Fish & Wildlife

Principles of Zoology and Ecology

Third Edition

L. DeVere Burton

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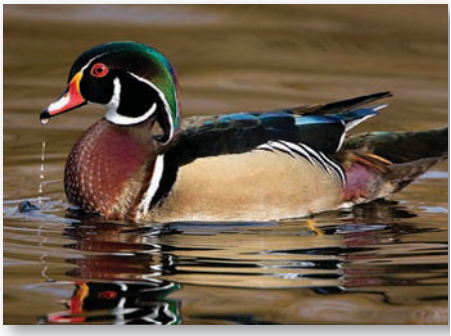

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L. DeVere Burton

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Table of Contents

Preface x
Acknowledgments xiii
About the Author xiv

SECTION I: ZOOLOGY AND ECOLOGY BASICS 1

CHAPTER 1 Principles of Zoology 2
Classification of Animals 3
Animal Behaviors and Habits 4
Animal Structure or Anatomy 6
Animal Nutrition and Digestion 8
Animal Growth 10
Animal Reproduction 11

CHAPTER 2 Principles of Ecology 17
Conservation of Matter 18
Laws of Energy 24
The First Law of Energy 25
The Second Law of Energy 26
Natural Cycles 27
The Carbon Cycle 27
The Nitrogen Cycle 29
The Water Cycle 30
Food Chains 33

CHAPTER 3 Understanding Relationships Between Wildlife and Agriculture 39
Fundamentals of Ecology 40
Agricultural Impacts on Ecosystems 43
Biological Succession 46

CHAPTER 4 Biomes of North America 53
Freshwater Biomes 55
Marine Biome 60
Terrestrial Biomes 64
Desert Biome 64
Tundra Biome 66
Grassland Biome 68
Deciduous Forest Biome 69
Temperate Forest Biome 70
Coniferous Forest Biome 70

CHAPTER 5 Our Wildlife Resources 75
A National Treasure 76
The U.S. Endangered Species Act 78
Controversy and Protectionism 79
Extinction and its Causes 85
Managing Endangered and Threatened Species 88

SECTION II: ZOOLOGY AND ECOLOGY OF MAMMALS 93

CHAPTER 6 Gnawing Mammals 94
Mice, Rats, Voles, and Lemmings 97
Squirrels 105
Marmots and Prairie Dogs 113
Rabbits, Hares, and Pikas 117
Porcupines 123
Gophers and Beavers 124

CHAPTER 7 Hoofed Mammals 130
Pronghorn 133
Deer 135
Bison and Musk Ox 142
Wild Sheep 145
Mountain Goats 148
Peccary 149
Horses and Burros 150

CHAPTER 8 Predatory Mammals 155
Wild Cats 156
Wild Dogs 161
Bears 167
Weasels 171
Raccoons 181

CHAPTER 9 Marine Mammals 186
Seals 187
Eared Seals 189
True Seals 191
Walrus 193
Manatees 194
Whales 196
Baleen Whales 197
Toothed Whales 199

CHAPTER 10 Unusual Mammals 209
Opossums 210
Shrews and Moles 212
Bats 214
Armadillo 218

SECTION III:
ZOOLOGY AND ECOLOGY OF BIRDS 223

CHAPTER 11 Waterfowl 224
Ducks 227
Geese 233
Swans 236

CHAPTER 12 Game Birds 242
Quails 244
Partridges 246
Pheasants 247
Grouse 249
Turkeys 253
Pigeons and Doves 255

CHAPTER 13 Birds of Prey 261
Hawk-like Birds 262
Eagles, Hawks, and Kites 262
Falcons 270
Vultures 273
Osprey 275
Owls 276
Typical Owls 276
Barn Owls 281

CHAPTER 14 Songbirds and Other Perching Birds 286
Songbirds 287
Crows and Jays 301
Cuckoos 303
Kingfishers 304
Hummingbirds 304

CHAPTER 15 Other Birds of North America 309
Long-legged Wading Birds 310
Gull-like Birds 314
Upright Perching Waterbirds 316
Duck-like Birds 318
Sandpiper-like Birds 321
Chicken-like Marsh Birds 324
Upland Ground Birds 325
Swallows and Swifts 327
Tree-Clinging Birds 329

SECTION IV:
ZOOLOGY AND ECOLOGY OF FISH, REPTILES, AND AMPHIBIANS 337

CHAPTER 16 Freshwater Fish 338
Catfish 340
Sunfish 342
Perch 345
Trout, Char, and Whitefish 347
Pike 352
Sturgeons 353
Minnows and Suckers 354

CHAPTER 17 Anadromous and Diadromous Fish 359
Salmon 365
Steelhead 370
Striped Bass 371
Shad 373
Freshwater Eels 373

CHAPTER 18 Saltwater Fish and Fauna 378
Sharks, Skates, and Rays 379
Mackerel, Tuna, and Marlins 383
Flounder, Halibut, and Sole 385
Herring 387
Codfish 389
Smelts 390
Sea Bass and Groupers 391
Mollusks 392
Crustaceans 394

CHAPTER 19 Reptiles and Amphibians 400
Reptiles 401
Alligators and Crocodiles 403
Lizards 405
Snakes 410
Turtles and Tortoises 416
Amphibians 419
Frogs and Toads 420
Salamanders and Newts 422

SECTION V:
CONSERVATION AND MANAGEMENT 429

CHAPTER 20 Responsible Management of Wildlife Resources 430
Role of Private Institutions 431
Farmers and Ranchers 432
Industry 439
Private Citizens 440
Game Farms and Preserves 441
Role of Special Interest Groups 443
Environmental Organizations 443
Recreational Interests 444
Role of Government 445
Government Agencies 446
National Parks and Monuments 447
National and International Law 448
Multiple-Use Concept of Management 450
Wildlife Careers 451
Education 451
Supervised Experience Programs 451
Employer Expectations 453
Occupational Safety 454

CHAPTER 21 Conservation of Natural Resources 458
Conserving the Soil 460
Maintaining a Pure Water Supply 463
Preserving Air Quality 465
Preserving and Restoring Wildlife Populations and Habitats 467
Reclaiming Damaged or Polluted Resources 469

CHAPTER 22 The Human Connection to Wildlife and Natural Resources 475
Foundation for Agriculture 476
Source of Materials for Medicines 477
Mechanism for Natural Cycles 477
Recreation 479
Intrinsic Value 479
Hunting and Fishing for Sport 481
Game Laws and Regulations 482
Using Campgrounds, Trails, Roads, and Waterways 483
Safety Education 487
Basis for Commerce 489
The Principle of Stewardship 490
Ethics, Privileges, and Responsibilities 491
Wildlife Management 492
Outdoor Recreation Management 495
Glossary 499
Index 508

Preface

NORTH AMERICA IS A PART OF THE WORLD where wildlife populations are considered to be valued treasures. We value wild animals for the pleasure we experience when we see them in their natural surroundings. We enjoy the birds and animals that have adapted to a world where we humans have modified the environment to suit our own purposes. We value the wild creatures that are seldom seen, and our laws attempt to provide protected habitats for the wild animals that struggle to survive in our changing world. We also value the role that each wildlife species plays in the ecosystem that we jointly share.

Despite the value that Americans place on wildlife, we must continually cultivate an awareness of the things we do that make it difficult for wild animals to coexist with us. Wild animals are vulnerable in many ways. As the human population grows, the availability of favorable wildlife habitat declines. Direct competition for habitats exists between humans and many wild animals. It is a result of land development for housing, manufacturing, farms, recreation, and other uses. This textbook edition is written in the early years of a new century and a new millennium. Interactions between humans and wild animals will increase with the passing years, and the opportunity for future generations to enjoy wildlife will depend largely upon our integrity in applying science to the conflicts that arise between the needs of humans and those of wild creatures. Broad areas of disagreement exist among those who conduct research on the needs of wild animals. It is particularly distressing when "scientific" studies appear to be intentionally designed to achieve results that favor a particular political position on a wildlife issue. Continuation of this practice will prove deadly to wildlife populations.

Sound scientific research is needed in order to reduce the contention that exists between those who see little need for protecting vulnerable wildlife species and those who are willing to sacrifice modern industries to restore wildlife habitat. A serious attempt has been made in this textbook to present both sides of major issues affecting wild animals and humans. It is the belief of the author that we should seek to find "middle ground" in resolving environmental issues and that it is wise to avoid radical positions on either side of an issue.

This textbook is organized in five sections:
SECTION I: Zoology and Ecology Basics
SECTION II: Zoology and Ecology of Mammals
SECTION III: Zoology and Ecology of Birds
SECTION IV: Zoology and Ecology of Fish, Reptiles, and Amphibians
SECTION V: Conservation and Management

The first section of the textbook deals with our understanding of the sciences of zoology and ecology, including the principles of science that are related to the life, growth, structure or anatomy, and classification of individual animal species. It also addresses our understanding of how the earth and the various ecosystems function. Sections II, III, and IV present specific information about the wild animals that are found in the North American ecosystem. Section V addresses the issues of conserving and managing fish and wildlife populations.

Chapter features include:

Objectives outline important concepts that will be covered within the chapter.

Key Terms highlight the critical vocabulary words that students need to be familiar with.

Animal Profiles provide detailed information on select animals, including where they live, their food preferences, their appearance, and more.

Ecology Profiles take a look at how certain modern-day events have affected the animal environment.

Key Internet Search Words provides terms that will lead the student to internet sites that provide additional information on the topics discussed in the chapter.

Career Option explores select career choices that relate to chapter content. Information includes a description of the career, job duties, and educational requirements.

Looking Back, found at the end of each chapter, summarizes important chapter content.

Chapter Review section includes Discussion and Essay, and Multiple Choice questions that test student comprehension of content, and Learning Activities that allow the student an opportunity to investigate topics in more detail.

Full-color photographs and illustrations assist students as they seek understanding of the concepts that are presented.

A great deal of effort has been directed toward schools to integrate the principles of math and science in the context of how the knowledge of the subject will be used. This textbook is an example of how science can be integrated into a subject in such a way that the student can understand how the principles of science apply to the wild animal populations found in North America.

ALSO AVAILABLE FOR THE INSTRUCTOR:

Instructor's Guide – ISBN 1-4354-1964-2

Instructor's Guide to Accompany Fish and Wildlife: Principles of Zoology and Ecology includes a chapter overview, list of chapter objectives, the Ecology Profile, and Answers to Review Questions.

ClassMaster - ISBN 1-4354-1965-0

ClassMaster CD-ROM to Accompany Fish and Wildlife: Principles of Zoology and Ecology is a powerful electronic resource designed to assist instructors in presenting the materials in the text. This instructor resource includes everything you will need to prepare for and teach about Fish and Wildlife.

The CD contains Lesson Plans for each chapter, beginning with a list of the chapter objectives, then sample interest approach ideas followed by how to present the content in the various sections within the chapter. In addition, the CD contains 450 instructor slides created in PowerPoint® that focus on each chapter's key points to facilitate classroom discussion. Lastly, the CD includes a computerized test bank of over 790 questions in multiple choice, true false, completion and short answer format, as well as the accompanying answers, organized by chapter, and can be used to generate tests and quizzes. Delivered via the ExamView Pro test generator platform, instructors can use the questions as provided or modify and add questions as needed to generate tests that meet their specific needs.

Acknowledgments

THIS BOOK IS DEDICATED TO students and teachers who appreciate the outdoors and the wild animals that live there. It also is dedicated to the people who work in the agriculture and natural resource systems of North America. These are the individuals whose management decisions directly affect our wildlife resources and our citizens.

Many people are involved in the creation of a textbook such as this one. Gratitude is expressed to family members, friends, and colleagues whose patience and encouragement have contributed to the completion of this work. Special thanks to the following reviewers for their many hours spent evaluating the manuscript and gathering materials to support the publication of this book:

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About the Author

L. DeVere Burton, author of *Fish and Wildlife: Principles of Zoology and Ecology, 3rd Edition*, recently retired as the Instructional Dean at the College of Southern Idaho to work full-time with textbooks and curriculum materials. His educational administration experience includes Director of Research and State Supervisor for Agricultural Science & Technology with the Idaho Division of Professional Technical Education. He is a past president of the National Association of Supervisors of Agriculture Education, and he has participated on several curriculum-related task forces for the National Agricultural Education Council.

The author was a high school agriculture teacher for 15 years and has been involved as a professional educator in agricultural education since 1967. He has experienced teaching assignments in large and small schools, and in single- and multiple-teacher departments. He has taught at four different high schools and at a major land grant university. He was involved in state-level supervision of agricultural programs from 1987 to 1997, and more recently, he has been responsible for post-secondary agriculture programs. All of these experiences have contributed to his philosophy that "education must be fun and exciting for those who learn and for those who teach."

A wide range of experiences has prepared the author for his career as an educator in agriculture and natural resources. He was raised on a farm in western Wyoming that bordered on forest lands, and he experienced many pleasant hours in the canyons and along the streams that provided habitats for regional wildlife.

He became interested in the regional wildlife as a youth, and he has always been an advocate for maintaining healthy environments for wild creatures.

During his years as a university student, Dr. Burton worked in the forest industry as a logger and sawmill worker. Other jobs he held include testing milk, caring for livestock, and being a maintenance/warehouse worker in a feed mill, a manager of a dairy farm, a finish carpenter, and an animal research assistant. He has also worked in the food processing, metal fabrication, and concrete construction industries, and he owned and managed a purebred sheep and row crop farm for several years.

Dr. Burton earned his B.S. degree in Agricultural Education from Utah State University in 1967, his M.S. degree in Animal Science from Brigham Young University in 1972, and his Ph.D. degree at Iowa State University in 1987 where he was also an instructor in the Agricultural Engineering Department.

Textbooks that Dr. Burton has authored, coauthored, or edited include *Agriscience and Technology, 2nd Edition; Fish and Wildlife: Principles of Zoology and Ecology, 3rd Edition; Introduction to Forestry Science, 2nd Edition; Agriscience Fundamentals and Applications, 5th Edition;* and *Environmental Science Fundamentals and Applications.*

SECTION

I

Zoology and Ecology Basics

Zoology is the branch of biology that studies the structure and life functions of animals.

Ecology is the branch of biology that describes relationships between living organisms and the environments in which they live.

CHAPTER

1

Principles of Zoology

Biology is the science that deals with the life processes and characteristics of plants and animals. It includes the study of the origin, history, and habits of the many forms of plant and animal life. Biology is divided into two main branches. Botany is the branch of biology that deals with plants. The branch of biology that addresses animal life is zoology. The science of fish and wildlife deals mostly with the study of zoology, which includes the life, growth, structure or anatomy, nutrition, reproduction, and classification of animal species.

After completing this chapter, you should be able to:

- distinguish between the sciences of botany and zoology
- list the different classification levels in the science of taxonomy
- describe how the anatomy of an animal is related to its ability to survive in the environment in which it lives
- list the steps in the process of mitosis that occur during growth of an animal
- identify the steps in the process of meiosis.

KEY TERMS

biology
botany
zoology
fauna
taxonomy
kingdom
phylum
class
order
family
genus
species
vertebrate
vertebrata
simple stomach
ruminant
rumen
crop
gizzard
mitosis
interphase
prophase
chromatid
centromere
metaphase
centrioles
spindles
anaphase
telophase
gametes
meiosis
homologous chromosomes
homologue

(*continued*)

A scientific study of animals can proceed in several different ways. For example, you might be interested in studying the characteristics that distinguish a species of deer from other species in the deer family. Another zoological study might attempt to describe the **fauna** or community of animals that are found in a particular region. Still another zoological study might attempt to describe the changes in the structure or anatomy of frogs that have been exposed to polluted water.

The zoology of a particular kind of animal is a description of the life, growth, structure or anatomy, nutrition, reproduction, and classification of that animal. The zoology of fish and wildlife that are found in North America are described in this textbook. Some species of animals that are found in localized regions may not be specifically discussed here; however, the more broadly defined discussions of animal families and classes include most North American animals.

CLASSIFICATION OF ANIMALS

The reason for classifying animals is to organize them into similar groups. Animals are classified into related groups based on their genetic and structural similarities to other animals. The field of science that classifies organisms and defines their relationships with one another is called **taxonomy**, see Figure 1–1. The animal **kingdom** includes all of the animals, and the plant kingdom includes all of the plants. The next smaller classification is the **phylum**. Below the phylum is a smaller unit called a **class**. Phylum Chordata includes the class Aves (birds), the class Mammalia (mammals), and the class Reptilia (reptiles). Examples of classes include the division of birds, mammals, and others. Continuing down the taxonomic scale, classes can be divided into more than one **order**; an order is divided into more than one **family**, and a family is

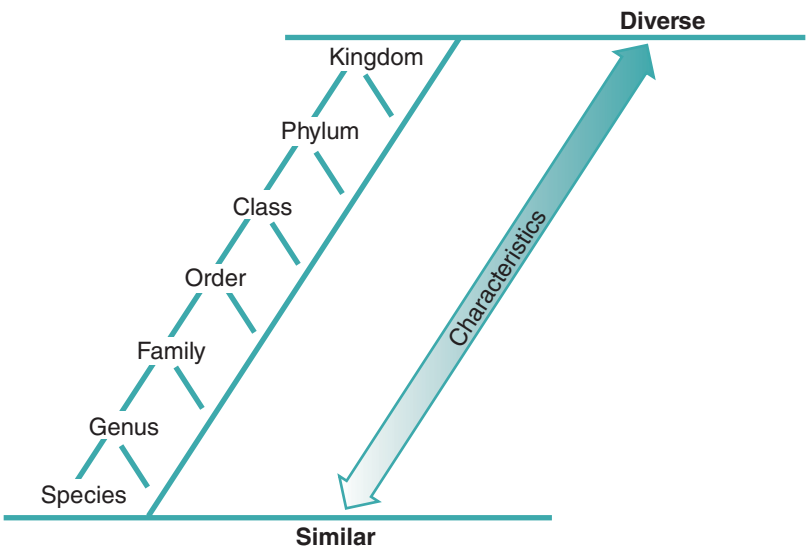


Figure 1–1 The taxonomy of living things.

KEY TERMS

sperm
egg
ovum
haploid
diploid
fertilization
zygote

divided into more than one **genus**. A genus is divided into **species** based on differences as simple as those between a dog and a wolf. Each of these groupings is further subdivided into smaller groups.

This textbook is focused on wild **vertebrate** animals that are found in North America. These include animals that have backbones, such as the mammals, birds, fishes, reptiles, and amphibians, see Figure 1–2. Vertebrates are part of the subphylum **vertebrata**, and despite differences among these animals, each of these classes of

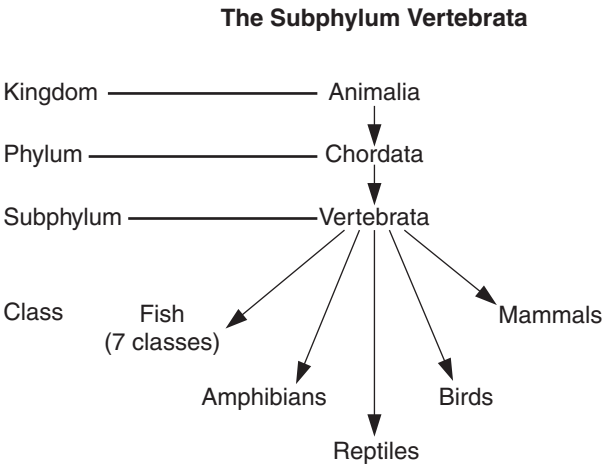


Figure 1–2 The subphylum vertebrata encompasses the vertebrate animals of North America that are included as subjects in this book.

animals is similar in that each has a skeleton with a segmented backbone composed of bone segments surrounding the spinal cord, extending from the tail to the skull, see Figure 1–3.

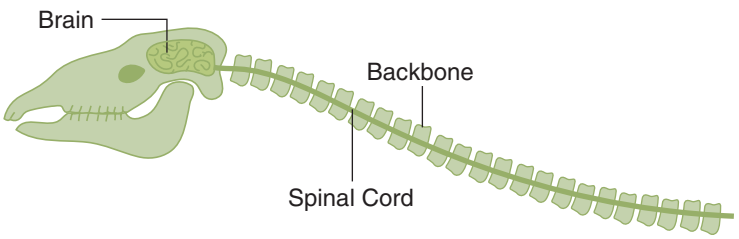


Figure 1–3 Vertebrates are identified by backbones composed of bone segments surrounding the spinal cord that extend from the tail to the skull.

ANIMAL BEHAVIORS AND HABITS

The life of an animal can be described as the distinct behaviors and habits that make it possible for the animal to find and consume food, obtain energy from it, grow physically, adapt to the environment, and reproduce itself. The differences that we observe among the many species of animals make it possible for them to live in a wide variety of environments. For example, some kinds of birds eat only small seeds, while other kinds of birds eat meat. In most cases, birds that are adapted to eating seeds would be unable to exist if they had to depend on their ability to capture and kill prey. In fact, the seed-eating birds are often killed and eaten by birds of prey.

The way that an animal goes about obtaining its basic needs is often distinctive to that animal, enabling it to occupy a specific niche in an environment. For example, a woodpecker is adapted through its ability

Figure 1–4 The woodpecker has a competitive advantage over other birds because it is equipped with a strong bill and skull that makes it possible for this bird to capture insects by drilling holes into the bark and wood of trees.

to drill holes in wood to finding and capturing insects that live beneath the bark and within the woody tissues of trees. Most other birds are unable to do this, and the woodpecker has a competitive advantage over them in obtaining this source of food, see Figure 1–4. It does not have to compete with most other birds for food from this source.

Some animals are able to obtain food from a number of different sources, giving them a strong competitive advantage over animals that depend upon a single source or type of food. If one source of food becomes unavailable to them, they simply seek food of another kind. There are animals, however, that are unable to do this. They are in grave danger of starving when their favored food is no longer available. They may be completely unable to adapt to a different diet even though there might be an abundance of other kinds of food.

In some instances, an animal may be completely incapable of digesting a particular kind of food and extracting adequate nourishment from it. For example, a member of the cat family would die of starvation if it had to eat grass and twigs as the deer family does. Cats are incapable of digesting large amounts of fiber, but the bacteria in the stomachs of deer are able to utilize fiber obtained from roughage. Deer then digest the bacteria, which are composed of high quality nutrients.

Some behaviors of animals are instinctive, while other behaviors are learned. An instinctive behavior is one that is evident at birth, such as the suckling instinct of a newborn mammal or the tendency of a duckling to go into the water and swim. The following is an old saying that many of us have heard: "He took like a duck to water." An instinctive behavior is a behavior that is natural to an animal and that is characteristic of other animals of the same species, see Figure 1–5. On the other hand, there are many behaviors that are learned by young animals through their life experiences. For example, young animals must learn to find food. They learn to do this by watching their parents and mimicking their behaviors. It is a common sight to see a young robin learning to

Figure 1–5 A newborn fawn instinctively hides from danger by lying motionless in an area where a combination of sunlight and shadow allows it to blend with its surroundings.

listen for the movement of a worm hidden under the soil surface. Most young animals must learn to drink water. They also learn to seek safety from their natural enemies. These are learned behaviors.

ANIMAL STRUCTURE OR ANATOMY

The structure or anatomy of an animal enables it to survive in the environment in which it lives. The anatomy of an animal is closely related to its method of obtaining food. Many animals have body parts that are highly adapted to their food supply. A water bird usually has a long beak or bill it uses to probe the shallow water for insects and small animals. The ruminant stomach of the deer family enables its members to digest food that is high in fiber. Animals with simple stomachs would not be able to obtain enough nutrition to survive on a diet of grasses, twigs, brush, and leaves. Deer are also equipped for running to evade predatory animals, while a predator is equipped with **canine teeth** that are designed to tear through thick hides and raw flesh, see Figure 1–6.

KEY INTERNET SEARCH WORDS

canine teeth

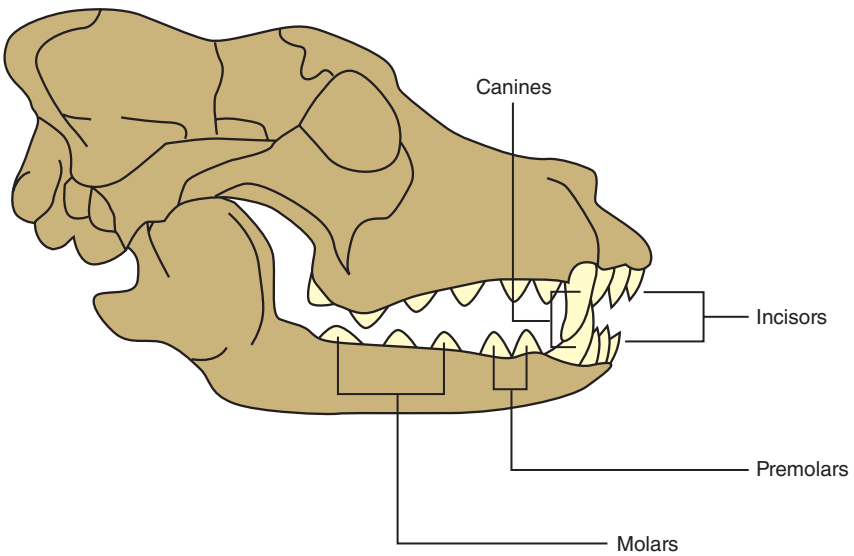


Figure 1–6 The structure or anatomy of an animal equips it to survive in a particular environment and to eat specific kinds of food. Predators are equipped with canine teeth that are designed to tear through tough hides and raw flesh.

Each class of animals has unique differences in anatomy or structure from other animal classes. There also are differences in their body systems. For example, fish, reptiles, and amphibians are cold-blooded animals, whereas birds and mammals are warm-blooded animals. Great differences exist in the mature size of animals of different classes. In many cases, there are also great size differences within animal families. An example of these size differences can be observed in the deer family. In contrast with the mature moose, which can weigh a thousand pounds or more, a mature Key Deer found in the Florida Keys seldom weighs more than 50 pounds, see Figures 1–7 and 1–8.

Animal structure includes the arrangement of the bones in the skeleton and the attachment of the muscles on the bones. It also includes unique features such as feathers on birds, hair on mammals, and scales on fish. Structure also includes the way that the internal

Figure 1–7 The moose is the largest member of the deer family in North America. Mature bulls often weigh more than 1,100 pounds. *Courtesy Claire Harkins.*

Figure 1–8 The Key Deer found in the Florida Keys are the smallest deer in North America. They usually weigh about 50 pounds at maturity. *Courtesy U.S. Fish and Wildlife Service. Photo by John Oberheur.*

organs are designed and arranged. For example, birds don't have teeth, but they have gizzards where food is ground into tiny pieces by small rocks that have been eaten for this purpose. The physiology of birds and some other animals enables them to reproduce by laying eggs instead of giving birth to live young.

The way that an animal moves about is somewhat controlled by its size and structure. For example, many of the whales are so heavy that they need to live in water in order to be able to move about. The natural buoyancy of their bodies in deep water makes it possible to move about gracefully despite their massive weight, see Figure 1–9. Birds are relatively light in weight, otherwise they would be unable to fly. Each of the classes of animals discussed in this text has a structure that is unique and helps it adapt to the environment where it lives.

Figure 1–9 The natural buoyancy of a whale in seawater makes it possible for the whale to move gracefully despite its massive weight. *Courtesy Eyewire.*

Career Option

SCIENCE TEACHER

ONE OF THE MOST INTERESTING CAREERS in the field of zoology is that of a teacher. Science education is important to every student because so much that we do in life has a scientific basis. Science teachers are needed desperately, and working with students is interesting and rewarding. A career as a science teacher requires at least a Bachelor of Science degree from a four-year college or university, and a graduate degree is preferred. Science is a laboratory-based discipline—a teacher must become skilled in conducting hands-on lab exercises. In addition, a teacher also needs to be the kind of person who enjoys working closely with people.

ANIMAL NUTRITION AND DIGESTION

Animals require food in order to live because energy is required to perform life functions. The growth and repair of living cells requires nutrients from which energy and materials are obtained. Energy is necessary to form chemical bonds that hold the materials together from which cells are formed. Warm-blooded animals require energy in order to maintain body temperature, and energy is also used each time a muscle flexes or a nerve sends an impulse racing through the body. Without energy there is no animal life, and without nutrients, energy is not available to an animal.

Differences exist in the ways that animals obtain nutrients. Some animals eat plants and break down the nutrients they contain through the process of digestion. These nutrients are then reassembled to form animal tissue. Some animals eat the flesh of other animals to obtain nutrients. Some animals, such as bears and raccoons, are able to assimilate foods obtained from both plants and animals. The discussion of food chains in Chapter 2, "Principles of Ecology," contains more information about these differences.

Figure 1–10 The squirrel is an example of an animal that is equipped with a simple stomach in which it digests foods, such as nuts, that contain highly concentrated nutrients.

Nearly every kind of mammal is equipped with a **simple stomach**, having a single compartment where food is stored and where the first steps in digestion occur, see Figure 1–10. The simple stomach does not have a large capacity, so foods with a relatively high concentration of nutrients must be eaten. For example, grains and meat contain high concentrations of nutrients, so they are ideal foods for an animal with a simple stomach.

Foods that are high in fiber, such as grass, twigs, and leaves, are generally low in nutrient concentration. For this reason, much greater amounts of food must be eaten by animals with high-fiber diets. Mammals such as deer, sheep, goats, and pronghorns eat high-fiber diets, and their digestive systems are much different from those of animals having simple stomachs. These mammals are equipped with stomachs that have four compartments, and such an animal is called a **ruminant**, see Figure 1–11. The largest of the four compartments is called the **rumen**. The rumen

KEY INTERNET SEARCH WORDS

digestion, rumen, ruminant
digestion, simple stomach
digestive system of birds

Figure 1–11 Bighorn Sheep are ruminant animals that have a stomach with four compartments. The largest of these is called the rumen, and it acts as a storage and fermentation vat for grasses, herbs, and other high-fiber foods that make up its diet.

stores large amounts of plant materials that ferment as they are broken down by bacteria. The bacteria assimilate the nutrients from the plant material as they multiply within the rumen. The ruminant animals then digest the bacteria. This occurs as the bacteria pass through the other three compartments of the stomach.

A different type of digestive system is present in birds, see Figure 1–12. Birds lack teeth, thus they cannot chew their food. As food is swallowed, it is stored in an organ called a **crop** where it absorbs water and is softened. The food then moves to a muscular organ called a **gizzard**, where it is ground into fine particles by small stones or grit that have been swallowed by the bird for this purpose.

Figure 1–12 The pheasant is equipped with a different digestive system than most other animals. Its unique digestive organs include the crop and gizzard. *Courtesy U.S. Fish and Wildlife Service.*

Each type of digestive system is designed to absorb water from the digestive tract along with the dissolved nutrients it contains. The water and nutrients then become part of the blood supply and the nutrients are transported to the cells of the body by the blood as it passes through the circulatory system. Despite the differences in the anatomy of the digestive tracts among the different animals, each system operates efficiently in extracting nutrients and energy from food.

ANIMAL GROWTH

Each newborn animal experiences a period of rapid growth in size. This growth is necessary before it can mature into an adult of its species. Cells divide to form new cells throughout the life span of an organism as old cells die and are replaced. Growth occurs when body cells divide at a faster rate than they die. The type of cell division that results in growth of the body is called **mitosis**. This important scientific process controls the rate of growth. As individual cells are produced by this method of cell division, the growth of tissues and organs occurs.

KEY INTERNET SEARCH WORDS
mitosis
pictures
photographs

Several steps occur during mitosis, see Figure 1–13. Each cell exists for most of its life span in a resting or nonreproductive stage. This is called **interphase**. The first stage of active cell reproduction is known as **prophase**. During prophase, the membrane around the nucleus

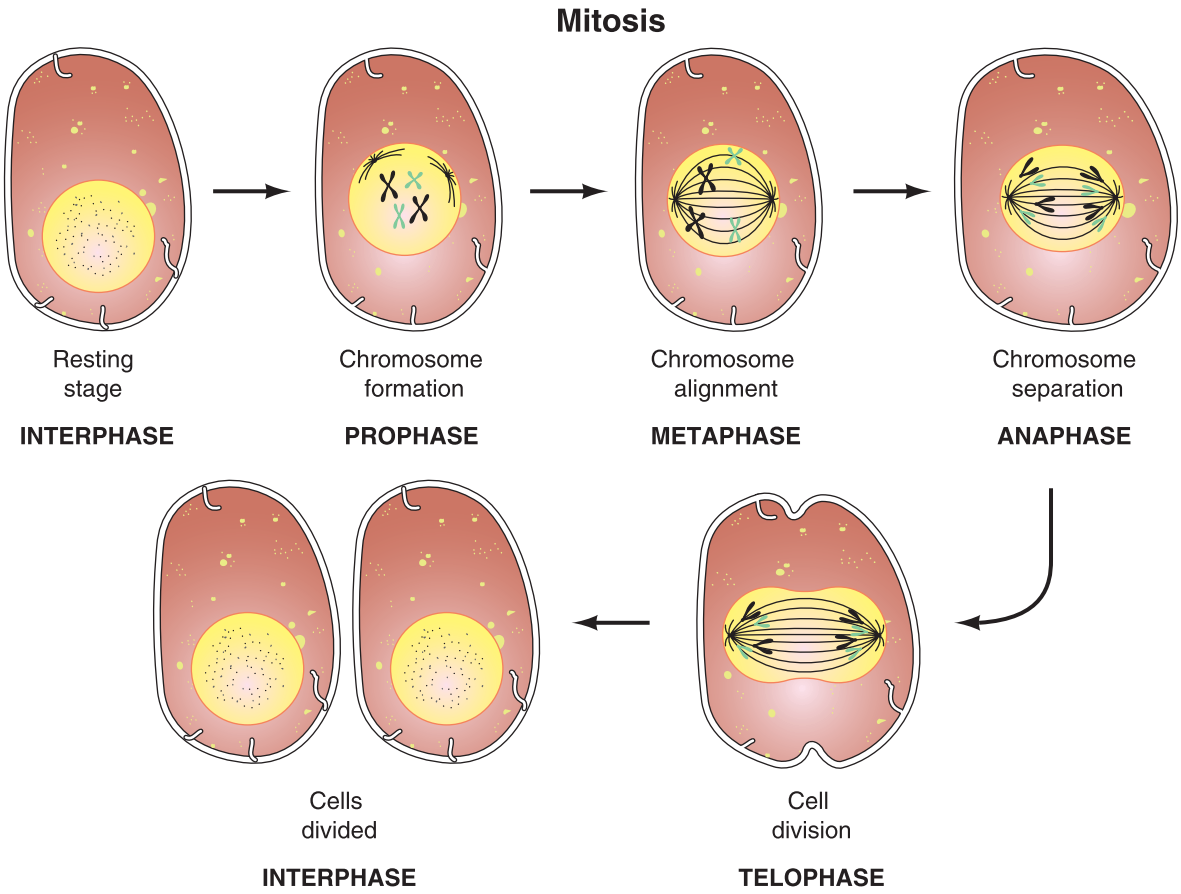


Figure 1–13 Growth in an animal occurs as cells divide through the process of mitosis.

disappears, and the chromosomes appear. Each chromosome has been replicated, and each half of the duplicated chromosome is known as a **chromatid**. The point where the chromatids are attached together is called the **centromere**.

The next step in cell division is **metaphase**. During metaphase, the chromosomes are pulled to the center of the cell by fibers attached to cell structures called **centrioles** that have migrated to opposite sides of the cell. These fibers or **spindles** are attached to the centromeres that connect the pairs of chromosomes together. The chromatids are pulled apart by the spindles as the cell elongates. This step is known as **anaphase**. A full set of chromosomes becomes evident on opposite sides of the cell during anaphase.

Telophase is the last phase of mitosis. During telophase, the cell becomes constricted with a new cell membrane forming, and the two new cells share the cytoplasm equally. A full set of chromosomes eventually becomes separated into each new cell. The membrane around each cell nucleus forms once again. Cells divide through the process of mitosis to form clusters of cells. Cell clusters become specialized in an undeveloped embryo to form different kinds of tissues such as heart or lung tissue.

In the process of growth, the cell masses expand the size of the tissue from which they originated. As a result, the baby fawn develops into a mature deer; the gosling grows into a mature goose; the tadpole becomes a mature frog or toad, see Figure 1–14. The growth process has occurred through mitotic cell division.

Figure 1–14 The process of mitosis is very active in a young gosling as it grows to a mature-sized bird during a period of a few months.

ANIMAL REPRODUCTION

Animal reproduction is the sexual process by which new individual animals are created. The formation of reproductive cells, also called **gametes**, occurs in the same manner for all of the animals described in this textbook. The reproductive cell division by which this occurs is called **meiosis**, see Figure 1–15.

KEY INTERNET SEARCH WORDS

meiosis, pictures

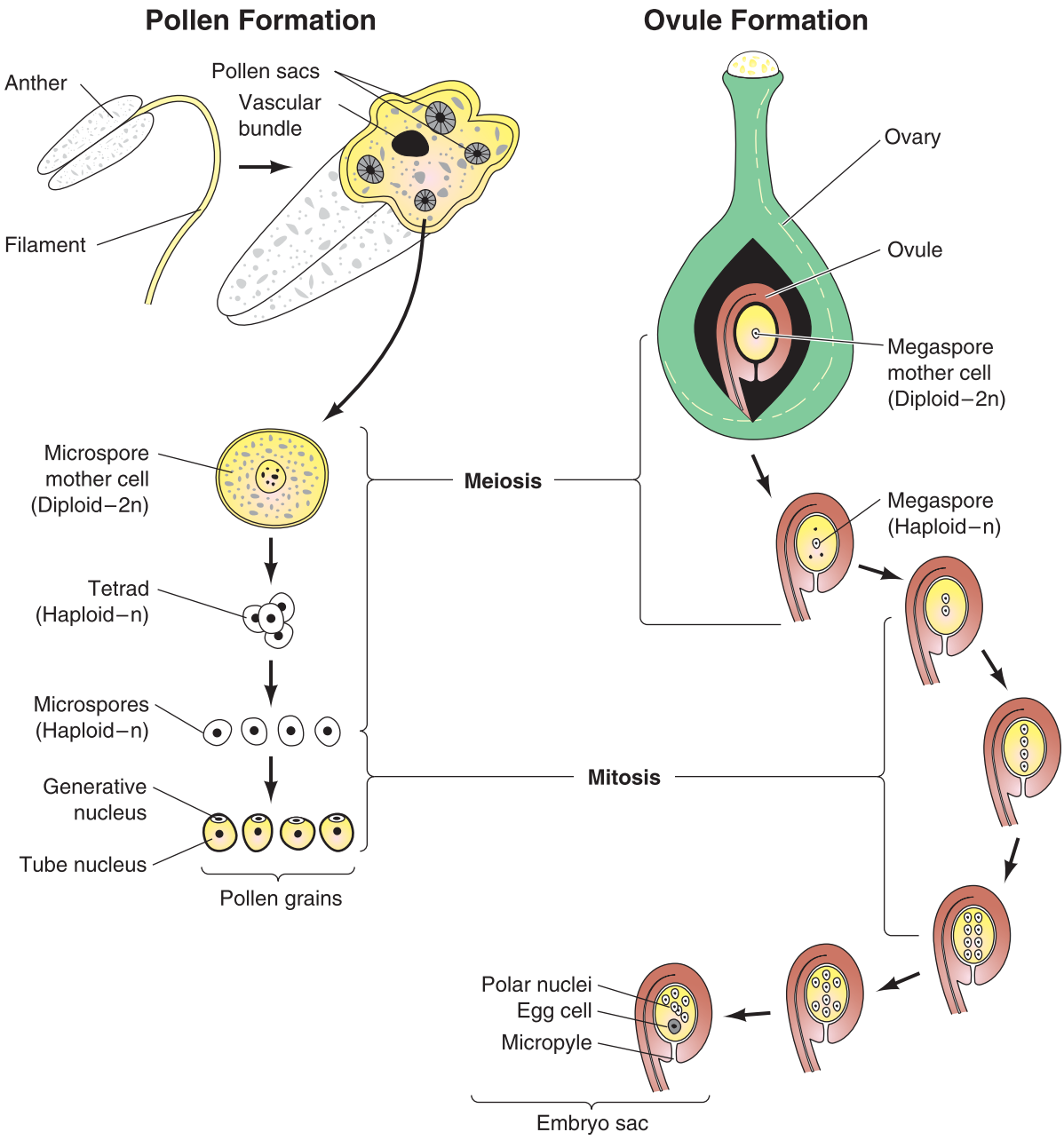


Figure 1–15 The process of meiosis.

The first step in meiosis occurs when chromosomes are duplicated in reproductive cells, and each chromosome becomes aligned in the center of the cell with its matching or **homologous chromosome**. Each of these matching chromosomes is also called a **homologue**. Once the chromosomes have become aligned, meiotic divisions begin. In the first division, the homologous chromosomes are separated into different cell masses. The division of cytoplasm is equal in the formation of male gametes, but in the female, this division of cytoplasm is unequal. One of the cell masses is larger than the other.

The second meiotic division results in the separation of the two chromatids that make up the duplicated chromosome. Once again, the

division of cytoplasm between cell masses is equal in the male, but unequal in the female. In animals, the four male cells that result from meiosis develop long, slender tails to form **sperm**. In females, only the largest cell mass matures to form an **egg** or **ovum**.

Each new cell that is formed through meiosis consists of one chromatid from each original chromosome pair. It is a **haploid** cell because it only contains half of the genetic material of the cell from which it was formed. The parent cell is a **diploid** cell, meaning that it contains both homologues of each chromosome. The process for gamete formation is the same for all of the animals. **Fertilization** is the process by which the male and female gametes join together in a single cell. This cell is called a **zygote**, and it is the first cell that is formed in the creation of a new individual. It is a diploid cell formed from two haploid cells.

Once the gametes are formed, other aspects of reproduction in animals are quite different among the many species. These differences between animal species are discussed in greater detail in later chapters of this textbook. In summary, some animals reproduce by laying eggs. In some instances, the eggs are fertilized inside the body of the female, and in other instances, the eggs are fertilized outside the body of the female. Birds and reptiles are examples of reproduction in which eggs are fertilized inside the body. Frogs, toads, salamanders, and fish are examples of animals whose eggs are fertilized outside the body of the female.

Mammals give birth to live young that develop from eggs fertilized inside the body of the female. The sperm from the male is deposited inside the reproductive tract of the female in close proximity to the unfertilized eggs. When the timing and conditions are favorable, the sperm cells migrate to the location of the egg and penetrate the egg, where the process of fertilization is completed.

Snakes and sharks are examples of animals in which the fertilization of eggs occurs inside the body of the female, see Figure 1–16. In some

Figure 1–16 A snake is an example of an animal whose eggs are fertilized internally.

ZOOLOGY PROFILE

Technology as a Tool: Saving Endangered Animals

A new tool with potential for expanding the populations of endangered animal species is genetic engineering. It is a common practice with domestic animals to divide the cell mass of a growing embryo into identical embryos and implant them in "surrogate mothers." This procedure is performed when the embryo has developed to the 8 to 32 cell stage. Performing this procedure with embryos obtained from a female of an endangered species offers the possibility of producing more offspring than would occur in nature. Extra embryos can be transferred to females of a closely related species that perform the function of "surrogate mothers."

instances the females lay the eggs prior to the time they hatch, and in other instances the eggs hatch inside the body of the female and live young are born. In addition to these examples of differences in animal reproduction, there are many other unusual behaviors exhibited by animals during the reproductive process. These behaviors are described in the chapters that deal with those particular animal species.

LOOKING BACK

The branch of biology that deals with animal life is zoology. It includes the life, growth, structure or anatomy, nutrition, reproduction, and classification of individual animal species. Animals are classified into related groups based on their genetic and structural similarities to other animals. The field of science that classifies organisms and defines their relationships to one another is called taxonomy. A vertebrate is an animal that has a skeleton with a segmented backbone composed of bone segments surrounding the spinal cord extending from the tail to the skull. Animals obtain energy and nutrients to perform their life functions from the food they eat. The organs and methods of digestion are different, but each process is efficient at extracting energy and nutrients from food. Growth of tissues and organs occurs as cells divide through the process of mitosis. Gametes are the reproductive cells that are produced through a process called meiosis. Although fertilization and other aspects of reproduction are different among the animal species, each method works well considering the many different environments in which individual species live.

Chapter Review

DISCUSSION AND ESSAY

1. How is the science of biology different from the science of zoology?
2. List the taxonomy groupings in descending order beginning with kingdom.
3. Distinguish between an instinctive behavior and a learned behavior.
4. How is the structure or anatomy of an animal related to its ability to survive in its environment?
5. Describe the anatomical differences in the digestive tracts of animals having a simple stomach, a rumen, and a gizzard.
6. Explain the process of cell division called mitosis.
7. What happens to the cell during the prophase period of mitotic cell division?
8. What is the difference between a diploid cell and a haploid cell?
9. What happens to the male and female gametes during the process of fertilization?
10. Identify some differences in the ways that reproduction occurs among mammals, birds, fish, reptiles, and amphibians.

MULTIPLE CHOICE

1. The branch of biology that deals with animal life is:
   a. Limnology
   b. Zoology
   c. Silviculture
   d. Botany
2. Which of the following animal classifications is not one of the key taxonomy headings used by taxonomists to describe an animal?
   a. Class
   b. Order
   c. Family
   d. Vertebrate
3. An animal that has canine teeth is most likely to eat a diet of:
   a. Grasses and herbs
   b. Meat
   c. Insects
   d. Worms and grubs
4. A ruminant animal is most likely to eat a diet of:
   a. Grasses and herbs
   b. Meat
   c. Insects
   d. Worms and grubs
5. Which of the following organs is not found in the digestive tract of a bird?
   a. Stomach
   b. Gizzard
   c. Intestine
   d. Crop

6. Identify the term that does not apply to a description of the process of mitosis:

   a. Haploid
   b. Prophase
   c. Chromatid
   d. Anaphase

7. Chromosomes are pulled to the center of the cell by spindles during which step of mitosis?

   a. Metaphase
   b. Telophase
   c. Prophase
   d. Anaphase

8. Gametes are formed during the process of:

   a. Meiosis
   b. Fertilization
   c. Mitosis
   d. Interphase

9. A zygote is a:

   a. Female gamete
   b. Male gamete
   c. Diploid cell
   d. Haploid cell

10. Reproduction in mammals involves which of the following processes?

   a. Laying fertilized eggs that hatch outside the body of the female
   b. Giving birth to live young
   c. Laying eggs that are fertilized outside the body of the female
   d. Producing eggs that hatch inside the body of the female just prior to birth

Learning Activities

1. Obtain a list of endangered and threatened species found in your state or region from the U.S. Fish and Wildlife Service site on the Internet <http://endangered.fws.gov/wildlife.html>. Assign students to work in groups to prepare a written report on one of these animals. Have each group prepare an oral report complete with charts and electronic presentations. Select the best reports to be presented to elementary school science classes. The teacher should coordinate these presentations with elementary school administrators and teachers.

2. Invite a professional from a government agency who works with endangered and threatened species to talk to the class about the criteria for listing or delisting a species on the endangered or threatened species list. Request that the presentation address ways that the criteria are assessed. Be cautious to select presenters who will present both sides of the issues.

CHAPTER

2

Principles of Ecology

After completing this chapter, you should be able to:

- explain the law of conservation of matter
- suggest ways by which waste materials can be properly disposed of to reduce or eliminate damage to the environment
- relate pollution of the environment to the law of conservation of matter
- examine the positive and negative effects of waste control methods that are used by modern society
- define the role of energy in the science of ecology
- explain the first and second laws of energy
- describe the major events that occur in natural cycles, such as the carbon, nitrogen, and water cycles
- investigate the importance of water to living organisms
- explain how a food chain is organized
- distinguish among food chains, food webs, and food pyramids.

The branch of biology that describes relationships between organisms and the environments where they live is called ecology. Different organisms relate differently to their environments. They eat different foods, seek different kinds of shelter, and require different environments in which to raise their young. They are also part of the food web and are used as food by a variety of other organisms. All of these relationships are described in the science of ecology. Ecology is concerned with all of the activities and relationships that affect the environment and the living organisms that depend upon it for food and shelter.

KEY TERMS

ecology
law of conservation of matter
industrial waste
surface water
aquatic species
pollutant
groundwater
solid waste
pesticide
insecticide
herbicide
rodenticide
hazardous materials
petroleum
energy
first law of energy
radiant energy
chemical energy
kinetic energy
thermal energy
electrical energy
second law of energy
elemental cycle
fossil fuel
nitrogen fixation
nitrogen-fixing bacteria
denitrification
nitrogen cycle
water cycle
transpiration
food chain
producer
herbivore
primary consumer

CONSERVATION OF MATTER

A basic law of physics is the **law of conservation of matter**: Matter can be changed from one form to another, but it cannot be created or destroyed by ordinary physical or chemical processes. This law holds true in the study of ecology.

The law of conservation of matter applies to everything that exists. Most organisms use only those materials that make up their food supply, and little waste material is generated. The waste that is generated is capable of being recycled through natural processes. While the law of conservation of matter applies to humans also, the wastes they generate are not easily disposed of through natural cycles. Some of the materials that humans create persist in the environment almost indefinitely, and some of these waste materials are harmful or toxic to other organisms.

Waste materials have become a major problem in many of the industrialized nations of the world: By-products of industrial processes; solid wastes from our population centers; pesticide residues from farms, gardens, and yards; petroleum leaks and spills are only a few of the waste materials that pollute the environment, see Figure 2–1. These materials do not just go away when we are finished with them.

Figure 2–1 Surface water pollution caused by spills of oil or chemicals is a major problem and causes serious damage to the environment.

The law of conservation of matter applies directly to waste materials. We may change the form of waste materials to make them more compatible with the environment, but we cannot destroy them. With this in mind, we must properly dispose of all waste materials to prevent serious environmental problems, see Figure 2–2. We can help solve this

secondary consumer
carnivores
decomposer
food web
food pyramid

Figure 2–2 Waste materials must be properly disposed of to prevent serious environmental damage.

KEY INTERNET SEARCH WORDS
Exxon Valdez Oil Spill

Figure 2–3 Industrial air pollution has been a problem for years and many industries have made serious efforts to reduce it.

problem by using fewer materials that are disposable and by recycling waste materials.

Industrial wastes have been a serious problem for many years, see Figure 2–3. They include a variety of harmful chemicals, poisonous metallic compounds, acids, and other caustic materials that are left over from manufacturing processes. Many of our **surface waters** (rivers, streams, ponds, and lakes) are seriously polluted by industrial wastes, see Figure 2–4. In many cases, fish and other **aquatic species**

Figure 2–4 Many of our natural resources are seriously polluted by waste materials.

of plants and animals that live in surface water environments have been poisoned.

Many industries have made serious efforts to reduce or eliminate water and air pollution by using water treatment plants and installing special equipment in smokestacks. Environmental laws have mandated improvements in the ways that **pollutants** (dangerous waste materials) are handled. It is important to research new ways to eliminate all forms of pollution to the environment regardless of their sources.

KEY INTERNET SEARCH WORDS

pollution, prevention, reduction

pesticide safety

solid waste

Most of the pollutants that affect surface water also cause problems in groundwater. This is the water that is located beneath the earth's surface. It is stored in large natural underground reservoirs where it occupies the space between soil particles such as sand, gravel, and rocks, see Figure 2–5. **Groundwater** provides a water supply to man-made wells and naturally flowing springs.

Many waste materials can be changed to reduce or eliminate pollution. **Solid wastes** include most of the materials that are gathered by trash collectors for disposal. Much of this trash is buried in landfills. In recent years, we have learned that highly toxic liquids, see Figure 2–6, tend to ooze out of the landfills and pollute the water and soil in the local area. Material buried in landfills tends to remain for long periods of time, and it does not break down as quickly as many people expected. Much of it will still be there centuries from now in much the same form as when it was buried.

Some communities burn the combustible portion of their solid waste as a source of energy. Metals, glass, and plastic materials are often separated out to be recycled, see Figures 2–7 and 2–8. Although this approach is considered to be a good alternative to burying garbage, it is not a perfect solution to the problem due to emissions into the atmosphere.

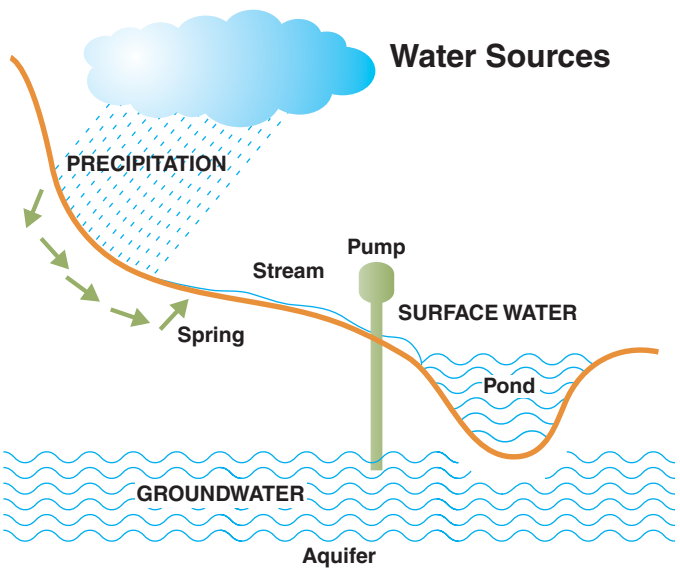


Figure 2–5 Water that is used to produce agricultural products is obtained from several sources. Many areas depend upon surface water and ground water for irrigation.

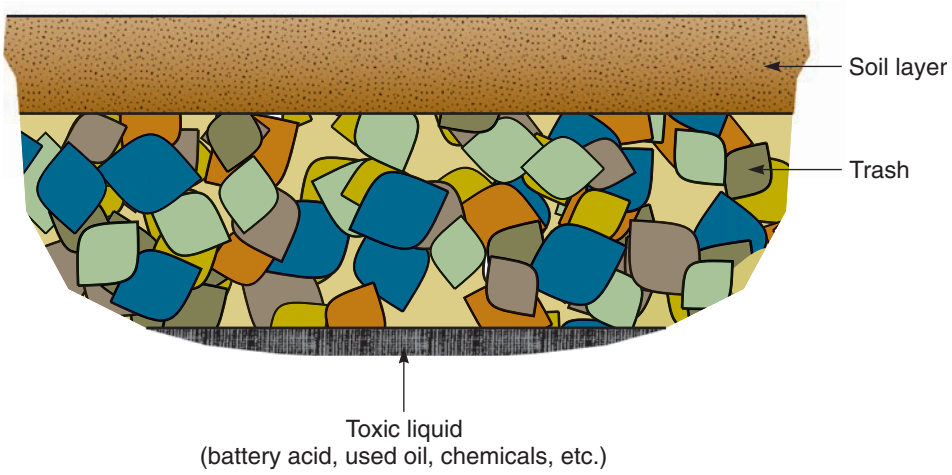


Figure 2–6 The layers of a landfill.

KEY INTERNET SEARCH WORDS
recycle waste

Care must be taken to prevent air pollution from the by-products of burning. The burning process releases carbon monoxide and sulfur dioxide into the air along with ash and other gases that can be harmful to the health of the people, animals, and plants that live in the surrounding area. New technologies have been developed that are effective in trapping pollutants; however, many of these processes are expensive and their current use is limited in many communities.

Figure 2–7 Plastic is one of the many products that we currently recycle.

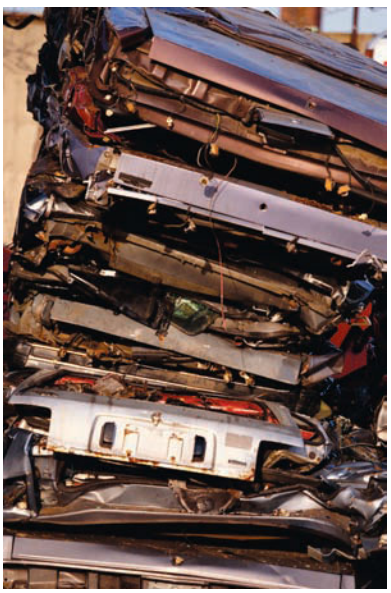


Figure 2–8 Metals can be recycled again and again. Old cars, cans, and other items made of metal can be melted down more efficiently than new ore can be refined. *Courtesy USDA/ARS#K5213–3*

Career Option

ENVIRONMENTAL SCIENTIST

AN ENVIRONMENTAL SCIENTIST conducts research related to pollution of the environment. He or she gathers and analyzes data to determine how the environment is affected by different approaches to controlling pollution.

They also use experimental results to determine pollution standards for government regulations and propose improved practices for managing pollution problems.

A career as an environmental scientist requires an advanced professional degree in chemistry or biology and may include emphasis on environmental science, wildlife, and/or natural resources. High school preparation should include a strong curriculum in science and mathematics, with a broad experience base in agriculture and natural resources.

KEY INTERNET SEARCH WORDS
pesticide safety

Pesticides are chemicals that are used to control insects or weeds. When a pesticide is used only to kill insects, it is called an **insecticide**, see Figure 2–9. A pesticide that is used to control plants is called an **herbicide**. A **rodenticide** is used to poison rodents. Large amounts of pesticides are used each year on lawns, gardens, golf courses, and farms to control unwanted species of plants, insects, and rodents. Each of these pesticides can be dangerous to the environment when they are not properly used.

Figure 2–9 Chemicals that control weeds and pests can be dangerous to the environment. It is important that they are used properly. *Courtesy U.S. Department of Agriculture.*

Empty pesticide containers are dangerous when proper disposal methods are not used. Most pesticides are sold in metal or plastic containers. Those who use these materials should carefully triple-rinse empty containers with water and dispose of the container and the rinse water according to the directions on the label. Most empty pesticide containers are considered to be **hazardous materials**. Such materials are treated as threats to the environment, and their disposal is controlled by law.

Petroleum is an oily, flammable liquid that occurs naturally in large underground deposits. We call it crude oil, and from this basic material, a large variety of products are manufactured. Gasoline, heating oil, and diesel fuels are the best-known and most widely used products obtained from petroleum.

Figure 2–10 A live, oiled goldeneye injured by a petroleum spill. *Courtesy U.S. Fish and Wildlife Service.*

When petroleum or petroleum products are spilled or leaked into the environment, they are often hazardous to the organisms that live there, see Figure 2–10. Thousands of aquatic animals, particularly fish and waterfowl, die each year due to spills of crude oil into surface waters.

Petroleum products are also damaging to the environment when they leak or spill on land. Leaking underground fuel tanks have polluted groundwater, contaminated drinking water, and destroyed plant and animal life. Poisonous fumes from petroleum spills are hazardous to the health of humans as well as animals, and they create potential fire hazards.

Environmental laws have been implemented in recent years requiring the inspection of underground tanks to detect leaks. In some cases, leaks have been found after many years of environmental pollution, see Figure 2–11. Spills of this type are often difficult to find and expensive to clean up. Some states have required that underground fuel tanks be removed.

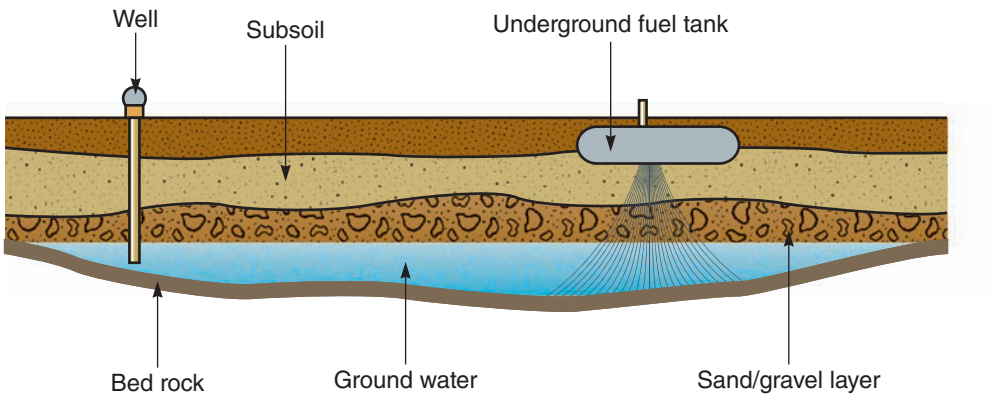


Figure 2–11 Underground fuel tank leakage. *Exxon Valdez Oil Spill*

ECOLOGY PROFILE

Exxon Valdez Oil Spill

One of the most damaging environmental accidents ever to occur took place on March 24, 1989, off the coast of Alaska. A large oil tanker ran aground, damaging the ship and spilling 11 million gallons of crude oil into the ocean at Prince William Sound. Despite a desperate effort to contain the spill, it became widely dispersed. It damaged a large area along the coast and killed massive numbers of birds, marine mammals, and fish. The ship's captain and owners were prosecuted for negligence that led to the spill, but we may never know the full extent of the damage to this ecologically sensitive area. Similar spills of petroleum products occur nearly every year. The most damaging of these spills usually occur in the oceans due to the large volume of the tanker ships that are used for transporting petroleum products. However, serious spills also occur along highways when tanker trucks overturn.

LAWS OF ENERGY

KEY INTERNET SEARCH WORDS
laws of energy

Energy is the ability to do work or to cause changes to occur. It is the power or force that enables animals to move or the tides to flow. Energy flows through systems from areas where it is concentrated to areas where it becomes dispersed or unorganized. For example, food is the source of energy for animals. As it is digested, it gives off heat to warm the body of the animal, and it provides power to the muscles making movement possible. Even the ability of the brain to think depends on a supply of energy.

Energy flows through entire ecosystems, see Figure 2–12. About two-thirds of the solar energy that passes from the sun to the earth is trapped by the land, water, plants, and atmosphere.

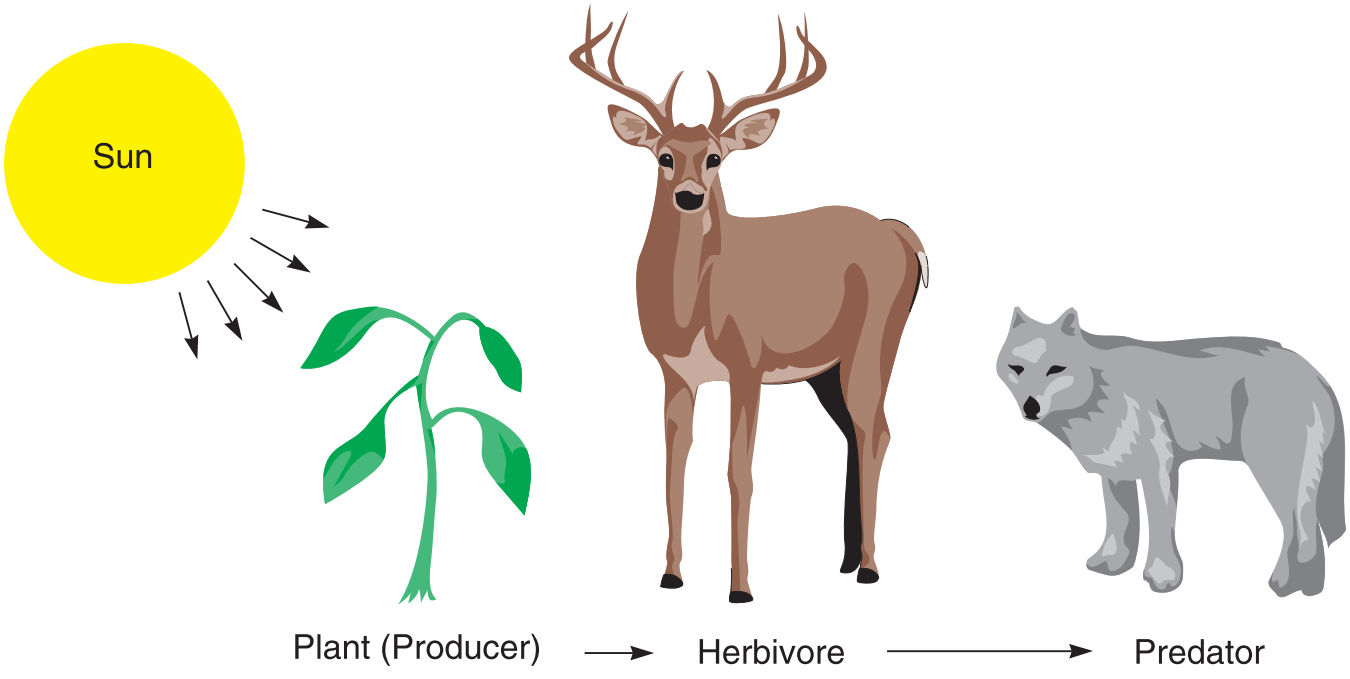


Figure 2–12 Energy flow in an ecosystem.

Solar energy in the form of sunlight is captured by plants and stored as molecules of sugar and starch. When a plant is eaten by an animal, the energy is released from the plant cells allowing the animal to do work, or it is stored in the animal's body in the form of fats, proteins, or carbohydrates until it is needed. When plants or animals die, the energy may be stored in the form of fossil fuels (coal or oil deposits) that store energy for long periods of time or it may be given up in the form of heat as the remains decompose. Sometimes energy is transferred to other animals when the remains of dead plants and animals are eaten and digested for food.

Energy cannot be recycled, but it can be stored for later use.

The First Law of Energy

The **first law of energy** states that energy cannot be created or destroyed, but it can be converted from one form of energy to another. For example, **radiant energy**, which comes from the sun, is converted to **chemical energy**, (sugars and starches) by plant leaves during the process of photosynthesis. Chemical energy from a plant that is eaten by an animal is converted into body heat and **kinetic energy**, the energy associated with motion and movement.

Large deposits of coal or crude oil have been formed from decayed plant materials. During the formation of these materials, energy is stored as chemical energy. **Thermal energy** is created in the form of heat when these fuels are burned. Thermal energy can be converted to **electrical energy** by heating water to operate a steam engine that uses kinetic energy to drive a generator, see Figure 2–13.

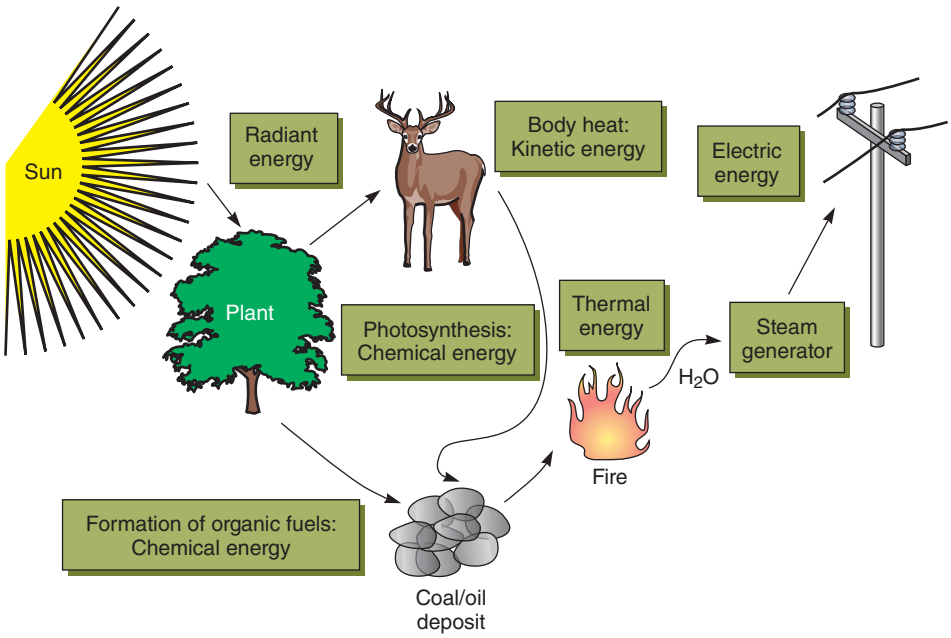


Figure 2–13 The first law of energy.

The Second Law of Energy

The **second law of energy** states that every time energy is converted from one form to another, some energy is lost in the form of heat, see Figure 2–14. The heat that is lost is not destroyed, but it simply becomes unavailable for later use. Every single change in the form of energy results in the loss of heat.

It is possible for some of the heat that is lost from living plants and animals to be trapped when the energy in the food is converted from one form to another. The process of digestion releases heat into the body cavity where it is used to maintain body temperature in warm-blooded birds and mammals, see Figure 2–15.

All living things respond to the laws of energy and all ecosystems on earth depend upon energy sources. Much of the controversy surrounding energy conservation deals with this important principle: We cannot continue to use more energy than the earth can replace.

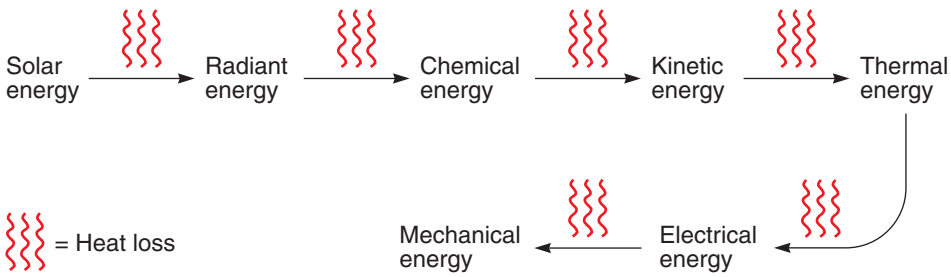


Figure 2–14 The second law of energy.

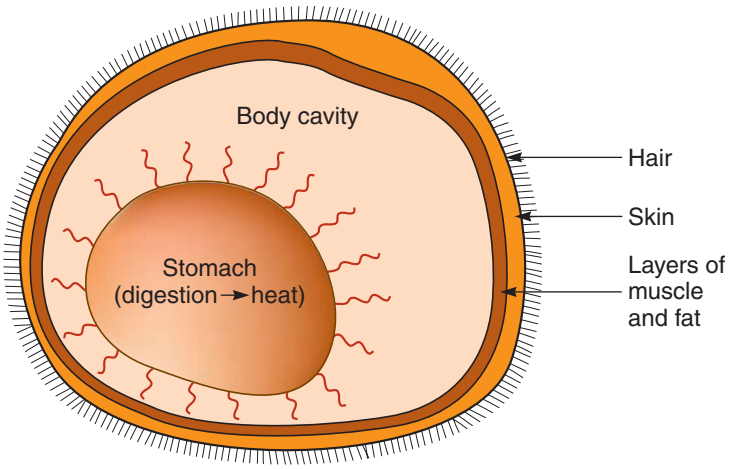


Figure 2–15 Maintaining body heat.

NATURAL CYCLES

Only a few of the known elements that are found in the upper crust of the earth, in water, or in the atmosphere are abundant in the tissues of living organisms. The most plentiful of these elements are carbon, hydrogen, oxygen, and nitrogen. These four elements account for 96 percent of the material that is found in living organisms. Over 30 other elements are known to make up the other 4 percent of living tissue.

These elements, which are so important in the formation of living organisms, are used over and over again. An atom of carbon may exist as part of a sugar molecule in a plant that is later eaten by an animal. It may then become part of the muscle of the animal. When the animal dies, the same atom of carbon may be passed into the soil or into the atmosphere as the tissue of the animal decomposes. Finally, it may be taken up by another plant to form new plant tissue. In this manner, elements cycle from living organisms to nonliving materials and back, again and again. This circular flow of elements from living organisms to nonliving matter is known as an **elemental cycle**.

Cycles exist for all of the elements that make up living tissue. We now consider only the carbon and nitrogen cycles.

KEY INTERNET SEARCH WORDS
carbon cycle

The Carbon Cycle

Carbon is the most abundant element found in living organisms. It makes up the framework of the molecules that are found in living tissue. In the absence of water, nearly half of the dry matter found in the bodies of animals or humans consists of carbon. Carbon moves readily between living organisms, the atmosphere, the oceans, and the soil, see Figure 2–16. The respiration process of both plants and animals releases carbon dioxide CO_2 into the atmosphere. Using light energy during the process of photosynthesis, plants take CO_2 from the atmosphere and turn it into sugars that they use to make new tissue such as roots, stems, and leaves. When plant tissue

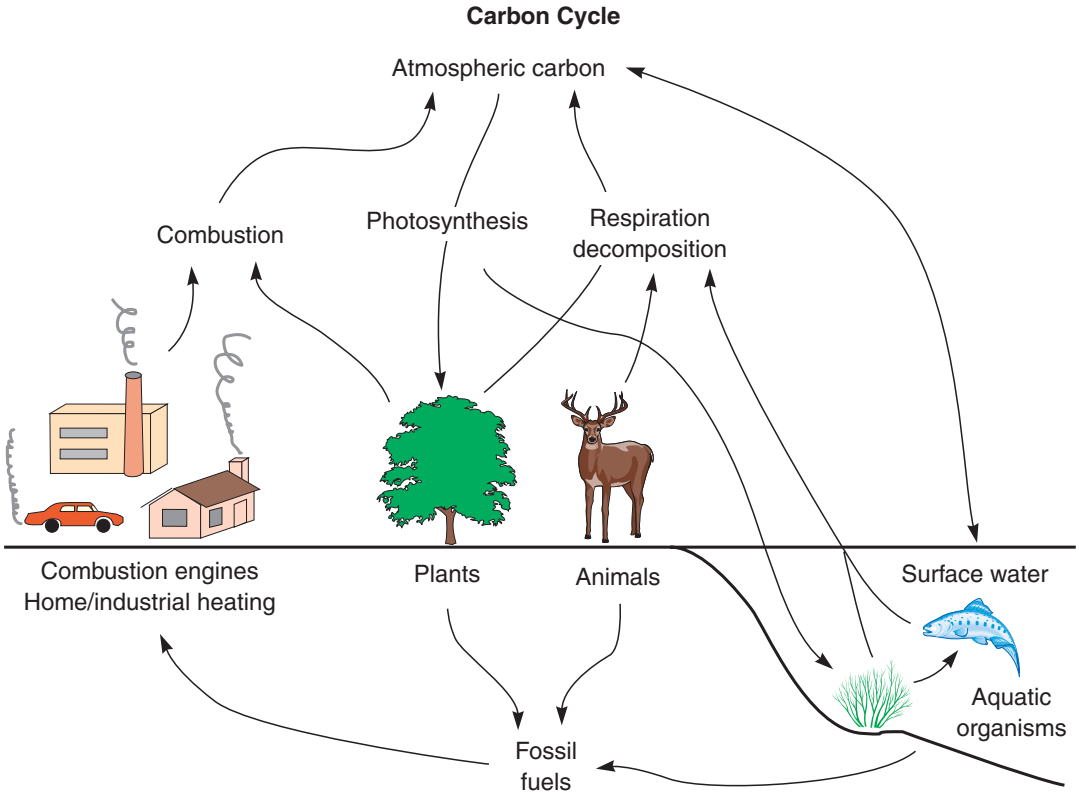


Figure 2–16 The carbon cycle.

decays, CO_2 is released back to the atmosphere as a gas or it is converted over a long period of time to **fossil fuels** such as natural gas, crude oil, or coal. Sometimes plant materials are eaten by animals. When animals die, their bodies decompose, releasing CO_2 to the atmosphere as a gas, or the carbon from their bodies may be converted over long periods of time to fossil fuels.

People mine or extract fossil fuels from the surface of the earth for use as fuels and for other purposes. When these materials are burned, the combustion process releases CO_2 to the atmosphere.

The oceans then absorb large amounts of CO_2 from the atmosphere when the carbon content of the atmosphere is high, and they release CO_2 to the atmosphere when atmospheric CO_2 decreases. Until recent years, the carbon content of the atmosphere has remained nearly the same due to this action by the oceans.

During the past 100 years, the large amounts of fossil fuels that have been burned have increased the levels of CO_2 in the atmosphere. We are burning these fuels faster than the oceans can absorb the extra atmospheric carbon. We do not know the effect of our massive CO_2 inputs to the atmosphere, but one effect is thought to be global warming. Long-term climatic change could have drastic consequences for natural and agricultural ecosystems.

Research has demonstrated that algae found in seawater is capable of removing large amounts of CO_2 from the atmosphere. Adding iron as a nutrient to the water surface has stimulated algae growth. Scientists are divided over what happens to the carbon that is absorbed by the algae. Some believe that it sinks to the ocean floor when the algae dies. Others believe that it is lost back to the atmosphere. Some scientists worry that promoting algae growth on a massive scale could upset the delicate balance of the oceans' ecosystems.

The Nitrogen Cycle

Nitrogen is the most abundant element in the atmosphere. It makes up about 80 percent of the air supply. In its elemental form (N_2), it is a colorless, odorless gas that cannot be used by plants or animals. It must be combined with oxygen or other elements before it becomes available as a nutrient for living organisms. Plants and animals use nitrogen compounds to form protein and other important molecules like DNA and vitamins.

KEY INTERNET SEARCH WORDS
nitrogen fixing bacteria

Nitrogen fixation is a process whereby nitrogen gas is converted to nitrates. This can occur in several different ways. **Nitrogen-fixing bacteria** are able to convert nitrogen gas to nitrates. Some forms of these bacteria live in the soil. Others live in nodules on the roots of clover, beans, peas, and other legumes, see Figure 2–17. These types of plants are able to make their own nitrogen fertilizer. Some types of blue-green algae and fungi also are capable of nitrogen fixation.

Figure 2–17 Nitrogen-fixing nodules on roots. *Courtesy U.S. Department of Agriculture's Agricultural Research Service.*

Several industrial processes convert nitrogen gas to nitrates. One of these processes converts nitrogen gas to ammonia as a by-product of steel production. Ammonia can also be obtained directly from natural gas. The ammonia is then converted to a form of nitrate that can be used for fertilizer, or it can be added directly to soil as a fertilizer.

Nitrogen fixation occurs naturally in the atmosphere when lightning strikes. The electrical current, which passes through the atmospheric nitrogen, converts some of the nitrogen gas to nitrogen compounds that can be used by plants. Nitrates are also released from animal wastes and from plants and animals that die and decay.

At the same time that nitrates are being produced from nitrogen gas, other nitrates are breaking down to release nitrogen gas back to the atmosphere. This process is called **denitrification**. It occurs when some forms of bacteria come into contact with nitrates. A similar process occurs when nitrates are carried by runoff water into surface water, which constantly exchanges nitrogen with the atmosphere.

KEY INTERNET SEARCH WORDS
nitrogen cycle

The circular flow of nitrogen from free nitrogen gas in the atmosphere to nitrates in the soil and back to atmospheric nitrogen is known as the **nitrogen cycle**, see Figure 2–18.

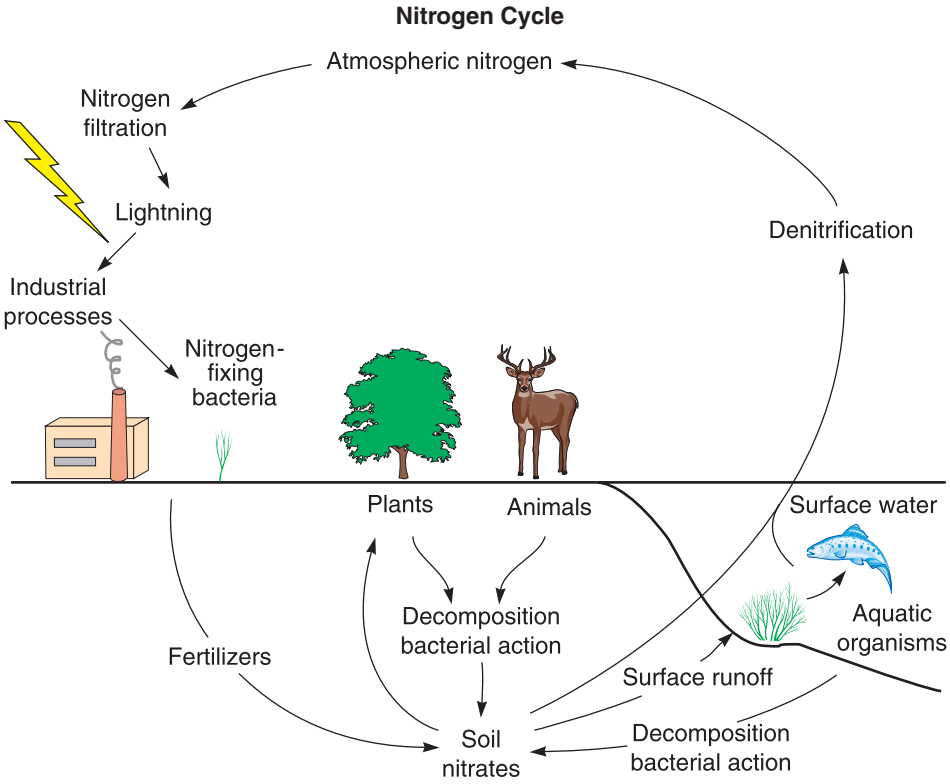


Figure 2–18 The nitrogen cycle.

The Water Cycle

Water is one of the most important resources in the environment, see Figure 2–19. It provides a living environment to many species of organisms and supports the growth of plant and animal life.

Water is a required nutrient for living things. It makes up between 50 and 70 percent of the weight of living plants and animals depending on their stage of maturity, see Figure 2–20. Water is used to control the temperature of organisms and as a solvent for nutrients. It also performs many other functions related to maintaining life. In addition, water in living tissues is part of the water cycle. It dissolves nutrients and carries them to the tissues that need them. It stores heat and helps stabilize the

Importance of water to the environment
• Soil formation.
• Living environment for plants and animals.
• Supports growth of plants.
• Dissolves and transports nutrients.
• Stores heat.
• Stabilizes temperature.
• Cools living organisms.
• Provides protection from natural enemies.

Figure 2–19 This chart shows the importance of water in the environment.

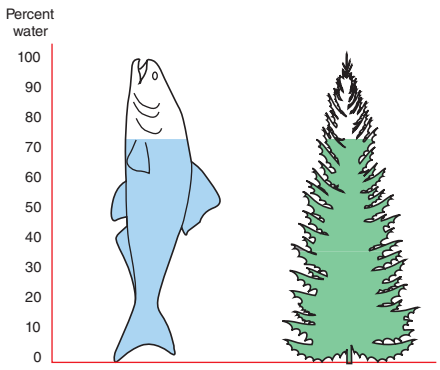


Figure 2–20 Water is an important component of living tissue.

temperature in the environment. Water action helps to create soil by breaking down rock into small particles. It also cleans the environment by diluting contaminants and flushing them away from vulnerable areas. Evaporation of water cools the surfaces of leaves and skin. Water even provides protection to some species of organisms, see Figure 2–21. Most living organisms require large amounts of water to survive.

Figure 2–21 Beaver pond, auxiliary dam, main dam, and lodge.

The **water cycle** occurs as water moves from the oceans to the atmosphere, to land in the form of rain or snow, to rivers and streams, and then back to the oceans, see Figures 2–22 and 2–23. The energy that drives this cycle comes from two sources—solar energy and the force of gravity.

Water is constantly recycled. A molecule of water can be used over and over again as it moves through the water cycle. Solar energy trapped by the ocean is a source of heat that causes water to evaporate. Additional water enters the atmosphere by evaporating from soil and plant surfaces, especially in areas of hot temperatures and high precipitation.

INTERNET ADDRESS

<http://wwwga.usgs.gov/edu/followdrip.html>

KEY INTERNET SEARCH WORDS

water cycle

Figure 2–22 A watershed is an area in which rainwater and melting snow are absorbed to emerge as springs of water or artesian wells at lower elevations.

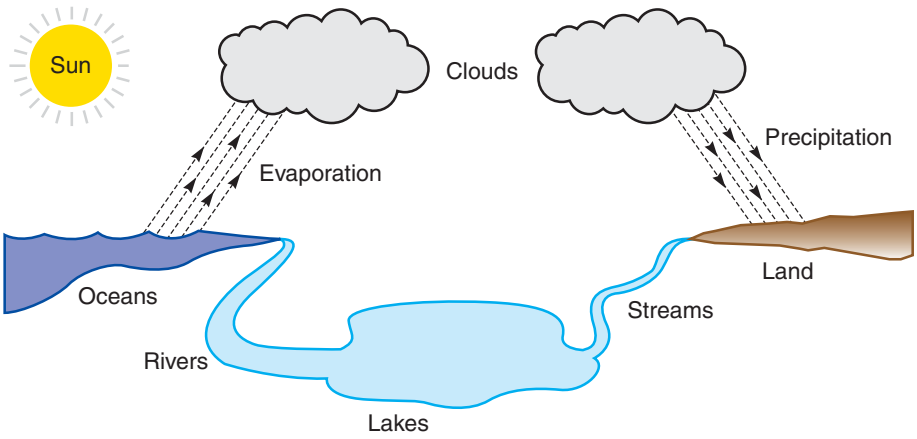


Figure 2–23 The water cycle.

KEY INTERNET SEARCH WORDS
water, transpiration

Plants give up large amounts of water to the atmosphere through a process called **transpiration**. This is a controlled evaporation process by which plants lose water through pores in their leaf surfaces. These pores open wide when leaf surfaces are hot, and they close when leaf surfaces are cool. Transpiration also creates a negative pressure that draws water and nutrients into the plant from the soil, see Figure 2–24.

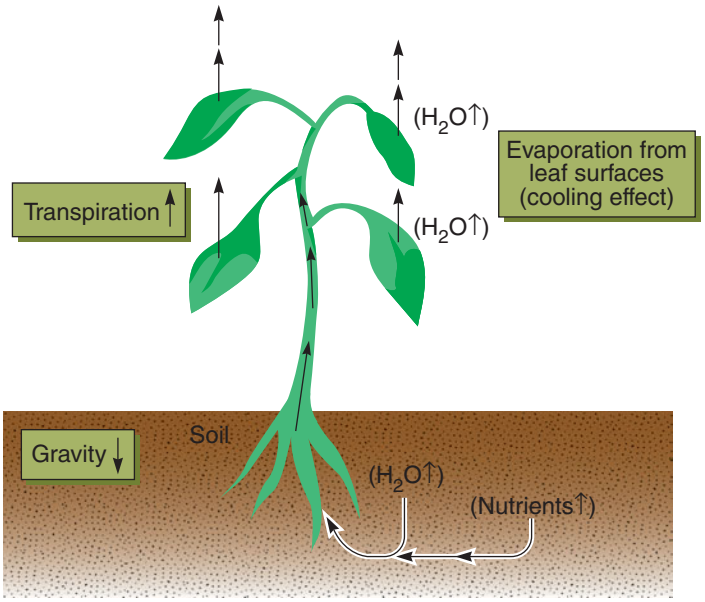


Figure 2–24 Effects of transpiration.

Mammals control the temperature of their bodies by releasing water through their skin pores in the form of sweat. Cooling takes place when the sweat evaporates from the skin's surface. Sweating in mammals occurs in much the same way that leaves transpire. Additional moisture is released to the atmosphere from the moist inner surfaces of the lungs, see Figure 2–25.

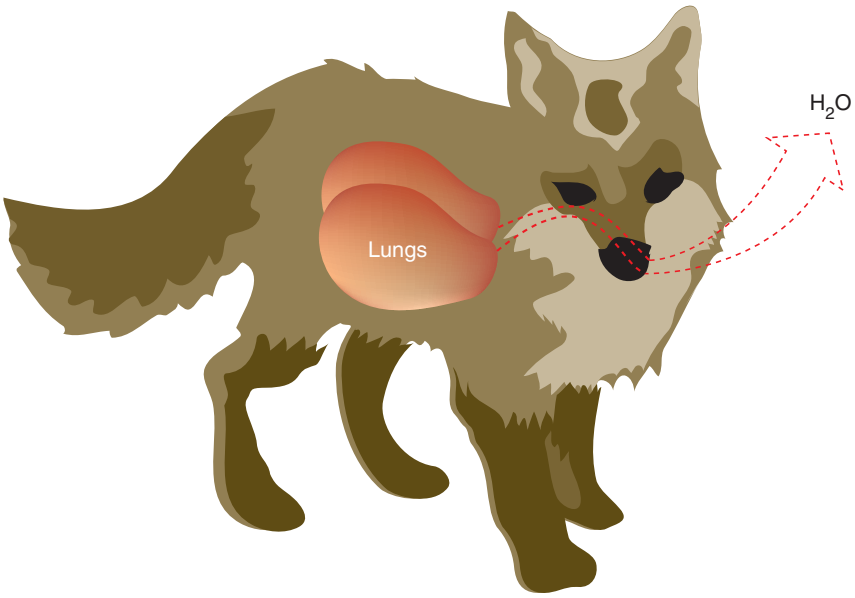


Figure 2–25 Cooling by evaporation occurs as water evaporates from the inner surface of the lungs.

Moisture from all of these sources builds up in the atmosphere, forming clouds. Clouds release stored water to the earth's surface in the form of rain or snow. Gravity draws the water back to the earth and causes it to flow from high to low elevations.

Large amounts of the earth's water supply are stored for long periods of time. Storage occurs in aquifers beneath the soil surface, in glaciers and polar ice caps, in the atmosphere, and in deep lakes and oceans. Sometimes this water is stored for thousands of years before it completes a single cycle.

FOOD CHAINS

KEY INTERNET SEARCH WORDS
food chain, web, pyramid

A **food chain** is made up of a sequence of living organisms that eat and are eaten by other organisms living in the community. Each member of the chain feeds upon lower-ranking members of that chain. The general organization of a food chain moves from organisms known as **producers** (usually considered to be food plants) to **herbivores** (plant-eating organisms). These plant-eating organisms are also called **primary consumers. Secondary consumers**, or **carnivores**, are meat-eating animals that eat primary consumers. A typical food chain begins with a plant as a food source and ends with a large predator. For example, a food chain may begin with meadow plants. Field mice eat plant roots and seeds and are prey for raptors such as hawks and eagles and other predators such as foxes and coyotes, see Figure 2–26.

The final life form that participates in a food chain consists of bacteria. These organisms are called **decomposers**, because they break down organic tissues from plants and animals that have died.

Most food chains become quite complicated because many predators will eat nearly any animal that they can catch and kill. Each

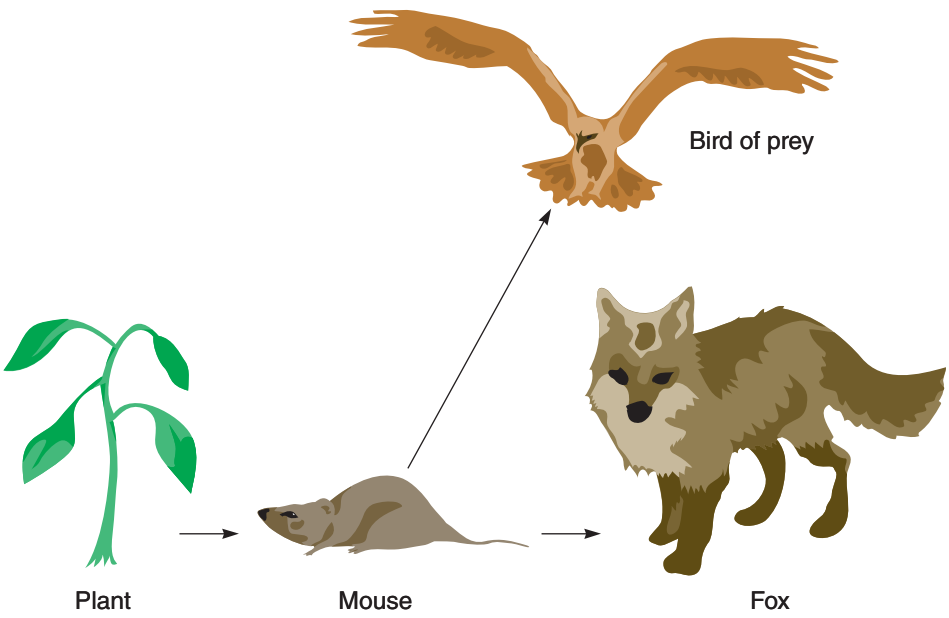


Figure 2–26 An example of a food chain.

food chain is interwoven with other food chains to create a **food web**, see Figure 2–27. A **food pyramid** arranges organisms in a ranking order according to their dominance in a food web.

