated since the early 1900s.
   3. Much of the prairie grassland habitat needed by prairie dogs has disappeared.
   4. The black-footed ferret has almost been wiped out as it preys on the prairie dog.
   5. This provides another example of unintended consequences, as a result of not understanding the connections between species.

12-13 What Is the Role of the Market for Exotic Pets and Decorative Plants? Are We Really Pet and Plant Lovers?

A. Globally, legal and illegal trade in wild species for pets is a very profitable business.
   1. More than 60 bird species, mostly parrots, are endangered or threatened because of the wild bird trade.
   2. Amphibians, reptiles, mammals, and tropical fish are also being depleted because of the pet trade.
   3. Ex-poachers in Thailand are now making more money taking ecotourists into the forest than they did by poaching hornbills. They also protect these birds from poachers.
   4. Collecting exotic pets and plants (such as orchids and cacti) kills large numbers of them and endangers these species and others that depend on them.

12-14 What Are the Roles of Climate Change and Pollution? Speeding Up the Treadmill and Poisoning Species

A. Climate change and pollution from human activities undermines habitats and the lives of species.
   1. Climate change threatens a number of species with extinction.
      a. Global warming will alter the world's habitats.
      b. Species may not have enough time to adapt to the climate change and will die.
   2. Pesticides threaten many species.
      a. They kill more that 67 million birds and 6 to 14 million fish each year in North America.

b. They negatively impact endangered and threatened species struggling for survival.

12-15 How Can International Treaties Help Protect Endangered Species? Some Success

A. Treaties help protect endangered and threatened species, but enforcement is difficult and punishment inadequate.
   1. The 1975 Convention on International Trade in Endangered Species (CITES) protects more than 978 species from being commercially traded, and also restricts international trade of about 5600 species of animals and 30 000 species of plants that are at risk of becoming threatened.
      a. Enforcement is difficult and varies from country to country.
      b. Many countries are not signatories and still trade in animals.
   2. The Convention on Biological Diversity (CBD) binds governments to reversing the global decline in biological biodiversity.
      a. The United States has not ratified this treaty.
      b. There are no severe penalties, or other enforcement mechanisms, in place.

B. Canada's 2003 Species at Risk (SARA) is a federal act that legally protects wildlife species.
   1. The purpose of the act is to
      a. prevent Canadian species from becoming extirpated or extinct,
      b. assist in the recovery of endangered and threatened species, and
      c. encourage conservation and management practices to prevent other Canadian species from becoming at risk.
   2. SARA designates the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as the independent body responsible for identifying and assessing species at risk.
   3. SARA does the following:
      a. It protects listed endangered and threatened species, and their critical habitats.
      b. It recognizes that if critical habitat is identified, and landowners are prevented from developing their land, compensation may be required.
      c. It creates a public registry to allow public inspection.
      d. It aligns efforts to save at-risk species with other existing legislation, such as Aboriginal and treaty rights.
   4. Following advice from COSEWIC, the government makes its own list of Wildlife Species at Risk (Schedule 1). This is the list of species that the government will legally protect.
      a. Species on federal lands, aquatic species, or migratory birds receive immediate legal protection.
      b. Other species receive protection more slowly because the province or territory needs to become involved.
      c. A recovery strategy for species added to the list of Wildlife Species at Risk must be prepared within a certain time frame:
         1) one year for endangered species, and
         2) two years for threatened species.
      d. A management plan must be prepared within three years for a species of special concern.
      e. Recovery plans must identify critical habitat.
      f. The public registry allows people 60 days to view and comment on the plans before action is taken.
      g. The government must report on the recovery plan's progress five years after initiating a recovery strategy.