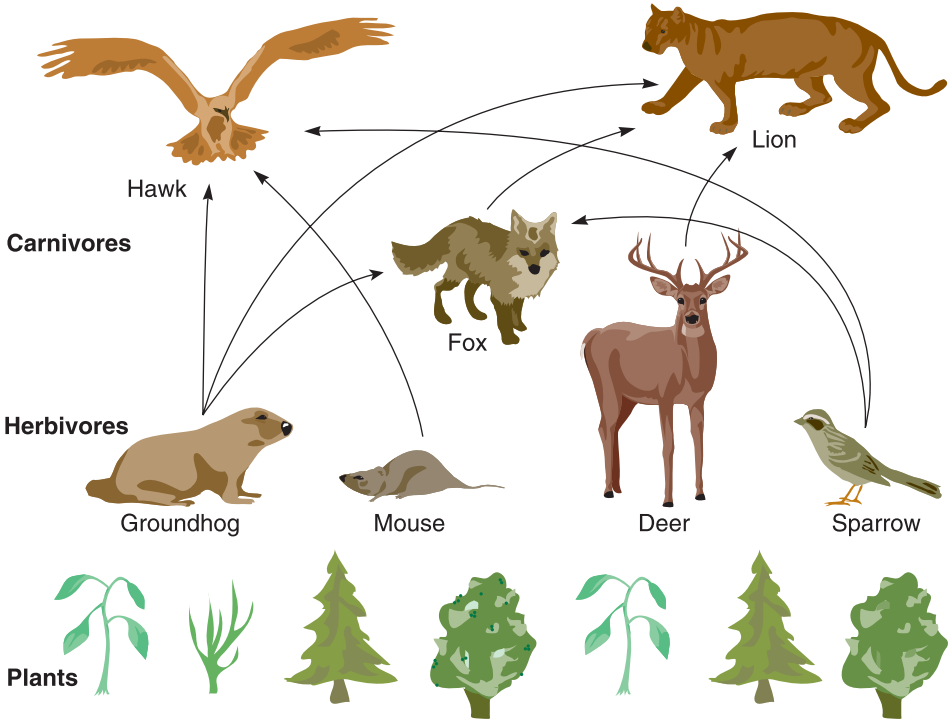


Figure 2–27 An example of a food web.

The most versatile predators usually occupy the highest rank in a food web, see Figure 2–28. These mammals or birds usually have few natural enemies, and they are capable of preying on a large variety of other species. They maintain their positions at the top of the food

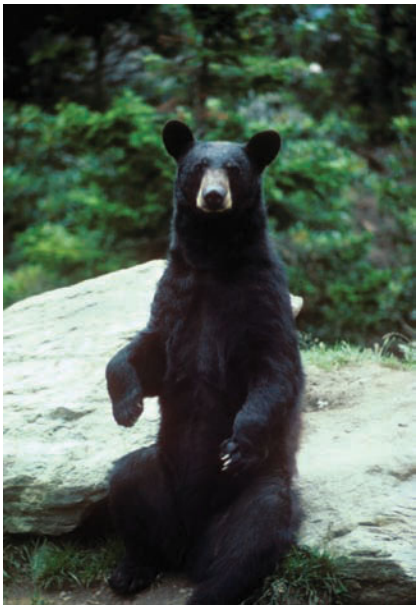


Figure 2–28 A black bear is capable of preying on many other animals.

pyramid unless a stronger predator migrates into the area that is capable of competing more favorably for the existing food supply. Sometimes a new predatory species even preys upon the species that previously occupied the highest rank in the food pyramid.

When changes occur in the kinds of organisms that occupy an ecosystem, they affect nearly every other species in the ecosystem. The movement of humans into a new area has the effect of displacing the predators that occupy the top ranks in a food web. Humans assume these positions by preying on the herbivores in competition with the predators. They also control the size of the predator population by killing these animals or driving them out of the area.

It is the dominance of humans in the food pyramid that has created the issues surrounding the movement to maintain and restore natural environments, see Figure 2–29. Extreme positions have been taken on both sides of the issue. Some people contend that human dominance over other species of organisms is a natural process that has evolved since the beginning of time. Others recognize that the human species is the only species capable of changing its habits to preserve other species of organisms. They contend that humans have the moral obligation to protect all other forms of life, see Figure 2–30.

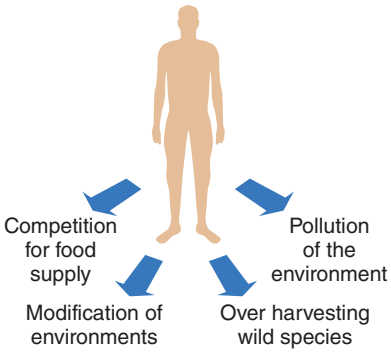


Figure 2–29 Human dominance.

Figure 2–30 Our natural resources should be appreciated and cared for.

LOOKING BACK

Ecology is the science that describes relationships between living organisms and their environments. It includes all of the activities that affect the environment and the organisms living within it. The law of conservation of matter states that the form of matter can be changed,

but matter cannot be created or destroyed by ordinary physical or chemical processes. Humans are capable of changing matter into a variety of materials that are not found in nature. When they are thrown away, they become pollutants. Pollution of the environment by waste materials is one of our greatest problems as a society. Environmental scientists spend their careers solving such problems and studying ways to maintain or restore the environment.

Energy is the force that drives all systems in nature. It originates from the sun and is lost to outer space in the form of heat. The first law of energy states that energy cannot be created or destroyed, but it can be converted from one form to another. The second law of energy states that each time energy changes from one form to another, some of it is lost in the form of heat.

The circular flow of an element from living organisms to nonliving matter is known as an elemental cycle. The carbon cycle and the nitrogen cycle are two of the most important elemental cycles. The water cycle is the circular flow of water from the oceans to the atmosphere, to the land as precipitation, to rivers and streams, and back to the oceans.

A food chain consists of a sequence of living organisms in which each member of the chain feeds upon the lower-ranking members of the chain. Overlapping food chains form food webs. The organization of a food pyramid progresses from organisms that produce food (plants) to animals that eat plants (herbivores), to animals that eat other animals (carnivores). Human dominance of the food pyramid has resulted in issues over the role of humans in conserving the environment and the species that occupy it.

Chapter Review

DISCUSSION AND ESSAY

1. State the law of conservation of matter and explain what it means.
2. Suggest some ways that waste materials might be disposed of to maintain or improve environmental quality.
3. Explain how pollution of the environment is related to the law of conservation of matter.
4. List several current methods of disposing of waste materials, and discuss the positive and negative effects that each method has on the quality of the environment.
5. Define what energy is and discuss the role that energy plays in nature.

6. Define and explain the first and second laws of energy.
7. Illustrate the carbon cycle, the nitrogen cycle, and the water cycle, and explain the importance of each cycle to living organisms and to the environment.
8. List some factors that make water important to all living organisms.
9. Describe the organization of a food chain.
10. Explain how a food chain is different from a food web.
11. Describe how a food pyramid is organized.

MULTIPLE CHOICE QUESTIONS

1. Which of the following materials is not considered to be industrial waste?
   a. Agricultural pesticides
   b. Harmful chemicals
   c. Poisonous metallic compounds
   d. Acids and other caustic materials
2. Which of the following is not classifieds as surface water?
   a. A river of stream
   b. A pond
   c. A lake
   d. An aquifer
3. Which pesticide is used to control weeds
   a. Insecticide
   b. Herbicide
   c. Rodenticide
   d. Fungicide
4. What is the name of the basic law of physics that states, "Matter can be changed from one form to another, but it cannot be created or destroyed by ordinary physical or chemical processes"?
   a. The first law of energy
   b. The second law of energy
   c. The law of conservation of matter
   d. The law of kinetic energy
5. The conversion of energy from one form to another is always accompanied by the loss of:
   a. Water
   b. Matter
   c. Carbon
   d. Heat
6. When water is not included, the most abundant element found in living organisms is
   a. Carbon
   b. Hydrogen
   c. Oxygen
   d. Nitrogen

7. Which of the following is the elemental cycle that is responsible for the formation of fossil fuels?

   a. The water cycle
   b. The nitrogen cycle
   c. The energy cycle
   d. The carbon cycle

8. The process of transpiration is important to which natural cycle?

   a. The water cycle
   b. The nitrogen cycle
   c. The conservation of matter
   d. The carbon cycle

9. Which of the following is a secondary consumer?

   a. A producer
   b. A carnivore
   c. A herbivore
   d. A food plant

10. The most comprehensive arrangement of organisms located in an environment in a ranking order that connects all of the producers to the primary and secondary consumers is called a:

   a. Food chain
   b. Food web
   c. Food network
   d. Food pyramid

Learning Activities

1. Develop an environmental research project to study the waste disposal system that is used in your area. Identify actual and potential pollution problems that are associated with each of the ways the different waste materials are disposed. Invite local sanitation authorities to visit your class to discuss local pollution problems. Develop possible solutions for each local waste disposal problem that is identified.

2. Take a field trip to an unpopulated area or nature center that is near your school. Have class members prepare and give reports on the habits of the organisms that are found there. Investigate and illustrate the ranking of each organism in the food pyramid. Suggest possible ways that the food chain might be organized, and illustrate how the food chains overlap to create a food web.

CHAPTER

3

Understanding Relationships Between Wildlife and Agriculture

After completing this chapter, you should be able to:

- explain how scientists organize living organisms for the study of ecology
- suggest ways through which balance might be restored to an ecosystem
- describe the impacts that modern agriculture has had on the ecosystems of North America
- identify the relationships between farming practices and the environments of different species of fish and wildlife
- distinguish between primary and secondary biological succession
- predict the biological succession of organisms in a particular environment.

Agriculture is the practice of raising plants and animals in a controlled environment. Competition from unwanted plants and animals is usually controlled. Fences and roads define the borders of this artificial environment, keeping domestic animals in and restricting the movements of some wild animals. Tillage machines and agricultural chemicals are often used to restrict or eliminate unwanted plants, animals, and diseases in the environment. Such practices disrupt the natural ecosystem that existed before agriculture was introduced in the area.

The practice of agriculture changes ecosystems. Some of the original species of organisms find it difficult or impossible to survive in areas where agriculture is practiced. Other species of animals and birds enjoy an abundance of food and shelter and find it easier to survive in agricultural areas.

KEY TERMS

- organism
- population
- community
- ecosystem
- biosphere
- ecosphere
- ecologist
- habitat
- biological succession
- primary succession
- secondary succession
- pioneers
- climax community
- niche
- competitive advantage
- competitive exclusion principle
- range of tolerance

FUNDAMENTALS OF ECOLOGY

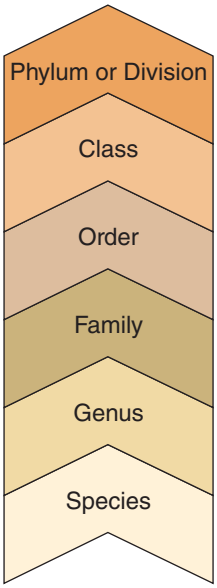


Figure 3–1 Taxonomy is a system that biologists use to organize living things according to their relationships to one another.

As students of ecology, it is important to understand the language and organization of this branch of science. All living organisms that are known to man are classified into naturally related groups in a systematic way. These are known as taxonomic groups and include the following divisions: species, genus, family, order, class, and phylum (animals) or division (plants), see Figure 3–1. Organisms of the same species are closely related and exhibit many of the same characteristics. Organisms of the same order exhibit some of the same characteristics but are not considered to be closely related.

Scientists who study ecology organize living things into different classifications. An **organism** is an individual plant or animal. A group of similar organisms that is found in a defined area is known as a **population** of plants or animals. A **community** includes all of the populations of organisms that live within a defined area such as a woodland, marsh, or cornfield.

An **ecosystem** is made up of the community of living organisms plus all of the nonliving features of the environment such as water, soil, rocks, and buildings. Each of the components of an ecological system or ecosystem has an impact on the other components of the ecosystem.

Relationships also exist between two or more ecosystems. For example, soil erosion in Canada has an effect on the ecosystem from which the soil was lost, but it also affects survival rates of aquatic organisms in the river systems and in the saltwater ecosystems where the silt is deposited in the oceans. When all of the ecosystems of the earth are considered as a whole, we call it a **biosphere** or **ecosphere**, see Figure 3–2.

Career Option

ECOLOGIST

A SCIENTIST WHO STUDIES relationships between living organisms and their environments is known as an **ecologist**. A person in this career will need a strong science background, and he or she should plan on additional graduate work after college. Ecology is a relatively new employment field that is continually evolving. With the emphasis on protecting the environment that is expected in the years ahead, a person who is educated as an ecologist can expect a high demand for his or her skills.

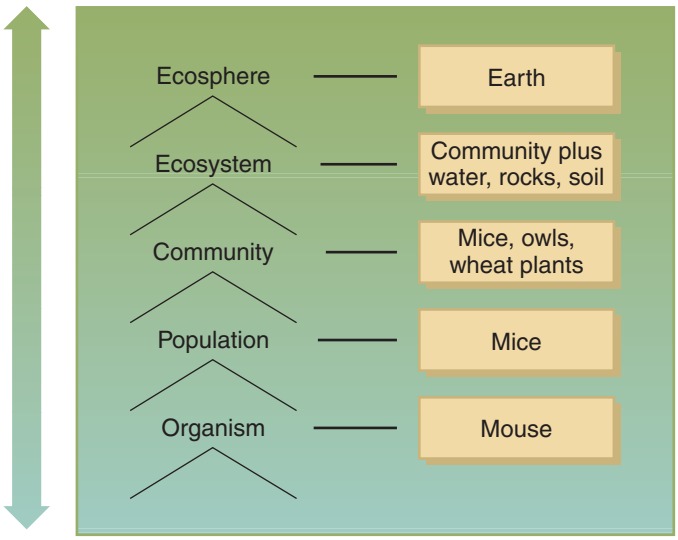


Figure 3–2 Ecologists organize living organisms and their environments into groups to make it easier to define and understand their relationships.

KEY INTERNET SEARCH WORDS

Ecosystem

biosphere

When an ecosystem supports all of the living community within it and nonliving resources are maintained at constant levels, it is said to be balanced, see Figure 3–3. A balanced ecosystem is rare, however, because the slightest change in any component of the ecosystem will affect all of the other components. If a population of organisms increases more rapidly than a resource is replaced in the system, it will eventually deplete the resource and cause the death of the organisms. Such an ecosystem is unbalanced, see Figure 3–4.

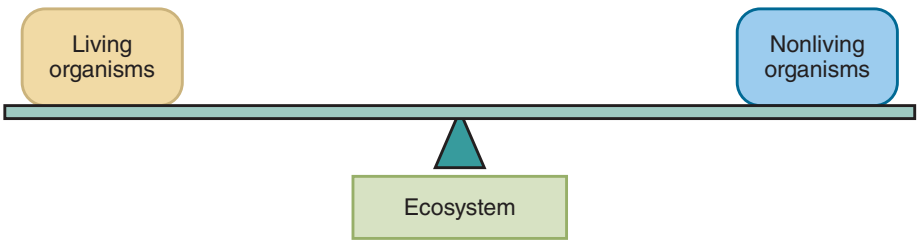


Figure 3–3 In theory, a balanced ecosystem would exist when living organisms and nonliving resources are maintained at constant levels. In practice, absolute balance seldom occurs.

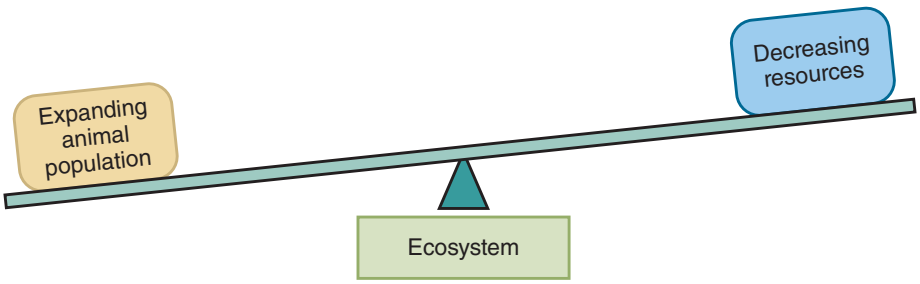


Figure 3–4 An unbalanced ecosystem exists when the community of living things uses up nonliving resources faster than they can be replaced.

KEY INTERNET SEARCH WORD

Biosphere

ECOLOGY PROFILE

Biosphere II

Biosphere II is an experimental man-made environment located in the Arizona desert. It's original purpose was to see whether humans could create a controlled, balanced, and sustainable living environment. It was sealed to prevent movement of air or water into or out of the facility. As an experimental prototype of an environment to sustain human life on the moon or another planet, Biosphere I contained many scientific features to produce food and oxygen for people and carbon dioxide for plants. Water was recycled by plants and through evaporation.

As the first real attempt to create an artificial environment, the original plan was for the people who lived in Biosphere I to remain sealed inside the structure for two years. Shortly after the structure was sealed in 1991, however, one person was removed because of an injury. Controversy followed the return of this person to the system following medical care. It was alleged that additional supplies were taken into the system at that time. Several scientists contend that this invalidated the original scientific study.

After several months of operation, it became evident that the environment was unbalanced. Oxygen levels in the closed environment became too low and the people living in the biosphere began to suffer from oxygen deficiency. Many of the birds, animals, and insects that were supposed to live in the environment died, except for cockroaches and ants. Eventually, oxygen was added to the environment to raise the oxygen level back up to a level that was considered safe.

During the remainder of the experiment, the people raised food for themselves and for their animals using the resources that were available within the biosphere. This experiment was a good learning experience that illustrated the difficulty of creating a stable environment.

Columbia University managed the facility from 1995 to 2003 as part of the university's Earth Institute. Since mid-2007, the University of Arizona has operated Biosphere II as a research facility.

AGRICULTURAL IMPACTS ON ECOSYSTEMS

Early in the twentieth century, most Americans were farmers. They lived in the rural areas and spent most of their time producing food and clothing for their own families. Today, the agricultural industry has changed. New intensive farming methods have been introduced, and less than 2 percent of our population now lives and works on farms.

Nearly all of the land that can sustain profitable crop production is now used for growing crops, see Figure 3–5. The native plants that used to grow abundantly on this land are mostly gone, and the **habitats** or environments where many birds, animals, and other organisms lived, have changed. Even the kinds of species that live in agricultural areas have changed as farming methods have been modified.

Agricultural practices have resulted in both positive and negative effects on living organisms. Some of the changes that have occurred have been favorable to wild birds and animals because they have resulted in a more dependable and abundant supply of food or shelter, see Figure 3–6. The white-tail deer, for example, is an animal that has benefited from modern farming practices. Many agricultural areas have large populations of resident deer that feed, at least part of the time, on cultivated plants.

Figure 3–5 Intensive cropping system.

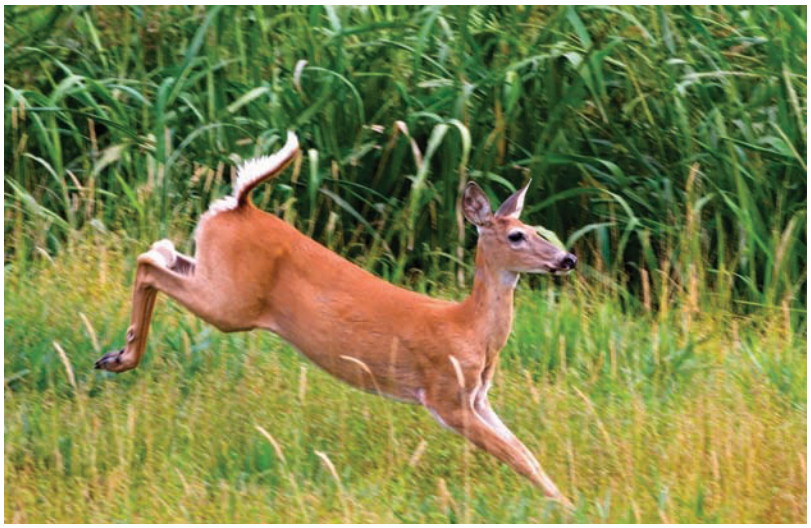


Figure 3–6 This healthy deer has adapted well to an agricultural environment where it has found an abundant supply of food.

Figure 3–7 The whooping crane is an endangered species. *Courtesy U.S. Fish and Wildlife Service. Photo by Luther Goldman.*

Some species of birds and animals have declined because farming practices have reduced or poisoned their food supplies, eliminated their shelter, or destroyed their breeding grounds, see Figure 3–7. The whooping crane and several other species of wetlands birds are examples of organisms that have suffered reduced populations due in part to modern agricultural practices and to human encroachment upon their habitat, see Figure 3–8.

KEY INTERNET SEARCH WORDS

wetlands

disposal of chemicals

The use of agricultural chemicals is often cited as a practice that has resulted in extensive damage to the environment. Some chemicals, such as DDT, are known to have side effects that were not known when they were approved for use. Damage to the environment due to misuse of agricultural chemicals sometimes occurs, just as it occurs when industrial, lawn, or garden chemicals are used improperly. Public

Figure 3–8 Wetland areas are a natural habitat to many organisms.

Figure 3–9 A pest control specialist is responsible to see to it that when it is necessary to use chemicals, they will be used safely and wisely.

criticism should be directed against the misuse of all chemicals in every segment of society, including the agricultural sector.

Chemicals that are applied for their intended purposes according to the recommendations of the manufacturer can usually be safely used, see Figure 3–9. Agricultural chemicals that are in use today are subject to extensive scientific testing in an effort to assure that they do not pose a threat to the environment.

The incorrect disposal of unused chemicals and chemical containers poses more of a threat to the environment than approved uses. Those who use agricultural, garden, and industrial chemicals must assume responsibility for applying them properly and for appropriately disposing of the waste associated with chemical use, see Figure 3–10. Most of the laws and regulations that apply to disposal of hazardous materials apply equally when handling these chemicals, and they should be strictly obeyed.

Figure 3–10 Laws and regulations for the disposal of hazardous waste materials should be strictly obeyed.

Figure 3–11 The population of wolves was nearly eliminated in the lower 48 states as farms modified habitats and bounties were placed on them. They have since rebounded in Idaho, Montana, and Wyoming with protection from federal laws and regulations.

Figure 3–12 The coyote is a highly adaptable animal that has learned to live with human neighbors. *Courtesy U.S. Fish and Wildlife Service. Photo by R.H. Barrett.*

BIOLOGICAL SUCCESSION

Animals and plants that were unable to adapt to the changes that occurred in their habitats as farms were established are no longer present or now exist as smaller populations, see Figure 3–11. They have been replaced by different species that are capable of surviving in the new environments, see Figure 3–12. The change that occurs as one kind of living organism replaces another organism in an environment is called **biological succession** or ecological succession.

KEY INTERNET SEARCH WORDS

ecological succession

Two forms of biological succession are known to exist. **Primary succession** occurs where organisms did not exist before. Such an area might be found on a lava flow that has cooled and hardened, see Figures 3–13 and 3–14.

Figure 3–13 A lava flow that has cooled and hardened requires the accumulation of soil particles before it is capable of supporting plant life.

KEY INTERNET SEARCH WORDS

primary biological succession in a lava flow

ECOLOGY PROFILE

Primary biological succession in lava flow

The material that remains after hot, molten lava has cooled is sterile and without life. The surface of such a flow consists of hardened lava rock and cinders. Over time, simple plants such as lichens and fungi begin to grow on the hard surface. The first plants to grow in an environment are called **pioneers**. The lichens begin to decay when they are acted upon by small fungi that feed off the plants. Tiny soil particles carried by the wind become trapped in the lichen growth, and a soil base begins to form on the hard lava surface. This makes it possible for other simple plants to germinate and grow. Hardy plants, such as thistles and weeds, are the first complex plants to grow in this environment. They are then followed by shrubs, trees, and other plants that are adapted to the conditions found in the area. Hundreds or even thousands of years may be required before sufficient soil exists to enable complex plants to survive. The plants that occupy an environment when the succession of species is complete and plant populations become stable are called **climax communities**.

Secondary succession occurs when an ecosystem is damaged or partly destroyed and remnants of the former community still exist. The changed environment will support only those organisms that are naturally found in an earlier stage of biological succession. Examples of secondary succession can be found in areas such as Yellowstone Park where large tracts of old-growth forests were destroyed by fire, see Figure 3–15.

Biological succession is a process that goes on all the time. An environment is seldom stable and unchanging. Every time a living environment changes in some way, the creatures that seek shelter or food from it are also affected. Some organisms find it difficult to adjust to changes in their environments. Such changes may even reduce their ability to survive. There are often other organisms that may benefit from a change in the environment. Sometimes a change makes it easier for them to compete with other organisms that live in a particular environment.

Figure 3–14 This plant is an example of primary succession on a lava flow.

A **niche** is a description of a role that an organism fulfills in an environment. This role may include the organism's position in the food web, where it lives, and when it is active. Several animals may appear to be competitors in a single habitat, but if they occupy different niches or are active at a different time, competition between them may be minimal.

A **competitive advantage** exists when one organism has an advantage over another in being able to survive in an environment. A species that enjoys a competitive advantage will increase in numbers as time passes,

Figure 3–15 Secondary succession occurs when remnants of the former community still exist.

Figure 3–16 An organism that can exercise competitive advantage over another usually takes over the niche in the environment and often excludes the competing species. *Courtesy Goldon wiltsie.*

and the populations of organisms lacking a competitive advantage will decrease. Eventually, the weakest competitors are lost from the environment, see Figure 3–16.

The loss of an organism from a specific niche or habitat is an example of the **competitive exclusion principle**. This is the hypothesis that two or more species cannot coexist on a scarce single resource relative to the demand for it. Some evidence exists that species can coexist when neither species exercises dominance over the other. The bighorn sheep is a good example of an organism that declined because it could not adjust to a changing environment, see Figure 3–17. In the Grand Canyon, the

Figure 3–17 Bighorn sheep were displaced by a wild burro population because the burros are more competitive grazers. *Courtesy U.S. Fish and Wildlife Service.*

KEY INTERNET SEARCH WORDS

secondary succession
pollution, fish survival

ECOLOGY PROFILE

Secondary succession after a forest fire

Forest fires are sometimes responsible for the destruction of old-growth forests and the habitat that they provide to the animals, birds, and other organisms living there. The heat that is generated by a forest fire often sterilizes the soil. It kills many of the organisms that are in the soil and frequently moves the stage of succession backward.

The 1988 fires that burned large tracts of the pine forest in Yellowstone Park were destructive because there was an abundance of dead plant material on the forest floor. This created extreme heat, causing the forest canopy to burn.

After a destructive fire occurs, hardy grasses, thistles, and other pioneer plants are some of the first forms of vegetation to be found in the area. In some instances, there are still living trees in the area that have been protected by their thick bark or by a physical feature in the environment. In other instances, trees are reseeded due to heat from the fire. Some kinds of pine cones depend on the heat from a fire to open them up and release the seeds.

Secondary succession following a fire often begins with cheatgrass and crabgrass growth followed by tall grasses and food plants. Pine trees eventually invade the grasslands, establishing pine forests. Hardwood trees are usually the last species to come into an area. They grow up through the pine forest and eventually become the dominant species.

Figure 3–18 The comfort zone for the flamingo is extreme warmth.

Figure 3–19 Pollution in rivers, streams, and ponds can jeopardize populations of many fish species. Through concerted efforts to clean up waters and through restocking programs we can avoid this problem. *Courtesy U.S. Fish and Wildlife.*

wild burro, which is not a native species, has established itself in habitats formerly occupied by bighorn sheep. The burros are more competitive grazers than the bighorn sheep, and they have a competitive advantage when food supplies are inadequate for both populations.

The ability of an organism to survive changes in its environment depends on its **range of tolerance** for change. All organisms have comfort zones in which living conditions are matched with their survival needs, see Figure 3–18. When an organism is able to adjust to a wide range of environmental conditions, its ability to survive increases.

The range of tolerance of an organism for its environment is largely determined by its inherited ability to adjust to changes in environmental conditions. A bird that is able to gather or digest only one kind of food will be unable to survive if that food supply is lost from the environment. Some organisms depend totally on a single kind of shelter; others cannot tolerate pollution in the air and water, see Figure 3–19. In addition, the temperature range in the environment often determines whether an organism is capable of surviving. A narrow tolerance range makes it very difficult for an organism to survive environmental changes.

LOOKING BACK

Ecology is the branch of science that describes relationships between living organisms and their environments. Organisms are organized into populations, communities, and ecosystems that overlap and react with each other. Modern agricultural practices have resulted in modified ecosystems and populations of organisms in cultivated areas. Environments are constantly changing, and the biological succession of living organisms occurs in an orderly and predictable manner. Organisms that have a competitive advantage over other members of the community, or a wide range of tolerance to changes in the environment, tend to survive while other organisms do not.

Chapter Review

DISCUSSION AND ESSAY

1. Explain how scientists organize living organisms to aid their study of ecology.
2. What differences exist between balanced and unbalanced ecosystems?
3. What impacts do modern farming methods have on ecosystems in North America?
4. What benefits and risks are associated with pesticide use on farms, lawns, roadsides, and gardens?
5. How are primary and secondary biological succession different? Give examples of each type of succession.
6. Predict how the science of ecology will be of benefit to the world in the twenty-first century.

MULTIPLE CHOICE

1. A group of similar organisms that is found in a defined area is known as a:

   a. Population
   b. Community
   c. Ecosystem
   d. Biosphere

2. All of the ecosystems of the earth when they are considered as a whole are known as the:

   a. Ecosphere
   b. Community
   c. Population
   d. Atmosphere

3. An ecosystem in which living organisms and nonliving resources are maintained at constant levels is considered to be:

   a. Natural
   b. Unbalanced
   c. Artificial
   d. Balanced

4. A scientist who studies relationships between living organisms and their environments is known as a/an:

   a. Taxonomist
   b. Ecologist
   c. Zoologist
   d. Limnologist

5. An environment in which a creature lives is known as its:

   a. Habitat
   b. Biosphere
   c. Ecosystem
   d. Preserve

6. An ecosystem that has been partly destroyed and that still has remnants of the former community of organisms is an example of a:

   a. Primary succession
   b. Secondary succession
   c. Biological succession
   d. Climax community

7. Primary succession occurs when:

   a. Organisms live in an area where they did not live before
   b. An ecosystem is damaged or partly destroyed
   c. Remnants of a former community still exist
   d. Plants displace animals from an environment

8. The ability of a particular organism to survive more easily in a shared environment than another is an example of:

   a. The competitive exclusion principle
   b. Adaptive superiority
   c. Secondary succession
   d. A competitive advantage

9. The ability of an organism to survive changes in an environment is a demonstration of its:

   a. Range of tolerance
   b. Comfort zone
   c. Competitive exclusion principle
   d. Niche

Learning Activities

1. Plan and set up an aquarium in which a balance between plant and animal life is considered. Observe the ecosystem carefully to determine whether adequate oxygen and carbon dioxide is produced to sustain the plants and animals that were placed in the system.
2. Conduct a public awareness campaign to encourage all users of agricultural and industrial chemicals to dispose of waste materials in a legal and safe manner.

CHAPTER

4

Biomes of North America

After completing this chapter, you should be able to:

- explain how events in one ecosystem affect events in a neighboring ecosystem
- describe the relationship between an ecosystem and a biome
- list the distinguishing characteristics of a freshwater biome
- identify similarities and differences between freshwater and marine biomes
- discuss ways in which wetland habitats function to cleanse the environment
- name the terrestrial biomes that are found in North America and describe their similarities and differences
- design a map of the North American continent that illustrates the locations of the major biomes found there.

An ecosystem is made up of plants, animals, and microorganisms that interact with each other and with the nonliving materials that surround them. Sometimes the boundaries of an ecosystem are easily identified because they consist of physical barriers such as mountains or water. Most of the time, however, ecosystems are not discrete communities, and they blend together where they meet. The boundaries of an ecosystem resemble a permeable membrane that enables organisms and materials to flow both in and out of the ecosystem, see Figure 4–1. The effects of an event that occurs inside a particular ecosystem usually spill over into neighboring ecosystems as well.

KEY TERMS

biome
freshwater biome
plankton
phytoplankton
zooplankton
turbid
lotic habitat
lentic habitat
thermal stratification
wetland
marine biome
salinity
intertidal zone
continental shelf
neritic zone
oceanic zone
marine biologist
limnologist
estuary
terrestrial biome
desert biome
tundra biome
grassland biome
deciduous forest biome
strata
canopy
understory
shrub layer
herb layer
forest floor
temperate rain forest
coniferous forest biome
conifer

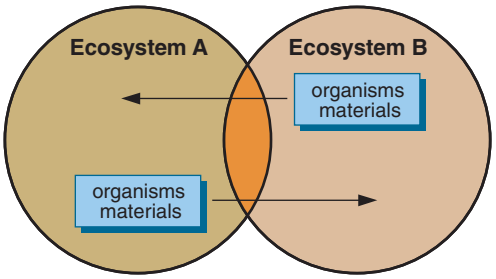


Figure 4–1 The boundaries between ecosystems frequently overlap and they are porous enough to enable organisms and materials to pass through in both directions.

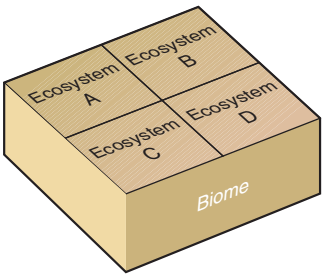


Figure 4–2 A biome consists of a group of similar ecosystems located in close proximity to one another.

Ecosystems that are located at similar latitudes and elevations often have many of the same characteristics. The temperature and the amount of precipitation usually do not vary significantly. A **biome** is a group of ecosystems within a region that have similar types of vegetation and similar climatic conditions, see Figure 4–2.

The climate of a region is determined in part by its latitude or distance from the equator. The temperature declines as the distance to the equator increases. Climate also is determined by altitude, see Figure 4–3. Conditions are different according to altitude within the same mountain range. The temperature decreases as the altitude increases. Ecosystems support different kinds of organisms as we move north or south from the equator and as we move from low to high elevations.

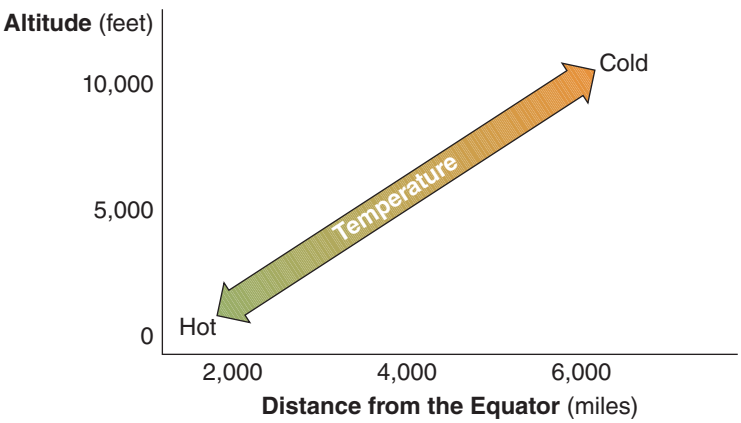


Figure 4–3 Climate is determined by altitude and by distance from the equator. The temperature becomes cooler as you travel away from the equator and as you gain altitude.

KEY INTERNET SEARCH WORDS
biomes, North America

Figure 4–4 An example of a freshwater biome.

KEY INTERNET SEARCH WORDS
freshwater ecosystem

Figure 4–5 A freshwater ecosystem may have many different kinds of plants and animals living within its boundaries.

FRESHWATER BIOMES

A **freshwater biome** is composed of plants, animals, and microscopic forms of life that are adapted to living in or near water that is not salty, see Figure 4–4. The term "freshwater" can be misleading, however, because some freshwater environments depend upon water that may be stagnant, muddy, or heavily polluted. Such water may not appear to be "fresh" at all.

There are many different environmental conditions that are found in freshwater ecosystems, and each set of conditions creates a unique living environment, see Figure 4–5. The water in a particular area may be hot, cold, or loaded with dissolved materials. In each instance, different kinds of plants and animals have become adapted to the present water conditions. In some cases, organisms have become so specialized that they may be unable to survive in any other known location.

ECOLOGY PROFILE

Southern Cavefish *(Typhlichthys subterraneus)*

The southern cavefish has become adapted to living in the darkness of a cave environment. It has no eyes and its skin color is pink-white. It has two rows of sensory feelers located on the caudal fin to help it navigate. It lives in caves east of the Mississippi River from Indiana on the north to Georgia and Alabama on the south.

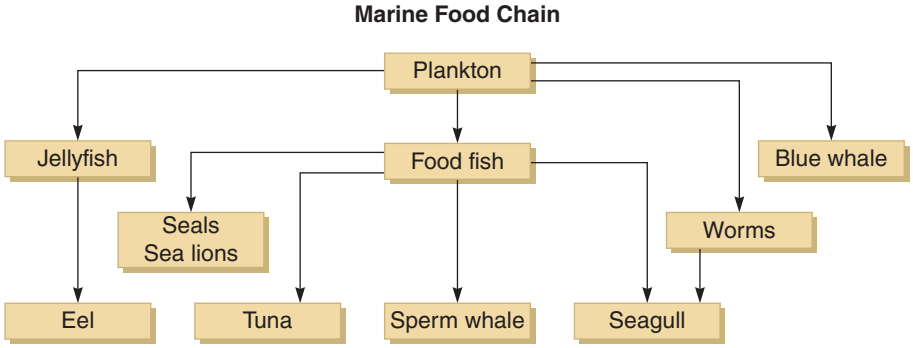


Figure 4–6 Plankton are the food source either directly or indirectly for nearly all marine animals.

KEY INTERNET SEARCH WORDS
marine food chain

Among the organisms that live in freshwater biomes are **plankton**. They consist of microscopic plants called **phytoplankton** and microscopic animals called **zooplankton**. They are found floating on the water surface. They serve as food producers in the food chain, and they are eaten by fish and other aquatic animals, see Figure 4–6.

The organisms that are capable of living in a freshwater habitat are limited by conditions such as water temperature, light intensity, concentration of dissolved materials, and the flow rate of the water, see Figure 4–7. Water temperature is one factor that determines which species of organisms can survive in the habitat. Some organisms have very little tolerance for changes in water temperature, and they die when the temperature becomes too warm or too cold for them. Some organisms can live in water that is quite hot, while others survive best in cold water. However, very few species can survive in water temperatures that fluctuate rapidly more than a few degrees. Some organisms can survive over a broad water temperature range as long as the temperature changes gradually.

A second condition that affects freshwater organisms is the amount of light that can penetrate the water. This determines the amount of photosynthesis that can occur and the kinds of plant life that can exist there. When water is **turbid** or cloudy with suspended particles of silt, photosynthesis is limited. This is because suspended particles block the sunlight and prevent light from reaching the water plants, see Figure 4–8.

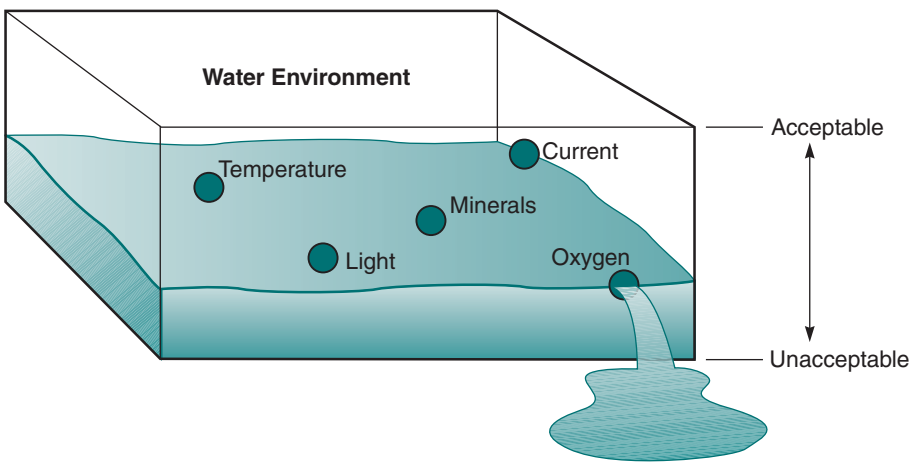


Figure 4–7 The most limiting factor in the water environment determines how acceptable the environment will be. Like holes in a water tank, the lowest hole determines the greatest capacity of the tank.

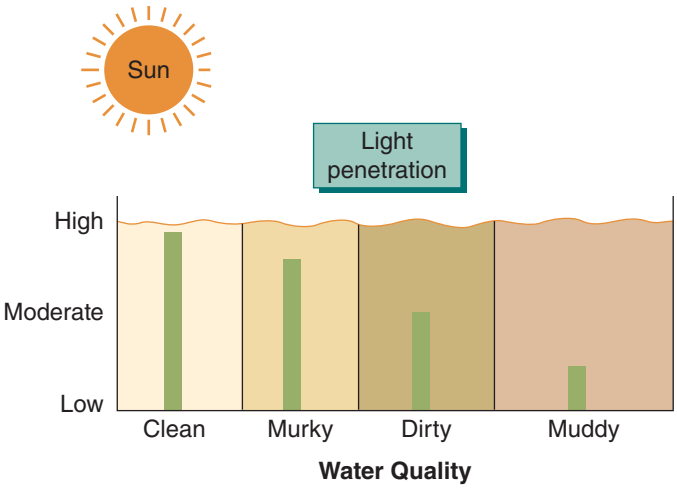


Figure 4–8 Light penetration in an aquatic environment.

Another factor that limits the kinds of organisms that can live in an aquatic environment is the concentration of dissolved minerals in the water. When high levels of nitrates and phosphates are present, dense blooms of blue-green algae and other plants may occur in the surface water. At the same time, fish and other aquatic animals may die if the concentration of these materials in the water becomes too high. They also may die if the concentration of dissolved oxygen in the water is too low. Fish and other aquatic animals that need a rich supply of oxygen may die or be replaced by other fish that can survive in a low oxygen environment.

The current or flow of the water in a river or stream may be the limiting environmental factor for some organisms, see Figure 4–9. The intensity of the current contributes to the amount of force that an organism must be able to withstand to prevent being carried downstream. It also

Figure 4–9 Water current in a stream may be the limiting environmental factor.

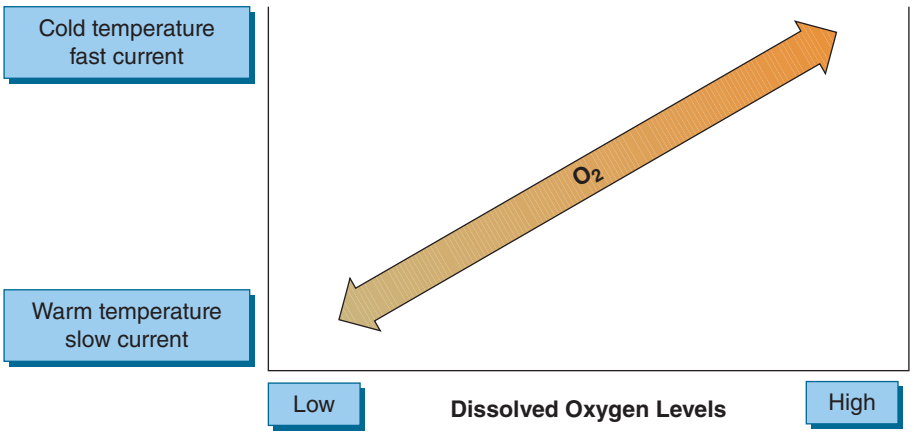


Figure 4–10 Dissolved O_2 in an aquatic environment.

Figure 4–11 Herons thrive well in a lentic habitat. *Courtesy U.S. Fish and Wildlife Service.*

affects the availability of food. A fifth factor that affects the organisms in a freshwater habitat is the amount of oxygen dissolved in the water. Cold water that is flowing rapidly tends to carry more dissolved oxygen than warm water that is moving slowly through a pond or swamp, see Figure 4–10. Flowing water tends to dissolve oxygen readily, and cold water temperatures help to stabilize oxygen in the water.

These five criteria interact to create the conditions found within freshwater ecosystems. If any one of them becomes unfavorable, an entire population of organisms may be eliminated or replaced by other species that are better suited to the new conditions.

Two different kinds of habitats are found in freshwater biomes. A **lotic habitat** exists where water flows freely in streams and rivers. The dominant unidirectional flow of water tends to support limited plant growth. It is typical of a detritus-based food web where food for fish and other aquatic animals is carried in by the water from distant sources.

In contrast, a **lentic habitat** is one in which water stands for long periods of time, as in swamps, ponds, and lakes. Lentic environments contain areas of differing light and lack a strong current. The water temperature also differs. Deep water tends to be cold, and the water near the surface is usually warmer. This is called **thermal stratification**. Some common plants and animals that live in these types of areas are cattails, lilies, herons, and frogs, see Figure 4–11.

A concept that is currently attracting public interest is **wetlands**. A wetland is defined as a land area that is flooded during all or part of the year. A wetland may consist of dry land for much of the time and still be classified as a wetland if it is subject to flooding during some seasons of the year.

It is clear that the size of the area occupied by wetlands in North America has declined with the advance of civilization. We have drained many acres of marshes and swamps to prepare the land for raising crops. The U.S. Department of Agriculture has reported that up to 90 percent of the original prairie wetlands located in Iowa, Minnesota, eastern North Dakota, and southeastern South Dakota have been converted to farms.

KEY INTERNET SEARCH WORDS

water quality, wildlife

thermal stratification

KEY INTERNET SEARCH WORDS

constructed wetlands

Similar trends are evident in other areas. A strong movement initiated by advocates for waterfowl and aided by federal legislation is attempting to reverse this trend in the United States.

Organized groups of sportspeople such as Ducks Unlimited have taken a lead role in the effort to restore wetlands. They have purchased large tracts of land with donated funds and returned them to marshlands. Through such efforts they hope to create favorable conditions for migrating waterfowl such as ducks and geese, thereby increasing the populations of these birds, see Figure 4–12. Other organizations that are involved in restoration of wetlands include state and federal agencies, conservation groups such as the Nature Conservancy, and ecological researchers.

Some attempts to increase the amount of wetlands have created controversy between landowners and the government agencies that are responsible for determining and enforcing wetland policy. Laws and regulations that encourage restoration of wetlands include: Executive Order 11990; Protection of Wetlands, 1977; The Federal Water Bank Program; State Water Bank programs; and the Watershed Protection and Flood Prevention Act.

The general sentiment today is that wetlands are difficult to restore. It is best not to disturb them in the first place. Some landowners believe that the law reaches too far by designating some lands as wetlands that historically did not flood. They define some of the land as wetlands that floods only seasonally as a result of land modification projects implemented on the property. Such changes include the diversion of water into new channels and irrigation practices that result in the ponding of water.

Regulations to refine the ways that wetlands can be used have been developed by federal and state government agencies. All efforts to promote or reduce government control of wetlands will affect the freshwater ecosystems of North America.

Figure 4–12 There has been a big effort to restore and maintain wetlands in North America. *Courtesy U.S. Fish and Wildlife Service. Photo by Bob Ballou.*

ECOLOGY PROFILE

The Southern Swamp

Among the most productive wetlands in North America are the swamp areas along the southern coastlines. These are freshwater resources that function as nurseries for shrimp, crawfish, and many ocean-going fish. They also provide habitat for resident freshwater fish and aquatic birds and animals of many kinds. Up to one-third of the harvest of food fish comes from the southern swamps, and they also provide abundant timber resources.

MARINE BIOME

KEY INTERNET SEARCH WORDS
marine biome, marine life, temperature, salinity, light

The world's largest biome is the **marine biome**. It consists of the oceans, bays, and estuaries and makes up approximately 71 percent of the earth's surface area, see Figure 4–13. A distinguishing characteristic of the marine biome is salinity, the salt concentration of the water; oceans have a salt concentration ranging from 3 to 3.7 percent. **Salinity** is an important factor that influences an organism's ability to survive in a marine environment. It varies quite a bit in surface waters, especially near land where rivers empty into the oceans, but it tends to be quite stable in deep ocean waters. The marine biome is also quite diverse. It covers the hot southern zones of the North American coast to the cold arctic regions of the continent's northern reaches.

The ability of organisms to live in the marine biome depends on several conditions that are necessary to sustain life in the ocean, see Figure 4–14. Water temperature, for example, varies considerably in the

Figure 4–13 The world's largest biome is the marine biome. *Courtesy PhotoDisc*.

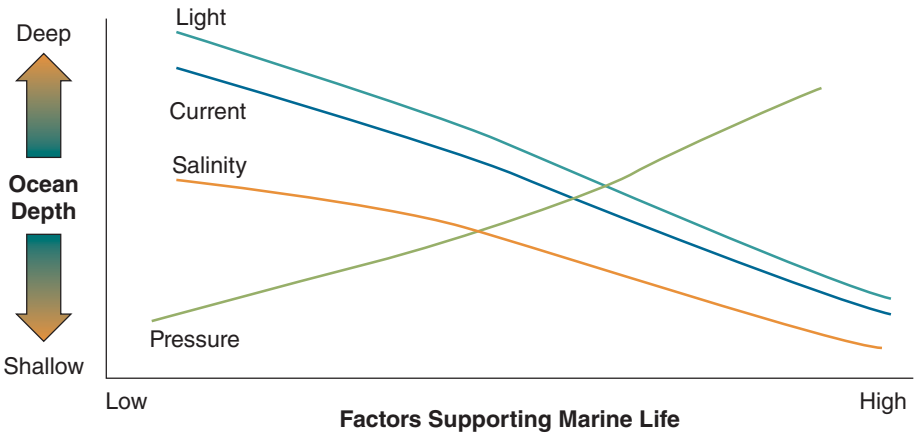


Figure 4–14 Factors supporting marine life.

marine biome. Deep ocean waters tend to be colder than surface waters, and arctic waters are colder than ocean waters located near the equator. Ocean currents such as the Gulf Stream, which is warm, and the Humboldt current, which is cold, distribute ocean temperatures differently.

The amount of light that penetrates the water's surface influences the amount of plant life that exists there. The presence of food-producing plants attracts fish and other aquatic organisms to waters where food is plentiful. A supply of nutrients for plants to use in photosynthesis also is important in producing food for aquatic animals. Certain areas of the ocean have strong ocean currents that circulate deep ocean waters to the surface. These currents are known as upwelling currents. These areas are important to the commercial fishing industry because deep waters tend to be high in nutrients, and fish concentrate in these areas to feed. Ocean currents are important in moving nutrients from deep ocean waters to surface waters where photosynthesis can take place. Plankton are found in abundance where sunlight and nutrients are available, and these organisms play important roles as food producers in the aquatic food chain.

Water pressure becomes greater as the water gets deeper. Water pressure occurs because of the action of gravity on water molecules. As more water molecules are stacked above an organism, they exert greater pressure on its body. A good example of this is the pressure that a person feels on his or her eardrums during a dive in deep water. The deeper you dive, the greater the pressure becomes.

Some organisms can withstand the pressure of deep ocean water, but most aquatic organisms tend to seek and remain in surface waters where food is more plentiful and where water pressures are not extreme.

KEY INTERNET SEARCH WORDS
neritic zone, intertidal zone, oceanic zone, continental shelf

Scientists have identified three important zones in ocean environments. The **intertidal zone** is located near the shore, see Figure 4–15. When the tide is low, this zone is an exposed beach that is above the water. During the high tide period, it is covered with water. The width of this zone is greatest when the slope of the ocean floor is gradual. It is narrow when the slope of the ocean floor is steep.

Animals and plants that live in the intertidal zone must be adapted to living both in and out of water. They must be able to cope with frequent

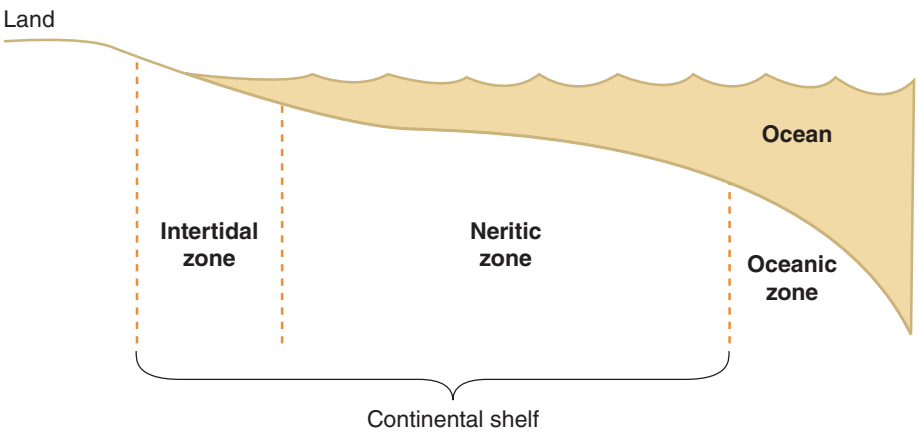
Figure 4–15 An intertidal zone. *Courtesy Wendy Troeger*.

changes in the temperature of their environment. They must also be capable of retaining moisture when the tide is out and of tolerating salinity when the tide is in.

The intertidal zone is subject to strong water currents that can wash plants and animals out to sea. Organisms living in this zone must be capable of withstanding these currents by attaching themselves to rocks or burrowing into the sand. The types of animals that can survive in tidal zones depends in a large part on the type of material composing the ocean floor.

The **continental shelf** is land that is submerged under the surface of the ocean, see Figure 4–16. It slopes gradually away from the shore

Figure 4–16 The continental shelf.



toward deeper water. The area beyond the intertidal zone that extends to the outer edge of the continental shelf is called the **neritic zone**. The most favorable living environment in the ocean is found here. Plankton and other food-producing organisms are abundant in this zone due to the abundance of nutrients and light. For most aquatic organisms, the neritic zone is the most productive area in the ocean.

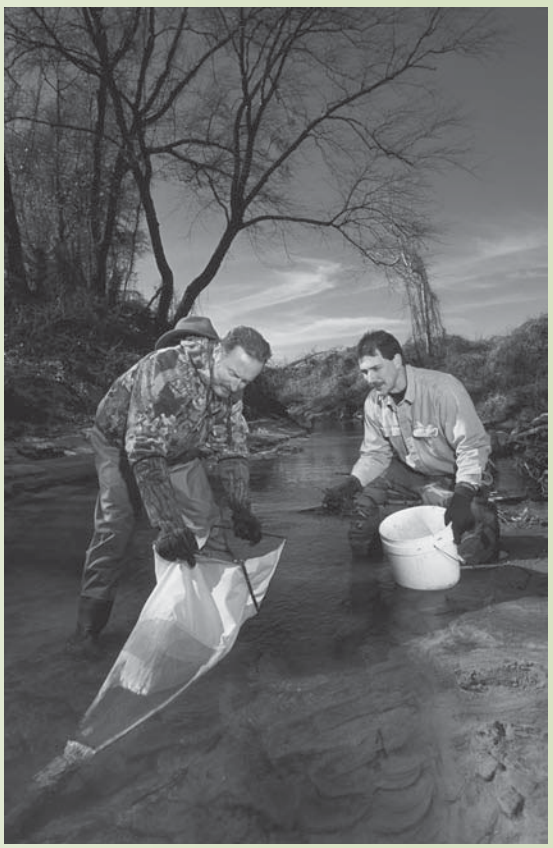
The **oceanic zone** begins at the outer edge of the continental shelf and includes the deep ocean waters. The surface waters in this zone are productive waters. The presence of light and nutrients supports the production of plankton and other food-producing organisms to a depth of about 200 yards. Below that depth, the waters become dark and the temperatures become cold. Some production does occur to depths of 2,000 yards, but beyond those depths, the living environment is generally cold and less productive. Deep-ocean volcanic vents, explored in the last 10 years, provide warmth and energy for strange communities of worms, mollusks, and shrimp-like crustaceans in some parts of the ocean floor (for example, off the coast of Seattle).

Career Option

AQUATIC BIOLOGIST

AN EDUCATION IN AQUATIC BIOLOGY prepares a person for a number of different occupations that study relationships between aquatic organisms such as fish, plankton, clams, and snails and the water environments in which they live. All of these careers require college degrees with emphasis placed on advanced graduate degrees.

An aquatic biologist who specializes in saltwater aquatic life is known as a **marine biologist**. A person who chooses a similar career specializing in freshwater aquatic life is a **limnologist**.



Mixing of fresh and saltwater occurs where rivers and streams enter the oceans. Such areas are often marshy and shallow, with abundant supplies of food-producing plants. An area such as this is called an **estuary**. The salinity of the water varies, depending upon the strength of the current as well as seasonal rainfall, tides, and evaporation in the shallows. These areas provide prime habitat for oysters and several types of young fish. An estuary has characteristics of both freshwater and marine biomes, see Figure 4–17.

Figure 4–17 This river opening is very close to sea level. At high tide, the sea flows in and the estuary becomes salty, almost like sea water. At low tide, the sea water flows out and the water becomes fresh, almost like fresh water. *Courtesy Bill Camp*.

TERRESTRIAL BIOMES

A **terrestrial biome** is a large ecosystem consisting of plants, animals, and other living organisms that live on land. Several distinct biomes are found on the North American continent, see Figure 4–18. Among these are the desert, tundra, grasslands, deciduous forests, temperate forests, and coniferous forests. Each of these biomes is distinctly different from the others, and each provides a set of environmental conditions that support different kinds of living organisms.

Desert Biome

KEY INTERNET SEARCH WORDS
desert biome

The **desert biome** is an environment that is very dry. Precipitation is usually less than 10 inches per year, only enough to enable specially adapted species of plants and animals to live. Daytime temperatures are usually very hot and the nights are often quite cold. The vegetation consists of very hardy plants such as different varieties of cactus, shrubs, and a large number of desert flowers that appear when moisture is adequate, see Figure 4–19.

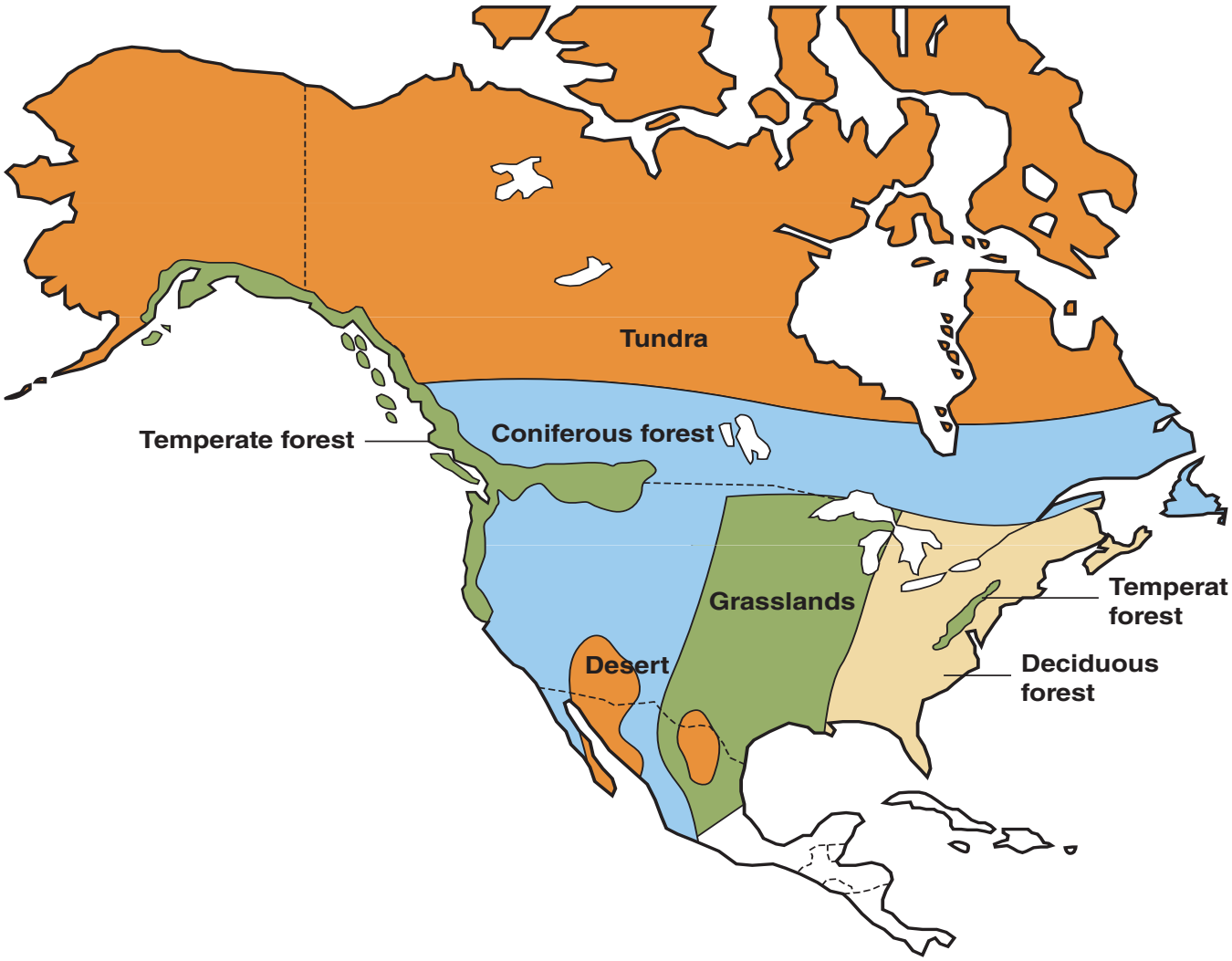


Figure 4–18 Several distinctive terrestrial biomes are found on the North American continent.

Figure 4–19 A desert biome is an environment that is very dry. *Courtesy PhotoDisc*.

Figure 4–20 A roadrunner is capable of surviving in a very dry environment. *Courtesy U.S. Fish and Wildlife Service. Photo by J.C. Leupold.*

Some plants survive in the desert because they have developed deep taproots that can draw moisture from deep in the soil. Others have very short growing seasons; they germinate and grow to the seed stage using the moisture of the melting winter snow or from a single rain storm. The desert literally does "blossom like a rose" before the hot, arid climate robs the soil of its moisture. Desert conditions are found on nearly 35 percent of the earth's land area. In North America, desert lands make up much of the Great Basin region located in Utah and Nevada, the southwestern United States, and northern Mexico.

The animals that inhabit the desert biome are highly specialized to survive with a limited supply of water, see Figure 4–20. Some of them get all the water they need from the plants they eat. Others lap up the dew drops that condense on plant leaves during the cool nights. Still others get their necessary moisture from the body fluids of the animals upon which they prey. In some cases, desert animals and birds travel long distances to drink at the few water holes found in these arid regions.

Among the animals that are found in the desert are small rodents such as rats and mice, birds, lizards, snakes, insects, and birds of prey. In some instances, larger animals such as jackrabbits (hares), coyotes, and pronghorn are found within traveling distance of water.

ECOLOGY PROFILE

The Great Basin—A Desert Profile

Jim Bridger was a famed mountain man during early explorations of western lands. He was a trapper and trader who spent much of his time alone or among the Native American tribes who lived in the region. Brigham Young, a colonizer of the American west, once inquired about the Great Basin as a possible location for a settlement, and Jim Bridger replied that it was unfit for human habitation. He further stated that crops could not be grown there, and he was reported to have offered $1,000 for the first bushel of corn grown in the valley of the Great Salt Lake. Before Brigham Young and the Mormon pioneers brought irrigation to this desert region, it was a land that fit the description of Jim Bridger: a desert unsuitable for human settlement. Today, irrigation has made it possible to convert large desert tracts into productive farmland.

Tundra Biome

KEY INTERNET SEARCH WORDS
tundra biome

The **tundra biome** is located in the frozen northern regions of the continent, extending from timberline on its southern limit to the areas of permanent snow and ice cover in the north, see Figure 4–21.

Figure 4–21 Alaskan range and tundra is located in a region that is very cold and dry.

Temperatures are well below freezing for most of the year, and the soil remains permanently frozen (permafrost) underneath the surface. Although less than 10 inches of precipitation falls annually in these areas, evaporation rates are low and the water cannot penetrate the frozen soil, so much of the area remains wet and spongy during the summer growing season.

Although the summer growing season is short in the tundra biome, the sun shines most of the time at these northern latitudes, and the tundra plants must mature and produce seed before the winter season returns. Water ponds up in the low spots, and the abundant aquatic and semiaquatic insects support migrating waterfowl and other birds in the summer. Caribou migrate into the tundra regions during the summer to graze on the grasses, mosses, lichens, sedges, and shrubs that grow there. As the growing season ends, the migratory birds and animals move back to the south.

The musk ox is a permanent resident of the tundra. Most of the precipitation in these areas comes in the form of rain during the fall months. Because snowfall is quite limited, the musk ox is able to graze year round on the short vegetation. This animal has adapted well to the difficult climatic conditions of the tundra environment. It is protected from the cold by a long, thick coat of hair and a layer of body fat. Its hooves are useful for defense against predators, and they are used to remove snow from the food supply.

Rodents such as lemmings become very abundant during some years and nearly disappear at other times. They provide food for predators such as the lynx, artic fox, ermine, birds of prey, and bears that move in and out of the tundra region. This natural cycle of the lemmings from abundance to scarcity controls the numbers of predators.

Grassland Biome

KEY INTERNET SEARCH WORDS
grassland, prairie, biome

The **grassland biome** in North America is often referred to as the prairie and is characterized by a lack of trees. It is located in the middle of the continent and includes the prairies of Canada, the midwestern region of the United States, and the grasslands that extend south into Mexico. Historically, the grassland areas formed the largest biome in North America, see Figures 4–22 and 4–23. The term grasslands is misleading in that many plants besides grasses are found there. Such plants include sedges, forbs, and a number of other types of plants. Many of the grasslands in North America have now been converted into farmlands where corn, wheat, and soybeans are the main crops.

The native species that inhabited the grassland region before the land was cultivated were well adapted to the region's climate and frequency of natural fires. Both the bunch grasses, which grow in tufts, and sod grasses with matted roots have deep root systems that make good use of soil moisture. Periodic burning is characteristic of this environment. The deep roots protect these plants against fire damage. Although fire may completely consume the foliage of these plants, new shoots arise from the roots when favorable growing conditions return.

The climate of the grassland biome is continental, meaning it is characterized by moderate to hot summers and cold, freezing weather in the winter. Grasslands are located in areas where severe droughts occur from time to time. These drought conditions contribute to the lack of trees in temperate grasslands. Lightning fires also are extremely

Figure 4–22 A tallgrass prairie. *Courtesy PhotoDisc.*

Figure 4–23 Pronghorns are well adapted to this shortgrass prairie. *Courtesy PhotoDisc.*

damaging to trees that are not specifically adapted to burning; thus, the fires keep them from becoming established.

It was in the prairie regions that the great herds of bison once ranged. Today, they have been replaced by herds of domestic cattle and sheep. Yellowstone National Park and Teton National Park provide native rangelands to wild herds of bison that are now found in abundance there. Other wild animals that are commonly found in the grasslands include prairie dogs, mice, snakes, rabbits, pronghorn, coyotes (prairie wolves), and several kinds of birds and insects.

Deciduous Forest Biome

KEY INTERNET SEARCH WORDS

deciduous forest

deciduous versus evergreen trees

forest, biome

The **deciduous forest biome** is identified by broadleaved trees such as oak, maple, cherry, ash, hickory, and beech that shed their leaves in the fall. The deciduous forest biome in North America begins south of the coniferous forests of Canada and Maine and extends southward along the east coast and westward until they are gradually replaced by grasslands. In its natural state, this entire area was a broadleaved forest. As civilization moved west, many woodland tracts were cleared and replaced by farms.

Precipitation in this habitat is generally in excess of 30 inches per year. Four distinct seasons are observed in these regions, with a bright-colored display of maple and ash leaves after the first frosts in the fall. This biome tends to be less homogeneous in its plant population than some other biomes because its climate is less homogeneous.

Several levels or layers of vegetation called **strata** are found in a deciduous forest. The tall trees form the **canopy** or ceiling of leaves at the highest levels. Smaller trees fill in the area beneath the canopy. These shorter trees make up the **understory** of the forest. Short bushes make up the **shrub layer** in the zone beneath the understory. The

shortest plants, including ferns and grasses, and other flowering plants are collectively called the **herb layer**. The **forest floor** is composed of a layer of decaying plant materials that acts as a mulch in preserving the soil moisture.

Mammals and birds of many kinds are native to the temperate forest biome. Squirrels and many species of birds prefer to live in the forest's canopy while other species prefer the understory. White-tailed deer, opossums, raccoons, skunks, foxes, birds of prey, snakes, squirrels, and mice are all common residents of broadleaved forests.

The passenger pigeon, which was a native species in this environment, became extinct primarily due to hunting pressure and the loss of critical nesting habitats. Wild turkeys and black bear are species that have suffered as deciduous forest habitat has been lost to timber harvests and land development. Today, the wild turkey has been introduced into many areas of the country where its preferred habitat is available, and the species is making a dramatic comeback in numbers.

Temperate Forest Biome

A **temperate rain forest** can exist in regions that have four distinct seasons along with normal annual precipitation of 68–78 inches. In North America, temperate rainforests are located in the Pacific Northwest along the coastline (from Northern California to British Columbia to Alaska), the inland forests of northern Idaho, Montana and the proximal forests of Canada, and inland forests parallel to the east-central coast of the United States, see Figure 4–18. These forests are home to many species of plants and animals, often forming a dense canopy that restricts sunlight and plant growth on the forest floor. Where the canopy is less restrictive, a dense growth of ferns, vines, and shrubs usually emerges on the forest floor.

Coniferous Forest Biome

KEY INTERNET SEARCH WORDS
coniferous forest biome

The **coniferous forest biome** is an evergreen forest of pine, spruce, fir, and hemlock. It forms a broad northern belt across the continent, extending from the grasslands and forests on the south to the tundra regions on the north and from the Northeast coastal region to the Pacific Northwest.

The vegetation in this biome consists mostly of trees known as **conifers** that produce seeds in cones. The foliage of conifer trees is dense, and as a result, the light intensity on the forest floor is inadequate to support the growth of most plants. A heavy carpet of dead needles covers the forest floor, and very few shrubs, grasses, or other plants are found there.

Precipitation in the region is mostly in the form of snow, and it generally ranges from 15 to 40 inches per year. The winters tend to be long and cold, and summer temperatures are moderate with cool

nights. The needle-shaped leaves of conifers are well-adapted to cold temperatures and to conserving moisture during dry periods. The shape of the trees and the flexibility of the branches enables heavy snow loads to fall to the ground without breaking the limbs.

The coniferous forest biome is the home of many birds, insects, and mammals. Large mammals such as elk, moose, mule deer, and caribou often graze in the meadows and wetlands that are scattered throughout the coniferous forests. Predatory species that are found in these regions include black bears, grizzly bears, wolverines, lynx, timber wolves, foxes, mink, hawks, and owls. Squirrels, porcupines, hares, mice, and a variety of birds also live in coniferous forests.

Coniferous forests provide much of the lumber that is used for construction, see Figure 4–24. These forests are an important renewable resource, and forests that are harvested using good management practices can continue to provide healthy environments for the living organisms that depend upon them.

Figure 4–24 Forests that are harvested under good management practices will continue to regenerate and prosper along with the wildlife that depend upon them.

LOOKING BACK

An ecosystem is seldom isolated from neighboring ecosystems, because its boundaries usually enable organisms and materials to flow in and out of the environment. Ecosystems that exist in areas with similar vegetation and climate are grouped together into biomes. A freshwater biome exists when water that makes up the living environment is not salty. Ocean water makes up the marine environment. The terrestrial biomes of North America include all environments that are land based. Water habitats are sometimes called wetlands. Federal regulations are in place that require restoration and preservation of these wetlands.

Chapter Review

DISCUSSION AND ESSAY

1. Explain how a problem in one ecosystem affects neighboring ecosystems that share its boundaries.
2. Assess the role of climate in the formation of biomes.
3. Identify the characteristics of a biome, and define the relationship of a biome to an ecosystem.
4. Create a chart that lists the distinguishing characteristics of each of the biomes in North America. It also should list the plants and animals that are found there, and describe the climates of the various biomes.
5. Identify ways that freshwater and marine biomes are similar, and contrast their differences.
6. Describe what plankton are and appraise their importance in the aquatic food chain.
7. Describe why wetland habitat restoration is important.

MULTIPLE CHOICE

1. A group of ecosystems within a region that have similar types of vegetation and similar climatic conditions is a:

   a. Strata
   b. Estuary
   c. Habitat
   d. Biome

2. Which of the following factors has no effect on the climate of a region?

   a. Latitude
   b. Altitude
   c. Distance from the equator
   d. Vegetation in the region

3. The world's largest biome is the:

   a. Marine biome
   b. Freshwater biome
   c. Temperate forest biome
   d. Coniferous forest biome

4. Microscopic plants and animals found floating on the water's surface where they provide food to aquatic animals are called:

   a. Bacteria
   b. Plankton
   c. Scum
   d. Molds

5. Water that is clouded with suspended particles of silt is described as:

   a. Turbid
   b. Stratified
   c. Clean
   d. Salty

6. Dense blooms of blue-green algae occur in surface water as a result of high levels of dissolved:

   a. Oxygen
   b. Calcium
   c. Nitrates
   d. Salt

7. A water habitat in which water tends to stand for long periods of time is called a:

   a. Lotic habitat
   b. Turbid habitat
   c. Murky habitat
   d. Lentic habitat

8. Which of the following water habitats is **not** part of the marine biome?

   a. A lake
   b. A bay
   c. An estuary
   d. An ocean

9. A zone in an ocean environment that is located underwater at high tide and above the water level at low tide is called a/an:

   a. Oceanic zone
   b. Intertidal zone
   c. Neritic zone
   d. Ozone

10. Which of the following terrestrial biomes is located in the frozen northern regions of the continent?

   a. The desert biome
   b. The grassland biome
   c. The coniferous forest biome
   d. The tundra biome

11. Short bushes that grow on the forest floor make up which layer of forest vegetation?

   a. The canopy
   b. The shrub layer
   c. The understory
   d. The herb layer

Learning Activities

1. Take a field trip to an area near your school, and instruct the students to perform the following tasks:
   - describe the major characteristics of the environment
   - list the kinds of plant life that are observed
   - list the animal species that are known to inhabit the area
   - identify the insect species that are observed
   - develop a chart that shows how each organism might fit into the food web
   - discuss how human activity in the area might benefit or harm the organisms and the environment in which they live

   Note: If a field trip is not possible, a good video showing the essential elements of the environment is a reasonable alternative.
2. Identify experts in your community who can provide factual information about the plants and animals that are found in your area. Invite one or more of these people to visit the class to discuss local environmental issues. Opposing points of view on controversial issues should be explored.

CHAPTER

5

Our Wildlife Resources

After completing this chapter, you should be able to:

- describe how wild animals have contributed to the survival and comfort of humans
- distinguish between responsible and abusive stewardship of the land and the environment
- explain how the U.S. Endangered Species Act provides protection to organisms that are in danger of becoming extinct
- discuss the controversial issues that have resulted from implementing the U.S. Endangered Species Act
- list several species of wild animals and birds that are protected by the U.S. Endangered Species Act, and describe what steps have been taken to improve their chances of survival
- identify environmental factors that contribute to extinction of organisms
- describe how a high degree of specialization in a species makes it more vulnerable to extinction
- suggest ways that nonadaptive behavior and low biotic potential contribute to extinction of some species of organisms
- defend the role of dependable research as a management tool for protected wildlife species.

Wild animals are some of the greatest treasures on planet earth. The Native Americans who were here when Columbus first arrived had depended on wild animals for hundreds of years to supply much of their clothing, shelter, and food. The early colonists could not have survived in the New World without the wild animals from which they, too, obtained food, shelter, and clothing, see Figure 5–1.

KEY TERMS

naturalist
stewardship
extinct
endangered species
threatened species
habitat
organism
alien species
nonadaptive behavior
biotic potential
biologist

Figure 5–1 Humans have depended on wild animals for food, clothing, and shelter for hundreds of years.

A NATIONAL TREASURE

The kinds and numbers of wild animals in North American ecosystems changed as civilization moved across the continent. Some species have been lost due to natural changes in the environment; some have declined due to human competition, neglect, or abuse. Other kinds of birds and animals have benefited from the changed environments created by humans, and they have become more abundant, see Figure 5–2.

Farmers, outdoor sportspersons, **naturalists** (people who study nature), and others who benefit from the use and ownership of land must exercise good **stewardship** by properly caring for the land, see Figure 5–3. This includes conserving and protecting the soil resources and the overall environments of the plants and animals that live there,

Figure 5–2 The hummingbird has adapted well to environments in close proximity to humans.

KEY INTERNET SEARCH WORDS
domestication of animals

KEY INTERNET SEARCH WORDS
land stewardship

Figure 5–3 It is important to our environment that we exercise responsible and careful management over natural resources and property. *Courtesy Shutterstock.*

see Figure 5–4. Landowners, managers, and users are responsible not only to their own generation but also to all future generations for care and management of our land and water resources. While most farmers and other property owners make serious efforts to protect the ecology of the area, some people abuse the right to control property by failing

Figure 5–4 The U.S. Department of Agriculture is responsible for the management of forest lands that are owned by the federal government. *Courtesy of USDA.*

to manage it in a reasonable and responsible manner. Abuse of property and wildlife resources has made it necessary to pass laws that protect wild animals and the environments they live in.

The U.S. Endangered Species Act

Congress passed legislation in 1969 that protected animal species whose numbers were declining to dangerously low levels. The act was expanded in 1973 to require the U.S. Fish and Wildlife Service to identify species of animals and plants that might become **extinct** due to the death of the entire population. The act identifies two classes into which those species that are found to be at risk may be placed. Those in immediate danger of extinction are classed as **endangered species**. These are the plants and animals that have small numbers in their population. In many cases, the population also is becoming smaller throughout most or all of the range that is occupied by the species, see Figure 5–5. Species that are in less danger of extinction, but which are at risk of becoming endangered, are classed as **threatened species**. These are species that can reasonably be expected to survive if immediate steps are taken to protect the environments they live in.

KEY INTERNET SEARCH WORDS
endangered, threatened species

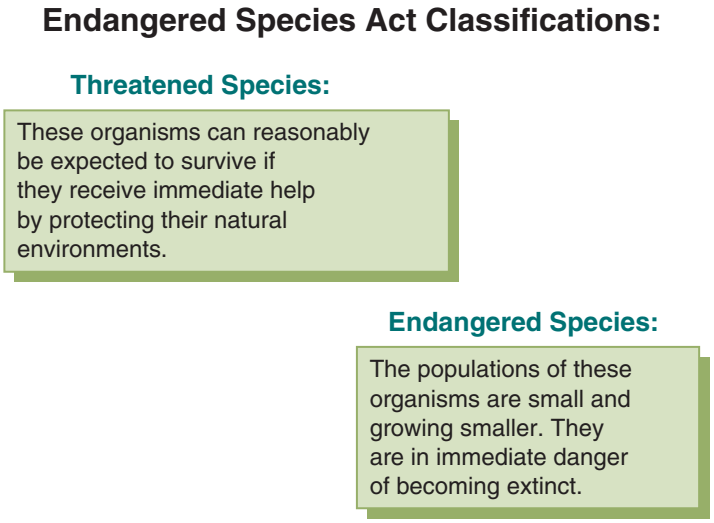


Figure 5–5 Endangered Species Act classifications of organisms.

The act protects both the species and its **habitat**, see Figure 5–6. Habitat is defined as the environment in which an **organism** or living creature makes its home and from which it obtains its food. Species that are protected under this legislation cannot be hunted or killed without heavy legal penalties being assessed. The act also protects the organism's habitat from development or other disruptive uses by people. Restricted use of the land area where protected species live is usually considered to be necessary to prevent the delicate balances of nature from being destroyed.

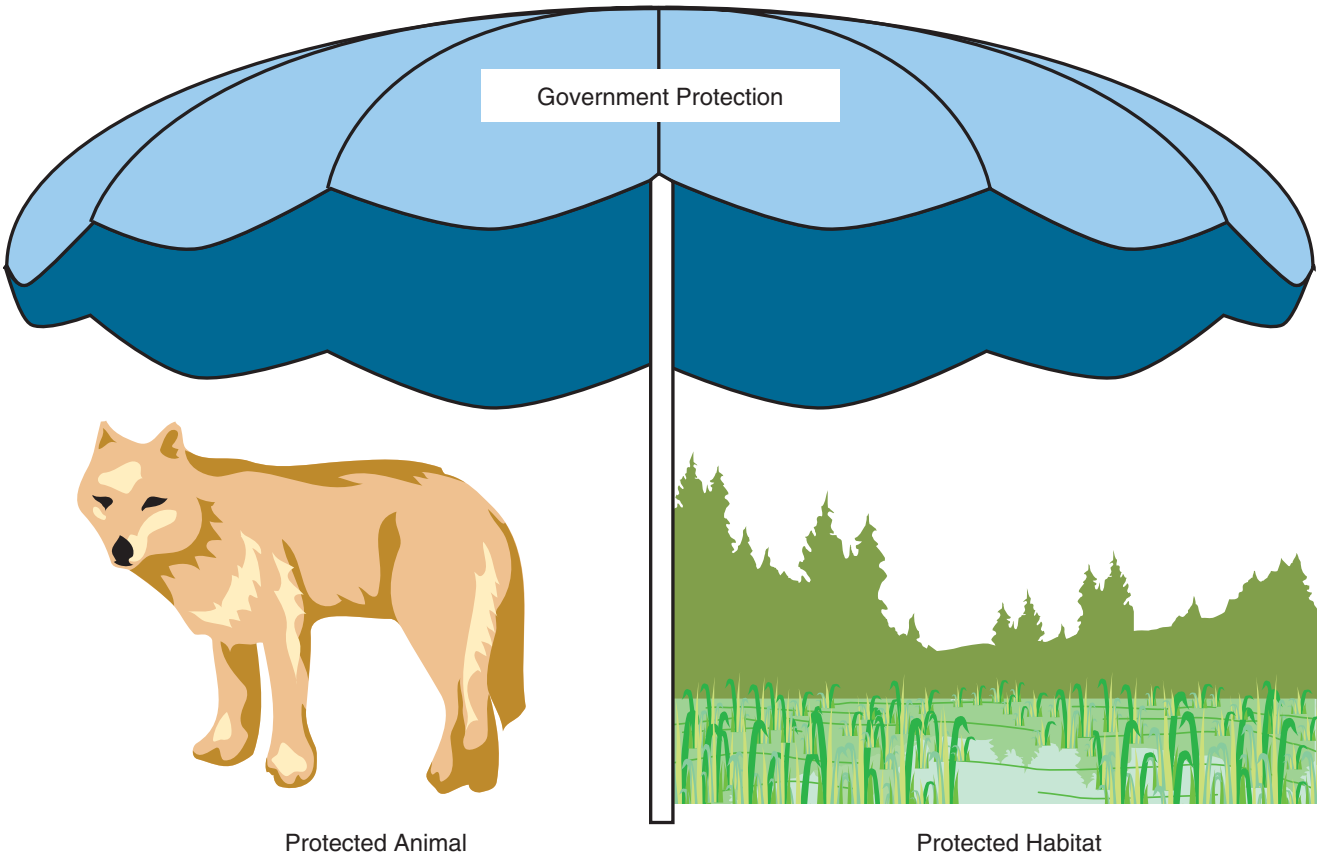


Figure 5–6 The Endangered Species Act protects both the species and its habitat.

CONTROVERSY AND PROTECTIONISM

Protection of endangered or threatened species has resulted in controversy over the provisions of the Endangered Species Act. This is because the act requires nonuse or restricted use of natural resources in the areas where protected species live. The economic cost to humans of enforcing the Endangered Species Act in a particular area is often very high.

The U.S. Fish and Wildlife Service often comes under pressure from people whose lives are affected by this act. Sometimes people want to prevent enforcement of the law or to change the way it is enforced because jobs, businesses, and even the welfare of entire communities may be adversely affected as the law is fully implemented. Pressure is also applied to those agencies and individuals who are responsible for enforcing the act by organizations and people who believe that greater protective measures are called for under the act's provisions.

KEY INTERNET SEARCH WORDS

Northern spotted owl

THREATENED SPECIES PROFILE

The Northern Spotted Owl

In the Pacific Northwest, the spotted owl has been identified as a threatened species, see Figure 5–7. Its favored habitat is mostly composed of old-growth forest; however, recent scientific studies have found spotted owl populations living and surviving in young forests. It is widely believed that this owl will hunt only in old-growth forests, but closer study has confirmed that they actively hunt in immature forest environments also. Harvest of timber in the Pacific Northwest has nearly been eliminated in some areas since the provisions of the Endangered Species Act have been enforced. Several court actions have been filed by interested groups to assure compliance with the act, and the result has been a decline in the timber industry of the region. Lumber mills have closed due to lack of a steady supply of logs, and many people who worked in the timber industry have been displaced from their communities. Protecting a threatened or endangered species is important; however, it is of equal importance that the issues on both sides are clearly and accurately presented and supported.

Figure 5–7 The northern spotted owl is classified as a threatened species. *Courtesy U.S. Fish and Wildlife Service. Photo by Randy Wilk.*

ECOLOGY PROFILE

Suckers Versus Farmer

Nearly 2000 farm families located in California and Oregon encountered the full impact of the Endangered Species Act on April 17, 2001, when the U.S. Bureau of Reclamation notified farm families in the Klamath Basin Project that nearly all of the water from the entire watershed had been shifted to endangered sucker fish recovery efforts. A U.S. district judge upheld the action of the Bureau of Reclamation citing the Endangered Species Act and treaty obligations. The legal action was supported by the California Council of Trout Unlimited, the Salmon Restoration Federation, the Northern California Association of River Guides, Waterwatch, The Wilderness Society, the Klamath Forest Alliance, and the Oregon Natural Resources Council along with other less prominent organizations. Almost all of the 200,000 acres of farmland and pastures located in the watershed dried up as a consequence of this action. Loss of farm income was estimated at $100 million in the first year, and farmland values were estimated to be down from $800 per acre to $50 per acre. It was expected that most of the 2,000 families affected by this action would face bankruptcy proceedings. Hundreds of farm laborers also were displaced. Also at risk as a result of the loss of water rights were the local businesses of the region that served the agricultural industry and the retail businesses that depended on the patronage of farmers, ranchers, and farm laborers. The conflict continues despite recovering populations of sucker fish. Part of the debate has now turned to proposals to remove dams from the river system. A fundamental question is raised as a result of these actions: Should all citizens of the United States be required to pay the cost of protecting endangered species, or is it fair and right that the entire burden should be carried by the unfortunate few?

Many controversies of a similar nature exist in different areas of the United States where species of birds and animals have been classified as threatened or endangered. In each case, conflict occurs between people who rely financially on the resources that make up the limited habitat of the listed species and the environmentalists who insist that there can be no compromise on the law that protects endangered and threatened species.

KEY INTERNET SEARCH WORDS

loggerhead sea turtle

Figure 5–8 The loggerhead sea turtle is classed as a threatened species by the U.S. Fish and Wildlife Service. *Courtesy Shutterstock.*

THREATENED SPECIES PROFILE

The Loggerhead Sea Turtle

The loggerhead sea turtle is a threatened species that begins its life on the east coast of Florida, see Figure 5–8. Females lay about one hundred eggs each year in the nesting area before returning to sea. However, only 1 in 10,000 of the baby turtles that hatch survives to adulthood. Many of the turtles are eaten by predators within a short time after hatching. Others are caught in shrimp nets where they drown. Shrimp fishermen are reluctant to modify their nets to protect the turtles because their catch of shrimp tends to be reduced. The issue is an economic one. Can shrimp fishermen afford to lose 25 percent of their catch to save 50,000 turtles per year? The law also restricts commercial and private development of the property where nesting areas are located along the shore.

Critics of the Endangered Species Act are concerned that the law does not take into account the human costs associated with its enforcement. Many of these people object to the law because local economies are often weakened, and jobs are lost when it is strictly enforced. They believe that there should be a balance between human rights and the rights of the protected species, see Figure 5–9.

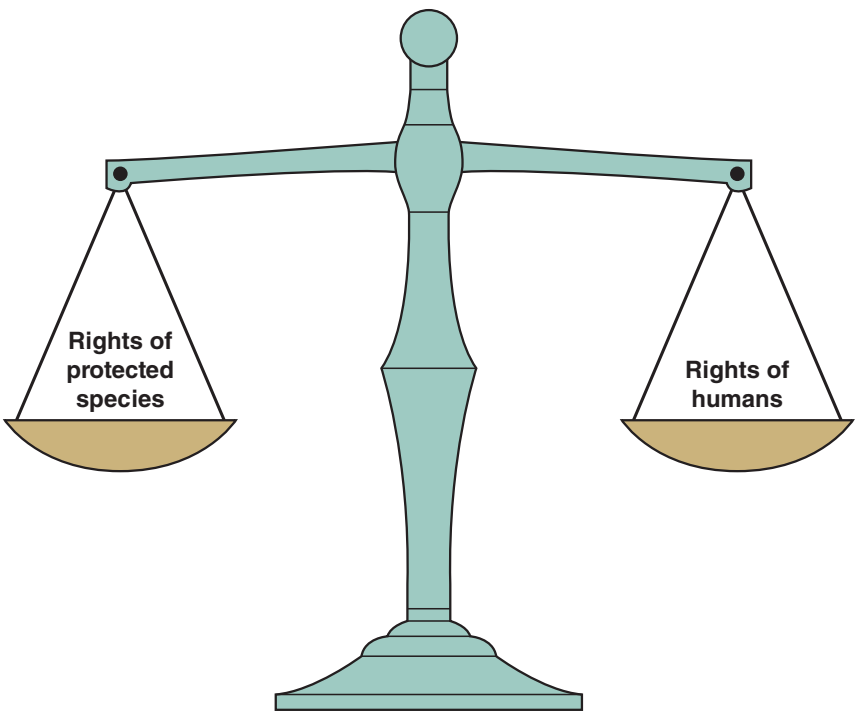


Figure 5–9 Many of the people whose jobs have been affected by the Endangered Species Act would like to see a balance established between the rights of humans and the rights of protected species.

KEY INTERNET SEARCH WORDS

red wolf

Canis rufus

Figure 5–10 The red wolf is an endangered species. *Courtesy Shutterstock.*

THREATENED SPECIES PROFILE

The Red Wolf

The red wolf is an endangered species whose native range extends from the southeastern United States to central Texas see Figure 5–10. Like other species of wolves, it is a predator. It feeds mostly on small animals and birds, but packs of wolves may also attack and kill large animals including domestic livestock. Like the gray wolf, red wolves have been hunted and killed because their feeding habits put them in competition with humans. They were nearly eliminated from many livestock ranges during the past 100 years. As an endangered species, it is illegal to kill these animals. The recovery of this species is generally opposed by livestock producers and by some hunting advocates.

A key issue in managing threatened and endangered species is the difficulty in distinguishing between species that are victims of natural selection and those that are victims of competition from humans and their management of the environment. Some protected populations continue to decline even when no human interference is evident. In some instances, no amount of human intervention can prevent the species from becoming extinct. This is not a new phenomenon. Natural selection and extinction are processes that have been occurring for as long as life has existed on this planet, but the problem has become more intense as the world population of humans has expanded into many areas. Much of the wild animal domain has now been converted to farms and other human uses. The black market trade in protected wildlife has become a major problem for some animal species. Ivory, fur, pets, and animal parts are sold illegally. On a world scale, trade in wildlife has been reported to rank second behind drug trafficking among illegal trade activities. Such activities can accelerate the extinction of a species. How do we know when we have done all that we can do, and when should we let nature run its course? Is it even ethical to intervene in the natural selection process? Is it ethical to choose not to intervene?

KEY INTERNET SEARCH WORDS

swift fox, habitat

THREATENED SPECIES PROFILE

The Northern Swift Fox

The historical range of the northern swift fox extends across the northern plains of the United States and into Canada. It is protected as an endangered species in Canada, see Figure 5–11. This fox is a victim of the encroachment of farms on prairie grasslands. Destruction of the habitat used by the birds and rodents that make up the diet of the northern swift fox has also seriously impacted the fox population.

Figure 5–11 The Northern swift fox is an endangered species in Canada. *Credit*: Helen Williams/*Photo Researchers, Inc.*

One endangered species that has generated recent controversy is the sockeye salmon, see Figure 5–12. One strain of sockeye spawns in Redfish Lake in Idaho and enters the Columbia River system at 1 to 2 years of age. They migrate past eight dams as they migrate down the river to the Pacific Ocean. The dams create a series of barriers that restrict the movement of the fish, and they appear to interfere with the ability of the fish to migrate swiftly and safely.

Efforts to draw down the reservoirs behind the dams have resulted in controversy over ownership of the water rights. The water in the reservoirs is legally managed for production of electrical power, commercial shipping, and for crop irrigation. The reduced water levels that are necessary to eliminate slack water during the annual migration of the sockeye is expected to restrict shipping and commerce on the Columbia River and to reduce or even deplete the supply of stored water necessary for producing electricity and crops.

Figure 5–12 The sockeye salmon. *Courtesy U.S. Fish and Wildlife Service*

KEY INTERNET SEARCH WORDS

cause of extinction

EXTINCTION AND ITS CAUSES

Extinction of a species of organisms is not something to be taken lightly. The diversity of species is considered to be an indicator of a healthy environment. Humans have become a dominant species because they are able to adapt to nearly any environment. They also act as predators toward many of the animals and birds with which they share the environment. They frequently disrupt the habitats upon which other species depend.