5. For offences against SARA, fines can vary from $250 000 for individuals to $1 million for corporations. It is an offence to do the following:
   a. kill, harm, capture, or take an individual that is listed as endangered, threatened, or extirpated
   b. possess, collect, buy, sell, or trade an individual (including its parts or derivatives) that is listed as an endangered, threatened, or extirpated
   c. damage or destroy the residence of one or more individuals, of a listed endangered, threatened, or extirpated species if a recovery strategy has recommended its reintroduction into the wild in Canada

12-16 How Have Canadians Responded to SARA? Mixed Feelings

A. Most feel that SARA is a step in the right direction but that there are many problems.
   1. Environmental Defence Canada reported in 2004 that the act
      a. listed only 66% of species designated by COSEWIC;
      b. applies only to certain areas of federal jurisdiction (about 5% of Canada's land area); and
      c. allows the federal government to intervene if provincial or territorial measures are ineffective in protecting a species; however, provincial and territorial laws are often weak, and they list only an average of 36% of the COSEWIC species.
   2. The British Columbia government continued to log habitat of the spotted owl, listed as endangered by COSEWIC. The federal government has said that it will not interfere with the decision of the B.C. government.
   3. Ecojustice, David Suzuki Foundation, Nature Canada, and Environmental Defence gave the federal government low marks for its ineffectiveness at applying SARA.
   4. David Suzuki feels that social and economic considerations are interfering with conservation goals. He is appalled that so little of Canada is directly protected by SARA, shocked at the lack of intervention for spotted owls in British Columbia, and disappointed that only 445 of the 551 COSEWIC species have been listed for legal protection.
   5. Another very serious concern is that SARA applies only to areas of federal jurisdiction—about 5% of the land area of Canada. SARA has a safety net provision whereby the federal government can intervene if provincial or territorial measures fail to adequately protect a species. Despite this, the federal government may chose not to intervene.

12-17 What Is an Extirpated Species? Gone but Reintroduction Still Possible

A. The prairie chicken and the black-footed ferret are extirpated species, but currently the conditions are not right to make them good candidates for reintroduction.
   1. The greater prairie chicken disappeared from Canada by 1977.
      a. Their natural grassland habitat had been consumed by agriculture.
      b. Due to the small size of natural grassland habitat remaining, the recovery team decided that reintroduction would not be considered.
   2. Black-footed ferrets were last seen in the Canadian prairies around 1974.
      a. Prairie dogs, their prey, were exterminated by farmers.
      b. Their grassland habitat was lost to agriculture.
      c. In the United States, a small black-footed ferret population was discovered, and a captive-breeding program initiated.
      d. A Canadian recovery team reintroduced 35 captive-born black-footed ferrets to Grasslands National Park in 2009, and that population seems to be established now.

12-18 What Is an Endangered Species? At Risk for Extirpation or Extinction

A. Endangered in Canada: 316 species listed
   1. Fowler's toads (Bufo fowleri) are small toads whose Canadian presence is restricted to three small remnant populations along Lake Erie. These toads are highly sensitive to pesticides at all stages of their life cycle.
      a. Experts suggest that Fowler's toads have a 20% chance of becoming extirpated within the next 100 years.
      b. Their habitat is fragmented.
      c. Classified at present as endangered, they are protected by SARA.
   2. The endemic Vancouver Island marmot, has suffered from the effects of logging.
      a. Populations, now more concentrated, are more susceptible to predators.
      b. The recovery strategy includes a captive-breeding program and actions to deter predators.

12-19 What Is a Threatened Species? At Risk of Becoming Endangered

A. Threatened in Canada: 167 species listed
   1. The swift fox has been trapped, and poisoned by bait intended for coyotes and ground squirrels.
      a. Since 1983, about 1000 swift foxes, live-trapped from the United States and captive-bred in Canada, have been released in the Prairie provinces.
      b. The current population is stable and self-sustaining.
   2. The woodland caribou's habitat has been fragmented by forestry, mining, and agriculture.
      a. They are sensitive to road and pipeline construction, and climate change.
      b. Other small populations of caribou across Canada range from endangered to special concern.

12-20 What Is a Species of Special Concern? In Danger of Becoming Threatened

A. Special concern in Canada: 205 species listed
   1. Polar bears are the largest terrestrial carnivores in the world.
      a. Females breed only about every 3.6 years, with two cubs per litter.
      b. Due to warmer Arctic conditions, seal-hunting time on pack ice has decreased.
      c. They bioaccumulate fat-soluble contaminants.

2. The mountain beaver lives in southern British Columbia, and is the world's most primitive rodent.
    a. Clear-cutting and other forestry practices erode the deep moist soil it needs for making tunnels.
    b. Urbanization and agriculture has caused habitat loss.
    c. This beaver seems to have difficulty dispersing to new locations.