Destruction or modification of a habitat is the greatest single cause of extinction. When organisms lose their food supply, they soon starve to death. When their shelter is damaged or destroyed, they can more easily be eliminated by natural enemies or by unfavorable weather conditions. Even modest changes in weather conditions are dangerous to an organism that has lost the shelter to which it is accustomed. Natural disasters such as severe storms or extreme temperatures are among the greatest threats to an already threatened or endangered species of organisms.

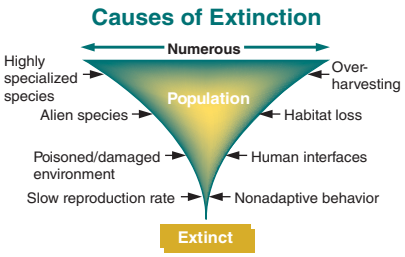


Figure 5–13 There are many factors that can lead to the extinction of a species.

Many organisms are unable to adapt quickly to changes in environmental conditions or to heavy losses from predators. They decline in numbers as their environments are modified or as predators increase. A single cause can result in the extinction of some plants or animals; however, a species is more likely to become extinct due to a combination of factors that impact it in a negative way, see Figure 5–13.

An important factor that sometimes leads to extinction of an established species is the introduction of an **alien species** into the ecosystem. The new species may compete with the native species for food and shelter or may prey upon it as a source of food. When this

happens, the balance in the ecosystem is upset, and the weaker species tends to decline while the newly introduced species increases in numbers. Alien species are sometimes sources of new diseases. Entire populations of organisms have been lost due to such diseases.

Still another major factor that contributes to extinction is over-hunting of a species by humans. In some instances, this has been done commercially, but in other instances, sport hunting of a vulnerable species has contributed to its extinction.

KEY INTERNET SEARCH WORDS

passenger pigeon

THREATENED SPECIES PROFILE

The Extinction of the Passenger Pigeon

A combination of negative factors led to the loss of the passenger pigeon as a species, see Figure 5–14. These wild pigeons were the most numerous of the world's birds in the 1800s. Nearly 2 billion of these birds were reportedly in a single flock observed by ornithologist Alexander Wilson in Kentucky. The passenger pigeon was intensely hunted for food, and a large market for meat developed in eastern population centers as transportation became available through the railroads. Destruction of the trees that provided nesting habitats and harvesting of young birds from densely populated nesting areas played significant roles in reducing their numbers.

Passenger pigeons lived in large flocks and this tendency made them vulnerable to diseases and predation. In addition to these problems, a pair of passenger pigeons produced only one egg and raised a single offspring during each nesting period. The last known passenger pigeon died in a zoo in Cincinnati in 1914. The lesson to be learned from the passenger pigeon is that even the most numerous species can become extinct when their habitat is destroyed and when unrestricted hunting occurs.

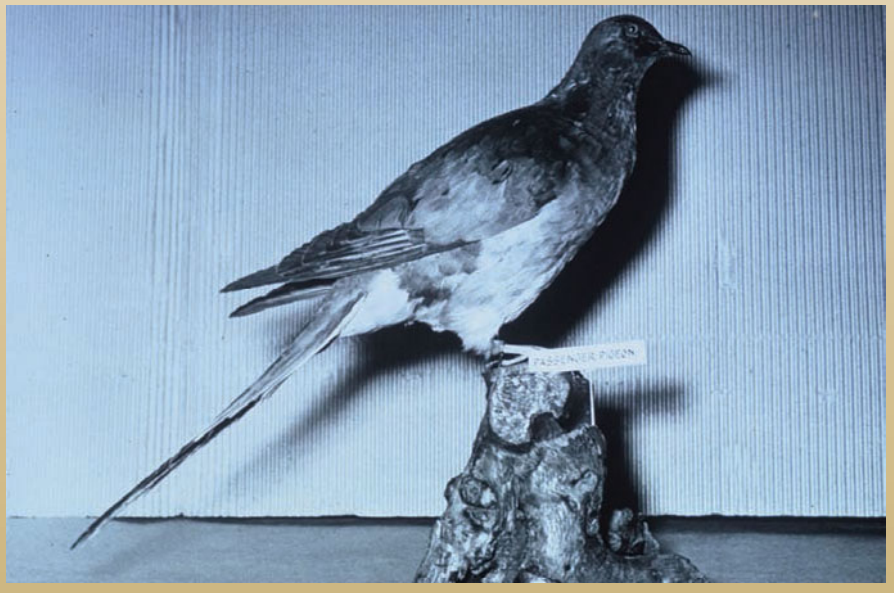


Figure 5–14 The passenger pigeon became extinct in 1914. *Courtesy U.S. Fish and Wildlife Service. Photo by Luther Goldman.*

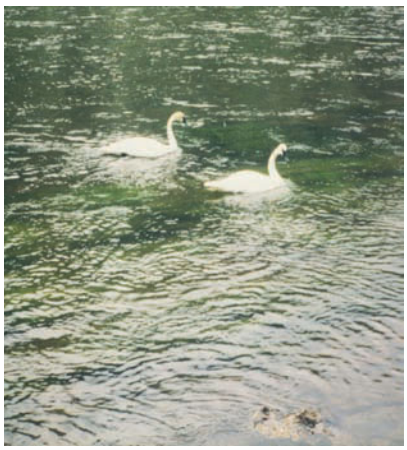


Figure 5–15 The trumpeter swan is an endangered species.

The degree of specialization in a species affects how vulnerable it is to extinction. Species that cannot adapt their behaviors or their diets to accommodate changes in their environment are at the greatest risk, see Figure 5–15. This is because a highly specialized mammal or bird may depend on a single source of food or shelter. When that source of food or shelter is no longer available, a highly specialized bird or animal is likely to be unable to adjust, and it will face extinction. Failure of a species to adapt to a changing environment is called **nonadaptive behavior**.

Many surviving species in the world today are able to adapt to modest changes in their environments. However, abrupt changes in an environment allow no time for living organisms to adjust, and in some cases adjustment is not possible.

A slow rate of reproduction contributes to extinction by reducing the recovery rate of an endangered species. Biologists refer to this problem as low **biotic potential** or fecundity. Examples of animals and birds that fall into this class include the California condor, which lays only one egg every two years, and the whooping crane, which takes several years to reach breeding age and then lays only two eggs per year, see Figure 5–16. More successful species of birds usually lay 8 to 10 eggs or nest two or more times per season.

Figure 5–16 A slow rate of reproduction reduces the recovery rate and can contribute to extinction. More successful species of birds lay 8–10 eggs or nest several times a year.

Career Option

FISH AND WILDLIFE BIOLOGIST

A BIOLOGIST WHO WORKS with fish and wildlife is a person who makes a career of learning and understanding the basic needs of animals. He or she studies the living habits of different animal species to determine the kinds of food and shelter that are needed. They also study other characteristics of organisms such as reproductive habits and territorial ranges.

A fish and wildlife biologist must have a strong background in the biological and environmental sciences. A person planning a career in this field will need a four-year degree from a good university with graduate study recommended. These biologists conduct field studies to determine management alternatives for wild animals.

KEY INTERNET SEARCH WORDS
management, endangered species

MANAGING ENDANGERED AND THREATENED SPECIES

Humans are the only species that can make conscious decisions to destroy or preserve other forms of life. They also have a moral responsibility to preserve other organisms with which they share the environment. People in some parts of the world take this stewardship seriously, but other cultures place little value on preserving threatened and endangered species. Even in societies that accept responsibility for protecting these organisms, there are strong differences of opinion concerning how much protection should be provided.

One of the most difficult problems facing fish and wildlife biologists is managing the surviving members of a population that is found to be endangered or threatened. They must learn to identify and understand relationships between the organism and its environment. Relationships of this kind are often difficult to define because the species' preferred habitat may no longer exist.

Effective management of endangered species of organisms must be based on reliable research. Those who are responsible for the recovery of endangered or threatened species should explore as many alternative management strategies as they can identify. Innovative ways of restoring acceptable shelter and providing appropriate food sources have been successfully used in some critical management situations, see Figure 5–17.

Figure 5–17 Nesting boxes are an innovative way to restore shelter in critical management situations.

LOOKING BACK

Wild animals are important natural resources to the human race. They have provided food, clothing, and shelter to many cultures around the world. Wild animal populations are seldom stable. They change as civilization and other species of animals expand into their environments. Environments often change as humans and other dominant species move into an ecosystem. Some species of organisms are favored by changes in their environments; however, in other cases, even minor changes make it difficult for some wild animals to survive.

Species of animals that are declining in numbers are often protected by government regulations when they become classified as endangered or threatened species. The introduction of competing or non-predatory species may contribute to extinction of some species due to loss of habitats, predation, starvation, and disease.

Serious controversies frequently occur over the management of protected species of organisms because human use of natural resources in such areas is restricted or stopped entirely. Human management of protected species should always be innovative and based on sound research.

Chapter Review

DISCUSSION AND ESSAY

1. Describe how wild animals have contributed to the survival, comfort, and growth of human populations.
2. How is responsible stewardship different from abusive stewardship as it relates to the land and the environment?
3. Explain how the U.S. Endangered Species Act might be used to protect species of organisms that are in danger of becoming extinct.
4. Identify a controversial issue that has surfaced as a result of implementing the Endangered Species Act, and discuss the pros and cons of the issue.
5. List some species of wild animals and birds in your region that are protected by the Endangered Species Act, and describe the steps that have been taken to improve their chances of survival.
6. Identify some factors that are known to contribute to the extinction of wild animals.
7. Explain how a high degree of specialization in a species makes it more vulnerable to becoming extinct.

8. How does low biotic potential and nonadaptive behavior contribute to population declines of some species?
9. Explain why good scientific research is needed as a management tool for protected wildlife species.

MULTIPLE CHOICE

1. Landowners, managers, and users are responsible not only to their own generation but also to all future generations for care and management of the land and water resources. This is the definition of:

   a. Nonadaptive behavior
   b. Low biotic potential
   c. Good stewardship
   d. Endangered Species Act

2. Which of the following practices *is not* a good stewardship practice?

   a. Soil conservation
   b. Pollution of ground water
   c. Protection of surface water
   d. Providing shelter for wildlife

3. A person who studies nature is defined to be a:

   a. Naturalist
   b Sportsperson
   c. Land manager
   d. Poacher

4. The U.S. Endangered Species Act defines an endangered species as:

   a. Organisms that are declining in population but which can reasonably be expected to survive if immediate steps are taken to protect their habitat
   b. A population whose members have all died
   c. A species that is at risk of becoming extinct due to small numbers in the population in all or most of its range
   d. A species that threatens the safety of humans

5. Which of the following is an endangered species?

   a. The northern spotted owl
   b. The coyote
   c. The loggerhead sea turtle
   d. The red wolf

6. Which of the following American species is extinct?

   a. The red wolf
   b. The California ground squirrel
   c. The passenger pigeon
   d. The whooping crane

7. Which of the following is a characteristic of an endangered species?

   a. Low biotic potential
   b. Ability to eat more than one kind of food
   c. Easy adaptation to the presence of humans
   d. Easy adaptation to new habitats

8. An organism that is not native to an ecosystem is known as a/an:

   a. Threatening species
   b. Endangered species
   c. Alien species
   d. Omnivore

9. The greatest single cause of extinction is:

   a. The destruction or modification of habitat
   b. Overharvesting
   c. A nonadaptive behavior
   d. An alien species

10. Low biotic potential is defined as:

   a. The failure to adapt well to a changing environment
   b. A slow reproductive rate
   c. A high susceptibility to poisons in the environment
   d. The production of large numbers of offspring each year

Learning Activities

1. Divide the class into two groups for the purpose of debating the issues that arise when the Endangered Species Act is invoked. Assign one group to debate in favor of restricting the use of resources that are part of the environment of an endangered species. Assign the second group to defend the rights of people who depend on those resources to earn a living.
2. Divide the United States (or the world) into geographic regions, and assign teams of students to research the species in their regions that are considered to be threatened or endangered. Describe the factors that contribute to the problem, and offer solutions for restoring the populations that are in danger of extinction. Each team should report back to the class.

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SECTION

II

Zoology and Ecology of Mammals

Mammals are members of a class (Mammalia) of warm-blooded animals with bony skeletons. They give birth to live young and nourish them with milk secreted from mammary glands. They usually have a protective coat of hair.

CHAPTER

6

Gnawing Mammals

The best known animals in North America are the mammals. These animals are warm blooded, and they usually have a protective coat of hair and a bony skeleton. Their babies are fed milk which is secreted by the mammary glands—the milk-producing organs of females. Mammals are also vertebrates along with birds, reptiles, amphibians, and fish. Vertebrates have backbones composed of many segments that enclose the spinal cord, see Figure 6–1.

After completing this chapter, you should be able to:

- identify the physical characteristics that distinguish mammals from other animals
- describe how scientists classify, organize, and define relationships among living organisms
- distinguish between primary and secondary consumers
- define the roles of rodents and other gnawing animals in the ecosystems of North America
- predict the effects of declining or expanding populations of gnawing animals on the populations of predators that depend on them for food
- predict the effects of declining or expanding populations of predators on the populations of rodents and other gnawing animals
- illustrate the distribution of gnawing animals on the North American continent
- profile the life cycles of specific gnawing mammals.

KEY TERMS

- mammal
- mammary gland
- vertebrate
- rodent
- primary consumer
- secondary consumer
- taxonomist
- nocturnal
- hibernate
- vole
- carrying capacity
- evolution
- estivation
- pika

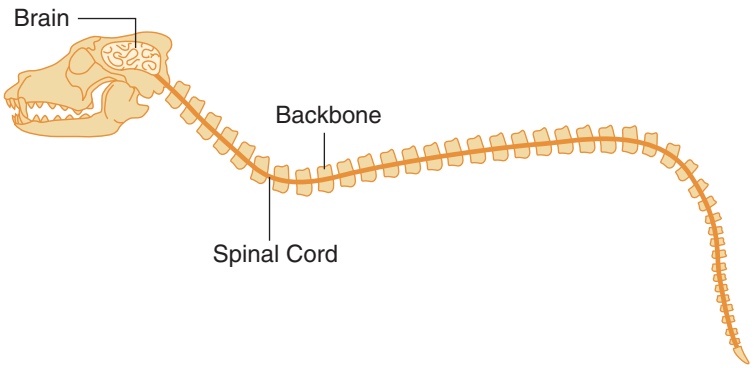


Figure 6–1 Vertebrates are identified by backbones composed of bone segments surrounding the spinal cord that extend from the tail to the skull.

Some gnawing mammals are called **rodents**. This group of animals is identified by the four large incisor teeth in the front of their mouths, see Figure 6–2. These teeth never stop growing, and rodents must gnaw on wood or other materials just to keep their teeth worn down. The front edge of a rodent's tooth is composed of harder material than the back edge, causing the back edge to wear faster than the front. The result is that the incisor teeth become chisel-shaped, and they are sharpened as they wear down, see Figure 6–3.

Rodents make up the most diverse group of mammals. There are many different species of these animals, and they are capable of living in many different environments. Rodents are often considered to be pests. This is due to their large numbers and the destructive gnawing habits of some species; however, these animals are an important food source for a large number of other animals.

In this chapter, we will explore the roles of rodents and other gnawing mammals in the ecosystems of North America. Some species will be discussed in detail. Scientific and common names will be used to identify the species that are featured in the mammal profiles. We will study their interactions with other living things in the environment and also explore how they fit into the food web.

Figure 6–2 One characteristic of rodents is that they are all equipped with four large incisor teeth they use to continually gnaw on things.

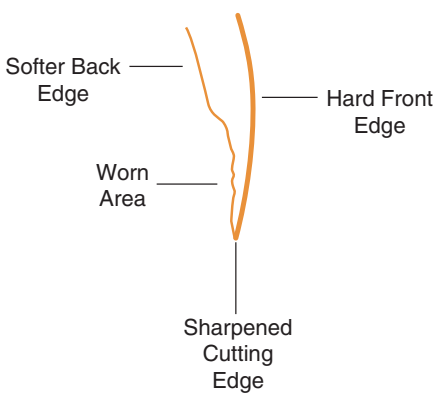


Figure 6–3 Rodent incisor tooth structure.

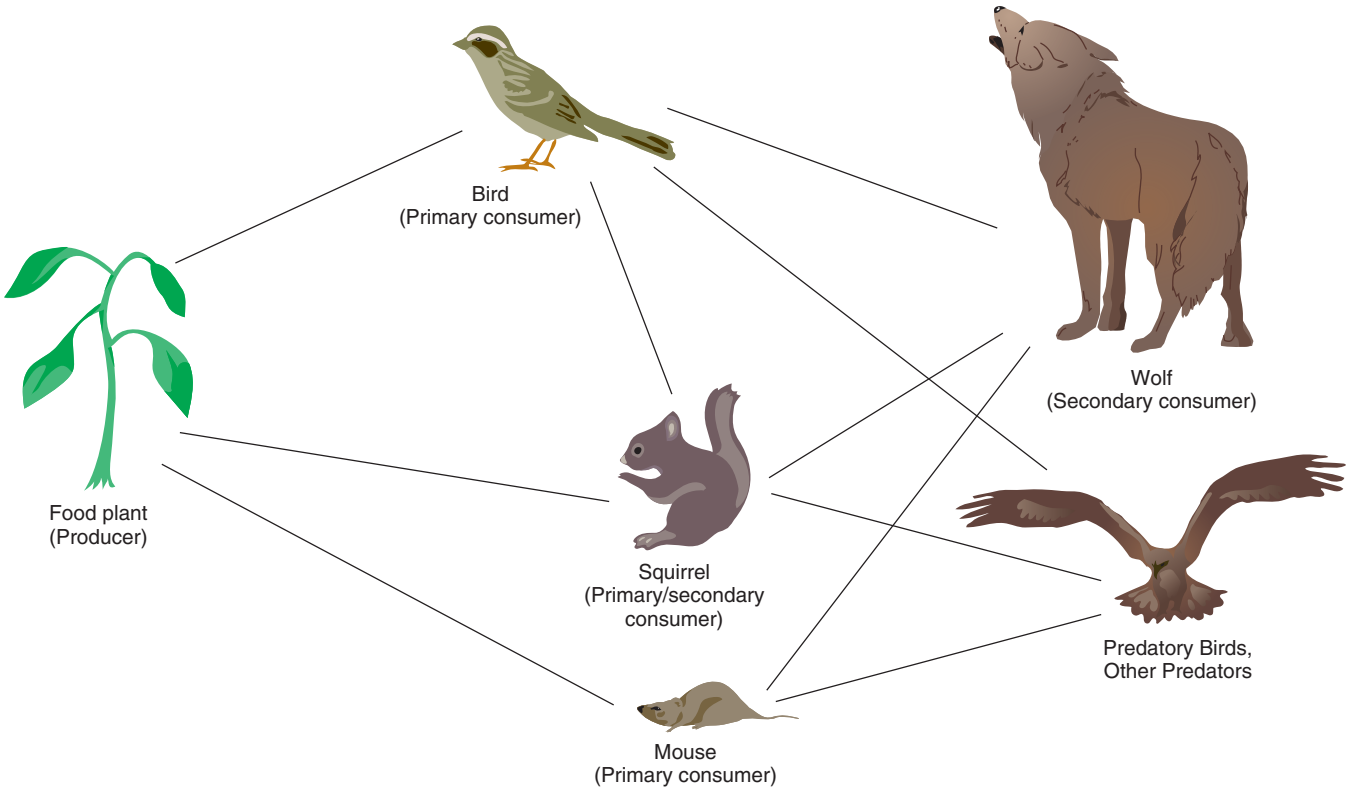


Figure 6–4 Gnawing mammals fill important roles as primary consumers in the food web.

KEY INTERNET SEARCH WORDS
gnawing mammals

KEY INTERNET SEARCH WORD
rodent

Most rodents are herbivores, meaning they eat plants. These animals are also known as **primary consumers**. Two examples of primary consumers are deer and squirrels. Herbivores are eaten by carnivores or meat eaters. Carnivores, such as the weasel and the mountain lion, are classed as **secondary consumers**. A field mouse that feeds upon the stems, seeds, and roots of plants is a primary consumer in a food web. The predator that eats the mouse is a secondary consumer, see Figure 6–4. We learned in Chapter 2, "Principles of Ecology," that the food plants that are eaten by the mouse are known in the food chain as producers.

Career Option

TAXONOMIST

A TAXONOMIST IS A SCIENTIST who classifies living organisms into related groups. This is a highly specialized field that requires a person to be able to observe and distinguish small but distinct differences among organisms. An advanced graduate degree is required from a reputable university. Much of the work of a taxonomist involves collecting specimens of organisms and accurately observing the features that make one organism distinctly different from other similar organisms.

Taxonomists often find careers at colleges and universities and in museums. Some are also involved in field research and collecting expeditions.

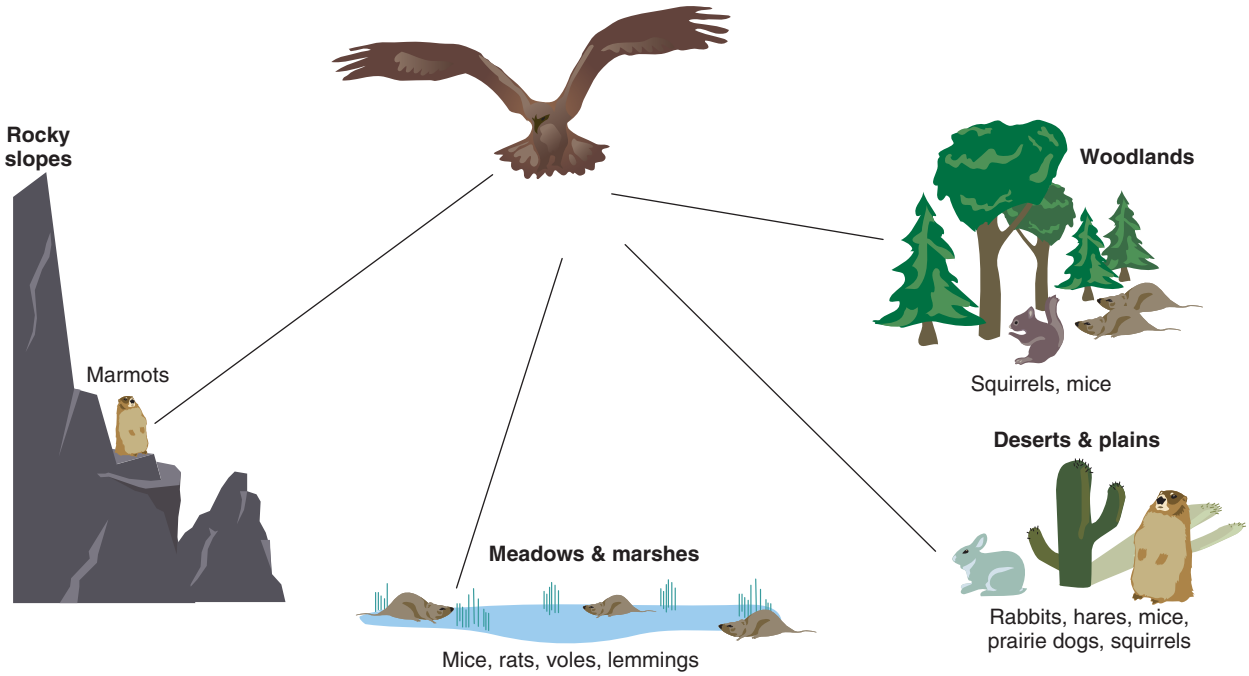


Figure 6–5 The relationship between gnawing mammals and birds of prey is that of prey to predator.

MICE, RATS, VOLES, AND LEMMINGS

There are many different species of mice, rats, voles, and lemmings in North America, but only a few of the most commons ones will be discussed in this chapter. These small rodents are very important as food animals. This group of animals is the most numerous class of rodents.

The mouse is the smallest of the rodents. Rats, voles, and **lemmings** are similar to mice in many ways, but they are larger in size. All of the animals in this group are efficient at converting plant materials into flesh, and they are a dietary staple for many predatory animals and birds, see Figure 6–5.

KEY INTERNET SEARCH WORDS
rodentia

Rodents are the main food source for predatory birds such as hawks and owls. The birds of prey have excellent eyesight, and they can see small rodents from great distances. Nearly everyone has observed a hawk riding the wind currents high above the ground while it scans the fields in search of mice, see Figure 6–6. When a mouse is seen, the hawk dives to the earth and grabs its prey in its strong talons. One blow from the bird's beak kills the mouse almost instantly, and it soon becomes a meal.

Figure 6–6 The superb eyesight of birds of prey makes it possible for them to soar high in the air while searching below for food.

KEY INTERNET SEARCH WORDS

house mouse

MAMMAL PROFILE

House Mouse *(Mus musculus)*

House mice are small rodents that range from 6 to 8 inches long from nose to tail, and they weigh from 0.5 ounce to 1 ounce. They are usually gray or brown in color, and they have long, hairless tails. During good weather, they often live outdoors; however, they prefer to live in buildings during the colder seasons. They live anywhere that food and shelter can be found in close proximity, that is, often inside houses and other buildings close to humans, see Figure 6–7. Their range extends throughout most of North America.

The house mouse begins reproducing young at 2 months of age, and it is capable of having up to eight litters each year. Litter sizes range from 3 or 4 to 10 or 11 young. They are born naked, helpless, and blind. They grow up in a nest lined with soft material that has been placed there by the female. Mice constitute an important food source for many kinds of predatory animals and birds.

Figure 6–7 A brown house mouse. *Courtesy PhotoDisc.*

Skunks, foxes, coyotes, bobcats, lynx, mink, weasels, and shrews are just a few of the mammals that eat large numbers of small rodents. These animals are patient and skillful hunters. They crouch motionless near an area that is inhabited by rodents and wait for the prey to come close enough to catch. Weasels and shrews go into the burrows of small rodents to pursue and kill their prey. Most predators have keen hearing and sharp eyesight, along with a highly developed sense of smell. They usually know where a rodent is because they can smell it and hear it as it moves about. Once the prey is seen, the hunter carefully chooses the moment when it will strike.

KEY INTERNET SEARCH WORDS

meadow jumping mouse

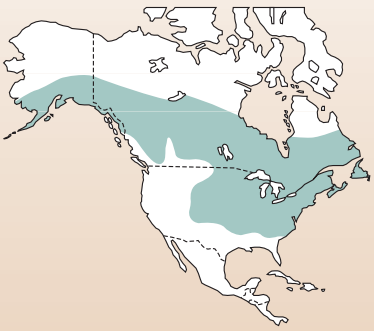


Figure 6–9 Distribution map of the meadow jumping mouse.

MAMMAL PROFILE

Meadow Jumping Mouse *(Zapus hudsonius)*

The meadow jumping mouse is light brown in color with long hind legs and tail. It measures from 7.5 inches to 9 inches long including its nose and tail, yet it usually weighs less than an ounce, see Figure 6–8. It is sometimes called a kangaroo mouse because it hops about on its long hind legs like a tiny kangaroo. When it is frightened, it can take leaps of up to 8 feet at a time. The ability to jump so far and fast makes this mouse difficult for predators to catch. Meadow jumping mice are **nocturnal**, which means that they prefer to sleep in the day and move about at night. They feed mostly on seeds and insects. Most days are spent sleeping in grass nests located in underground burrows. Three to six young are usually born in June, with a second brood born in September. Their range extends from Alaska to the east coast of the United States, see Figure 6–9.

Meadow jumping mice **hibernate** during the winter. While hibernation is referred to as sleeping, it is different from sleep because the animals' body processes slow down, and they use the energy stored in body fat as their only source of nutrition. By late fall, animals that hibernate must store enough body fat to nourish them through the winter. When it gets cold, they enter deep burrows well below the frost line where they hibernate until spring.

Figure 6–8 The meadow jumping mouse has long hind legs that enable it to take great leaps to escape predators. *Courtesy Shutterstock.*

Snakes and other kinds of reptiles use small rodents as sources of food, see Figure 6–10. Mice and rats are never safe when a snake is hunting for a meal. Snakes can go anywhere that small rodents can go, and they frequently do their hunting inside the dens of mice and rats.

Some snakes paralyze rodents with their poisonous venom before swallowing them whole. Some nonpoisonous snakes kill or stun small rodents by biting them. Other kinds of snakes coil around their prey and squeeze it to death before eating it. Snakes are not able to tear their prey into small pieces, so they always eat it whole. This is possible because they have hinged jaws that separate to allow large meals to pass through.

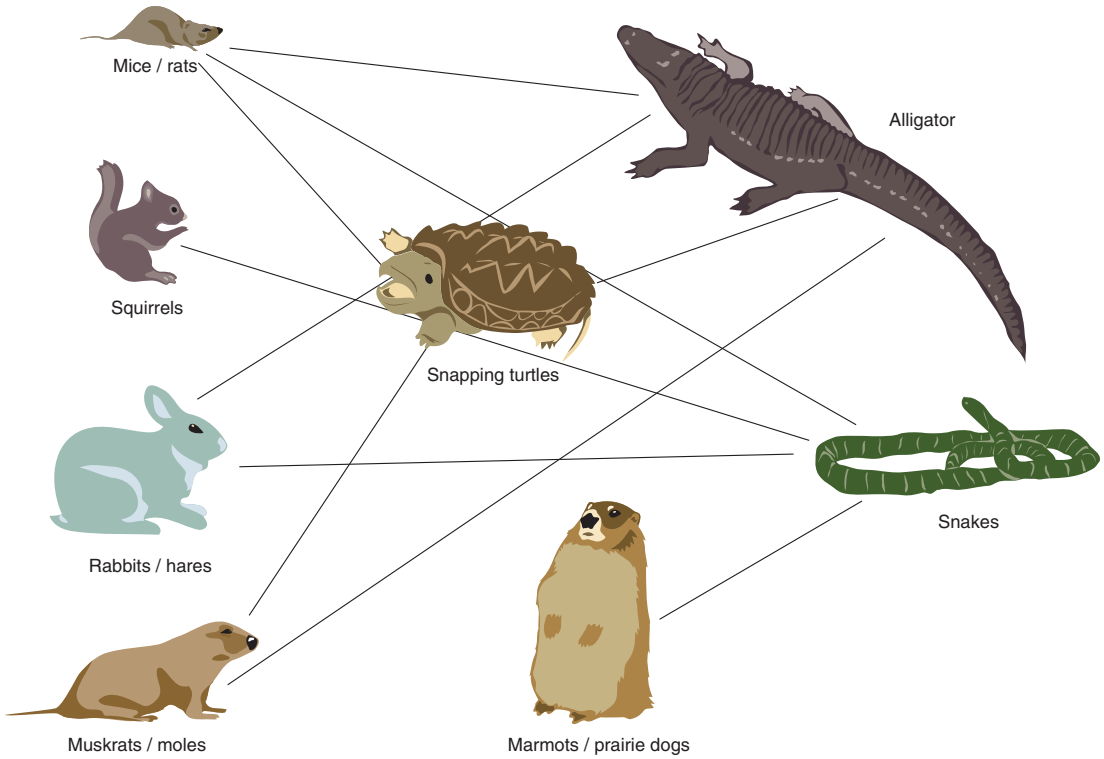


Figure 6–10 The relationship between small gnawing mammals and reptiles is that of prey to predator.

KEY INTERNET SEARCH WORDS

pine vole

Figure 6–11 Distribution map of the pine vole.

MAMMAL PROFILE

Pine Vole *(Pitymys pinetorum)*

As the name suggests, the pine vole lives in the woods, see Figures 6–11 and 6–12. This vole digs shallow tunnels beneath the leaves on the forest floor, and it spends most of its time underground. It is small and brown, with a stubby tail. It measures from 4 to nearly 6 inches in length and weighs from 1 to 1.5 ounces. It ranges in the eastern third of the United States.

The pine vole eats seeds, berries, roots, and tubers, and it stores food in underground larders. Several pine voles are often found living together. They emit warning calls when danger is near.

Pine voles are born in small litters of two to four young. Because they spend most of their time in underground tunnels, they have few enemies in comparison with other small rodents. They do not reproduce nearly as rapidly as house mice and field voles. Shrews and snakes sometimes venture into their tunnels, and other predators might occasionally dig up their burrows, but pine voles are usually relatively safe from their enemies.

Figure 6–12 A pine vole.

Bears are the largest of the predatory animals that prey upon mice, voles, rats, and lemmings. Although a rodent doesn't make a very big meal for a bear, it is not uncommon for a bear to dig up a large area in an attempt to catch one of these small animals.

KEY INTERNET SEARCH WORDS

Norway rat

MAMMAL PROFILE

Norway Rat *(Rattus norvegicus)*

The Norway rat is not native to North America—it arrived here on ships from Europe, see Figure 6–13. It is a hardy rodent that adapts well to many different environments, and its range extends to most regions of North America. This rat is brown in color, with a long, hairless tail. It weighs 0.5–1.5 pounds and measures 13–18 inches long from its nose to the tip of its tail. It is attracted to garbage dumps and sewers and usually lives near humans.

Norway rats will eat almost anything that can be chewed. A single rat can eat up to 50 pounds of grain in a year, and they ruin even more grain than they eat by polluting it with their urine and droppings. They are also predators that kill and eat small birds and animals of many kinds.

The gnawing habits of rats cause damage to many materials in their habitats. Much of the food supply for humans and domestic animals is damaged by rats when storage facilities are poor. Rats also can transmit diseases to humans and animals, including bubonic plague and typhus.

Norway rats live in colonies anywhere that they can find shelter and food. They reproduce at a rapid rate. Litters usually average eight or nine young; however, litters as large as 20 have been observed. Rats have many enemies including cats, dogs, snakes, birds of prey, and humans, but their high reproductive capacity helps compensate for losses to predators.

Figure 6–13 A Norway rat. *Courtesy Terry Whittaker. Photo Researchers, Inc.*

Owls depend almost entirely on mice, rats, voles, squirrels, and rabbits for food. They hunt primarily at night when many small rodents are the most active. The eyes of an owl are adapted to night vision, and they have excellent hearing. Once a meal has been located, the owl swoops silently down on its unsuspecting victim and carries it away.

KEY INTERNET SEARCH WORDS

white-throated woodrat

Figure 6–15 Distribution map of the white-throated woodrat.

MAMMAL PROFILE

White-Throated Woodrat *(Neotoma albigula)*

The white-throated woodrat is a vole. It is unusual in that it builds a house of spines. Using cactus spines, it builds large clumps of debris in which it lives protected from most of its enemies except for snakes. Outside of their homes, however, woodrats are still vulnerable to other predators. They are nocturnal, spending their nights looking for seeds, berries, and succulent plants to eat. The woodrat obtains moisture from plants and seldom drinks water.

Some woodrats build homes in trees or live in caves. All of these woodrats have the strange habit of collecting things. It may take a spoon or other interesting item, and leave a small rock or other object in its place. For this reason, woodrats are sometimes called "pack rats" or "trade rats."

Woodrats live solitary lives except during the mating season. The male leaves before the female has her young. Two or three litters of young are born each year. At about 2 months of age, the female forces the young out of the nest, and they begin life on their own.

White-throated woodrats are brown in color with white throats and feet, see Figure 6–14. They have hair-covered tails and range from 13 to 16 inches in length. They weigh between 6 and 8 ounces, and their range extends through the desert region in the southwestern United States and northern Mexico, see Figure 6–15.

Figure 6–14 A white-throated woodrat. *Courtesy Gerald C. Kelley. Photo Researchers, Inc.*

A **vole** is a small rodent with a stout body and short tail; it is often confused with a mouse or a rat. It is different from mice and rats due to its blunt face, small eyes, large ears, and hairy tail. The most common voles in North America are the meadow vole, the field mouse, and the muskrat.

KEY INTERNET SEARCH WORDS

meadow vole

Figure 6–16 Distribution map of the meadow vole.

MAMMAL PROFILE

Meadow vole *(Microtus pennsylvanicus)*

A meadow vole is frequently called a field mouse. It is a small brown rodent that ranges in length from 5 to 8 inches from nose to tail and weighs from 1 to 2.5 ounces. It has a stocky body and a short tail, and it is constantly on the move looking for food. It eats its own body weight in seeds, berries, and roots every 24 hours.

Meadow voles thrive in many locations; however, they do best in meadows and grasslands. Their range extends across Alaska, Canada, and the northern United States, see Figure 6–16. They construct networks of burrows and trails for protection from the many predators that feed on them. Nearly every kind of predator feeds on meadow voles. Its enemies include birds of prey, weasels, coyotes, foxes, skunks, bobcats, and fish.

Five to nine offspring are born in each litter, and females are capable of producing up to seventeen litters each year. By the time a vole is 3 weeks of age, it is living on its own, and its mother is busy raising another litter. Huge numbers of meadow voles may live in a favorable area. Large populations can destroy large acreages of crops. They are especially destructive to fruit orchards. Meadow voles damage and sometimes kill trees by gnawing through the bark all the way around the tree trunks.

The muskrat is a large vole that is sometimes called a marsh rabbit. It lives in marshes and streams, and spends much of its time in the water. It builds a house of reeds and grass in shallow water that it enters beneath the surface of the water. It also digs burrows in stream banks, sometimes with entrances located beneath the water level.

The muskrat is one of the most important furbearing animals in North America. Several million pelts are harvested each year, and the meat of the muskrat is considered a delicacy by some people. The muskrat has been exported to several European countries where it now thrives in the wild.

KEY INTERNET SEARCH WORDS

muskrat

Figure 6–18 Distribution map of the muskrat.

MAMMAL PROFILE

Muskrat *(Ondatra zibethica)*

Figure 6–17 The muskrat. *Courtesy U.S. Fish and Wildlife Service. Photo by Dave Menke.*

A muskrat can grow as large as 24 inches from nose to tail, at maturity. It is a nocturnal animal that inhabits many of the freshwater biomes of North America, see Figure 6–17. It is active throughout the year and does not hibernate. It has two scent glands located near the tail from which it gets its name and from which it obtains a musky oil to waterproof its fur. It has a flat hairless tail that it uses as a rudder while it swims. Its range extends through much of the United States and Canada, see Figure 6–18.

Three or four litters are born each year in the northern regions; in the southern areas, mating continues throughout the year. Each litter consists of seven or eight offspring. Young muskrats begin to swim when they are about 3 weeks old. They seldom live to be more than 4 years of age. The most successful predators of muskrats are eagles, otters, and mink. Large numbers of muskrats have been trapped for their pelts since the early North American fur traders discovered them in great abundance.

Figure 6–19 A brown lemming. *Courtesy Tom McHugh. Photo Researchers, Inc.*

A lemming migration is a spectacular and unusual event. In much the same way that bees swarm from the hive when they become too numerous for the colony, entire populations of lemmings sometimes leave their tunnels and move overland. Millions of these small rodents advance across the land during a migration, like a forage-devouring tidal wave, see Figure 6–19. They eat every plant they come to. Most of the forage is eaten by the migrating lemmings, and the caribou sometimes begin to eat the lemmings that have been crushed beneath their feet.

Prior to the migration, the predator population increases along with the lemming population. As the migration begins, there is such an abundance of food for predators that even the fish eat small lemmings as they swim across streams.

In the end, the migrating lemmings die. Many are killed by predators. Others die from disease that has become more common as the lemming population has grown too large. Some die from exhaustion, and many drown in rivers and lakes. In coastal areas, large groups of lemmings have been observed swimming in the ocean until they drown.

When the lemmings are gone, the predators die too, but enough lemmings always survive to replenish the population. Eventually, the whole cycle is repeated.

KEY INTERNET SEARCH WORDS

brown lemming

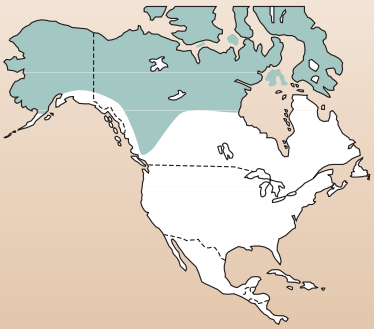


Figure 6–20 Distribution map of the brown lemming.

MAMMAL PROFILE

Brown Lemming *(Lemmus trimucronatus)*

The brown lemming is a small rodent that lives in the tundra regions of Alaska and Canada, see Figures 6–19 and 6–20. It has long brown fur and a stubby tail, and it lives in colonies, much as prairie dogs do. Brown lemmings are 5–6.5 inches long and weigh 1.5–4 ounces. Lemmings live in tunnels connected by runways. They eat a variety of grasses, sedges, and mosses, and they store a supply of harvested forage underground for winter use. They prefer lowland areas where snow cover insulates the colonies during the cold winters.

Between April and September, a new litter of 3–11 young is born to a mature female each month. They are born in grass nests shaped like a ball and lined with soft materials like feathers, moss, or hair. Such high biotic potential results in a huge population of lemmings in years when the environment is favorable to their survival.

SQUIRRELS

Squirrels are broadly divided into two groups. Tree squirrels spend much of their time in trees, and they are usually more appreciated than ground squirrels by their human neighbors, see Figure 6–21. The ground squirrels live in burrows in the ground and are generally considered to be pests, see Figure 6–22.

Figure 6–21 There are several species of tree squirrels found in many different environments.

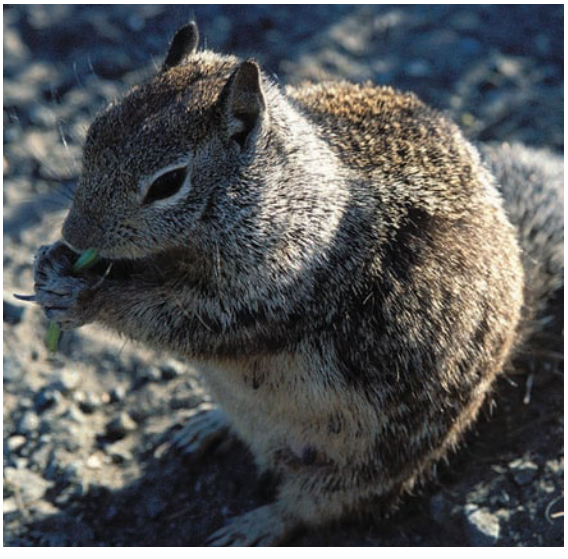


Figure 6–22 Ground squirrels consist of several common squirrel species and chipmunks of several species.

KEY INTERNET SEARCH WORDS

Douglas squirrel, chickaree

Figure 6–24 Distribution map of the Douglas squirrel.

MAMMAL PROFILE

Douglas Squirrel *(Tamiasciurus douglasii)*

The Douglas squirrel is also known as the chickaree. It makes its home in pine forests and ranges from British Columbia to California, see Figures 6–23 and 6–24. It spends much of its time in the treetops, clipping pine cones loose from the trees and coming down to the forest floor to gather its harvest and cache the cones in safe places for winter use. In addition to pine seeds, this squirrel eats mushrooms, nuts, and fruits.

Douglas squirrels are brown with rust-colored belly, legs, and feet, and they have long furry tails fringed with yellow. They chatter vigorously as they scold any creature that invades their territory. Foxes, coyotes, fishers, and martens are primary predators of the Douglas squirrel.

Females give birth to a single litter of three to seven young in the spring and summer. They are born in a hollow tree, a burrow, or in a tree nest made of twigs. Adult squirrels of this species range from 12 to 14 inches long and weigh between 5 and 11 ounces.

Figure 6–23 The Douglas squirrel. *Courtesy Tom Brakefield. Getty Images.*

Tree squirrels live in forested areas and depend on trees for both food and shelter. They are excellent climbers, and they move swiftly from branch to branch with ease. Their homes in the trees provide protection from many of the predators that kill and eat ground squirrels. Tree squirrels tend to have smaller litters of young than ground squirrels; however, they sometimes have more than a single litter in a year. The late litters are able to survive because tree squirrels stay awake through the winter, and they eat food that they have gathered and stored away during the summer.

KEY INTERNET SEARCH WORDS

eastern gray squirrel

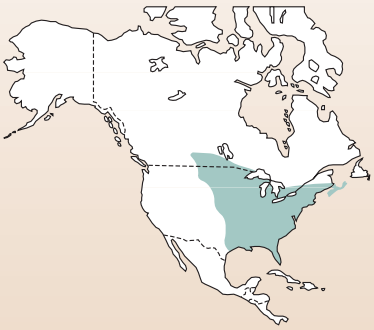


Figure 6–25 Distribution map of the eastern gray squirrel.

MAMMAL PROFILE

Eastern Gray Squirrel *(Sciurus carolinensis)*

The eastern gray squirrel is a native of the hardwood forests located in the eastern United States, see Figure 6–25. Its numbers declined under extreme hunting pressure and in response to the loss of habitat as the hardwood forest that once covered much of the eastern part of the continent was cleared away, making room for farms and towns.

The passage of game laws to protect this squirrel has helped the population to recover. Many areas of the eastern United States are forested once again after being extensively cleared for agricultural use.

One or two litters, each consisting of five or six young, are born to mature females in the spring and summer months each year. The squirrels are born in treetop nests of twigs, where they remain until they are about 6 weeks of age.

The main diet of the eastern gray squirrel is hickory nuts and acorns. These squirrels stay busy during much of the summer gathering and hoarding a winter supply of food. They are between 16 and 21 inches in length and weigh from 1 to 1.5 pounds; western gray squirrels are a little bigger. The gray squirrels have long tails completely covered with hair. Despite their names, they are actually black or black and tan in color with white tips on the fur, see Figure 6–26.

Figure 6–26 The eastern gray squirrel. *Courtesy E. R. Degginger. Photo Researchers, Inc.*

Some of the larger species of tree squirrels are classed as game animals. Fish and game agencies in different states and provinces set the hunting seasons and bag limits based on population numbers of the squirrels and the **carrying capacity** of the habitat. Carrying capacity is the largest population that the resources of an environment, habitat, or ecosystem can support without being damaged. It is based on the amount of food and shelter that is available for the animals that depend on a particular habitat. Because hunters are the most effective predators that tree squirrels face, protection from hunting during critical survival periods has enabled these squirrel populations to increase. Regular seasons are established for hunting squirrels in many areas.

INTERNET ADDRESS

http://www.nsrl.ttu.edu/tmot1/sciunige.htm

KEY INTERNET SEARCH WORDS

eastern fox squirrel

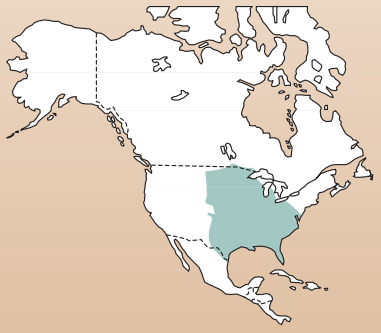


Figure 6–27 Distribution map of the fox squirrel.

MAMMAL PROFILE

Eastern Fox Squirrel *(Sciurus niger)*

The fox squirrel is the largest squirrel in North America. An adult measures from 19 to 28 inches long and weighs from 1.5 to 3 pounds. These squirrels are slow compared to their smaller cousins, and they spend a lot of time on the forest floor gathering and hiding their stores of nuts for the winter.

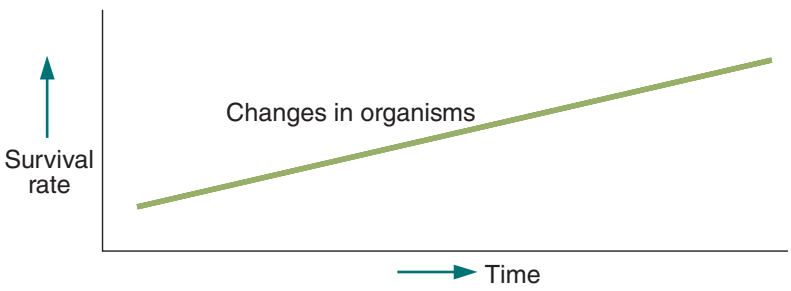
Figure 6–28 The fox squirrel. *Courtesy U.S. Fish and Wildlife Service. Photo by Jon Nickles.*

This squirrel lives in hardwood forests and cypress swamps in the eastern United States, with the exception of New England, see Figure 6–27. In addition to nuts, it also eats fruits, corn, roots, and insects. It even taps maple trees and laps up the sweet sap that oozes from the damaged area.

Two to four young are born in the early spring, and they sometimes live as long as 6 years. Bobcats and foxes are their natural predators, but they also are hunted by humans as game animals. They range in color from rusty yellow to black with white ears and nose, see Figure 6–28.

Evolution is a natural process in which the genetic makeup of a population of organisms changes in response to changes in the environment. Physical changes become evident in organisms over a long period of time, usually several generations, see Figure 6–29. These physical changes help the organism survive in its modified environment. An example of an evolving species is found in the region of the Grand Canyon. A single species of squirrel whose population was divided long ago by the Colorado River has developed into two similar, but distinctly different, subspecies.

Figure 6–29 Physical changes in an organism become apparent over time. These changes can help an organism survive in a changing environment.



KEY INTERNET SEARCH WORDS

tassel-eared squirrel

kaibab, abert

Figure 6–30 Distribution map of the tassel-eared squirrel.

MAMMAL PROFILE

Tassel-Eared Squirrels (*Sciurus aberti* and *Sciurus Kaibabensis*)

The tassel-eared squirrels are found on the north and south rims of the Grand Canyon, see Figure 6–30. Separated by the Colorado River and isolated by the desert, these squirrels have evolved into two distinctly different species. The Abert squirrel is found on the canyon's southern rim but ranges into Colorado and New Mexico. It has white undermarkings and a gray-topped tail. The Kaibab squirrel lives on the northern rim of the Grand Canyon, see Figure 6–31. It has a black chest and a snowy tail.

Figure 6–31 The Kaibab squirrel. *Courtesy Thomas & Pat Leeson. Photo Researchers, Inc.*

Both squirrels are gray with chestnut-colored markings over the tops of their backs. During the winter, they grow long tufts of hair from their ears. They share the same diet consisting of acorns, pine seeds, roots, mushrooms, and young birds. Unlike most other tree squirrels, they do not store winter food. During the winter, they sometimes eat the bark from pine twigs.

These squirrels prefer mountain slopes and forested areas covered with aspen, fir, and yellow pine trees. Their range extends into parts of Arizona, New Mexico, Colorado, and Utah. Three or four young are born during the summer months. As adults, they measure 19–21 inches in length and weigh 1.5–2 pounds. They are preyed upon by hawks and a variety of other predators.

Squirrels are generally considered to be primary consumers of plant materials. While this is true most of the time, they become predators when the opportunity presents itself. Some species prey heavily on bird eggs and young birds during the nesting season. Ground squirrels are known to eat the carcasses of other squirrels that have been killed on roads and highways.

KEY INTERNET SEARCH WORDS

red squirrel

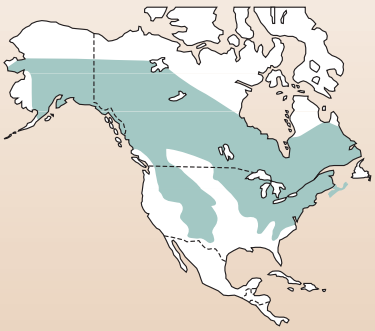


Figure 6–33 Distribution map of the red squirrel.

MAMMAL PROFILE

Red Squirrel (*Tamiasciurus hudsonicus*)

Figure 6–32 The red squirrel.

The red squirrel is easily recognized by its distinctive red color and light-colored belly and throat, see Figure 6–32. Its range includes parts of Alaska, Canada, to the Appalachian Mountains, and the southern Rocky Mountains, see Figure 6–33. This squirrel's home is in the forest. It eats a variety of foods, including acorns, spruce and pine nuts, and wild mushrooms. During the spring, it also eats bird eggs and young birds.

Red squirrels are at home in hollow trees as well as in twig nests anchored in the tree branches. Sometimes they even live beneath the roots of trees in underground burrows. Like most other tree squirrels, the red squirrel gathers and stores a supply of food for winter use. It defends up to one-half acre of forest territory and becomes cross when any creature ventures into the area. It will chatter and scold all trespassers until they leave.

A litter consisting of four or five offspring is born in the spring or early summer, and a second litter is sometimes born in September. The young squirrels learn to climb even before they are weaned, and they are soon moving about in the trees. Mature red squirrels measure from 11 to 14 inches long and weigh from 5 to 11 ounces.

Ground squirrels tend to have large litters in the spring. Large litters are necessary because the ground squirrel is prey to many different predators, some of which enter right into the underground dens of squirrels to pursue their meals. Most ground squirrels hibernate during the winter months, and they depend on their fat reserves for nutrition during this time. If ground squirrels were born late in the season, they would have a hard time accumulating enough fat reserves to survive through the following winter.

INTERNET ADDRESS

http://www.npwrc.usgs.gov/resource/distr/mammals/mammals/richard.htm

KEY INTERNET SEARCH WORDS

Richardson's ground squirrel

Figure 6–34 Distribution map of Richardson's ground squirrel.

MAMMAL PROFILE

Richardson's Ground Squirrel (*Spermophilus richardsonii*)

The Richardson's ground squirrel is one of twenty-seven species of ground squirrels recognized in North America. It is brownish gray in color with short legs and a short, white-edged tail. It is between 10 and 14 inches long and usually weighs 11–18 ounces. The Richardson's ground squirrel lives in long underground tunnels. It eats seeds and other plant materials and is especially fond of grains. This has led to efforts by property owners in some areas to reduce the population of this rodent. Its range extends through inland areas of northwestern United States and southwestern Canada. Its preferred habitat is grassland and sagebrush areas that are near water, see Figure 6–34.

Figure 6–35 Richardson's ground squirrel. *Courtesy Jim Zipp. Photo Researchers, Inc.*

This squirrel is curious and stands erect beside its hole to keep watch on intruders. When it becomes alarmed, it whistles a warning and dives into its hole. Soon it comes back out to take another look, and a patient predator like a coyote or fox simply waits for the squirrel to come back out of its hole, see Figure 6–35. Most predatory birds, snakes, and mammals are enemies of the ground squirrel.

Litters of 6–11 young are born to adult females in late spring. They are born underground in nests lined with grass and other soft materials. During the heat of middle to late summer, mature squirrels begin to estivate or sleep in their burrows until the temperature declines during the fall season. The young squirrels continue to eat and grow until early fall, after which they hibernate until spring.

MAMMAL PROFILE

Thirteen-Lined Ground Squirrel (*Spermophilus tridecemlineatus*)

Figure 6–36 Thirteen-lined ground squirrel. *Courtesy Purestock.*

Figure 6–37 Distribution map of the thirteen-lined ground squirrel.

The thirteen-lined ground squirrel gets its name from the 13 distinct white stripes that run the length of its body. It is a grassland squirrel native to the Great Plains region, see Figures 6–36 and 6–37. Its diet is varied, consisting of seeds, green shoots, vegetables, fruits, roots, flowers, grains, wireworms, cutworms, insect eggs, grasshoppers, beetles, caterpillars, small birds, earthworms, and even the flesh of other squirrels. They gather and cache large amounts of seeds and grass, which are eaten during times when food is scarce.

These squirrels hibernate in early fall continuing until late March to early May. They mate soon after they emerge from hibernation, and a single litter averaging ten young is born four weeks later. When a large population of these squirrels is found in the same general area, crops and fields are often damaged by their foraging activities.

KEY INTERNET SEARCH WORDS

California ground squirrel

MAMMAL PROFILE

California Ground Squirrel (*Spermophilus beecheyi*)

Figure 6–38 The California ground squirrel. *Courtesy U.S. Fish and Wildlife Service. Photo by Gary R. Zahm.*

Figure 6–39 Distribution map of the California ground squirrel.

The California ground squirrel looks very much like a tree squirrel with its large, curved, and bushy tail, see Figure 6–38. It is mottled brown in color and lives in long underground tunnels. These squirrels live in colonies much like marmots do. They prefer to live in grain fields, meadows, or orchards, where their feeding and tunneling activities often cause severe damage to crops and irrigation ditches. They eat green vegetation, seeds, fruit, berries, eggs, birds, and insects. The range of this species extends inland along the coastal region from Mexico to Washington State, see Figure 6–39. This squirrel is usually 16–20 inches long and weighs 1–1.5 pounds. Between 4 and 11 young are born in the spring of the year. The enemies of this squirrel include most predatory mammals, birds, and humans.

Chipmunks are small ground squirrels that are found in many regions of North America. There are numerous species of these little rodents living in a variety of different environments. They eat insects and seeds, and they gather supplies of food that are eaten when they awaken during the winter. They are recognized by the alternating light- and dark-colored stripes on their backs and by their frisky behavior.

INTERNET ADDRESS

http://www.borealforest.org/zoo/chipmunk.htm

KEY INTERNET SEARCH WORDS

least chipmunk

Figure 6–41 Distribution map of the Least chipmunk.

MAMMAL PROFILE

Least Chipmunk *(Eutamias minimus)*

There are 16 different species of western chipmunks in this genus, see Figure 6–40. They are 6½–9 inches in length from head to tail and weigh 1–2 ounces. The range of these small ground squirrels extends from Alaska to Mexico and from the West coast to the Great Lakes region. It occupies a variety of habitats from sagebrush deserts to mountain coniferous forests and northern hardwood forests, see Figure 6–41.

Figure 6–40 Least chipmunk. *Courtesy Gerald C. Kelley. Photo Researchers, Inc.*

Four or five young are born in the spring. By the fall, these chipmunks have constructed burrows of their own. They spend the summer and early fall seasons gathering supplies of seeds for winter food. Their diets consist of seeds, fruits, nuts, meat, and insects.

MARMOTS AND PRAIRIE DOGS

Several species of closely related rodents fall into this group of animals. They occupy terrain from flatlands and prairies to rolling hills and high alpine meadows, see Figure 6–42. They are burrowing animals that build underground dens lined with dry grass. Marmots and prairie dogs are vegetarians that eat a wide variety of plants. They gorge all summer long, and by fall, they are fat and pudgy; this body fat sustains them through their long winter hibernation.

Figure 6–42 A prairie dog community. *Courtesy U.S. Fish and Wildlife Service. Photo by G. R. Zahm.*

KEY INTERNET SEARCH WORDS

woodchuck

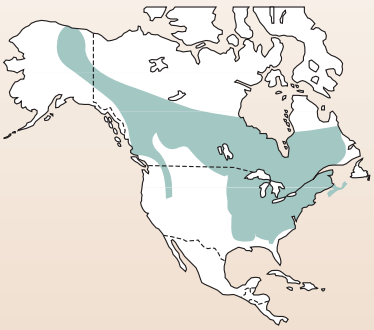


Figure 6–44 Distribution map of the woodchuck.

MAMMAL PROFILE

Woodchuck *(Marmota monax)*

The woodchuck is probably the only rodent for which a holiday has been declared. The woodchuck is also called a groundhog, and it is rumored that if a groundhog sees its shadow on the second day of February, it will go back into hibernation for six more weeks of winter. This forecast is seldom reliable, and the woodchuck probably does not even wake up that early in the year, but most people know the woodchuck because of this tradition.

The woodchuck is 20–27 inches long from head to tail. It weighs 5–10 pounds, and it is brown in color, see Figure 6–43. It eats large amounts of green plants during the spring and summer. In September, it goes into hibernation and sleeps until springtime. The woodchuck prefers open woodlands and meadows. It can be found as far north as Alaska and Northern Canada and as far South as Georgia and Alabama, see Figure 6–44. It causes problems for farmers by eating crops, and the mounds of dirt beside its burrows can damage farm machinery.

Figure 6–43 A woodchuck. *Courtesy Scott Camazine. Photo Researchers, Inc.*

Marmots and their relatives communicate effectively by calling with a shrill whistle to warn of danger and to challenge rivals during the mating season. A marmot will chirp for as long as it can sense that danger exists. This chirping call has resulted in the names “whistler” and “whistle pig,” by which it is known in some regions of North America.

KEY INTERNET SEARCH WORDS

yellow-bellied marmot

Figure 6–46 Distribution map of the yellow-bellied marmot.

MAMMAL PROFILE

Yellow-Bellied Marmot (*Marmota flaviventris*)

The yellow-bellied marmot is also known as a rockchuck because it has a habit of building its den among the crevices of rocks, see Figure 6–45. It lives in the mountains and lines its rocky den with dried grass. Once inside the den, this animal is safe from almost any enemy. Its diet consists of grasses and other vegetation located close to its den.

Much of the life of this marmot is spent sleeping. When the weather gets hot, it takes a long nap. This habit is called **estivation.** Early in the fall, it begins a long hibernation period that lasts until spring. As many as eight young are born in May.

Rockchucks range from 19 to 28 inches in length, and they usually weigh between 4 and 12 pounds. They are usually yellowish brown or black in color with a dark face having a band of white across it. Its range extends from Canada to California in the mountains of the western United States, see Figure 6–46.

Figure 6–45 The yellow-bellied marmot or rockchuck prefers to build a den in crevices located in rocky environments. *Courtesy U.S. Fish and Wildlife. Photo by James C. Leupold.*ç

Most marmots have the unusual habit of biting off green vegetation and laying it out in the sun to dry. In this manner they harvest hay that is used as bedding and as an emergency supply of food when they awaken before spring.

Marmots often live in areas where water is scarce, and most of the food that they eat consists of fresh plants. They are able to obtain enough water from the plants to satisfy most of their needs for water.

INTERNET ADDRESS

http://www.nhptv.org/natureworks/hoarymarmot.htm

KEY INTERNET SEARCH WORDS

hoary marmot

Figure 6–47 Distribution map of the hoary marmot.

MAMMAL PROFILE

Hoary Marmot *(Marmota caligata)*

The hoary marmot lives high in the mountains among cliffs and rock outcroppings, see Figure 6–47. It is the largest of the marmots found in North America and can weigh as much as 15 pounds. Its range extends from the northwestern United States to Alaska. Its fur is dark gray with white tips on the hair, which matches the color of the rocks on which it suns itself between meals, see Figure 6–48. Most predators that inhabit the high mountain ranges will attempt to prey upon the hoary marmot, but the one most likely to succeed is the eagle. The marmot's home among the boulders and cliffs usually provides protection from most other predators. It feeds on a variety of plants that grow at high altitudes. Up to five young are born in the spring, and they normally stay with their mother until the following spring.

Figure 6–48 A hoary marmot. *Courtesy U.S. Fish and Wildlife Service. Photo by Steve Moore.*

Prairie dogs are closely related to marmots, and many of the behaviors of these animals are similar. They belong to the same family (sciuridae) as the marmots, ground squirrels, chipmunks, and tree squirrels. There are five species of prairie dogs in North America: black-tailed, white-tailed, Gunnison's, Mexican, and Utah prairie dogs. The two best known species are the black-tailed and white-tailed prairie dogs.

The tail of a prairie dog is covered with hair. These animals are active during the day, and many of them store food during the summer for later use. Their diets consist of plants, mostly grasses and other vegetation, along with insects such as grasshoppers. They function in the food chain as herbivores or food animals, converting plant materials to a suitable form of food to nourish predatory animals.

INTERNET ADDRESS

http://www.nsrl.ttu.edu/tmot1/cynoludo.htm

KEY INTERNET SEARCH WORDS

black-tailed prairie dog

Figure 6–50 A white-tailed prairie dog.

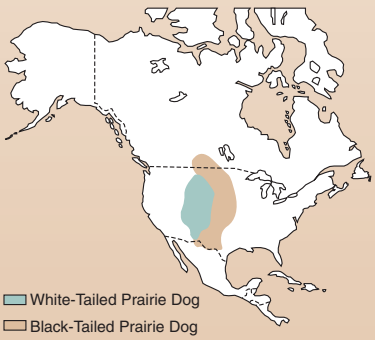


Figure 6–51 Distribution map of the black-tailed and white-tailed prairie dog.

MAMMAL PROFILE

Black-Tailed Prairie Dog *(Cynomys ludovicianus)* and White-Tailed Prairie Dog *(Cynomys leucurus)*

Figure 6–49 A black-tailed prairie dog. *Courtesy U.S. Fish and Wildlife Service. Photo by Gary M. Stolz.*

Two kinds of prairie dogs are common to North America, see Figures 6–49 and 6–50. The black-tailed prairie dog is yellowish brown in color with a black-tipped tail. It is a plains dweller that builds dikes around the entrance to its burrow to prevent flooding from heavy rains. Its range extends in a narrow band from Texas to Canada. The members of this species live in closely-knit social groups. They are 14–17 inches long from nose to tail and weigh 2–3 pounds. They greet and groom one another and generally graze peacefully together. They remain active throughout the year. Young are born in litters of 3–5 in March and April.

White-tailed prairie dogs live at high elevations in upland meadows where natural slopes eliminate flood danger, see Figure 6–51. These prairie dogs do not build dikes around the burrow entrances. They also demonstrate fewer social behaviors within their colonies than their black-tailed relatives. They are 12–14.5 inches in length from head to tail and weigh 1.5–2.5 pounds. They are yellowish brown in color with white-tipped tails. They hibernate during the winter months. Litters of five or six young are born after the weather warms in early May. Their range extends from Montana to Arizona and New Mexico in the Rocky Mountain Range.

Prairie dogs sound alarms each time a member of the colony spots something that might be dangerous. Their worst enemies are rattlesnakes and ferrets that enter the burrows, and badgers that dig them out of their burrows. They also are eaten by birds of prey, coyotes, and other predators.

RABBITS, HARES, AND PIKAS

Not all of the gnawing mammals are true rodents. Rabbits and hares have many similar characteristics with rodents, and they were once classed as rodents because of their large incisor teeth that are so well adapted to gnawing. Further study revealed that this group of animals is different from the rodents because they have a second set of upper incisor teeth behind the front set of teeth, see Figure 6–52. The **pika** has this same tooth arrangement, and it is classified in the same order (Lagomorpha) with rabbits and hares.

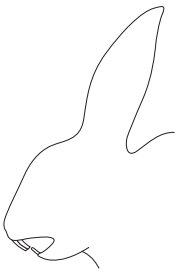


Figure 6–52 Rabbits, hares, and pikas have a second set of upper incisor teeth behind the front set.

Distinct differences exist between rabbits, hares, and pikas. Hares have longer hind legs and longer, wider ears than rabbits. Their offspring are born with a full coat of fur, and their eyes are open at birth. Young rabbits are born without any hair and their eyes are closed for several days; they are completely helpless at birth. Pikas have short legs, ears, and no visible tail. Rabbits, hares, and pikas are found in many different environments.

KEY INTERNET SEARCH WORDS

eastern cottontail

mountain cottontail

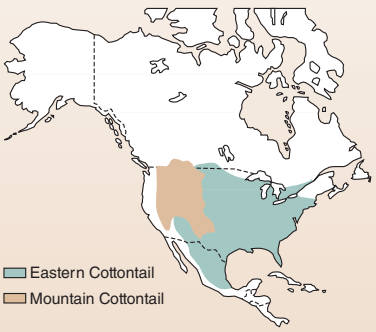


Figure 6–53 Distribution map of the Eastern and Mountain cottontail.

MAMMAL PROFILE

Eastern Cottontail Rabbit *(Sylvilagus floridanus)*

There are 13 species of cottontail rabbits, see Figure 6–53. They live in many different environments in North America ranging from deserts to wooded areas. Their diets consist almost entirely of grass and other succulent vegetation, see Figure 6–54.

The Eastern cottontail rabbit has short legs and cannot run very fast. They are generally brown to gray in color, and they measure 14–17 inches in length. They hide from their enemies by sitting very still, and they prefer brushy habitats. They are a major source of food for such predators as skunks, foxes, snakes, and birds of prey. Litters consist of 4–7 young born in fur-lined nests. Females give birth to 3–4 litters per year. The diet of the cottontail consists of green vegetation in the summer, with bark and twigs making up its winter diet. The range of this rabbit extends across the eastern two-thirds of the United States and Mexico. Most states protect the cottontail and manage it as a small game animal that is hunted for sport.

Figure 6–54 A cottontail rabbit. *Courtesy U.S. Fish and Wildlife Service. Photo by James C. Leupold.*

Rabbits and hares are preyed upon by many predators, including humans. They reproduce rapidly, and even though many of them survive less than a year, a population of rabbits or hares can expand very rapidly. Females have up to five litters of offspring each year with several young in each litter. When conditions are favorable, a few rabbits can multiply into many rabbits in a relatively short period of time.

KEY INTERNET SEARCH WORDS

pygmy rabbit

Figure 6–55 Distribution map of the pygmy rabbit.

MAMMAL PROFILE

Pygmy Rabbit *(Sylvilagus idahoensis)*

This rabbit is found in the Great Basin region of the western United States, see Figure 6–55. It is a burrowing rabbit that digs a hole or burrow in which it lives. It raises 5 to 8 young that are born during the summer months. Its habitat is the desert, and it prefers to live near a clump of rabbit brush or sagebrush, which provides cover in which to hide from predators. It is a small, brownish-gray rabbit that usually measures 8½–11 inches long and weighs no more than a pound, see Figure 6–56. The diet consists mostly of sagebrush, and it seldom moves more than 30 yards from its burrow or den. The range of this species is restricted to the northwestern United States.

Figure 6–56 Pygmy rabbit.

Most rabbits make grass nests for their young and line them with fur that is pulled from the female's sides and belly. The fur-lined nest is warm and protects the young rabbits during the early days of their lives. Newborn rabbits are blind, and they have no fur, so the warm fur-lined nest is important to their survival. Some kinds of rabbits build their nests in underground holes. Others build them in depressions on the ground. Some even make their nests on piles of reeds and grass in the middle of marshy areas.

Baby rabbits grow fur quickly, and their eyes open by 2 weeks of age; however, they remain relatively helpless until they are over a month of age.

INTERNET ADDRESS

http://animaldiversity.ummz.umich.edu/accounts/lepus/l._othus$narrative.html
http://www.nhptv.org/natureworks/arctichare.htm

KEY INTERNET SEARCH WORDS

arctic hare

MAMMAL PROFILE

Arctic Hare *(Lepus arcticus)*

The arctic hare is large, weighing between 5 and 12 pounds, see Figure 6–57. In the far north, it is white in color throughout the year and blends in well with the snow-covered ground. In southern areas, it changes color in the summer to a brownish gray. Litters as large as eight young are born in June and July with their eyes open and full coats of fur.

This hare is equipped with long coarse hair on its feet that makes it possible to move about on the surface of the snow without sinking in. In forested areas, the arctic hare sometimes eats bark and pine needles; however, it prefers the treeless tundra habitat of the arctic region where its diet consists of tundra plants, see Figure 6–58. Like other hares, it can leap high into the air as it runs. This enables it to see over brush and watch its enemies during its attempt to escape.

Figure 6–58 Distribution map of the arctic hare.

Figure 6–57 The arctic hare. *Courtesy U.S. Fish and Wildlife Service.*

Hares are faster and more mobile than rabbits, and they depend upon their speed and mobility to avoid predators. Speed is important because they tend to live in wide-open spaces where cover is not always available and where hiding from predators may be difficult. Hares have acute hearing, and they turn their ears toward the slightest sound as they are approached.

Populations of hares and rabbits tend to cycle up and down in a regular and predictable manner. After rabbit or hare populations become high, they become stressed due to inadequate food and shelter, leading to outbreaks of diseases. Diseases, such as distemper, eventually kill off many of the animals. When the hare and rabbit populations drop, the predators that depend on them for food also decline in number, see Figure 6–59.

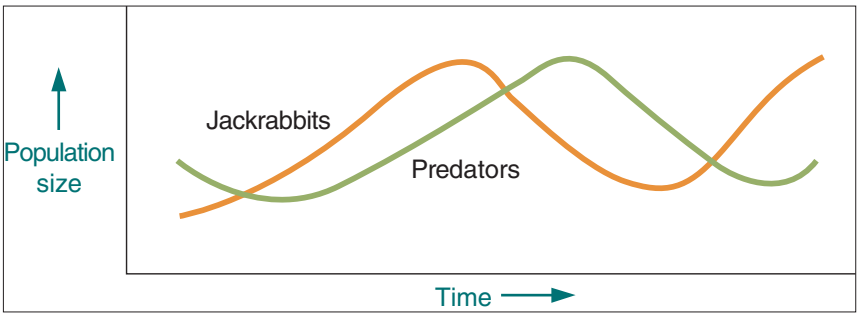


Figure 6–59 Population cycles of jackrabbits and their predators.

MAMMAL PROFILE

Snowshoe Hare *(Lepus americanus)*

Figure 6–61 Distribution map of the snowshoe hare.

The most distinguishing characteristic of a snowshoe hare is its large hind feet. They are up to six inches long, with toes that can be spread out to support the animal on snow, thus the name *snowshoe* hare. This hare is very much like the cottontail rabbit in appearance, but it is very different in other ways. It does not build a nest or dig a burrow. Instead, its young are precocial—born with their eyes open and fur on their bodies. Unlike rabbits, their hair color changes from brown in summer to white in winter, see Figure 6–60. Adults weigh 2-2.5 pounds, and they are about 17 inches long.

Hares are food animals, and they are eaten by nearly all mid-size predators. These include weasels, owls, ravens, coyotes, lynx, hawks, pine martens, and other opportunistic predators. Most of them are eaten before they are a year old, and up to half of the adults are also preyed upon each year. In order to sustain the population, females give birth to two or three litters per year averaging eight young per litter. Snowshoe hares live in dense, second-growth forests of lodgepole interspersed with fir and spruce ranging across the northern United States and Canada, see Figure 6–61.

Figure 6–60 Snowshoe hare. *Courtesy Tom Brakefield. Getty Images.*

KEY INTERNET SEARCH WORDS

black-tailed jackrabbit

Figure 6–63 Distribution of the black-tailed jackrabbit.

MAMMAL PROFILE

Black-Tailed Jackrabbit *(Lepus californicus)*

Western settlers shortened the name of this well known hare to jackrabbit, see Figure 6–62. It is well adapted to life in the desert and plains, see Figure 6–63, and its gray coat blends in with the environment in which it lives. Litters of one to six young are born every three or four months. The young are called *leverets*, and they are born with fur-covered bodies and eyes open. They are able to move about almost from the moment of birth.

The acute hearing of the jackrabbit helps in detecting the movements of its enemies long before they are seen. It runs at speeds up to 36 miles per hour and is able to evade many of its enemies with bursts of speed. Jackrabbits reproduce at a rapid rate, and there are wide swings in the number of animals in the population. Every few years, the population becomes too great to be supported by the resources that are found in its environment. When this happens, the jackrabbits become susceptible to diseases that drastically reduce the population.

The jackrabbit is a desert animal that eats grasses, twigs, leaves, sagebrush, and cacti. They get most of the water they require from the plants they eat and are known to eat their own droppings to extract the remaining water and nutrients from them.

Figure 6–62 A jackrabbit. *Courtesy U.S. Fish and Wildlife Service.*

Rabbits and hares occupy most of the North American ecosystems. They are found in evergreen and hardwood forests, plains, deserts, tundra, and marshes. In all of these regions, they are important food animals for many kinds of carnivores.

INTERNET ADDRESS

http://www.nature.ca/notebooks/english/pika.htm

Figure 6–65 Distribution map of the pika.

MAMMAL PROFILE

Pika (*Ochotona princeps*)

Figure 6–64 A pika. *Courtesy Craig K. Lorenz. Photo Researchers, Inc.*

The pika is a small animal weighing between 4 and 6 ounces. It has short legs, ears, and a tail and resembles a guinea pig more than its own relatives, the rabbits and hares, see Figure 6–64. It has two sets of upper incisor teeth, however, and it is this characteristic that results in its classification with the rabbits and hares.

The pika lives high in the mountains in piles of rocks located near areas where grass and other forage are abundant. It harvests plant materials and stores them for winter food in much the same way as some marmots do. Its range extends through the mountain region of the western United States and Canada, see Figure 6–65. These small animals remain active throughout the winter, and they survive by eating the hay they stored during the summer. Three or four young are born in the spring, and by the time the grass is ready to harvest, they are big enough to help harvest the hay that will feed them through the next winter. The pika is preyed upon by hawks, eagles, and other animals that are lucky enough to find it outside its home in the rocks.

PORCUPINES

The porcupine is a rodent that is best known for its sharps quills, which are used to defend itself against its enemies. It cannot throw its quills, but it is capable of imbedding them into the flesh of any creature that comes close enough to be within reach of its tail. It has been reported that the mountain lion and the bobcat prey on the porcupine and that they avoid injuries from quills by flipping the animal over and attacking its unprotected throat and belly. Other predators are sometimes successful, but they frequently gain nothing except a painful muzzle filled with quills.

Porcupines cause considerable damage to trees and shrubs as they gnaw the buds and bark for food. Trees that have been gnawed on by porcupines become scarred where the bark has been removed. When the porcupine eats the bark all the way around a tree, the flow of nutrients in the tree stops, and the tree dies see Figure 6–66.

Like other rodents, a porcupine must gnaw constantly to keep its teeth worn down. The front teeth grow in length throughout its life.

Figure 6–66 Damage to a tree caused by a porcupine.

The gnawing habits of the porcupine, along with its craving for salt, have resulted in confrontations with humans. It has been known to chew on nearly anything that is salty, including boots, saddles, and tool handles.

KEY SEARCH WORD

porcupine

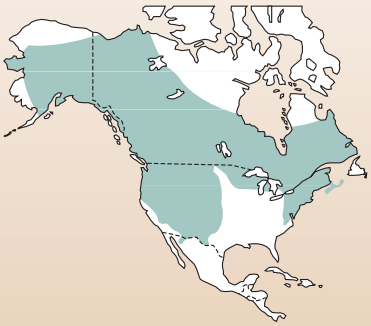


Figure 6–67 Distribution map of the porcupine.

MAMMAL PROFILE

Porcupine *(Erethizon dorsatum)*

This North American porcupine is found in the northern forests of Alaska and Canada and in coniferous forests of the northeastern and western states, see Figure 6–67. It is active throughout the year, eating tree bark when the snow is deep and feeding upon a variety of other plants when the snow has melted.

A mature porcupine may weigh as much as 25 pounds and measure up to 34 inches in length, see Figure 6–68. A single offspring is born in the spring with soft quills that soon harden. After nursing for 4–6 weeks, young porcupines begin to eat a diet of plants and the inner layer of tree bark. Porcupines are nocturnal animals that spend much of their time in thickets and trees.

Figure 6–68 A porcupine. *Courtesy Linda Freshwaters Arndt. Photo Researchers, Inc.*

GOPHERS AND BEAVERS

Pocket gophers include 272 species and subspecies that are only slightly different from one another. They spend their lives alone in underground tunnels where they eat the roots of plants and dig new tunnels. During the night, they gather grasses and other plants that are eaten or carried in their cheek-pouches to storage areas located in the underground tunnels.

They come out of their tunnels to seek a mate, but most of their time is spent digging in complete darkness. They remove the dirt from their burrows by pushing it to the surface where it is seen in mounds near the tunnel entrances. Tunneling activities get them into trouble when they burrow into ditch and canal banks causing them to leak or break. The dirt mounds also damage the blades of farm machinery when gophers take up residence in hay fields.

INTERNET ADDRESS

http://www.nsrl.ttu.edu/tmot1/geomburs.htm

KEY INTERNET SEARCH WORDS

pocket gopher

Figure 6–69 Distribution map of the pocket gopher.

MAMMAL PROFILE

Pocket Gopher *(Geomys bursarius and related species)*

The pocket gophers include several species that range across the western half of the United States extending from Canada to Mexico and Panama, see Figure 6–69. Its presence is evident from a series of earth mounds that have been pushed to the surface. They prefer habitats where the earth is soft and easy to dig in, and they spend most of their time underground. Coyotes and foxes sometimes catch gophers by waiting at the entrances to open tunnels until the gopher pushes out a load of dirt from the hole. Badgers are less patient and simply dig the gophers out.

As many as seven young are born in the spring. As soon as they are weaned, they dig burrows of their own and begin life alone. Mature gophers are 6–13 inches long and weigh up to a pound. They range in color from brown to black, with most gophers being brownish gray. Their bodies are fur covered except for a short stubby tail, and they are equipped with cheek pouches that are used to carry food, see Figure 6–70. Their diets consist of roots, tubers, and some surface vegetation.

Figure 6–70 The pocket gopher. *Courtesy Richard R. Hansen. Photo Researchers, Inc.*

KEY INTERNET SEARCH WORDS

Aplodontia rufa

Figure 6–72 Distribution map of the mountain beaver.

MAMMAL PROFILE

Mountain Beaver *(Aplodontia rufa)*

The name mountain beaver is somewhat of a misnomer because this rodent behaves much more like a pocket gopher than a beaver, see Figure 6–71. It tunnels like a gopher, and it harvests plants like a marmot or pika, carrying them to an underground storage area after they have cured in the sun. This rodent weighs 2–3 pounds, and it remains active during the winter. Its preferred habitat is in forests and thickets where soil is moist and digging is done easily. Two or three young are born in the spring, and they set off on their own soon after they are weaned. The mountain beaver has brown fur that was used for clothing by Indians. They dig with long claws, and unlike true North American beavers, they have a short, stubby tail. This animal ranges inland from the coastal regions from California to Canada, see Figure 6–72.

Figure 6–71 A mountain beaver. *Courtesy Tom McHugh. Photo Researchers, Inc.*

The true beaver (not to be confused with the mountain beaver) is the largest rodent found in North America. It lives in tunnels constructed in the banks of streams or inside lodges constructed in ponds, see Figure 6–73. It feeds on the bark of willows and other trees and constructs dams from the trees it cuts down. Using its four large incisor teeth, it fells trees. It is capable of chewing small trees into lengths that can be moved. It anchors the branches to the floor of its pond to be used as winter food and adds materials to its dams to strengthen them in preparation for winter.

Beavers are considered to be valuable animals due to their dam-building activities and manipulation of water. They can transform a small stream into a series of ponds that reduce spring flooding and erosion. The ponds also store fresh water for livestock and wildlife, and they raise the water table in the area, creating meadows. While beavers change the environment to meet their own needs, they also improve the habitat for many other wild animals and birds.

When beavers become neighbors to people, however, their instincts to cut trees and to build dams often create problems. They gnaw down trees that are valued by people, and they build dams that flood property. When this happens, the beavers are often livetrapped and moved to new locations where their dam building is appreciated.

Figure 6–73 The beaver lives in underground tunnels or in lodges that are constructed of trees and mud. *Courtesy Edward Kinsman. Photo Researchers, Inc.*

INTERNET ADDRESS

http://www.beaversww.org/beaver.html

KEY INTERNET SEARCH WORDS

Castor canadensis

Figure 6–74 A beaver. *Courtesy PhotoDisc.*

MAMMAL PROFILE

Beaver (*Castor canadensis*)

The beaver is a hard-working animal whose dam-building skills are valuable in preventing soil erosion and in storing water, see Figure 6–74. Its fur coat is waterproofed with oil secreted from two oil glands located near its tail. The beaver was trapped for its fur until it was no longer found in many of its native areas. The beaver has webbed hind feet and a long, flat tail, both of which aid in swimming. When danger approaches, beavers, slap their tails on the surface of the water as a signal to other members of the colony.

Mature beavers measure 3–4 feet in length and weigh up to 70 pounds. A litter consists of three or four young, called kits. They are born with full coats of fur and with their eyes open. They are not mature until they are about 2 years old. Their waterproof fur is reddish brown in color, and it covers the entire body except for the tail.

In addition to humans, natural enemies of the beaver include the wolverine, bear, wolf, coyote, lynx, and mountain lion. A beaver is vulnerable when it is on land or when the pond surrounding its lodge dries up. Most of the time, however, it is quite safe from predators.

LOOKING BACK

Taxonomy is the branch of science that classifies mammals and other living organisms into related groups. Mammals are warm-blooded animals with protective coats of hair and bony skeletons, and they nourish their young with milk. Gnawing mammals are identified by their large incisor teeth that grow continuously and that require constant gnawing to keep them worn down.

Rodents make up the largest group of mammals, and they are distributed in nearly every ecosystem in North America. They include all of the gnawing mammals except rabbits, hares, and pikas. Rabbits, hares, and pikas have a second set of upper incisor teeth located behind the front incisors. Each of the gnawing mammals is distinctly different from other animals, and each fills an important role in the habitat that it occupies.

Gnawing mammals are primary consumers that convert plants to meat. Predators are secondary consumers. They obtain energy from plants indirectly by eating primary consumers. Populations of rodents and other gnawing animals expand or decline in response to the abundance of their food supply, and environmental factors. Populations of predators depend on the supply of food animals, and they decline rapidly when the populations of rodents and other prey animals decline.

Chapter Review

DISCUSSION AND ESSAY

1. List the characteristics that distinguish mammals from other animals.
2. Describe the system that scientists use to classify and define relationships among different kinds of animals.
3. Explain how primary consumers are different from secondary consumers.
4. Describe the roles that gnawing mammals fill in the ecosystems of North America.
5. Predict the effects on populations of gnawing animals when predator populations increase or decline.
6. Predict the effects on populations of predators when populations of gnawing animals increase or decrease.
7. Prepare maps that illustrate where populations of specific gnawing animals are distributed in North America.
8. Select at least one animal from each group of similar animals profiled in this chapter, and describe a typical life cycle.

MULTIPLE CHOICE

1. Which of the following is not a characteristic of a mammal?
   a. Young are produced from eggs.
   b. They are warm-blooded.
   c. Young are nourished with milk.
   d. They are protected by a coat of hair.
2. In the food chain, gnawing mammals are generally considered to be:
   a. Nocturnal
   b. Producers
   c. Primary consumers
   d. Secondary consumers
3. Which of the following gnawing mammals is considered to be a true rodent?
   a. The pika
   b. The rat
   c. The hare
   d. The rabbit
4. Which of the following animals is considered to be the smallest of the rodents?
   a. The vole
   b. The lemming
   c. The porcupine
   d. The mouse
5. The large number of young produced by many of the rodents is an indicator of:
   a. Evolution
   b. Nocturnal behavior
   c. A high biotic potential
   d. Consumerism

6. Which of the following is a ground squirrel?
   a. The chipmunk
   b. The fox squirrel
   c. The gray squirrel
   d. The chickaree

7. Which of the following animals is also known as the "rockchuck?"
   a. The yellow-bellied marmot
   b. The hoary marmot
   c. The black-tailed prairie dog
   d. The woodchuck

8. Which of the gnawing mammals is equipped with a second set of incisor teeth behind the front set?
   a. The prairie dog
   b. The rabbit
   c. The squirrel
   d. The rat

9. How is the population cycle of jackrabbits related to the population cycle of coyotes?
   a. When jackrabbit populations are high, coyote populations are low.
   b. Low jackrabbit populations correspond to high coyote populations.
   c. Jackrabbit and coyote populations rise and fall at the same time.
   d. Coyote populations follow the same pattern of jackrabbit populations, but the coyote population cycle is delayed behind that of the jackrabbit.

10. The preferred food of the porcupine is:
   a. Tree bark
   b. Berries
   c. Flesh
   d. Seeds

Learning Activities

1. Prepare a written report on a gnawing animal describing its habits and life cycle, and identifying a major predator. Explain how the predator is adapted to successfully prey upon the animal you have chosen.
2. Locate an area near your home or community and observe it carefully to detect the presence of gnawing animals and their predators. Prepare an oral report for the class describing the evidence you found that helped you determine which animals were living in the area.

CHAPTER

7

Hoofed Mammals

Hoofed mammals include deer, pronghorns, peccaries, goats, sheep, horses, and cattle. Wild species of each of these animals are found in North America. Their feet and toes are encased in tough horn-like material forming a hoof. Another name for a mammal with hooves is ungulate.

After completing this chapter, you should be able to:

- name the hoofed mammals that are found in North America
- describe the process by which ruminant animals digest their food
- recognize and describe members of the deer family
- distinguish between wild sheep and goats
- identify similarities and differences between pronghorns and members of the deer family
- evaluate the roles of ungulates in the ecosystems of North America
- speculate about why the musk ox developed the instinct to form a defensive circle with other members of the group during times of stress
- define the role of the peccary in the ecosystem where it lives
- conclude whether wild horses and burros should be managed as wild animals.

KEY TERMS

ungulate
cloven hoofed
javelina
ruminant
rumen
cud
symbiosis
pronghorn
buck
doe
antler
bull
cow
calf
fawn
rut
velvet
bison
ram
ewe
lamb
billy goat
nanny goat
kid
peccary
boar
sow

All of the hoofed mammals except horses and burros are **cloven hoofed**. The hooves of cloven hoofed animals are divided into two parts. The hoof of a horse is not cloven; it consists of a single hoof on each foot, see Figure 7–1.

INTERNET ADDRESS

http://www.ultimateungulate.com

KEY INTERNET SEARCH WORDS

ungulate

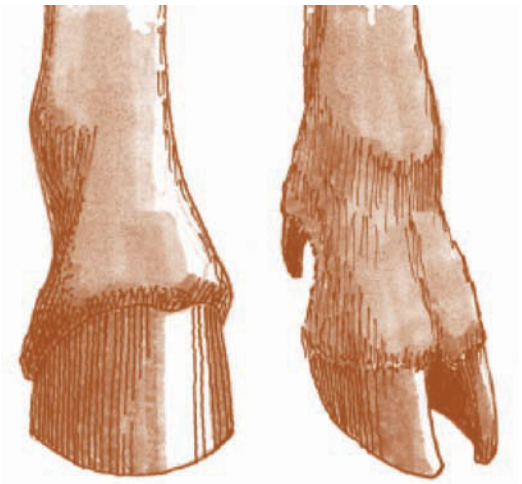


Figure 7–1 The single hoof of the horse, donkey, and burro is distinctly different from the cloven hoof structures of other ungulates such as deer, peccaries, and bison.

Some of the hoofed mammals are well known and easily recognized by most people. The deer family belongs to this group along with wild horses and cattle, sheep, goats, and pronghorns. A group of other hoofed animals that is less well known is the **javelina**. It is sometimes called a wild pig, but it belongs to a different family than the true pigs. The true pigs that are found in the wild in North America are the offspring of domesticated pigs that have become feral by returning to a wild living environment. Most hoofed animals are native to North America; however, the wild horses that we know today were introduced by the Spaniards during their conquest of the New World as they established territories in America. The wild burros are of North African descent.

Sheep, goats, pronghorns, wild cattle, and members of the deer family all belong to a group of hoofed animals known as **ruminants**. These animals have a series of four stomach compartments that are capable of digesting foods containing large amounts of fiber, see Figure 7–2. Grasses, brush, twigs, and other forage plants are high in fiber.

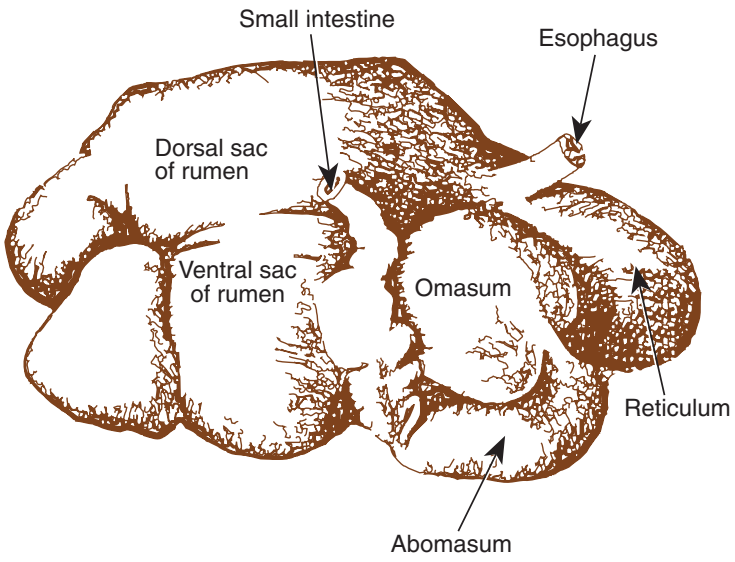


Figure 7–2 A ruminant digestive system. Note the four compartments of the ruminant stomach.

KEY INTERNET SEARCH WORDS

ruminant

ruminate

ECOLOGY PROFILE

Ruminant Digestion

Digestion of high-fiber plant materials by ruminant animals is possible because bacteria digest the food. After the food is swallowed, it enters a large stomach compartment called the **rumen**, where it is warmed and soaked, creating a favorable environment for ruminant bacteria. Bacteria reproduce rapidly in the rumen and begin to digest the fiber in the food. Most of this fiber consists of complex carbohydrates known as cellulose. When the ruminant animal has eaten its fill, it lays down to chew its **cud**. A cud is a small portion of the food material from the rumen that is regurgitated and chewed thoroughly. After this material is chewed, it passes through the other stomach compartments where bacteria continue to digest the food. In the last compartment, the bacteria are broken down by the digestive juices, and they become food for the animal. **Symbiosis** is defined as a relationship between two organisms in which each organism receives benefits from its association with the other. A symbiotic relationship exists between ruminant animals and the bacteria that digest the fiber in their food.

All of the ruminant animals are primary consumers. Each plays an important role in nature by converting nutrients stored in forage plants to meat. They are prey for large carnivores and for humans, see Figure 7–3.

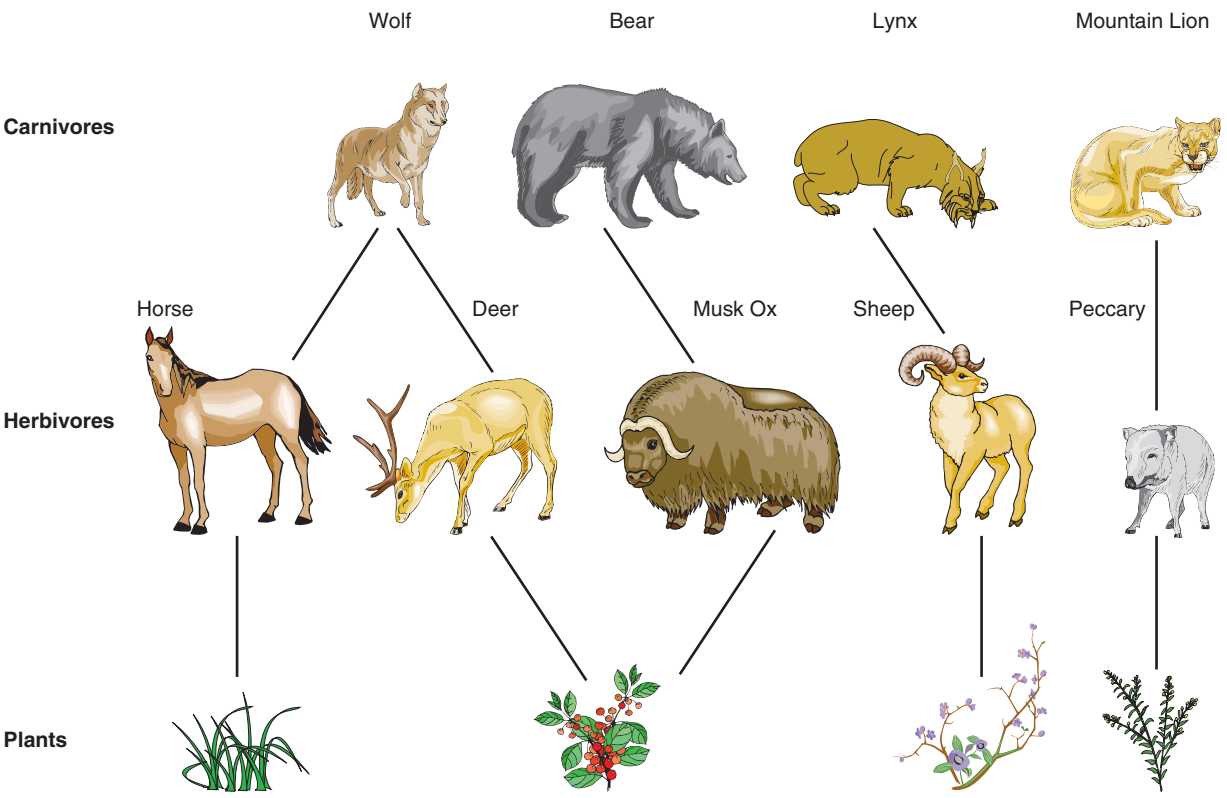


Figure 7–3 The role of ungulates in the food web.

Populations of ruminant animals have increased considerably during the last half of the twentieth century. This is due in part to government regulation of hunting and implementation of management practices that improve habitats.

PRONGHORN

KEY INTERNET SEARCH WORDS

food chain

food web

The **pronghorn** is the only remaining member of a family of animals that was once found in large numbers in North America. Although it is often called an antelope, it is not a member of the same family as the true antelopes that are found in other parts of the world. Despite its similarity to deer, it is not a member of the deer family either.

INTERNET ADDRESS

http://www.nsrl.ttu.edu/tmot1/antiamer.htm

KEY INTERNET SEARCH WORDS

Antilocapra americana

MAMMAL PROFILE

Pronghorn *(Antilocapra americana)*

Pronghorns live in deserts and plains where the terrain is relatively flat, see Figure 7–4. They depend on grasses, forbs, domestic crops, and plants such as sagebrush for food. Their best defenses against predators are their eyesight and speed. Pronghorns can run faster than any other animal in this part of the world, running at speeds of up to sixty miles per hour for short distances.

Figure 7–4 Pronghorns depend on their great speed to avoid their enemies. *Courtesy of U.S. Fish and Wildlife Service. Photo by James C. Leupold*

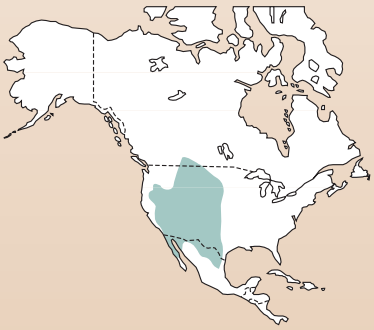


Figure 7–5 Distribution map of the pronghorn.

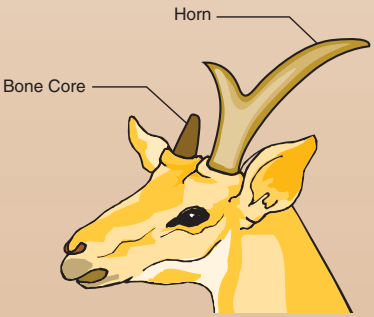


Figure 7–6 The horns of pronghorns are hollow except for a bony core over which the horns are developed and attached.

The pronghorn is one of the smallest ungulates; it is marked with a light brown body, white undermarkings, and a white rump patch. In the early part of the twentieth century, its numbers were threatened by overharvesting. It is now protected by hunting regulations and can be found in semi-arid western habitats from Canada to Mexico, see Figure 7–5. It is managed as a game animal, and hunting is allowed only during short seasons. Restrictions on hunting have made it possible for the population of this animal to increase, and an annual harvest is now considered necessary to keep herds in balance with their food supply.

The horns of pronghorns are hollow except for a core of bone over which the horns grow. They are shed after the fall mating season, and new horns grow from the bony core, see Figure 7–6. The horn splits into two separate prongs, and it is this characteristic that gives the pronghorn its name. Both males and females have horns; those of the **buck** or male are somewhat larger than those of the **doe** or female.

Young pronghorns are born in late spring or early summer. Twins are quite common, and they are able to run well by the time they are a few days old. Coyotes and wolves are the most common predators of pronghorns. When a pronghorn gets excited, the white rump patch becomes visible and acts as a warning for other animals

DEER

Members of the deer family in North America include moose, elk, caribou, and several species of deer. They are found in a variety of widely distributed environments. They are also popular game animals. Members of the deer family are similar in that they have cloven hooves and ruminant digestive systems. Males have scent glands and **antlers** (solid bony horns) that are shed annually. Unlike the pronghorn, the entire antler is shed. Except for caribou, the females do not have antlers. Populations of these animals have recovered well since they were badly depleted by excessive hunting pressure in the early part of the twentieth century. It is now evident that the most controlling factor of the size of the deer population is the amount of food available during the winter season.

KEY INTERNET SEARCH WORDS

fawn

calf

deer

Male elk, caribou, and moose are called **bulls**, females are **cows**, and the young of either species is a **calf**. The males of the other deer species are called **bucks**, females are **does**, and their young are **fawns**.

Four different subspecies of moose are found in North America. They are the eastern moose, Manitoba moose, Shiras moose, and Alaskan moose. These animals are the largest of the game animals in America. Despite their large size, moose are preyed upon by wolves, bears, and other large predators.

Figure 7–8 Distribution map of the moose.

MAMMAL PROFILE

Moose *(Alces alces)*

The moose is the largest member of the deer family, see Figure 7–7. A mature Alaskan bull moose may be nearly 8 feet tall at the shoulder and weigh 1,800 pounds. His massive antlers sometimes measure 6 feet across. The animal that Americans call a moose is referred to as an elk in Europe, see Figure 7–8.

Moose usually prefer to live alone in areas where there is abundant water. They feed on lush vegetation and water plants when they are available, and they eat twigs, small branches, and tree bark during the winter months.

Bulls battle one another for cows during the breeding season, and calves are born in the spring. Calves stay with their mothers for nearly a year and are driven away just before the next new calves are born. Although bulls are very aggressive during the breeding season, they are quite docile during the rest of the year. Cows with calves are very protective, and they will attack nearly anything that appears to threaten the safety of their calf.

Figure 7–7 The moose is the largest member of the deer family.

The elk that are found in North America are large deer whose native range crossed the continent, from northern Canada to Mexico and from coast to coast. It is generally restricted now to the Rocky Mountains and the northern regions of the continent. As settlers moved to the western lands, the vast herds of elk were depleted. The eastern elk were hunted to extinction. Other elk populations were greatly reduced as wintering grounds were converted to farms and as the elk were slaughtered as food for people.

Elk management has drastically improved today in comparison with the recent past. Their populations have tended to grow larger in most regions. They have been introduced back into some areas that have not had any elk for many years. Preserves have also been established, and winter feeding programs continue to be in place in some areas.

Elk are migratory animals that move to the high mountain meadows during the summer and to lower elevations during the winter. They are fast runners and strong swimmers. They were called wapiti by Native Americans, a name that is still used today.

INTERNET ADDRESS

http://www.fs.fed.us/pnw/exforests/starkey/index.shtml

KEY INTERNET SEARCH WORDS

starkey, deer, elk

ECOLOGY PROFILE

Starkey Research Station

The Starkey Research Station is operated by the U.S. government, and it is located near Pendleton, Oregon. It is a good example of science at work. A captive herd of wild deer and elk live inside a fenced area of more than 40,000 acres. A number of experiments are conducted there to determine the best long-term management practices for multiple use of rangelands by elk, deer, and cattle. Data from these experiments is published in research journals, indicating that rangelands can be effectively used under controlled conditions by livestock without damaging habitat for the other wild game species. Other research conducted at the Station evaluates birthrates of deer and elk when young males are used for breeding in comparison with mature males. Another research project is measuring the elk metabolism of different feed materials.

INTERNET ADDRESS

http://animaldiversity.ummz.umich.edu/accounts/cervus/c._elaphus$narrative.html

KEY INTERNET SEARCH WORDS

elk
wapiti
Cervus elaphus

Figure 7–9 Distribution map of the elk.

Figure 7–11 The speckled coat of an elk calf helps it to blend with its surroundings to avoid detection by predators. *Courtesy Robert Pratt.*

MAMMAL PROFILE

Elk *(Cervus elaphus)*

Elk are popular game animals whose range extends through Canada and the western region of the United States, see Figure 7–9. They can reach heights of 5 feet at the shoulder, and mature bulls weigh more than 800 pounds, see Figure 7–10. Bulls have large, branched antlers that they shed each year. Their new antlers grow from buds, and they grow larger in size each year until a bull is mature.

Bulls use their antlers to protect themselves from predators. They also battle each other for harems of cows during the **rut** or mating season in the fall. During this time, the bulls bugle whistling calls to challenge rivals and to attract cows. Hunters imitate this call, and bulls frequently forget caution as they rush to challenge what they think is another bull.

Calves are born in late May or June. They are camouflaged from predators by white spots on their backs. When a calf is lying perfectly still, the spots look like splashes of sunlight on the forest floor, see Figure 7–11. Calves are strong enough to follow their mothers when they are only a few days old. Elk are most vulnerable to predators during the first few weeks after birth, but wolves, bears, and mountain lions are capable of killing elk even after they reach maturity. Elk prefer mountains and forests, and they graze on grasses, forbs, twigs, and bark.

Figure 7–10 A bull elk. *Courtesy U.S. Fish and Wildlife Service.*

Caribou are closely related to domesticated reindeer. Both the males and females have large, branched antlers. Caribou are adapted to northern climates, and their range rarely extends south of Canada. They are large migratory deer that move along established migration routes from their southern ranges in the woodlands of southern Canada to the northern tundra regions and back again. Large herds of migrating caribou, numbering in the hundreds or even thousands, make the same round-trip every year.

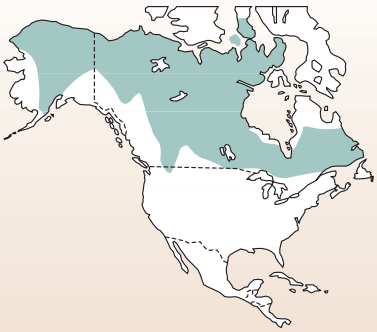


Figure 7–12 Distribution map of the caribou.

Figure 7–13 A bull caribou. *Courtesy PhotoDisc.*

MAMMAL PROFILE

Barren-Ground Caribou *(Rangifer tarandus)*

Barren-ground caribou are so named because of the tundra region that they occupy during the summer months, feeding on lichens, mosses, and shrubs, see Figure 7–12. The cows lead the annual migration north each spring. They are heavy with unborn calves, and they arrive at the traditional calving grounds just in time to deliver their young. The bulls follow the cows a few days later.

When the fall season arrives, the migration turns south and the caribou return back to the shelter of the boreal forest for the winter. Mature caribou measure as tall as 4.5 feet at the shoulder and weigh up to 375 pounds, see Figure 7–13.

Caribou numbers declined seriously due to loss of food resources, excessive hunting pressure, and other factors during the early part of the twentieth century. Some populations are recovering as a result of conservation practices and better management of the herds, but they are still classified as endangered in some regions by the government agencies in the United States and Canada. Caribou have been moved with moderate success by wildlife biologists into some Rocky Mountain areas located south of the Canadian border.

The main predator of the caribou is the wolf. Packs of wolves follow the caribou herds along the migration routes, feeding on them along the way. Young and weak animals are most vulnerable to predators, but carnivores are opportunistic feeders that will eat the strong as well as the weak. Bears and some other large predators also prey on caribou.

KEY INTERNET SEARCH WORDS

caribou

Rangifer tarandus

KEY INTERNET SEARCH WORDS

white-tailed deer

Odocoileus virginianus

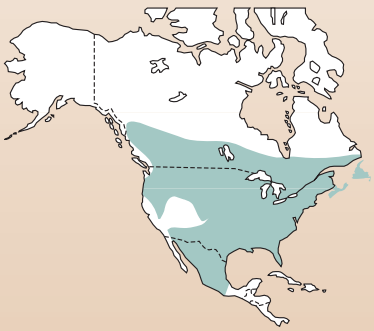


Figure 7–14 Distribution map of the white-tailed deer.

MAMMAL PROFILE

White-Tailed Deer *(Odocoileus virginianus)*

The white-tailed deer is more widely distributed in North America than any other deer. With the exception of California and the Great Basin, they are found throughout the United States, southern Canada, Mexico, and as far south as Central America, see Figure 7–14. They are approximately 4 feet tall at the shoulder, and a large buck can weigh in excess of 300 pounds. Several types of white-tailed deer are found in North America. Among these are the Florida Keys white-tails, which are the smallest in size. Their range is restricted to several islands off the coast of southern Florida.

The white-tailed deer is named for the white color of the hair on the lower surface of its tail, see Figure 7–15. When it is excited, it waves its tail like a white flag and snorts a call of alarm as it bounds away to safety. This deer is at home in woodlands, fields, deserts, and plains. It has a reputation among hunters for being extremely crafty.

Figure 7–15 The white-tailed deer is more widely distributed than any other deer in North America. *Courtesy Shutterstock.*

Natural predators of deer include the coyote, mountain lion, bear, and wolf; however, some deer are undoubtedly killed by lynx, bobcats, wolverines, foxes, and even eagles. Mountain lions often prey exclusively on deer. Domestic dogs are among the predators of deer, especially in late winter and early spring. One reason that deer populations have grown in the recent past is because predator populations have been controlled to protect domestic livestock. This has also provided protection to deer populations.

As deer antlers grow and develop, they are covered with skin and hair. This covering is called **velvet**. A rich supply of blood is pumped to the growing antlers through a network of blood vessels in the velvet. When the antlers are fully developed, the blood supply stops flowing and the antlers harden. The animals then rub their antlers on objects to remove the velvet before the beginning of the rut. The antlers are shed each year following the breeding season.

Career Option

GAME WARDEN

A GAME WARDEN IS A LAW OFFICER who is responsible for patrolling an assigned area to prevent fish and game law violations, investigating complaints about crop damage by wildlife, and gathering biological research data. Game wardens also apprehend violators of fish and game laws, issue citations, and make arrests when appropriate. They present evidence in court hearings, investigate hunting accidents, offer educational programs to the public, and work with community groups to improve fish and game habitat. Education requirements for this career include training in law enforcement and a strong emphasis in biological sciences.

INTERNET ADDRESS

http://animaldiversity.ummz.umich.edu/accounts/odocoileus/o._hemionus$narrative.html

KEY INTERNET SEARCH WORDS

mule deer

Odocoileus hemonius

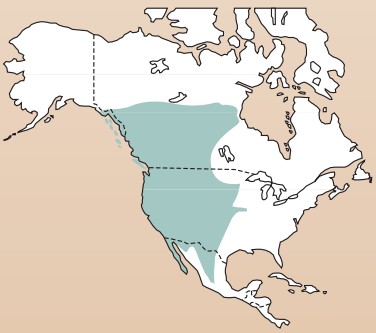


Figure 7–17 Distribution map of the mule deer.

MAMMAL PROFILE

Mule Deer *(Odocoileus hemionus)*

Mule deer are distinguished from other deer by the branched beams of the antlers and a white rump and tail, see Figure 7–16. The tail is short with a black tip, and the mule deer tends to hold its tail down as it runs. The ears of a mule deer appear to be quite large in comparison with the ears of other deer, and bucks have dark markings shaped like horseshoes on their foreheads.

Figure 7–16 Mule deer can be identified by their large ears and black- tipped tails. *Courtesy U.S. Fish and Wildlife Service.*

The diet of mule deer consists of grasses, herbs, brush, and forbs during the summer, and shrubs, fungi, twigs, acorns, and lichens during the winter.

A mature buck often weighs close to 300 pounds, and a doe weighs around 200 pounds. Mating occurs in the fall, and the young are born in early summer. Most births are twins, with some single and triplet births. Although mule deer prefer high mountain elevations and wooded habitats, they also thrive in desert areas in the western regions of North America. Their range extends across the western United States from the South Yukon territory to Mexico, see Figure 7–17.

Bucks get their first set of antlers when they are one year old. They consist of single spikes; an occasional antler has a single fork. These young bucks are often called spikes. Antlers grow larger as the young bucks or bulls mature. A young bull elk develops some branching in its antlers when it is two years old. A young bull in this stage of antler development is sometimes called a raghorn.

KEY INTERNET SEARCH WORDS

black-tailed deer

MAMMAL PROFILE

Black-Tailed Deer *(Odocoileus hemionus columbianus)*

The black-tailed deer was so named because of its black tail, see Figure 7–18. The antlers of mature bucks separate on the main beam to form two forks on each side. This deer species is found in the coastal mountains from central California to British Columbia, see Figure 7–19.

Figure 7–19 Distribution map of the black-tailed deer.

Figure 7–18 A black-tailed deer. *Courtesy PhotoDisc.*

Bison and Musk Ox

The North American **bison** or buffalo is closely related to domestic cattle. It is estimated that the bison population once approached 60 million, but it was nearly hunted to extinction between 1865 and 1885. During the peak of their slaughter, bison were killed by the millions just for their hides, and the meat was often left to rot.

In 1893, only 21 bison remained in the wilderness of Yellowstone, and a few hundred others were scattered in other areas. These were the conditions that existed when a bill to protect the bison was signed by President Grover Cleveland in 1893.

The decline of the bison is a classic example of human abuse of a wildlife resource. In only 20 years during the late 1800s, millions of bison were hunted until only a few of them remained in the wild. Most of the wild bison that remain are living in Yellowstone National Park and in other game preserves, such as federal and state parks, refuges, and preserves, see Figure 7–20. Some also survive in domesticated herds on farms and ranches where they are raised as meat animals.

The decline of the great bison herds caused serious problems for the Native American tribes who depended on the bison for many of their needs. They used the bison for food, shelter, and clothing. The

destruction of this wildlife resource caused great hardships for their people and contributed to the wars that were fought between the immigrants and the native tribes during this time period. Destruction of the bison herds also contributed to the outcome of the wars because it deprived the natives of their most important food resource.

ECOLOGY PROFILE

Yellowstone Bison Controversy

The bison living within Yellowstone National Park in Montana and Wyoming do not always stay within established park boundaries. As the bison population in the park increases, they move beyond Yellowstone's borders in search of food. Much of this park is already severely overgrazed by the resident herds of bison and elk. One reason wolves have been introduced into this area is to control the size of the bison and elk populations. The wolf introduction has been opposed by ranchers and some wildlife groups who fear for the safety of livestock and game animals outside the park boundaries. Despite opposition, wolves have been established in the park, and the states of Montana, Wyoming, and Idaho have been given responsibility for wolf management. In some instances, wolves have been relocated or killed when they have preyed on livestock outside the park.

Ranchers are concerned that bison leaving Yellowstone National Park carry with them a serious disease, brucellosis, that threatens the cattle industry in those states that surround the park. Brucellosis causes cattle to abort their calves, and the bacteria can be passed on to humans as undulant fever. Many of the Yellowstone bison are infected with brucellosis, and ranchers fear that it is passed to domestic cattle by the bison. Research has confirmed that the same brucellosis organism that infects bison also infects cattle.

In an effort to protect cattle, the state of Montana has conducted bison hunts to remove bison from public and private lands outside the park. Public sentiment against this control measure has prompted consideration of other ways to solve this problem.

Figure 7–20 The Yellowstone National Park bison. *Courtesy U.S. Fish and Wildlife Service.*

KEY INTERNET SEARCH WORDS

bison

buffalo

Figure 7–21 Distribution map of the wild bison.

MAMMAL PROFILE

Bison *(Bison bison)*

Bison are among the largest big game animals in the world. Mature bulls stand 6 feet tall at the shoulder and weigh over a ton. These large ungulates feed on grasses, forbs, sedges, and shrubs. They occupy a variety of habitats including woodlands, forests, and prairies. Bison traveled in herds that numbered several hundred thousand before their population declined to near extinction.

The natural range of bison used to include the plains, grasslands, and woodlands of much of North America. It is now restricted to small areas that are scattered through its ranges, see Figure 7–21. Cows give birth in the spring to single calves weighing 30–40 pounds. Mature animals have short necks, distinct humps on the shoulders, crescent-shaped horns, and shaggy, brown coats, see Figure 17–22. Another race of bison is the wood bison found in parts of Canada. They are smaller than the bison described here, but they are similar in most other ways.

Figure 7–22 A bison. *Courtesy U.S. Fish and Wildlife Service. Photo by E. Smith.*

The musk ox is a member of the same family as domestic cattle, sheep, and goats. Like the deer and pronghorns, they were nearly exterminated by humans during the late 1800s. They are well equipped for life in the arctic with long, wooly coats that protect them from the cold and sharp horns to fight off predators such as wolves.

KEY INTERNET SEARCH WORDS

musk ox

Ovibos moschatus

MAMMAL PROFILE

Musk Ox *(Ovibos moschatus)*

Musk oxen are arctic animals whose range is restricted to the arctic tundra of North America, most of the arctic islands, and Greenland, see Figure 7–23. During the summer season, they graze on lichens, grasses, sedges, and forbs. They also browse on willows. During the winter, they stay close to the wind-swept high ground where they can dig through the snow to graze. They huddle together for warmth, with the calves in the middle, during arctic blizzards. A herd also forms a circle for defense with adults facing out and calves in the middle when they are attacked by predators. The adults use their sharp horns and their feet to battle anything that attempts to attack.

Mature bulls give off a strong, musky odor from the glands on their faces that can be smelled from a distance of 100 yards or more. Bulls battle one another for cows during the breeding season, and the losers join other bulls to form their own groups. When the breeding season is over, bulls usually join a group composed of cows, calves, and other bulls.

Calves weigh around 20 pounds at birth, and they huddle under the long shaggy hair of their mothers for protection from cold and predators. Mature bulls can weigh as much as 900 pounds and stand 5 feet tall at the shoulders.

Figure 7–23 Musk oxen. *Courtesy U.S. Fish and Wildlife Service. Photo by Jerry Hout.*

WILD SHEEP

Several types of wild sheep range among the high mountain peaks of North America. They can be found from Alaska and western Canada down to Mexico. The most common wild sheep are the bighorn sheep and the Dall's sheep. Male sheep are called **rams**, female sheep are **ewes**, and young sheep are **lambs**.

INTERNET ADDRESS

http://www.bcadventure.com/adventure/wilderness/animals/bighorn.htm

KEY INTERNET SEARCH WORDS

bighorn sheep
Ovis canadensis

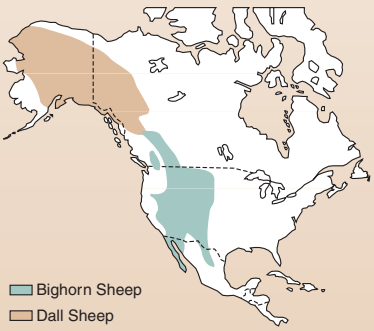


Figure 7–24 Distribution map of bighorn and Dall's sheep.

MAMMAL PROFILE

Rocky Mountain Bighorn Sheep *(Ovis canadensis)*

Bighorn sheep occupy habitats that include deserts, prairies, and alpine meadows. They spend much of their lives among the cliffs and ledges of some of the most rugged mountains on the North American continent. They eat many kinds of vegetation, including sedges, grasses, brush, shrubs, and cacti.

Bighorn sheep band together in small groups with ewes and lambs living in separate groups from the rams during much of the year, see Figure 7–24. During the breeding season, the most dominant rams battle one another for the ewes. The winners guard their ewes jealously and take on any ram that tries to interfere with their hard-earned breeding right.

Rams are polygamous and mate with several ewes. Lambs are born in the late spring in mostly single or twin births. Lambs soon learn to follow their mothers as they travel to water and return to the high ledges. An old experienced ewe provides leadership to the other ewes, guiding them to water and feeding areas.

Bighorn sheep are brown in color with white rump patches. Mature rams weigh up to 300 pounds and stand close to 3.5 feet at the shoulder, see Figure 7–25. Another race of bighorn sheep called desert bighorns is native to North America. They are smaller than the rocky mountain bighorn race of wild sheep, but they are very similar to their larger relatives in anatomy and behavior.

Rams are equipped with massive curled horns. During the heated battles of the breeding season, they back up and charge at each other at full speed. The crash of their horns can be heard for great distances.

Figure 7–25 Bighorn sheep occupy habitat high in the Rocky Mountain region. *Courtesy U.S. Fish and Wildlife Service. Photo by Peter Carboni.*

Natural predators of wild sheep include mountain lions, lynx, eagles, and wolves. Mountain lions are as much at home on the high ledges as the sheep. Lynx and wolves take advantage of the need for water that brings the sheep down from the cliffs. Young lambs are preyed upon by eagles and other predators. Sheep are endowed with large curling horns that flare out from the head. By counting the growth rings on their horns, the age of the rams can be determined.

KEY INTERNET SEARCH WORDS

Dall's sheep

Ovis dalli

Figure 7–27 A nearly black stone sheep. *Courtesy of Getty Images. Credit Tom Brakefield.*

MAMMAL PROFILE

Dall's Sheep *(Ovis dalli)*

Northern Dall's sheep are white in color, see Figure 7–26. Both sexes have horns. A gray-colored race known as Fannin sheep live in the Yukon region, and further south a race of nearly black Stone sheep can be found, see Figure 7–27.

Dall's sheep live in rocky, mountainous terrain where their diet consists of grasses, sedges, and shrubs. Their range is restricted to Alaska and western Canada.

Dall's sheep are slightly smaller than bighorn sheep. Mature rams get up to 40 inches tall, and they weigh as much as 200 pounds.

Figure 7–26 Dall's sheep at Denali National Park. *Courtesy Shutterstock.*

Mountain Goats

Mountain goats travel together as families with an experienced billy goat as the leader. They are extremely sure-footed, and they climb carefully. A goat has a natural pad on the bottom of each hoof that is practically skidproof. They seldom have trouble crossing cliffs and ledges. Thirty minutes after kids are born they are able to jump about, and it doesn't take them long to get used to their environment. Male goats are called **billy goats**, female goats are **nanny goats**, and young goats are **kids**.

KEY INTERNET SEARCH WORDS

mountain goat

Oreamnos americanus

Figure 7–29 Distribution map of the mountain goat.

MAMMAL PROFILE

Mountain Goat *(Oreamnos americanus)*

Mountain goats occupy habitats on steep slopes and cliffs at high altitudes above the timberline. Their range extends from Alaska to northern Idaho, Montana, and Wyoming, see Figure 7–28. Their diets consist of grasses, forbs, sedges, and shrubs. Billy goats are equipped with sharp, spiked horns that they use to defend themselves from predators and with which they fight for females during the breeding season. Large mature billy goats are often close to 3.5 feet tall at the shoulder, see Figure 7.29. A nanny goat gives birth to a single kid in May or June, and it is active soon after it is born. Golden eagles are the most successful predators of young goats. Mountain goats are white in color, and they weigh up to 300 pounds. They are extremely agile and coordinated. Only a few hunting permits outside of Alaska are issued for these animals each year.

Figure 7–28 A mountain goat. *Courtesy PhotoDisc.*

Peccary

The **peccary** is sometimes called a musk hog or a javelina. Although it resembles the wild pigs found in Europe, it is not a true pig. A peccary is smaller than a wild pig. It stands about 20 inches tall and may weigh up to 65 pounds.

INTERNET ADDRESS

http://www.desertusa.com/magnov97/nov_pap/du_collpecc.html

KEY INTERNET SEARCH WORDS

collared peccary
javelina
Dicotyles tajacu

MAMMAL PROFILE

Collared Peccary *(Dicotyles tajacu)*

Peccaries are native to the desert of southwestern United States and Mexico, see Figure 7–30. Its bristled hair coat is gray in color, with a distinct white stripe or collar around the neck. It has musk glands in its back that give off strong odors when the animal becomes excited or scared, see Figure 7–31. Males are called **boars** and females are **sows**. They breed throughout the year, and a normal litter consists of two piglets. Newborn peccaries are able to run quite fast within a few hours of birth. This is an important survival skill because the peccary is preyed upon by a number of animals, including the jaguar, bobcat, wolf, coyote, and ocelot. Peccaries eat nearly anything from snakes and birds to prickly pear cactus. They dig or root in the soil for grubs, worms, and plant roots. They are known to cause serious damage to farmers' crops by rooting in cultivated fields.

Figure 7–30 Distribution map of the peccary.

Figure 7–31 A javelina. *Courtesy U.S. Fish and Wildlife Service. Photo by Tom Stehn.*

Horses and Burros

When the Spanish conquerors invaded the region that is now Texas and Mexico, they left horses and donkeys behind. In the ensuing years, descendants of these animals multiplied in the wild. Mustangs, or wild horses, inhabit deserts, rangelands, and plains, see Figure 7–32. Their diets consist of grasses, forbs, sagebrush, saltbrush, and shrubs. The wild horses and burros that inhabit the western ranges are primary consumers. They convert plants to meat, and they are sometimes preyed upon by large predators such as mountain lions. Their range is now restricted mostly to federally owned forests and rangelands in the western United States.

Figure 7–32 Wild mustangs. *Courtesy Mark Newman. Photo Researchers, Inc.*

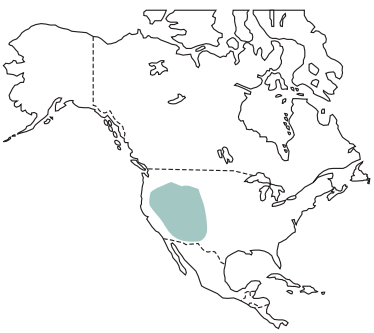


Figure 7–33 Distribution map of the wild mustangs.

These animals are not native to North America, but they are protected by the Wild Horses and Burros Act of 1971. Congress requires that they be managed by government agencies as though they were wild, native species, see Figure 7–33. Since they gained protection under the law, some herds have multiplied until their ranges have become damaged by overgrazing. In recent years, the Bureau of Land Management has started a program that allows people to adopt wild horses for a modest fee. This has tended to ease the conflict between ranchers and environmentalists over grazing rights in areas where free-roaming mustangs and burros live.

INTERNET ADDRESS

http://www.desertusa.com/magjan98/jan_pap/du_wildburro.html

KEY INTERNET SEARCH WORDS

wild horse
wild burro

MAMMAL PROFILE

Wild Burro

The Grand Canyon is the home to a species of wild donkey that has adapted very well to the rugged terrain of the region, see Figure 7–34. Donkeys and burros are generally considered to be domesticated offspring of the wild asses found in North Africa. The wild burro found in the Grand Canyon is an example of a domesticated animal that has returned to the wild state.

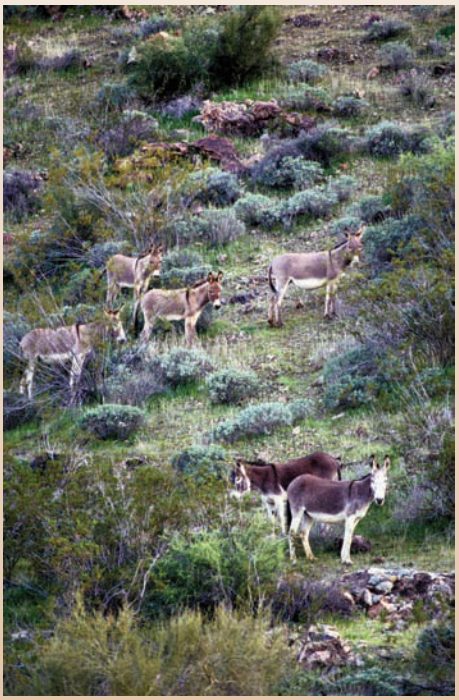


Figure 7–34 The wild burro is descended from animals that were brought to Texas and Mexico by Spanish Conquerors. *Courtesy Frank Zullo. Photo Researchers, Inc.*

LOOKING BACK

Hoofed mammals, also called ungulates, include the wild horses, sheep, goat, bison, musk ox, deer, and peccary. Some of these animals also are ruminants that benefit from symbiotic relationships with the bacteria that digest the fiber in their diets. All of the hoofed mammals are primary consumers or herbivores with the exception of the peccary. All of the hoofed mammals fill roles in the environment as food animals for meat-eating carnivores.

Chapter Review

DISCUSSION AND ESSAY

1. Name the hoofed mammals of North America that are described in this chapter.
2. Describe how ruminant animals digest their food.
3. List the characteristics that distinguish species within the deer family from one another.
4. Describe the differences between wild sheep and goats.
5. How are pronghorns and members of the deer family similar?
6. List the differences between pronghorns and members of the deer family.
7. What roles do hoofed mammals fill in the ecosystems of North America?
8. Describe the defensive behavior of the musk ox, and speculate on ways that this behavior may have evolved.
9. Describe the habitats and diets of wild peccaries.
10. Describe the kind of protection that wild horses and burros gained from the Wild Horses and Burros Act of 1971.

MULTIPLE CHOICE

1. The hoof of a cloven-hoofed animal is:
   a. A single hoof
   b. Divided into two hooves
   c. Divided into three toes
   d. Divided into four toes
2. Wild animals that are ruminants eat diets consisting mostly of:
   a. Meat
   b. Roughage
   c. Seeds
   d. Crustaceans
3. Which of the following animals is not a member of the deer family?
   a. Pronghorn
   b. Elk
   c. Moose
   d. Key Deer
4. A mature female pronghorn is called a:
   a. Cow
   b. Doe
   c. Ewe
   d. Sow
5. A newborn baby deer is called a:
   a. Cub
   b. Lamb
   c. Calf
   d. Fawn

6. A male moose is called a:

   a. Bull
   b. Buck
   c. Stag
   d. Ram

7. In which species in the deer family do both males and females have antlers?

   a. Moose
   b. Elk
   c. Caribou
   d. Deer

8. Which species of ungulate once roamed the plains in large herds before nearly becoming extinct due to over-hunting?

   a. Musk ox
   b. Pronghorn
   c. Mule deer
   d. Bison

9. Which species of ungulate occupies a range that is restricted to the arctic tundra region of North America?

   a. Musk ox
   b. Moose
   c. Elk
   d. Bison

10. In which family of ungulates are the adult males called rams and females called ewes?

    a. Deer
    b. Mountain goats
    c. Wild sheep
    d. Musk ox

11. The adult male of which family of ungulates is called a billy?

    a. Deer
    b. Mountain goats
    c. Wild sheep
    d. Musk ox

12. Which of the following ungulates is not a ruminant?

    a. Peccary
    b. Pronghorn
    c. Deer
    d. Musk ox

13. Which of the North American ungulates is not a native species?

    a. Peccary
    b. Wild sheep
    c. Wild burro
    d. Deer

Learning Activities

1. Choose a species of hoofed mammals that is common to your region. Learn from experts such as fish and game management officials who have been invited to the class to discuss how these animals have been managed in the past. Take field trips (or locate and view videos) to observe the animal in its natural habitat. Identify the problems that are associated with management of the species and develop a management proposal to resolve the issues you identified.
2. Study the wild horse issue as a class, and divide the class into two groups according to their stand on whether wild horses and burros should enjoy protection as a wild species or whether they should be treated as an invading species. Set up a mock courtroom complete with judge, jury, defense attorneys, and prosecuting attorneys. Charge one or more of your students with criminal behavior for capturing and selling wild horses to a horse-meat processing company. Allow students to use their imaginations as they testify on both sides of the issue, and have the jury render a verdict.

   Note: This activity is a re-enactment of an actual court case.

CHAPTER

8

Predatory Mammals

After completing this chapter, you should be able to

- explain the rise or decline of specific animal populations due to food supplies, diseases, environmental accidents, and natural disasters
- describe how predators help to stabilize populations of primary consumers
- evaluate the roles of the wild cats in the ecosystems of North America
- evaluate the roles of the wild dogs in the ecosystems of North America
- speculate on the effects that total destruction of all predators would have on other animal populations
- assess the roles of bears in North American ecosystems
- discuss the characteristics of members of the weasel family that contribute to their success as predators
- speculate on reasons that raccoons and coyotes have been successful in adapting to human civilization.

Wild animals are part of a cycle that moves from an abundance of food to famine and back to abundance. Populations of wild animals rise and fall in response to food supplies, diseases, predation, environmental accidents, and natural disasters. Predatory animals bring stability to ecosystems by preventing populations of food animals from expanding beyond the capacity of their habitats in order to find food and shelter.

KEY TERMS

predator
puma
ocelot
margay
jaguarundi
jaguar
dog
vixen
gestation
omnivore
carrion
delayed gestation
photoperiod
musk

Predators are animals that kill and eat other animals. As cruel as this may appear to be, it is really a more humane method of controlling animal populations than starvation. Animals that become too numerous for their food supplies are in agony for weeks as they slowly starve to death.

Predators help to keep animal populations stable by preventing them from increasing so rapidly that food supplies are threatened. Predators do not eliminate starvation among the animals known as primary consumers, but they do reduce the frequency of mass starvation by slowing the growth rates of animal populations. Predators are secondary consumers in the food chain, see Figure 8–1. They are the meat eaters, and they are totally dependent upon abundant populations of other animals that can be killed and eaten for food. Predators eat large numbers of primary consumers, but they also eat other predators that they are strong enough to kill.

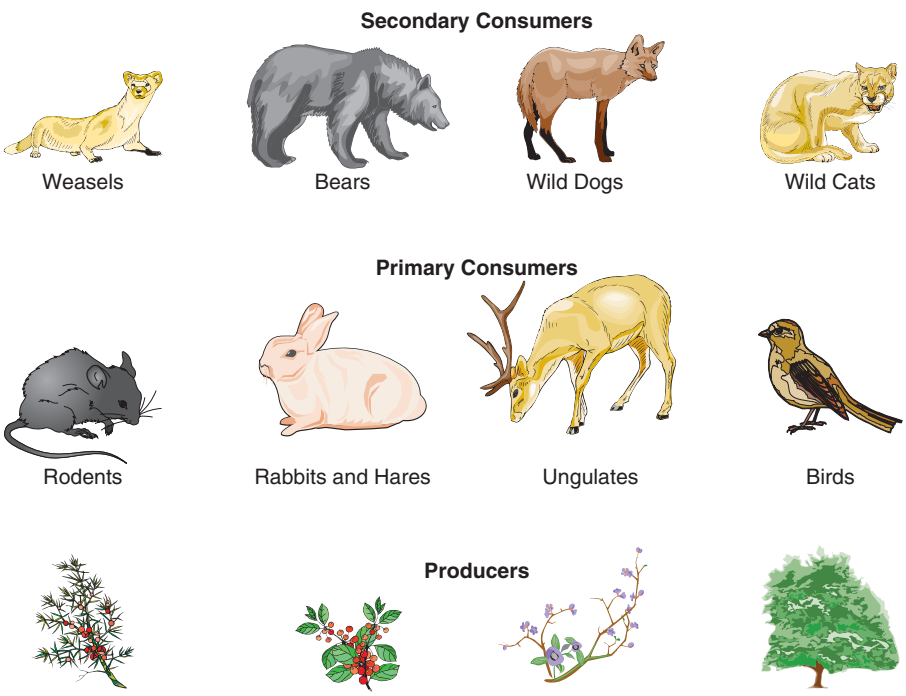


Figure 8–1 The role of large predators in the ecosystem.

WILD CATS

The most elusive predators are the wild cats. They prefer to hunt at night, and they tend to live alone. They are patient hunters that wait motionless for hours beside a game trail until an unsuspecting creature comes along. Wild cats are found in many of the wildlife habitats of North America.

INTERNET ADDRESS

http://www.biology.ualberta.ca/uamz.hp/lynx.html

KEY INTERNET SEARCH WORDS

Lynx canadensis

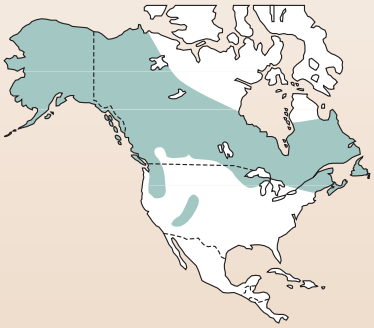


Figure 8–2 Distribution map of the Canada lynx.

Figure 8–3 The Canada lynx preys heavily on hares. *Courtesy Eyewire.*

MAMMAL PROFILE

Canada Lynx *(Lynx canadensis)*

The Canada lynx is a native to the northern coniferous forests of Alaska, Canada, and the Rocky Mountains of the United States, see Figure 8–2. The lynx is easily identified by its grayish-brown fur, short tail with a black tip, and tufts of hair on its ears and cheeks, see Figure 8–3. A mature adult male weighs up to 40 pounds and stands nearly 2 feet tall at the shoulder.

The lynx preys heavily on hares. The lynx also preys on birds and other small animals, including foxes and small deer. When there is an abundance of hares, the lynx population tends to increase. When a disease reduces the hare population, the lynx population soon decreases too. Starvation claims some of these predators, but some losses occur because lynx reproduction decreases when food is scarce. A significant reduction occurs in the average number of kittens produced per litter. Young males are known to disperse widely when food is scarce as they search for new territory. This contributes to a diverse gene pool in the lynx population.

During the mating season, adult lynx yowl like domestic cats. Kittens are born in the spring with their eyes closed until they are about 10 days old. They are spotted at birth, but the spots fade as the kittens mature. Kittens hunt with their mothers until they are almost 1 year old. She teaches them how to find and catch their own food before she abandons them.

Most members of the cat family are blind at birth and completely helpless. They require long periods of care by their mothers before they are prepared to survive in the world by themselves. The mothers nurse them during the early weeks of their lives and bring food home to the den when they are old enough to eat meat. Teaching the young cats to hunt, catch, and kill their food requires a long period of training that is provided by the female.

KEY INTERNET SEARCH WORDS

bobcat

Lynx rufus

Figure 8–5 Distribution map of the bobcat.

MAMMAL PROFILE

Bobcat *(Lynx rufus)*

The bobcat also is known as a wildcat. It is similar to the Canada lynx in appearance ranging from 22 to 47 inches in length, see Figure 8–4. It has a mottled reddish-brown fur coat and a short white-tipped tail.

Figure 8–4 The bobcat feeds on rabbits, rodents, and birds. *Courtesy PhotoDisc*

Bobcats are well adapted to forests and to brushy desert environments as long as there is an abundance of cover and an adequate food supply, see Figure 8–5. The range of this species extends from southern Canada to Mexico, except for the Midwest. They feed on rabbits, rodents, and birds, but they also will kill picas, fawns, and lambs when the opportunity arises. They are good tree climbers; however, they do most of their hunting on the ground at night.

Two to four young are born in the spring in a nest of leaves or grass. They are completely blind and helpless when they are born, and it is several weeks before they are strong enough to join their mother as she hunts.

Cats of the same species that live in the desert are usually lighter in color than those that live in the forest. The lighter color helps them to blend in better with the desert floor and with the brushy vegetation that is found in desert environments.

KEY INTERNET SEARCH WORDS

mountain lion

Felis concolor

Figure 8–7 Distribution map of the mountain lion.

MAMMAL PROFILE

Mountain Lion *(Felis concolor)*

The mountain lion is often called a **puma**, see Figure 8–6. Other names for the mountain lion are cougar or panther. It is a large, tan-colored cat, weighing up to 175 pounds and measuring 7.5 feet in length.

Figure 8–6 A mountain lion prefers to eat deer, but it also eats many other animals when it gets the opportunity. *Courtesy U.S. Fish and Wildlife Service.*

Pumas are able to adapt to many different kinds of environments. Their range is mostly confined to the Western United States, but they are also found in isolated areas in the Appalachian Mountains and in Florida. Their habitats are found on high mountain tops, in the deserts, and in humid jungle regions expanding into Central and South America, see Figure 8–7. Although deer are the favorite prey of the mountain lion, it will kill and eat many other animals including elk, porcupines, sheep, cattle, and horses. Rare instances have also been reported where pumas have attacked and killed humans.

Kittens are born in late winter or early spring. They are blind and helpless at birth and covered with spots. Their eyes open about a week after they are born. Up to five young are born, and they feed only on their mother's milk for several months. Young pumas sometimes stay with their mothers until they are 2 years old. Adult males are solitary animals that occupy and defend their territory against intrusion by other lions.

Several other wild cats are found in North America, see Figure 8–8. They include the ocelot, see Figure 8–9, the margay, and the jaguarundi or otter cat. The **ocelot** is a spotted cat that ranges from Texas and Arizona to Central America. It preys on small animals, birds, and reptiles from

the deserts of the southwest to the tropical forests of Central America. Ocelots breed at any time of the year, and two kittens are born several weeks later.

The **margay** and **jaguarundi** are relatives of the ocelot. They range in the extreme southern areas of the United States and south to South America. The ocelot, margay, and jaguarundi are all listed as endangered species.

KEY INTERNET SEARCH WORDS

wildcats

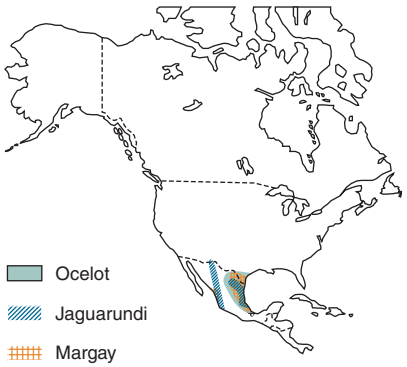


Figure 8–8 Distribution map of the margay, ocelot, and jaguarundi.

Figure 8–9 An ocelot is a rare predator that feeds on birds, small animals, and reptiles. *Courtesy U.S. Fish and Wildlife Service. Photo by William Hutchinson.*

KEY INTERNET SEARCH WORDS

jaguar

Felis onca

Figure 8–10 Distribution map of the jaguar.

MAMMAL PROFILE

Jaguar *(Felis onca)*

The **jaguar** is the largest cat living on the North American continent, see Figure 8–10. Its spotted coat resembles that of a leopard. Its range extends across forests, plains, deserts, and mountains, and it eats deer, peccaries, and a number of other large and small animals. Jaguars also prey on domestic livestock such as sheep, cattle, and horses. The jaguar stands 27–30 inches tall and weighs up to 250 pounds at maturity. It ranges from Mexico to Argentina.

WILD DOGS

Members of the wild dog family include foxes, coyotes, and wolves. All of the wild dogs are meat eaters. They live in a variety of habitats, and they prey on many different kinds of mammals, birds, and fish.

A male fox is called a **dog** and a female is a **vixen**. Mating takes place in late winter or early spring, and the young are born in dens a few weeks later. Dens may be located in rock piles, in hollow logs, or in underground burrows. Cubs usually remain with their parents for a few months until they have been taught to hunt for their own food.

KEY INTERNET SEARCH WORDS

red fox

Vulpes fulva

Figure 8–12 Distribution map of the red fox.

MAMMAL PROFILE

Red Fox *(Vulpes fulva)*

The red fox is easily recognized by its rust-colored coat and full, white-tipped tail, see Figure 8–11. Its ears, legs, and nose may be black, and some members of this species are completely black or silver in color. This fox thrives in farming areas. Four to ten cubs are born in the spring, and both parents help, feed, and care for them.

Red foxes get as tall as 16 inches and weigh up to 15 pounds at maturity. They prey heavily on rodents and birds but will sometimes kill and eat domestic poultry and other small farm animals. Foxes also eat fruit and insects. The range for this fox includes all of North America except the Pacific coast and central plains, see Figure 8–12.

Figure 8–11 A red fox preys on food animals such as rodents and birds. *Courtesy Shutterstock.*

KEY INTERNET SEARCH WORDS

gray fox

Urocyon cinereoargenteus

Figure 8–14 Distribution map of the gray fox.

MAMMAL PROFILE

Gray Fox *(Urocyon cinereoargenteus)*

The gray fox is recognized by its gray coat with reddish, black, and white markings, see Figure 8–13. An adult of this species weighs 7.25–15.5 pounds. It is sometimes called a tree fox because of its habit of climbing trees to escape its enemies. A single litter of one to seven kits is born in the spring in a protected den.

This fox ranges from southern Canada to northern South America, see Figure 8–14. It usually hunts at night and is adept at catching rodents, lizards, insects, and birds. It also is fond of eggs, fruit, nuts, berries, and fish.

Figure 8–13 A gray fox eats rodents, lizards, birds, and insects. *Courtesy U.S. Fish and Wildlife Service.*

Most predatory animals will kill and eat other smaller or weaker predators. Foxes prey upon small animals, but in turn they are preyed upon by bobcats, wolves, coyotes, and other predators that are able to catch and kill them. The most important threats to foxes are humans who hunt them for sport, and who kill them in attempts to protect their pets and livestock.

KEY INTERNET SEARCH WORDS

arctic fox

Alopex lagopus

Figure 8–16 Distribution map of the arctic fox.

MAMMAL PROFILE

Arctic Fox *(Alopex lagopus)*

As its name implies, the arctic fox is a native of the northern tundra region, see Figures 8–15 and 8–16. This fox has a brown coat in the summer that is replaced by a white or grayish-blue coat for the winter. It has short ears, which help to reduce the loss of body heat in the cold climate in which it lives. It also has hair on the bottom of its feet, which gives it better traction on ice.

Figure 8–15 An arctic fox. *Courtesy Shutterstock.*

This fox feeds on lemmings, other small rodents, and birds. When lemmings are scarce, the foxes extend their hunting range to the south in search of other food. They also follow larger predators such as polar bears and wolves and eat from their kills when they have the opportunity to do so.

Adults pair up in March and early April, and cubs are born in late spring in hillside burrows. Four to eight kits are the usual number born, but when lemmings are abundant, the litter size increases. This is probably due to better nutrition before and during **gestation**, the period of pregnancy.

Foxes have long been trapped for their furs. When furs were in the greatest demand, foxes were raised on specialty farms. Today the demand for fox furs has diminished and most commercial fox farms have gone out of business. Trapping of wild foxes also is less common now than it used to be. The foxes that are native to North America are widely distributed across the continent.

KEY INTERNET SEARCH WORDS

kit fox

Vulpes macrotis

Figure 8–18 Distribution map of kit foxes.

MAMMAL PROFILE

Kit Fox *(Vulpes macrotis)*

The kit fox is a small fox that is about one foot tall and weighs between 4 and 6 pounds, see Figure 8–17. This fox is reddish gray in color with a black-tipped tail and dark markings on either side of its nose. It is a nocturnal hunter that preys mostly on insects, lizards, rodents, and rabbits. Its range extends from the southwestern United States to southern Oregon, and its preferred habitat is desert rangelands. (Figure 8–18) The desert swift fox is closely related to the kit fox, and except for its larger ears and lighter color, it is very similar in appearance. A single litter of three to six kits is born in the spring.

Figure 8–17 Kit fox and pups. *Courtesy U.S. Fish and Wildlife Service. Photo by B. Peterson.*

KEY INTERNET SEARCH WORDS

swift fox

Vulpes velox

Figure 8–20 Distribution map of swift fox.

MAMMAL PROFILE

Swift Fox *(Vulpes velox)*

The swift fox is a small, buff-colored fox with large ears. Distinguishing features include dark coloring on either side of its snout and a black tip on its bushy tail, see Figure 8–19. This fox population has suffered from the conversion of the native plant species of the prairie to productive farmlands. It is a native of the plains, thriving on open desert and plains habitat, but is now restricted to habitat that is greatly reduced, see Figure 8–20.

Figure 8–19 Swift fox. *Courtesy Helen Williams. Photo Researchers, Inc.*

The swift fox feeds on insects and small mammals. It constructs its den in a ground burrow, and kits are born in late winter to early spring. Litters usually consist of four to seven kits.

Coyotes and wolves play roles in the environment by preying on rodents, rabbits, hares, peccaries, and hoofed mammals. Both species are sometimes seen as enemies to humans because they also kill pets and domestic livestock when the opportunity arises.

Bounty hunting eliminated much of the wolf population in the United States during the twentieth century. Wolf restoration became a priority of some environmental organizations during the mid-1990s, and the populations in Montana, Wyoming, and Idaho had strongly rebounded by 2008 when the wolf was taken off the endangered species list in these three states, and management of the populations was turned over to the states. Controversy continues, however, because within months of being de-listed from the endangered species list, they were placed back on the list in response to an order of the courts.

During the same period, the coyote adapted very well to living near humans. It even expanded its range in spite of the use of poisons, bounty hunting, and trapping in areas where sheep and cattle are grazed.

INTERNET ADDRESS

http://www.wildtexas.com/wildguides/coyote.htm

KEY INTERNET SEARCH WORDS

coyote

Canis latrans

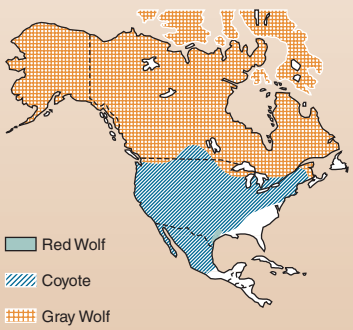


Figure 8–22 Distribution map of coyotes and wolves.

MAMMAL PROFILE

Coyote *(Canis latrans)*

The coyote is sometimes called a prairie wolf or a brush wolf, see Figure 8–21. It ranges from Alaska to Central America, and not only has it adapted to humans, but it has learned to thrive near population centers, see Figure 8–22. It generally feeds on rodents, rabbits, hares, and birds but is also known to prey on fish, domestic cats, and small dogs. They also damage the sheep and cattle industries by killing lambs and newborn calves. The coyote is an **omnivore**, meaning that it eats both plants and animals. Coyotes living near population centers sometimes eat melons and other fruits and vegetables.

Coyotes are tawny colored with black-tipped, bushy tails. They weigh up to 50 pounds, and large males sometimes measure as tall as 26 inches at the shoulder. Coyotes mate for life, and the female gives birth to a large litter of pups in the spring. A large hole in the ground serves as a den until the pups are old enough to follow their parents.

Figure 8–21 The coyote has adapted well to living near humans. *Courtesy Jeffrey Lepore. Photo Researchers, Inc.*

Career Option

PREDATORY ANIMAL CONTROL OFFICER

THE KILLING INSTINCTS of predatory animals regularly bring them into conflict with humans. Animals that develop appetites for domestic livestock are usually eliminated or removed to areas where access to livestock is reduced.

Government agencies that manage public lands employ officers whose duties include controlling predation on livestock. One of their methods includes live trapping for relocation. When this fails or when large numbers of predators are concentrated in a region, the population is reduced by lethal means. A strong background and understanding of the habits and behaviors of wild animals are required.

Wolves and coyotes are related closely enough to domestic dogs that they are capable of interbreeding. This is possible only when there is a close match in the chromosomes of both species. Interbreeding is a serious concern to environmentalists and wildlife biologists who have established wild populations of wolves in Yellowstone National Park and in other remote wilderness areas. They do not want the wild populations to lose their genetic purity through interbreeding because it could reduce their chances of survival in their natural habitat.

KEY INTERNET SEARCH WORDS

gray wolf
Canis lupus

Figure 8–23 The gray wolf is a predator that feeds on deer and other large food animals. *Courtesy U.S. Fish and Wildlife Service. Photo by Gary Kramer.*

MAMMAL PROFILE

Gray Wolf *(Canis lupus)*

The gray wolf is also known as the timber wolf. Its color varies from black to white, including several intermediate shades of color, see Figure 8–23. In North America, the range of this wolf has been greatly reduced as areas have become populated by people. It is now restricted to Alaska, Canada, and the northern forests of Minnesota, Wisconsin, Michigan, Wyoming, Idaho, and Montana.

Wolves mate for life. A single litter of 6–12 pups is born in a den every spring. Only one litter is born in the pack each spring, parented by the alpha male and alpha female. The male hunts for food while the female cares for the pups. After the pups are weaned, they are fed partially digested meat that the parents and other pack members disgorge for them. Members of the pack consist mostly of the older offspring of the dominant pair.

Mature wolves are large. They sometimes weigh as much as 175 pounds and stand as tall as 38 inches at the shoulder. They prey on small and large animals such as rodents, birds, deer, elk, caribou, and moose. When bison were plentiful, wolves followed the herds just as they follow migrating caribou today. Their raids on domestic sheep, cattle, and horses led to the elimination of gray wolf populations in many areas where they were once abundant. The gray wolf is listed as an endangered species in most regions of the United States.

Wolves hunt together in packs made up mostly of family members. A pack of wolves working together can bring down large animals such as moose, elk, caribou and bison. They also prey on rabbits, rodents, and birds. They communicate among themselves by a variety of whimpers, howls, and body language. A single dominant wolf leads the pack, and only the dominant male and his mate produce offspring.

INTERNET ADDRESS

http://www.nsrl.ttu.edu/tmot1/canirufu.htm

KEY INTERNET SEARCH WORDS

red wolf
Canis rufus

MAMMAL PROFILE

Red Wolf *(Canis rufus)*

The red wolf is smaller than the gray wolf but larger than the coyote, see Figure 8–24. Both red and black wolves are found in the population. Red wolves once ranged from Florida to Texas and north to Illinois and Indiana. Today the Florida race of the red wolf is extinct, and the Texas red wolf is listed as an endangered species. The range of its wild population is now restricted to the Alligator River National Wildlife Refuge in North Carolina. Other red wolves are scattered through zoos and captive wolf recovery centers.

Figure 8–24 The red wolf is an endangered species that is found in the wild only in the Alligator River National Wildlife Refuge in North Carolina. They can also be seen in a few zoos and captive wolf recovery centers. *Courtesy Millard H. Sharp. Photo Researchers, Inc.*

BEARS

Bears are the best known and largest predators in North America. There has been an increase in bear populations in the northeastern United States where forests have grown up in areas of abandoned agriculture. Before the land was settled, black bears were found in most wooded areas of North America.

KEY INTERNET SEARCH WORDS

black bear

Ursus americanus

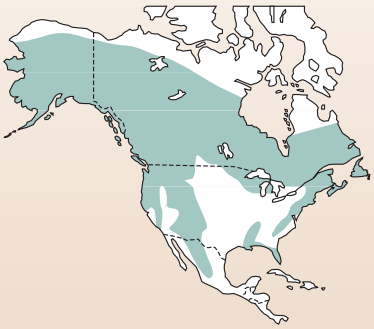


Figure 8–25 Distribution map of the American black bear.

MAMMAL PROFILE

American Black Bear *(Ursus americanus)*

The black bear is the most widely distributed bear in North America, see Figure 8–25. It ranges from the arctic region to central Mexico. Adults usually weigh 200–400 pounds, and large black bears stand as tall as 40 inches at the shoulder. Its colors include black, cinnamon brown, blonde, and chocolate brown, see Figure 8–26.

Bears mate in the summer, and the cubs are born during the winter. Twins are common among black bears, and triplet births occur regularly. Cubs stay with their mothers for several months while they learn to find food and to take care of themselves. At birth they are blind and completely helpless. By the time the female emerges from her winter den, the cubs are large enough to follow her about. When the cubs are in danger, the mother sends them up a tree until the danger passes. Unlike some bears, adult black bears are able to climb trees.

Figure 8–26 The black bear is widely distributed in North America. *Courtesy PhotoDisc*.

Bears require large undisturbed areas covered with forest where they can find plenty of food and protective cover. Most bears are nocturnal, but in undisturbed areas, they spend part of the day looking for food. Bears are omnivores, and they will eat almost any food that they find. Their diet includes grass, berries, insects, rodents, and larger animals when they can catch them. Over half of a bear's diet consists of plants. They have ravenous appetites. They often eat **carrion**, which is the rotting flesh of dead animals. Bears must get fat enough during the summer to keep them from starving to death while they hibernate during the cold winter months.

KEY INTERNET SEARCH WORDS

grizzly bear

Ursus horribilis

MAMMAL PROFILE

Grizzly Bear *(Ursus horribilis)*

The grizzly bear gets its name from the light-colored tips of its hair coat, which gives it a silvery or *grizzled* look. This bear is large and powerful, measuring 6–7 feet in length, 3–3.5 feet tall, and weighing 350–850 pounds. It is afraid of nothing, see Figure 8–27. It has poor eyesight, but its hearing and sense of smell are excellent. It can outrun a horse for a short distance, which enables it to catch some of the larger animals upon which it preys.

The grizzly bear mates in the summer and gives birth to its cubs during the winter hibernation. One to three cubs are normal, with twins being the most common. Bears reach maturity when they are about 10 years old, and they sometimes live for over 30 years.

Grizzly bears require large territories that are isolated from human activity. Conflicts between grizzly bears and humans usually occur when the bears are startled or when they are protecting their cubs. Major conflicts also arise when bears prey on livestock.

Figure 8–27 A grizzly bear is a large predator, but it also eats plants. *Courtesy U.S. Fish and Wildlife Service. Photo by Chris Servheen.*

Bears live alone most of the time. They come together in groups when there is an abundance of food in a small area. This is common when large numbers of fish are moving up a stream to spawn or when a patch of berries ripens.

A mature female bear is called a **sow**, and a mature male bear is a **boar**. Sows with cubs tend to avoid large boars because the boars sometimes kill and eat cubs.

KEY INTERNET SEARCH WORDS

Alaska brown bear

Ursus gyas

MAMMAL PROFILE

Alaska Brown Bear *(Ursus gyas)*

The Alaska brown bear is the second largest bear species in the world, and it is the largest carnivore that lives on land. It weighs up to 1,500 pounds and stands between 4 and 5 feet tall at the shoulder when it reaches maturity. It spends its summers feeding on salmon or any other food that it can find.

Mating occurs in the summer, and up to four tiny cubs are born seven months later. A sow with cubs makes a den in late fall, and they spend the winter together. She remains with her yearling cubs and teaches them to fish for salmon and to find other food.

Alaska brown bears include the huge Kodiac and Peninsula bears, Figure 8–28. Eight different races of Alaska brown bear are known, including the Shiras bear that is almost black in color.

Figure 8–28 Alaska brown bear. *Courtesy U.S. Fish and Wildlife Service. Photo by Steve Hillebrand.*

Most bears eat fish when they are available, but none is more at home in the water than a polar bear. This bear spends its entire life in or near the water, and it sometimes swims far out to sea in search of seals or other prey.

KEY INTERNET SEARCH WORDS

polar bear

Ursus maritimus

MAMMAL PROFILE

Polar Bear *(Ursus maritimus)*

Polar bears are found in the cold arctic regions of North America. They are the largest bears in the world weighing 440–1,300 pounds on average and measuring 7–8 feet in length and 3–4 feet tall at the shoulder. Individual males weighing in excess of 1,750 have been observed. They are completely white except for their dark eyes and nose, see Figure 8–29. Polar bears are carnivores, and except for seaweed, they eat meat for almost every meal. They prey mostly on seals; however, they also eat lemmings, birds, fish, walrus, and whales that have died or become stranded. A hungry polar bear will attack just about any animal it can find, including humans.

Pregnant females go into dens to give birth to their cubs. They are the only polar bears that go into dens during the cold winters. Male polar bears and females with half-grown cubs spend the winter season on the ice looking for seals or other food. The polar bear has poor hearing, but it has excellent eyesight and a keen sense of smell. It depends on these highly developed senses to locate food.

Figure 8–29 The polar bear depends upon the ocean to provide the seals that make up its major source of food. *Courtesy U.S. Fish and Wildlife Service. Photo by Dave Olson.*

WEASELS

The weasel family is made up of an unusual group of predators. It includes the weasel, mink, ferret, fisher, marten, otter, wolverine, badger, and skunk. They are some of the most vicious predators in the animal kingdom. Predators kill to eat, but members of the weasel family often kill many more animals than they need for food. They are relatively small, highly efficient predatory animals that are adapted to survival in the wild.

KEY INTERNET SEARCH WORDS

short-tailed weasel

Mustela erminea

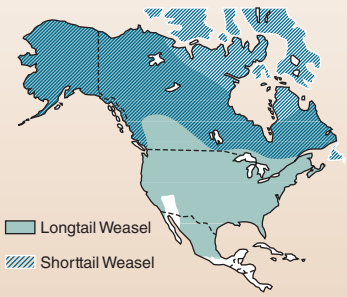


Figure 8–31 Distribution map of the long-tailed weasel and the short-tailed weasel.

MAMMAL PROFILE

Short-Tailed Weasel *(Mustela erminea)*

The short-tailed weasel and its close relatives are long, slender animals with short legs and black-tipped tails, see Figure 8–30. Their coats change color with the seasons—white in the winter and brown in the summer. Such color changes help the weasel to hide more easily from its enemies such as hawks, eagles, and predatory cats and dogs, and to stalk its prey with minimal chance of detection.

Weasels are found in nearly every kind of habitat, where they prey on rabbits, birds, and rodents, see Figure 8–31. During the winter season, they live in underground burrows. Large litters are born in the spring consisting of up to a dozen or more young. The mother begins to teach them to hunt as soon as they are old enough to follow her about. Mature weasels of this species are 7–14 inches long, and they weigh 2–5 ounces.

Figure 8–30 The short-tailed weasel is an efficient predator that eats rabbits, birds, and rodents. *Courtesy U.S. Fish and Wildlife Service. Photo by Steve Hillebrand.*

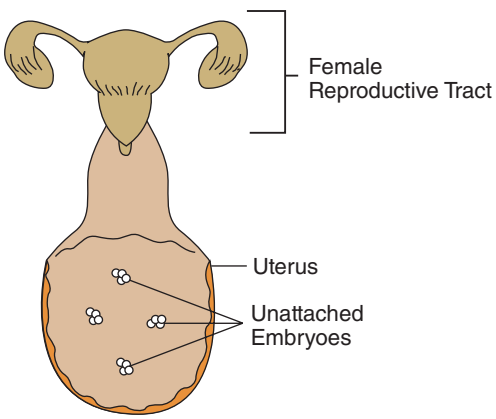


Figure 8–32 Members of the weasel family experience delayed pregnancy following mating. Embryos do not attach to the uterine wall until the chemical makeup of the mother's blood signals the approach of spring.

Most members of the weasel family experience **delayed gestation** following mating, see Figure 8–32. This occurs because the embryo does not become attached to the inner surface of the female's reproductive tract until chemicals in her blood prepare her body for gestation.

Gestation is delayed until the length of the **photoperiod**—the number of daylight hours in a day—increases to signal the longer days of spring. Gestation does not begin in many of these animals until the photoperiod is long enough to assure that the spring season is near and the conditions are favorable for the survival of the young.

INTERNET ADDRESS

http://www.aquatic.uoguelph.ca/mammals/freshwater/accounts/mink.htm

KEY INTERNET SEARCH WORDS

mink

Mustela vison

Figure 8–34 Distribution map of the mink.

MAMMAL PROFILE

Mink *(Mustela vison)*

The mink is an animal that resembles the weasel in the shape of its body. It is bigger than a weasel, however, measuring 18–28 inches long with weights from 1.5 to 3.5 pounds. It ranges in color from light to dark brown with a white spot on the throat, see Figure 8–33. It is an important furbearing animal that is raised commercially on farms. Several fur colors have been bred into domestic mink that are not observed in the wild.

Mink live solitary lives in dens that are often taken from their prey. Adult mink come together only to mate. Four to eight kits are born in the den in the spring. They are completely helpless and blind at birth, and they remain in the den for several weeks.

Mink hunt birds and small mammals on land and crayfish, frogs, snakes, and fish in water habitats. They are active day and night and require large amounts of food to supply their energy. They range throughout the United States and Canada with the exception of the desert regions of the southwest, see Figure 8–34.

Figure 8–33 The mink is a prized fur-bearing animal. *Courtesy Shutterstock.*

The existence of predatory animals depends on adequate populations of animals that are acceptable as food. When a predator becomes so specialized that it depends on a single food source and it is unable to adapt to a different diet, it faces possible extinction, especially when the population of its prey declines.

INTERNET ADDRESS

http://www.nsrl.ttu.edu/tmot1/mustnigr.htm

KEY INTERNET SEARCH WORDS

black-footed ferret

Mustela nigripes

MAMMAL PROFILE

Black-Footed Ferret (*Mustela nigripes*)

The black-footed ferret is a medium-sized member of the weasel family that measures 18–22 inches in length and weighs 2–3 pounds. It is yellowish brown in color, with black feet, forehead, and tail tip. The population of black-footed ferrets has been small for as long as the animal has been known, see Figure 8–35. Its range is the plains region bordering the Rocky Mountains on the east. This animal eats prairie dogs as its principal source of food. As prairie dog populations have declined, a serious decline has been observed in the population of black-footed ferrets. It has been a protected species since 1967. Several times, it has been thought to be extinct, but its numbers have been augmented by breeding it in captivity. These captive animals are reintroduced to the wild as the population increases sufficiently to do so.

Figure 8–35 The black-footed ferret is a rare mammal that has been thought to be extinct on several occasions. *Courtesy U.S. Fish and Wildlife Service. Photo by LuRay Parker.*

The long slender bodies of the weasel, mink, ferret, and marten make it possible for these predators to enter the dens of many of the animals they prey upon. This gives them a distinct advantage against their prey. Most rodents and other small animals have no place to go for safety once predators enter their dens.

KEY INTERNET SEARCH WORDS

marten

Martes americana

Figure 8–37 Distribution map of the marten.

MAMMAL PROFILE

Marten (*Martes americana*)

The marten is a large weasel-shaped animal with brown fur and light orange-colored undermarkings, see Figure 8–36. It is 20–25 inches long and weighs 1.5–2.75 pounds. It is an agile climber that pursues tree squirrels and other prey such as rodents, rabbits, birds, and insects. It also eats the fruits of some plants.

Martens live in forested areas extending from the northeastern states across Canada and much of Alaska. They also range along the Pacific coast and in the Rocky Mountains, see Figure 8–37. Their dens are often hollow trees lined with dry leaves. Martens mate in the summer, but delayed gestation results in the birth of three or four offspring in the spring. Birth occurs about nine months after mating. The young are blind and helpless when they are born, but by fall, they will have learned to hunt alone.

Figure 8–36 A marten is an agile climber that lives in forested areas. *Courtesy U.S. Fish and Wildlife Service.*

Members of the weasel family have glands at the base of the tail from which a foul-smelling fluid known as **musk** is secreted when the animal is disturbed or frightened. It is also used during the mating season to attract a mate. Nearly everyone is familiar with the odor of a skunk, but few people realize that other members of the weasel family have scent glands too.

INTERNET ADDRESS

http://www.pacificbio.org/ESIN/Mammals/PacificFisher/fisher_page.htm

KEY INTERNET SEARCH WORDS

fisher

Martes pennanti

Figure 8–39 Distribution map of fishers

MAMMAL PROFILE

Fisher *(Martes pennanti)*

Figure 8–38 The fisher. *Courtesy Art Wolfe. Photo Researchers, Inc.*

The fisher is an efficient predator whether it is on the ground or climbing trees, see Figure 8–38. This dark-colored predator ranges across Canada with populations occurring in the United States in the Rocky Mountains of the west and mountainous region of the northeast, see Figure 8–39. It preys on all kinds of birds and mammals. The only fish it is likely to eat is one that it has stolen from another predator. A large fisher seldom weighs more than 12 pounds; however, it is capable of killing a deer. It is one of the few animals that consistently preys on porcupines. It does this by flipping the porcupine over onto its back and biting the throat or belly where there are no quills.

The female fisher gives birth in the spring to three or four young in the hollow trunk of a standing tree. Soon after they are born, she mates again. Delayed gestation accounts for her extended pregnancy. Mother and young usually split up when winter comes, and they establish separate hunting territories.

Several kinds of skunks are found in North America. Among them are the hog-nosed skunks and hooded skunks that range from the southwestern United States to Central America. Spotted skunks and striped skunks are more widely distributed, see Figure 8–40.

KEY INTERNET SEARCH WORDS

striped skunk

Mephitis mephitis

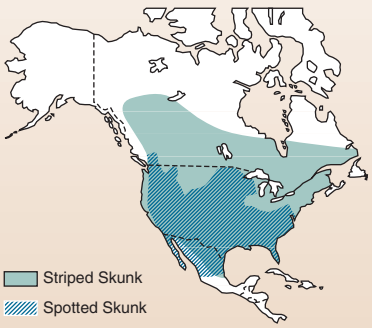


Figure 8–40 Distribution map of skunks.

MAMMAL PROFILE

Striped Skunk *(Mephitis mephitis)*

The striped skunk is recognized by its distinct white stripes on a black body, see Figure 8–41. It is 20–30 inches long and weighs 4–9.75 pounds. The skunk odor comes from musk secreted by scent glands located near the base of the tail. An enemy that gets too close to the raised tail of a skunk is likely to be the target of a well-directed stream of musk. A few predators such as the great horned owl, cougar, mink, and coyote will kill and eat skunks despite the pungent smell.

Skunks are omnivores that feed on berries, nuts, fruits, insects, rodents, frogs, and birds. They also kill chickens and eat eggs when the opportunity arises. They live in burrows, sometimes in groups, located underground or under buildings or piles of debris. Their range extends from Canada to Mexico and includes desert, plains, and woodland habitats. Four or five young are born in the spring, and they may remain with their mother when she enters the den to sleep through the cold months of winter.

Figure 8–41 The striped skunk is widely distributed in the United States and Mexico. *Courtesy U.S. Fish and Wildlife Service. Photo by C.J. Henry.*

The badger and wolverine have a distinctly different body form from other members of the weasel family. They have short, powerful legs and heavy bodies combined with strong teeth and claws. They are among the strongest animals considering their size.

INTERNET ADDRESS

http://animaldiversity.ummz.umich.edu/accounts/taxidea/t._taxus$media.html

KEY INTERNET SEARCH WORDS

badger

Taxidea taxus

Figure 8–43 Distribution map of the badger.

MAMMAL PROFILE

Badger *(Taxidea taxus)*

The badger is a predator that is equipped with long digging claws, see Figure 8–42. It uses them to dig for mice, gophers, squirrels, and other small mammals that live in underground burrows. A badger can dig a hole fast enough to escape many of its enemies, filling the hole behind it as it digs.

Badgers live in underground burrows and make nests of dried grass at the ends of their tunnels. Up to five young are born in the nest in late winter or early spring. They are helpless and blind at birth, and they stay in the den for several weeks. When the spring season arrives, they are strong enough to join their mother on hunting trips.

The coat of the badger is grizzled with a silvery appearance, and its face and head are marked with white stripes. Mature males often weigh over 20 pounds, and they are sometimes as long as 30 inches. Their range includes much of the western United States and southwestern Canada, extending as far south as Mexico, see Figure 8–43. The badger's preferred habitat includes open areas and farmlands.

Figure 8–42 A badger is equipped with strong claws for digging up mice, gophers, and other small animals. *Courtesy U.S. Fish and Wildlife Service.*

Members of the weasel family prey on nearly every animal in North America. They consider every living creature to be a potential meal. All of these animals are fearless predators that do not hesitate to attack much larger creatures.

INTERNET ADDRESS

http://animaldiversity.ummz.umich.edu/accounts/gulo/g._gulo$narrative.html

KEY INTERNET SEARCH WORDS

wolverine

Gulo gulo

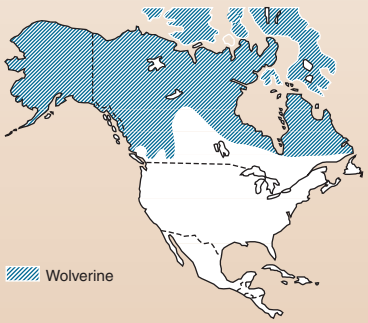


Figure 8–45 Distribution map of the wolverine.

MAMMAL PROFILE

Wolverine *(Gulo gulo)*

The wolverine is one of the most aggressive predators in North America, see Figure 8–44. It is known to prey on animals as large as the caribou and to drive bears and mountain lions from their kills. It has no fear of man, and it has been known to break into cabins and caches containing food supplies. It usually destroys anything it finds. Anything that is left after it has eaten its fill is sprayed with musk to establish its ownership. Wolverines prefer mountain, forest, and tundra habitats. They sometimes climb trees to lie in wait for prey. Wolverines have great endurance, and sometimes they pursue an animal until it is exhausted and unable to get away.

Adult wolverines live alone except during the mating season. Two or three young are born in late spring. During the summer, their mother teaches them to hunt, and by winter, they are on their own.

Mature wolverines weigh up to 60 pounds, and they are the largest members of the weasel family. They look like small brown bears with light-colored markings around their rumps and along their sides. The range of the wolverine extends from Alaska to the forests of the northwest and northern California, see Figure 8–45.

Figure 8–44 The wolverine is an aggressive predator that is capable of intimidating much larger predators like bears, wolves, and mountain lions. *Courtesy U.S. Fish and Wildlife Service. Photo by Steve Hillebrand.*

Some of the most valuable furs in the world once came from otters. Sea otter pelts were responsible for much of the exploration of Alaska and the northwest coast of North America,

Figure 8–46 Distribution map of the otter.

see Figure 8–46. Otter pelts drew trade from many parts of the world during the eighteenth and the nineteenth centuries. This brisk trade nearly caused the extinction of the sea otter as they were slaughtered for their pelts with no thought of preserving the population. It is now illegal in most places to take otter pelts because populations of both river and sea otters have declined, although river otters are still frequently found in some areas.

KEY INTERNET SEARCH WORDS

river otter

Lutra canadensis

MAMMAL PROFILE

River Otter *(Lutra canadensis)*

The body of a river otter is shaped much like that of a mink, and the quality of the fur is similar. The otter is much larger than a mink, weighing as much as 30 pounds and measuring as long as 55 inches, see Figure 8–47. It is an expert at catching fish, snakes, and other aquatic animals. River otters prefer wetland habitats that have cover, such as woodlands. Their range used to extend to many parts of North America, but they are now found in scattered pockets within their former range.

Pups are born in the spring in a den under a stream bank, and the female protects them carefully from every possible danger. Otters are sociable animals that live together in family groups. They are also playful animals, building mud slides down stream banks where they frolic together.

Figure 8–47 A river otter. *Courtesy U.S. Fish and Wildlife. Photo by Dave Menke.*

KEY INTERNET SEARCH WORDS

sea otter

Enhydra lutris

MAMMAL PROFILE

Sea Otter *(Enhydra lutris)*

Sea otters are larger than river otters, and they spend their time in the coastal waters of Alaska, Washington, Oregon, California, and Mexico, see Figure 8–48. A female gives birth to a single pup in the spring. Pups are developed enough at birth to survive in the water, and their eyes are open. They have waterproof fur to keep them warm, since they do not have blubber to insulate their bodies like most mammals.

Female sea otters cuddle their young and carry them about as they swim. They rest and hide from predators in kelp beds. The favorite foods of the sea otter are abalone, mussels, crabs, and fish. Pups remain with their mothers for a year or more and continue to depend upon them even after they are grown. The U.S. Fish and Wildlife Service placed this otter on the threatened species list in California.

Figure 8–48 The sea otter obtains its food from the animal life in the ocean. *Courtesy PhotoDisc.*

RACCOONS

Raccoons are among the most adaptable animals in North America. They are found in nearly every habitat from deserts to woodlands. They are adept at swimming and at climbing trees, and they can find food almost anywhere. They live in house subdivisions almost as easily as they live in the woods. Raccoons seem to find advantages in living near humans. They find shelter in human structures, and they eat garbage and other foods that are abundant near humans.

KEY INTERNET SEARCH WORDS

raccoon

Procyon lotor

Figure 8–49 Distribution map of the raccoon.

MAMMAL PROFILE

Raccoon (*Procyon lotor*)

The raccoon is a nocturnal animal that ranges from southern Canada to South America, see Figure 8–49. They eat almost anything that is edible, but they are especially fond of shellfish. The habitats of raccoons nearly always include water, and their preferred habitat is located along wooded streams.

Raccoons are recognized by their black-ringed tails and their masked faces, see Figure 8–50. The white hair in their brown coats helps them to blend in with their surroundings. A large raccoon may weigh as much as 30 pounds, but some species are as small as 5 pounds. Three to six young are born in the spring, and they stay with their mother until the following year.

Figure 8–50 The raccoon prefers a habitat near water, and it is well adapted to living near humans. *Courtesy U.S. Fish and Wildlife Service. Photo by Dave Menke.*

LOOKING BACK

Predators fill important roles in ecosystems by keeping populations of primary consumers from expanding too rapidly. When populations of food animals rise, predators gain an abundant food supply. This soon prompts a rise in the predator population. When the predator population gets too large or when diseases infect the primary consumers, populations of food animals decline. As the food supply for predators is reduced, the predator population also declines due to starvation, diseases, and reduced birth rates.

The predators that were discussed in this chapter are the wild cats, wild dogs, bears, weasels, and raccoons. All of these predators feed on rodents and birds. Some of them also feed on hoofed mammals, and some predators eat other predators. Many of the predators also eat carrion. Predatory mammals influence the rates at which most animal populations expand. This helps to prevent extreme fluctuation in animal numbers. It also tends to reduce instances of mass starvation of animal populations that have outgrown their food supplies.

Chapter Review

DISCUSSION AND ESSAY

1. Explain how food supplies, diseases, and natural disasters affect the rise or decline of the animal populations near your home.
2. Describe how predatory animals play a role in stabilizing populations of primary consumers in the food web.
3. What roles do wild cats fill in the ecosystems of North America?
4. Select a predatory animal and summarize the events in its life cycle and their significance, such as the timing of mating, gestation, birth, and weaning of the young, and other important events.
5. What are the roles of foxes, coyotes, and wolves in the ecosystems where they live?
6. What do bears eat and what are their roles in North America?
7. List some characteristics of members of the weasel family that contribute to their success as predators.
8. What characteristics of raccoons and coyotes have enabled them to thrive in and near human population centers?

MULTIPLE CHOICE

1. The preferred prey of the Canada lynx is:
   a. Deer
   b. Squirrels
   c. Lemmings
   d. Hares
2. Which member of the cat family is widely distributed through most of the United States and Mexico?
   a. Canada lynx
   b. Bobcat
   c. Puma
   d. Ocelot
3. Which member of the cat family preys most heavily upon deer?
   a. Ocelot
   b. Margay
   c. Puma
   d. Bobcat
4. Which of the following members of the cat family is not classified as an endangered species?
   a. Mountain lion
   b. Margay
   c. Ocelot
   d. Jaguarundi

5. Which of the following foxes is distributed only in the northern tundra region of North America?

a. Red fox
b. Kit fox
c. Arctic fox
d. Gray fox

6. The correct term for a male fox is:

a. Dog
b. Lobo
c. Vixen
d. Bitch

7. Which of the following members of the dog family has adapted best to living near humans?

a. Coyote
b. Gray wolf
c. Arctic fox
d. Red wolf

8. Which of the bears is most widely distributed in North America?

a. Alaskan brown bear
b. American black bear
c. Polar bear
d. Grizzly bear

9. Which of the North American bears is the largest?

a. Alaskan brown bear
b. American black bear
c. Polar bear
d. Grizzly bear

10. Which member of the weasel family depends upon prairie dogs as its principle source of food?

a. Short-tailed weasel
b. Mink
c. Black-footed ferret
d. Fisher

11. Which member of the weasel family prefers to live and hunt in forested areas?

a. Striped skunk
b. Martin
c. Black-footed ferret
d. Wolverine

12. Which member of the weasel family is equipped with long digging claws that are used to construct its burros and to dig up small rodents that live in underground burrows?

a. Striped skunk
b. Fisher
c. Badger
d. Wolverine

Learning Activities

1. Assign groups of students to research a predatory animal and have them prepare written and oral reports on their findings. Have each group make an oral presentation to the rest of the class on the species they selected.
2. Identify a person in the area who has a collection of pelts and/or skulls of predatory animals. Fish and game officers are usually aware of people who have these interests. Invite them to bring their materials to class for a presentation.

CHAPTER

9

Marine Mammals

Mammals are found in all types of environments, including the oceans. Mammals that are found in the oceans are called marine mammals. They have special adaptations to their bodies that make it possible for them to survive in ocean environments. They are equipped with flippers instead of feet, see Figure 9–1, and they store layers of fat on their bodies, improving their buoyancy in the water. Fat layers also insulate them from the cold.

After completing this chapter, you should be able to:

- describe how the bodies of marine mammals are adapted for living in the ocean
- name and describe the different kinds of animals that are classified as seals
- identify the differences that distinguish eared seals, true seals, and the walruses from one another
- list the major species of pinnipeds that make up the three seal groups
- evaluate the roles of the seals in marine ecosystems
- analyze the roles of manatees in the North American marine ecosystems
- consider the characteristics of whales that qualify them as mammals
- distinguish between toothed whales and baleen whales
- describe the characteristics of major species of whales found in the oceans of North America.

KEY TERMS

marine mammal
finfeet
pinniped
crustacean
mollusk
shellfish
white coat
manatee
oceanology
oceanologist
blowhole
cetacean
blubber
baleen whale
whalebone
toothed whale
krill
dolphin
cuttlefish
pod

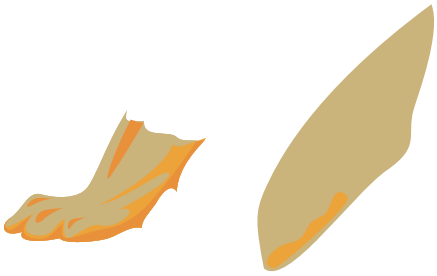


Figure 9–1 Marine mammals have special adaptations to their bodies that make it possible for them to survive in their water environment. Land-based mammals have feet, whereas the marine mammals have flippers.

In contrast with most other life forms that are found in the sea, the marine mammals are warm-blooded animals. They give birth to live young, and they nourish their offspring with milk.

Marine mammals are very much at home in the ocean, and those that can leave the water are usually quite awkward on land. Unlike many sea dwelling animals, they obtain oxygen and eliminate waste gases through their lungs, see Figure 9–2. Most other sea animals exchange respiratory gases across their gills.

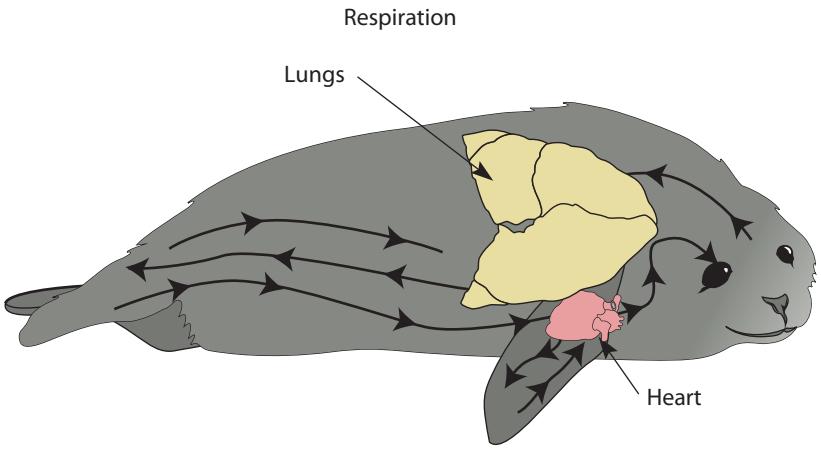


Figure 9–2 The circulatory system functions as the heart pumps blood from the tissues to the lungs where CO_2 is exchanged for O_2. The oxygenated blood is returned to the heart and pumped back to the tissues, completing the cycle.

SEALS

Seals are marine animals that have flippers instead of feet. For this reason, they are sometimes called **finfeet**. Scientists call them **pinnipeds**. Mature pinnipeds are equipped with strong molars that are used to break the shells of the mollusks and crustaceans on which they feed. The different species of seals, sea lions, and walruses are all classified as seals. Fourteen species of these animals live along the coasts and offshore islands of North America. They are found in the Atlantic, Pacific, and Arctic Oceans.

Seals are predators. They eat **crustaceans** such as lobsters and crabs, which have hard outer shells on their bodies, see Figure 9–3. **Mollusks** also make up a part of their diets. These organisms include clams, oysters, mussels, and snails. Mollusks and crustaceans are called **shellfish** because they have shells for protection.

INTERNET ADDRESS

http://www.tmmc.org

KEY INTERNET SEARCH WORDS

seal
pinniped
Marine Mammal Center

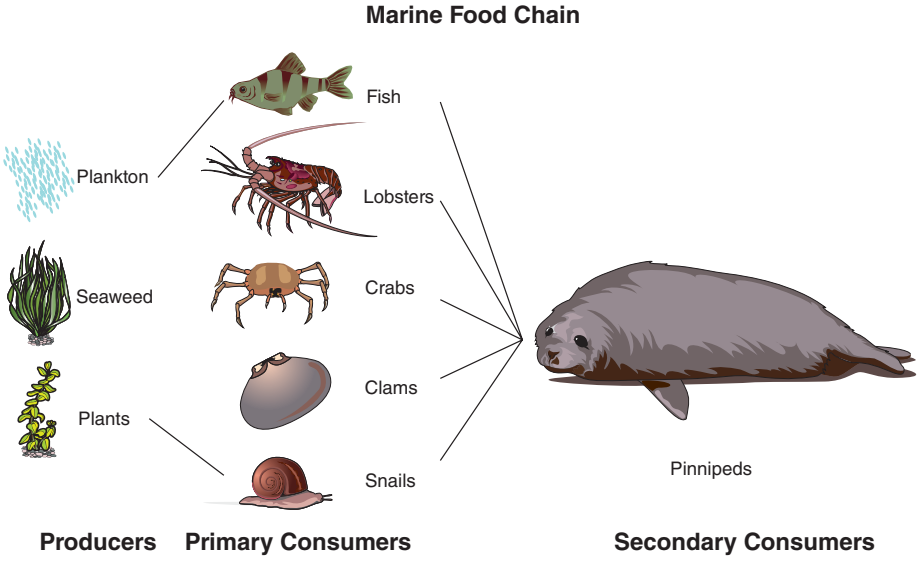


Figure 9–3 Pinnipeds are predators, and their diets include shellfish such as lobsters, crabs, clams, and snails.