12-21 What Is the Role of Wildlife Refuges and Sanctuaries? Protect Resident Wildlife and Aid Migrating Birds

A. Wildlife refuges and sanctuaries are located so that they also protect migratory birds.
    1. These birds fly along migration corridors or flyways.
    2. Ducks Unlimited Canada and the North American Waterfowl Management Plan have ensured the protection of wetlands along major migration routes.

12-22 Can Gene Banks, Botanical Gardens, and Farms Help Save Most Endangered Plant Species? Important but Limited Solutions

A. Gene banks, botanical gardens, and farms can be used to raise threatened species, and help protect species from extinction, but funding is inadequate.
    1. Raising some threatened or endangered species on farms can reduce the pressure on species in the wild, and also may provide meat or plants for commercial sale.

12-23 Can Zoos and Aquariums Help Protect Most Endangered Animal Species? Important but Expensive and Limited

A. Zoos and aquariums can help protect some endangered animal species as well, but both are notoriously underfunded.
    1. Egg pulling involves collecting wild eggs laid by endangered bird species and hatching them in zoos or research centres.
    2. Captive breeding involves taking wild individuals into captivity for breeding, with the commitment to reintroduce the offspring back into the wild.
    3. Artificial insemination, use of surrogate mothers, use of incubators, and cross-fostering by a similar species are other ways to increase populations of rare species.
    4. The ultimate goal is to reintroduce these species into the wild.
    5. Reintroductions of endangered species to the wild fail because
        a. there is not enough suitable habitat,
        b. individuals bred in captivity are not able to survive in the wild, and
        c. there is overhunting and capture of the returned species.
    6. A large population of a species (more than 10 000) is needed to maintain the capacity for biological evolution.
    7. The major conservation role of zoos is to educate the public about the biological importance of a species and the need to protect habitats. Zoos do not have the space to sustain the necessary numbers in an animal population.

12-24 What Is Reconciliation Ecology? Rethinking Conservation Strategy

A. We need to share the places we dominate with other species.
    1. Michael L. Rosenzweig identifies the real challenge for biodiversity: to sustain wild species in the human-dominated portion of nature.

a. He advocates that we implement reconciliation ecology: learn to share the spaces we dominate with other species.
b. Reconciliation ecology is the science of inventing, establishing, and maintaining new habitats to conserve species diversity where people live out their lives.

12-25 How Can We Implement Reconciliation Ecology? Observe, Be Creative, and Cooperate with Your Neighbours

A. There are several ways to implement reconciliation ecology.
1. Maintain diverse yards using native plants, which attract certain species.
2. Share the responsibility for supporting biodiverse yards and gardens.
3. Apply reconciliation ecology to local plant and animal life (e.g., bluebirds project).
4. Plant rooftop gardens that can support a variety of species, provide insulation, reduce evapotranspiration, conserve water, and cool cities.
5. Golden Gate Park in San Francisco is a good example of reconciliation ecology; it was transformed from sand dunes to a park by humans.
6. Government land, college campuses, and schools could be used for reconciliation ecology laboratories.

12-26 What Can Canadians Do to Protect Species? Get Involved

A. There are many conservation initiatives in Canada.
1. The annual Christmas Bird Count (CBC) provides information on bird trends.
   a. Birds Studies Canada coordinates the Canadian part of the survey.
   b. Since 1990, birders from many locations count all the birds they see on Christmas Day.
2. Project Feederwatch, organized by Bird Studies Canada and the Cornell Laboratory of Ornithology, is a North American survey of winter birds that visit feeders. The goals are to
   a. collect long-term data on winter bird populations in North America, and
   b. involve and educate the public.
3. The Canadian Lakes Loon Survey, co-ordinated by Birds Studies Canada, monitors population changes of the common loon.
   a. Changes are thought to be due to acid rain, shoreline lake development, and human activities.
   b. Lakes are surveyed three times in June.
4. Nocturnal Owl Surveys of potential owl habitat are carried out by trained volunteers in April.
5. In Ontario, a set of wildlife atlases were compiled based on public participation.