Pinnipeds are divided into three major groups—the eared seals, the true seals, and the walruses, see Figure 9–4. Eared seals have small external ears. This group includes sea lions and fur seals. They are able to travel more easily on land than the true seals because they are capable of rotating their rear flippers forward enough to walk and even run. The true seal has no external ears, and its hind flippers cannot be moved forward for travel on land. These seals are very mobile in water, but they must drag their

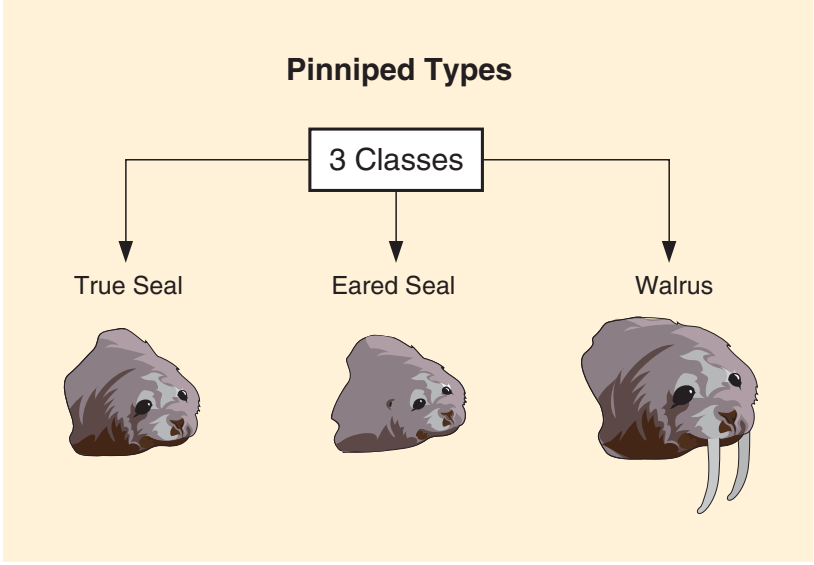


Figure 9–4 Pinnipeds include the true seals, eared seals, and walruses.

bodies on land. Members of this group include harbor seals, harp seals, ribbon seals, and elephant seals.

The walrus is different from both the eared or the true seals. It is the largest seal and the only seal species in this grouping. Its flippers rotate forward enabling it to travel on land, and it has no external ears. Its skin is hairless, and it is equipped with large tusks.

Eared Seals

INTERNET ADDRESS

http://www.bcadventure.com/adventure/wilderness/animals/sealion.htm

KEY INTERNET SEARCH WORDS

California sea lion

Zalophus californianus

Figure 9–6 Distribution map of the California sea lion.

MAMMAL PROFILE

California Sea Lion *(Zalophus californianus)*

The California sea lion is the seal that most animal trainers teach to perform, see Figure 9–5. It is an intelligent animal that is easily tamed and taught to do tricks. In the wild, it ranges from the coasts of southern Canada to southern California, see Figure 9–6.

Cows are mature at about 3 years of age, and they give birth to a pup each year. Bulls establish breeding territories on beaches that they vigorously defend. Cows mate again soon after their calves are born, and the young stay near their mothers for nearly a year. The diet of an adult sea lion includes octopus, squid, crabs, and fish.

Sea lions also occupy a role in the food chain as prey for sharks and killer whales. Adult sea lions grow as large as 8 feet long and they may weigh up to 600 pounds.

Figure 9–5 California sea lions are eared seals. *Courtesy Gary Meszaros. Photo Researchers, Inc.*

Pinnipeds occupy a niche in the marine environment that is similar to that of a small land-based predator like the fox. They feed on sea life much as a fox feeds on rodents and other animals on land; however, they are eaten in turn by larger predators.

KEY INTERNET SEARCH WORDS

stellar sea lion

Eumetopias jubatus

MAMMAL PROFILE

Steller's Sea Lion *(Eumetopias jubatus)*

The Steller's sea lion's range encompasses much of the same territory as the California sea lion, but the territory is bigger, see Figure 9–7. Its diet consists mainly of fish, and it competes with commercial fishermen for salmon. It is capable of diving to depths of several hundred feet in search of food. Mature males measure as long as 12 feet, and they weigh as much as a ton. Females are much smaller than the males. A single pup is born to a mature female each year on the rocky shores of the Barren, Pribilof, and Aleutian Islands and along the West Coast of North America from the Gulf of Alaska to the California Channel Islands.

Figure 9–7 Steller's sea lions consume a diet consisting mostly of fish. *Courtesy U.S. Fish and Wildlife Service. Photo by Anne Morkill.*

The pinnipeds are graceful and move easily through the water. They are somewhat awkward on land, however, and this makes them easy prey for predators such as polar bears and hunters. The young animals of all species have been hunted for their meat, oil, and furs for centuries, and some species have been hunted to near extinction. The Guadalupe fur seal has twice been incorrectly thought to be extinct, because the known breeding herds were destroyed by hunters.

KEY INTERNET SEARCH WORDS

northern fur seal

Callorhinus ursinus

Figure 9–9 Distribution map of the fur seal.

MAMMAL PROFILE

Northern Fur Seal *(Callorhinus ursinus)*

Northern fur seals are one of the species of *eared seals*, having small external ears and rear flippers that can be turned to allow them to walk on hard surfaces such as ice and rocks. Males grow to a length of 6 feet and weigh up to 600 pounds. They are black on the upper body surface, gray on the shoulders, and reddish-colored underneath. Females are much smaller at 4.5 feet in length with an average weight of 135 pounds. They are gray on the upper body and reddish underneath, see Figure 9–8.

The fur seal is a migratory animal. It ranges from the Bering Sea islands to California and Japan. These seals migrate to southern regions during the winter and return primarily to the Pribilof Islands in the Bering Sea, see Figure 9–9, each spring where the bulls fight to establish harems of cows.

The female gives birth to a single pup, and she mates sometime during the summer months to conceive next year's pup. Dominant bulls guard their harems through the entire summer. They don't dare leave even to eat, or their cows will be taken by another bull. By fall, they are thin and exhausted from the difficult summer.

Figure 9–8 The fur seal is a migratory seal that moves between northern and southern territories. *Courtesy U.S. Fish and Wildlife Service. Photo by John and Karen Hollingsworth.*

True Seals

True seals have sleek, smooth heads because they have no external ears. Some of them also have little or no hair on their bodies. They must drag themselves with their front flippers when they come ashore because their rear flippers cannot rotate forward for walking.

INTERNET ADDRESS

http://ourworld.compuserve.com/homepages/jaap/othphoca.htm

KEY INTERNET SEARCH WORDS

harp seal
Phoca groenlandica

Figure 9–11 Distribution of the harp seal.

MAMMAL PROFILE

Harp Seal *(Phoca groenlandica)*

The harp seal is considered to be valuable for its oil and hide, see Figure 9–10. Newborn harp seals are sometimes called **white coats** because of their white fur. The white fur is harvested when the pups are just a few days old. A lot of controversy has been generated by the practice of killing the pups with clubs for their pelts. Mother harp seals nurse their pups for only two or 3 weeks before abandoning them on the ice. During the nursing period, these young seals often gain 50 pounds or more.

Figure 9–10 The harp seal is a furbearing animal that is valued for its white fur. *Courtesy PhotoDisc.*

The abandoned pups live for a week or more on their fat reserves before going into the water in search of food. Soon they are eating fish, squid, mollusks, and crustaceans, and they join the adults again. Harp seals are migratory animals that drift south with pack ice to the Atlantic Coastal region around the Hudson Bay from their northern range in the Arctic, see Figure 9–11. Mature harp seals weigh as much as 500 pounds and measure 5–7 feet long.

The polar bear depends on seal meat for survival. Polar bears and seals are at home on the sea ice of the far northern regions of the continent. The polar bear is profiled in Chapter 8, "Predatory Mammals," in the discussion of predatory land mammals. Seals live in the water, and they seldom leave the water except to give birth and to mate. Polar bears are capable of swimming long distances in the cold water. They venture out on the ice to hunt seals, and they return to the shore when the ice pack breaks up in the spring. Seals also come to the shore at this time. Seals must come to the surface to breathe, and polar bears wait at their blow holes in the ice or at the edge of open water to catch them.

INTERNET ADDRESS

http://ourworld.compuserve.com/homepages/jaap/harbseal.htm

KEY INTERNET SEARCH WORDS

harbor seal

Phoca vitulina

Figure 9–13 Distribution map of the harbor seal.

MAMMAL PROFILE

Harbor Seal *(Phoca vitulina)*

The harbor seal is the most widely distributed seal in North America, see Figure 9–12. It is found near the shore on both coasts, in the Bering Sea, Arctic Ocean, and along major coastal rivers, see Figure 9–13. Its extensive range results from its adaptability and wide tolerance of temperature and water salinity. These seals live in small groups of 30–80 animals with groups being larger in areas where food is plentiful. Pups are born in the spring, and within a few days, they shed their newborn white coats for spotted ones.

Seals prefer diets consisting of fish, crustaceans, and mollusks that are abundant on the seabed. Pups grow quickly due to the richness of their mother's milk. Within a few weeks they are weaned, and they learn to feed with the adults. Female seals usually have one or sometimes two pups each year. Mature harbor seals average 220 pounds and measure 5.5 feet in length.

Figure 9–12 The harbor seal is the most widely distributed seal in North America. *Courtesy U.S. Fish and Wildlife Service. Photo by Sue Matthews.*

Walrus

Walruses are found in the Atlantic, Pacific, and Arctic regions of North America. They are large sea mammals that are grouped with the seals. One way that they are different from other pinnipeds is that both sexes have tusks.

KEY INTERNET SEARCH WORDS

walrus

Odobenus rosmarus

Figure 9–15 Distribution map of the walrus.

MAMMAL PROFILE

Walrus *(Odobenus rosmarus)*

The walrus is the largest pinniped in the Arctic region; adult males are up to 12 feet long and weigh up to 2,700 pounds, see Figure 9–14. It is able to turn its rear flippers forward, allowing it to walk on hard surfaces. Cows are much smaller. Adults have tusks up to 3 feet long that are used to dig for food on the ocean floor. Large bulls also use their tusks to fight for cows during the mating season and to pull themselves from the water onto the ice pack.

The walrus ranges from the Arctic Ocean to areas of the Bering Sea and Hudson Bay, see Figure 9–15. The Arctic ice breaks up as the weather warms, and it floats south, carrying the walrus to the Bering Sea during the summer. In the spring, they migrate back to the Arctic Ocean where the cycle begins again.

Cows have young every 2 years. Walrus calves are born on the ice in the spring, and they live on their mother's milk for about 2 years. When the calf gets tusks, it is able to dig mollusks from the bed of the sea to feed itself. The enemies of the walrus are humans, killer whales, and polar bears.

Figure 9–14 Walrus bulls and cows both are equipped with large tusks. *Courtesy U.S. Fish and Wildlife Service.*

MANATEES

The **manatee** is a large aquatic mammal that resembles a small whale in shape. It is a primary consumer in the food chain, grazing on vegetation that grows in and near the water. It performs a valuable service to humans by keeping coastal waterways from becoming restricted by growing plants. The manatee was once hunted for oil and meat, thus reducing its numbers.

Career Option

OCEANOLOGIST

THE SCIENCE OF OCEANOLOGY is focused on the environments in the world's oceans. An **oceanologist** works with water quality, plants, animals, reefs, and any other features that affect the ability of the ocean to support life. This career field also includes the exploration of underwater environments.

A person who qualifies to become an oceanologist will need a university degree in science with a strong emphasis on biological science. He or she will usually need a graduate degree in a specialty that is within the science of oceanography or closely related to it.

INTERNET ADDRESS

http://www.citrusdirectory.com/hsswp/manatees/types.html

KEY INTERNET SEARCH WORDS

manatee

Trichechus manatus

Figure 9–16 Distribution map of the manatee.

MAMMAL PROFILE

Manatee *(Trichechus manatus)*

The manatee ranges from the warm coastal waters of Florida to South America, see Figure 9–16. Its whalelike body is equipped with paddle-shaped forelimbs, a large flat tail instead of rear limbs, and an upper lip covered with bristles, see Figure 9–17. The manatee can get as large as 1,200 pounds and as long as 15 feet. It is a close relative of the Steller's sea cow that was hunted to extinction by Russian hunters in the late 1700s. It is now classed as an endangered species and protected by law. Only one species now exists in North America.

The manatee gives birth to a single offspring every 2–3 years. These mammals cannot survive temperatures below 46 degrees. Their greatest threat of death comes from motorboat props that injure them before they can dive to safety.

Figure 9–17 The manatee ranges in the warm coastal waters on the Florida coast. *Courtesy U.S. Fish and Wildlife Service. Photo by Jim P. Reid.*

INTERNET ADDRESS

http://www.geocities.com/RainForest/Jungle/1953/b.html

KEY INTERNET SEARCH WORDS

whales

cetaceans

WHALES

Whales are the largest animals on earth. Like other mammals, they are warm-blooded, give birth to live offspring, and nourish their young with milk. They have lungs instead of gills, and they must come to the surface of the water to breathe. A whale has one or two **blowholes** or nostrils on top of its head. Whales are called **cetaceans** by scientists due to the location of their blowholes, their horizontally flattened tails, lack of external hind limbs, and the presence of paddle-like forelimbs.

Whale hunting has long been important to humans because huge amounts of oil can be rendered from the thick layer of **blubber** or fat that insulates the bodies of whales against the cold waters in which they live. Whale oil has long been used to provide heat and light for the dwellings of native Eskimos. Blubber provided the high energy food that was needed to provide body heat in cold climates.

Many of the whale populations of the world have been reduced to dangerously low levels due to harvesting practices that kill whales faster than they are able to reproduce. Declining whale populations have caused enough concern among conservation-minded people that a large movement has started to protect whales. "Save the whales!" a common slogan among these groups, is widely promoted, and even young school children have been exposed to the plight of the whales. Many of the whales are protected in North American coastal waters by the U.S. Fish and Wildlife Service.

There are two types of whales, see Figure 9–18. The **baleen whales** have toothless jaws, and their mouths are equipped with whalebone. **Whalebone** is a comblike sieve composed of horny, flexible material with which whales strain small food organisms out of the water. The

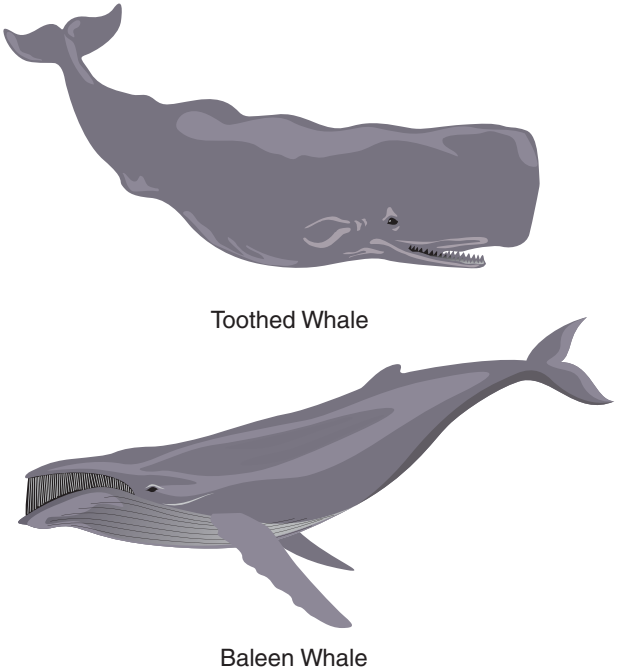


Figure 9–18 Types of whales.

throats of these whales are small, and they are only able to swallow small organisms. Baleen whales also have two blowholes through which they breathe.

Toothed whales have large throats and sharp teeth that are used to attack large prey and to bite it into pieces that are small enough to swallow. The toothed whale has a single blowhole for breathing.

Baleen Whales

The baleen whales include a number of species that strain their food from sea water. These whales swim with their open mouths through masses of plankton or small, shrimplike crustaceans known as **krill**. When a sufficient amount of food has been gathered, they expel the sea water through the whalebone sieves that hang from their upper jaws, collect the food with their tongues, and swallow the trapped organisms.

INTERNET ADDRESS

http://www.nature.ca/notebooks/english/bluwale.htm

KEY INTERNET SEARCH WORDS

blue whale

Balaenoptera musculus

MAMMAL PROFILE

Blue Whale *(Balaenoptera musculus)*

The blue whale is the largest mammal ever to live on earth, see Figure 9–19. Large members of this species reach 100 feet long and weigh as much as 150 tons. This whale has blue coloring mottled with gray. It spends the summers feeding in Arctic waters and goes south in the winter. Its only enemy other than humans is the killer whale.

A blue whale calf weighs 2 tons at birth. Whale milk is high in fat and protein compared to the milk of land mammals, and a whale calf consumes up to 200 pounds of milk every day until it is weaned at about 7 months of age. By then the calf will weigh around 23 tons and measure 52 feet long. The blue whale matures sexually in 4–6 years and has a life expectancy of 30–40 years. It is protected as an endangered species.

Figure 9–19 The blue whale. *Courtesy Shutterstock.*

The baleen whales have been important to the whaling industry for many years. During the nineteenth century, the whalebone or baleen was as valuable to whale hunters as the oil or meat. As much as 1.5 tons of whalebone can be obtained from some species. Three of the baleen whales are discussed in this chapter. Other important baleen whales are the bowhead whale, the gray whale, and the fin whale.

KEY INTERNET SEARCH WORDS

humpback whale

Megaptera novaeangliae

MAMMAL PROFILE

Humpback Whale *(Megaptera novaeangliae)*

The humpback whale is a baleen whale with a black body and a white throat and breast, see Figure 9–20. It is a thick-bodied whale with flippers that are long and narrow (nearly 1/3 as long as the body). The dorsal fin is far back on the whale's body, and the baleen is dark colored. The mature humpback is 40–50 feet long, and it weighs 45–50 tons. It ranges in both the Atlantic and Pacific oceans.

These whales are sexually mature between 4 and 8 years of age. Mating occurs during their migration to warmer waters during the winter and females give birth 11–12 months later. A newborn calf is approximately 16 feet long at birth, and it grows rapidly. It consumes approximately 100 pounds of rich milk each day and is weaned by 7 months of age. Its average weight at weaning is about 10 tons.

This whale was hunted until its population was seriously depleted in the 1960s. An international moratorium on hunting whales was established in 1986 which is honored by most nations, with the result that the humpback whale population has increased significantly.

Figure 9–20 Humpback whale. *Courtesy PhotoDisc.*

KEY INTERNET SEARCH WORDS

right whale

Eubalaena glacialis

Figure 9–22 Distribution map of the right whale.

MAMMAL PROFILE

Right Whale *(Eubalaena glacialis)*

The right whale was once the most common species of whale, see Figure 9–21. It is divided into a northern race and a southern race, with both whale populations protected today as endangered species.

These whales are shorter and more stocky than many of the other whales. Like other baleen whales, they breathe through two blowholes. They measure up to 55 feet in length at maturity, with females slightly larger than males. Right whales are dark gray to black in color, and they are found in the North Atlantic and the Pacific Oceans, see Figure 9–22.

Cows give birth to single calves, to which they are extremely devoted. A cow will stay with her calf even if it is dead. Whale hunters used this devotion against female whales by killing the calf first. The cow was then an easy target because she refused to leave.

Figure 9–21 The right whale is protected as an endangered species. *Courtesy Shutterstock*.

Toothed Whales

The toothed whales include the sperm whales, the killer whales, narwhals, porpoises, and dolphins. They are of many sizes and shapes. The smallest of the toothed whales are called **dolphins** and the large ones are called whales. These two categories are based more on size than upon genetic relationships.

KEY INTERNET SEARCH WORDS

sperm whale

Physeter catodon

MAMMAL PROFILE

Sperm Whale *(Physeter catodon)*

The largest of the toothed whales is the sperm whale, see Figure 9–23. This whale measures up to 50 feet in length and has a very large head and mouth. It feeds on squid, octopus, and cuttlefish. The **cuttlefish** is a squid-like mollusk with 10 arms and a hard internal shell. These creatures are found in deep water. Sperm whales consume as much as a ton of food every day. Sometimes they also eat fish such as herring.

Sperm whales live together in **pods** or herds of females and calves. Each group is led by one or two older cows. Bulls win dominant positions by defeating their challengers, and they enter the herds during the breeding seasons. Calves are born about 16 months after conception. They are nursed by their mothers for 6 months, during which time they double in size. Cows are very protective of their calves, and they remain with them even when they die. Sperm whales are protected by law as an endangered species. They range in all oceans.

Figure 9–23 The sperm whale feeds on squid, octopus, and cuttlefish. *Courtesy Shutterstock.*

Most species of whales are highly intelligent animals. They learn simple tasks quickly, and animal trainers find some of them, particularly the dolphins, to be willing performers. They form social groups called *pods* that feed and travel together. They band together for protection from enemies, and some whales hunt together. Whales have demonstrated an ability to communicate with each other through a series of tones that carry for long distances through the water.

INTERNET ADDRESS

http://www.nsrl.ttu.edu/tmot1/orciorca.htm

KEY INTERNET SEARCH WORDS

killer whale
Orcinus orca

KEY INTERNET SEARCH WORDS

whale songs

Figure 9–25 Distribution map of sperm and killer whales.

MAMMAL PROFILE

Killer Whale *(Orcinus orca)*

Killer whales are black and white in color, and they are the largest of the dolphins, see Figure 9–24. They grow as long as 31 feet and weigh as much as 8 tons. This whale has a reputation as the most feared predator in the oceans of the world, see Figure 9–25. Killer whales frequently hunt together, and they are known to prey upon some of the largest of the marine animals. Their prey includes seals, penguins, walrus, squid, fish, and other whales.

These giant dolphins live together in pods, and they are known to coordinate their movements in attacking large prey. They range in all oceans, and scientists believe that they are able to communicate effectively with one another. A mature female gives birth to a single calf at 2–3 years intervals.

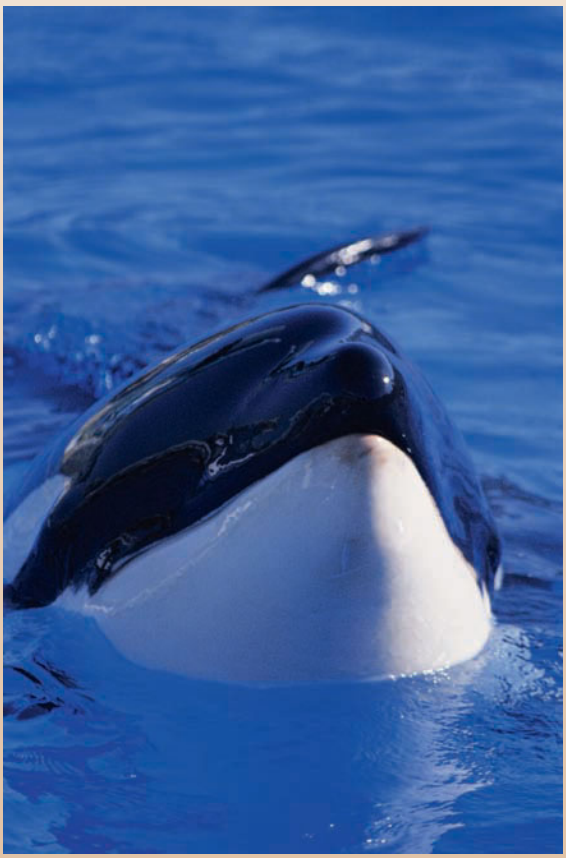


Figure 9–24 Killer whales have the reputation of being the most feared predator in the ocean. *Courtesy PhotoDisc*.

Whales communicate with each other using musical sounds that carry through the water for long distances. The brains of whales appear to be quite highly developed in comparison with most other animals.

KEY INTERNET SEARCH WORDS

narwhal

Monodon monoceros

MAMMAL PROFILE

Narwhal *(Monodon monoceros)*

The narwhal is an unusual whale with a long, hollow spiraled tusk in the left upper jaw of the male, see Figure 9–26. Adult narwhals are 13–16 feet long, weighing 3,500 pounds, and the single tusk of the male can reach 9 feet in length. This animal is countershaded, meaning that it is dark on the top and light-colored on the bottom. Adults develop a leopard-spotted color pattern.

This whale ranges in the far northern latitudes of the Arctic seas. It eats Arctic cod, flatfish, pelagic shrimp, squid, and cephalopods. Females mature at 4–7 years of age and produce a calf approximately every 3 years. Calves are known to stay with their mothers as long as 20 months.

Narwhals have been hunted for food by Eskimos who also prize the ivory tusk. The oil obtained from this whale was traditionally used to provide heat and light for their dwellings.

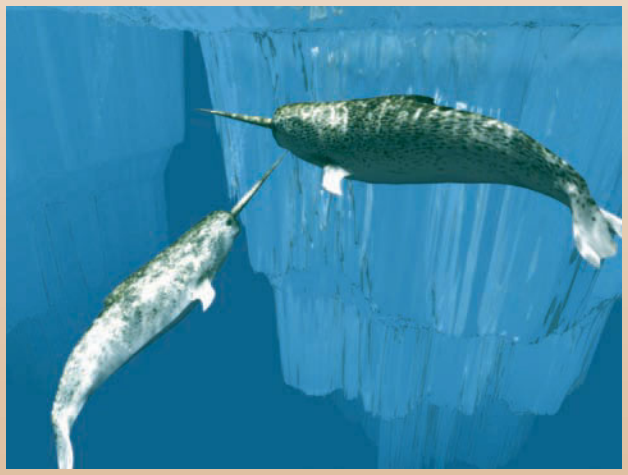


Figure 9–26 A narwhal is a small whale that is distinguished by the single ivory tusk of the male. *Courtesy Christian Darkin. Photo Researchers, Inc.*

Dolphins make up another group of the toothed whales. North American species included in this group are porpoises and dolphins. A characteristic that is used to distinguish dolphins from porpoises is the shape of their mouths, see Figure 9–27. Most dolphins have beak-like mouths lined with teeth. The snout and mouth of a porpoise is more blunt in appearance. These animals are mostly fish eaters that fill roles as secondary consumers in marine environments. The dolphin's appetite for fish includes the tuna. These fish are caught by fishermen using large nets. Dolphins get caught in the nets along with the tuna, and they drown. Modified nets enable many of the dolphins to escape, but they also yield reduced catches of fish. Controversy has developed over the deaths of dolphins in the nets of fishermen.

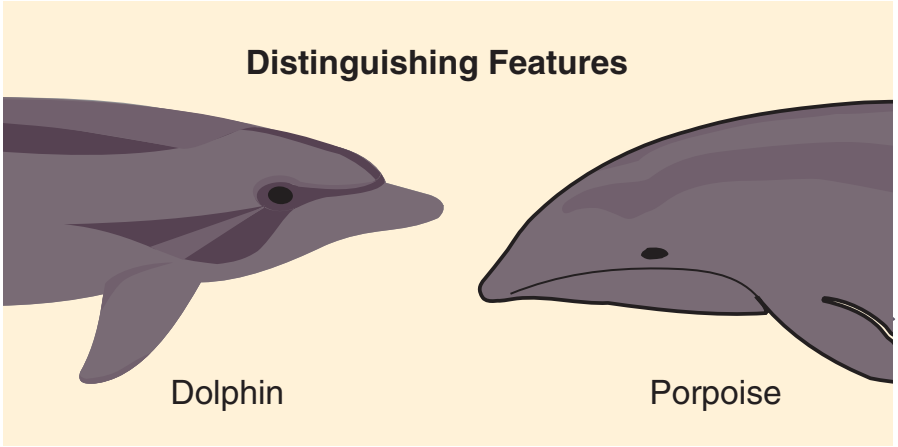


Figure 9–27 Most dolphins have beak-like mouths lined with teeth, whereas the snouts and mouths of most porpoises are blunt in shape.

INTERNET ADDRESS

http://www.angelfire.com/mo2/animals1/cetacean/commondolph.html

KEY INTERNET SEARCH WORDS

common dolphin
Delphinus delphis

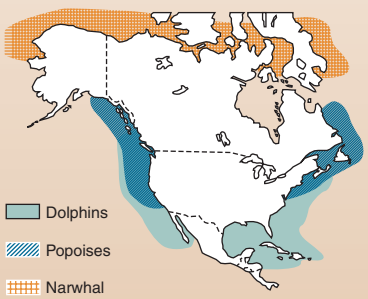


Figure 9–28 Distribution map of dolphins, porpoises, and narwhals.

MAMMAL PROFILE

Common Dolphin *(Delphinus delphis)*

Related species of the common dolphin are found all over the world in warm and temperate seas, see Figure 9–28. This dolphin is common on both the Pacific and Atlantic coasts of North America. They mature at lengths up to 8 feet and weigh up to 180 pounds. Their long, thin jaws that look like pointed beaks lined with sharp teeth distinguish them from porpoises, see Figure 9–29. They are adept at catching the fish that make up their diets. Dolphins are preyed upon by sharks and killer whales.

These dolphins are intelligent animals that are often seen swimming alongside boats and ships at sea. They often live together in large herds. They are very streamlined in their appearance, and the colors that distinguish this species are black backs with brown or yellow sides. A single offspring is born to a mature female every 2–3 years.

Figure 9–29 The common dolphin is found in warm and temperate seas. *Courtesy PhotoDisc.*

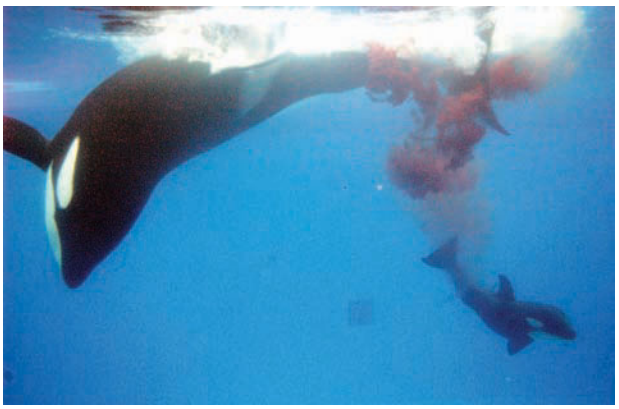


Figure 9–30 Whales and dolphins are born tail first to keep them from filling their lungs with water and drowning. They are fully developed at birth. *Courtesy Getty Images*.

Dolphins and other whales are born tail first to keep them from filling their lungs with water and drowning, see Figure 9–30. They are fully developed at birth, and they live on milk diets during their first several months of life. Mother whales are sometimes seen lying on their sides in the water, making it possible for their young to breathe while they nurse.

KEY INTERNET SEARCH WORDS

bottle-nosed dolphin

Tursiops truncates

Figure 9–31 Distribution map of the bottle-nosed dolphin.

MAMMAL PROFILE

Bottle-Nosed Dolphin *(Tursiops truncatus)*

The Atlantic bottle-nosed dolphin is commonly seen on the Atlantic coast. The Pacific bottle-nosed dolphin is a similar species that is found off the west coasts of the North and South American continents, see Figure 9–31. They are easily domesticated and trained and are sometimes taught to perform tricks in public shows. They are usually 9–12 feet long, with a range that extends from Alaska or New England to South America, see Figure 9–32.

These dolphins mate in the spring or summer, and give birth the following spring. The young dolphins nurse for about 16 months before they are weaned to diets of fish. They are known to rescue other dolphins that are sick by lifting them to the surface to breathe.

Figure 9–32 A bottle-nosed dolphin. *Courtesy PhotoDisc*.

KEY INTERNET SEARCH WORDS

harbor porpoise

Phocaena phocaena

MAMMAL PROFILE

Harbor Porpoise *(Phocaena phocaena)*

The harbor porpoise lives along the Atlantic, Pacific, Bering, and Arctic coasts of North America, see Figure 9–33. It has a medium-sized dorsal fin, a black body, and a light-colored belly. Its mouth is shaped differently from that of a dolphin—it does not have a beak-like appearance. Its flippers are small and the dorsal fin is located slightly behind the center of the body. This adult porpoise is about 6 feet long, and weighs up to 200 pounds, with females being larger than males.

The harbor porpoise requires approximately 10 percent of its body weight in food each day. Fish are the mainstay in the diet, especially cod, herring, sardines, pollock, whiting, and squid. Porpoises give birth in late spring or early summer. By 15 months of age, the porpoise is sexually mature. Killer whales and sharks prey upon harbor porpoises.

Figure 9–33 The harbor porpoise. *Courtesy U.S. National Oceanic and Atmospheric Administration.*

The Sea Otter is a mammal that lives in a marine environment; however, it is included as part of Chapter 8 along with the land otters. It is not included as part of this chapter.

LOOKING BACK

Marine mammals are adapted to living in a seawater environment. They have flippers instead of feet, and they have fat layers in their bodies to insulate against the cold and improve their buoyancy. Fourteen species of seals (pinnipeds) live in the coastal waters of North America. They are classed as eared seals, true seals, or walruses, and they eat fish and shellfish such as mollusks and crustaceans.

Other marine mammals are the whales and manatees. Whales are the largest mammals on earth. They are of two types known as baleen whales and toothed whales. Baleen whales strain small organisms known as krill out of ocean water using the whalebone that lines their jaws. Toothed whales eat larger prey, including fish and other marine animals. Dolphins and porpoises are toothed whales. Manatees are primary consumers in the food chain; however, all of the other marine mammals discussed in this chapter are secondary consumers, see Figure 9–34.

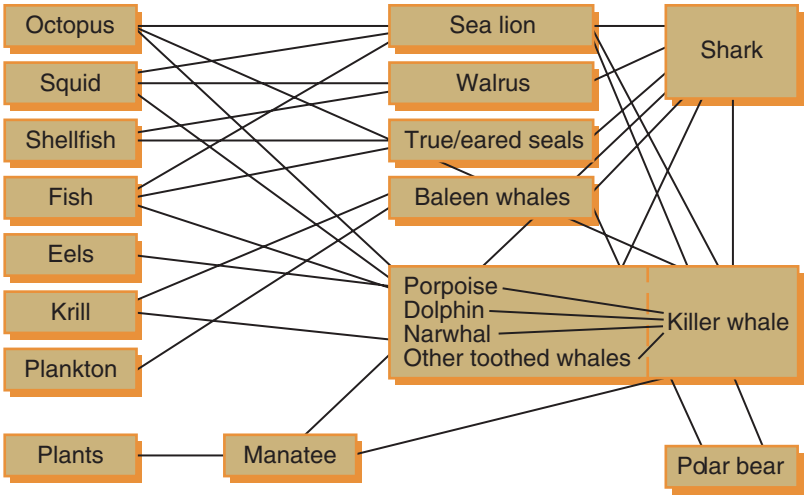


Figure 9–34 The place of marine mammals in the marine food web.

Chapter Review

DISCUSSION AND ESSAY

1. Describe how the bodies of marine mammals, which are adapted to living in the water, are different from the bodies of land-based mammals.
2. Make a chart listing the three different kinds of seals and the distinguishing characteristics of each.
3. Identify the major differences between eared seals, true seals, and walruses.
4. List the species of pinnipeds that belong to each of the three seal groups.
5. Discuss the roles of seals in the marine ecosystem in which they live.
6. Analyze the role that the manatee plays in the North American marine ecosystem.
7. Describe the characteristics of whales that identify them as mammals.
8. List the characteristics that distinguish toothed whales from baleen whales.
9. List the species of whales discussed in the chapter that are found in North America, and describe the characteristics of each that distinguish them from other whales.

MULTIPLE CHOICE

1. Marine mammals are:

   a. Amphibians
   b. Warm-blooded
   c. Fish
   d. Cold-blooded

2. Which of the following descriptions does not apply to the seals?

   a. Pinniped
   b. Gas exchange through gills
   c. Finfeet
   d. Marine animal

3. A seal is a predatory animal that eats which of the following foods?

   a. Krill
   b. Mollusks
   c. Plankton
   d. Water birds

4. Pinnipeds include each of the following classes with the exception of the:

   a. True seal
   b. Manatee
   c. Eared seal
   d. Walrus

5. The California and Steller's sea lions are:

   a. Eared seals
   b. True seals
   c. Whales
   d. Walruses

6. Most of the trained seals that perform in animal acts are:

   a. California sea lions
   b. Northern fur seals
   c. Harp seals
   d. Harbor seals

7. Which of the following sea mammals has tusks in both males and females?

   a. California sea lion
   b. Harp seal
   c. Manatee
   d. Walrus

8. Which of the following sea mammals obtains food by grazing on vegetation in and near water?

   a. Killer whale
   b. Walrus
   c. Manatee
   d. Sea lion

9. Which of the following terms applies to whales?

   a. Cetacean
   b. Crustacean
   c. Pinniped
   d. Mollusk

10. Which of the following whales is a baleen whale?

   a. Killer whale
   b. Sperm whale
   c. Dolphin
   d. Blue whale

11. Whalebone lines the jaws of baleen whales for the purpose of obtaining which of the following foods?

   a. Algae
   b. Krill
   c. Seaweed
   d. Seals

12. Which of the following whales is a predator that eats large marine animals?

   a. Killer whale
   b. Sperm whale
   c. Dolphin
   d. Blue whale

Learning Activities

1. Obtain a video from an educational supplier that describes the habitats and behaviors of one or more species of marine mammals. Watch it in class and identify the critical survival needs, such as habitat, diet, and reproduction, of each animal that is featured.
2. Obtain photographs of the different marine mammals found in North America, and have the class prepare a marine mammal photo display. Assign different class members to prepare a short summary of the behaviors and needs of each animal. Invite elementary school classes to hear the presentation and to view the display.

CHAPTER

10

Unusual Mammals

After completing this chapter, you should be able to:

- describe the reproductive characteristics that make marsupials different from other mammals
- explain how placental mammals nourish their developing babies during gestation
- analyze the roles of opossums in the ecosystems of North America
- speculate on the possible relationships between the rates of metabolism in moles and shrews and their short life spans
- identify the roles of moles and shrews in the ecosystems of North America
- predict the life span of a mammal based on its rate of reproduction
- explain how bats are able to navigate safely as they fly in darkness
- identify how bats are able to match the birthdates of their offspring to favorable survival conditions
- evaluate the roles of bats in North American ecosystems
- appraise the roles of armadillos in the ecosystems in which they live.

Some of the mammals that are found in North America are different in unique ways from all of the other native mammals. Some are highly specialized for living under unusual circumstances. The animals discussed in this chapter are unrelated to any of the other mammals that we have studied in earlier chapters.

KEY TERMS

marsupial
marsupium
placenta
uterus
placental mammal
prehensile
insectivore
metabolism
prolific
carapace

OPOSSUMS

The opossums found in North America belong to an unusual class of pouched animals known as **marsupials**, see Figure 10–1. Most of the surviving animals in this classification are located in Australia. They include the kangaroo, wombat, and bandicoot.

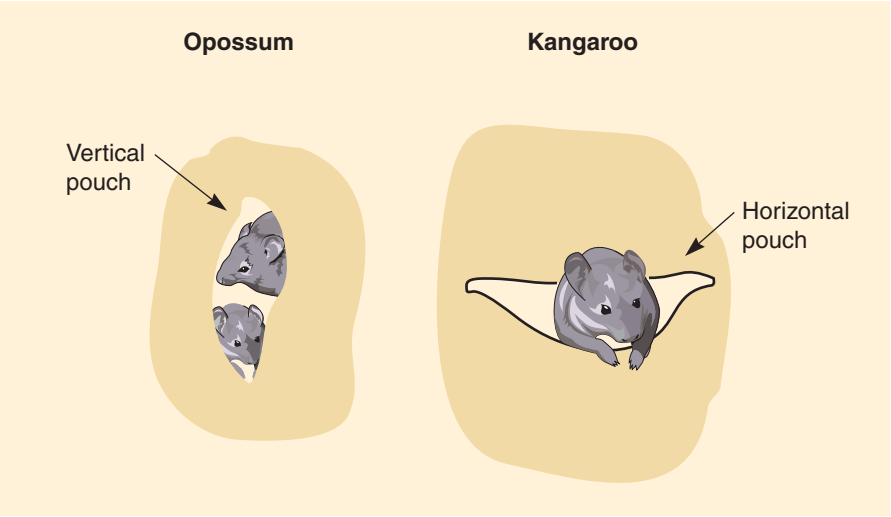


Figure 10–1 Both opossums and kangaroos are marsupials. Their young are not fully developed at birth and must continue to develop in the safety and warmth of their mother's pouch.

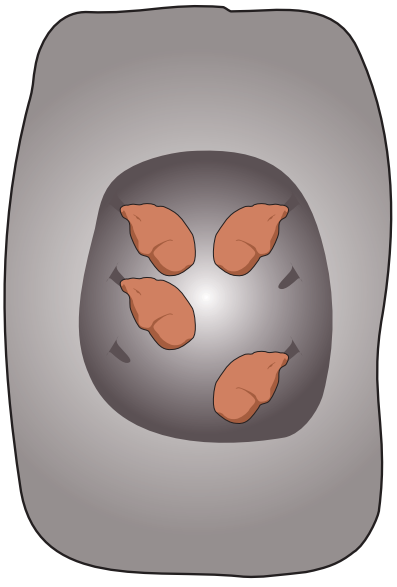


Figure 10–2 Because a marsupial female lacks a placenta to nourish her young, they must obtain nourishment by nursing on the teats located in the mother's pouch.

Prior to birth, the babies of marsupials are free-floating in the mother's uterus. Marsupial females give birth to their young before they are fully developed. The tiny newborn must crawl into the external pouch or **marsupium** of its mother to continue its development. The teats of the mother are located in the marsupium, and the partially developed offspring nurses to obtain nourishment, see Figure 10–2. It rides in its mother's pouch, and it uses the pouch for warmth and protection. As a marsupial matures, it is able to leave the pouch, riding on its mother's back clinging to her fur. Within a few weeks, the young are able to obtain nourishment from other sources.

In contrast to marsupials, most mammalian females nourish their unborn babies through a **placenta**. This organ consists of blood vessels and protective tissues that attach to the inner surface of the female organ called the **uterus**, see Figure 10–3. Nutrients that are needed by an unborn animal flow across the membranes, which separate the blood supply of the mother from the blood supply of her offspring. Once the nutrients reach the blood of the fetus, they are circulated through its body and used as food. Waste materials flow across the membranes to the blood supply of the mother. Her body eliminates these waste materials along with those produced by her own metabolism. Mammals that nourish their unborn young in this manner are called **placental mammals**.

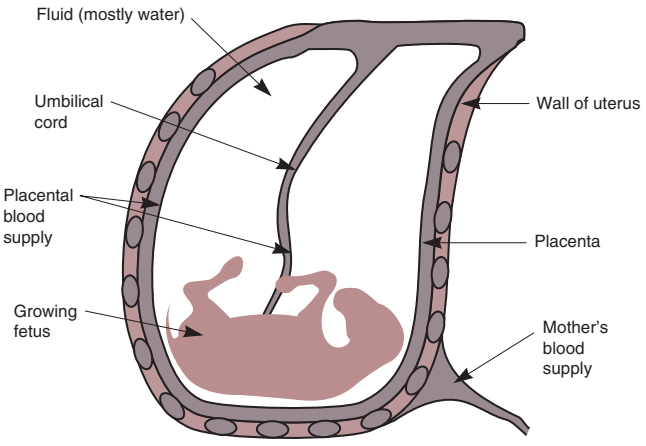


Figure 10–3 The placenta nourishes the unborn offspring of placental mammals.

KEY INTERNET SEARCH WORDS

marsupial

opossum

Didelphis marsupialis

Figure 10–4 Distribution map of the opossum.

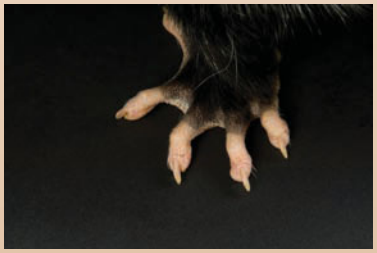


Figure 10–6 Foot of an opossum. *Courtesy Getty Images/Joel Sartore.*

MAMMAL PROFILE

Opossum *(Didelphis marsupialis)*

Figure 10–5 An opossum. *Courtesy Getty Images/Joel Sartore.*

Opossums (commonly called possums) are the only marsupials in North America. Females give birth after a gestation period of only 11–13 days; the young are barely the size of beans when they are born. The number of young in a litter is sometimes 20 or more. They compete with one another for a teat to nurse on, and because females have only 11–13 nipples, the weakest ones die. The mother's warm pouch serves as an incubator until the young are mature enough to survive without its protection. At 3 months of age, they begin to live on their own. The mother carries her offspring on her back from the time they leave the pouch until they are strong enough to follow her. Usually, only one litter per year is produced, although two litters are often born in the same year in southern environments. The opossum's range extends south to Mexico from Southern Canada, including the eastern half of the United States, and the Pacific coastal states, see Figure 10–4.

Mature opossums look somewhat like rats, but they are larger, measuring between 12 and 20 inches in length and weighing from 4 to 12 pounds. They have long, bare, **prehensile** tails, adapted for grasping, that they use like an extra hand to hang upside down from branches, see Figure 10–5. The foot of the opossum is adapted to grasp and hold small objects. They have a clawless opposing toe that is much like the human thumb, see Figure 10–6.

They are nocturnal animals that move about at night. They are omnivores, and they eat insects, frogs, snakes, snails, small birds, voles, seeds, berries, grass, and other green vegetation. They prefer wooded habitats near water, but they can also survive in a wide range of habitats. They are preyed upon by bobcats, foxes, coyotes, birds of prey, and other predators. They are also hunted and eaten by humans. They are known to play dead when they are in danger.

SHREWS AND MOLES

Shrews and moles are small predatory mammals that prey on worms, insects, grubs, crustaceans, and small rodents. They are classed as **insectivores** by scientists because they are animals that feed heavily on insects. Shrews and moles have large appetites, and they spend nearly all their time eating or looking for food. They seldom sleep.

Metabolism includes the processes by which food is digested and used by the cells of the body to release energy. Moles and shrews expend a tremendous amount of energy. Their heart and metabolism rates are very high compared with those of other mammals, and they are extremely active. Thus, they require large amounts of food to sustain their energy levels. A mole will eat its weight in food every day, while a shrew sometimes consumes its weight in food in 3 hours.

The rapid rates of metabolism in moles and shrews are thought to explain why these animals have very short life spans in comparison with other mammals. Moles that are not eaten by predators will probably die of old age before they reach 3 years. Shrews live half that long.

KEY INTERNET SEARCH WORDS

Townsend's mole

Scapanus townsendii

MAMMAL PROFILE

Townsend's Mole *(Scapanus townsendii)*

The Townsend's mole has a long nose and a strong, muscular body with hand-like feet and claws for digging, see Figure 10–7. It is a predator that builds tunnels constantly as it searches for worms, insects, and grubs. Female moles give birth to three or four offspring in March, and by June they will be matured enough to live on their own.

This mole is the largest North American mole, measuring up to 9 inches long. Most of its life is spent underground, but it does come out on the surface occasionally. Its range is generally limited to the coastal areas of the Pacific Northwest. Its preferred habitat is moist areas in meadows, flood plains, fields, and coniferous forests. Other relatives include the eastern mole and the star-nosed mole.

Figure 10–7 A Townsend's mole. *Courtesy Shutterstock.*

Shrews are not as well equipped for digging as moles; however, they still spend a considerable amount of time underground. Shrews have small beady eyes that are not covered with skin as are the eyes of some moles. Shrews have small external ears that are concealed by fur, and moles have no external ears. The front feet of shrews are equipped with much smaller digging claws than those of moles. They are ferocious predators that can kill mice and other animals larger than themselves. They kill and eat other shrews. Some shrews, such as the short-tailed shrew, are equipped with poison glands in their lower jaws. This causes mice and other prey to become paralyzed as the shrew's poisoned saliva penetrates their bite wounds.

Career Option

WILDLIFE TECHNICIAN

A CAREER AS A WILDLIFE technician will require in-depth study and an education to develop specialized skills that deal with wildlife problems. Most careers in this field require a bachelor of science degree. Technicians are usually skilled in gathering appropriate testing materials, such as blood or tissue samples, and in conducting laboratory tests. They may specialize in the causes and treatments of diseases or in finding ways to overcome reproductive problems in certain animals. Whatever the wildlife problem might be, technicians try to find ways to identify the causes and to discover solutions.

Shrews and moles are solitary animals, meaning that they live alone most of the time. They are widely distributed in North American ecosystems, ranging from Alaska to Mexico.

INTERNET ADDRESS

http://animaldiversity.ummz.umich.edu/accounts/blarina/b._brevicauda

KEY INTERNET SEARCH WORDS

short-tailed shrew
Blarina brevicauda

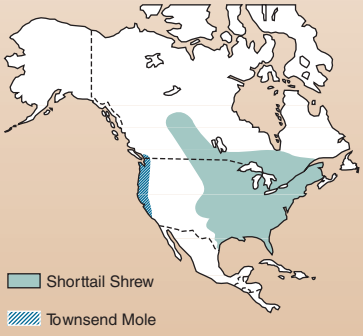


Figure 10–9 Distribution map of the short-tailed shrew and Townsend's mole.

MAMMAL PROFILE

Short-Tailed Shrew *(Blarina brevicauda)*

The short-tailed shrew is gray with very small eyes, a pointed nose, and a short tail, see Figure 10–8. It may be the most deadly predator in relation to its size in the world. It is a vigorous hunter that poisons its victims with its bite. It eats two or three times its weight in food every day, with its diet consisting of insects, snails, worms, and small mice. This shrew is found in the eastern United States and southeastern Canada. Its habitat includes grasslands, forests, brushy areas, and marshes. Females give birth to two to three litters each year, and each litter consists of five to eight offspring, see Figure 10–9.

Figure 10–8 The short-tailed shrew is one of the deadliest predators in the world for its size. *Courtesy Scott Camazine. Photo Researchers, Inc.*

KEY INTERNET SEARCH WORDS

masked shrew

Sorex cinereus

Figure 10–10 A masked shrew. *Courtesy Gary Meszaros. Photo Researchers, Inc.*

Figure 10–12 Distribution map of the masked shrew.

MAMMAL PROFILE

Masked Shrew *(Sorex cinereus)*

The masked shrew is a small, gray-brown mammal with a pointed nose that is found in underground tunnels or hunting for food under the cover of vegetation, see Figure 10–10. Its most critical need is food. A shrew may starve to death in a single day if it doesn't have adequate food, see Figure 10–11. Its metabolism is very high as evidenced by a heartbeat of 1,200 beats per minute. Female shrews become sexually mature at 5–6 months of age and give birth to litters of up to 10 young. A female often becomes pregnant again while she is still nursing a litter. Because they have such large numbers of offspring, these shrews are described as being very **prolific**.

This shrew has adapted to a wide range of climates and conditions, and it can be found from Alaska, across Canada, to the northern tier of states in the United States, see Figure 10–12. It prefers damp areas in brushlands, forests, open grasslands, and fields.

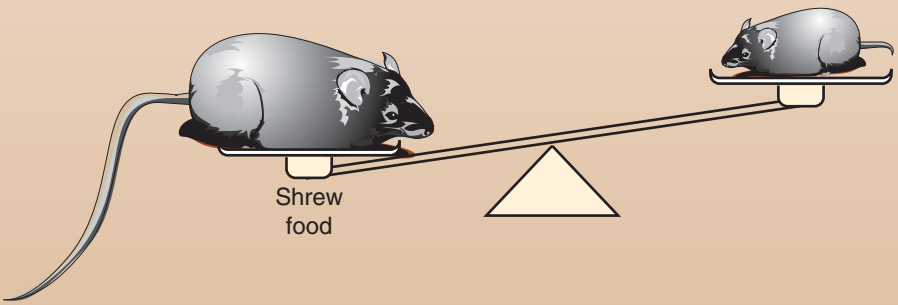


Figure 10–11 A shrew must eat several times its weight in food per day in order to survive.

Shrews and moles are active night and day, and their constant movement makes them vulnerable to predatory birds and animals when they venture above the ground. A short life span is balanced by a prolific reproductive capacity, and they remain plentiful in many regions.

KEY INTERNET SEARCH WORDS

bat

flying mammal

BATS

Bats are the only known mammals that have the ability to fly under their own power. The wings of a bat consist of skin stretched over the bones of their arms and fingers like the webbed foot of a duck, see Figure 10–13. They are furry mammals that bear live offspring and nurse them when they are young.

Bats are warm-blooded animals, but during winter hibernation in a cold cave, their body temperature may fall nearly as low as the surrounding air. Their body processes slow down during hibernation,

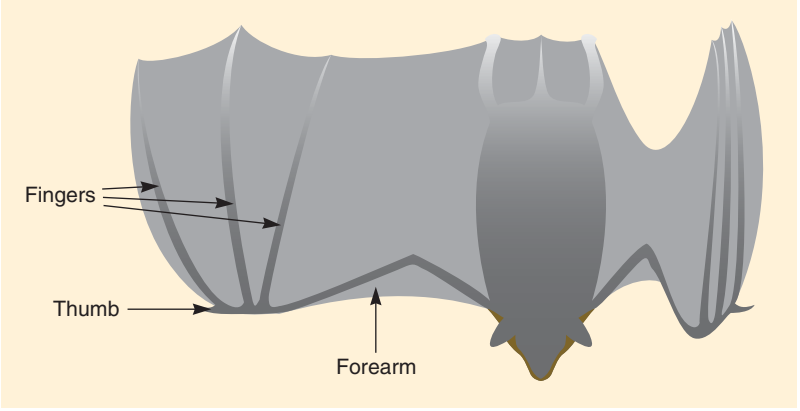


Figure 10–13 The wings of bats are made up of skin stretched over the arms and fingers.

helping them to conserve energy. If the cave temperature is too high, the bat will starve to death during hibernation because its body uses too much energy at the higher temperature. If the temperature drops below freezing, hibernating bats must find a warmer area or die.

A high frequency sound is emitted by a bat during flight to help it locate objects so that it can navigate around them. They are guided by the echoes from their signals as they fly, see Figure 10–14. Using this system, they are able to precisely locate obstacles as well as the insects that many bats feed on. The effect of the echoes from their sound waves is similar in many ways to the use of radar to navigate aircraft.

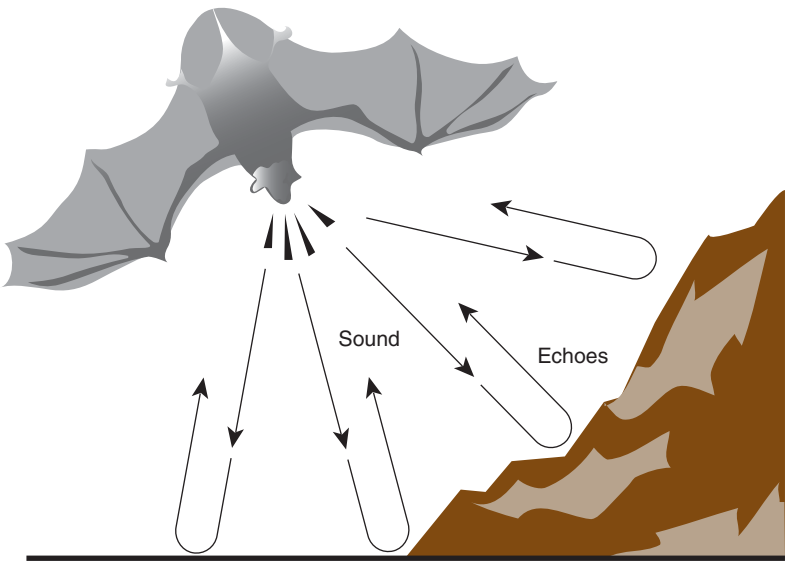


Figure 10–14 Bats are able to navigate by listening to the echoes from their high-pitched cries as they fly.

KEY INTERNET SEARCH WORDS

Mexican freetail bat

Tadarida brasiliensis

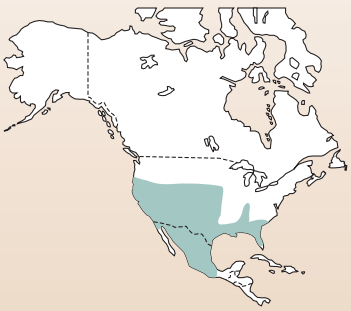


Figure 10–16 Distribution map of the Mexican freetail bat.

MAMMAL PROFILE

Mexican Freetail Bat *(Tadarida brasiliensis)*

The Mexican freetail bat is also known as the guano bat. It has short, soft fur and a long tail, which extends beyond the skin membrane that encloses the tails of most species of bats, see Figure 10–15. It is a cave-dwelling species that is abundant in the South and Southwest, see Figure 10–16. Several million of these bats leave and return to the Carlsbad Caverns in New Mexico and other sites after dusk every day. They hang upside down during the day from the rock surfaces of the cave roof and emerge at dusk to search for the insects that make up their primary source of food. A single offspring called a *pup* is born in June or July, and the mother leaves it with other young bats in the roosting area while she gathers food. Each female is able to identify her own pup among thousands of others in the roosting area.

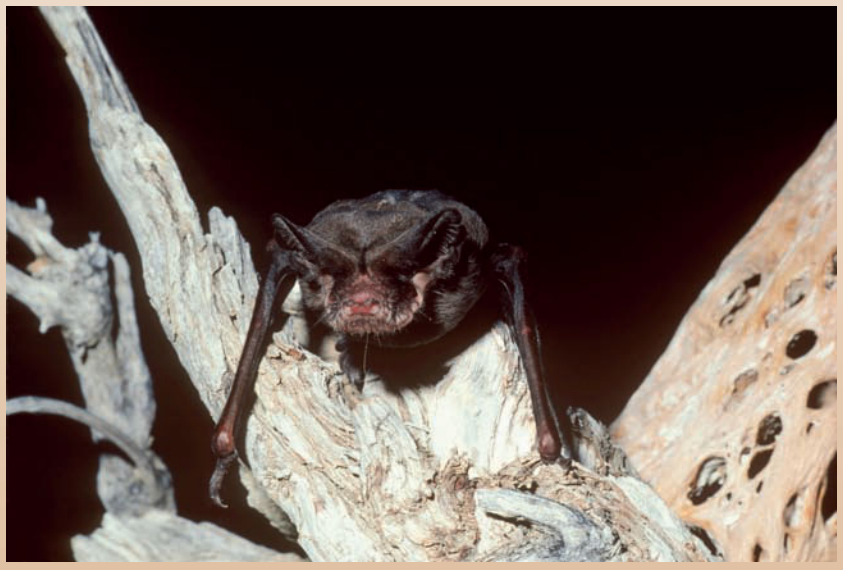


Figure 10–15 Mexican freetail bat. *Courtesy Gilbert S. Grant. Photo Researchers, Inc.*

Based on tag and recapture studies, bats are known to live 20 years or longer. Only a few predators such as owls, hawks, snakes, and cats are successful in catching bats. Their survival rate is quite high compared with most other small mammals. This accounts for the low birth rate in bats, see Figure 10–17. They are able to maintain their population numbers with the birth of only one or two offspring each year.

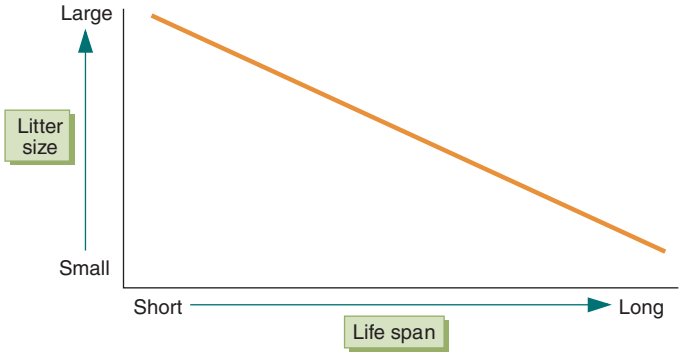


Figure 10–17 The relationship between the life span and litter size of bats.

INTERNET ADDRESS

http://www.nature.ca/notebooks/english/bigbat.htm

KEY INTERNET SEARCH WORDS

big brown bat

Eptesicus fuscus

Figure 10–19 Distribution map of the big brown bat.

MAMMAL PROFILE

Big Brown Bat *(Eptesicus fuscus)*

The big brown bat is large in size with pale to dark brown body color and black membranes, see Figure 10–18. It is widely distributed through Mexico, the United States, and southern Canada, see Figure 10–19. It seeks shelter in wooded areas, buildings, hollow trees, caves, and tunnels. The favorite food of this bat is beetles, but it also eats other insects. Some of these bats migrate south in the winter, while many seek shelter in buildings. Females give birth in May or June. Two offspring is the most common number of offspring, with occasional single births.

Figure 10–18 A big brown bat in flight. *Courtesy Getty Images. Purestock.*

Although many bats mate during the fall before they hibernate, the male sperm is stored in the body of the female until spring when the ovum or egg is fertilized. Young bats are known to cling to the nipples of their mothers as they fly to new roosting areas.

KEY INTERNET SEARCH WORDS

little brown bat

Myotis lucifugus

Figure 10–21 Distribution map of the little brown bat.

MAMMAL PROFILE

Little Brown Bat *(Myotis lucifugus)*

The little brown bat is widely distributed in North America, see Figure 10–20. It ranges from Alaska and Labrador south to California and Mexico, except for the southern coastal and border areas of the United States, see Figure 10–21. It hibernates during the winter in nearly any cave that has a favorable temperature.

Figure 10–20 A little brown bat. *Courtesy Edward Kinsman. Photo Researchers, Inc.*

This bat primarily eats soft insects, such as flies and moths. Female bats leave their caves to give birth in buildings and near water. Mature bats of this species have wing spans of approximately 10 inches and weigh up to a third of an ounce.

Even though several species of bats are widely distributed in North America, they generally do not live in the polar regions or in high mountain areas. In addition to the bats that are discussed in this chapter, several other bats are quite widespread and well known. Nearly all of the bats in this part of the world eat insects. Some bats located in other parts of the world prefer fruit, pollen, nectar, fish, or even blood.

ARMADILLO

The armadillo is found only in North and South America. It is related to the anteaters and sloths that live in Central and South America. Except for its belly, it is covered by a **carapace**, or coat of bony armor.

Armadillos are nocturnal animals. They also are omnivores, eating grubs, ants, roaches, tarantulas, grasshoppers, and other insects along with some plant materials. They live in burrows underground. Coyotes and domestic dogs prey upon them by turning them over and attacking their soft underparts. They are also killed by hunters and cars.

INTERNET ADDRESS

http://www.wildtexas.com/wildguides/armadillo.htm

KEY INTERNET SEARCH WORDS

nine-banded armadillo

Dasypus novemcinctus

Figure 10–23 Distribution map of the armadillo.

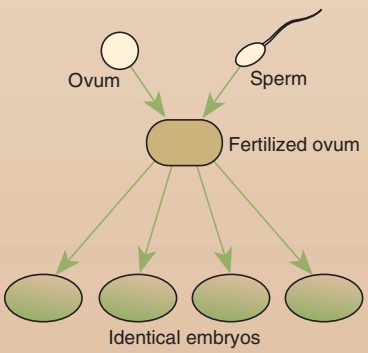


Figure 10–24 Armadillo quadruplets are quite common. The ovum splits into four embryos after being fertilized.

MAMMAL PROFILE

Nine-Banded Armadillo *(Dasypus novemcinctus)*

The nine-banded armadillo is the only animal of its kind found in North America, see Figure 10–22. Its range is restricted to the South central and Southeastern regions of the United States extending south to Mexico, see Figure 10–23. Its preferred habitat is open fields where it can dig. Its nine bands are telescoping joints that help the animal move about quite freely. Like its southern hemisphere relatives, it is well named. The Spanish meaning of armadillo is "little armored thing." Quadruplets are common in armadillo litters. This is because the female produces a single egg or ovum that splits into four embryos after it is fertilized, see Figure 10–24. Each of the offspring in a litter is identical to each of its littermates because all of them were produced from a single fertilized egg cell.

Young armadillos depend on their mother's milk until after they are weaned at about 2 months of age. At this time, she teaches them to root in the ground to find grubs and worms. Mature armadillos of this species are about the size of a domestic housecat.

Figure 10–22 The nine-banded armadillo is protected by a carapace or bony shell. *Courtesy U.S. Fish and Wildlife Service. Photo by John and Karen Hollingsworth.*

LOOKING BACK

Some North American mammals have traits that are different from those of all the other native species. Opossums are marsupial animals. They give birth prematurely, and the offspring continue their development in the mother's marsupium or pouch where they nurse to obtain nourishment. Most other mammals nourish their unborn offspring during this period of development through an internal organ called the placenta.

Moles and shrews are small predatory mammals whose metabolic rates are extremely high. They require large amounts of food to maintain their active lifestyles. They consume their own body weight in food one or more times every day.

Bats are the only mammals that are able to fly under their own power. They have long life spans and low birth rates. Females store the sperm from fall mating until spring, when they conceive and give birth to live offspring.

The armadillo is the only mammal of its kind that is found in North America. It is covered by a carapace or coat of bony armor that surrounds its entire body except for its belly. It gives birth to identical quadruplets that originate from the same ovum.

Chapter Review

DISCUSSION AND ESSAY

1. Describe how reproduction is different in marsupial mammals than it is in placental mammals.
2. Explain how the placenta exchanges nutrients and waste products between the circulatory systems of the mother and her offspring.
3. Identify ways that opossums are unique among the mammals of North America.
4. Explain how the metabolic rates of moles and shrews might be related to the short life spans of these mammals.
5. Identify the roles of moles and shrews in the ecosystems of North America.
6. Describe how an animal's life span might be predicted based on the reproductive rate of the species.
7. Explain the method that bats use to navigate safely as they fly in darkness.

8. Identify how the birthdates of young bats are timed to assure that they are born when conditions are favorable to their survival.
9. Discuss the roles of bats in the environments where they live.
10. Describe the characteristics of armadillos that make them different from other mammals.

MULTIPLE CHOICE

1. Which of these animals is the only American marsupial?

   a. Raccoon
   b. Opossum
   c. Wombat
   d. Kangaroo

2. A young marsupial animal lives and finds nourishment during its early life inside the mother's:

   a. Placenta
   b. Marsupium
   c. Uterus
   d. Incubator

3. The prehensile tail of the opossum is adapted for:

   a. Swimming
   b. Carrying their young
   c. Grasping branches
   d. Fighting

4. A nocturnal animal:

   a. Eats only insects
   b. Has a high metabolism rate
   c. Migrates
   d. Is active at night

5. The mammal with the highest known metabolism rate is a:

   a. Mole
   b. Shrew
   c. Pine mouse
   d. Martin

6. A mammal that lives mostly underground and that eats worms, insects, and grubs is the:

   a. Shrew
   b. Squirrel
   c. Weasel
   d. Mole

7. A shrew is classified as a:

   a. Predator
   b. Omnivore
   c. Herbivore
   d. Producer

8. A bat is classified as a:

   a. Marsupial
   b. Mammal
   c. Rodent
   d. Ungulate

9. The bats are able to navigate during flight using which of the senses:

   a. Smell
   b. Hearing
   c. Sight
   d. Touch

10. The hard outer covering on the body of the armadillo is called a(n):

   a. Carapace
   b. Exoskeleton
   c. Hide
   d. Shell

Learning Activities

1. Assign students to prepare group reports on the mammals discussed in this chapter. Have them prepare visuals and charts for oral presentations in a panel discussion format. Allow time for the groups to answer questions from the class.
2. Obtain commercially prepared specimens of one or more of the animals that are discussed in this chapter, and examine the unique physical characteristics of each in the laboratory. Invite a fish and game expert to talk to the class about the specimens that have been obtained.

SECTION

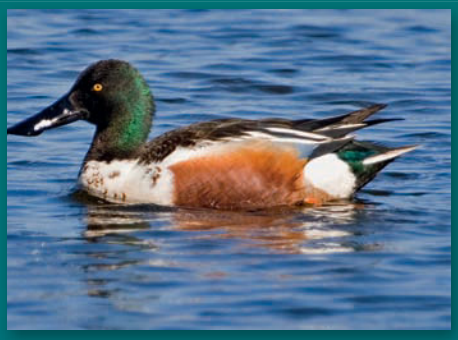
III

Zoology and Ecology of Birds

Birds are members of the class (Aves) of warm-blooded feathered vertebrates, most of which are capable of flight. They reproduce by laying and incubating eggs and care for their young by providing food and warmth. They are widely distributed in North American ecosystems.

CHAPTER

11



Waterfowl

Birds are found in nearly all environments that are capable of supporting life. Each bird species is adapted to its environment by the small differences that make it unique from other birds.

Some birds depend upon a water habitat for protection and for food. These include both swimming and wading birds. This chapter focuses on the swimming birds that are classified by scientists as waterfowl, including ducks, geese, and swans.

After completing this chapter, you should be able to:

- identify birds classified as waterfowl
- define the term oviparous
- clarify how hunting regulations contribute to the protection of waterfowl during critical periods in their life cycles
- describe how the restoration of wetlands contributes to maintaining and increasing populations of migratory waterfowl
- distinguish differences between ducks classified as divers or as surface feeders
- explain how ducks are different from swans and geese in their devotion to their mates
- evaluate the roles of ducks in North American ecosystems
- identify major species of North American ducks, geese, and swans
- suggest ways that the migratory instincts of waterfowl contribute to their survival
- evaluate the roles of geese and swans in North American ecosystems
- identify characteristics of swans that make them more susceptible than geese to declines in their populations.

KEY TERMS

waterfowl
avian
oviparous
incubation
viviparous
ornithology
ornithologist
down
plumage
lamellae
duckling
dabbling duck
molt
gosling
grit
gizzard
cygnet

Birds play important roles in all of the biomes of North America. They belong to a zoological class called Aves, and for this reason, birds are sometimes referred to as **avians**. Some birds are predators, while others eat fleshy fruits, seeds, or other plant parts. All birds are **oviparous**, meaning that they produce eggs that hatch after they leave the body of the female, see Figure 11–1. The eggs hatch only after a period of **incubation** during which time they are warmed by the body heat of a parent (usually the female). In contrast, animals that give birth to live young are **viviparous**.

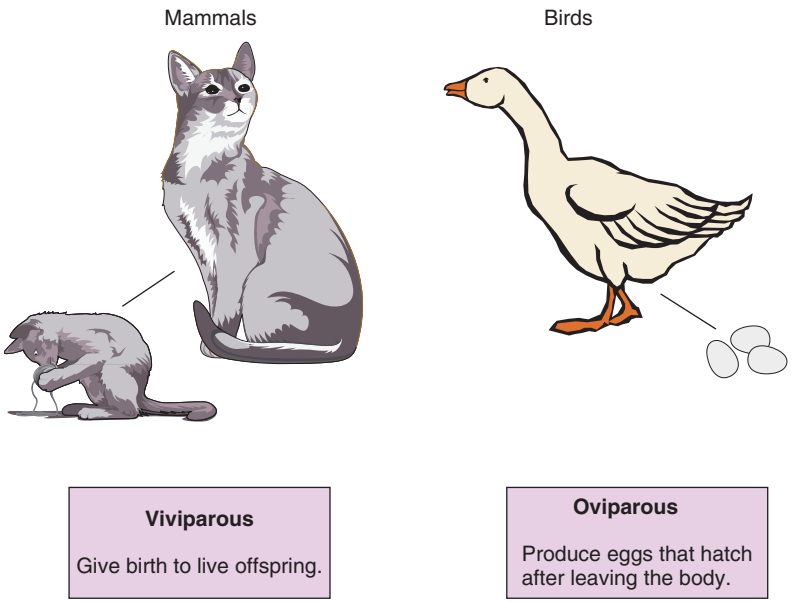


Figure 11–1 Reproduction differences in mammals and birds.

Career Option

ORNITHOLOGIST

THE BRANCH OF ZOOLOGY that studies birds is called **ornithology**. A scientist who studies birds is an **ornithologist**. A career in this field requires a graduate degree in zoology, biology, or a related science, and a specialty in ornithology.

The work of an ornithologist will require gathering research data through fieldwork, and using the data to learn more about the relationships of birds to the environments in which they live. Ornithologists also use their knowledge of bird migration and behavior to assist in the evaluation of hunting regulations and the restoration of endangered and threatened species.

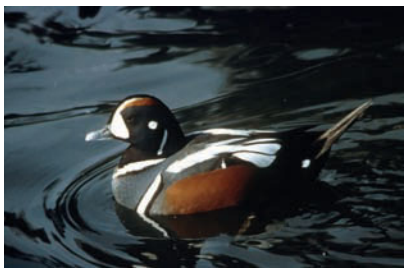


Figure 11–2 The harlequin duck is a brightly colored bird. *Courtesy U.S. Fish and Wildlife Service*. Photo by Glen Smart. *#K8307-9*.

INTERNET ADDRESS

http://www.ns.ec.gc.ca/wildlife/harlequin/

KEY INTERNET SEARCH WORDS

harlequin duck

Waterfowl are adapted to living in and near water. They produce oil that is used to waterproof their outer feathers. They also have an insulating layer of **down** or soft, fluffy feathers beneath this outer coat. The sum total of all of the feathers of a bird make up its **plumage**. Of all the North American birds, the plumage of male waterfowl is among the most colorful, see Figure 11–2.

One hundred and forty-nine species of waterfowl have been identified in the world. Ten of these species are restricted to North America. Fifty more species found in North America are also found on two or more continents.

Hunting regulations protect waterfowl during the critical stages of their life cycles when they are nesting and raising their young. Because nearly all waterfowl are migratory, another crucial period is during their biannual migrations every spring and fall, see Figure 11–3. Organized groups such as the Nature Conservancy, the Izzak Walton League, U.S. Fish and Wildlife Service, and state fish and game agencies contribute to the improvement of water habitats for waterfowl by raising funds that are used to restore wetlands along active migration routes, see Figure 11–4. The prairie pothole region includes some of the most important wetland habitat in North America. This is because it supports migratory waterfowl and provides ideal conditions for duck reproduction.

Figure 11–3 Nearly all waterfowl are migratory and they migrate biannually.

INTERNET ADDRESS

http://www.nature.org/

KEY INTERNET SEARCH WORDS

nature conservancy
Izzak Walton League
state, fish, game, wildlife

Figure 11–4 Wetlands are being improved and maintained along active migration routes. *Courtesy U.S. Fish and Wildlife Service.*

DUCKS

The best-known waterfowl are probably the ducks. These birds have thick, waterproof plumage. The males of most of the duck species are brightly colored, and the females usually have a plain or dull coloring. The beak of a duck is flat with comb-like **lamellae** that it uses to strain small food particles from the water. They have webbed feet and short legs that are placed far back on the body, ideally located for swimming. On land, a duck walks with a waddle due to the placement of its legs.

Many species of ducks migrate south from their breeding grounds to warmer climates for the winter season. This is necessary because these birds must be able to find open water. Because ducks obtain nearly all their food from the water, they would starve if they remained in the northern regions of Canada and Alaska after the water freezes over. When spring comes, they migrate north where they mate and raise their young.

Ducks are divided into two types known as divers and surface feeders. Divers feed on mollusks, shellfish, and other aquatic life found on the seabed and the bottoms of lakes and ponds, see Figure 11–5. Surface feeders eat insects, grass, seeds, weeds, and aquatic plants in addition to small animals.

Feed sources for ducks

Divers:	Surface Feeders:
Mollusks	Insects
Shellfish	Grass
Aquatic plants	Seeds
Worms	Aquatic plants

Figure 11–5 Ducks are adapted to a wide variety of foods from sources above and below the water surface.

KEY INTERNET SEARCH WORDS

environment, advocate, fish, wildlife

KEY INTERNET SEARCH WORDS

common merganser

Mergus merganser

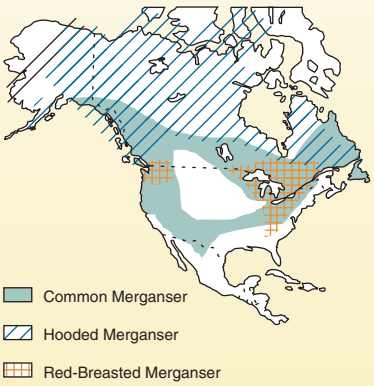


Figure 11–7 Distribution map of the common hooded and red-breasted mergansers.

AVIAN PROFILE

Common Merganser *(Mergus merganser)*

The common merganser is a diving duck with a spike-like bill. It feeds on small fish and aquatic insects in freshwater streams, rivers, and lakes, see Figure 11–6. The merganser uses its wings as well as its feet to swim underwater when it dives for food. This duck is found in northern regions of North America during the breeding season, but it migrates southward to open waters for the winter, see Figure 11–7.

Female mergansers lay 6–12 eggs in hollow trees or in protected areas on the ground. Its preferred habitat is cold mountain rivers and lakes, but it may rear its young in coastal inlets and bays when nesting near the ocean. Other relatives include the hooded and red-breasted mergansers. These ducks are also known as sawbills.

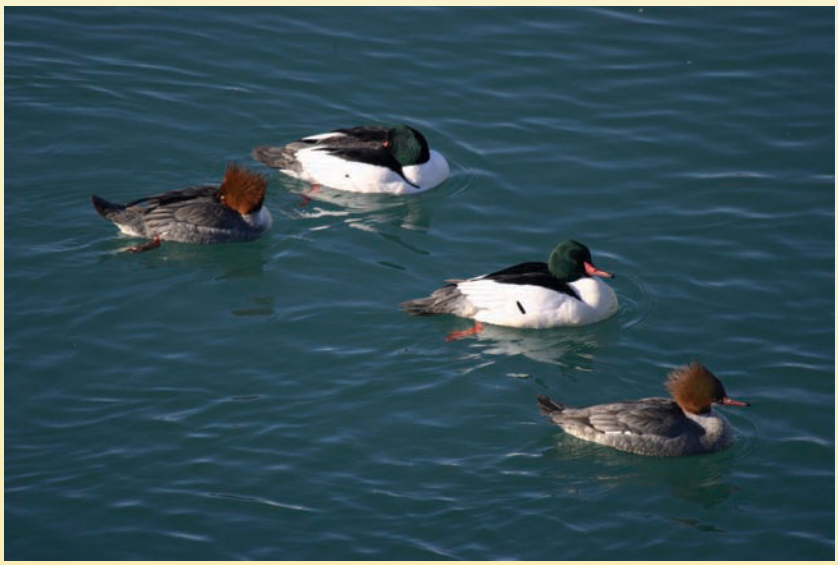


Figure 11–6 The common merganser is a fish-eating duck that pursues and catches fish underwater. *Courtesy U.S. Fish and Wildlife Service.*

Unlike geese and swans that usually mate for life, most ducks remain in pairs only during the breeding season. The pair bond is usually broken when the female begins to incubate her eggs. Nesting ducks seek protected areas for their nests. This might be under a bush or in an area protected by thick vegetation that is located near water. Dry vegetation is used to form the nest, and the female lines it with downy feathers plucked from her own breast.

KEY INTERNET SEARCH WORDS

mallard

Anas platyrhynchos

Figure 11–9 Distribution map of the mallard.

AVIAN PROFILE

Mallard *(Anas platyrhynchos)*

The mallard is a colorful duck distinguished by a green-colored head and upper neck area in males, and by a blue speculum (wing stripe) in both sexes, see Figure 11–8. Females are drab-colored in comparison with males. Wild mallards are found in most areas north of the equator, see Figure 11–9, and domestic mallards have been raised for eggs, meat, and feathers for thousands of years. Nesting females lay 6–10 eggs early in the season in nests built of grass, leaves, and other vegetation and lined with down.

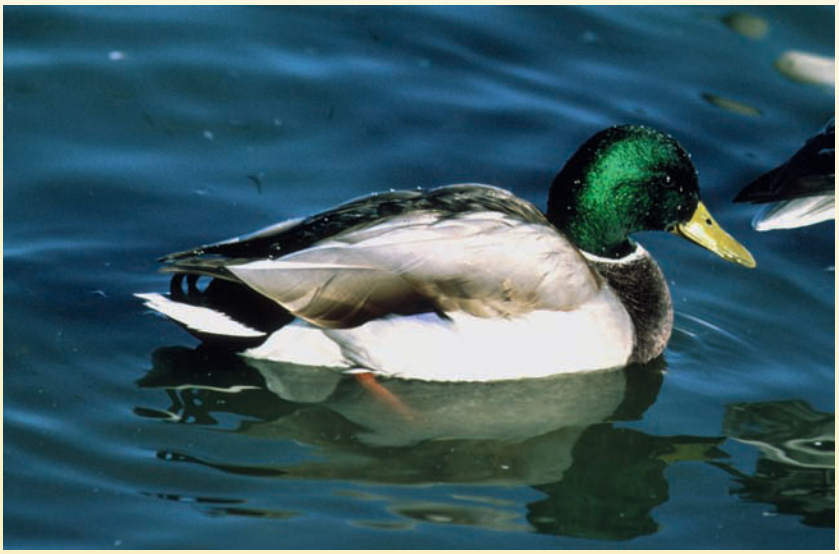


Figure 11–8 The mallard. *Courtesy U.S. Fish and Wildlife Service. Photo by Dave Menke.*

Figure 11–10 Newly hatched ducklings are active, and they are able to follow their mothers within a few hours. *Courtesy U.S. Fish and Wildlife Service.*

Young ducks are called **ducklings**. They are self-feeders—they gather their own food. They are active and able to follow their mothers within a few hours after they hatch, see Figure 11–10. They are natural swimmers and have no fear of water.

Some species of ducks care for their young for long periods of time; others abandon them almost as soon as they hatch. Most female ducks remain with their young only until they can fly. The mother duck keeps them warm beneath her wings during cold weather. Ducklings are sometimes observed riding on their mother's back as she swims.

A mother duck with babies can be quite resourceful in her attempts to protect them. Often, she will attempt to lure enemies away from her

young by pretending to be injured. She will drag a wing on the ground and stay just out of reach of a predator as she leads it away from her ducklings. Once she thinks her ducklings are safe, she flies away and circles back to gather up her family.

INTERNET ADDRESS

http://www.honoluluzoo.org/northern_shoveler.htm

KEY INTERNET SEARCH WORDS

northern shoveler

Anas clypeata

AVIAN PROFILE

Northern Shoveler *(Anas clypeata)*

The northern shoveler is a large marsh duck with a green head like a mallard and a white lower neck and breast, see Figure 11–11. It has a large spoon-shaped bill to strain food from the water and mud in shallow marshes. Its main diet consists of worms, leeches, snails, insects, tadpoles, and aquatic plants.

The preferred habitat for this duck is shallow freshwater marshes and ponds. Females lay 8–12 eggs in ground nests beneath bushes or weeds. Nests are located near water. These ducks range across the western half of the continent from Alaska to Mexico, see Figure 11–12. During the winter season they inhabit tidal bays in coastal regions.

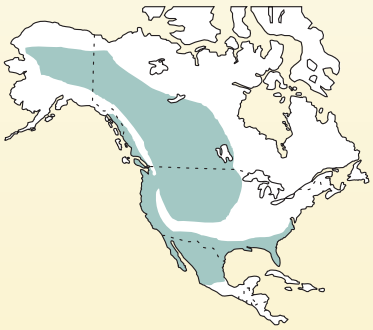


Figure 11–12 Distribution map of the northern shoveler.

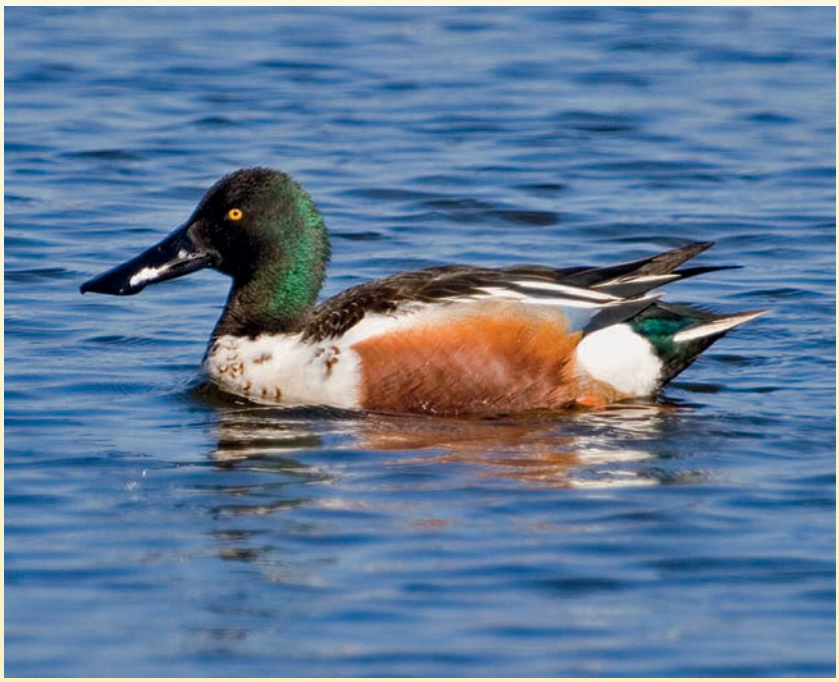


Figure 11–11 The northern shoveler is adapted to shallow freshwater ponds. *Courtesy U.S. Fish and Wildlife Service. Photo by Donna Dewhurst.*

KEY INTERNET SEARCH WORDS

common eider

Somateria mollissima

Figure 11–14 Distribution map of the common eider.

AVIAN PROFILE

Common Eider *(Somateria mollissima)*

The common eider is a large sea duck with a short neck and white back, neck, and breast. Its lower body is black, and the head is topped with a black cap and light green nape, see Figure 11–13. This duck ranges along the Arctic and Canadian coasts, see Figure 11–14.

Females nest in colonies on small rocky islands. They lay 4–7 eggs in down-filled nests that are located on the ground in small depressions lined with down. In some parts of the world farmers entice eiders to nest by furnishing nesting sites, from which they harvest the down for use in insulated clothing and sleeping bags.

Figure 11–13 This female common eider is a large sea duck. *Courtesy U.S. Fish and Wildlife Service.*

Sea ducks of several species inhabit both coasts of North America. They are larger than most other ducks, and they live on diets of mollusks, shellfish, and aquatic plants, obtained by diving to great depths. These ducks usually feed during the day and rest offshore at night.

Ducks that feed on the surface or just beneath the surface by upending with their heads submerged are called **dabbling ducks**. These ducks are usually small in size, which contributes to their ability to maneuver in flight. They migrate long distances each year. Examples of these ducks include mallards, shovelers, pintails, widgeons, and teal.

KEY INTERNET SEARCH WORDS

blue-wing teal

Anas discors

Figure 11–16 Distribution map of the blue-wing teal.

AVIAN PROFILE

Blue-Winged Teal *(Anas discors)*

The blue-winged teal is a small marsh duck with a bluish-gray head, a brown upper body, and a buff-colored lower body spotted with black, see Figure 11–15. It ranges throughout much of southern Canada and into the northern two-thirds of the United States. During the winter season, it migrates to southern coastal regions and to northern Mexico, see Figure 11–16.

This duck prefers a diet of seeds, grasses, and aquatic weeds, but it also eats insects, snails, and tadpoles. Its habitat of choice is a small marshy pond, meadow, or boggy area. Females lay 10–12 eggs in a ground nest near water.

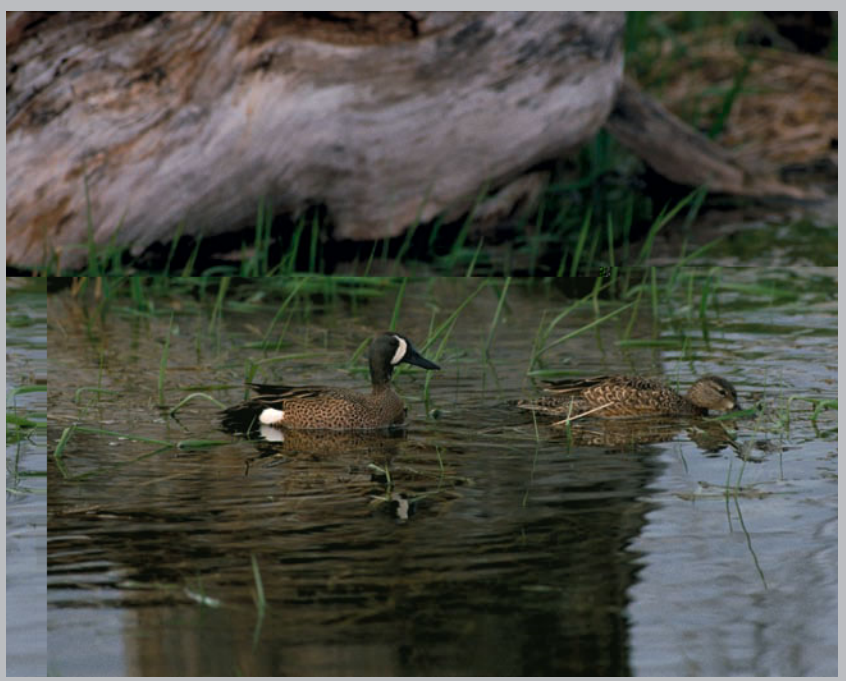


Figure 11–15 A blue-wing teal is a small marsh duck. *Courtesy U.S. Fish and Wildlife Service. Photo by John and Karen Hollingsworth.*

Ducks are most likely to become prey for predatory animals during the nesting and brooding periods and again during the **molt** when they lose their old feathers and replace them with new ones. Sometimes a duck loses its ability to fly during this period, and it is caught more easily by predators such as foxes, coyotes, mink, skunks, snapping turtles, and birds of prey. Newly hatched ducklings are also eaten by large fish. Thus, ducks occupy a niche in the food chain in which they feed on aquatic plant and animal life before becoming prey for other animals.

INTERNET ADDRESS

http://migratorybirds.fws.gov/mgmt/geese.html

KEY INTERNET SEARCH WORDS

goose, problems, predation

Geese are vegetarians, and they gather food both on land and in water. They often gather kernels of grain from stubble fields during the fall and winter months, see Figure 11–23. They are fond of grain sprouts and can cause serious damage to fields in which grain is sprouting and beginning to grow by plucking up entire plants as they graze.

Figure 11–23 Canada geese resting and feeding. *Courtesy U.S. Fish and Wildlife. Photo by Gary Zahm.*

KEY INTERNET SEARCH WORDS

Canada goose

Branta canadensis

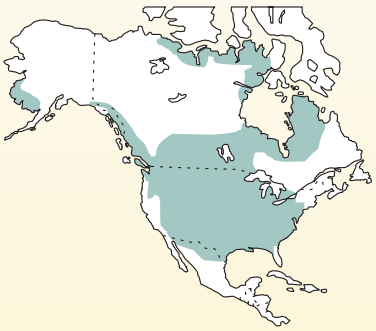


Figure 11–25 Distribution map of the Canada goose.

AVIAN PROFILE

Canada Goose *(Branta canadensis)*

The Canada goose is a large bird with a gray body, black rump, tail, neck, and head, and white cheek and throat markings, see Figure 11–24. This species is probably the most wide-ranging and best-known goose in North America. During the breeding season, it ranges across the northern tier of states and southern Canada as well as into some parts of northern Canada and Alaska. Its winter range includes parts of Mexico and much of the United States, except the most northern states, see Figure 11–25. Some of these geese no longer migrate north but breed locally along the Atlantic seacoast and other waterways. They are often considered to be a nuisance or health hazard when they become accustomed to living near people. The Canada goose prefers habitat where bogs, sloughs, marshes, and lakes are found. Several subspecies of Canada geese have been identified; the largest of these are called honkers.

Figure 11–26 Nesting platforms are provided for geese in some areas to protect the nests from flooding and predators.

Figure 11–24 Canada geese land to feed.

Females often nest on piles of vegetation where 6–7 eggs are deposited in down-filled nests. Nesting platforms mounted on posts are provided for geese in some areas to protect the nests from predators and flooding, see Figure 11–26. Both parents take responsibility for raising the family after the goslings have hatched.

Geese go through mating rituals in the spring before they begin nesting. They become quite noisy and males become aggressive as they attempt to drive off rivals. Nesting begins while the spring season is still wet and cold. By the time the weather warms up, the goslings have hatched and are feeding heavily. They grow rapidly and attain most of their growth within a few weeks.

Both parents assist in rearing their offspring, and they usually molt while they are raising their broods. During this period, they are unable to fly, and they spend their time grazing with their young in meadows and marshy areas near their nesting sites.

ECOLOGY PROFILE

Lead Poisoning of Waterfowl

The lead shot used by hunters is sometimes found and eaten by waterfowl. All birds eat small pebbles that are used to grind seeds during the process of digestion. These pieces of rocks and gravel are called **grit**. They are swallowed whole and remain in the **gizzard** of the bird that consumed them. The gizzard is a muscular organ that grinds seeds and other food into small particles by crushing them between the hard pebbles. Waterfowl confuse lead shot with small stones, and they sometimes eat lead shot as they replenish the grit with which their food is crushed.

The lead shot breaks down in the gizzards of birds and lead compounds in the body fluids eventually poison them. Death is slow and the birds are unable to feed. In recent years, most hunters have replaced lead shot with steel shot, which is less toxic. However, in areas where much hunting has taken place over many years, the lead shot will remain a hazard to waterfowl for some time to come.

In addition to the geese that are discussed in this chapter, several other species are native to North America.

SWANS

Swans are large aquatic birds with graceful necks that are longer than their bodies. They are white with some black markings, and they are the largest waterfowl. Swans mate for life, and they usually nest at high altitudes or in the northern arctic regions. Their diet consists mostly of seeds and other plant materials.

KEY INTERNET SEARCH WORDS

trumpeter swan

Olor buccinator

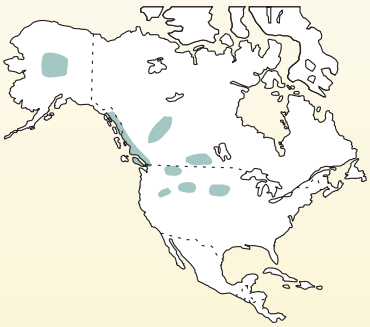


Figure 11–28 Distribution map of the trumpeter swan.

AVIAN PROFILE

Trumpeter Swan *(Olor buccinator)*

The trumpeter swan is a large migratory bird with a wingspan that may exceed 6.5 feet. It is white with a black bill, see Figure 11–27. The breeding range of this swan includes isolated areas in Canada and the states of Alaska, Idaho, Wyoming, Montana, and Oregon, see Figure 11–28. This swan spends the winter in many of the same areas where open water can be found.

Members of this species do not breed until they are 4 years of age or older, and they produce only 4–6 eggs. With such a low reproductive rate, their numbers do not increase very quickly, even when conditions are favorable. The preferred habitat of this swan is marshlands, rivers, and lakes.

Figure 11–27 Trumpeter swans with their young. *Courtesy U.S. Fish and Wildlife Service. Photo by Donna Dewhurst.*

Swans build huge nests of reeds, twigs, and other vegetation, and they return to the same nest each year. Males become very aggressive in defending their breeding territory from intruders. Young swans are called **cygnets**. After the eggs have hatched, both parents help rear their young. Cygnets remain with their parents for 4 to 5 months.

INTERNET ADDRESS

http://www.kwic.com/~pagodavista/schoolhouse/species/birds/tundswan.htm

KEY INTERNET SEARCH WORDS

tundra swan

Cygnus columbianus

AVIAN PROFILE

Tundra Swan *(Cygnus columbianus)*

The tundra swan, formerly called the whistling swan, is a large white bird with a black bill. It closely resembles other swans except for a small yellow marking near each eye, see Figure 11–29. It calls with a high-pitched whistling sound as it migrates.

This swan nests on small islands in lakes and marshes of the northern tundra region, see Figure 11–30. Females lay 4–5 large eggs, and the young cygnets remain with their parents during the fall migration. Whistling swans winter along both the Atlantic and Pacific coasts in freshwater marshes and marine estuaries.

Non-native mute swans compete with tundra swans, often displacing them because mute swans are more aggressive. They also have longer necks than tundra swans, giving them a competitive advantage by allowing them to feed deeper in the water than other swans, geese, and ducks.

Figure 11–30 Distribution map of the tundra swan.

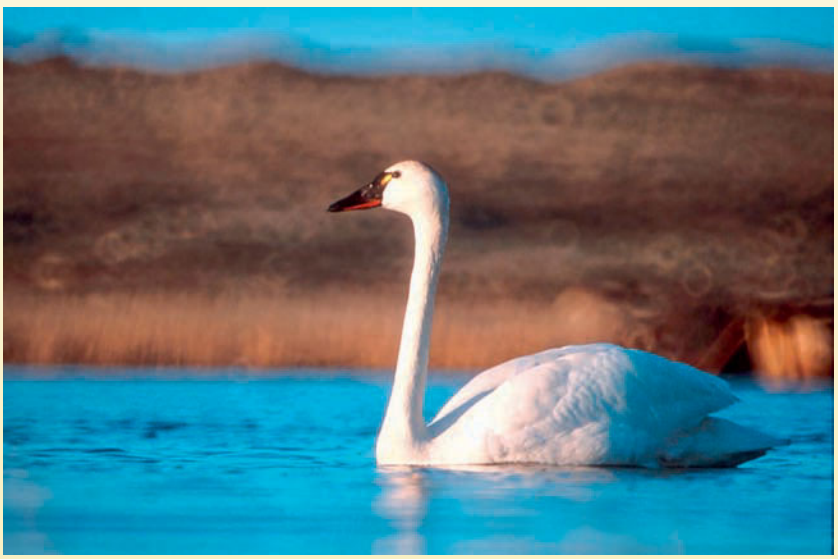


Figure 11–29 The tundra swan (whistling swan). *Courtesy U.S. Fish and Wildlife Service. Photo by Tim Bowman.*

Swans and geese play similar roles to ducks in the habitats that they occupy. Because of their longer necks, however, they can reach into deeper water than the dabbling ducks. They are primary consumers and are preyed upon by a number of animals that occupy both their summer and winter ranges.

LOOKING BACK

Aves is a scientific term for a class of animals that is commonly known as birds. The branch of science that studies birds is called ornithology. Waterfowl are migratory birds such as ducks, geese, and swans. All birds are oviparous, meaning they produce eggs that hatch after they

leave the female's body. Hunting regulations protect waterfowl during critical periods in their life cycles, such as when they are nesting and rearing young.

Some species of ducks are predators while others eat only plants and seeds. Most geese and swans tend to be vegetarians. Some waterfowl obtain food by diving for aquatic animals and plants living on the bottom of streams and lakes. Others strain floating food particles out of the water with bills equipped with lamellae.

Most ducks, geese, and swans nest on the ground, but some ducks, such as the wood duck, nest in trees. Waterfowl prefer wet habitats where protective ground cover is available. They like bogs, ponds, marshes, streams, and lakes because these areas usually offer an abundance of food and protection.

Ducks, geese, and swans fill intermediate roles between aquatic plants and predators in the ecosystems and food chains of North America.

Chapter Review

DISCUSSION AND ESSAY

1. Identify what waterfowl are, and name several species of birds that are classified as waterfowl.
2. Define what is meant when a bird is described as an oviparous member of the animal kingdom.
3. Clarify how hunting regulations are used as a tool to protect waterfowl during critical periods in their life cycles.
4. Describe how the restoration of wetlands contributes to maintenance or expansion of migratory waterfowl populations.
5. Distinguish some differences between ducks classified as divers and ducks classed as surface feeders.
6. Contrast swans and geese in comparison with most ducks in their devotion to their mates.
7. Describe the roles of ducks in North American ecosystems.
8. Name the major species of ducks, geese, and swans that are found in North America, and list traits that are helpful in identifying them.

9. Suggest some ways that the migratory instincts of waterfowl contribute to their survival.
10. Describe the roles of geese and swans in the ecosystems of North America.
11. Identify some characteristics of swans that make it difficult for them to maintain their populations.

MULTIPLE CHOICE

1. Which of the following terms does not apply to birds?
   a. Oviparous
   b. Viviparous
   c. Incubation
   d. Aves
2. A scientist who specializes in the science of birds is called a/an:
   a. Ornithologist
   b. Taxonomist
   c. Marine biologist
   d. Botanist
3. A viviparous animal reproduces by:
   a. Laying eggs that hatch outside the body
   b. Producing eggs that hatch inside the body prior to birth
   c. Giving birth to live young
   d. Incubating eggs in a nest of sand and vegetation
4. Nearly all waterfowl are birds that:
   a. Are viviparous
   b. Nest in trees
   c. Are known as birds of prey
   d. Migrate between northern and southern ranges
5. Ducks known as surface feeders eat foods such as:
   a. Seeds
   b. Mollusks
   c. Underwater plants
   d. Shellfish
6. Which of the following is a diving duck that eats mostly fish and aquatic insects?
   a. Mallard
   b. Merganser
   c. Common eider
   d. Teal
7. A colorful woodland duck that often nests in trees is the:
   a. Mallard
   b. Wood duck
   c. Northern shoveler
   d. Mud hen

8. The correct term for a baby swan is:
   a. Cygnet
   b. Chick
   c. Duckling
   d. Gosling

9. Which of the following water birds are vegetarians?
   a. Geese
   b. Merganser ducks
   c. Diving ducks
   d. Northern shovelers

10. Which of the following waterfowl is the largest in size?
   a. Swan
   b. Goose
   c. Duck
   d. Snipe

Learning Activities

1. Visit a marsh, bog, or lake, and do a complete assessment of the food supply that is available for waterfowl. Identify the plants that are available. Skim the surface of the water, and study the particles that you find to determine whether they might be used as a food source by ducks that are equipped with well-developed lamellae. Use screens to separate small plants and animals from the mud, sand, or gravel on the bottom and edges of the body of water. After the food supply is inventoried, identify some waterfowl that use the kinds of foods that you found. Consider whether any conditions exist that might interfere with the survival of the waterfowl species that you identified.

2. Have each member of the class choose a species of duck, goose, or swan, and prepare a short written and oral report to be shared with the rest of the students. The report should address the following—description, range, preferred habitat, diet, nesting habits, rearing of young, migration routes, natural enemies, and unusual features or habits.

CHAPTER

12

Game Birds

The game birds discussed in this chapter include birds whose habitats include the deserts, fields, mountains, and forests. These birds are often hunted for human food, and hunting regulations have been implemented to protect them during critical periods in their life cycles. Their diets consist mostly of seeds, insects, and plant materials.

After completing this chapter, you should be able to:

- list the kinds of game birds that are found in North America
- describe the nesting behaviors of gallinaceous birds
- distinguish between polygamous and monogamous birds
- describe the relationship between doves and pigeons
- evaluate the roles of game birds and pigeons in the ecosystems of North America
- assess the similarities and differences among quails, partridges, and pheasants
- identify major species of North American game birds and pigeons
- speculate on the effects that a reduced population of game birds might have on populations of birds of prey that live in the same region
- consider the importance of camouflage coloration in female game birds
- explain why most game birds must produce large clutches of eggs
- describe the importance of mating rituals among game birds.

KEY TERMS

gallinaceous
clutch
polygamous
polygynous
monogamous
plume
covey
catkin
scrape
wattle
beard
crop
gizzard
squab
pigeon milk
fledge

North American game birds include pigeons, quails, partridges, pheasants, grouse, and turkeys. These birds are all similar in body shape, with plump bodies and short powerful wings, see Figure 12–1. They have similar diets consisting mostly of seeds and plant shoots that are sometimes supplemented with insects.

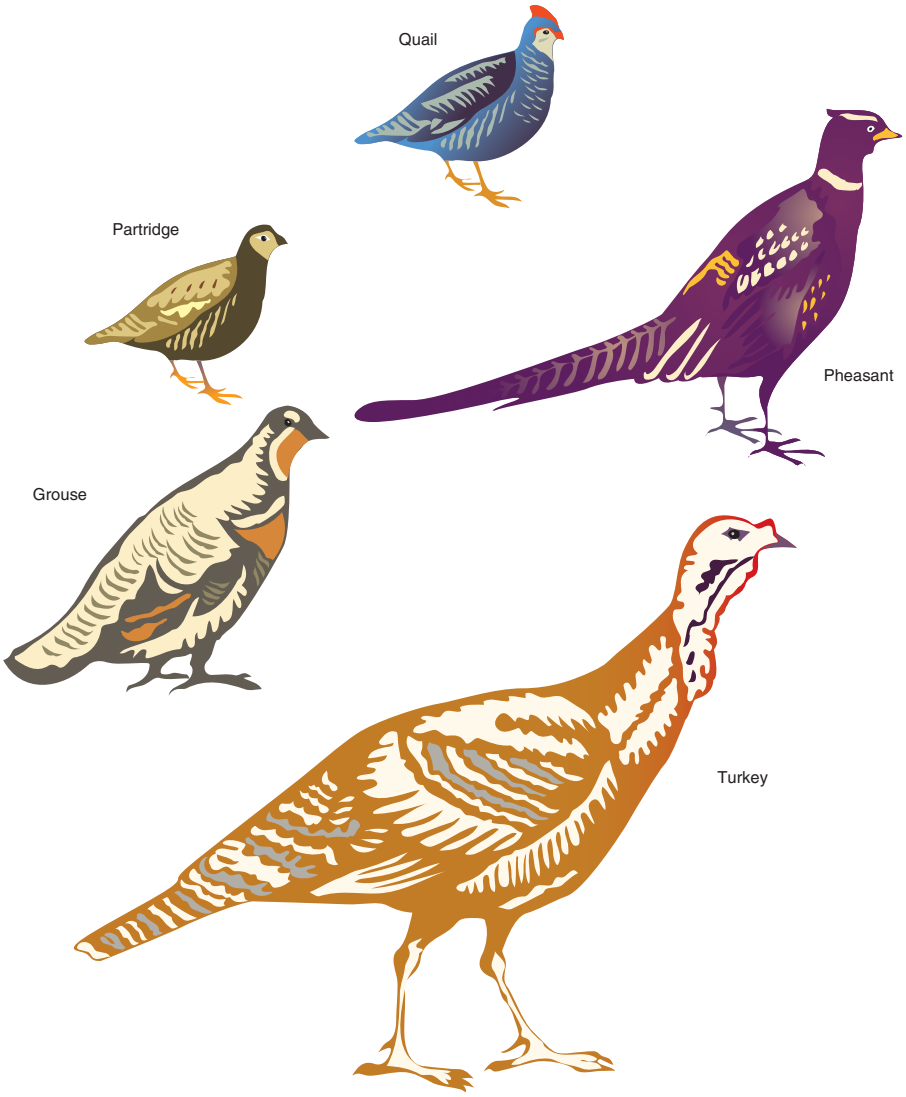


Figure 12–1 Relative sizes and shapes of game birds.

Most game birds are **gallinaceous** birds, meaning that they are heavy bodied, and they nest on the ground. The number of their eggs and young is known as a **clutch**. The clutches of gallinaceous game birds are larger than the clutches of most other birds. This is necessary to maintain game bird populations because large numbers of them are lost due to predation and weather. Some game birds are **polygamous**

in their breeding habits in that both males and females may have more than one mate, and they do not bond as pairs. Others are **polygynous**, meaning that the males attract and mate with several females.

The pigeon family includes 11 species found in North America. Both pigeons and doves belong to the same family; however, a dove is really just a small pigeon. Pigeons are **monogamous**, meaning that they have only one mate at a time. They usually mate for life. They are not gallinaceous birds—they prefer to nest on ledges and in trees.

QUAILS

KEY INTERNET SEARCH WORDS
gallinaceous birds

Quails, partridge, and pheasants are all members of the same family. The terms *quail* and *partridge* are also common names for related groups of birds, and there is a tendency for birds that are called quail in one region to be referred to as partridge in another. This chapter identifies quail as the smallest of the gallinaceous game birds.

KEY INTERNET SEARCH WORDS
California quail
Laphortyx californicus

Figure 12–3 Distribution map of the California quail.

AVIAN PROFILE

California Quail *(Lophortyx californicus)*

The California quail is a small, plump bird with a black **plume** or feather that curves forward on its head, Figure 12–2. It has a brown back, a grayish blue breast, and a cream-colored belly with brown markings. It prefers a habitat in brushy open areas located in foothills, canyons, deserts, and suburbs. Its range extends along the Pacific coast from Canada to Mexico, and inland to southern Idaho and northern Nevada, Figure 12–3.

Males defend their territories during the breeding season, where they strut about and call to attract females. Twelve to fifteen eggs are incubated by the females in grass-lined depressions on the ground. Chicks are covered with a coat of down when they hatch, and by 10 days of age, their wing feathers have developed enough to fly. Quail roost in trees for safety, and they feed on seeds and insects. They gather in large groups called **coveys** in the late summer and fall. The California quail is the state bird of California.

Figure 12–2 A male California quail. *Courtesy U.S. Fish and Wildlife Service. Photo by Lee Karney.*

Many of the gallinaceous game birds are fast runners, and they prefer running to flying. They are capable of rapid flight for short distances when they are in immediate danger. Some of these birds fly to water in the early morning and evening hours, but they usually prefer to run. Some species even travel between winter ranges in the lowlands and summer ranges at higher elevations by walking or running.

KEY INTERNET SEARCH WORDS

bobwhite

Colinus virginianus

Figure 12–4 Distribution map of the bobwhite quail.

AVIAN PROFILE

Bobwhite *(Colinus virginianus)*

The bobwhite is usually considered to be an eastern quail because it is native to the eastern half of the United States and to the Gulf Coast of Mexico, Figure 12–4. It also has been successfully introduced into the northwestern United States. It is a small brown bird with a white throat and a white stripe across its eye, Figure 12–5. The male has a distinctive whistle that sounds like "bob-white."

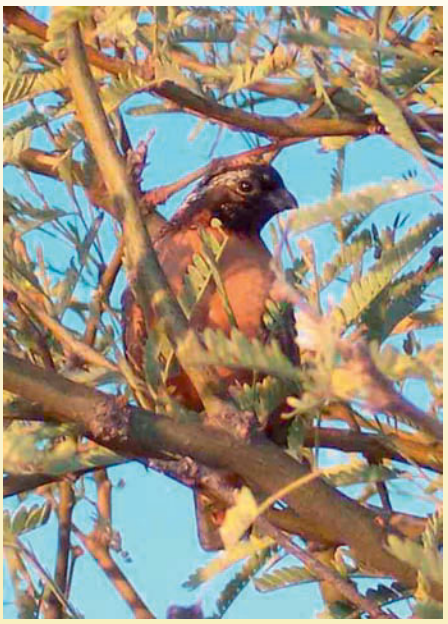


Figure 12–5 A bobwhite quail. *Courtesy U.S. Fish and Wildlife Service.*

The bobwhite is attracted to farms where it eats weed seeds and insects during the growing season and gleans grain when it is available. Stubble fields make good places for bobwhites in the fall and winter because kernels of grain are scattered throughout the fields by the grain combines that are used to harvest the crop. The male bobwhite is a family-oriented bird. Unlike most other game birds, once it attracts a mate, it helps incubate the eggs and raise the young. The clutch of the bobwhite quail consists of 10–15 eggs or young birds that are active almost as soon as they hatch. Family groups form coveys that stay together until the next breeding season. They seek cover in bushes, and during cold weather they huddle together for warmth.

One of the greatest threats to quail and other ground-dwelling game birds is heavy snow followed by crusting on the surface. Game birds tend to crowd together in the shelter of weeds and brush until a storm passes. When a hard crust forms on the surface of the snow, the birds may become trapped beneath it and starve to death, see Figure 12–6. Game birds are preyed upon by birds of prey and most small- to medium-sized predators such as foxes, coyotes, badgers, and skunks.

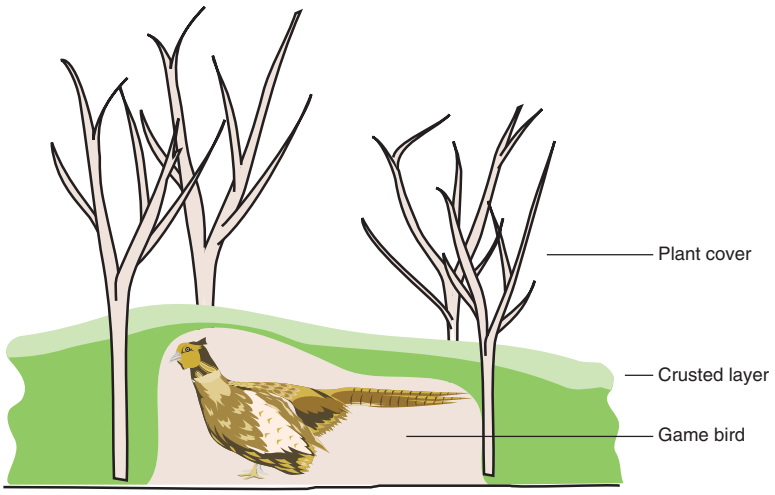


Figure 12–6 A sudden snow and crusting of the surface is a serious threat to ground-dwelling game birds that can be trapped beneath it.

PARTRIDGES

Partridges are medium-sized game birds that have been successfully introduced to North America from Europe. They band together in coveys that are usually made up of family units. Unattached birds join the coveys, and males often leave to join other coveys as the mating season approaches. This behavior helps to reduce inbreeding.

INTERNET ADDRESS

http://museum.gov.ns.ca/mnh/nature/nsbirds/bnso102.htm

KEY INTERNET SEARCH WORDS

gray Hungarian partridge
Perdix perdix

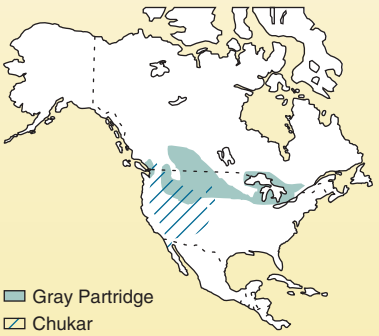


Figure 12–8 Distribution map of the gray partridge and the chukar.

AVIAN PROFILE

Gray or Hungarian Partridge *(Perdix perdix)*

The gray (Hungarian) partridge is a brown bird with a gray neck and breast and a bar-shaped pattern on the flank region and tail feathers. On the lower breast is a chestnut-colored marking shaped like a horseshoe, see Figure 12–7. This partridge prefers a habitat of open farmland and grain fields. Its diet consists of grains, seeds, buds, and insects. Its range extends across the prairie region of southern Canada and the northern border states of the United States, see Figure 12–8.

Females lay 10–16 eggs in ground nests sheltered by brush, weeds, or crops. Both parents help to rear the chicks. They do not roost but seek sheltered areas on the ground to rest during the night.

Figure 12–7 Gray (Hungarian) partridge. *Courtesy Getty.*

Partridges are considered to be a worthy challenge for hunters because they are so difficult to approach. They can usually be heard calling to one another just out of range. They are very fast in their short flights, and hunters usually find it difficult to harvest them.

Partridges are most vulnerable to predators during the nesting period and until the chicks are capable of flight. Once the young chicks learn to fly, they are able to escape most ground predators, but they are never safe from birds of prey. Hawks, falcons, and eagles are natural predators of these birds.

AVIAN PROFILE

Chukar Partridge *(Alectoris chukar)*

The chukar is a moderately sized bird that is not native to North America—it was introduced from Europe and Asia. It is marked with a light-colored neck and chin with a black band that passes across the eyes. The rest of the bird is gray, with black, white, and brown bar patterns on the sides. The breast and chest are slate-colored, the belly is a buff color, and the legs and beak are red, see Figure 12–9.

Figure 12–9 A chukar partridge is adapted to living on steep canyon slopes. *Courtesy Kenneth W. Fink. Photo Researchers, Inc.*

This bird is adapted to slopes, and they thrive in steep canyon habitats. Chukars eat cheatgrass seeds, and they are usually found in areas that are fairly close to water. In the evenings, they can be heard calling to one another as they descend the slopes to the water source.

Chukars are very prolific birds with females producing large clutches of eggs. Their nests are located in sheltered areas among the rocks or beneath the shelter of bunch grasses. Chicks use the shrub cover on the slopes for protective cover. This game bird is abundant in many areas, and it is a favorite of hunters. It is also well adapted to game farm production.

PHEASANTS

Pheasants can be distinguished from other game birds by their long tails and bright, colorful plumage. They are not native to North America but were widely introduced to this country from Asia. Pheasants are fast runners, and they prefer to escape from danger by running or hiding rather than flying. If they are in immediate danger, however, they will burst from cover and quickly fly to safety.

Career Option

GAME BIRD FARM MANAGER

FISH AND GAME AGENCIES and private hunting preserves often supplement the natural populations of game birds with birds that have been raised on game farms. Managers of these farms are required to have administrative and managerial skills to direct the farm employees.

In most cases, a college degree related to wildlife management is required. A strong background in the biological sciences is the foundation of all of the careers in fish and wildlife management. A good understanding of avian nutrition and diseases is also essential to success in this career.

KEY INTERNET SEARCH WORDS

ring-necked pheasant
Phasianus colchicus

Figure 12–11 Distribution map of the ring-necked pheasant.

AVIAN PROFILE

Ring-Necked Pheasant *(Phasianus colchicus)*

Figure 12–10 A ring-necked pheasant is adapted well to grain fields and farms. *Courtesy USDA. Photo by Ron Nichols.*

The male ring-necked pheasant is brightly colored, and it can be distinguished by an iridescent greenish-black head, bright red facial coloring, and a white ring around the neck. Its body is a deep reddish brown with light-colored mottling on the flank area, and the tail is long and pointed, see Figure 12–10. In contrast, females are plain mottled brown and have shorter tails. Pheasants range throughout much of the Pacific Northwest, the grain-producing regions of the Midwest and southern Canada, and the northeastern United States, see Figure 12–11.

Pheasants prefer farmland habitat with plenty of woodlands or brushy cover nearby. The male crows to attract a harem of females, which he protects from other males until the eggs are laid. The clutch numbers 6–15 offspring that are cared for by the female. They feed on insects, berries, seeds, and grain.

Pheasants are polygynous birds; males form harems of several females during the breeding season. Females may nest two or more times in a single season if their eggs are damaged by predators or bad weather. Unlike quails and partridges, pheasants usually scatter after they have raised their broods, and they tend to live solitary lives.

GROUSE

Grouse are among the largest of the game birds, second only to the turkey in size. In most species, the legs and feet are protected by feathers, enabling them to live in cold, northern climates. Feathers also protect the nostrils of grouse.

KEY INTERNET SEARCH WORDS

ruffed grouse

Bonasa umbellus

AVIAN PROFILE

Ruffed Grouse *(Bonasa umbellus)*

The ruffed grouse is one of the better-known grouse species due to its ability to adapt to a wide range of habitats including Alaska, Canada, and the northern United States. It prefers to occupy the edge zones in coniferous forests or deciduous woodlands where clearings and meadows interrupt the cover of trees and brushy plants. This grouse is mottled brown in color on its upper body with alternate gray-brown and buff crossbar markings on the lower body, see Figure 12–12. The tail of the ruffed grouse is shaped like a fan, and it has a small crest of feathers on its head. The male of this species drums its wings during the mating season to attract females, but it does not help rear the chicks. Females lay 6–12 eggs in sheltered ground nests lined with leaves and other vegetation. Ruffed grouse feed on small fruits and berries in the summer, and gather buds and **catkins**, the flowering parts of trees and shrubs, during the winter. Several races of the ruffed grouse are recognized in the different regions that they occupy.

Figure 12–12 A ruffed grouse.

Figure 12–13 Distribution map of the grouse.

Grouse are adapted to a variety of habitats including forested areas, tundra, and plains. Several different species range over the North American continent from arctic regions to Mexico, see Figure 12–13. Their range is somewhat restricted on its northern and southern borders by the distribution of coniferous forests.

INTERNET ADDRESS

http://goodfelloweb.com/birds/upland_ground/spruce_grouse.html

KEY INTERNET SEARCH WORDS

spruce grouse

Canachites canadensis

AVIAN PROFILE

Spruce Grouse *(Canachites canadensis)*

The spruce grouse is a northern wilderness bird that occupies most of the wooded areas of Canada and Alaska. Its habitat is coniferous forest areas where it eats the foliage and buds from coniferous trees, along with insects, berries, and other fruits.

The male of this species is gray on its upper body and black on its lower body with a white line around the throat, a red patch above the eye, and white spots on its flanks, see Figure 12–14. Females are drab in coloring compared to males. Males display in the mating ritual by fanning their tails and strutting about on the breeding grounds to attract females. After mating, the female lays 8–12 eggs in a shallow **scrape** or depression on the ground that she has prepared by scratching away some of the dirt and lining it with dry vegetation. Females raise their broods of chicks alone.

The spruce grouse is called the spruce partridge in some areas, and several races of this species have been identified, including a southern one that has long since been destroyed. This bird is very tame and does not fly away when it is approached. It survives in remote areas where there are few people.

Figure 12–14 A spruce grouse hen. *Courtesy U.S. Fish and Wildlife Service. Photo by Mike Boylan.*

With the exception of the spruce grouse, most other grouse spend the majority of their time on the ground. They find most of their food there, and they always nest on the ground. They sometimes seek the protection of trees by landing in them when they are forced to fly away from danger.

KEY INTERNET SEARCH WORDS

sage grouse

Centrocercus urophasianus

AVIAN PROFILE

Sage Grouse *(Centrocercus urophasianus)*

The sage grouse is the largest gallinaceous bird except for the wild turkey. It has a gray-streaked upper body and a black lower body. The male has a long, pointed tail, a black throat, and a white collar and breast, see Figure 12–15. During the courtship display, the male is able to inflate his neck and breast region by expanding specialized air sacs. They make chuckling and popping sounds as they are alternately inflated and deflated.

Figure 12–15 A sage grouse. *Courtesy U.S. Fish and Wildlife Service. Photo by Gary Kramer.*

Females wander about the breeding grounds inspecting the males before choosing their mates. They lay seven to eight eggs in shallow nests sheltered by sagebrush or other cover. Chicks are able to move about soon after they hatch.

This grouse prefers open areas in dry foothills and plains where sagebrush is plentiful as a source of food and cover. The buds and leaves of sagebrush form the main part of its diet. The sage grouse population has declined recently in many areas. This is probably because large tracts of their sagebrush habitat have been cleared for farming. They are also severely affected by wildland fires that often destroy thousands of acres of sagebrush habitat. In recent years, the West Nile virus, spread by mosquitoes, has killed large numbers of sage grouse. Some environmental advocacy organizations have proposed that this species should be considered for protection under the Endangered Species Act.

Young grouse tend to eat large amounts of insects in comparison with adult birds. Insects are high in protein and are an important source of nutrition to chicks during this period of rapid growth. As they grow older, they increase the proportion of fruits, seeds, acorns, and other vegetable matter in their diets.

KEY INTERNET SEARCH WORDS

greater prairie chicken

Tympanuchus cupido

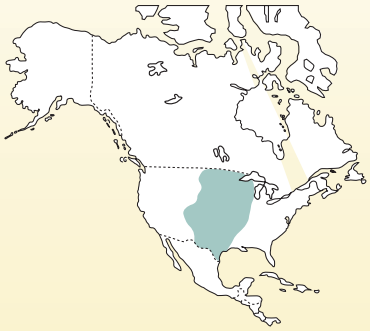


Figure 12–16 Distribution map of the greater prairie chicken.

AVIAN PROFILE

Greater Prairie Chicken *(Tympanuchus cupido)*

The greater prairie chicken is a medium-sized grouse that inhabits tallgrass prairies, rangelands, and brushy fields. Its diet consists of seeds, berries, buds, and insects. The range of this grouse has been reduced, but it currently extends from Canada to Texas, see Figure 12–16. The population of the greater prairie chicken has declined as the tallgrass prairie habitat has been converted to farming and other uses. (The Atlantic Coast race known as the Heath Hen is now extinct.) It is brown with buff-colored bar markings with yellow on the comb above the eyes, see Figure 12–17. Males have long, black feathers on their necks that are raised during mating displays.

During courtship, the polygynous males make loud, booming sounds that can be heard for long distances. Females choose their own mates, and they lay 8–12 eggs in scrapes located in tall grass. After the chicks hatch, the females raise them alone.

Figure 12–17 The greater prairie chicken. *Courtesy R. Van Nostrand. Photo Researchers, Inc.*

Grouse are adapted to nearly every region of North America. Some grouse, such as ptarmigan, change their color from brown summer plumage to white plumage in the winter months. This protective coloring is important when cover is less available due to snow accumulations.

KEY INTERNET SEARCH WORDS

rock ptarmigan

Lagopus mutus

Figure 12–18 Distribution map of the rock ptargmigan.

AVIAN PROFILE

Rock Ptarmigan *(Lagopus mutus)*

The rock ptarmigan is a grouse that is adapted to cold, northern climates. It ranges across the tundra regions of Alaska and northern Canada, see Figure 12–18. This grouse changes color with the seasons. In the summer, it is mottled gray and brown with white wings and belly. In the winter months, it molts to a completely white plumage, see Figure 12–19. The feathers on their feet work like snowshoes to keep them from sinking in the deep snow. The males have red combs over their eyes.

Females produce six to nine eggs that are incubated in shallow nests on the ground. The young are cared for by the female. The digestion of woody material such as buds and twigs is aided by bacteria residing in the bird's digestive tract that digest the fiber for their own use. The grouse then digests the bacteria.

Figure 12–19 The rock ptarmigan. *Courtesy U.S. Fish and Wildlife Service. Photo by Karen*

TURKEYS

The wild turkey is a native American species. It is the largest of the game birds. The Aztec civilization tamed turkeys long before the Spanish conquerors took them to Europe. Our modern domestic turkeys are descendants of the wild turkey.

KEY INTERNET SEARCH WORDS

turkey

Meleagris gallopavo

Figure 12–21 Distribution map of the wild turkey.

AVIAN PROFILE

Turkey *(Meleagris gallopavo)*

The turkey is a large bird. Males measure 4 feet in length from head to tail and females are as long as 3 feet. They are brown in color with a bronze glow to the feathers. Their heads, in contrast, are blue in color and lack feathers. Males have prominent red facial tissue called **wattles** that swell with blood taking on a bright red color when the birds are displaying in the mating ritual, see Figure 12–20. A tuft of feathers called a **beard** dangles from the breast; females are unlikely to have a beard.

The turkey is a wary bird whose habitat is open woodlands, but its range has declined steadily as wooded areas have given way to farms and houses. Because of agricultural development of farmland, such practices as clearing land contributed to declines in turkey populations. Other contributing factors included loss of trees due to disease and over-hunting of the turkey populations. Since the 1960s, populations have recovered in many areas due to restricted hunting, increased woodlands and introduction of populations to suitable areas. The range of the wild turkey extends from the eastern states to the southwestern states and Mexico. It has also been introduced successfully to the Northeast and in several western states, see Figure 12–21. The diet of the wild turkey consists of nuts, acorns, berries, seeds, and insects.

Figure 12–20 Wild turkeys. *Courtesy of USDA Service. Photo by Gary Zahm.*

Turkeys are polygynous, and the dominant males gather harems of females by calling and displaying in a mating ritual. Hens usually lay 8–15 eggs in a nest on the ground. Sometimes nests are observed with large numbers of eggs because more than one female is using it. The

eggs are incubated by the female, also known as a hen. She also cares for the young.

The turkey is active only during daylight. It spends much of its time searching for food such as nuts and acorns on the forest floor. At night, turkeys roost in trees where they are safe from natural enemies.

PIGEONS AND DOVES

Distinguishing features of pigeons include rounded tails and larger sizes than the birds of this family known as doves. Doves have pointed tails, and they are the smaller members of the pigeon family.

KEY INTERNET SEARCH WORDS

band-tailed pigeon

Columba fasciata

Figure 12–23 Distribution map of the band-tailed pigeon.

AVIAN PROFILE

Band-Tailed Pigeon *(Columba fasciata)*

The band-tailed pigeon is a forest bird that is larger than most domestic pigeons. It has a purple-colored head, neck, and underparts, and a dark gray upper body. A small white collar extending partway around the neck is also evident, see Figure 12–22. Its range extends along the Pacific coast to Alaska and into southwestern United States and Mexico, see Figure 12–23.

These pigeons live in coniferous forest areas or oak woodlands, where acorns are important in their diets. They also feed on berries and seeds. Clutches of one to two eggs are laid on a platform-shaped nest of twigs located in a tree or bush.

Figure 12–22 Band-tailed pigeon. *Courtesy U.S. Fish and Wildlife Service. Photo by Gary Kramer.*

Pigeons and doves drink by putting their bills in water and sucking. Most birds drink by getting water into their bills and quickly raising their heads, causing the water to flow down their throats by gravity. Water and food are mixed and food particles are soaked in an organ called the **crop**. Once the food has become soft, it moves into the **gizzard**, which is an organ that grinds the food particles between small rocks that have been ingested for this purpose.

KEY INTERNET SEARCH WORDS

rock dove

Columba livia

Figure 12–25 The rock dove. *Courtesy U.S. Fish and Wildlife Service. Photo by Lee Karney.*

AVIAN PROFILE

Rock Dove *(Columba livia)*

The rock dove is not native to North America, but it is probably the best-known species of pigeon. It was introduced from Europe and is now found throughout southern Canada and the continental United States, see Figure 12–24. It is a city bird that varies in color from pure white to brown, black, blue, or a combination of these colors, see Figure 12–25. It is a cliff-dwelling bird that has adapted to city buildings and urban environments. Its diet consists of fruits, insects, grains, and seeds.

Two eggs are laid in a flat nest on a sheltered building or cliff ledge, and it is common to find young birds that are nearly old enough to fly in a nearby nest. Several broods are raised each year in most locations. Both parents help to care for their young.

Figure 12–24 Distribution map of the rock dove.

Young pigeons are called **squabs**. Their parents feed them a food called **pigeon milk** that is secreted in the crops of both parents. It is composed of cells that are sloughed off the inner wall of the crop, and its food value and appearance is similar to cottage cheese. The squabs place their beaks in the mouths of their parents to receive this regurgitated food.

KEY INTERNET SEARCH WORDS

mourning dove

Zenaida macroura

Figure 12–27 Distribution map of the mourning dove.

AVIAN PROFILE

Mourning Dove *(Zenaida macroura)*

The mourning dove is a moderate-sized member of the pigeon family. It is brownish gray in color with lighter underparts and a black spot on the ear patch, see Figure 12–26. The mourning dove gets its name from the cooing call of the male. In northern regions, it is a migratory bird whose range extends from southern Canada to northern Mexico, see Figure 12–27.

A pair of mourning doves normally nests two to four times each year, producing two eggs each time. Both parents care for the young. Although they usually nest in trees, they also are known to nest on the ground. Squabs grow rapidly and **fledge** (learn to fly) by the time they are a month old. The preferred habitat of mourning doves is dry, upland areas, grain fields, deserts, and suburban areas. Their diet includes mostly insects, seeds, grain, and fruits.

Figure 12–26 A mourning dove. *Courtesy. Anthony Mercieca. Photo Researchers, Inc.*

Pigeons and doves are primary consumers that convert plant materials to meat. They are preyed upon by a wide variety of animals during the nesting period, but adults are most often eaten by falcons, hawks, and other birds of prey.

The passenger pigeon was cited earlier in this text as a bird that was hunted until it became extinct. It was probably once the most abundant bird on earth and certainly the most numerous of the North American pigeons. Nonetheless, it was wiped out in just a few years due to overhunting. The loss of this species is a powerful example of the importance humans should place on proper management of our wildlife heritage.

LOOKING BACK

The game birds include quails, partridges, pheasants, grouse, pigeons, and turkeys. They are managed as game birds by many state and federal fish and game agencies.

All of the game birds except pigeons are gallinaceous, meaning that they have heavy, plump bodies, and they nest on the ground. Some of them are polygynous or polygamous in their mating behavior, others are monogamous. All of the birds discussed in this chapter are primary consumers, although some of them eat insects in addition to vegetable matter.

Game birds are preyed upon in large numbers by a variety of predators, including several of the birds of prey. They are strong runners, and they often choose to run instead of fly to escape their enemies. They are generally able to sustain their numbers because they produce large numbers of offspring each year.

Chapter Review

DISCUSSION AND ESSAY

1. Name the six kinds of game birds that are considered in this chapter.
2. Describe a nesting behavior of gallinaceous birds that distinguishes them from other birds.
3. Distinguish between monogamous, polygynous, and polygamous birds, and list some examples of each.
4. Define the relationship between doves and pigeons.
5. Evaluate the roles of game birds in the environments that they inhabit.
6. List the common species of quails, partridges, and pheasants that are found in the region where you live, and record them on a chart.
7. Identify some of the major species of North American game birds and pigeons, and list additional species that are found where you live.
8. List the probable effects that a reduced population of game birds might have on populations of birds of prey that inhabit the same area.
9. Describe how the coloring of many game birds differs between the sexes. List some ways that color differences between males and females contribute to mating and to survival during the nesting period.
10. Explain the relationship between the survival rates of game birds and the number of eggs that the females produce.
11. Describe how mating rituals among game birds are used to attract mates.

MULTIPLE CHOICE

1. Birds that nest on the ground and that are heavy bodied are classed as:

   a. Polygynous
   b. Polygamous
   c. Gallinaceous
   d. Deciduous

2. A mating habit in which a male mates with several females is called:

   a. Gallinaceous
   b. Polygynous
   c. Monogamous
   d. Polygamous

3. A mating habit in which pair bonding does not occur and both males and females may have more than one mate is called:

   a. Monogamous
   b. Polygynous
   c. Gallinaceous
   d. Polygamous

4. The gallinaceous bird that forms coveys and is adorned with a plume on its head is the:

   a. California quail
   b. Bobwhite quail
   c. Hungarian partridge
   d. Ring-necked pheasant

5. Males of this gallinaceous species help incubate the eggs and raise the chicks:

   a. California quail
   b. Ring-necked pheasant
   c. Chukar partridge
   d. Bobwhite quail

6. An example of a polygynous bird is the:

   a. Bobwhite quail
   b. Ring-necked pheasant
   c. Band-tailed pigeon
   d. Mourning dove

7. This species of game bird is native to North America:

   a. Bobwhite quail
   b. Hungarian partridge
   c. Chukar partridge
   d. Pheasant

8. The largest species of gallinaceous game bird is the:

   a. Quail
   b. Turkey
   c. Grouse
   d. Partridge

9. A game bird species that is protected from the cold by feathers on its feet and legs is the:

   a. Turkey
   b. Mourning dove
   c. Grouse
   d. Quail

10. A game bird that changes its summer plumage to white in winter is the:

   a. Rock ptarmigan
   b. Turkey
   c. California quail
   d. Pheasant

Learning Activities

1. Do a survey of the game birds in your region and map the distribution of the species that are found in your area. Obtain photographs, prints, and other visuals of these species from local fish and game centers. Research the ecology and management practices for each species. Prepare, validate, and present a conservation program to elementary school classes using the materials and information that you have gathered.
2. Obtain an incubator, and purchase fertile eggs of quail or other game birds from a game bird farm. Incubate the eggs to ensure that they will be hatching at the time you are studying the game bird unit.

CHAPTER

13

Birds of Prey

After completing this chapter, you should be able to:

- list the major differences between birds of prey and other kinds of birds
- name the six families of raptors that are found in North America
- describe the species of raptors that are representative members of each of the raptor families
- identify the similarities and differences among raptors
- evaluate the roles of raptors in the ecosystems of North America
- discriminate between hawks and owls
- name the two families of North American owls and distinguish between them
- describe the species of owls that are representatives of the two families of North American owls
- discuss the roles of owls in North American ecosystems
- discuss the positive and negative impacts on raptors of chemicals that are manufactured for garden, yard, industrial, and agricultural uses.

The birds of prey are the predators of the sky. North American birds of prey include four families of hawk-like birds and two families of owls. They are also called raptors. They are important as secondary consumers in all of the ecosystems of North America. Predatory birds help to maintain a natural balance between living organisms and their food supplies. They do this by helping to control populations of birds, reptiles, rodents, and other small animals.

KEY TERMS

raptor
talons
diurnal
eaglet
polyandry
aerie
color phase
kite
harrier
accipiter
kestrel
stoop
facial disk
pellet

All the birds of prey are carnivores—they are meat eaters. Their toes are equipped with claw-like **talons** they use to grasp their prey. They have three toes pointed forward and a fourth toe pointing backward, making it possible for them to grip things. The beaks of these birds are sharp, and they are shaped to tear raw flesh, see Figure 13–1. The jaws and feet of these birds are strong and powerful, and they have exceptional eyesight. They generally kill prey with their talons and tear it into bite-size pieces with their bills. They are well fitted for their roles as predators.

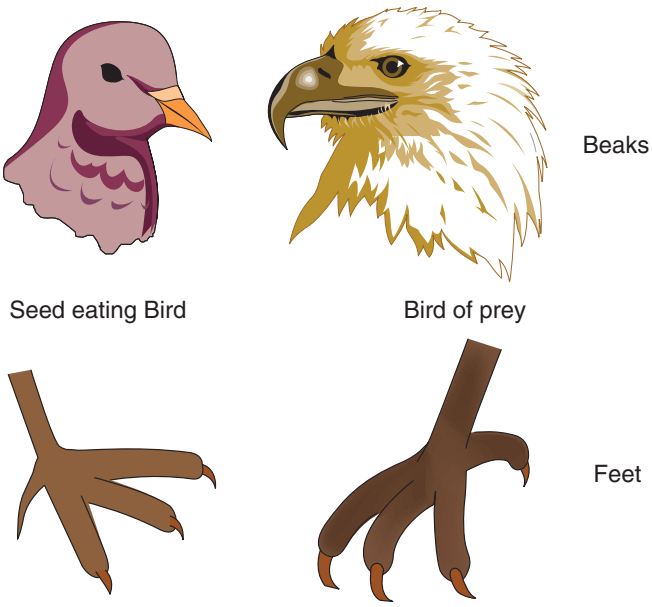


Figure 13–1 Seed eating birds use their claws to scratch at the ground in search of food and their beaks to break open seeds. Birds of prey use their claws to grasp and kill their prey and their beaks to tear it into bite-size pieces.

HAWK-LIKE BIRDS

One family of hawk-like birds found in North America consists of the eagles, hawks, and kites. Others are the New World vultures, ospreys, and falcons, see Figure 13–2. These birds of prey belong to the scientific order known as falconiformes. Other birds of prey are the owls. They belong to the order strigiformes, which includes two families, the typical owls and the barn owls.

Eagles, Hawks, and Kites

The eagles, hawks, and kites are **diurnal** birds of prey, meaning that they are active only during daylight hours. The nocturnal birds of prey such as owls are most active during hours of darkness. The eagles, hawks, and kites are all similar in shape; however, there are major differences among them in size, diet, and their preferred habitats.

Raptor Families

Hawks, Eagles, and Kites

Black hawk
Cooper's hawk
Ferruginous hawk
Gray hawk
Harris hawk
Marsh hawk
Red shouldered hawk
Red tailed hawk
Rough-legged hawk
Sharp-shinned hawk
Swainson's hawk
Zone-tailed hawk
Bald eagle
Golden eagle
White-tailed kite
Goshawk

Vultures

California condor
Black vulture
Turkey vulture

Osprey

Osprey

Falcons

Aplomado falcon
Peregrine falcon
Caracara

Owl Families

Elf owl
Burrowing owl
Great gray owl
Great horned owl
Pygmy owl
Long-eared owl
Saw-whet owl
Screech owl
Short-eared owl
Snowy owl
Spotted owl

Barn owl

Barn Owls

KEY INTERNET SEARCH WORDS

birds of prey

Figure 13–2 Raptors are important as secondary consumers in all the ecosystems of North America. Hawks, eagles, kites, vultures, osprey, falcons, and owls are all considered birds of prey.

KEY INTERNET SEARCH WORDS

bald eagle

Haliaeetus Leucocephalus

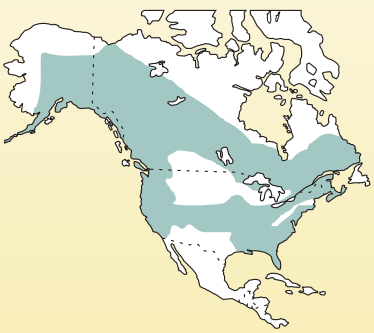


Figure 13–4 Distribution map of the bald eagle.

AVIAN PROFILE

Bald Eagle *(Haliaeetus leucocephalus)*

A mature bald eagle has a yellow bill, a dark brownish-black body, and a white neck, head, and tail, see Figure 13–3. Immature birds are brown with light-colored markings on their underparts, and they take up to 5 years to acquire adult plumage. The wingspan of this bird ranges from 6.5–7.75 feet. They prefer coastal habitats or rivers and lakes, where fish are available for food. For this reason, the bald eagle is classified as a fish eagle. It is also a scavenger that eats carrion. Birds (especially water birds), rodents, rabbits, hares, and snakes also are included in the diets of bald eagles.

Figure 13–3 The majestic bald eagle. *Courtesy U.S. Fish and Wildlife Service. Photo by Laura L. Whitehouse.*

The bald eagle is the national bird of the United States of America. It ranges through much of the United States and Canada, except for some areas in the southwest and the grain belt along the border between the two countries, see Figure 13–4. It is most abundant in Alaska but avoids the far northern tundra biome. Although the distribution of eagles is widespread, they are only abundant in localized areas.

Two or three eggs are laid each year, and a single brood of offspring is raised. Young eagles are called **eaglets**. They are covered with a whitish down when they hatch. Mated pairs of eagles first nest at 3–5 years of age, and they tend to return to the same nesting sites year after year. Nests are constructed of sticks, and new material is added each nesting season.

A number of the members of this family, particularly the eagles, have long been thought to mate for life. Some raptor experts now say that there is limited evidence to support this claim. They prefer to say that many raptors mate with the same partners for one or more seasons. Some species of raptors are known to be polygynous, meaning that a male mates with more than one female. In a few instances, females have been known to mate with more than one male. This latter mating behavior is known as **polyandry**. Some raptors return to the same nesting sites each year. The nest of a raptor, called an **aerie**, is usually located in a high place such as a cliff or treetop. Both parents are typically involved in caring for their young, and some species will attempt to drive intruders away from their nests when they get too close. There are few recorded instances, however, of these birds actually attacking a human. An unusual trait among raptors is the tendency for males to help incubate the eggs.

KEY INTERNET SEARCH WORDS

golden eagle

Aquila chrysaetos

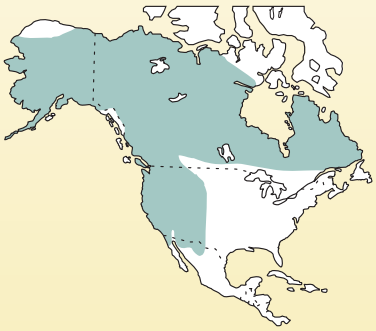


Figure 13–6 Distribution map of the golden eagle.

AVIAN PROFILE

Golden Eagle *(Aquila chrysaetos)*

The golden eagle is a large bird with a wingspan of 7–7.5 feet. It has dark brown plumage, and unlike the bald eagle, it has feathers on its legs, see Figure 13–5. The range of this eagle extends across much of Alaska and Canada, throughout most of the western United States, and south to Mexico, see Figure 13–6.

The golden eagle is a hunter that eats fresh meat but seldom eats carrion. It hunts in forests and rangelands for rabbits, birds, and rodents, occasionally preying on the lambs of wild sheep and the kids of mountain goats. It is also known to occasionally kill domestic animals such as lambs, small goats, young pigs, and chickens when the opportunity is presented.

Figure 13–5 The golden eagle. *Courtesy U.S. Fish and Wildlife Service. Photo by Tom Smylie.*

Golden eagles may alternate between nesting sites, but they usually return to established aeries. They begin to reproduce starting at 3–5 years of age, and females lay only two eggs per season. Breeding pairs build platform nests of sticks lined with grass or other vegetation. These nests are located on cliff ledges or tree tops. Males assist with raising the young by hunting for food, which they bring back to the nest. The eaglets begin to fly at about 2 months of age.

Most raptors establish territories that they defend against others of their kind. Territory boundaries surround the nesting area, and the size of the territory varies depending on the raptor species and the abundance

of the food supply. In a preferred raptor habitat, nests tend to be spaced fairly evenly throughout the area. Marsh hawks are exceptions because they live and nest in colonies.

INTERNET ADDRESS

http://www.desertusa.com/aug96/du_hawk.html

KEY INTERNET SEARCH WORDS

red-tailed hawk
Buteo jamaicensis

Figure 13–8 Distribution map of the red-tailed hawk.

AVIAN PROFILE

Red-Tailed Hawk *(Buteo jamaicensis)*

The red-tailed hawk is a large bird that is dark brown on the upper body and light-colored underneath. A dark band extends across its belly. The tail is light colored in juveniles and reddish in adults, see Figure 13–7. This hawk is widely distributed in North America, see Figure 13–8. Its breeding range extends northward from the border between the United States and Canada, and it ranges permanently throughout most of the United States and parts of Mexico.

This hawk is adapted to a wide range of habitats from desert to tundra. It preys mostly on small rodents and some insects. Without the red-tailed hawk and other birds of prey, rodent populations would become far too abundant for the environment to support. Females of this species lay from one to four eggs in large nests made of sticks and lined with twigs and plant roots. Their aeries are constructed in trees or on cliffs.

Figure 13–7 The red-tailed hawk. *Courtesy U.S. Fish and Wildlife Service.*

Many birds and animals experience differences in the color of their skin, scales, fur, or feathers as they mature. Others experience color differences each time the season changes. Each of these changes in color is known as a **color phase**. In many instances, the color phase of an individual bird or animal can make it appear to be a member of a different species that exhibits a similar color phase. For this reason, color descriptions of the raptors describe the adults of the species and should not be confused with the immature color phases exhibited by many birds.

KEY INTERNET SEARCH WORDS

swainson's hawk

Buteo swainsoni

Figure 13–10 Distribution map of the Swainson's hawk.

AVIAN PROFILE

Swainson's Hawk *(Buteo swainsoni)*

The Swainson's hawk is a large, slender raptor that is similar in size to the red-tailed hawk. It is difficult to identify by color alone because it has many color phases. Most adults, however, are dark on top with cream-colored or tawny color markings on the underside, see Figure 13–9.

The Swainson's hawk ranges throughout much of the western half of North America, see Figure 13–10. They gather in large flocks and migrate south to Argentina in the winter, returning each spring. The migration covers from 11,000 to 17,000 miles each year.

The diet of this hawk consists almost entirely of rodents and other small animals, along with large insects such as locusts, grasshoppers, and crickets. It prefers open spaces such as prairies and plains with few trees where it can see its hunting territory as it searches for prey.

The Swainson's hawk is a monogamous bird, and mated pairs tend to return to the same nesting sites year after year. The female lays two to three eggs in a nest constructed of twigs and grass. The nests are located in trees, on ledges, or on the ground. The male and the female both help to incubate the eggs and care for the young.

Figure 13–9 The Swainson's hawk migrates to Argentina each winter and returns in the spring. *Courtesy U.S. Fish and Wildlife Service. Photo by Gary R. Zahm.*

A **kite** is a hawk with a long square or forked tail and long wings that come to a point at the tips. Kites are found only in the warmer areas of North America, mostly in the southeastern and Gulf Coast states with a few in California. Kites are generally few in number. They include the swallow-tailed kite, black-shouldered kite, Mississippi kite, snail kite, and white-tailed kite.

ENDANGERED SPECIES PROFILE

Everglade Snail Kite *(Rostrhamus sociabilis)*

Figure 13–11 Distribution map of the Everglade snail kite.

The Everglade snail kite is an unusual bird in that it eats only one species of freshwater snail found in the Florida Everglades, see Figure 13–11. It is this limited diet and the destruction of natural wetlands in southern Florida that have resulted in this bird being included on the endangered species list by the U.S. Fish and Wildlife Service. It is bluish gray in color with black bill and talons, orange feet, and reddish eyes, see Figure 13–12.

Mated pairs produce only two to three eggs in a season, so recovery of this population is likely to be very slow.

Figure 13–12 The Everglade snail kite eats a single species of snail found in the Florida Everglades. *Courtesy Jim Zipp. Photo Researchers, Inc.*

The genus of hawks known as **harriers** are excellent hunters in tall vegetation such as marsh reeds and field grasses. They are unusual in their nesting habits because several pairs of these birds nest in close proximity to one another instead of establishing separate territories.

KEY INTERNET SEARCH WORDS

northern harrier

Circus cyaneus

Figure 13–14 Distribution map of the northern harrier.

AVIAN PROFILE

Northern Harrier *(Circus cyaneus)*

The male northern harrier (marsh hawk) is light gray on top with white underparts. Females are brown with white underparts marked with brown streaks. Their wingtips are black, and they have white rumps, see Figure 13–13. Northern harriers are widely distributed in North America, see Figure 13–14.

Northern harriers have become specialized in finding and catching mice that are hidden in tall vegetation. They do this through their acute hearing. They are able to locate mice without being able to see them because they hear the mice when they squeak.

Females lay four to six eggs each year in ground nests located in a marsh. Both parents help rear the young, and family groups gather to roost together on the ground each night.

Figure 13–13 The northern harrier, also called the marsh hawk, locates mice in tall vegetation by hearing them when they squeak. *Courtesy Shutterstock*.

Accipiters, or woodland hawks, range widely through North America. In addition to the goshawk, this genus includes the Cooper's hawk and the sharp-shinned hawk. All three of these birds are commonly called chicken hawks, because they are occasional predators of domestic birds including chickens.

These are medium-sized hawks that are very adept at flying. They have short wings and long tails, and they are well equipped to weave swiftly through their woodland and forest habitats. These three hawks occupy much of North America, and their territories overlap significantly.

KEY INTERNET SEARCH WORDS

goshawk

Accipiter gentilis

Figure 13–16 Distribution map of the goshawk, the Cooper's hawk, and the sharp-shinned hawk.

AVIAN PROFILE

Goshawk *(Accipiter gentilis)*

The goshawk is gray colored on the upper body with barred markings of light gray and white on the underside, see Figure 13–15. Young birds are more brown than gray in color. This species has a distinctive white stripe above each eye, and the females are larger than males. The goshawk ranges through much of North America, see Figure 13–16.

Figure 13–15 A goshawk prefers to eat medium-sized birds. *Courtesy U.S. Fish and Wildlife Service. Photo by Karen Laubenstein*

These hawks fly by flapping their wings to gain speed followed by a long glide. They can maneuver swiftly through trees and branches in pursuit of prey. The preferred prey of goshawks are medium-sized birds, and it makes no distinction between domestic chickens and game birds. Forest-inhabiting grouse also are a favorite prey of goshawks.

Goshawks nest high in coniferous trees. Females lay three to four eggs, and the male supplies food to the female during the incubation period. Both parents hunt when the demand for food becomes a burden to the male.

KEY INTERNET SEARCH WORDS

cooper's hawk

Accipiter cooperii

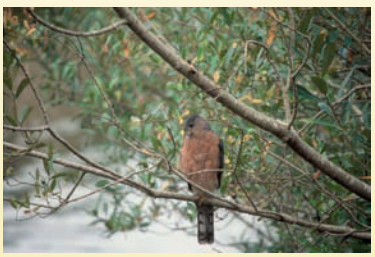


Figure 13–17 This young Cooper's hawk is a medium-sized bird of prey that feeds mostly on birds. *Courtesy U.S. Fish and Wildlife. Photo by Lee Karney.*

AVIAN PROFILE

Cooper's Hawk *(Accipiter cooperii)*

The Cooper's hawk is a medium-sized raptor that feeds mostly on birds. They have dark heads, blue-gray backs and upper wings, with a white breast, belly, and underwing with reddish flecks or streaks, see Figure 13–17. They prefer to eat songbirds and woodland game birds; however, they are also known to eat small mammals and reptiles. They hunt on the wing, and their long tails act as rudders, enabling them to move easily through wooded areas in search of prey.

A mature Cooper's hawk has a wingspan of approximately 28 inches, with the females being larger than the males. A mated pair builds its nest in a wooded area, and they produce a clutch of four to five eggs that hatch after 32–36 days of incubation. The young birds fledge at about 1 month of age, and their parents teach them to catch and kill the fledgling birds of other species that are abundant during that season of the year.

This hawk is considered to be an environmental success story in Illinois, where it has recently been removed from the state endangered species list. It is similar but smaller than the goshawk. The sharp-shinned hawk also looks very much like the Cooper's hawk except that it is smaller.

Several of the small-sized and medium-sized hawks that are discussed here belong to the same genus. They are swift and agile, with long tails and short, rounded wings. They are called **accipiters**. These birds of prey do not distinguish between domestic chickens and wild birds—they kill and eat both.

AVIAN PROFILE

Sharp-Shinned Hawk *(Accipiter striatus)*

The sharp-shinned hawk is a small hawk with a wingspan of 21–22 inches. It is a slender, long-bodied hawk with a blue-gray back and a rust-colored barred pattern on a light-colored breast, belly, and underwings. Its tail is somewhat narrow and squared or slightly notched. The female is larger than the male, and she is often confused with the male Cooper's hawk, which is about the same size. The sharp-shinned hawk is much quicker in flight than the Cooper's hawk, however, and it also tends to have more contact with humans. The sharp-shinned hawk ranges throughout much of North America. It shows a preference for deciduous and coniferous forests, ranging as far north as Canada and as far south as the Gulf states. This bird appears on some state lists of endangered and threatened species.

These hawks sometimes visit backyard bird feeders because their prey is more concentrated in such areas. Sharp-shinned hawks usually weigh 6–8 ounces, and they sometimes kill prey that is larger than they are, such as rabbits and pigeons.

Mating pairs build nests of twigs in the lower branches of woodland trees. The clutch usually consists of three to four eggs or young. The fledgling hawks leave the nest in time to prey upon young songbirds. Many of these are still in the nest or have recently fledged, so they are easy prey for the young predators.

Falcons

Accipiters and falcons are similar in their preference to feed heavily on birds. The goshawk preys on large game birds such as pheasants or ruffed grouse. Some falcons also prey on these species. Other falcons, such as the American kestrel, are small birds of prey, and they feed on small birds such as sparrows and finches. The goshawk and falcons also eat small mammals.

KEY INTERNET SEARCH WORDS

sharp-shinned hawk

Accipiter striatus

KEY INTERNET SEARCH WORDS

American Kestrel

sparrow hawk

Falco sparverius

Figure 13–19 Distribution map of the American kestrel.

AVIAN PROFILE

American Kestrel or Sparrow Hawk *(Falco sparverius)*

The American kestrel is commonly known as a sparrow hawk. Its diet consists of mice, voles, small birds, and insects such as grasshoppers. It is a small falcon that can maintain a fixed position above the ground by hovering on rapidly beating wings. Hawks that are able to hover in this manner are called **kestrels**. Hovering enables the kestrel to keep small prey in sight before diving down to capture it.

This kestrel is reddish colored on the back, crown, and tail with blue-gray head and wings. The breast and underparts are lighter in color than the upper body, and a black marking is present just behind the ear, see Figure 13–18. The sparrow hawk is widely distributed in North America, ranging from Alaska and southern Canada to Mexico, see Figure 13–19.

Females lay three to five eggs in tree holes or in other protected areas. They do not build nests.

Figure 13–18 The American kestrel or sparrow hawk has the ability to hover in place before diving to capture its prey. *Courtesy U.S. Fish and Wildlife Service. Photo by Tom Smylie.*

Among the raptors, the females are often larger in size than the males. There appears to be a relationship between these size differences and how fast the prey is. Among raptors that catch birds in flight, the females are sometimes twice as large as males. The size differences are not nearly so great among raptors that eat slow-moving prey such as snails.

KEY INTERNET SEARCH WORDS

peregrine falcon

Falco peregrinus

Figure 13–21 Distribution map of the peregrine falcon.

AVIAN PROFILE

Peregrine Falcon *(Falco peregrinus)*

Figure 13–20 The peregrine falcon is an extremely fast flyer. It captures birds while in flight. *Courtesy U.S. Fish and Wildlife Service. Photo by Phil Million.*

The peregrine falcon is gray in color on the upper body with a nearly white throat and distinctive bar markings on the light-colored underparts, wings, and tail, see Figure 13–20. Females are more brown than gray. This falcon occupies habitats in open prairie regions and along sea cliffs and rivers. It ranges from Alaska and northern Canada along the Rocky Mountain range to Mexico, see Figure 13–21. In 1970, it was listed as an endangered species under the provisions of the federal Endangered Species Act. The federal listing was removed in 1999; however, it is still listed as an endangered species by some states. The peregrine falcon is an extremely fast flier, and it often captures its prey in flight. Once it has spotted its victim, it makes a fast dive called a **stoop** that ends when it makes contact with its target. It is used in the sport of falconry as a trained hunting bird to hunt game birds.

The preferred prey of this bird consists of pigeons, game birds, water birds, and ducks. It is sometimes found living among the tall buildings of cities where it preys on pigeons. It nests on cliffs and building ledges where the females lay and incubate two to four reddish-colored eggs.

Falcon populations dropped dramatically as the use of organic pesticides such as DDT became standard practice during the 1900s. The use of DDT contributed to weakness in the shells of raptor eggs, causing them to become too thin. The end result was that the eggs of these birds were often broken during incubation. Sometimes chemicals used to kill insects on farm crops, lawns, and home gardens have proven to be harmful to birds and other animals. Such chemicals build up in the bodies of birds until they reach harmful or even toxic levels. Chemicals

such as DDT often persist even after their use has been discontinued. This is due to the accumulation of the chemical in the tissues of plants and animals. Such chemicals pass from plants to primary consumers to secondary consumers—a toxic chemical can persist in the food web for a long time.

It is not necessary to eliminate all of the chemicals that are used around our yards, gardens, roads, golf courses, farms, and industrial sites to protect wildlife. However, we must use such materials prudently. Chemicals that are demonstrated to have long-term negative effects on wildlife or humans must not be used.

Vultures

The vultures discussed in this chapter are New World vultures found on the American continents. They are scavenging birds that eat carrion. The North American species of vultures are the black vulture, turkey vulture, and California condor.

KEY INTERNET SEARCH WORDS

turkey vulture

Cathartes aura

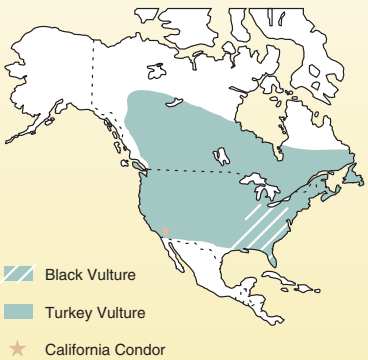


Figure 13–22 Distribution map of the black vulture, the turkey vulture, and the California condor.

AVIAN PROFILE

Turkey Vulture *(Cathartes aura)*

Figure 13–23 The turkey vulture. *Courtesy U.S. Fish and Wildlife Service. Photo by Luther C. Goldman.*

The turkey vulture is one of the largest birds in North America. It is a scavenging bird that ranges throughout much of the United States and Canada, see Figure 13–22. It inhabits open areas where it feeds on carrion and can be seen circling at high altitudes searching the landscape below for dead or weak animals. They have superb eyesight. The turkey vulture is brown to black in color with a naked, red head, and broad wings that span up to 6 feet, see Figure 13–23. Its naked head enables it to thrust its head into the body cavities of dead animals as it feeds. This is a sanitary adaptation that helps to keep this bird much cleaner than it would be if the head and neck were covered with feathers. Females lay one to three eggs in a sheltered place on the ground, in rock cavities, or in hollow logs.

Vultures are awkward, ugly birds when they are on the ground, but they are graceful in flight as they ride the air currents to high altitudes. They perform an important role in the environment by eating the rotting flesh of dead animals.

KEY INTERNET SEARCH WORDS

California condor

Gymnogyps Californianus

ENDANGERED SPECIES PROFILE

California Condor *(Gymnogyps californianus)*

The California condor is the largest bird of prey in North America. It is black in color with a naked, reddish orange head, see Figure 13–24. Only one breeding flock is known to remain in the hills of southern California. Another wild breeding flock has been established in Arizona from captive birds that have been released to the wild.

These birds were rare even before North America was settled by Europeans, but loss of habitat for human use, improper use of pesticides, and disturbance by humans have all contributed to their decline. Their rate of reproduction also is very slow. Under natural conditions, a breeding pair raises only one offspring every 2 years. These birds do not breed until they are 5–6 years old, contributing to the slow rate of population recovery.

Captive flocks of these birds have been established in an effort to prevent them from becoming extinct. One of these flocks is located at the National Birds of Prey Center in Boise, Idaho, where they are isolated from all human contact to preserve their wild instincts and behaviors. In recent years, some young birds have been released to the wild from this center. At the time the condor was listed as an endangered species, there were only 27 birds remaining. The total captive and wild population of California condors living today is approximately 330.

Figure 13–24 The California condor is the largest bird of prey in North America. *Courtesy U.S. Fish and Wildlife Service. Photo by Glen Smart.*

Osprey

Only one species of osprey is known. It is sometimes called the fish hawk or fish eagle because its diet consists of fish that are taken alive. This bird is a superb fishing bird that plunges feetfirst into the surface of the water to snag fish.

KEY INTERNET SEARCH WORDS

Osprey

Pandion haliaetus

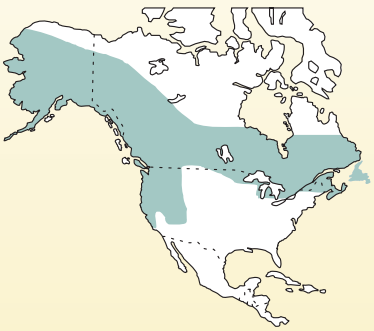


Figure 13–26 Distribution map of the osprey.

AVIAN PROFILE

Osprey *(Pandion haliaetus)*

The osprey is a large bird with white underparts and dark brown upper body. The underside of its tail is striped, and its wings have dark edges. The head is white, and it has a dark stripe that extends across the eyes, see Figure 13–25. Ospreys mature sexually in 5–7 years, and they usually mate for life, nesting in the spring. Females lay two to four eggs in platform nests located near water on trees, cliffs, bridges, or utility poles. Ospreys occupy habitats along rivers, lakes, and seacoasts where fish are abundant. They range through parts of the northern and coastal regions of the United States and Canada, except for the far northern regions, see Figure 13–26.

Figure 13–25 The osprey is a raptor that catches and feeds on fish. *Courtesy U.S. Fish and Wildlife Service. Photo by Bart Foster.*

OWLS

The two owl families in North America are the typical owls and the barn owls. Owls have some unique characteristics unlike those of most other birds. They have soft down on the margins and tips of their wing feathers that deaden the sounds of flight. This helps owls to hear potential prey and prevents prey from hearing the approaching owl. They have excellent vision, and they are able to see quite well at night. They also have a highly developed sense of hearing, and they are capable of hunting by sound alone.

Career Option

WILDLIFE MITIGATION SPECIALIST

A WILDLIFE MITIGATION SPECIALIST works to improve habitat to meet the needs of wild animals. He or she must be well versed in ecology, life cycles, population trends, and habitat requirements of wild animals. This career is focused on the development and implementation of plans to reduce the negative impacts of human activities on wildlife. This is done by identifying and evaluating habitat losses and modifying land and water environments to create or improve critical wildlife habitat. A university degree in ecology or a related science is required.

Owls can be found in any habitat that has a suitable supply of food. They are nocturnal birds that hunt mostly at night or during twilight hours. They prey on rodents, rabbits, birds, reptiles, fish, and insects. Some small owls also eat worms. North American owls are generally not very specialized in the kinds of food they eat.

Typical Owls

Typical owls belong to a family that is also known as "true" owls. They have large round heads, large eyes, hooked bills, and fluffy plumage that muffles the sound of flight. Seventeen species of typical owls have been identified in North America.

KEY INTERNET SEARCH WORDS

great gray owl
Strix nebulosa

Figure 13–28 The arrangement of feathers on the facial disk of an owl contributes to its acute hearing.

AVIAN PROFILE

Great Gray Owl *(Strix nebulosa)*

The largest owl in North America is the great gray owl with a wingspan up to 4.5 feet. It lives in the northern coniferous forests that are densely populated with larch, spruce, and pine dispersed with open meadows, see Figure 13–27. Much of the population of this species is found in the bogs and marshes of Alaska and Canada. The head and neck of this owl are mottled brown and gray in color with a barred pattern on a gray background on the lower body. The owl's head is large and round, lacking the prominent ear tufts of some owls. The call of this bird is deep and loud, with a distinct "whoo, hoo" sound.

Figure 13–27 The great gray owl is the largest owl in North America. *Courtesy Shutterstock.*

This owl is a silent hunter that is capable of hunting day or night. It eats mostly rodents, shrews, and birds. Its face is described as a **facial disk** because the feather pattern on the face helps to direct sounds toward the ear openings that are hidden beneath the feathers, see Figure 13–28. It is able to hear and locate mice and other prey by the sounds they make as they communicate or move about, even in complete darkness. The most important predator of the great gray owl is the great horned owl.

Breeding pairs of owls usually use the old nests of hawks or ravens. The female lays one to nine eggs in the nest in early spring. The number of eggs produced is controlled by the female's nutrition. In years when rodents are abundant, the number of eggs and young is high compared to seasons when food is scarce.

Scientists have learned much of what they know about the eating habits of owls by examining owl **pellets**. A pellet is the regurgitated remains of a digested prey animal containing its undigested skull, bones, and hair. Pellets are gathered beneath the tree limbs where the owl roosts as it rests.

KEY INTERNET SEARCH WORDS

great horned owl

Bubo virginianus

Figure 13–30 Distribution map of the great horned owl.

AVIAN PROFILE

Great Horned Owl *(Bubo virginianus)*

The great horned owl is a very large owl with large, yellow eyes, and ear tufts or "horns" on its round head. It is mottled brown in color with gray barring on the underside, see Figure 13–29. It hunts rabbits, rodents, and birds, including the young nestlings of crows and ospreys. It even kills and eats other owls. This owl is forced to do some of its hunting in daylight because part of its range is located in a region that does not always get dark at night.

The great horned owl may be the best-known owl in North America because its territory includes most of the continent, see Figure 13–30. It calls in a deep voice with a rhythmic sound like "hoo, hoo, hoo." The female lays two to three eggs in the old nest of another bird.

Figure 13–29 The great horned owl is an important predator of rabbits, rodents, and birds. *Courtesy U.S. Fish and Wildlife Service. Photo by Robert Drieslein.*

All of the North American owls except the barn owl belong to the family of typical owls. These owls are widely dispersed across the continent. They range in size from birds the size of sparrows to some that are as large as ducks.

KEY INTERNET SEARCH WORDS

elf owl

Micrathene whitneyi

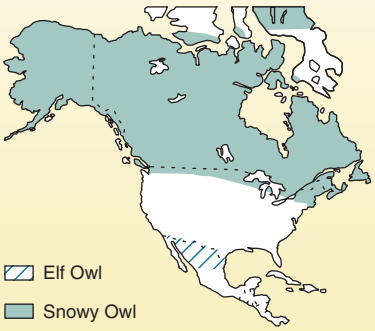


Figure 13–32 Distribution map of the elf owl and the snowy owl.

AVIAN PROFILE

Elf Owl *(Micrathene whitneyi)*

The elf owl is the smallest owl in North America, comparable in size with the sparrow, see Figure 13–31. Its habitat is the Saguaro desert region in the southwestern part of the continent, see Figure 13–32. It is also known to live in dry wooded canyons and arid regions covered with scrub growth.

This owl lives on a diet of large insects. It nests in abandoned woodpecker holes in trees or large cactus plants, where females lay three to four eggs.

Figure 13–31 The elf owl is the smallest owl in North America. *Courtesy Craig K. Lorenz. Photo Researchers, Inc.*

INTERNET ADDRESS

http://library.thinkquest.org/3500/snowy_owl.html

KEY INTERNET SEARCH WORDS

snowy owl

Nyctea scandiaca

AVIAN PROFILE

Snowy Owl *(Nyctea scandiaca)*

The snowy owl is a large white owl with dark spots and a wingspan up to 55 inches, see Figure 13–33. Its range extends throughout Canada and into the northern arctic region. It is a migratory bird whose summer range includes the tundra of Alaska and northern Canada. During the winter season, it moves southward.

Figure 13–33 The snowy owl prefers to live in the arctic region, where it preys heavily on lemmings. *Courtesy U.S. Fish and Wildlife Service.*

Lemmings make up a major part of the diet of the snowy owl. In years when lemmings are not very abundant, this owl migrates south in search of food. It nests on the ground in shallow depressions lined with moss and grass. Females lay five to seven eggs each nesting season.

KEY INTERNET SEARCH WORDS

eastern screech owl
western screech owl
Otus asio
Otus kennicottii

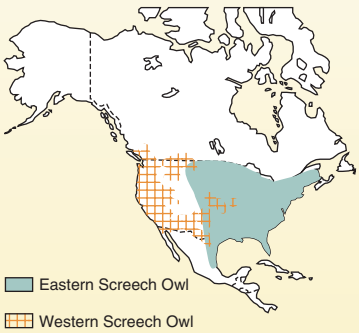


Figure 13–35 Distribution map of the western screech owl and eastern screech owl.

AVIAN PROFILE

Eastern Screech Owl *(Otus asio)* and Western Screech Owl *(Otus kennicottii)*

The screech owl name comes from the sound of this owl's evening call. It is one of the smallest owls, and it has learned to adapt to living near humans. This owl goes through two color phases, gray and red, and it has distinct ear tufts and yellow eyes, see Figure 13–34. The eastern screech owl ranges throughout the eastern two-thirds of the United States from Canada to Florida. The western species overlaps the eastern species in several areas, see Figure 13–35.

Figure 13–34 The screech owl has a distinctive call from which it gets its name. *Courtesy U.S. Fish and Wildlife Service.*

These owls feed on a variety of organisms with insects and rodents being preferred. They are nocturnal feeders that catch nocturnal insects in flight. They also eat squirrels and jays. The screech owl is prey to the great horned owl and other raptors that feed at night. Its best defense during the daytime is to sit quietly beside a tree trunk enabling its protective coloration to hide it. Many of these birds also are killed by cars as they hunt mice and voles in the grassy areas along highways and roads.

The screech owl's preferred nesting site is a hollow tree; however, nearly any sheltered habitat is adequate for their needs. The average number of offspring that are fledged each year are three, and the adult birds vigorously defend them from intruders. Screech owls usually live 6–13 years.

Most owls are opportunistic feeders. This means that they will usually eat whatever suitable food they find. Scientific studies demonstrate that the diets of owls that depend on more than one food source are seldom predictable in the percentage of the different foods they consumed.

KEY INTERNET SEARCH WORDS
burrowing owl
Speotyto cunicularia

KEY INTERNET SEARCH WORDS
northern spotted owl
Strix occidentalis

Figure 13–36 A burrowing owl nests in underground burrows. *Courtesy Shutterstock.*

AVIAN PROFILE

Burrowing Owl *(Speotyto cunicularia)*

The burrowing owl is a long-legged owl that lives in abandoned underground burrows of mammals such as squirrels, prairie dogs, and badgers. It is capable of digging its own burrow but prefers to use those of other animals. This owl lacks ear tufts, but it has distinctive white eyebrows. It is a sandy-colored bird with a barred pattern on the head, back, and upper wing surfaces with speckled cream-colored underparts, see Figure 13–36. As many as 18 subspecies of burrowing owls are known to live in North America.

They prefer open habitat found in grasslands, deserts, farmlands, and rangelands. These owls are often observed living along the edges of airports and golf courses. They range throughout the western half of the United States and Canada, extending through Mexico. An isolated population exists in Florida and the Bahamas.

Females lay 6–11 eggs in underground nests lined with grass or leaves. The female incubates the eggs, and the male cares for the young while they remain in the nest. Later, both parents bring food for the young birds until they are able to catch insects by themselves. These owls feed mostly on beetles and grasshoppers, but they also are known to eat reptiles and amphibians, small rabbits, birds, and bats. They are most active at dusk and dawn but hunt both day and night when food is scarce.

Figure 13–37 Spotted owls are endangered birds in the Pacific Northwest. *Courtesy U.S. Fish and Wildlife Service. Photo by John and Karen Hollingsworth.*

Several other species of typical owls are found in North America. One well-known owl is the spotted owl of the Pacific Northwest and British Columbia, see Figure 13–37. Efforts to protect this endangered species have led to the closure of much of the logging and timber industry in the disputed region.

Barn Owls

Members of the barn owl family are distinctive in their appearance because they have heart-shaped faces. Only one member of this family is found in North America.

INTERNET ADDRESS

http://www.desertusa.com/june97/du_barnowl.html

KEY INTERNET SEARCH WORDS

barn owl

Tyto alba

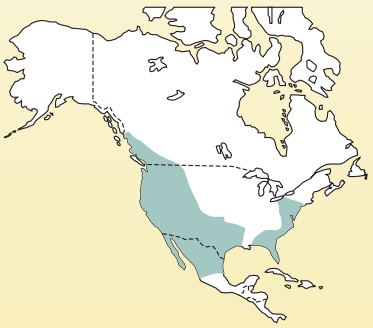


Figure 13–39 Distribution map of the barn owl.

AVIAN PROFILE

Barn Owl *(Tyto alba)*

The barn owl is a medium-sized, tan-colored owl, with gray streaks in its plumage and a heart-shaped white face rimmed with tan, see Figure 13–38. Its habitat includes woodlands, prairies, farms, and suburban areas, and it ranges throughout much of the United States, see Figure 13–39. It perches on trees and feeds mostly on rodents. Barn owls are attracted at night to dangerous highways, particularly during the winter season, because mice are active on the cleared surfaces. Highway mortality causes significant losses in the barn owl population.

Barn owls nest in protected areas of many kinds, including barns where 5–11 eggs are laid on a bare surface. It is from this nesting behavior that this bird gets its name. The barn owl is considered to be a friend of man because it preys on rodents and is willing to live in close proximity with humans.

Figure 13–38 The barn owl is widely distributed in the United States where it is considered to be a friend of man. *Courtesy Shutterstock.*

LOOKING BACK

Birds of prey include six families of raptors. Raptor families include one group composed of eagles, hawks, and kites. Three other families are the vultures, ospreys, and falcons, and the two owl families are the typical or true owls and the barn owl.

Birds of prey fill roles in the environment as secondary consumers. By preying on birds, reptiles, fish, and mammals, they help maintain a balance in nature between each of these animal populations and their food supply. Some raptors also eat carrion, which helps maintain a healthy environment by recycling the flesh of dead animals.

Chapter Review

DISCUSSION AND ESSAY

1. Name the major differences between birds of prey and other kinds of birds.
2. List the differences between hawk-like raptors and owls and other birds.
3. Identify the six families of raptors, and list each of the North American raptor species mentioned in this chapter and the family to which it belongs.
4. Describe some similar characteristics of all raptors, and identify ways that raptors differ from one another.
5. Define the roles that raptors fill in the ecosystems of North America.
6. Identify the two families of owls, and list some representative species of each.
7. Distinguish between typical owls and barn owls.
8. Discuss the positive and negative impacts on birds of prey of chemicals that are manufactured for uses in gardens, yards, highway weed control, golf courses, industry, and agriculture.

MULTIPLE CHOICE

1. Which of the following birds is not considered to be a raptor?
   a. Seagull
   b. Kite
   c. Owl
   d. Osprey
2. The golden eagle, kite, and osprey are all known as:
   a. Falcons
   b. Vultures
   c. Hawk-like birds
   d. Typical owls
3. Which of the following birds is diurnal?
   a. Osprey
   b. Great horned owl
   c. Barn owl
   d. Screech owl
4. Which of the following birds is nocturnal?
   a. Cooper's hawk
   b. California condor
   c. Peregrine falcon
   d. Great gray owl
5. The national bird of the United States of America is:
   a. Peregrine falcon
   b. Bald eagle
   c. Osprey
   d. Golden eagle

6. A mating habit in which a female mates with more than one male is called:

   a. Polyandry
   b. Polygamy
   c. Monogamy
   d. Ornithology

7. The nest of a raptor is called a/an:

   a. Clutch
   b. Aerie
   c. Stoop
   d. Biome

8. Which of the following raptors lives and nests in colonies?

   a. Golden eagle
   b. Red-tailed hawk
   c. Northern harrier
   d. Marsh hawk

9. A woodland hawk is classified as a/an:

   a. Vulture
   b. Accipiter
   c. Falcon
   d. Kite

10. The largest North American owl is the:

    a. Burrowing owl
    b. Great horned owl
    c. Northern spotted owl
    d. Great gray owl

11. The arrangement of the feathers in the facial disk of an owl affects which of its senses?

    a. Sight
    b. Hearing
    c. Smell
    d. Touch

12. The correct term for the regurgitated remains of an owl's meal, consisting of hair and bones is:

    a. Pellet
    b. Cud
    c. Aerie
    d. Stoop

Learning Activities

1. Identify a falconer in your area and invite this person to bring his/her bird to class. Schedule plenty of time for a discussion about falcons and other birds of prey, and request an outdoor demonstration of the bird's training.
2. Obtain permission from your state fish and game agency to prepare skull specimens of different birds of prey for educational use. Request the agency to provide the skulls from wounded birds that die in their care.
3. Establish an aviary at the school that is approved by the state fish and game agency for the care of wounded birds of prey.

CHAPTER

14

Songbirds and Other Perching Birds

The songbirds are part of a larger group of birds identified by the Audubon Society as perching birds. This group also includes the kingfishers, hummingbirds, and cuckoos. As with all attempts to organize birds in groups, they do not fit neatly into classifications. The groups discussed here have similar characteristics, but their placement in groups is arbitrary. Perching birds are adapted to a wide range of habitats, and they are found in most locations in North America. As the name implies, these birds are adapted to perching upright on branches and other surfaces.

After completing this chapter, you should be able to:

- name the different families of perching birds that are found in North America
- describe the characteristics and habits of several kinds of songbirds
- speculate about the tendency for males of many species of birds to be more brightly colored than females
- discuss the importance of the calls and songs of territorial birds
- analyze the characteristics of house sparrows and starlings that have helped them adapt so well to North America since they were introduced from Europe
- differentiate among the following terms that describe mating behaviors of birds—polygynous, polyandry, polygamous, monogamous, and promiscuous
- name some popular members of the thrush family of birds
- describe the reproductive behaviors of parasitic birds
- explain why gregarious birds frequently cause extensive damage to crops while solitary birds with the same eating habits are seldom blamed for crop damage
- describe some adaptations of hummingbirds that enable them to gather nectar for food.

KEY TERMS

territorial
conical bill
gregarious
tanager
dipper
shrike
brood
polygynous
parasitic bird
promiscuous

SONGBIRDS

Songbirds use their calls and songs to define the boundaries of their territories. Singing and calling makes other birds aware of their presence in the area. These birds are **territorial**, meaning that they defend their living areas against intrusion by other birds. The call of each bird species is unique, and an experienced bird-watcher can often identify a bird by its call. Only a few of the songbirds will be described in this chapter due to the large number of bird species in this group.

The largest bird family in the world (Fringillidae) includes sparrows, finches, grosbeaks, and buntings. Seventy-two species are found in North America. An introduced bird species that has similar characteristics but which belongs to the Ploceidae family is the English or house sparrow. It was introduced to North America in 1850 when a few birds from England were released in New York City. This sparrow is a weaver finch, and it is not related to native sparrows. It is included in this group because it is similar to the other birds that are described here.

INTERNET ADDRESS

http://www.naturesound.com/birds/birds.html

KEY INTERNET SEARCH WORDS

bird call songs

KEY INTERNET SEARCH WORDS

house sparrow
Passer domesticus

Figure 14–2 Distribution map of the house sparrow.

AVIAN PROFILE

House Sparrow *(Passer domesticus)*

The male house sparrow or English sparrow is a small brown bird with black stripes on the wings and back, a dark breast, a white face with chestnut markings, and a gray head, see Figure 14–1. Females are more drab in their colors. Since introduction of this bird to New York City, it has expanded its range to include most of North and South America, see Figure 14–2.

This sparrow inhabits cities, towns, and farms, where it nests in buildings and other sheltered areas. Females lay five to six eggs in large nests of grass, feathers, and other soft materials. Up to three broods per year may be raised. They eat grain, seeds, fruits, insects, and buds. They are preyed upon by raptors, cats, and other carnivorous mammals. Like most birds, they are most vulnerable to predators immediately after fledging.

Figure 14–1 The house sparrow is a species introduced from Europe. *Courtesy Shutterstock.*

Members of the Fringillidae family have **conical bills** (cone shaped) with sharp edges that are adapted to cracking seeds. They are technically omnivores; however, they feed mostly on seeds of grasses and weeds. They live in terrestrial as well as wetland habitats, and they are found throughout North America. Many finches, grosbeaks, buntings, and sparrows are **gregarious** birds that live together in flocks. Some of them are brightly colored, and many of them migrate between summer and winter ranges.

KEY INTERNET SEARCH WORDS

house finch

Carpodacus mexicanus

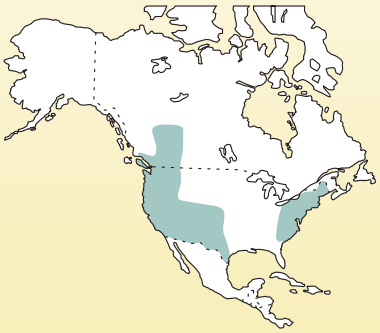


Figure 14–4 Distribution map of the house finch.

AVIAN PROFILE

House Finch *(Carpodacus mexicanus)*

The house finch is a sparrow-sized bird with the males exhibiting shiny red crowns, rumps, and breasts, see Figure 14–3. It was introduced to the east coast from the west coast around 1940. Females are striped brown. The clutch consists of three to five eggs. This finch sings from a high perch with a song similar to that of a canary. Its habitat is diverse, ranging from deserts to coastal regions, see Figure 14–4. It often lives in close proximity to humans. The finch's diet includes grass and weed seeds during the winter along with insects in the summer.

Figure 14–3 A house finch. *Courtesy U.S. Fish and Wildlife Service. Photo by David Menke.*

There is a pattern among many birds for the males to be more brightly colored than the females of the same species. There may be several reasons for this. Males use their colors in mating rituals to bluff other males in defense of their territories. They also use color to attract potential mates. One explanation for the dull colors of most female birds is that drab colors help camouflage them during the nesting season, when they are most vulnerable to predators.

KEY INTERNET SEARCH WORDS

northern cardinal

Cardinalis cardinalis

Figure 14–6 Distribution map of the cardinal.

AVIAN PROFILE

Northern Cardinal *(Cardinalis cardinalis)*

Figure 14–5 The cardinal. *Courtesy U.S. Fish and Wildlife Service. Photo by Luther C. Goldman.*

The male cardinal is a bright red bird with a high crest and a black face, see Figure 14–5. Females are buff brown with red wings and tail. It is a familiar bird, ranging from the eastern United States to Mexico, see Figure 14–6. Females lay three to four eggs in a cup nest located in shrubs or bushes. The cardinal is considered to be a garden bird in much of this territory because it is attracted to garden plantings with berries and seeds. Winter feeding by homeowners has extended its range northward. The cardinal is a nonmigratory bird that eats fruits, insects, weed seeds, and grains.

The **tanagers** of the Traupidae family have notched bills. They are colorful forest birds that prefer diets of small fruits and insects. These songbirds are migrating birds that spend their winters in Central and South America. Five species are found in North America. It is important to maintain habitats for migratory birds such as tanagers in their winter range. Loss of winter habitats in South or Central America would seriously harm these bird populations.

KEY INTERNET SEARCH WORDS

summer tanager

Piranga rubra

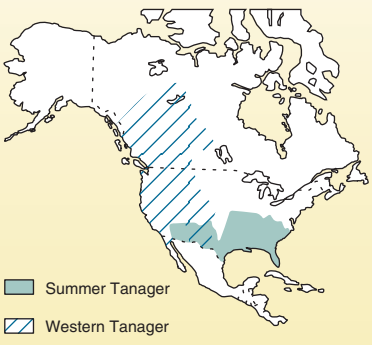


Figure 14–8 Distribution map of the summer and western tanager.

AVIAN PROFILE

Summer Tanager *(Piranga rubra)*

Figure 14–7 The summer tanager is one of five species of tanagers, and it is one of the most colorful of all the songbirds. *Courtesy Shutterstock.*

The summer tanager is one of the most colorful of all the songbirds. The males are red, and the females are olive on top and yellow underneath. Young males acquiring adult plumage often have patches of all three colors, see Figure 14–7. They prefer oak woodlands; however, they also inhabit cottonwood and willow thickets along streams in the eastern and southern regions of the United States, see Figure 14–8. The western tanager is a close relative that occupies habitats in coniferous forests and willow thickets in the western regions of the United States and Canada. Its diet includes insects and small fruits that are gathered in the canopy of trees. Clutch size is three to four offspring that are raised in shallow cup nests attached to tree branches.

Wrens are tiny brown birds with upturned tails and loud singing voices. Ten species of wrens are found in North America. They eat mostly insects and spiders, and they are found from southern Canada to Mexico. They are adapted to a wide range of environments from humid coastal regions to dry deserts. The cactus wren builds its nest among the spines of a cactus.

The males of some species of wrens build elaborate nests that are used for sleeping as well as nesting. During the mating season, they sing loudly and perform elaborate rituals to lure mates to their nests. The males of some species are known to construct as many as 25–30 nests in their attempts to attract mates. The females inspect the nests as part of the mating ritual. Once a female has chosen a mate, a completely new nest may be constructed for the purpose of raising their young.

KEY INTERNET SEARCH WORDS

house wren

Troglodytes aedon

AVIAN PROFILE

House Wren *(Troglodytes aedon)*

The house wren is a small brownish-gray bird with a short upturned tail and alternating light-colored crossbar markings on its back, see Figure 14-9. It prefers open woods or brushy habitats and ranges from southern Canada to Mexico, see Figure 14-10. The diet of the wren consists mostly of insects and spiders.

Figure 14–9 The house wren. *Courtesy U.S. Fish and Wildlife Service. Photo by Dave Menke.*

Figure 14–10 Distribution map of the house wren.

House wrens nest in simple nests that are constructed in tree cavities or bird boxes. The females lay five to eight eggs, and they may nest two or more times in a season. These birds are attracted to yards and gardens where they live in close proximity with humans.

KEY INTERNET SEARCH WORDS

American dipper

Cinclus mexicanus

Figure 14–12 Distribution map of the dipper.

AVIAN PROFILE

American Dipper *(Cinclus mexicanus)*

The dipper is a small gray bird with a short tail that closely resembles a wren, see Figure 14–11. It is found mostly in the western United States between the Pacific coast and the eastern slope of the Rocky Mountains, see Figure 14–12. A wren-like bird that is found in and near streams of water is the **dipper**. It feeds on aquatic insects that it gathers from stream bottoms. This small bird has a habit of bobbing up and down continuously as it perches on rocks near the water. It walks and flies in and out of the swift current, and it appears to walk along the bottoms of fast-moving streams as it searches for food.

Figure 14–11 A dipper. *Courtesy Shutterstock.*

Dippers nest in protected areas along stream banks. The nests are insulated with dry moss, and the females lay three to six eggs. Young dippers are able to dive for food even before they learn to fly.

Shrikes are birds with shrill voices, hooked bills, and hawk-like behaviors. They have the habit of hunting insects, mice, small birds and lizards, and storing them for later meals. They often impale their prey on thorns or barbed wire or force them into cracks and crevices. Only two species, the loggerhead and the northern shrikes, are known in North America. Both are migratory birds.

KEY INTERNET SEARCH WORDS

loggerhead shrike

Lanius ludovicianus

Figure 14–13 Distribution map of the loggerhead shrike.

AVIAN PROFILE

Loggerhead Shrike *(Lanius ludovicianus)*

Figure 14–14 The loggerhead shrike. *Courtesy U.S. Fish and Wildlife Service. Photo by Dave Menke.*

The loggerhead shrike lives south of the northern coniferous forests with a range that extends into Mexico, see Figure 14–13. It is 8–10 inches tall and has a gray upper body with white underparts and a black mask on its face, see Figure 14–14. The population of this bird is declining, and it is now gone from much of its northern range east of the Mississippi River. These birds build nests of twigs in which they raise **broods** or families of four to six nestlings. They sit on high perches as they hunt for food. Their prey consists of large insects, lizards, small birds, and mice.

The thrushes are members of the Turdidae family of songbirds. They are migratory birds, and 13 species are known to exist in North America. The best known of these birds are the robins and the bluebirds. The young birds of this family have spotted breasts, as do the adult thrushes except for the adult robins and bluebirds.

KEY INTERNET SEARCH WORDS

American robin

Turdus migratorius

Figure 14–15 Distribution map of the American robin.

AVIAN PROFILE

American Robin *(Turdus migratorius)*

Figure 14–16 An American robin. *Courtesy U.S. Fish and Wildlife Service. Photo by Lee Karney.*

The American robin is widely distributed, and its range spans the continent, see Figure 14–15. It is a colorful bird with a reddish-orange breast, brownish-gray upper body, and a dark-colored head and tail, see Figure 14–16.

The male of this species has a strong singing voice that is often heard in the evenings as he sings from a high perch. The females lay three to four blue eggs in a nest made of grasses, roots, string, mud, and other materials. Two broods are often produced during the summer and the young birds have speckled breasts. Robins eat mostly insects and worms, but they become garden pests during some seasons because they also eat berries and other fruits.

The thrushes are monogamous birds that form pairs each breeding season. Some species, such as robins, are quite aggressive in defending their nesting territories. They are found in a variety of habitats—some inhabit woodlands, while others prefer meadows and pastures interspersed with trees.

KEY INTERNET SEARCH WORDS

mountain bluebird

Sialia currucoides

AVIAN PROFILE

Mountain Bluebird *(Sialia currucoides)*

The male mountain bluebird is bright turquoise blue on its upper body with light-colored underparts, see Figure 14–17. Females tend to be drab gray; however, a blue coloring can be seen as they fly. This species is found mostly in the Rocky Mountain region from Alaska to Mexico, see Figure 14–18. Its preferred habitat is high mountain forests of pine or aspen interspersed with open meadows. It nests sometimes in buildings or nesting boxes that are within its territory.

Figure 14–18 Distribution map of the mountain bluebird.

Figure 14–17 The mountain bluebird inhabits territory in the high altitudes of the Rocky Mountains. *Courtesy U.S. Fish and Wildlife Service. Photo by Dave Menke.*

These birds are hole nesters, and they lay four to six eggs in grass nests located in tree cavities or in holes in the eaves of buildings. Their diets consist mostly of insects.

Avocational Option

BIRD-WATCHERS

A FAVORITE HOBBY for many people is to observe and identify birds in their natural environments. Field notes of observations by knowledgeable and interested hobbyists have contributed immensely to the body of scientific knowledge about birds and their habits. The thousands of amateur birders from around the world comprise a valuable volunteer field staff whose sightings of birds have contributed to the accuracy of range maps.

Bird-watchers in all areas of the country participate in identifying and counting birds during the month of December each year. These counts are used to track bird populations and to give an early warning when birds are experiencing problems in their environments. These bird counts have lead to some important scientific findings. For example, the American robin alerted residents of Madison, Wisconsin to the dangers of DDT, an insecticide used to reduce the spread of Dutch Elm disease in trees. Because the effects of this pesticide are magnified in the food chain, the contaminated earthworms that were eaten by the robins resulted in far greater concentrations of DDT in the robins. This killed the robins in large numbers and alerted scientists to the problem with DDT.

The Mimidae family is one of the best known songbird families. It includes the mockingbirds, catbirds, and thrashers. These birds have strong voices, and their songs are quite complex. They have demonstrated the ability to mimic the sounds of other birds and animals, and this is the characteristic for which the family is named. Their food consists mostly of insects and spiders; however, they also eat fruits and berries.

INTERNET ADDRESS

http://www.holoweb.com/cannon/birds.htm

KEY INTERNET SEARCH WORDS

northern mockingbird
Mimus polyglottos

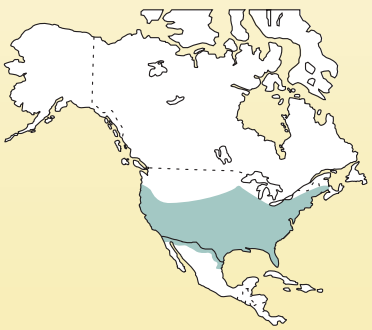


Figure 14–20 Distribution map of the mockingbird.

AVIAN PROFILE

Mockingbird *(Mimus polyglottos)*

The mockingbird is a plain-looking bird with gray coloring on the upper body and white underparts, see Figure 14–19. There is nothing plain about this bird, however, when it begins to sing. It can copy many of the sounds it hears, including other birds and mammals, and musical instruments. For this reason, it was named the mockingbird.

Figure 14–19 The northern mockingbird. *Courtesy U.S. Fish and Wildlife Service. Photo by Ryan Hagerty.*

This bird is found in many parts of the United States, see Figure 14–20. Its habitat includes woodlands, gardens, and open grassy areas. It nests in thick shrubs that provide protective cover. The females lay three to six eggs in nests lined with fine plant materials. Males require high perches from which they defend their territories and sing their unusual songs.

KEY INTERNET SEARCH WORDS

brown thrasher

Toxostoma rufum

Figure 14–22 A distribution map of the brown thrasher.

AVIAN PROFILE

Brown Thrasher *(Toxostoma rufum)*

The brown thrasher is sometimes known as a "mimic thrush" because it tends to mimic or copy the calls of other birds. Each phrase of the call is repeated twice. It is brown on the upper body with light-colored wing bars and brown stripes on a light-colored breast. It also has a long tail, slightly curved bill, and yellow eyes, see Figure 14–21. The sexes are alike in their markings. This songbird prefers an environment made up of shrubs, brush, bushes, and thickets, and it eats insects and fruits. Its name comes from its feeding habit of flicking or thrashing leaves with its bill to expose insects. It breeds in southern Canada and the eastern states of the United States. A cup nest made of twigs lined with fine materials is placed in a bush or heavy undergrowth. The brown thrasher is found in a range extending from southern Canada to the Gulf states and from the east coast to the Rocky Mountains, see Figure 14–22.

Figure 14–21 A brown thrasher. *Courtesy Millard H. Sharp. Photo Researchers, Inc.*

INTERNET ADDRESS

http://www.birdnature.com/catbird.html

KEY INTERNET SEARCH WORDS

gray catbird
Dumetella carolinensis

AVIAN PROFILE

Gray Catbird *(Dumetella carolinensis)*

The gray catbird is gray in color with a patch of chestnut beneath the tail and a black cap on its head, see Figure 14–23. The call of the catbird resembles the mew of a cat, although it also mimics the calls of other birds. It is an active bird with the curious habit of flipping its tail. It inhabits thickets located in woodlands, and its diet consists of small invertebrates, seeds, berries, and insects. It spends a lot of time on the ground where most of its food is found. It is fond of bathing and is often seen fluffing its feathers in dust or splashing in the water.

During the breeding season, the gray catbird is widely distributed east of the Rocky Mountains, see Figure 14–24. Its nest is a cup nest made of twigs that is lined with fine roots and placed in a bush or shrub.

Figure 14–24 A distribution map of the gray catbird.

Figure 14–23 A gray catbird. *Courtesy Jim Zipp. Photo Researchers, Inc.*

The Icteridae family of perching birds includes the blackbirds, meadowlarks, and New World orioles such as Northern oriole. These birds have powerful bills, and they feed on insects, fruits, seeds, and nectar. The males are usually larger and more brightly colored than the females.

Blackbirds and closely related birds of the Icteridae family include the yellow-headed blackbird, red-winged blackbird, Brewer's blackbird, grackle, cowbird, and others. Some blackbirds are polygamous, meaning that a bird of either sex may take several mates. Sometimes, several males may tend a single nest with a female. At other times, several females may mate with one male and nest nearby.

INTERNET ADDRESS

http://www.birdsofoklahoma.net/Gtailgrack003.htm

KEY INTERNET SEARCH WORDS

great-tailed grackle

Quiscalus mexicanus

AVIAN PROFILE

Great-Tailed Grackle *(Quiscalus mexicanus)*

The male great-tailed grackle is a shiny blackbird with a long tail and wings and a green sheen to its plumage—females are smaller in size and dull black in color with a brownish-gray breast and head, see Figure 14–25. It is found in parts of Mexico and Texas and along the southern border of the United States from Texas to California, see Figure 14–26. The common grackle is a related species that ranges from Canada and east of the Rocky Mountains to the Atlantic coast.

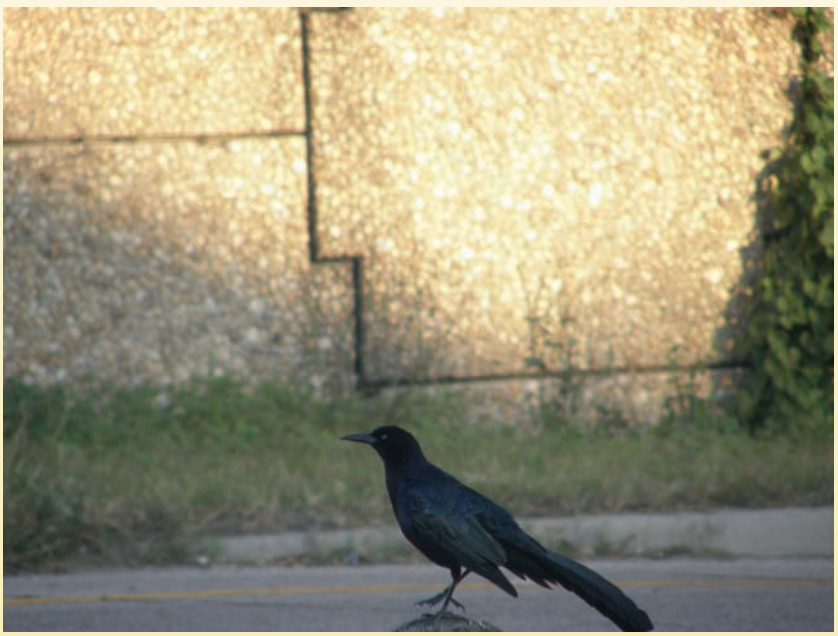


Figure 14–25 A greattailed grackle. *Courtesy* Austin, TX.

Figure 14–26 Distribution map of the great-tailed and common grackle.

Grackles and other members of the Icteridae family are omnivorous birds that feed on seeds, small fruits, and grains, as well as on insects. They also eat the eggs and young of other birds. The males are **polygynous** and tend to attract several mates. Males display vigorously to attract females. The females lay three to five eggs in large grass-lined nests that are anchored in trees, bushes, or reeds.

The birds in the Icteridae family tend to gather in large flocks before migrating in the fall season. Flocks of several million blackbirds of various species have been observed in their wintering areas. These flocks of birds sometimes cause extensive damage to grain crops due to the large numbers of individuals that congregate to eat in small areas.

Some species of cowbirds do not take care of their own young. They are bold **parasitic birds**, more specifically, nest parasites that lay their eggs in the nests of other birds. When a female lays an egg in another

bird's nest, she also may remove one of the eggs belonging to the host bird. Some species of cowbirds simply take over the nests of other birds and raise their broods in stolen nests. Cowbirds are **promiscuous** birds that mate with numerous members of the opposite sex. They do not form pair bonds.

INTERNET ADDRESS

http://www.wbu.com/chipperwoods/photos/cowbird.htm

KEY INTERNET SEARCH WORDS

brown-headed cowbird
Molothrus ater

AVIAN PROFILE

Brown-Headed Cowbird *(Molothrus ater)*

The brown-headed cowbird is the smallest blackbird in North America. The males are shiny greenish black with dark brown heads and the females are dull brownish gray, see Figure 14–27. They gather in wooded areas along streams and waterways during the breeding season, and they inhabit pastures and fields during other times of the year. The diet of the cowbird consists mostly of seeds and insects. Their range extends from southern Canada to Mexico, see Figure 14–28. They lay four to five eggs in the nests of other songbirds.

Figure 14–28 Distribution map of the brown-headed cowbird.

Figure 14–27 A young male brown-headed cowbird. *Courtesy U.S. Fish and Wildlife Service. Photo by Lee Karney.*

The birds that make up the Icteridae family are found in a variety of habitats. Some of the blackbirds inhabit wetland areas. The meadowlarks prefer open fields and grasslands. The birds in this family eat such varied diets that they are able to live under a wide range of environmental conditions.

KEY INTERNET SEARCH WORDS

Eastern, Western meadowlark
Sturnella magna
Sturnella neglecta

AVIAN PROFILE

Eastern Meadowlark *(Sturnella magna)* and Western Meadowlark *(Sturnella neglecta)*

These two species of meadowlarks are nearly identical in appearance and habits. The songs of the two species are distinctly different, however, although they are able to mimic each other where their ranges overlap. These birds have yellow breasts crossed with a black v-shaped bib and mottled brown backs, necks, and wings, see Figure 14–29. The ranges of these two birds overlap, and they occupy similar habitats, see Figure 14–30.

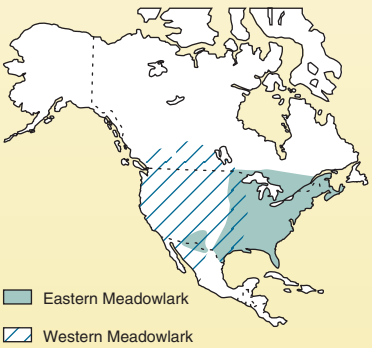


Figure 14–30 Distribution map of the eastern and western meadowlark.

Figure 14–29 The meadowlark is a bird that inhabits fields and roadsides. *Courtesy U.S. Fish and Wildlife. Photo by John and Karen Hollingsworth.*

Meadowlarks nest on the ground in a domed-over nest constructed of dried grass and concealed in vegetation. The females lay four to six eggs. They are helpful birds to gardeners and farmers because they eat large amounts of harmful insects and weed seeds.

The blackbird family includes the New World orioles. This leads to some confusion because they belong to a different family than many of the birds known as orioles. Orioles have black and orange or yellow-colored plumage.

INTERNET ADDRESS

http://museum.gov.ns.ca/mnh/nature/nsbirds/bnso399.htm

KEY INTERNET SEARCH WORDS

northern oriole

Icterus galbula

Figure 14–32 Distribution map of the northern oriole.

AVIAN PROFILE

Northern Oriole *(Icterus galbula)*

The northern oriole is a medium-sized bird with a black upper body, neck, and head. The underparts are yellow to orange, see Figure 14–31. Both the Baltimore and Bullock's orioles are races of northern orioles. These birds interbreed and are widespread in North America, ranging throughout most of the United States from Canada to Mexico, see Figure 14–32. The diet of the northern oriole consists mainly of insects, seeds, and small fruit. Females lay three to six eggs in woven nests that hang from tree branches. The preferred habitat for the northern oriole is a wooded area along a stream. They also inhabit areas located near humans where tall trees are plentiful.

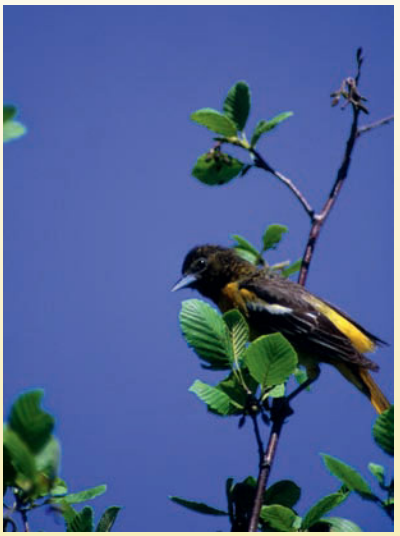


Figure 14–31 A male northern oriole at his nest. *Courtesy U.S. Fish and Wildlife Service. Photo by John and Karen Hollingsworth.*

KEY INTERNET SEARCH WORDS

starling

Sturnus vulgaris

Figure 14–34 Distribution map of the starling.

AVIAN PROFILE

Starling *(Sturnus vulgaris)*

Starlings are gregarious birds that eat and roost in large flocks. They are mostly iridescent black with light-colored speckles especially in winter, see Figure 14–33. The females lay five to six eggs in cavities, and they usually raise two broods each year.

The starling was introduced to North America from Europe in 1890. Since that time, it has become established throughout much of the continent, see Figure 14–34.

The starling is one of the most adaptable birds in the world due to its ability to feed on many different kinds of food. It has become a serious pest in some places because it causes damage to vegetables and fruits. Starlings also eat or pollute grains intended for livestock feed.

Figure 14–33 A starling is a scavenging bird that has thrived in North America. *Courtesy Shutterstock.*

CROWS AND JAYS

The crows and jays belong to the Corvidae family. This family includes the common crow, the raven, the magpie, and the blue jay. Fifteen North American species are members of the Corvidae family. They are omnivores that feed on vegetables, fruits, insects, and meat. Some of these birds are scavengers that eat carrion.

KEY INTERNET SEARCH WORDS

common crow

Corvus brachyrhynchos

AVIAN PROFILE

Common Crow *(Corvus brachyrhynchos)*

The common or American crow is sometimes confused with the raven. Both of these birds are black, but the crow is the smaller of the two species, see Figure 14–35. The range of the crow includes much of the United States and Canada, see Figure 14–36.

Figure 14–35 The common crow is considered to be the most intelligent of all birds. *Courtesy Shutterstock.*

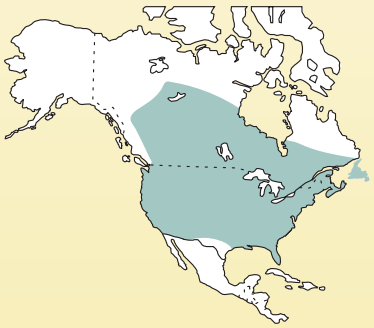


Figure 14–36 Distribution map of the common crow.

Preferred habitat for these birds is deciduous forest and bushes close to rivers and streams, farmlands, and agricultural fields. Nesting occurs in large stick nests lined with dried vegetation. Four to six eggs are common, and families stay together after the young have fledged. Crows are thought to be the most intelligent of all birds.

Crows and their close relatives have been observed performing simple tasks that demonstrate an ability to learn unusual skills. Experiments with ravens have shown that they can count to as high as five or six. Crows have been known to drop shellfish on hard surfaces to break them open. Some of these birds also are able to mimic the calls of other birds.

KEY INTERNET SEARCH WORDS

black-billed magpie

Pica pica

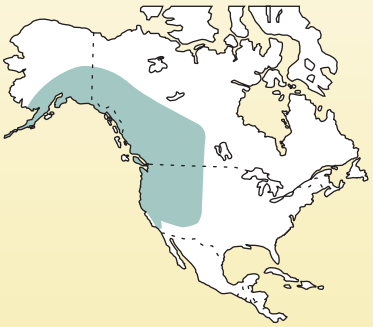


Figure 14–38 Distribution map of the black-billed magpie.

AVIAN PROFILE

Black-Billed Magpie *(Pica pica)*

The magpie is a moderate-sized black-and-white bird with a long black tail, see Figure 14–37. It ranges along the Rocky Mountains from Alaska to New Mexico, see Figure 14–38. Magpies are sometimes quite noisy birds when they are gathered in flocks.

Their nests are made of sticks and mud and lined with fine roots and grasses. Females lay six to nine eggs, and the young are cared for by both parents even after they leave the nest. They eat almost any kind of food, including insects, carrion, rodents, eggs, fruits, berries, small mammals, and young birds.

Figure 14–37 The black-billed magpie is well adapted to many kinds of food, making it possible to thrive in a wide range of environments. *Courtesy U.S. Fish and Wildlife Service. Photo by Dave Menke.*

KEY INTERNET SEARCH WORDS

blue jay

Cyanocitta cristata

Figure 14–40 Distribution map of the blue jay.

AVIAN PROFILE

Blue Jay *(Cyanocitta cristata)*

The blue jay is a bird with blue plumage, a crested head, gray underparts, and a black necklace, see Figure 14–39. It ranges east of the Rocky Mountains from southern Canada to the Gulf of Mexico, see Figure 14–40. This bird inhabits oak and pine woods and adapts well to gardens and human neighbors.

Blue jays build nests in trees where they raise three to six offspring. They use nearly all kinds of building materials. They are noisy birds that eat seeds, fruits, invertebrates, and the eggs and nestlings of other birds.

Figure 14–39 The blue jay is well adapted to living near humans. *Courtesy U.S. Fish and Wildlife Service. Photo by Dave Menke.*

Other birds in the Corvidae family include the Clark's nutcracker, which differs from other family members in that it eats mostly pine nuts. Several other species of jays are found in North America, including the "camp robber," or gray jay that is most often observed by campers in the northern coniferous forests. The raven is another important member of this family.

CUCKOOS

The family Cuculidae includes the North American cuckoos and the roadrunner. The roadrunner is discussed in Chapter 15, "Other Birds of North America," as an upland ground bird.

Many of the Old World cuckoos are parasitic birds; however, the New World cuckoos care for their own young. These birds eat insects, spiders, centipedes, and worms, and some cuckoos' diets consist of hairy caterpillars that are avoided by many kinds of birds. They live in wooded habitats, thickets, and orchards.

KEY INTERNET SEARCH WORDS

yellow-billed cuckoo

Coccyzus americanus

Figure 14–42 Distribution map of the yellow-billed cuckoo.

AVIAN PROFILE

Yellow-Billed Cuckoo *(Coccyzus americanus)*

The yellow-billed cuckoo is a long-tailed bird that is olive brown on the upper body with white underparts. It has a long, curved bill with a yellow lower mandible, see Figure 14–41. This bird ranges from the East Coast to the Rocky Mountains and from southern Canada to Mexico, see Figure 14–42. Preferred habitat for this bird is deciduous woods with large trees, usually located near rivers.

Females lay two to four eggs in nests made of twigs that are located in trees or bushes. They are perching birds, sitting quietly as they watch and listen for the insects that make up their diets.

Figure 14–41 The yellowed-billed cuckoo depends on insects as a source of food. *Courtesy Gregory G. Dimijian, M.D. Photo Researchers, Inc.*

KINGFISHERS

Kingfishers are solitary birds that spend most of their time alone looking for fish. Once they see one, they plunge into the water to catch it. These birds have strong bills, and some members of this family have large crested heads. The belted kingfisher is the more common of the two North American species of kingfishers.

INTERNET ADDRESS

http://www.aquatic.uoguelph.ca/birds/speciesacc/accounts/kingfish/alcyon/account.htm

KEY INTERNET SEARCH WORDS

belted kingfisher

Megaceryle alcyon

Figure 14–44 Distribution map of the belted kingfisher.

AVIAN PROFILE

Belted Kingfisher *(Megaceryle alcyon)*

The belted kingfisher is bluish gray on the upper body and wings with a white neck and underparts. The female of this species is more brightly colored than the male. The kingfisher has a large crested head and a long, heavy bill, see Figure 14–43. This bird ranges from Alaska and Canada to Central America, see Figure14–44.

These birds prefer wooded habitats along rivers, lakes, and coastlines. They perch on limbs overlooking the water where they watch for fish. They catch their prey by hovering above a fish and then diving into the water to catch it. The females lay five to eight eggs in tunnels that have been excavated in stream banks.

Figure 14–43 A belted kingfisher eats a diet of fish that it catches by diving into the water. *Courtesy U.S. Fish and Wildlife. Photo by C. Schlawe.*

HUMMINGBIRDS

Hummingbirds are unusual in that much of their nourishment comes from nectar, and they beat their wings so fast that they can hover in place during flight. This group of birds also includes the smallest birds in the world with one member of the Trochilidae family being only about the size of a bumblebee. Fifteen species of these colorful birds breed in North America. They have long bills and tubelike tongues they use to take nectar from flowers. They also eat soft insects.

The wings of hummingbirds beat at 15–79 times per second depending on the species, and the familiar whirring sound that is created as they fly has earned them their name. These birds are able to rotate their wings in a manner similar to the way humans rotate their wrists. This enables them to fly forward or backward. Their spectacular flying skills enable them to perform amazing display flights during the mating season as they attempt to attract and win mates.

KEY INTERNET SEARCH WORDS

black-chinned hummingbird

Archilochus alexandri

Figure 14–46 Distribution map of the black-chinned hummingbird.

AVIAN PROFILE

Black-Chinned Hummingbird *(Archilochus alexandri)*

The black-chinned hummingbird is one of the more common hummingbirds in North America. It is green in color with a black chin and a purple throat, see Figure 14–45. It is less than 4 inches long, and it is found mostly in the western United States, see Figure 14–46.

Figure 14–45 The black-chinned hummingbird feeds mainly on nectar; however, it also eats insects and spiders. *Courtesy Shutterstock.*

The nests are constructed of wool and/or lichens, and they are usually woven together and hung in a shrub or tree using spider webs. Two eggs make up a clutch, and males vigorously defend their territories. Nectar is their main food, but they will also eat spiders and insects. These birds migrate south for the winter to warm locations where food is available.

There are many perching birds in North America that have not been discussed in this book. They include, but are not limited to, the following—wood warblers, flycatchers, titmice, wagtails, pipits, trogons, wrentits, flycatchers, gnatcatchers, vireos, and waxwings.

All of these birds fill important niches in the ecosystems of North America. Their roles frequently overlap those of many of the other birds that have been discussed in more detail. Five chapters of this text have been devoted to birds, and in such limited space, it is impossible to discuss in detail the roles of all the North American birds.

LOOKING BACK

The perching birds include songbirds of many kinds as well as cuckoos, kingfishers, hummingbirds, crows, and jays. All of these birds perch upright on tree branches or other surfaces. Songbirds use songs to help define the boundaries of the territories that they defend.

Perching birds occupy many different habitats and eat many different kinds of food. Some are solitary birds while others are gregarious birds. They have a variety of mating and nesting behaviors. Some are colorful birds and others are plain with the males generally being more colorful than the females. The only thing that is common to all of them is their perching behavior.

Chapter Review

DISCUSSION AND ESSAY

1. Identify the major families of North American perching birds using their Latin names, and list the birds that belong to these families using their common names.
2. Make a chart listing the major songbirds discussed in this chapter, and describe their physical appearances.
3. List some reasons why the males of many species of birds are brightly colored while the females often have dull and plain coloring.
4. Discuss the importance of the calls and songs of territorial birds.
5. Identify some characteristics of house sparrows and starlings that helped them adapt quickly to the ecosystems of North America.
6. Define the following terms that describe mating habits of birds—polygynous, polygamous, monogamous, polyandry, and promiscuous.
7. Name and describe some well-known members of the thrush family of birds.
8. Describe how parasitic birds are able to reproduce without building their own nests.
9. Explain why gregarious birds tend to cause greater damage to crops than do solitary birds that have similar eating habits.
10. List some unique physical characteristics of hummingbirds that make it possible for them to gather and eat nectar.

MULTIPLE CHOICE

1. The main purpose of the calls of songbirds is to

   a. Entertain humans and other creatures
   b. Define the boundaries of their territories
   c. Call their offspring together
   d. Inform other birds of a source of food

2. Which of the following birds is not a native of North America?

   a. Finch
   b. Grosbeak
   c. Bunting
   d. House sparrow

3. Which of the following is the world's largest bird family?

   a. Fringillidae
   b. Traupidae
   c. Turdidae
   d. Mimidae

4. Birds that live together in flocks are described as

   a. Family birds
   b. Parasitic birds
   c. Gregarious birds
   d. Territorial birds

5. Among the perching birds, the male of the species

   a. Is more brightly colored
   b. Brings food to the nesting female
   c. Is always monogamous
   d. Does not help rear its offspring

6. Which of the following birds gathers aquatic insects from beneath the surface of the water for its food?

   a. Wren
   b. Cardinal
   c. Dipper
   d. Shrike

7. Which of the following birds impales its prey on thorns to store it for a later meal?

   a. Wren
   b. Cardinal
   c. Dipper
   d. Shrike

8. Which of the following bird families mimics the calls of other birds?

   a. Fringillidae
   b. Traupidae
   c. Turdidae
   d. Mimidae

9. Birds that mate with numerous members of the opposite sex are described as being:

   a. Parasitic
   b. Promiscuous
   c. Gregarious
   d. Monogamous

10. Which of the following birds is often described as the most intelligent?

   a. Crow
   b. Starling
   c. Oriole
   d. Grackle

11. Which of the following birds depends on nectar as a source of food?

   a. Cuckoo
   b. Jay
   c. Hummingbird
   d. Magpie

Learning Activities

1. Call on members of the Audubon Society or a local birdwatchers group to make a presentation to your class. Ask them to concentrate on birds that are found locally and to illustrate their presentations with specimens or pictures. Where possible, divide the class into small groups and go on a field trip to observe and identify birds that are found in the local community. Invite local *birders* to lead the groups.
2. Obtain and show a video or slides illustrating the appearance and habits of the songbirds and other perching birds. Sources of these materials are PBS television, biological supply houses, and public libraries. Follow up this activity by having each student prepare an illustrated written report about a particular bird species.
3. Assign each class member to make a birdhouse for a particular species of bird (bluebird, wren, and so forth). Plan a field day to install them in appropriate areas where they are likely to be used. Conduct an annual inventory of bird usage of the birdhouses.

CHAPTER

15

Other Birds of North America

After completing this chapter, you should be able to:

- list the distinguishing characteristics of the different families of waterbirds
- define the roles of the long-legged wading birds in the ecosystems of North America
- evaluate the roles of gull-like birds in North American ecosystems
- define the roles of the upright perching waterbirds in the ecosystems of North America
- evaluate the roles of duck-like birds in the ecosystems of North America
- consider the roles of the sandpiper-like birds in North American ecosystems
- explain the roles of upland ground birds in the ecosystem of North America
- appraise the roles of swallow-like birds in North American ecosystems
- describe how the torpid state affects some kinds of birds and contributes to their survival during cold weather conditions
- evaluate the roles of the tree-clinging birds in the ecosystems of North America.

Many species of birds are found in North American ecosystems. Although they are too numerous to include all of them in a textbook that focuses on the sciences of zoology and ecology, this chapter discusses representative species of several large families of birds.

The waterbirds include swimming or wading birds that depend on water environments for food or protection. The swallow-like birds are insectivores that often live close to human habitation. Upland ground birds spend their lives living on the ground, while the tree-clinging birds are insectivores that depend on trees for food and shelter.

KEY TERMS

scavenger
auklet
solitary
lobe
precocial
plover
phalarope
avocet
frontal shield
nightjar
terrestrial
swift
nestling
torpor
torpid
creeper

The waterbirds included in this chapter are grouped as long-legged wading birds, gull-like birds, upright perching waterbirds, duck-like birds, sandpiper-like birds, and chicken-like marsh birds. All of these birds depend on water habitat to survive.

LONG-LEGGED WADING BIRDS

The long-legged wading birds include the herons, egrets, bitterns, storks, ibises, and cranes. These are all wading birds that enter shallow water in pursuit of frogs, crayfish, and small fish. Some of these birds stand still and wait for their prey to pass nearby. Others actively seek out and pursue their prey.

INTERNET ADDRESS

http://animaldiversity.ummz.umich.edu/site/accounts/classification/Andrea_herodias.html

KEY INTERNET SEARCH WORDS

great blue heron
Ardea herodias

AVIAN PROFILE

Great Blue Heron *(Ardea herodias)*

The great blue heron is a large bird that stands 4 feet tall. Its back and wings are blue-gray, and its light-colored underparts are streaked with black. It has a white head with a black crown and plumes behind its eyes, see Figure 15–1. A subspecies is the great white heron that is found mostly in Florida and further south. The heron's diet consists of insects, fish, small birds, and mice.

This heron is distributed throughout the United States and along the southern border of Canada, see Figure 15–2. It is a migratory bird that breeds in the northern part of its range and spends the winter in the southern states. It nests in colonies among tall trees where females lay three to seven eggs in stick nests. Its preferred habitat is marshlands, swamps, and shorelines.

Figure 15–2 Distribution map of the great blue heron.

Figure 15–1 The great blue heron is a large wading bird. *Courtesy U.S. Fish and Wildlife Service.*

Herons are better adapted to their environments than many birds. They eat several different kinds of food such as fish, voles, frogs, and insects. They choose safe nesting sites on piles of reeds and sometimes on man-made structures. The versatility of these birds helps them to survive where more specialized birds might have difficulty finding suitable food or nesting sites.

INTERNET ADDRESS

http://animaldiversity.ummz.umich.edu/site/accounts/information/Botaurus_lentiginosus.html

KEY INTERNET SEARCH WORDS

American bittern

Botaurus lentiginosus

AVIAN PROFILE

American Bittern *(Botaurus lentiginosus)*

The American bittern is a moderate-sized heron that is brown with light-colored streaks, which help it blend in with the marsh reeds in its habitat, see Figure 15–3. Its nesting range includes much of the United States and Canada with northern populations migrating south in the winter, see Figure 15–4. Its preferred habitat is marshy lakes and meadows where it eats frogs, crayfish, and grasshoppers.

Bitterns are territorial, and males defend their home territories against other birds. The females lay three to seven eggs in platform nests that are protected by heavy plant cover. This bird has a distinctive call that is heard in the morning and evening hours. During the nesting season, the young are especially vulnerable to predators such as mink, snakes, and birds of prey.

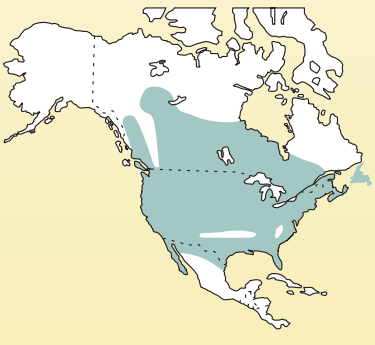


Figure 15–4 Distribution map of the American bittern.

Figure 15–3 The American bittern blends well with its marshland habitat.

Some members of the heron family nest together in large colonies. Birds and animals that live together in large groups are described as being gregarious. Other members of this family are territorial, and a single nesting pair is found in a given area.

INTERNET ADDRESS

http://www.assateague.com/sn-egret.html

KEY INTERNET SEARCH WORDS

snowy egret
Egretta thula

AVIAN PROFILE

Snowy Egret *(Egretta thula)*

The snowy egret is a gregarious medium-sized white heron with a black bill, dark-colored legs, and yellowish feet, see Figure 15–5. It is found in marshy habitats along estuaries and inland lakes in widely dispersed regions of the United States, see Figure 15–6.

Males and females look very much alike, and they share the duties of incubating the eggs and caring for the young. Females lay three to six eggs in platform nests constructed in willows or other trees. They hunt in the marshes for small fish and other aquatic animals and insects.

Figure 15–6 Distribution map of the snowy egret.

Figure 15–5 The snowy egret feeds mostly on small fish and other aquatic animals and insects. *Courtesy U.S. Fish and Wildlife Service. Photo by Gary M. Stoltz.*

The heron family contains several members that are not discussed in this chapter. They include the Louisiana heron, little blue heron, black-crowned night heron, yellow-crowned night heron, green heron, reddish egret, great egret, cattle egret, and least bittern. Other large wading birds include the stork, limpkin, ibis, and flamingo.

KEY INTERNET SEARCH WORDS

whooping crane

Grus americana

Figure 15–8 Distribution map of the sandhill crane.

Figure 15–9 The whooping crane is an endangered bird that has failed to respond well to human efforts to save the population. *Courtesy U.S. Fish and Wildlife Service. Photo by Steve Van Riper.*

AVIAN PROFILE

Sandhill Crane *(Grus canadensis)*

The sandhill crane is a large bird with long legs and a long neck. It stands over 3 feet tall, and it is bluish gray in color with a bald red forehead, see Figure 15–7. It is an omnivorous marsh bird that eats mostly plants and seeds but will also eat frogs, snakes, lizards, and mice.

Figure 15–7 The sandhill crane is a large wading bird that lives in or near marshlands. *Courtesy U.S. Fish and Wildlife Service.*

Breeding pairs build nesting mounds of reeds and other plant materials in marshes where the females lay two eggs. Both parents incubate the eggs and care for the young. These birds range in marshlands from the far northern regions to Texas, with another population of these birds living year-round in southern Florida, see Figure 15–8.

An endangered crane known as the whooping crane occupies similar habitats and has similar habits. The breeding flock of these birds has seriously declined, and scientists have gone to great efforts to save the birds from extinction, see Figure 15–9. Some whooping crane populations have increased due to their efforts. The decline of the whooping crane is due in part to loss of habitat, shooting, and disturbance by humans. Unfortunately, several whooping cranes that were reared in the recovery effort died when they flew into overhead power lines.

Some of the wading birds are adorned with beautiful plumage and/or exotic coloring. In some species, these bright colors and plumage are only evident during the mating season. Other birds such as the scarlet ibis, roseate spoonbill, and the flamingo have spectacular plumage during all seasons of the year.

KEY INTERNET SEARCH WORDS

American flamingo

Phoenicopterus ruber

Figure 15–11 Distribution map of the American flamingo.

AVIAN PROFILE

American Flamingo *(Phoenicopterus ruber)*

The American flamingo is a large, slender wading bird with pink plumage, black wing feathers and salmon pink legs. It also has a dark-colored bill that curves sharply downward, see Figure 15–10. In North America, it is found only along the coast of Florida, see Figure 15–11. It inhabits saltwater flats and lagoons. Flamingos feed by filtering small organisms from the water through the comblike bristles in their bills. Females lay one or two eggs in cone-shaped mud nests on remote offshore islands. They nest in colonies with several hundred birds crowded together in close quarters.

Figure 15–10 The American flamingo is an elegant, colorful bird. *Courtesy Shutterstock.*

GULL-LIKE BIRDS

Gulls and gull-like birds are widely distributed in North America. These birds are strong flyers, and they sometimes travel long distances each day in search of food. They feed mostly on fish and other animal matter, and they nest in colonies.

Gulls of numerous species are found along the seacoasts and inland waters of North America. They have similar habitats and behaviors, and most gulls are **scavengers**, meaning that they will eat any food they can find. They have adapted to modern agricultural practices, and some gulls feed on worms and larvae that have been exposed by tillage or that have come to the surface during the irrigation of crops. Many of them also use garbage dumps as feeding sites. They also prey on the eggs and young of other shorebirds.

KEY INTERNET SEARCH WORDS

California gull

Larus californicus

Figure 15–13 Distribution map of the California gull.

AVIAN PROFILE

California Gull *(Larus californicus)*

The California gull has a dark-colored eye, white head, neck, and body, with a gray back, red and black spot on its lower bill, and black-tipped wings, see Figure 15–12. This gull ranges along the California coast and inland from northeastern California to the prairie regions of central Canada, see Figure 15–13. It is the state bird of Utah because it saved the early settlers from famine by eating the grasshoppers that were destroying their crops.

This gull nests in colonies on islands surrounded by shallow inland lakes. Females lay two to three eggs in nests made of grass and sticks. They feed on carrion, small rodents, large insects, worms, and various kinds of aquatic animals.

Figure 15–12 The California gull can range far inland as it forages for food. *Courtesy Shutterstock.*

There are over 31 species of gulls and terns found in North America. Gulls vary greatly in size and in their geographic ranges. They are swimming birds with webbed feet and hooked beaks. Most gulls are gregarious birds. While several kinds of gulls are often found together in nesting areas, they mate only with members of their own species.

Terns are closely related to gulls; however, they mostly eat fish and are not scavengers. They resemble gulls in their body structure, but they have sharp-pointed (not hooked) bills. The tails of gulls are usually square on the ends, while the tails of most terns are forked.

INTERNET ADDRESS

http://animaldiversity.ummz.umich.edu/site/accounts/classification/Sterna_paradisaea.html

KEY INTERNET SEARCH WORDS

arctic tern

Sterna paradisaea

Figure 15–15 Distribution map of the arctic tern.

AVIAN PROFILE

Arctic Tern *(Sterna paradisaea)*

The arctic tern is identified by its white face and underparts, black cap, red bill, and gray back and wings, see Figure 15–14. It inhabits coastal regions and tundra lakes in northern Canada and Alaska and migrates to the Antarctic regions during the arctic winter, see Figure 15–15. Some arctic terns migrate close to 23,000 miles roundtrip each year.

Females lay two eggs in scrapes on the ground. They nest either in colonies or as pairs. When the young are able to fly, flocks of terns begin their migrations south. Like most terns, this bird often hovers before diving beneath the surface of the water to catch its food.

Figure 15–14 The arctic tern is known to migrate as far as 23,000 miles each year. *Courtesy U.S. Fish and Wildlife. Photo by Donna Dewhurst.*

There are many gulls and gull-like birds in North America besides those that are discussed in this chapter. Among them are the petrels, skuas, jaegers, boobies, tropicbirds, frigatebirds, fulmars, shearwaters, and albatrosses.

UPRIGHT PERCHING WATERBIRDS

The upright perching waterbirds are unusual in that their legs are placed far back on their bodies and they stand in an upright position. The auks, murres, and puffins belong to this family, the Alcidae. They are arctic birds that are found in the greatest numbers in the far north. Although they are awkward on land, they are expert swimmers. They are capable of pursuing and catching fish that comprise a large percent of their diet.

KEY INTERNET SEARCH WORDS

tufted puffin

Lunda cirrhata

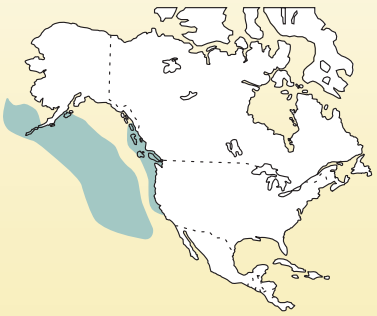


Figure 15–17 Distribution map of the tufted puffin.

AVIAN PROFILE

Tufted Puffin *(Lunda cirrhata)*

The tufted puffin is a short seabird that is black on the upper body and white on the lower body, with a beak like that of a parrot, see Figure 15–16. Puffins are sometimes called sea parrots. The range of these birds is restricted to the arctic coast and to the Pacific coast from Alaska to California, see Figure 15–17.

The puffins' diet consists mostly of small fish that they gather at sea. The puffin nests in a colony, and a female lays a single egg in a burrow or rock crevice.

Figure 15–16 The tufted puffin is a seabird with a parrot-like beak and head. *Courtesy U.S. Fish and Wildlife Service. Photo by Mike Boylan.*

The alcids are unusual birds. In many respects, they are like the penguins of the Antarctic except that they can fly. Small members of the auk family are called **auklets**. Some of these birds venture quite far out to sea as they search for food.

KEY INTERNET SEARCH WORDS

Cassin's auklet

Ptychoramphus aleuticus

Figure 15–19 Distribution map of Cassin's auklet.

AVIAN PROFILE

Cassin's Auklet *(Ptychoramphus aleuticus)*

The Cassin's auklet is a seabird the size of a robin. It is slate colored on the upper body with light gray coloring underneath except for its white belly, see Figure 15–18. Its range extends from Alaska to Baja California, see Figure 15–19. A pair of these birds produces a single egg, and they nest in burrows or rock cavities. Parents incubate the single chick in shifts.

Figure 15–18 The Cassin's auklet is a small seabird found along the Pacific coast. *Courtesy U.S. Fish and Wildlife. Photo by L. Lauber.*

This auk sometimes goes far out to sea in search of tiny shrimplike plankton for food. Its preferred habitat is the open ocean; however, it nests on sea cliffs and promontory points of land that extend out into the sea. Its natural enemies include seagulls, foxes, weasels, and other predatory mammals.

The upright perching water birds use their webbed feet and their short wings to propel themselves as they swim. They are well adapted to living in marine biomes. Cormorants are long-necked seabirds that dive for food. They swim using both their feet and their wings, and they have been known to dive to depths in excess of 100 feet. Their diets consist entirely of fish.

KEY INTERNET SEARCH WORDS

Brandt's cormorant

Phalacrocorax penicillatus

Figure 15–21 Distribution map of Brandt's cormorant.

AVIAN PROFILE

Brandt's Cormorant *(Phalacrocorax penicillatus)*

The Brandt's cormorant is a large black seabird with a long neck and body, see Figure 15–20. Its range extends along the Pacific coast from Alaska to Mexico, see Figure 15–21. This bird eats fish that it pursues and captures beneath the ocean's surface. Females lay three to six eggs in nests located on cliffs and rocky island coastlines.

Figure 15–20 A cormorant swims underwater with both its wings and feet. *Courtesy U.S. Fish and Wildlife Service. Photo by Steve Hillibrand*

These birds are gregarious, and several hundred of them often dive together for food. This improves their chances of catching the fish upon which they feed because they are able to confine their prey to an area just beneath the water's surface, making them easier to catch.

DUCK-LIKE BIRDS

Ducks were discussed along with other waterfowl in Chapter 11, "Waterfowl." There are a number of other duck-like birds such as pelicans, loons, and grebes. These are water birds that inhabit freshwater and saltwater environments at different seasons of the year. All of these birds depend on diets of fish.

Two kinds of pelicans are found in North America. They are the white pelican and the brown pelican. The pouched bills of these birds are used as nets to catch fish. They also are used as containers to carry captured fish to young pelicans still in the nest.

The brown pelican sometimes plunges into the water during flight to capture fish. White pelicans fish while swimming and are known to form lines to drive fish to shallow water where they can be scooped up more easily. Pelicans are most vulnerable to predators during the nesting season.

KEY INTERNET SEARCH WORDS

white pelican

Pelecanus erythrorhynchos

Figure 15–23 Distribution map of the white pelican.

AVIAN PROFILE

White Pelican *(Pelecanus erythrorhynchos)*

The white pelican is a large white bird measuring between 5 and 6 feet in height. It has a large, pouched bill and black wing feathers, see Figure 15–22. It breeds along inland lakes and rivers from British Columbia to Utah, and it migrates to the coastal regions of California and to the Gulf Coast during the winter, see Figure 15–23.

Pelicans nest in large colonies, and the females usually lay two eggs in large mound nests located in marsh and prairie regions. Young pelicans are naked, and their parents have to shield them from the sun to prevent sunburn. During long flights, pelicans fly together in long lines to reduce wind resistance on the birds behind the leader.

Figure 15–22 The white pelican uses its bill to scoop up fish that are carried in its pouch. *Courtesy U.S. Fish and Wildlife Service. Photo by John Foster.*

Loons are swimming birds that capture fish by spearing them with their sharp bills. They are **solitary** birds, meaning they spend much of their lives alone or in pairs. They are well known in the northern woods of Canada and Alaska for their strange nocturnal calls.

KEY INTERNET SEARCH WORDS

common loon

Gavia immer

pied-billed grebe

Podilymbus podiceps

Figure 15–25 Distribution map of the common loon.

AVIAN PROFILE

Common Loon *(Gavia immer)*

The common loon is a large dark-colored bird with a distinctive pattern of white markings on its back. It has a glossy, greenish-black head and neck with a white marking around its neck, and white underparts, see Figure 15–24. The summer range of this bird includes the wooded areas of Alaska, Canada, and the Great Lakes region of the United States. It migrates to both the Pacific and Atlantic coasts during the winter, see Figure 15–25.

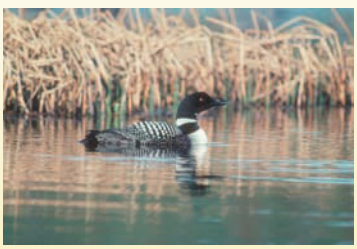


Figure 15–24 The common loon is a bird that is found in the woods of northern Canada and Alaska. *Courtesy U.S. Fish and Wildlife. Photo by William Troyer.*

Females nest on piles of vegetation along the shores of freshwater ponds and lakes. This loon is a diving bird that is known to reach depths of over 200 feet in pursuit of fish. They often escape notice by their enemies by gradually sinking in the water to avoid detection.

Grebes are aquatic diving birds that eat mostly insects and small aquatic animals. They also eat small amounts of vegetation. Unlike many waterbirds, they do not have webbed feet. They have **lobes** on their toes to help them swim easier, see Figure 15–26. Ten species of grebes are found in North America.

Figure 15–26 The lobed feet of a grebe. *Courtesy Leonard Lee Rue III.*

Figure 15–27 Distribution map of the pied-billed grebe.

AVIAN PROFILE

Pied-Billed Grebe *(Podilymbus podiceps)*

The pied-billed grebe is found in most regions of the United States and southern Canada, see Figure 15–27. It is a small bird with a bill similar to that of a chicken. A black mark around the bill accounts for its name, see Figure 15–28.

This grebe prefers marshland habitat, and it can be found most readily where the water is shallow and water plants are abundant. Its diet consists of aquatic insects, crayfish, fish, frogs, crustaceans, and some plant materials. Its winter habitat is usually open ocean and saltwater bays. The females lay five to seven eggs in floating nests constructed of marsh vegetation. These nests are anchored to plants to keep them from floating into open water. Young grebes ride on the backs of their parents or hold onto their tails to be towed.

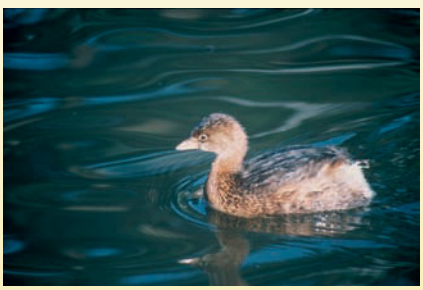


Figure 15–28 The pied-billed grebe lives in the marsh and prefers shallow water. *Courtesy U.S. Fish and Wildlife. Photo by Lee Karney.*

SANDPIPER-LIKE BIRDS

The sandpiper-like birds are small to medium-sized birds whose coloring matches the habitats in which they live. They are long-legged wading birds with long slender bills, and they feed mostly on insects and small aquatic animals. They nest on the ground near ponds and marshes.

KEY INTERNET SEARCH WORDS

spotted sandpiper

Actitis macularia

Figure 15–29 Distribution map of the spotted sandpiper.

AVIAN PROFILE

Spotted Sandpiper *(Actitis macularia)*

The spotted sandpiper is the most widespread of the sandpipers. It ranges throughout most of Alaska, Canada, and the continental United States, see Figure 15–29. It is a migratory bird that flies south to warm climates each winter. It is one of the smallest sandpipers and has a straight bill of moderate length. It has a brown upper body and white underparts that are covered with brown spots in the summer, see Figure 15–30.

The females lay four eggs near water in depressions on the ground. Spotted sandpipers can be identified by their habit of teetering as if they are unbalanced.

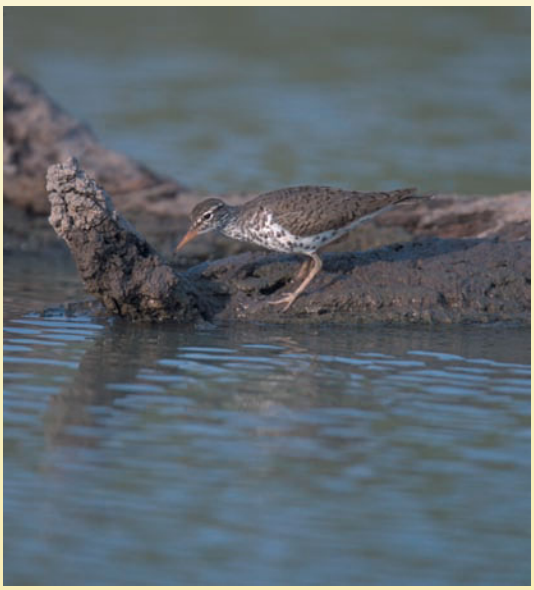


Figure 15–30 The spotted sandpiper is the most widespread of the sandpipers. *Courtesy U.S. Fish and Wildlife. Photo by Gary Kramer.*

Sandpipers, snipes, and other closely related birds are described as **precocial** birds. This means that the young are covered with down, and they become active immediately after they have hatched. They do not require care in their nests.

KEY INTERNET SEARCH WORDS

long-billed curlew

Numenius americanus

Figure 15–32 Distribution map of the long-billed curlew.

AVIAN PROFILE

Long-Billed Curlew *(Numenius americanus)*

The long-billed curlew is a large shorebird that is mottled brown on the back and wings, with buff-colored underparts. It has a long neck and long, curved bill, see Figure 15–31. It inhabits marshes, mud flats, and open plains where it eats insects, worms, fish, shellfish, and other small aquatic animals. During the winter, it feeds in fields or along beaches and salt marshes. The range of this bird extends from southern Canada to the Great Basin and eastward to Oklahoma and Texas, see Figure 15–32.

Females lay four eggs in grass-lined ground nests. They defend territories during the nesting season, but they are social birds during the rest of the year.

Figure 15–31 The long-billed curlew inhabits marshes, mud flats, and open plains. *Courtesy Shutterstock.*

The **plovers** are a family of small to medium-sized shorebirds. Ten species are found in North America. These birds have loud voices, and they nest in scrapes on the ground. The females usually lay four speckled eggs that are incubated by both parents. The chicks are active almost as soon as they hatch. These birds feed on insects and small aquatic animals. They gather food in the wet areas along the shorelines, but they don't normally wade very far from the shore.

INTERNET ADDRESS

http://animaldiversity.ummz.umich.edu/site/accounts/classification/Charadrius_vociferus.html

KEY INTERNET SEARCH WORDS

killdeer plover
Charadrius vociferus

Figure 15–34 Distribution map of the killdeer plover.

AVIAN PROFILE

Killdeer Plover *(Charadrius vociferus)*

The killdeer is about the size of a robin. It is white underneath and grayish brown above, with a long, tan-colored tail and two black bands on its breast, see Figure 15–33. This bird is found throughout much of North America, see Figure 15–34. It is easily recognized by its shrill "kill-deeah" call, from which it gets its name. The killdeer feeds on insects, worms, and small crustaceans.

The adult killdeer often draws predators away from its young by dragging one wing on the ground and pretending to be injured. The parent will stay just far enough ahead to encourage the predator to follow as it leads it away from the young birds.

Figure 15–33 A killdeer plover. *Courtesy Shutterstock.*

Other birds that belong among the sandpiper-like birds are the phalaropes, oystercatchers, and avocets. The **phalaropes** are unusual birds in that females are brightly colored and the drab-colored males incubate the eggs. Oystercatchers live on coastal beaches and tidal flats where they feed on shellfish and other marine animal life in the intertidal zone. These areas are covered with water during high tide, but they are above the water line at low tide. The bills of these birds are adapted for opening the shells of mollusks and other shellfish. The **avocets** are unusual-looking shorebirds whose bills curve upwards.

CHICKEN-LIKE MARSH BIRDS

The family Rallidae includes rails, gallinules, and coots. Most members of this family have short wings and tails. They are usually dull-colored birds that feed on vegetable and animal matter they find by swimming or diving along seashores and in shallow marshlands. Their narrow bodies are adapted to moving easily through the reeds and other aquatic plants found in their natural environments.

An interesting characteristic observed in some of the birds discussed in this section is the **frontal shield**. This is a fleshy growth that extends from the top of the bill to the forehead. In some species it is white, while in others it is dark red. The frontal shield is used by strong birds to intimidate weak birds. It is known to increase in size in males that are defending their territories.

KEY INTERNET SEARCH WORDS

common gallinule

Gallinula chloropus

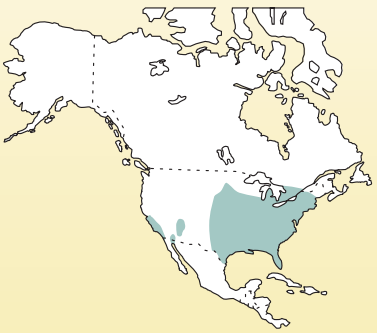


Figure 15–36 Distribution map of the common gallinule.

AVIAN PROFILE

Common Gallinule *(Gallinula chloropus)*

The common gallinule is a slender bird with brown wings and back; the rest of its body is dark gray. It has a red frontal shield that extends from its red bill to its forehead. The tip of its bill is bright yellow, see Figure 15–35.

Gallinules are found in marshes and open water habitats in many areas of North America, see Figure 15–36. They are omnivorous and their diet includes insects, tadpoles, seeds, and fruits. Gallinules are also prolific birds that lay 9–12 eggs in platform nests near the edge of the water.

Figure 15–35 A common gallinule has an unusual red frontal shield extending from its bill to its forehead. *Courtesy U.S. Fish and Wildlife Service. Photo by. Rathert/MO Conservation, Jim.*

Rails are divided into three main groups that include the long-billed rails, the crakes and gallinules, and the coots. These birds live in the reeds that line the shores of many wetlands. They nest on platform nests that float on the water. Some species of rails are unable to fly. This inability to fly contributed to the extinction of some species that were native to offshore islands. The remaining North American species of rails are birds that are capable of flight.

KEY INTERNET SEARCH WORDS

American coot

Fulica americana

Figure 15–38 Distribution map of the American coot.

AVIAN PROFILE

American Coot *(Fulica americana)*

The American coot is a dark gray waterbird with a black neck and head. Its lobed toes aid in swimming or walking in soft mud, and it has a distinct white frontal shield above the bill, see Figure 15–37. Coots are gregarious birds that are found from Canada to California and the Gulf Coast, see Figure 15–38. Their preferred habitats include marshes, ponds, and lakes. These birds dabble, but they also will dive to the bottoms of marshes and small bodies of water to feed on submerged vegetation.

Females lay up to a dozen eggs in platform nests constructed of plant materials. These nests are located offshore, and they are used as resting areas after the young have hatched.

Figure 15–37 The American coot is a marsh bird that feeds mostly on aquatic plants. *Courtesy U.S. Fish and Wildlife Service.*

Some of the chicken-like marsh birds, including coots and gallinules, are game birds that are hunted during certain seasons of the year. Many of them are similar in body structure to partridges, except that they are more slender. They are noisy birds, and it is believed that they call to one another to warn other birds away from their territories.

UPLAND GROUND BIRDS

The upland ground birds most commonly found in North America are nightjars, grouse, roadrunners, pheasants, quails, partridges, and turkeys. All of these birds except the nightjars and roadrunners were discussed in Chapter 12, “Game Birds.”

The **nightjars** are nocturnal birds that eat insects and for this reason are called insectivores. Their mouths are large, and their bills are lined with bristles that aid in capturing insects. Their harsh or jarring calls after dark earned these birds the name of nightjars. The whip-poor-wills and poor-wills are common nightjars found in North America.

INTERNET ADDRESS

http://museum.gov.ns.ca/mnh/nature/nsbirds/bnso222.htm

KEY INTERNET SEARCH WORDS

whip-poor-will
Caprimulgus vociferus

AVIAN PROFILE

Whip-poor-will *(Caprimulgus vociferus)*

The whip-poor-will is a forest dweller whose range includes the eastern half of the United States and the border region of southern Canada, see Figure 15–39. This species is also found along the Gulf Coast and in some areas of the southwest and northern Mexico. Its name comes from the sound of its call, which is repeated throughout the night. Its color is a mixture of mottled tan, gray, brown, and black. It blends well with the forest floor where it lays its two eggs in a ground nest.

These birds were once known as goatsuckers because goat herders believed that they were sucking the milk from their animals. Nightjars call to each other during the night at about the same time of the year that the milk production of goats begins a natural decline. However, the actual diet of the bird consists of insects.

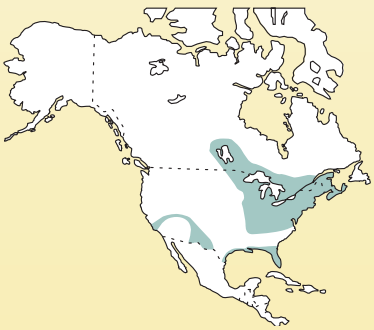


Figure 15–39 Distribution map of the whip-poor-will.

The plumage of nightjars is mottled to help them blend with their surroundings. Nightjars are not known as social birds. However, during the nesting season, a single male may have several mates nesting close together on the ground. This nesting habit makes them vulnerable to most **terrestrial** or land-based predators.

KEY INTERNET SEARCH WORDS

Roadrunner

Geococcyx californianus

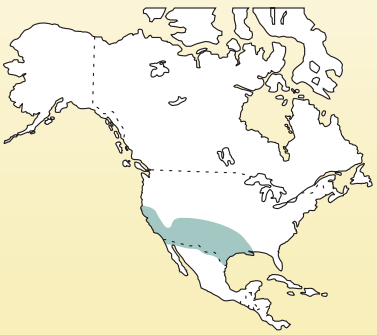


Figure 15–41 Distribution map of the roadrunner.

AVIAN PROFILE

Roadrunner *(Geococcyx californianus)*

Figure 15–40 The roadrunner prefers to run rather than to fly.

The roadrunner has become famous in the cartoon that matches the bird against the wily coyote. It is brown in color, and streaked with black and white on the upper body, with a greenish sheen to its plumage. The lower body is buff-colored and streaked with brown. Its bill is large, and the bird has a long tail and a crested head, see Figure 15–40. The roadrunner ranges throughout the desert regions of the southwestern United States, see Figure 15–41.

Roadrunners prefer to run rather than fly, and they seek shelter in the brush and scrub found in desert habitats. Females lay three to six eggs in nests located in mesquite bushes, large cacti, or shrubs. They are predatory birds that eat snakes, rodents, lizards, scorpions, insects, and young birds.

SWALLOWS AND SWIFTS

Swallows are insectivores that usually live in complete harmony with humans, and their mud nests are often found attached to man-made structures. Sometimes they build nests in banks and cliffs by making holes and lining them with grass. These birds are easily recognized by their long wings and tails and by their large mouths that they use to catch insects in flight. Eight species of swallows are found in North America.

KEY INTERNET SEARCH WORDS

barn swallow

Hirundo rustica

Figure 15–42 Distribution map of the barn swallow.

AVIAN PROFILE

Barn Swallow *(Hirundo rustica)*

Figure 15–43 The barn swallow is well known for its nests made of mud and grass that are anchored on walls of buildings and bridges. *Courtesy U.S. Fish and Wildlife Service. Photo by Dave Menke.*

The barn swallow ranges throughout much of North America, see Figure 15–42. It is a bluish-black bird on the upper body with rust-colored underparts. Its wings are long and streamlined, and its tail is forked, see Figure 15–43. Barn swallows inhabit open country near water, where insects are abundant.

They nest in colonies and they hunt together. They also join together to drive hawks and other predatory birds away from their nesting sites. Females lay four to six eggs in feather-lined nests made of mud and straw.

Swallows are migratory birds, and they fly to Central or South America each winter.

These birds return to the same nesting sites year after year, with the older birds arriving first. They are monogamous birds, and both parents are involved in feeding the young. Two clutches of eggs are often produced in a year, and the young birds from the first brood have been observed helping their parents gather food for the second brood. They are somewhat territorial even though they often nest in colonies. They tend to defend small territories around their nests against other members of the colony.

One group of birds often mistaken for swallows is the **swifts**. These migratory birds often have slightly forked tails and an appearance similar to that of a swallow or martin. They have weak legs and feet, and they seldom land except during the nesting period. They cling to vertical surfaces to avoid landing on the ground. These birds are insectivores that sometimes spend several weeks in flight without landing. They even mate in flight.

Swifts are monogamous birds that return to the same nesting sites each year. They prefer to nest on cliffs and canyon walls in sheltered areas. Their nests are constructed mostly of sticks, vegetation, grass, and algae glued together with sticky saliva.

KEY INTERNET SEARCH WORDS

white-throated swift

Aeronautes saxatalis

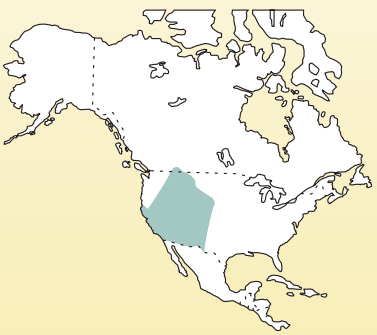


Figure 15–45 Distribution map of the white-throated swift.

AVIAN PROFILE

White-Throated Swift *(Aeronautes saxatalis)*

Figure 15–44 The white-throated swift spends most of its time in flight.

The white-throated swift is the size of a barn swallow with a slightly forked tail and long, narrow wings. Its wings, sides, and tail are black, and the throat and breast areas are marked with white, see Figure 15–44. This bird ranges from British Columbia to Central America, although much of its habitat is in the Rocky Mountains and the southwestern United States, see Figure 15–45. These birds nest in colonies on cliffs. A typical clutch consists of three to six eggs. Immature birds or **nestlings** are fed pellets of insects that are collected in the throats of the parents during flight.

Some birds survive cold weather conditions by slowing their metabolism until they appear near death. Their body heat is temporarily lost, all of the bodily functions slow down, and they require little or no food. This condition is similar to that experienced by animals that hibernate. It is a state of dormancy known as **torpor**. A bird or animal that is found in this state is described as being **torpid**.

Swifts have been known to leave their nesting areas during cold, rainy weather when insect food is hard to find. They fly long distances to feed until the storm is over. While they are gone, the nestlings become cold and torpid. Due to this state of torpor, they are able to survive until their parents return to feed them.

KEY INTERNET SEARCH WORDS

chimney swift

Chaetura pelagica

Figure 15–46 Distribution map of the chimney swift.

AVIAN PROFILE

Chimney Swift *(Chaetura pelagica)*

The chimney swift is an inhabitant of the eastern half of the United States and southern Canada, and it is slowly expanding its range westward, see Figure 15–46. It is charcoal brown with a light-colored throat. It has a short, square tail and long, narrow wings, see Figure 15–47. In flight, it tends to alternate between rapid flight and gliding. This bird used to be found mostly in woodland areas, but it now inhabits cities and towns where females lay four to five eggs in chimney nests. They also nest in hollow trees or caves. A nest consists of a few twigs glued together with the bird's saliva.

Figure 15–47 The chimney swift is a relative of the more abundant barn swallow. *Courtesy Steve & Dave Maslowski. Photo Researchers, Inc.*

TREE-CLINGING BIRDS

The tree-clinging birds include the woodpeckers, nuthatches, and creepers. All of these birds are insectivores, and they spend most of their time climbing tree trunks in search of insects. These birds play important roles in forest and desert ecosystems by controlling insects that damage trees and cacti. In addition, woodpeckers make holes in trees and other woody plants that are used for nesting sites and shelter by many other birds and animals.

Twenty species of woodpeckers live in North America. These birds are usually distinctively colored, and they are equipped with strong skulls and straight bills. They use their bills like chisels to dig into the surfaces of trees as they hunt for insects. Their long tongues are used to get insects out of the holes in the wood. They are solitary birds that come together only to nest.

KEY INTERNET SEARCH WORDS

common flicker

Colaptes auratus

Figure 15–48 Distribution map of the common flicker.

AVIAN PROFILE

Common Flicker *(Colaptes auratus)*

The common flicker is a woodpecker that is widely distributed in North America, see Figure 15–48. Three different color variations are known for this bird, depending on its race. The wings and tail of the race known as the red-shafted flicker are lined with pink that is easily noticed as the bird flies. The lower body is black and white, the back is barred with cinnamon and brown, the rump is white, the neck and face are gray, and the head is brown. The males have red mustaches, see Figure 15–49.

Figure 15–49 A female yellow-shafted flicker. *Courtesy U.S. Fish and Wildlife. Photo by Donna Dewhurst.*

Common flickers prefer deciduous or mixed woodland habitats, but they are adaptable to a wide variety of environmental conditions. A nesting female lays 6–10 eggs in a nesting hole drilled into a tree, cactus, or post. The diet of the flicker consists of ants and other insects, with berries making up part of the diet during the winter. Unlike many other woodpeckers, the flicker is frequently seen on the ground pursuing ants.

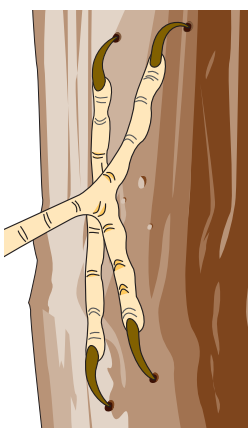


Figure 15–50 The toe arrangement of a climbing bird is two toes forward and two toes behind. This arrangement enables these birds to grip the irregular surfaces of the bark of trees.

The diets of woodpeckers vary quite a bit, with insects and spiders making up a large part of the food supply. They also are known to eat seeds, berries, and other fruit. One woodpecker eats only acorns, and another known as the sapsucker eats the sap of trees and the insects that the sap attracts.

The toes of many of the climbing birds are arranged with two toes forward and two behind, see Figure 15–50. The toes are long for gripping the bark of trees as they search for insects. The rear toes also provide leverage as these birds peck holes in woody plants and trees.

Most species of woodpeckers go through a courting ritual that includes inspecting or excavating nesting holes and drumming loudly with their bills to attract prospective mates to likely nesting sites. The males and females usually share the duties of incubating the eggs and caring for the nestlings. After the young woodpeckers leave the nest,

INTERNET ADDRESS

http://animaldiversity.ummz.umich.edu/site/accounts/classification/Dryocopus_pileatus.html

KEY INTERNET SEARCH WORDS

pileated woodpecker

Dryocopus pileatus

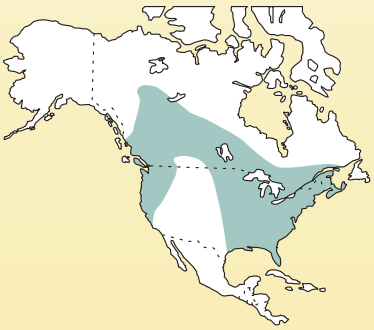


Figure 15–52 Distribution map of the pileated woodpecker.

AVIAN PROFILE

Pileated Woodpecker *(Dryocopus pileatus)*

The pileated woodpecker is a large bird about the size of a crow. It is mostly black in color with white markings on the flank, throat, face, and underwing areas. The male has a red crest and mustache, see Figure 15–51, and the female is similar but without as much red coloring. This woodpecker is found in the eastern United States and in the Pacific Northwest, and it ranges across much of southern and central Canada, see Figure 15–52.

This woodpecker especially favors carpenter ants that it finds in dead trees and stumps. It pecks out a large oval or oblong hole in decaying wood and captures ants by extending its long sticky tongue into their nest. A breeding pair works together to excavate a hole for a nesting site, and three to five eggs are incubated in the cavity.

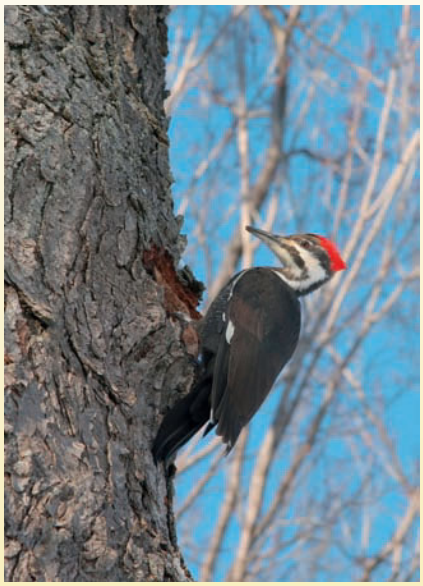


Figure 15–51 A male pileated woodpecker at his nest hole. *Courtesy Shutterstock.*

the parents of some species divide the brood. Each parent assumes the care of some of the young birds until they are mature enough to care for themselves.

Four species of nuthatches are native to North America. They are migratory birds that depend mostly on insects, nuts, and berries for food. They range in size from 4.5–6 inches. They spend most of their time climbing up and down the trunks of trees as they gather food. They position themselves on the tree trunk with their heads facing down as they seek food.

KEY INTERNET SEARCH WORDS

red-breasted nuthatch

Sitta canadensis

Figure 15–53 Distribution map of the red-breasted nuthatch.

AVIAN PROFILE

Red-Breasted Nuthatch *(Sitta canadensis)*

The red-breasted nuthatch is a common bird in many parts of North America, see Figure 15–53. It is a small blue-gray bird with a rust-colored breast and a black cap, see Figure 15–54. It inhabits coniferous forests and mixed woods where it gathers insects, spiders, and seeds for food.

These birds nest in holes located in dead trees, and the entrance areas are often protected with sticky pitch. This helps to defend the nest from larger birds and other predators. These birds are monogamous and they usually produce a single brood of 4–7 young each year.

Figure 15–54 The red-breasted nuthatch inhabits forested areas where it feeds on insects, spiders, and seeds. It is also attracted to backyard bird feeders. *Courtesy U.S. Fish and Wildlife Service. Photo by Dave Menke.*

Creepers are small brown birds that are usually observed climbing up tree trunks in search of insects. They have long bills that curve slightly downward that they use to probe for insects. Only the brown

creeper is found in North America. It can easily be distinguished from the nuthatches by the way its head is positioned to face up the tree trunk in contrast with nuthatches that face downward.

KEY INTERNET SEARCH WORDS

brown creeper

Certhia familiaris

Figure 15–56 Distribution map of the brown creeper.

AVIAN PROFILE

Brown Creeper *(Certhia familiaris)*

The brown creeper is a small bird with mottled brown coloring on the upper body and white underparts, see Figure 15–55. It is distinguished by its long, curved bill, and by its stiff tail feathers which brace it on the tree trunk as it works to gather food from beneath the bark of the tree. Its preferred habitat is coniferous or mixed forests, see Figure 15–56.

Figure 15–55 A brown creeper. *Courtesy U.S. Fish and Wildlife. Photo by Donna Dewhurst.*

This bird builds a nest of twigs, moss, and bark behind loosened chunks of tree bark in which it incubates four to eight eggs. Breeding pairs are sometimes assisted with the duties of gathering food by the male offspring from earlier broods. These family groups sometimes tend more than one nest at any given time. Females tend to scatter earlier than males, and they do not assist other females with parenting duties.

LOOKING BACK

A large number and variety of bird species occupy the ecosystems of North America. Each performs an important role in the food chain, and each species interacts with other living and nonliving resources in the environment. The birds that were discussed in this chapter occupy niches in many different habitats. Each has adapted to its environment in different ways. This is evident when their differences in diet, coloring, body structure, metabolic functions, and habits are considered. The groups of birds included in the chapter are arbitrarily grouped by their commonly shared characteristics. They include long-legged wading birds, gull-like birds, upright perching birds, waterbirds, duck-like birds, sandpiper-like birds, chicken-like marsh birds, upland ground birds, and tree-clinging birds.

Chapter Review

DISCUSSION AND ESSAY

1. Make a chart listing the characteristics of the different kinds of waterbirds discussed in this chapter. The information on the chart should include identifying traits, habitats, range, food, and reproductive traits.
2. Name several species of long-legged wading birds discussed in this chapter and describe their diets and habitats.
3. Name the major species of gull-like birds and describe their preferred habitats and diets in the North American ecosystems.
4. Explain the roles of several upright perching waterbirds named in this chapter.
5. Name some roles of the duck-like birds described in this chapter, and list the diet and preferred habitat of each.
6. Describe the habitats of the sandpiper-like birds considered in this chapter and name some major species.
7. Explain the role of upland ground birds, and list the major species discussed in this chapter.
8. Describe the similarities and differences between swallows and swifts.
9. Describe how torpor in birds and hibernation in animals contributes to the ability of an organism to survive.
10. Name several kinds of tree-clinging birds and describe their diets and preferred habitats.

MULTIPLE CHOICE

1. The American bittern belongs to which class of birds?
   a. Upright perching waterbirds
   b. Long-legged wading birds
   c. Gull-like birds
   d. Sandpiper-like birds
2. Which of the following birds is not considered to be a heron?
   a. Flamingo
   b. Great egret
   c. Sandhill crane
   d. Brandt's cormorant
3. Which of the following fish-eating birds obtains the majority of its food from the ocean?
   a. Snowy egret
   b. Great blue heron
   c. Tufted puffin
   d. Common loon
4. A gull-like bird that migrates to Antarctic habitats during the arctic winter season is the:
   a. Arctic tern
   b. Tufted puffin
   c. California gull
   d. Snowy egret

5. Which of the following birds is not an upright perching waterbird?

   a. Whooping crane
   b. Cassin's auklet
   c. Tufted puffin
   d. Brandt's cormorant

6. Which of the following bird families has some resemblance to the penguin of the Antarctic?

   a. Tufted puffin
   b. Cassin's auklet
   c. Pied-billed grebe
   d. White pelican

7. Which term describes newly hatched birds that are covered with down and become active immediately at birth, requiring no care in their nests?

   a. Phalarope
   b. Precocial
   c. Terrestrial
   d. Torpid

8. Which term describes a grouping of birds in which females are brightly colored and males are drab in color?

   a. Phalarope
   b. Precocial
   c. Terrestrial
   d. Torpid

9. Which of the following birds is known as a nightjar?

   a. Plover
   b. Whip-poor-will
   c. Partridge
   d. Swift

10. Which of the following birds does not depend on flying insects as their main source of food?

   a. Whip-poor-will
   b. Swallow
   c. Swift
   d. Bittern

11. Which term describes a land-based organism?

   a. Phalarope
   b. Precocial
   c. Terrestrial
   d. Torpid

12. Which of the following birds is not classed as a tree-clinging bird?

   a. White-throated swift
   b. Common flicker
   c. Red-breasted nuthatch
   d. Brown creeper

Learning Activities

1. Select an observation area near your school, and lead the students in conducting a survey to identify the species of birds that use the area. Evaluate the role of each bird species that occupies the habitat. Prepare a group presentation, and solicit opportunities for class members to deliver it to other classes, civic clubs, and community groups.
2. Conduct a magazine picture contest in your school with categories for several different kinds of pictures obtained from magazines or printed materials. Each photo that is submitted should be attached to a data sheet listing habitat, diet, range, etc. Obtain sponsors for the prizes (if allowed in your school), and display the pictures in a prominent location in the school or community. Make sure that the activity and winning entries receive plenty of publicity.

SECTION

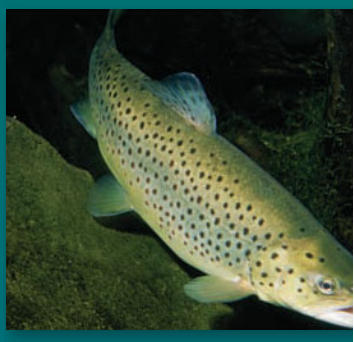
IV

Zoology and Ecology of Fish, Reptiles, and Amphibians

Fish, reptiles, and amphibians are cold-blooded animals that depend on their environments for body heat. Most of these animals are oviparous or ovoviviparous in their reproductive habits. Most of these animals also are protected by scales, shells, or plates. Some of them guard their eggs and care for their offspring, and others do not. They are widely distributed in the ecosystems of North America.

CHAPTER

16



Freshwater Fish

Freshwater fish include all of the fish species living in water habitats that are not salty. The freshwater habitats of North America include springs, canals, streams, rivers, lakes, marshes, and ponds. Each of these waters provides a different living environment, and each environment is inhabited by fish that are adapted to the conditions found there. The freshwater habitats of North America provide living environments for a great variety of fish.

After completing this chapter, you should be able to:

- distinguish between freshwater and saltwater habitats
- describe the spawning process by which fish reproduce
- analyze the roles of catfish in the freshwater habitats of North America
- define the roles of sunfish in the freshwater environments of North America
- consider the importance of salmonids in freshwater ecosystems
- appraise the roles of perches in North American ecosystems
- explain the predatory roles of pikes in freshwater habitats
- evaluate the importance of sturgeons in the river environments of North America
- define the roles of minnows and suckers in the ecosystems of North America.

KEY TERMS

freshwater
anatomy
spawn
roe
milt
bullhead
barbel
dorsal fin
pectoral fin
adipose fin
pelvic fin
anal fin
laterally compressed
hybrid
darter
tapetum lucidum
aerated water
race
aquaculturist
school
char
cannibalistic
caviar
scute

Freshwater includes all of the waters on the continent that are not high in salt content. Most springs, streams, rivers, lakes, marshes, canals, and ponds are classed as freshwater habitats. A notable exception is the Great Salt Lake located in the Great Basin area of Utah and Nevada. This watershed has no outlet to the ocean, and the salt content of the water in this lake is much higher than that of ocean water.

Freshwater sources differ from one another in many ways. Minerals become dissolved in water as it passes over rock formations. This results in differences in the water's mineral content. Water also differs greatly in temperature, oxygen content, pH, rate of flow, dissolved nutrients, and degree of pollution, see Figure 16–1. All of these factors combine to create unique water environments of many kinds. Fish have adapted over long time periods to the water habitats in which they live. Some species are able to survive in a wide range of water environments, but

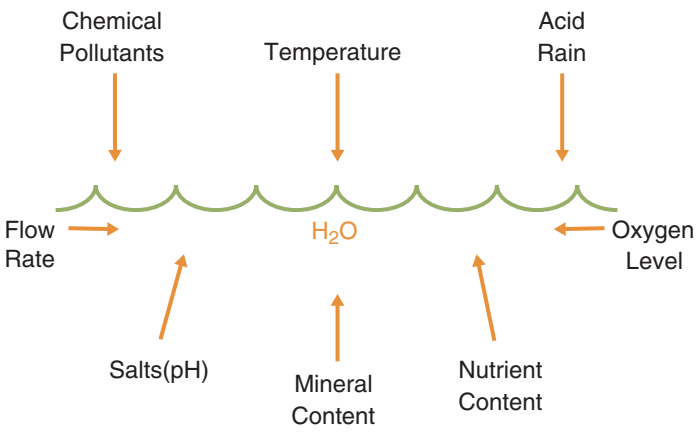


Figure 16–1 Fresh water sources differ from one another in many ways.

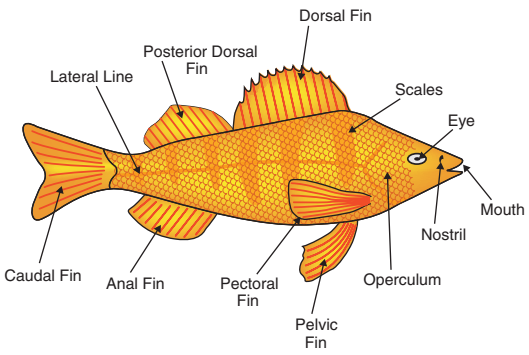


Figure 16–2 The external anatomy of the fish.

others are unable to tolerate even small changes in their living conditions.

It is important to be familiar with the **anatomy** or structure of a fish. While the shapes and sizes of particular body parts differ from one fish species to another, the structure is similar for most of them, see Figure 16–2. The descriptions of the fish in this chapter will focus

KEY INTERNET SEARCH WORDS
Great Salt Lake

on similarities and differences in their anatomies. Respiration in fish is accomplished when water containing dissolved oxygen passes through the gills of a fish. Oxygen enters the tissue in the gills where it becomes attached to blood cells. Waste materials flow across the gill tissue to the surrounding water.

Reproduction in fish is accomplished when they **spawn**. This is a sexual process during which a female deposits eggs or **roe** in depressions beneath the water, and a male fertilizes them by discharging **milt** or sperm on the surfaces of the eggs.

CATFISH

KEY INTERNET SEARCH WORDS
fish, anatomy

Catfish are found in two different families and include 46 freshwater species in North America. The largest family of catfish is the Ictaluridae or **bullhead** family. Forty-five species of catfish belong to this family, and they are found in waters from Canada to Mexico. The other family is the Clariidae family to which the walking catfish belongs. It is so named because it can walk over land on its fins during rainy weather. This fish is an exotic species that is found in Florida.

KEY INTERNET SEARCH WORDS
channel catfish
Ictalurus punctatus

Figure 16–4 Distribution map of channel catfish (introduced in other waters).

FISH PROFILE

Channel Catfish *(Ictalurus punctatus)*

The channel catfish has dark spots on its back and sides against light blue to greenish-black coloring. The underparts are white. Fish of this species can reach 50 inches in length, see Figure 16–3. This fish is a popular game species that inhabits deep rivers and lakes. It has been introduced to waters beyond its native habitat, see Figure 16–4. It is now found throughout much of the United States. This fish is a scavenger that eats mostly animal matter. Similar species include the Yaqui, blue, and headwater catfish.

Figure 16–3 The channel catfish is a scavenger that is found in deep rivers and lakes. *Courtesy Suzanne L. & Joseph T. Collins. Photo Researchers, Inc.*

Figure 16–5 Catfish are equipped with barbels or feelers that give the fish a sense of touch. *Courtesy U.S. Fish and Wildlife. Photo by Eric Engbretson.*

Bullhead catfish have four pairs of barbels, sometimes called feelers or whiskers, surrounding their mouths, see Figure 16–5. **Barbels** are organs that give the fish a sense of touch, and they are used to locate food. They also have bony spines located at the bases of their **dorsal fins** (located on their backs), and their **pectoral fins** correspond to front legs in terrestrial vertebrates.

Bullhead catfish also have **adipose fins** that store fat and **pelvic fins** that correspond to the rear limbs of terrestrial vertebrates. The **anal fin**, located on the underside between the anus and the tail, is very prominent in the catfish. North American catfish have tough skins with no scales on their bodies. Their sharp spines are used as weapons, and in some cases, they are poisonous. The Madtom catfish species are well known for their ability to injure their enemies with their poisonous spines.

INTERNET ADDRESS

http://waterknowledge.colostate.edu/blackbul.htm

KEY INTERNET SEARCH WORDS

black bullhead

Ameiurus melas

FISH PROFILE

Black Bullhead *(Ameiurus melas)*

The black bullhead measures up to 24 inches long. It is olive to yellowish brown on the back fading to a greenish-gold coloring on the sides. Its barbels are black, and its underparts range in color from white to yellow, see Figure 16–6. Habitats for these fish include sluggish rivers, pools, lakes, and ponds. Black bullheads are native to interior waters in the United States from the Great Lakes to Mexico, see Figure 16–7, and they have been introduced to suitable waters in many other regions. Similar species are the brown and yellow bullheads.

Figure 16–7 Distribution map of the black bullhead (introduced in other waters).

Figure 16–6 The black bullhead lives in slow, sluggish waters. *Courtesy U.S. Fish and Wildlife. Creator Duane Raver.*

Catfish are considered to be warm-water fish because they are able to tolerate higher water temperatures than most other species. These fish are nocturnal bottom feeders.

Numerous other species of catfish are found in North America, and they vary greatly in size. The flathead catfish, for example, grows to lengths of more than 5 feet, whereas the pygmy madtom matures at 1½ inches.

The second catfish family includes only one North American species. It is an imported fish known as the walking catfish. It is abundant in Florida waters, and it was introduced in other states as far west as California. It is capable of breathing air because a small part of each gill functions like lung tissue. This catfish uses its tail and pectoral fins to propel itself over the surface of the ground.

SUNFISH

Sunfish are natives of North America. They belong to a family called Centrarchidae. Included in this family are such game fish as the basses, crappies, and bluegills. These fish are **laterally compressed**, meaning that they measure much longer from their backs to their bellies than from side to side. Sunfish become active in direct sunlight, and their activity decreases in subdued light. This dependence on sunlight has resulted in the sunfish's name.

Several distinctly different fish that belong to different families are included among the basses. Many of them are freshwater fish, but some basses live in the ocean. They are described as moderately compressed fish with elongated bodies that become deeper as the fish gets older.

KEY INTERNET SEARCH WORDS

largemouth bass

Micropterus salmoides

Figure 16–8 Distribution map of the largemouth bass (introduced in other waters).

FISH PROFILE

Largemouth Bass *(Micropterus salmoides)*

The largemouth bass is a popular game fish in North America. Its native range extends across the eastern United States and Canada, see Figure 16–8, and it has been introduced to many other areas beyond this range. This fish sometimes grows to a length of 36–38 inches. Its mouth is large with the upper jaw extending back past the eye. The upper body is metallic green in color, the sides are mottled, and the underside is white, see Figure 16–9.

The favored habitat for this fish is the quiet waters of lakes, sloughs, and ponds and deep pools in rivers and streams. They prefer waters where plants are abundant. This bass is a predatory fish that feeds mostly on aquatic animals.

Figure 16–9 Largemouth Bass (micropterus salmoides) also known as Black Bass, Green Trout, Bigmouth Bass or Lineside Bass. *Courtesy E. R. Degginger/Photo Researchers, Inc.*

The males of the Centrarchidae family build nests in which the females lay their eggs. Each nest is a shallow depression in the gravel or sand on the stream or lake bottom that is created by the male as he fans loose material away with his fins. Each male defends a small area in the vicinity of the nest, and he guards the eggs and the young fish.

KEY INTERNET SEARCH WORDS

smallmouth bass

Micropterus dolomieu

Figure 16–11 Distribution map of the smallmouth bass.

FISH PROFILE

Smallmouth Bass *(Micropterus dolomieu)*

The smallmouth bass is brownish olive on the back and mottled with dark markings. It has dark bars on yellowish-green colored sides, and the underparts are yellow, see Figure 16–10. This fish is distributed beyond its native range, and today, it is found from southern Canada to the central region of the United States, see Figure 16–11.

Preferred habitat for this fish is clean, flowing water in streams, rivers, or shallow lakes that have rock or gravel bottoms. This bass is a predatory fish that feeds mostly on small fish and aquatic animals.

Figure 16–10 The smallmouth bass is a predator that feeds on small fish and aquatic animals. *Courtesy Gary Meszaros. Photo Researchers, Inc.*

KEY INTERNET SEARCH WORDS

black crappie

Pomoxis nigromaculatus

Figure 16–13 Distribution map of the black crappie (introduced to other waters).

FISH PROFILE

Black Crappie *(Pomoxis nigromaculatus)*

The black crappie has a deep, laterally compressed body that is gray green on the back. Its silvery-blue sides are marked with black-colored wavy lines and blotches, and it is white underneath, see Figure 16–12. This fish prefers clean, quiet water, and it lives in lowland ponds, lakes, and sloughs. It also is sometimes found in deep, calm pools in slow-flowing streams. Its native range has been expanded from the eastern United States by introductions of the fish into other suitable waters, see Figure 16–13.

Figure 16–12 The black crappie lives in quiet, clean water in lowland ponds, lakes, and sloughs. *Courtesy © John G. Shedd Aquarium.*

Sunfish of different species frequently mate together. The offspring of these matings are called **hybrids**. Hybridization is observed most often when the water in the spawning areas is polluted or dirty. It is thought that the fish may have difficulty distinguishing between the different species due to poor visibility.

INTERNET ADDRESS

http://www.rook.org/earl/bwca/nature/fish/lepomismac.html

KEY INTERNET SEARCH WORDS

bluegill

Lepomis macrochirus

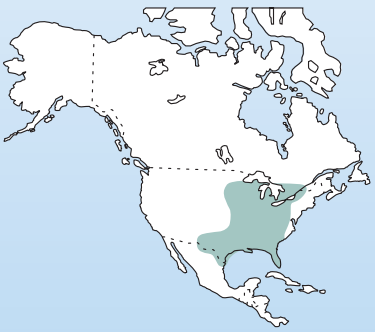


Figure 16–14 Distribution map of the bluegill (introduced to other waters).

FISH PROFILE

Bluegill *(Lepomis macrochirus)*

One of the most common fish in freshwater ponds and lakes is the bluegill. This popular game fish is native to the eastern United States, and its current range extends through the southern states and from Canada to Mexico, see Figure 16–14. Its preferred habitat includes ponds, lakes, swamps, and pools where vegetation is abundant. Its diet consists of small invertebrates (such as worms), insects, and zooplankton.

The sunfish has a very compressed body that is quite deep from top to bottom. It is olive colored on its back and sides with green and yellow dots and narrow black bars marking the sides. Its underparts are colored reddish orange, see Figure 16–15. The males engage in elaborate mating rituals to attract females to their territory. Eggs are deposited in shallow depressions near the shoreline.

Figure 16–15 The bluegill prefers habitats where vegetation is abundant, such as ponds, lakes, swamps, and pools. *Courtesy U.S. Fish and Wildlife. Photo by Eric Engbretson.*

PERCH

Perch and other members of the Percidae family are widely distributed in North America. The Percidae ranks second among North American fish families in the number of different species. The most numerous of these are small fish called **darters**. There are 150 species of these bottom-dwelling fish. They are a major food source for larger fish that live in the same environments.

KEY INTERNET SEARCH WORDS

yellow perch

Perca flavescens

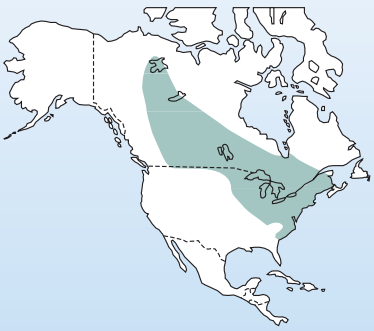


Figure 16–17 Distribution map of the yellow perch (introduced to other waters).

FISH PROFILE

Yellow Perch *(Perca flavescens)*

The yellow perch has a deep, laterally compressed body and a large mouth. Its coloring is greenish brown on the back, with yellow sides and underparts, see Figure 16–16. This fish is found in Atlantic drainages from Central Canada to the northeastern part of the United States, see Figure 16–17. It has also been introduced in many other areas that extend beyond its native range. It inhabits ponds, lakes, and deep pools in streams and rivers. Perch prefer vegetated habitats where they can hide as they stalk their prey. The diet of the perch consists mostly of aquatic insects and animals. Perch grow to lengths of about 16 inches when they are mature.

Figure 16–16 The yellow perch. *Courtesy U.S. Fish and Wildlife. Photo by Duane Raver.*

Some of the most popular game fish in this family are the sauger and the walleye. These are large fish that have the ability to see in the dark. They have special tissue in their eyes known as **tapetum lucidum** that gathers light and gives them their night vision.

INTERNET ADDRESS

http://www.rook.org/earl/bwca/nature/fish/stizostedionvit.html

KEY INTERNET SEARCH WORDS

walleye

Stizostedion vitreum

FISH PROFILE

Walleye *(Stizostedion vitreum)*

The walleye is a large predatory fish up to 36 inches long, with a very large mouth that extends back beyond the middle of the eye. Coloring ranges from yellow to brown on the back with yellowish-blue sides that are marked with dark green, see Figure 16–18.

Walleyes inhabit rivers, lakes, and pools, and they prefer clear water and brushy banks. Immature walleye eat mostly insects, but as they grow older, their diet changes to consist mostly of minnows. They are native to Canada and the central region of the United States, see Figure 16–19. This fish is popular with sportsmen due to its large size and its fighting instinct when it is caught.

Figure 16–19 Distribution map of the walleye.

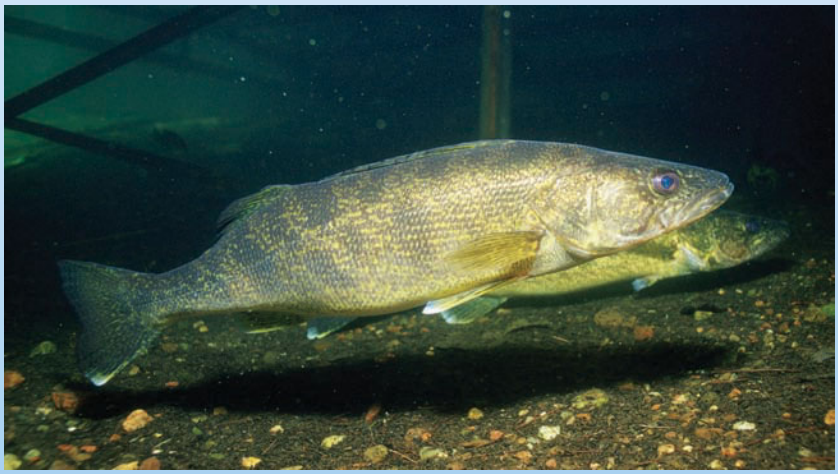


Figure 16–18 The walleye is a large predatory fish. *Courtesy U.S. Fish and Wildlife. Photo by Eric Engbretson.*

TROUT, CHAR, AND WHITEFISH

All of the fish in this group belong to the Salmonidae family. In addition to the freshwater species, there also are several salmonids that migrate to the ocean during certain stages of their lives. These fish will be discussed in a later chapter. The species considered here are strictly freshwater fish.

KEY INTERNET SEARCH WORDS

brown trout

Salmo trutta

FISH PROFILE

Brown Trout *(Salmo trutta)*

The brown trout is a brightly colored fish with an olive-brown back, silvery yellowish-brown sides, and white or yellow underparts. The sides and head are covered with red and black spots, and some of the fins may be orange or red, see Figure 16–20. The males have hooked lower jaws.

These predatory fish live in cold, clean streams and lakes. Their diets consist mostly of insects, small fish, frogs, and other aquatic animals. They were introduced to North America from Europe in 1883, and they now occupy many regions of the United States and Canada. These fish require cool temperatures and **aerated water**, containing high levels of dissolved oxygen. Its favorite habitats are deep pools in fast-moving streams. Reproduction is accomplished by laying eggs in the gravel beds of rivers and streams.

Figure 16–20 The brown trout is a predatory fish that lives in cold, clean streams and lakes. *Courtesy U.S. Fish and Wildlife. Photo by Eric Engbretson.*

The Salmonidae family includes a large number of fish that belong to the same species even though they appear to be distinctly different from one another in their color and markings. They are divided up into similar groups or **races** within the species. The difficulty of classifying these fish is complicated by the many hybrids that have resulted from crossbreeding between species.

KEY INTERNET SEARCH WORDS

rainbow trout

Oncorhynchus mykiss

Figure 16–22 Distribution map of the rainbow trout (introduced to other waters).

FISH PROFILE

Rainbow Trout *(Salmo gairdneri)*

The rainbow trout varies in color from one habitat to another. Those living in lakes are often silver over much of their bodies, while those living in streams may be nearly brown on their backs with yellow to greenish coloring and silvery sheens on their sides, see Figure 16–21.

This fish is native to the Pacific drainage, and it is found in many of the cold-water streams, rivers, and lakes in the region, see Figure 16–22. It also is found in isolated streams in other areas. This is one of the most important fish in North America. It is a popular game fish, and it is raised on fish farms as a commercial fish that is processed for food. Its diet consists of insects, worms, small aquatic animals, and other fish. Reproduction is accomplished by depositing eggs in shallow scrapes in gravel streambeds. The males discharge milt on the eggs to fertilize them.

Figure 16–21 The rainbow trout is a native of the Pacific drainage that is now raised commercially on fish farms. *Courtesy U.S. Fish and Wildlife. Photo by Eric Engbretson.*

Career Option

AQUACULTURIST

AN AQUACULTURIST RAISES domesticated fish for human consumption or use. Such uses may include stocking fishing waters or processing the fish for food. An aquaculturist is responsible for maintaining a high quality water environment for the fish from the time they are placed in the hatchery as eggs until they are mature. A person who pursues this career will require a strong understanding of the sciences associated with aquatic environments and fish culture. Testing water quality and preventing fish diseases are only two of many applied science skills that will be required in this career. A BS degree that includes strong components in business, science, and fish culture is required.

Most of the fish in the Salmonidae family migrate to spawning areas. Those living in lakes and ponds move out of the quiet water and into the flowing streams that are the sources of fresh water. They spawn in clean gravel beds where the eggs are trapped in the rocks and where plenty of well-aerated water is available. Many of these fish retreat back to the lakes when spawning is completed. Fish living in a river often migrate upstream or into the small streams that flow into the river. There they spawn before returning to familiar waters.

KEY INTERNET SEARCH WORDS

mountain whitefish

Prosopium williamsoni

Figure 16–24 Distribution map of the mountain whitefish.

FISH PROFILE

Mountain Whitefish *(Prosopium williamsoni)*

The mountain whitefish has a small mouth, greenish-brown coloring on top, and silvery or white coloring on the underside, see Figure 16–23. It grows as big as 22.5 inches in length. It lives in cold water habitats in lakes and streams, and it is distributed throughout the United States and Canada, see Figure 16–24. These fish live together in large groups called **schools**. Its diet consists of insects, worms, and other small aquatic animals. Reproduction is accomplished by spawning in the sand and gravel bottoms of rivers and streams.

Figure 16–23 Whitefish live together in schools, and they feed on insects, worms, and small aquatic animals. *Courtesy Robert J. Erwin. Photo Researchers, Inc.*

Brook trout and closely related fish are also known as **chars**. During the spawning season, these fish are especially bright in their coloring, with many of them having red coloring on their fins and sides, see Figure 16–25.

KEY INTERNET SEARCH WORDS

brook trout

Salvelinus fontinalis

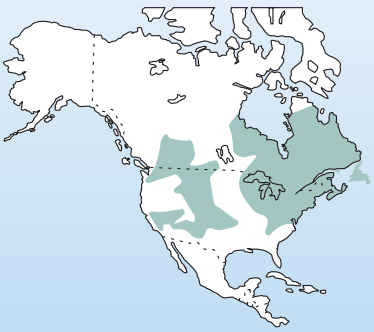


Figure 16–25 Distribution map of the brook trout.

FISH PROFILE

Brook Trout *(Salvelinus fontinalis)*

The brook trout is native to the eastern waters of the continent, and it has been introduced into the waters of the Pacific drainage. These fish live in the cool, flowing waters of creeks and streams. It is a predatory fish, and its diet consists of insects and other aquatic organisms. Other closely related species include the Dolly Varden and the bull trout. Males are brightly colored during the spawning season with bright orange or red on their lower bodies and fins and pink or red spots surrounded by blue highlights on their sides, see Figure 16–26. Spawning occurs in flowing streams where the eggs are deposited in clean gravel on the streambed.

Figure 16–26 The brook trout is native to the eastern waters of the continent. *Courtesy U.S. Fish and Wildlife. Photo by Eric Engbretson.*

KEY INTERNET SEARCH WORDS

arctic grayling

Thymallus arcticus

FISH PROFILE

Arctic Grayling *(Thymallus arcticus)*

The arctic grayling is native to the Arctic, Pacific, and upper Missouri River drainages of North America. It has been widely distributed beyond its native range in the western United States.

Figure 16–27 Arctic grayling.

The grayling has a large dorsal fin on which rows of red and green spots are arranged, see Figure 16–27. It has a small mouth with small teeth on both the upper and lower jaws. The tail or caudal fin is forked, and it is protected with fairly large blue-gray scales on the upper body. This fish prefers clear, cold water in medium to large rivers.

There are other fish in this family that are not discussed in this chapter. They include the salmon and cisco.

PIKE

Pike are members of the Esocidae family of fish. They are vigorous predators that attack and eat other fish, and they are capable of eating fish that are almost as large as themselves. Their jaws are long, and they swallow their prey whole. Pikes are also **cannibalistic**, meaning that they eat other fish of their own kind.

INTERNET ADDRESS

http://www.rook.org/earl/bwca/nature/fish/esox.html

KEY INTERNET SEARCH WORDS

northern pike

Esox lucius

Figure 16–29 Distribution map of the northern pike (introduced to other waters).

FISH PROFILE

Northern Pike *(Esox lucius)*

The northern pike is a large gray fish with a huge mouth lined with sharp teeth, see Figure 16–28. It grows as long as 6 feet, and it has an appetite to match its size. This fish inhabits marshes, rivers, lakes, pools, and ponds that have heavy vegetation growing in and near the water. They use this vegetation for cover as they stalk their prey consisting of fish and other aquatic animals including other pikes. This fish is found in the northern regions of the continental United States and throughout much of Canada and Alaska, see Figure 16–29.

Figure 16–28 The northern pike is a large predatory fish that is capable of eating fish almost as big as itself. *Courtesy U.S. Fish and Wildlife. Courtesy Timothy Knepp.*

The muskellunge or "musky" is very similar to the northern pike, both in its habits and in its appearance. It is a large fish that grows up to 6 feet in length. A popular game fish known as the "tiger musky" is a hybrid produced by musky and northern pike parents. It is a more ferocious hunter than either of the parent species.

STURGEONS

Sturgeons are the largest fish in North America. The white sturgeon has been known to grow to lengths of 20 feet, see Figure 16–30. Sturgeons inhabit large rivers, and they belong to the family Acipenseridae. They are long-lived fish that live up to 75 years. Sturgeons stir up the mud on river bottoms in their search for food. The eggs of sturgeons are used as a delicacy food called **caviar**.

Figure 16–30 The white sturgeon. *Courtesy Shutterstock.*

KEY INTERNET SEARCH WORDS

shovelnose sturgeon

Scaphirhynchus platorynchus

Figure 16–32 Distribution map of the white and shovelnose sturgeon.

FISH PROFILE

Shovelnose Sturgeon *(Scaphirhynchus platorynchus)*

The shovelnose sturgeon has a flat shovel-shaped snout and a sharklike tail. Its mouth is on the underside of the snout, and this fish has four barbels to aid in locating its food, Figure 16–31. It eats aquatic organisms and carrion that it locates in the mud or on the bottom of the river. It is protected by large bony plates called **scutes** that cover its head, back, and sides. The habitat for this sturgeon is the bottom of river channels in flowing water. Sturgeons lay eggs to reproduce. This fish ranges in the Mississippi, Mobile Bay, and Rio Grande drainages, see Figure 16–32.

Figure 16–31 Shovelnose sturgeon.

MINNOWS AND SUCKERS

The minnows make up the largest family of fish—the Cyprinidae. Members of the family are found on every continent, and include 231 species that occur north of Mexico. Many people incorrectly believe that all minnows are small. Some species of minnows are large in size. For example, the grass carp grows to a length of 49 inches. The Cyprinidae includes carp, goldfish, squawfish, shiners, chubs, and many others.

INTERNET ADDRESS

http://animaldiversity.ummz.umich.edu/site/accounts/classification/Cyprinuscarpio.html

KEY INTERNET SEARCH WORDS

common carp
Cyprinus carpio

FISH PROFILE

Common Carp *(Cyprinus carpio)*

The common carp has a long, deep body. Its back is arched with a long dorsal fin, and its belly is somewhat level. This fish has large, dark scales, and mature fish show a dark, metallic green coloring, see Figure 16–33. The carp is reported to grow to a length of 48 inches.

This fish was introduced to North America in 1831 from Europe, and it thrives in slow-moving pools containing organic matter. Its diet consists mostly of plants; however, it also eats aquatic organisms when they are available. Its habit of stirring up mud in the water is thought to cause deaths of more desirable fish species that require clean water to live. It can be found in the quiet waters of rivers, lakes, and ponds throughout the United States and southern Canada.

Figure 16–33 The common carp is a fairly large fish that eats vegetation and aquatic organisms. *Courtesy Shutterstock.*

Some carp are strict vegetarians, and they eat large amounts of aquatic plants. The grass carp was introduced to North America in the 1960s for the purpose of controlling weeds and grasses in ponds, lakes, and waterways. It has become widespread since its introduction, and

some biologists are concerned that some native species that depend on vegetation may have trouble surviving.

Suckers are members of the Catostomidae family. There are 63 species of suckers in North America. The name sucker comes from the feeding habits of these fish. Their mouths are shaped for feeding off the bottoms of streams and lakes, and they eat by sucking small invertebrates into their mouths.

KEY INTERNET SEARCH WORDS

white sucker

Catostomus commersoni

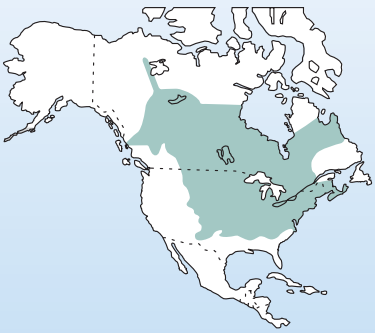


Figure 16–35 Distribution map of the white sucker (introduced to other waters).

FISH PROFILE

White Sucker *(Catostomus commersoni)*

The white sucker is black to olive brown on the back and sides, and it has light-colored underparts. Its mouth is located on the underside of the head with the upper and lower lips shaped for sucking up food, see Figure 16–34. Its diet consists of aquatic organisms and plant materials gathered from the bottoms of streams, lakes, and ponds. This fish is distributed widely in North America, see Figure 16–35. It lives in habitats ranging from small creeks to large lakes, and it sometimes grows to lengths of 25 inches. It reproduces by spawning in the substrate material of flowing streams.

Figure 16–34 The white sucker gathers food from the bottom of the stream or lake by sucking the particles into its mouth. *Courtesy A. Rider. Photo Researchers, Inc.*

Many of the minnows and suckers are considered to be trash fish, because they are not very desirable for human food, and they tend to be more competitive than some of the more useful fish. The net result is that populations of desirable fish decline while the populations of trash fish increase. They do, however, serve an important role as food fish for larger game fish that are more useful to the human population.

LOOKING BACK

Freshwater fish include all of the fish that live in nonsalt water environments. Each species has adapted to the living conditions found in its habitat. The great variety of fish is evidence of the diversity of the freshwater habitats that are found in North America. In this chapter, we learned about the most common freshwater fish, including the sunfish, catfish, trout, perch, pike, sturgeon, minnows, and suckers. Each group of fish plays important roles in the biomes of North America.

Chapter Review

DISCUSSION AND ESSAY

1. List the characteristics that distinguish freshwater habitats from marine habitats.
2. Illustrate and label the external anatomy of a fish.
3. Describe the spawning process by which fish reproduce.
4. Name some freshwater habitats and describe ways that each is different from the others.
5. Create a chart listing each of the fish families considered in this chapter. List their preferred habitats, diets, sizes, and identifying characteristics.
6. Explain how hybrids occur among similar fish, and describe how hybridization complicates the process of identifying fish species.
7. Describe how the anatomies of different fish are modified to accommodate their feeding habits.
8. Suggest some factors that should be considered before new species of nonnative fish are introduced to a water environment.

MULTIPLE CHOICE

1. The characteristic that determines whether a water supply is classified as freshwater is the:
   a. Mineral content
   b. Oxygen content
   c. Temperature
   d. Salt content

2. A term that describes the structure of a living creature such as a fish is:
   a. Anatomy
   b. Taxonomy
   c. Tapetum lucidum
   d. Hybrid

3. Which of the fins of a fish also is called the tail?
   a. Caudal fin
   b. Posterior dorsal fin
   c. Pectoral fin
   d. Dorsal fin

4. The bullhead is a member of which family of fish?
   a. Sunfish
   b. Perch
   c. Catfish
   d. Char

5. Organs that are used by some fish to provide a sense of touch are called:
   a. Operculi
   b. Lateral lines
   c. Roe
   d. Barbels

6. Which of the following fish families is described as being laterally compressed?
   a. Catfish
   b. Char
   c. Sunfish
   d. Trout

7. The offspring of matings between fish of different species are called:
   a. Barbels
   b. Hybrids
   c. Bullheads
   d. Char

8. Which of the following fish families includes the greatest number of species?
   a. Sunfish
   b. Perch
   c. Sturgeons
   d. Minnows

9. Which of the following statements is not true of the fish known as darters?
   a. It belongs to the perch family
   b. It is a bottom-dwelling fish
   c. It is a food fish for larger species of fish
   d. It is correctly classified as a minnow

10. A special tissue in the eyes of some fish that gives them night vision is called the:
   a. Tapetum lucidum
   b. Milt
   c. Operculum
   d. Caviar

11. Which of the following terms is used to describe brook trout and other closely related fish?
    a. Pike
    b. Skute
    c. Char
    d. Grayling

12. A large group of fish that live together is called a:
    a. Skute
    b. School
    c. Flock
    d. Race

13. The eggs of sturgeon are used to make a delicacy food called:
    a. Roe
    b. Jelly
    c. Caviar
    d. Sushi

Learning Activities

1. Identify a freshwater environment near the school, and design a water quality study to determine the characteristics of the water over a period of several weeks. Contact a state agency (the Department of Environmental Quality, the Department of Water Resources, and so on) that deals with water quality and ask for instructions on water sampling techniques. Gather weekly samples, and measure factors that affect water quality. Involve the students in every aspect of this activity. Prepare charts and written reports, and present your findings to the community. Enter the project in the Agriscience Student competition sponsored by the National FFA Organization, and in science fairs.
2. Develop a community plan to protect and/or to improve the water quality of the site that you selected for your water assessment study. Implement your plan.

CHAPTER

17

Anadromous and Diadromous Fish

After completing this chapter, you should be able to:

- define the difference between anadromous, diadromous, and catadromous species of fish
- name some common anadromous fish in North America, and describe their life cycles
- explain the spawning process that is common among anadromous fish
- discuss the effects that silty water might have on live fish eggs
- appraise the positive and negative effects of the drawdown plan as a method for increasing endangered populations of salmon
- evaluate the roles of fish hatcheries in maintaining populations of fish
- suggest ways that the anadromous fish are able to find their way back to the stream where their lives began
- consider reasons why anadromous steelhead trout grow larger than freshwater rainbow trout of the same species.

Some of the fish in North America hatch in freshwater streams from which they migrate to the ocean. A fish that migrates between freshwater and marine habitats is classed as a diadromous fish. A fish that migrates up a river from the sea to spawn is called an anadromous fish. After reaching maturity, these fish leave the ocean, and migrate up rivers and streams to spawn. They then return to the same streams in which their lives began. A freshwater fish that migrates to the ocean to spawn is known as a catadromous fish. A fish that is capable of spawning more than one time is an iteroparous fish.

KEY TERMS

diadromous fish
anadromous fish
catadromous fish
iteroparous fish
redd
alevin
yolk sac
yolk-sac fry
yolk
fry
fingerling
smolt
barging
wild stock
hatchery stock
anadromy
kelt
jacks
steelhead
ichthyology
leptocephali
elver

An anadromous fish lives its life in two very different environments. The early part of its life cycle is spent in the freshwater environment of a stream or river. Female fish make nests in the gravel for their eggs by rolling on their sides and churning the gravel with their tails. This nest is called a **redd**. The female lays her eggs in the nest as the male discharges sperm or milt on them. The female then covers them with gravel to protect them while they develop in the egg, see Figure 17–1.

The eggs are held in position in the flowing stream by falling into the spaces between the stones in the gravel. It is important for the gravel in spawning areas to be free from silt. Silt tends to coat the egg surfaces, preventing the eggs from absorbing oxygen from the water. Under such conditions, the live eggs suffocate and die.

The fertilized eggs hatch into tiny fish called **alevins**. In this immature stage of growth, a structure called a **yolk sac** is attached to the underside of the alevin, and a newly hatched fish is also known as a **yolk-sac fry**, see Figure 17–2. The yolk-sac is a membrane containing a highly nutritious substance called yolk that is obtained from the egg. The **yolk** sac shrinks as the yolk is used to nourish the alevin. When it is gone, the alevins emerge from the redds, and they begin to search for food. In this stage of maturity, alevins are also called **fry**.

As the fry grows, it is called a **fingerling**. It may be called by this name until it is about a year old. At

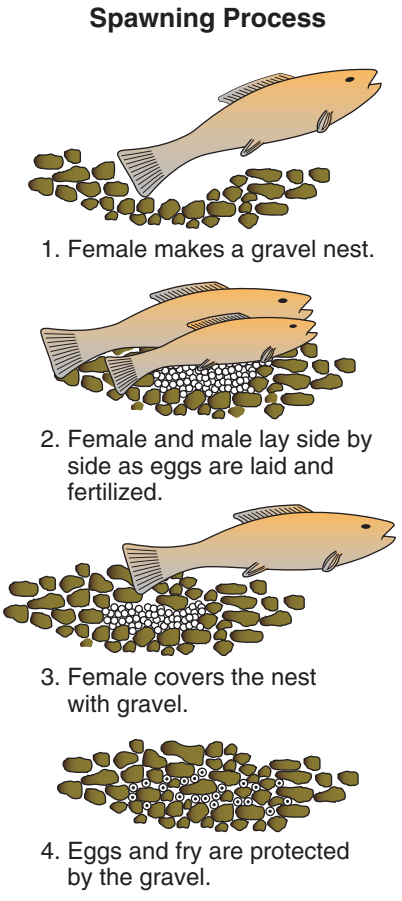


Figure 17–1 The spawning process of anadromous fish.

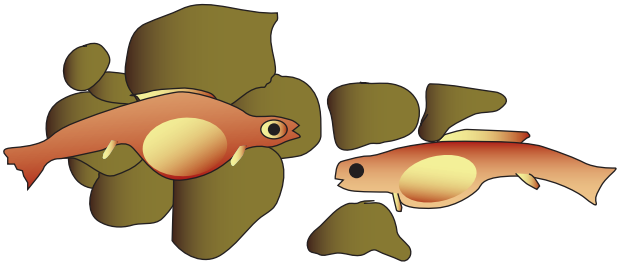


Figure 17–2 Yolk-sac fry.

KEY INTERNET SEARCH WORDS
salmonid life cycle

INTERNET ADDRESS

http://www.yoto98.noaa.gov/books/salmon/salmon3.htm

KEY INTERNET SEARCH WORDS
smolt, migration, predation

about 2 years of age, when the young fish is ready to migrate to the ocean, it is a smolt. During this phase of development, its body adjusts to enable it to maintain its body fluids while living in a salt water environment.

The migration of smolts to the ocean is the most dangerous time in the life cycles of anadromous fish. During this migration they are often eaten by predatory fish such as the squawfish. They also have trouble migrating through the backwaters of dams that have been constructed on many major rivers. The smolts face upstream during their migration down the river, see Figure 17–3. In this position, they depend on water currents to carry them, and they often experience difficulty moving through the slack water behind the dams, see Figure 17–4.

One management practice that is used to assist migrating smolts is known as **barging**. Smolts are collected above a dam and placed in large river vessels called barges, see Figure 17–5. River water flows through the interior of a barge to maintain a constant water environment. The barges are transported below the dams through the

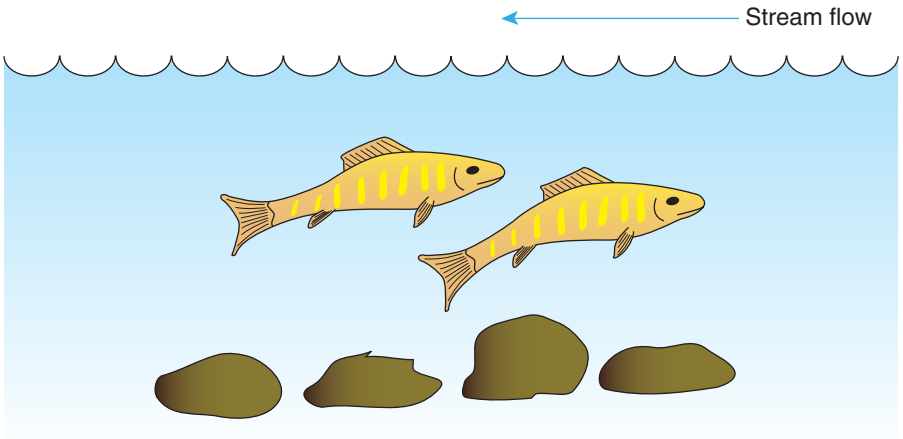


Figure 17–3 Smolts face upstream as they migrate to the ocean. They are carried by the flowing water.

KEY INTERNET SEARCH WORDS
smolts, barging, transport

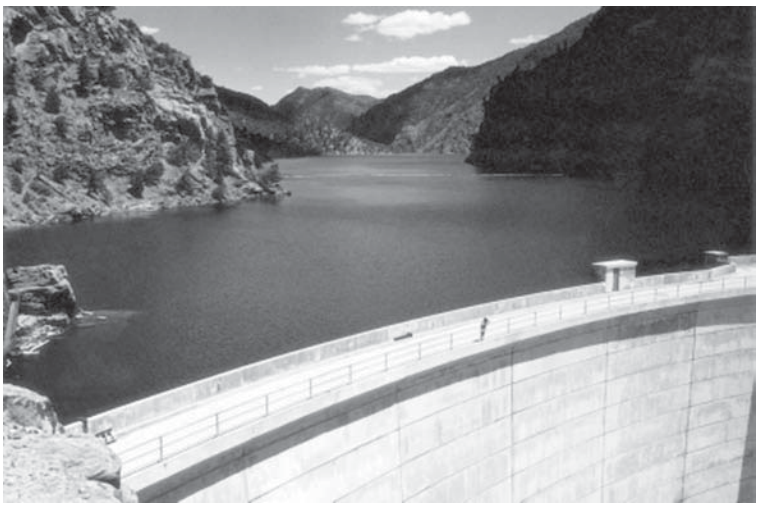


Figure 17–4 Smolts depend on water currents to carry them to the ocean during their migration. Slack water behind dams create problems for the migrating smolts because the current is interrupted and their movement is impaired. *Courtesy Bureau of Reclamation, U.S. Department of the Interior.*

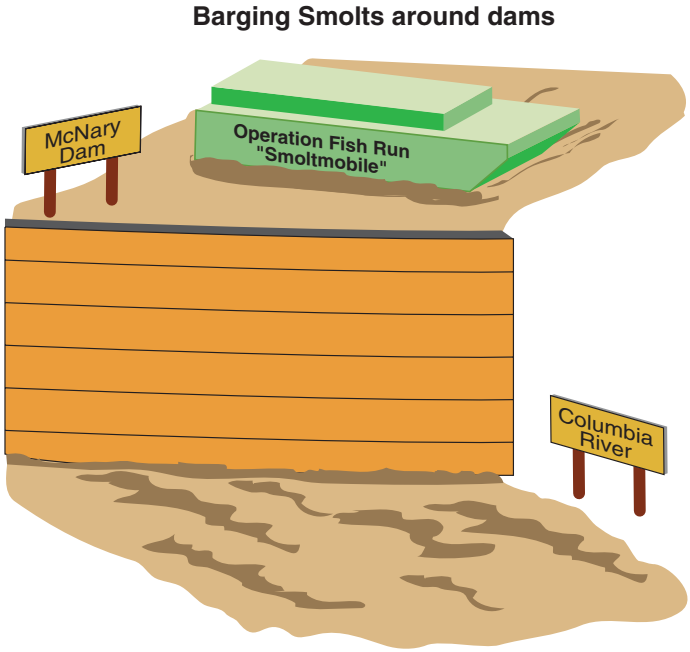


Figure 17–5 To assist migrating smolts through the slack water behind dams, they are sometimes collected above the dam, placed in barges, and transported below the dam to continue their migration.

shipping locks that enable ocean-going ships to pass the dams. The smolts are released back into the river below the dams to continue their migration to the ocean.

Anadromous fish usually remain in the ocean for 1–6 years, where they grow and mature. When they are mature, they begin the long journey back to their freshwater birthplaces to spawn, see Figure 17–6. These fish possess powerful homing instincts that guide them as they return to the streams where their lives began. Along the way, a migrating fish must find its way past dams, river rapids, and fishermen. Some of them are also caught and eaten by predators such as seals, eagles, bears, otters, and humans.

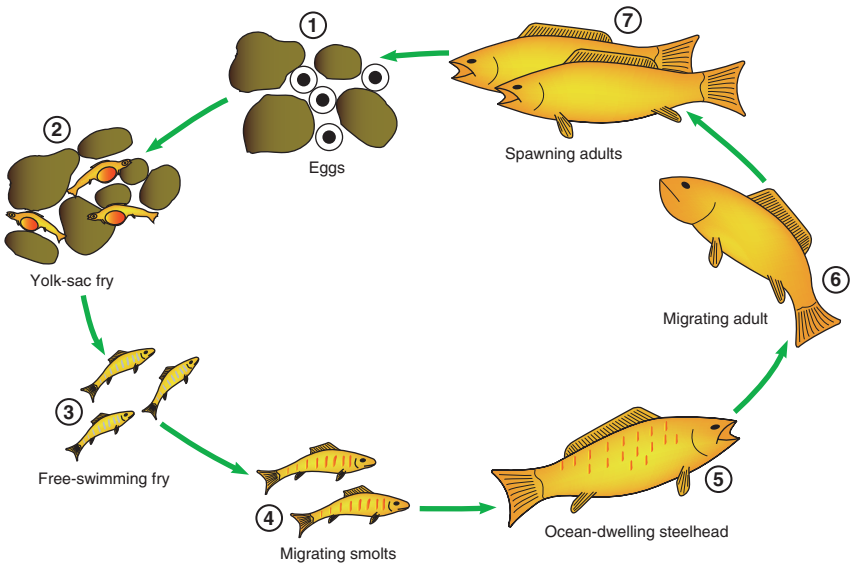


Figure 17–6 The life cycle of anadromous fish.

KEY INTERNET SEARCH WORDS
salmon recovery plan

ECOLOGY PROFILE

Salmon Recovery Plan

A management practice for sockeye salmon known as the drawdown plan created great controversy among people affected by its use. It is the practice of releasing water from the dams in the lower river system and flushing large amounts of water down the river channel from water storage reservoirs on the upper end of the river system. This practice was attempted in the Columbia River system in 1994. The purpose of a drawdown is to carry young smolts to the ocean more quickly in the fast water, improving their chances of survival during migration. The controversies over this practice arise for several reasons. One problem that occurs is that riverbanks and structures are damaged by the drawdowns. Commercial shipping on rivers is halted. Great economic losses are incurred by people in the shipping industry and by people who use ships and barges to transport goods to the coast. Water that is stored for the purposes of generating electrical power and irrigating crops goes into the ocean instead. The cost to implement the drawdown plan was estimated to be more than $350 million per year. This does not include any of the losses from agriculture, commerce, or the generation of electrical power. Proponents of the drawdown believe that the economic benefits of healthy salmon runs will make up for the other losses to the area's economy. The tourism industry flourishes in river communities when strong runs of anadromous fish occur. Controversy is also generated as mature fish migrate up the rivers. Offshore fishing fleets and sportsmen along the Columbia River are allowed to harvest substantial numbers of mature fish before they reach their inland spawning areas. Citizens are divided over the issue of whether the use of drawdowns to aid recovery of salmon runs can be justified when the economic losses incurred by the plan are so high. Although a team of scientists has suggested that the drawdown plan is the best alternative to improve salmon recovery, drawdowns have not become the "method of choice" to aid migrations of anadromous fish.

In addition to the hazards encountered during migration, offshore fishing fleets have contributed to reduced fish populations and to the endangered status of some anadromous species. The populations of most species of migrating fish have declined in recent years.

KEY INTERNET SEARCH WORDS
fish hatchery practices

Two populations of anadromous fish now exist. One population includes **wild stock** that spawn naturally in rivers and streams. The other is made up of **hatchery stock** that has been spawned and raised in artificial environments in fish hatcheries. These fish can be distinguished from one another by the clipped adipose fins of hatchery stocks of fish. Government agencies and power utilities have developed fish hatcheries along major rivers, and these are used to supplement

the wild fish populations, see Figure 17–7. Mature adult fish are trapped as they arrive back in their spawning areas, see Figure 17–8. The eggs from these females are fertilized with milt from the males, and the eggs are placed in trays. Fresh, cold water is directed over them to provide oxygen and to maintain a constant temperature until they hatch, see Figure 17–9.

The young fish are raised in long fish runs or tanks until they are about 1 year of age, see Figure 17–10. These hatchery-raised smolts are then released to streams and rivers to migrate to the ocean.

Figure 17–7 Fish hatcheries are used to supplement the wild fish populations. *Courtesy Rick Parker.*

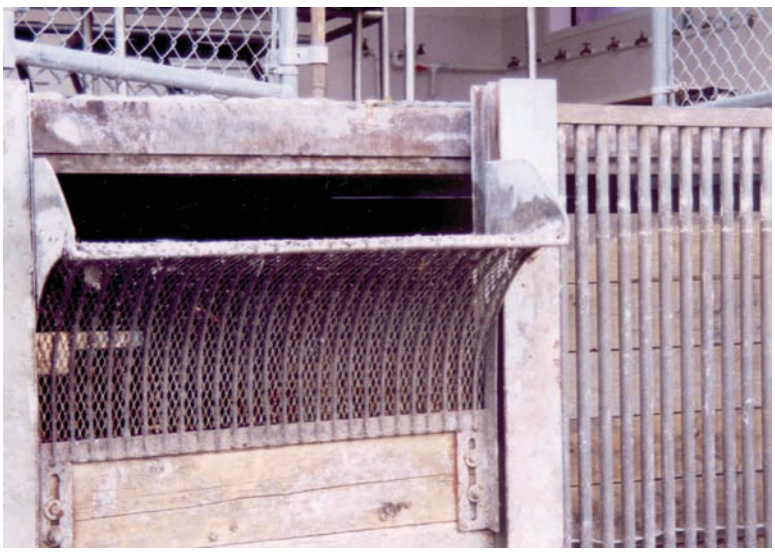


Figure 17–8 A fish trap.

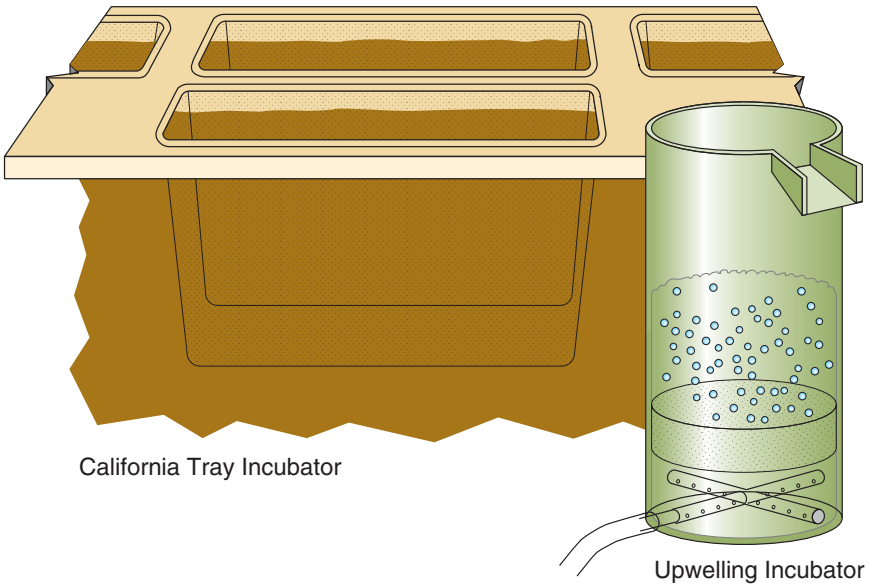


Figure 17–9 Fresh river water is directed over incubating eggs to provide them with the proper amount of oxygen and to maintain a constant temperature.

Figure 17–10 Young smolts are raised in tanks until they are about a year old.

SALMON

Salmon belong to the Salmonidae family of fish. They are close relatives of freshwater species of trout and whitefish. These fish are found in the coastal waters and rivers along the Atlantic and Pacific coasts of North America.

Salmon and other anadromous fish migrate to the ocean where they grow and mature to become adults. When they mature sexually, they return to the rivers of their birth to reproduce the next generation of their species. The process by which they return to their home waters is called **anadromy**. Along the way, their bodies must adjust from a

KEY INTERNET SEARCH WORDS
homing instincts
anadromous fish

saltwater to a freshwater environment. Much of their body tissue is broken down and used as a source of nutrients and energy during the long swim up the rivers and streams to their birth sites.

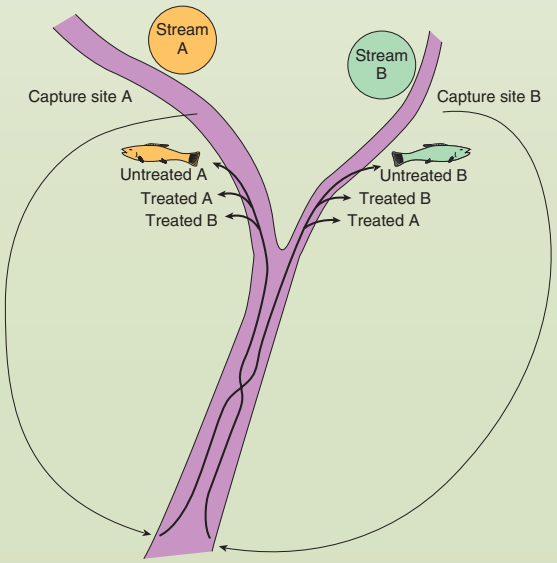
When anadromous fish enter their home rivers, they quit eating, and their bodies begin the process of producing eggs or milt. As the migrations are completed and the time for spawning approaches, the fish become brighter colored. The males of most species tend to be more colorful than the females.

The migrations up the rivers to the spawning streams deplete the energy and strength of these fish. After they spawn, they become weak. The Atlantic salmon usually recovers and returns to the ocean after spawning. None of the Pacific salmon are known to survive after they spawn. Steelhead trout, however, frequently survive after they have spawned. Populations of salmon have been reduced due to pollution of streams, rivers, and coastal waters.

ECOLOGY PROFILE

Homing Instinct of Anadromous Fish

It has been demonstrated that adult fish locate their rivers of origin by the smell of the water. This theory was tested by two scientists who captured salmon from two different branches of the Issquah River in the state of Washington. Half of the fish from each branch had their nasal sacs plugged with cotton. The fish then were taken back down the river and released. The untreated fish returned to the same branches of the river in which they were originally captured. Those fish with plugged nasal sacs were not able to locate their home waters, and approximately, half of them returned to the wrong branch of the river.



INTERNET ADDRESS

http://www.fishingnet.com/salmon_recognition.htm

KEY INTERNET SEARCH WORDS

Atlantic salmon
Salmo salar

Figure 17–12 Distribution map of the Atlantic and pink salmon.

FISH PROFILE

Atlantic Salmon *(Salmo salar)*

The Atlantic salmon is a long, streamlined fish that reaches up to 55 inches in length. It has silver sides with brown, green, or blue coloring on its back, and the males have a hooked lower jaw, see Figure 17–11. Colors become darker when these fish enter freshwater, and they often develop red spots on their bodies as the time for spawning approaches. These fish range along the Atlantic coast where they feed on shrimp and other marine animals. They enter coastal rivers and streams during the fall season to spawn, see Figure 17–12. Their eggs are deposited in the gravel substrate where they are fertilized by the males. Young fish live in freshwater for 2–3 years before entering the ocean where they remain for a year or more. Then, they migrate back into the rivers to spawn, but return to the ocean when spawning is complete. Atlantic salmon are classified as interoparous, meaning that they are capable of spawning more than one time. A post-spawn salmon that remains in freshwater is called a **kelt**. It is also known as a *black salmon*.

The Atlantic salmon used to be an important commercial fish, and in some instances, it has been harvested beyond its capability to reproduce. Some of the rivers and streams that used to be included in the range of this species are no longer populated by them. The U.S. Fish and Wildlife Service and the National Marine Fisheries Service placed the wild population of this fish on the endangered species list in November, 2000, where it remains.

Figure 17–11 The Atlantic salmon feeds on shrimp and other small marine animals. *Courtesy U.S. Fish and Wildlife Service. Photo by William W. Hartley.*

Anadromous North American Salmons
Atlantic Ocean:
Atlantic Salmon
Pacific Ocean:
Chinook Coho Pink Chum Sockeye

Figure 17–13 There are five species of Pacific salmon and one Atlantic species.

There are five known species of Pacific Salmon. They are the chiook, Coho, pink, chum, and sockeye salmons, see Figure 17–13. These are valuable commercial fish that are harvested in coastal regions from the Arctic to California. The sockeye salmon is included in the discussion of endangered species in Chapter 5, "Our Wildlife Resources." They live their first year in freshwater, and then spend from one to several years in the ocean before returning to their spawning areas. After they spawn, they die.

KEY INTERNET SEARCH WORDS

chinook or king salmon

Oncorhynchus tshawytscha

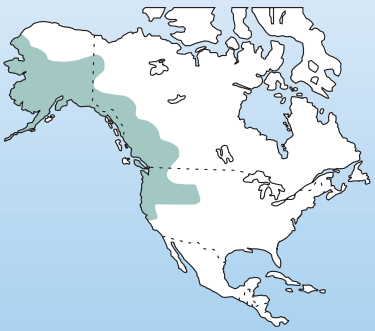


Figure 17–15 Distribution map of the king or chinook salmon.

FISH PROFILE

Chinook or King Salmon *(Oncorhynchus tshawytscha)*

The chinook or king salmon is the largest salmon, and it usually weighs 30–50 pounds, though some are much larger. It is blue, gray, or green with black spots on the back, and it has reddish sides and silver underparts, see Figure 17–14. The diet of the king salmon includes fish, shrimp, and other marine organisms. It ranges in the Pacific and Arctic Ocean drainages of North America, see Figure 17–15, and it has been successfully stocked in the Great Lakes. It is the least abundant of the Pacific salmon. This salmon returns to its home river to spawn, and it dies soon afterward.

Figure 17–14 Chinook salmon. *Courtesy U.S. Fish and Wildlife Service. Photo by Dave Menke.*

KEY INTERNET SEARCH WORDS

pink salmon

Oncorhynchus gorbuscha

FISH PROFILE

Pink Salmon *(Oncorhynchus gorbuscha)*

The pink salmon is metallic blue to blue green with large black spots on the back and on the caudal fin. Males often have a pink or brown stripe down their sides. They are silver underneath, and they grow to lengths of 30 inches. The males develop hooked upper jaws and humped backs, see Figure 17–16. This salmon occupies coastal ocean and stream habitats from California to the arctic region, see Figure 17–12. It has also been successfully introduced to Lake Superior and to Newfoundland. Its diet consists of fish, shrimp, and other marine organisms. It dies soon after it spawns.

Figure 17–16 The pink salmon migrates to its home river to spawn, and it dies soon afterward. *Courtesy Peter Scoones. Photo Researchers, Inc.*

KEY INTERNET SEARCH WORDS

sockeye salmon

Oncorhynchus nerka

FISH PROFILE

Sockeye Salmon *(Oncorhynchus nerka)*

The best known salmon among the Pacific species is the sockeye. It is the most important of all the salmon species to the salmon fishing industry. This is because of the firm reddish flesh that retains its quality when it is processed and canned. The quality of the meat from this fish is thought to be closely related to its diet of shrimp and other crustaceans.

It is believed that the name of this fish comes from the Indian name "sukkai," which was used by the natives of the British Columbia region of Canada. While the fish lives in the ocean, it is silver colored sprinkled with small black speckles. As it moves into freshwater to spawn, it changes in color to various shades of red, and the males develop large teeth and hooked jaws.

After hatching, this fish migrates to a downstream lake where it lives for up to 3 years before migrating downstream to the ocean. Most of them return to their home rivers to spawn at 4–6 years of age. Those in the far northern region may wait to return until they are 7–8 years of age. Some races of sockeye do not venture very far from the ocean to spawn; however, a few races travel hundreds of miles inland to their home waters. This salmon is native to the Pacific ocean and its rivers.

KEY INTERNET SEARCH WORDS

Coho salmon

Oncorhynchus kisutch

FISH PROFILE

Coho Salmon *(Oncorhynchus kisutch)*

An adult Coho salmon is silver colored with a metallic blue back and black spots, see Figure 17–17. During the spawning phase, both males and females develop a bright green back with red sides and hooked jaws. During their 2 year stay in the ocean, they change from a diet in the first year of insects, herring, sand lance copepods (crustaceans), crab larvae, and similar species to a diet of squid, herring, sand lance, and large zooplankton in the second year. Most of their growth occurs during the second year.

These salmon stay in coastal streams for 2 years before migrating to the ocean as smolts. Many remain close to the coast, but some go far out to sea during their ocean-going phase of life. They range along the Pacific coast from California to Alaska with most of them concentrated between the mouth of the Columbia River to the Cook Islands in southern Alaska. Some Coho males return to spawn after only 1 year in the ocean. These are called **Jacks**, and they are somewhat smaller than those that wait 2 years before returning to fresh water.

Figure 17–17 The Coho salmon. *Courtesy Thomas & Pat Leeson. Photo Researchers, Inc.*

STEELHEAD

The **steelhead** is a race of large rainbow trout that migrates to the ocean from freshwater streams at about 2–3 years of age. Steelhead usually remain in the ocean for 1–3 years before returning to spawn in the rivers and streams where they were hatched. It is believed that the abundant supply of food that is available in the ocean contributes to the large size of the steelhead.

KEY INTERNET SEARCH WORDS

anadromous, steelhead trout

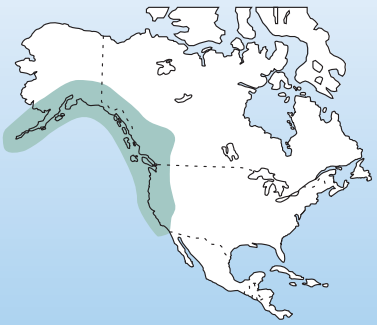


Figure 17–19 Distribution map of the steelhead.

FISH PROFILE

Steelhead *(Salmo gairdneri)*

The steelhead is an anadromous rainbow trout. It grows to lengths of 18–40 inches. It is silver colored with a bluish tint on the back, small black spots on the fins and back, and a pink or reddish side stripe, see Figure 17–18.

These fish are native to the streams, rivers, and coastal waters in the Pacific coast region of North America, see Figure 17–19. They have been transplanted to other waters including inland lakes. The diets of the steelhead consist of aquatic insects, worms, crustaceans, and small fish.

Figure 17–18 A steelhead trout. *Courtesy Shutterstock.*

Different races of steelheads are known. Each spawns at different times of the year, and each differs in size from one another. Each race returns to its spawning area at a predictable time. The eggs require 4–7 weeks to hatch, depending on the temperature of the water in which they develop.

The Fish and Game agencies of several states define a steelhead as any rainbow trout that is over 20 inches long. The name "steelhead" also has been used in the past for other kinds of ocean-run trout, such as the brook trout, cutthroat trout, and brown trout.

STRIPED BASS

The striped bass belongs to the Moronidae family of fish. It is an anadromous fish that spends most of its life in a marine environment; however, it migrates far upstream to spawn in coastal rivers. This fish is a native of the Atlantic coastal waters. It was transplanted to the Pacific coast in 1879 and 1882, see Figure 17–20, and has since reproduced and populated the Pacific coast from Vancouver Island, British Columbia to Baja California, Mexico.

Career Option

ICHTHYOLOGIST

ICHTHYOLOGY IS THE BRANCH OF zoology that deals with the classification, structure, and life cycles of fish. An **ichthyologist** is a scientist who studies fish. Ichthyologists are employed for fish management in marine and freshwater fisheries, hatcheries, and commercial fish farms. Other ichthyologists serve as curators of scientific collections of fish in museums and educational institutions. Employment in this field requires a graduate degree in the biological sciences. A master's degree will sometimes suffice in fish management positions; however, a doctorate is usually required of curators.

KEY INTERNET SEARCH WORDS

anadromous striped bass

Morone saxatilis

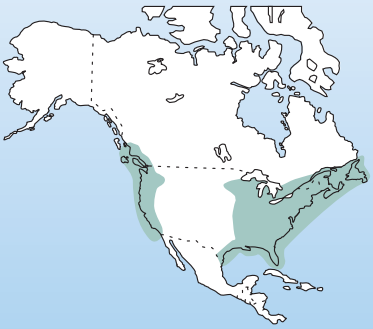


Figure 17–20 Distribution map of the striped bass.

FISH PROFILE

Striped Bass *(Morone saxatilis)*

The striped bass can be identified by its dark olive to bluish gray color on the back and six to nine gray stripes on its silvery sides, see Figure 17–21. It is a large fish that grows as long as 79 inches, and it has been known to weigh over 70 pounds at maturity. They are predatory fish that feed on smaller fish and other marine organisms.

Striped bass move into freshwater environments to spawn in the spring of the year. The females become sexually mature at about 5 years of age. Males mature by 2 years of age, and they are about half the size of the females when they spawn. In many areas where striped bass have been introduced, they have mated with white bass, and hybrids of these two species are quite common.

Figure 17–21 The striped bass is native to the Atlantic coast. It was transplanted to the Pacific coast more than 100 years ago. *Courtesy U.S. Fish and Wildlife Service.*

SHAD

Shad are anadromous fish that are native to the Atlantic seacoast of North America, where their range extends from Newfoundland to Florida. They have also been introduced to Pacific coastal waters where they now range from Alaska to California, see Figure 17–22.

Shads are members of the herring or Clupeidae family. They are deeper-bodied fish than most herrings, and they swim together in large schools. They spend most of their lives in the ocean, and they only enter freshwater habitats to spawn. Their diets consist mostly of plankton that are strained from the water.

KEY INTERNET SEARCH WORDS

American shad

Alosa sapidissima

Figure 17–22 Distribution map of the American shad.

FISH PROFILE

American Shad *(Alosa sapidissima)*

The American shad ranges in color from green to blue on the back with silver sides tinged with yellow. Its fins are light green or clear. A bluish black spot is evident in the upper gill area aligned with one or two rows of smaller spots, see Figure 17–23. These fish enter coastal rivers to spawn in the spring, and they prefer large rivers with open water. Shad live in vast schools, and they feed on plankton. They grow as long as 24 inches with mature fish weighing about 2 pounds.

Figure 17–23 The American shad. *Courtesy of U.S. Fish and Wildlife.*

FRESHWATER EELS

Freshwater eels are members of the Anguillidae family. They are fish that lack pelvic fins, and their scales are so small that they are seldom noticed. They are 3–5 feet in length, and they inhabit rivers and lakes in the eastern regions of North America. The females migrate up streams

and rivers along the Atlantic coast where they remain for as long as 15 years before they return to the ocean to spawn. Males tend to remain in saltwater environments and in streams near the ocean. Some eels are capable of traveling short distances over land to other bodies of water.

KEY INTERNET SEARCH WORDS

American eel

Anguilla rostrata

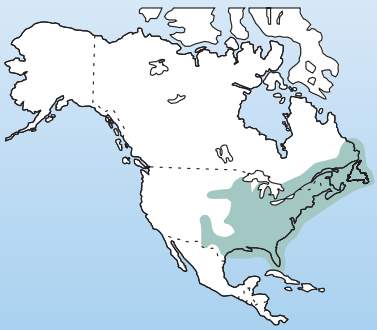


Figure 17–25 Distribution map of the American eel.

FISH PROFILE

American Eel *(Anguilla rostrata)*

The American eel is a long, snakelike fish with a long dorsal fin that extends around the tail and merges with the anal and caudal fins. This eel ranges in color from brownish green to yellow on the back, and it fades to light yellow or white on the belly, see Figure 17–24. It inhabits the rivers and coastal waters along the Atlantic coast of North America, see Figure 17–25, and ranges as far inland as the midwestern states.

A young eel's diet consists mostly of small crustaceans and insects. It expands to worms, frogs, fish, clams, and crabs as the eel grows larger. They also eat dead animals that they find in their aquatic environment.

Figure 17–24 The American eel inhabits rivers and waters along the Atlantic coast. *Courtesy Nature's Images. Photo Researchers, Inc.*

The freshwater eel is a catadromous fish because it migrates down freshwater streams to spawning areas in the Sargasso Sea. Adults die soon after spawning, and their larva-like offspring, called **leptocephali**, spend the next year migrating back to the streams of North America. Along the way, their bodies change to look like young eels, at which

time they are called **elvers**. They reach maturity shortly after this time, and the females return to freshwater rivers. The males remain in salty or brackish coastal waters.

LOOKING BACK

Anadromous fish migrate up freshwater rivers from the ocean to spawn. Catadromous fish spend their adult lives in freshwater environments, and they migrate down the rivers to spawn in the ocean. Diadromous fish include fish that migrate between freshwater and saltwater habitats in either direction. Iteroparous fish are capable of spawning more than one time. Anadromous North American fish include members of the Salmonidae (salmon and steelhead), the Clupeidae (shad), and the Moronidae (striped bass) families. The Anguillidae (freshwater eel) family is catadromous.

Chapter Review

DISCUSSION AND ESSAY

1. Define the difference between anadromous, diadromous, and catadromous species of fish.
2. Name some anadromous fish found in North America.
3. Describe the life cycle that is typical of anadromous fish such as the salmon, steelhead, and ocean-run basses.
4. Contrast the life cycle of a catadromous fish such as a freshwater eel with that of an anadromous fish.
5. Describe the spawning process that is common among anadromous fish.
6. Discuss the effects that silty water conditions might have on live fish eggs that have been spawned in freshwater streams.
7. Appraise the positive and negative effects of the drawdown plan as a recovery method for endangered populations of salmon.
8. Evaluate the roles of fish hatcheries in maintaining populations of fish.
9. Describe how anadromous fish are able to find the streams where their lives began.
10. Suggest a reason why ocean-run steelhead trout grow larger than rainbow trout of the same species that live in freshwater habitats.

MULTIPLE CHOICE

1. A fish that migrates up a river from the sea to spawn is a/an:

   a. Catadromous fish
   b. Fingerling
   c. Smolt
   d. Anadromous fish

2. A fish that has recently hatched from an egg is a:

   a. Smolt
   b. Fry
   c. Fingerling
   d. Smelt

3. Which sense does an anadromous fish depend upon to find the river of its birth?

   a. Sight
   b. Smell
   c. Hearing
   d. Touch

4. Which of the following is not a species of Pacific Salmon?

   a. Chinook
   b. Coho
   c. Sockeye
   d. Steelhead

5. The largest species of salmon is the:

   a. Chinook
   b. Coho
   c. Pink
   d. Chum

6. The steelhead is a race of ocean-going fish of what kind?

   a. Salmon
   b. Trout
   c. Bass
   d. Shad

7. The branch of zoology that deals with the classification, structure, and life cycles of fish is called:

   a. Entomology
   b. Ichthyology
   c. Taxonomy
   d. Botany

8. Which of the following fish is a member of the herring family?

   a. Shad
   b. Striped Bass
   c. Steelhead
   d. Salmon

9. Leptocephali are the larva-like offspring of which of the following diadromous fish?

   a. Shad
   b. Bass
   c. Eel
   d. Chum

10. A term that applies to a young eel is:

   a. Chum
   b. Shad
   c. Coho
   d. Elver

Learning Activities

1. Take a field trip to a fish hatchery and observe the process of raising fish in this protected environment. Have each of the students take field notes containing their observations. Make certain that the students know what they can expect to see before they arrive, and help them develop a set of questions that they can ask the tour guide. Assign each student to prepare a written report on the tour activity using the field notes that each has prepared. If you do not have a fish hatchery available to you, contact your state Fish and Game agency for a guest lecturer or a video.
2. Obtain some fish scales and observe them under a microscope. Determine the ages of the fish from which the scales were obtained by counting the annual growth rings on the scale.
3. At the conclusion of this unit of study, divide the class into two groups and conduct a debate on the use of barging and/or the drawdown salmon recovery plan as management tools for aiding the recovery of endangered or threatened salmon populations. Students should prepare fact sheets before engaging in debate.

CHAPTER

18

Saltwater Fish and Fauna

Saltwater fish and fauna include the fish and all of the other animals that live in estuaries and oceans. Their bodies are adapted to living in salty environments. The oceans are rich in nutrients in comparison with freshwater environments, and most marine animals are able to find abundant food supplies.

After completing this chapter, you should be able to:

- describe the characteristics of a marine biome
- identify the factors that contribute to differences in marine environments
- evaluate the roles of sharks and rays in the marine ecosystems of North America
- define the roles of mackerel, tuna, and marlins in the ocean environments of North America
- speculate about the environmental factors that may have contributed to the body shape and anatomy of flatfish
- explain the roles of food fish such as herring and codfish in the food web
- specify the roles of smelts and similar fish in marine ecosystems
- evaluate the roles of sea bass and groupers in saltwater habitats
- identify the characteristics that distinguish mollusks from other marine animals, and define their roles in marine environments
- name four important crustaceans and identify their distinguishing characteristics.

KEY TERMS

fauna
cartilaginous fish
egg case
torpedo
pelagic
billfish
flatfish
sinistral fish
dextral fish
camouflage
isospondylous fish
demersal spawner
larva
smelt
hermaphrodite
bivalve
antenna
compound eye
swimmeret

A marine biome is a water environment in which the salt content is 3–3.7 percent. It is the world's large biome. Oceans cover 71 percent of the earth's surface, and because they are connected to one another, organisms may pass from one ocean to another.

Many different environmental conditions exist in the ocean, see Figure 18–1. Water temperatures are different in the arctic regions as compared to southern waters. Water pressure is much less in shallow waters and near the surface than it is at depths of several hundred feet. Food supplies vary in different depths of the oceans due to the lack of penetration of sunlight into the deeper strata. The amount of salt varies in the upper layers of the oceans, and salt content also is affected by proximity to large rivers of freshwater. These differences provide environments for many kinds of saltwater fish and other marine fauna.

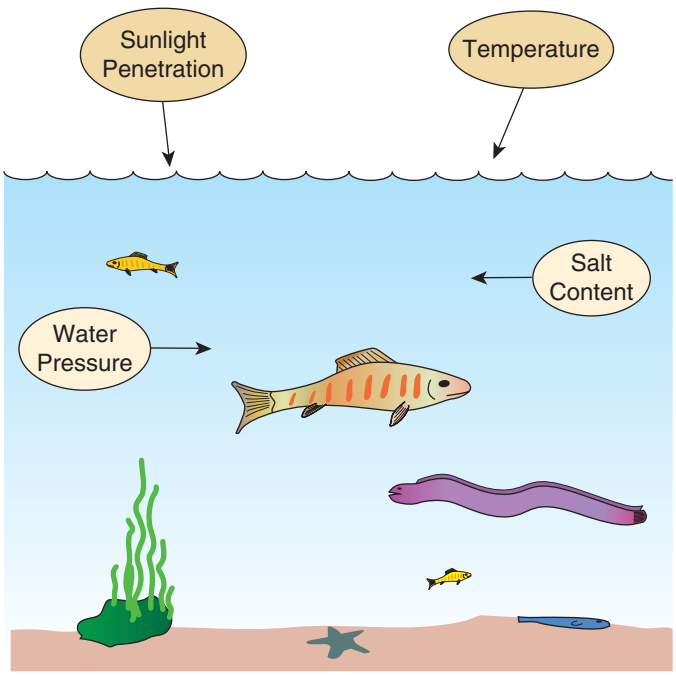


Figure 18–1 Factors affecting marine environments.

SHARKS, SKATES, AND RAYS

The sharks and rays belong to a classification called **cartilaginous fish**. Their skeletons are composed of hard cartilage instead of bone. Cartilage is a tough elastic tissue that enables more freedom of movement than bone. Sharks and rays are also unusual because they have five to seven gill slits located on each side of their heads.

Most sharks are moderate in size; however, the whale shark is the largest of all the fish. It belongs to the Rhincodontidae family, and individuals can reach as long as 60 feet. It eats plankton that it sieves out of the seawater, along with small fish and crustaceans.

KEY INTERNET SEARCH WORDS

whale shark

Rhincodon typus

FISH PROFILE

Whale Shark *(Rhincodon typus)*

The whale shark is the world's largest fish. It grows to lengths of 18 meters, and it has a broad head and a mouth with tiny, hooked teeth. Three rows of ridges extend along its back on each side. This shark varies in color from dark gray to reddish or greenish brown with light-colored spots on its upper body. Its belly is white or yellow, see Figure 18–2.

Figure 18–2 A whale shark is the largest of the world's fish. *Courtesy Shutterstock.*

Figure 18–3 Distribution map of the whale shark.

Whale sharks range throughout warm regions near the Atlantic and Pacific coasts and in the Gulf of Mexico, see Figure 18–3. They reproduce by laying eggs. The diet of this shark consists of plankton that are gathered as the shark swims near the ocean's surface. The shark takes in a large mouthful of water and expels it through its gills. Plankton are filtered out of the water by the gills, and swallowed.

Sharks are probably the most feared fish known to man. This is because some sharks are ferocious predators, and although attacks on humans are rare, they have been regularly documented. Sharks have several rows of sharp teeth that are used to kill and to cut their prey into bite-size chunks. Their teeth are really enlarged scales that are soon replaced with new ones when they break or fall out. One of the best known sharks is the white shark. It is a member of the Lamnidae family, and it is also called the great white shark.

INTERNET ADDRESS

http://www.enchantedlearning.com/subjects/sharks/species/Greatwhite.shtml

KEY INTERNET SEARCH WORDS

white shark

Carcharodon carcharias

Figure 18–5 Distribution map of the white shark.

FISH PROFILE

White Shark *(Carcharodon carcharias)*

The white shark is a large predator of the sea that eats seals, sea lions, birds, turtles, some shellfish, other sharks, and many kinds of fish. It is a large shark, up to 30 feet long, with coloring that blends from near black or slate on its back to white on its underparts, see Figure 18–4. It has large triangular teeth with serrated edges. White sharks are found in temperate to tropical seas on both North American coasts, see Figure 18–5. White sharks are **ovoviviparous**, giving birth to live offspring after they hatch from eggs inside the mother. Baby sharks are capable predators at birth.

Figure 18–4 The white shark is a large predator of the sea. *Courtesy Michael Patrick O'Neill. Photo Researchers, Inc.*

Sharks range in length from less than a foot up to 60 feet. They also vary greatly in their manner of reproduction, see Figure 18–6. Some sharks are oviparous, and the females expel **egg cases** from their reproductive tracts. Other species such as the sand tiger sharks are ovoviviparous, since the eggs of the female remain inside her body as the young develop and until they have hatched. Still other sharks are viviparous, and give birth to live young. In all of these cases, reproduction requires the internal fertilization of the eggs or ova with the sperm of male sharks.

Figure 18–6 The manner of reproduction varies among the shark species.

Shark Reproduction		
Oviparous	**Ovoviviparous**	**Viviparous**
• Female lays eggs	• Eggs hatch inside female • Young sharks expelled	• Female gives birth to live offspring

Figure 18–7 Distribution map of the sand tiger shark.

FISH PROFILE

Sand Tiger Shark *(Carcharias taurus)*

The sand tiger shark is an Atlantic coast species that belongs to the Carchariidae family. It ranges from Maine to Florida, see Figure 18–7, and lives in shallow waters on both sides of the Atlantic Ocean. It is a light-colored shark with numerous dark spots on its sides, see Figure 18–8.

Figure 18–8 The sand tiger shark. *Courtesy Shutterstock.*

Females become sexually mature when they are about 7 feet in length. These sharks are ovoviviparous and only two young are born at a time. After young sharks hatch in each half of the female's uterus, they become cannibalistic and eat any remaining eggs that have not yet hatched.

KEY INTERNET SEARCH WORDS

sand tiger shark

Carcharias taurus

Rays and skates are fish with flattened bodies, long thin tails, and large winglike pectoral fins. Like the sharks, they have skeletons made of hardened cartilage. They are found in North American coastal waters in both the Atlantic and Pacific Oceans. They live on the seafloor where they eat shellfish.

Some of the rays and skates are very unusual. The stingray, for example, (Dasyatidae family) has a deadly poisonous spine on its tail which it uses to defend itself. Electric rays (Torpedinidae family) are able to emit an electrical shock to their enemies. The sawfish (Pristidae family) is a sharklike ray that is equipped with a long projection on its snout with teeth along both sides like a saw blade. Skates (Rajidae family) have wide pectoral wings with which they appear to "fly" through the water.

KEY INTERNET SEARCH WORDS

Pacific electric ray

Torpedo californica

FISH PROFILE

Pacific Electric Ray *(Torpedo californica)*

Figure 18–9 The Pacific electric ray is sometimes called a torpedo. *Courtesy Gregory Ochocki. Photo Researchers, Inc.*

The Pacific electric ray, sometimes called a **torpedo**, is a smooth-skinned, disk-shaped fish, see Figure 18–9. Its upper body is in various shades of gray, and the underparts are lighter colored. The females are larger than males and can reach 4½ feet in length and weigh up to 90 pounds. This species is ovoviviparous, meaning that the young hatch from eggs inside the mother's body before they are born. Litter size is 17–20 young, with females giving birth every 2 years.

This ray often buries itself in the sand on the seabed. It uses a powerful electric shock to discourage its enemies and to paralyze its prey. It eats halibut, herring, shellfish, and other fish.

MACKEREL, TUNA, AND MARLINS

Mackerel, tuna, and marlins are large, streamlined fish that are very fast swimmers. They are surface feeders that swim together in large schools as they chase other fish to the water's surface. By hunting in this way, they are able to surround and catch the fish that they depend upon for food.

KEY INTERNET SEARCH WORDS

chub mackerel

Scomber japonicus

FISH PROFILE

Chub Mackerel *(Scomber japonicus)*

Chub mackerel are green or blue on their upper bodies with numerous vertical bars on their sides that blend to a silvery color on their undersides, see Figure 18–10. They are small fish in comparison with related species such as the tuna. Most mature chub mackerel are 16–18 inches in length. They are caught in large numbers by commercial fishermen.

Chub mackerel are **pelagic** fish, meaning that they inhabit the open ocean. They feed mostly on plankton; however, they also eat fish and crustaceans. They are found in temperate ocean waters in many parts of the world, but they are most abundant in the Pacific Ocean from Alaska to Mexico. Chub mackerel are also known as Pacific Mackerel because of their abundance in the Pacific region.

Figure 18–10 The chub mackerel is a fish that inhabits the open ocean.

Mackerel and tuna belong to the Scombridae family of fish. They occupy most temperate and tropical oceans, and they are found both inshore and offshore. They are migratory fish that travel north in the summer and south in the winter, following the migration patterns of the fish that make up their diets. Tuna is an important human food. The tuna diet includes plankton, crustaceans, and other fish. They are unusual among fish because their body temperature is higher than the surrounding water.

KEY INTERNET SEARCH WORDS

albacore tuna

Thunnus alalunga

FISH PROFILE

Albacore *(Thunnus alalunga)*

The albacore is a premium quality commercial tuna. It is abundant in the Pacific Ocean with a smaller population found in the Atlantic Ocean. It is a migratory species that prefers pelagic habitat and lives in schools. It prefers warm tropical or subtropical waters.

Albacore are bright blue in color on their upper bodies. They are shaded to silvery white on their underparts, and they have long pectoral fins, see Figure 18–11. At maturity, they are about 4½ feet in length and usually weigh 75–80 pounds.

Figure 18–11 The albacore is an important species to commercial fishing fleets.

A group of fish that is closely related to the tuna and mackerel is the Istiophoridae family. In the members of this family, which includes the marlins, sailfish, spearfish, and swordfish, the upper jaw is long, forming a swordlike bill. These fish also are known as **billfish**, and they are highly prized as gamefish.

KEY INTERNET SEARCH WORDS

blue marlin

Makaira nigricans

FISH PROFILE

Blue Marlin *(Makaira nigricans)*

The blue marlin is a large fish that can reach lengths of 11 feet or more. Large members of this species have been observed that weigh over 1,800 pounds. This fish is brown to dark blue on top and white or silver underneath with vertical bar markings on its sides, see Figure 18–12.

Blue marlins are found in both the Atlantic and the Pacific Oceans, although the Atlantic specimens are smaller. They are surface feeders that can swim as fast as 50 miles per hour. Blue marlins eat other fish, including blackfin tuna and frigate mackerel, along with squid and other pelagic fish. They use their bills to strike and kill their prey. Little is known about the reproduction of these fish.

Figure 18–12 The blue marlin is a highly prized game fish. *Courtesy Shutterstock.*

FLOUNDER, HALIBUT, AND SOLE

The flounder, halibut, sole, and similar fish are members of an order of **flatfish**, the Heterosomata. These fish spend most of their lives lying on the ocean bottoms. Their bodies are flattened to accommodate this adaptation, and both eyes are located on the upper side of the head.

The eggs of flatfish float in the water until they hatch. Soon after hatching, the bodies of the young fry begin to change. The eye on the "blind side" of the head migrates across to the other side of the head, and the dorsal fin grows forward. One of the pectoral fins often grows larger than the other, and the young fish sink to the bottom of the ocean where they lie on their blind sides.

KEY INTERNET SEARCH WORDS

dover sole

Microstomus pacificus

Figure 18–13 Distribution map of the Dover sole.

FISH PROFILE

Dover Sole (*Microstomus pacificus*)

The Dover sole is a flatfish that is considered to be among the best flavored fish for human consumption. It is a slender, right-eyed flatfish that is found in Pacific waters from Alaska to Mexico, see Figure 18–13. This fish spawns in deep ocean waters but lives most of its life on the continental shelf. It is brown in color on the upper side, and gray on the blind side. This fish is somewhat soft and limp with a small mouth in comparison to other species of soles, see Figure 18–14. It averages 12 inches in length. Its mouth lies underneath its head, which suits it well for bottom feeding.

Figure 18–14 The Dover sole is a bottom-dwelling fish with both eyes on the same side of its head.

Some species of flatfish are always lefteyed. They are known as **sinistral fish**, and they belong to the Bothidae family of fish. Others are always righteyed. They are called **dextral fish**, and they belong to the Pleuronectidae family. Some species, such as the starry flounder, may be either sinistral or dextral even though they are classed as right-eyed flatfish.

KEY INTERNET SEARCH WORDS

Pacific sanddab

Citharichthys sordidus

Figure 18–16 Distribution map of the Pacific sanddab.

FISH PROFILE

Pacific Sanddab (*Citharichthys sordidus*)

The Pacific sanddab is the most common sinistral or left-eyed flounder. Its coloring is light brown mottled with dark brown, and some individuals have yellow or orange spots. The blind side of this fish ranges from white to tan in color, see Figure 18–15. The Pacific Sanddabs are found from Alaska to Mexico, see Figure 18–16, and they are popular food fish. They often bury themselves in the sediment on the ocean floor with only their eyes uncovered. They feed on crustaceans and small fish.

Figure 18–15 The Pacific sanddab is a left-eyed flat fish. *Courtesy Getty Images. Photo by Jeff Foott*

Flatfish are carnivorous fish that eat bottom-dwelling marine animals such as squids, crustaceans, and a variety of fish. In turn, the flatfish are eaten by other predatory fish, and many species are significant to commercial fisheries. Some flatfish use a method of protection against their natural enemies known as **camouflage**. They are able to change their coloring to blend with the color of the seabed.

INTERNET ADDRESS

http://www.bcadventure.com/adventure/angling/game_fish/halibut.phtml

KEY INTERNET SEARCH WORDS

Atlantic, Pacific halibut
Hippoglossus hippoglossus
Hippoglossus stenolepis

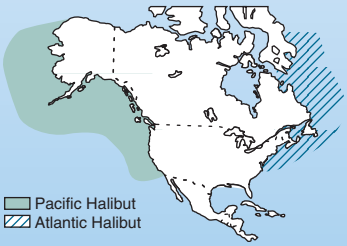


Figure 18–18 Distribution map of the Atlantic and Pacific halibut.

FISH PROFILE

Atlantic Halibut *(Hippoglossus hippoglossus)* Pacific Halibut *(Hippoglossus stenolepis)*

Figure 18–17 The Atlantic or Pacific halibut are large fish that weigh up to 400 pounds.

The Atlantic and Pacific halibut are large dextral or right-eyed fish that have been known to reach lengths of 8 feet and weights of 400 pounds. The Atlantic halibut tends to live longer and reach larger average sizes than the Pacific species. Both of these halibuts have flattened shapes; however, they are more plump than most other flatfish. They are generally dark colored on their upper surfaces and white on their blind sides, see Figure 18–17.

Like other flatfish, both eyes of a halibut are on the same side of its head. The halibut is different from other flatfish, however, because it has a normal-shaped mouth. The jaws of halibut are not twisted like those of the flounders. During their first year of life, halibut feed on plankton. As they grow larger, they feed on small shrimplike organisms and small fish. Fish, along with crabs, clams, herring, octopus, and smaller halibut, become more important in their diets as they mature.

Halibut thrive in cold and temperate oceans, see Figure 18–18.

HERRING

The herring and their relatives are the most important food fish in the world. They are members of an order of fish known as **isospondylous fish**. These fish are similar in that the vertebrae near the head are the same as the vertebrae located in the tail. This group includes such well known fish as herring, salmonids, tarpon, sardines, anchovies, and shad.

Herring belong to the Clupeidae family of fish, and 175 different species of herring are found in the oceans of the world. Different races of herring also are identified within some of the species. These fish are surface feeders that eat floating plankton.

Herring form vast schools of fish that tend to move in a counter clockwise rotation in the Northern Hemisphere. The movements within these schools of fish are coordinated, and when they change the direction in which they are swimming, they do it together.

KEY INTERNET SEARCH WORDS

Pacific, Atlantic herring
Clupea pallasi
Clupea harengus

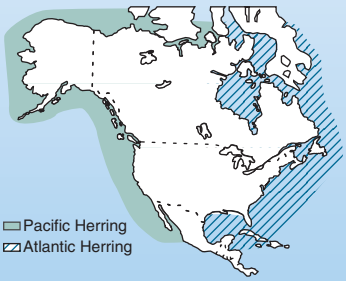


Figure 18–20 Distribution map of the Atlantic and Pacific herring.

FISH PROFILE

Pacific Herring *(Clupea pallasi)* and Atlantic Herring *(Clupea harengus)*

The Pacific and Atlantic herring are olive to bluish green on top with silver-colored underparts and forked tails, see Figure 18–19. As a group, herring may be the most important fish on earth because of the vast amounts of food that they provide for humans and for predatory animals. They average only about 12 inches in length, but billions of them are harvested or preyed upon every year.

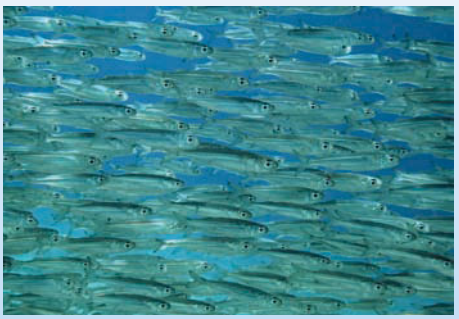


Figure 18–19 The Atlantic and Pacific herring are food fish that humans and predators depend upon. *Courtesy Peter Scoones. Photo Researchers, Inc.*

The Pacific herring is considered by some scientists to be a population of Atlantic herring located in the Pacific Ocean, see Figure 18–20. Their diets consist of plankton obtained from the ocean surface.

Herring are known as **demersal spawners** because they attach their eggs to weeds and other materials on the ocean floor. Herring that spawn in deep water are protected by this behavior, but when spawning activity occurs in shallow water, large numbers of predators are drawn to the area to eat the eggs and catch the spawning fish.

Career Option

MARINE BIOLOGIST

A CAREER IN MARINE BIOLOGY involves the study of animals and plants that live in saltwater environments. This includes the effects that environmental conditions such as light intensity, salinity, temperature, pollutants, and other factors have on marine organisms. This career requires an advanced science degree with emphasis on the biological sciences. Field work is an important aspect of this career.

Some of the other important species of North American herring include the skipjack herring that is found in the Gulf of Mexico and in freshwater habitats of the Mississippi River and its eastern tributaries. The alewife is a herring that inhabits the Atlantic coast from Newfoundland to North Carolina.

CODFISH

Codfish are second in importance to herring as food fish. They are members of the Gadidae family, and they inhabit the cold and temperate waters of all of the oceans. These fish live on the ocean bottom where they feed on small fish and squid.

KEY INTERNET SEARCH WORDS

Atlantic codfish

Gadus morhua

FISH PROFILE

Atlantic Codfish *(Gadus morhua)*

The Atlantic codfish averages 10–12 pounds and seldom exceeds 60 pounds. It is a plump, elongated fish with specked olive green to brown coloring. This codfish has a single barbel under its chin that is used as a feeler, see Figure 18–21.

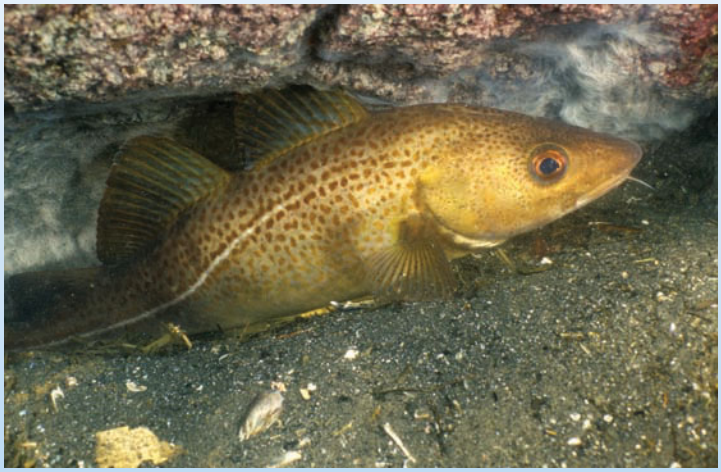


Figure 18–21 The Atlantic codfish is a plump, elongated fish with a single barbel under its chin that is used as a feeler. *Courtesy Andrew J. Martinez. Photo Researchers, Inc.*

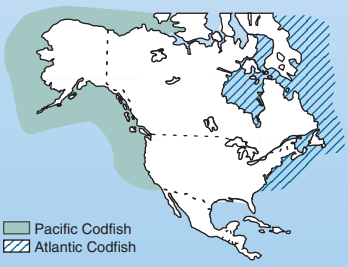


Figure 18–22 Distribution map of the Atlantic and Pacific codfish.

This codfish is found on both sides of the North Atlantic Ocean, see Figure 18–22. It grows rapidly, and many fish of this species are 15 inches long by the time they are 2 years of age. They migrate south in the winter season where they spawn in mid-ocean beginning at about 5 years of age. Large females lay up to 5 million eggs; only a few survive to maturity.

Codfish usually spawn during the winter months, and each female is capable of laying several million eggs. The eggs float until they hatch.

The newly hatched, immature fry are called **larva**, and they float near the water's surface with the plankton deposits. When they are about 1 inch long, they sink to the bottom.

KEY INTERNET SEARCH WORDS

Pacific codfish

Gadus macrocephalus

FISH PROFILE

Pacific Codfish *(Gadus macrocephalus)*

The Pacific codfish has a gray to brown upper body with pale areas and spots of brown on its sides and back. Its underparts are light colored, and it has a small barbel on its chin, see Figure 18–23. It also is known as the gray cod. This fish is distributed throughout the cold waters of the Pacific Ocean from Alaska to California, refer to Figure 18–22. It is an important commercial fish that seldom exceeds 35–40 inches in length.

Figure 18–23 The Pacific codfish is also known as the gray cod.

A close relative of the codfish that is important in the Atlantic region is the haddock. This fish occupies many of the same areas as the codfish, and like other fish in this family, it also is an important food fish.

Figure 18–24 Distribution map of smelts.

SMELTS

Smelts are small, slender fish that live together in schools. They are members of the Osmeridae fish family. These fish are important in North American ecosystems because they provide a dependable food supply for larger fish, seals, and cormorants. Most smelts are marine, but some are anadromous. These fish are found on both coasts of the North American continent and in much of the cold arctic region, see Figures 18–24 and 18–25.

Figure 18–25 Smelts provide food for many larger marine animals. *Courtesy North Dakota Game and Fish Department.*

SEA BASS AND GROUPERS

The sea bass and groupers belong to the Serranidae family. They are important food fish, as well as being carnivores that feed on crustaceans and small fish. Much of their time is spent on the ocean floor looking for food. These fish have large mouths and sharp teeth that equip them well for their predatory roles.

KEY INTERNET SEARCH WORDS

snowy grouper

Epinephelus niveatus

Figure 18–27 Distribution map of the snowy grouper.

FISH PROFILE

Snowy Grouper *(Epinephelus niveatus)*

The snowy grouper is a reddish brown fish with white spots and a large mouth, see Figure 18–26. It inhabits the Atlantic Ocean, where it is found in warm and temperate seas, see Figure 18–27. A similar species, *Epinephelus niphobles*, commonly known as the star studded grouper, is found along the Pacific Coast south from Baja California, Mexico. This fish has often been misidentified as a snowy grouper.

Snowy groupers live on rocky ocean bottoms where they feed on crustaceans, cephalopods, fish, and gastropods. This fish grows up to 4 feet long in the Atlantic Ocean, but it seldom reaches more than 31 inches in the Pacific Ocean.

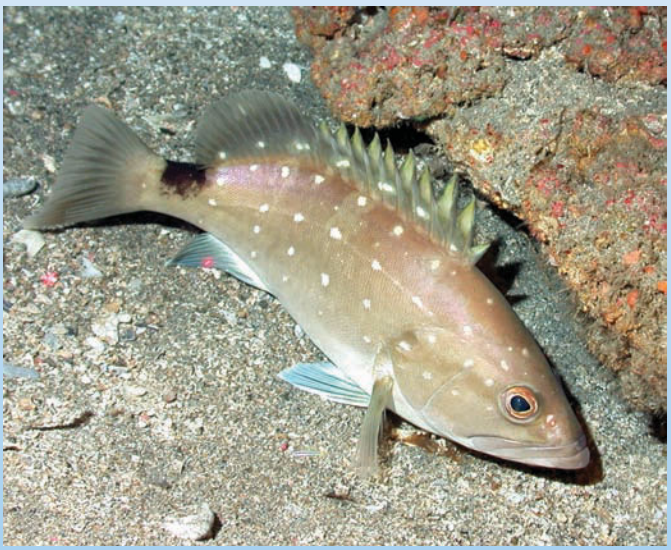


Figure 18–26 The snowy grouper is a carnivore that feeds on crustaceans and small fish.

Most of the members of the Serranidae family are less than a foot long, although a few of them attain lengths of 4 feet. Most of these fish are **hermaphrodites**, meaning that the same fish has the sex organs of a male and a female at the same time. These species tend to function as females when they are small and as males when they become larger.

KEY INTERNET SEARCH WORDS

spotted sand bass

Paralabrax maculatofasciatus

Figure 18–28 Distribution map of the spotted sand bass.

FISH PROFILE

Spotted Sand Bass *(Paralabrax maculatofasciatus)*

The spotted sand bass is a popular sport fish found off the coast of Southern California southward to Mexico and the Gulf of California, see Figure 18–28. It is a bottom-dwelling fish that occupies water from the shoreline to depths of 200 feet. It has a wide range of tolerance for water temperature; it lives in water temperature as low as 45 degrees and as high as 90 degree Fahrenheit. It is often found in bays and harbors.

This fish is brown to olive colored on the upper body with light-colored underparts. It has bar markings on the back and sides and round black spots on its fins and body, see Figure 18–29. Mature males weigh approximately 5 pounds.

Figure 18–29 The spotted sand bass is a popular sport fish that is found along the Pacific coast of California and Mexico.

MOLLUSKS

The mollusks make up one of the largest phyla of organisms in the animal kingdom. This group of invertebrates include the slugs, snails, bivalves, squids, octopuses, and cuttlefish. All of these animals have soft bodies; however, many of them are protected by shells. Slugs and snails belong to a class known as Gastropoda. Each of these organisms moves about on a muscular foot.

Animals known as **bivalves** are organisms with a shell of two parts, or valves, that are hinged together. A well-known member of this group is the clam, see Figure 18–30. Other members of this group of mollusks are the mussels, scallops, and oysters. These animals obtain food by sucking seawater through their bodies, from which they strain food particles.

Figure 18–30 The clam is an example of a bivalve organism.

The movement of water through their bodies also flushes wastes from their systems. All of the bivalves live in either freshwater or seawater.

Another class of mollusks is the Cephalopoda. Its best-known members are squids, octopuses, and cuttlefish. The head of a cephalopod is surrounded by 8–10 arms. Each arm is equipped with sucking organs that are used to capture prey for food. They are also capable of hiding from their enemies by discharging clouds of ink into the water or by changing their coloring to match their backgrounds.

KEY INTERNET SEARCH WORDS

squid
cuttlefish
octopus

Many different species of squids have been identified. Squids have eight arms, like those of the octopus, and two additional tentacles that are longer than the other eight, see Figure 18–31. Their bodies are supported by an internal plate. These animals move about by drawing water into their bodies and forcing it out at the back of the head. This propels them through the water. The squid's diet consists of fish and crustaceans. Among the unusual characteristics of squids are their internal shells, the ability of some to produce light from special cells, and the unusual blue color of their blood.

Figure 18–31 The squid has two tentacles that are longer than the other eight. *Courtesy Shutterstock.*

The octopus is a cephalopod with eight arms and a round, short body, see Figure 18–32. Octopuses range widely in size. The Pacific octopus is the largest, with a span up to 33 feet. Some species of octopuses live in deep water, while others live among the rocks in shallow coastal waters. They eat crustaceans and small fish. Unlike the squids, octopuses have no internal shell.

Figure 18–32 The octopus has eight tentacles it uses to capture prey. *Courtesy Scott Camazine. Photo Researchers, Inc.*

The cuttlefish is similar to both the octopus and the squid. It has two long tentacles and eight arms, and its body contains a chalk-like plate containing gas-filled cells that increase its buoyancy. The largest of these animals spans more than 5 feet, the smallest less than 2 inches. Like the squid and octopus, it catches prey with the suckers on its tentacles.

CRUSTACEANS

Crustaceans are marine animals that have exoskeletons and several pairs of jointed limbs. They belong to the phylum Arthropoda, which also includes insects, spiders, centipedes, millipedes, and scorpions. The best known marine crustaceans are the shrimps, crabs, and lobsters. However, the most numerous are tiny animals called plankton. Crustaceans provide a food supply for many of the fish and other animals that are found in the oceans. Their respiration occurs using gills that take oxygen from the water.

Crustaceans molt or shed their hard outer shells as they grow. These exoskeletons are replaced with larger ones that provide their bodies more room. Some crustaceans may lose legs or pincers during escapes from natural enemies or in battles with others of their species. These limbs are replaced with new ones when they molt. Shrimps include a number of small crustaceans that are similar in appearance and in their habits. They have two pairs of **antenna** located on their heads that serve as sensing organs or feelers. They also have five pairs of legs, see Figure 18–33. Some species spend daylight hours buried in the sand or mud, and they feed at night. Shrimp eat many kinds of small aquatic animals, as well as seaweed.

INTERNET ADDRESS

http://www.enchantedlearning.com/subjects/invertebrates/crustacean/shrimp.shtml

KEY INTERNET SEARCH WORDS

crustacean
shrimp

Figure 18–33 Shrimp are crustaceans that shed their outer shells as they grow. *Courtesy USDA*.

Crabs are animals with four pairs of legs, a pair of pincers, a flattened shell, and a broad abdomen, see Figure 18–34. Some of them live in seawater; others live in freshwater. Most crabs breed in marine habitats even when they must migrate from freshwater areas to do so. Some crabs eat only plant materials, while others eat only meat. Still other crabs are scavengers that eat nearly anything consisting of organic material.

INTERNET ADDRESS

http://www.enchantedlearning.com/subjects/invertebrates/crustacean/Hermitcrab.shtml

KEY INTERNET SEARCH WORDS

Crustacean

crab

Figure 18–34 The crab has four pairs of legs and a pair of pincers. *Courtesy U.S. Fish and Wildlife. Photo by Dan Boone*.

Lobsters are among the large crustaceans. They are strange-looking animals, with **compound eyes** made up of many simple eyes that function together. They live on rocky seabeds near the shore, and they eat several kinds of prey, including other lobsters, mollusks, crabs, and small fish.

Lobsters have four pairs of walking legs and one pair of pincers. Their shells are dark green or blue, but they turn red when they are cooked. Lobsters also have other appendages called **swimmerets** that are located on their undersides, see Figure 18–35. These are used to propel the lobsters forward. The powerful tail is used to propel the lobster backward. Freshwater relatives of lobsters with similar anatomy are the crayfish. They are found in many freshwater habitats in North America.

INTERNET ADDRESS

http://www.stemnet.nf.ca/CITE/oceanlobsters.htm#Lobsters

KEY INTERNET SEARCH WORDS

lobster

Figure 18–35 The lobster is considered to be a delicacy food. *Courtesy Shutterstock.*

Numerous tiny crustaceans live in the oceans of the world and float on the water's surface with other microscopic plants and animals. These life-forms are grouped together and called plankton. Many of the fish and other marine animals depend on plankton for food. Some of the whales are able to strain enough plankton from the water to survive and to grow at extremely rapid rates. The tiny planktonic crustaceans may be the most important of all the crustaceans because they provide such a massive volume of food to other living creatures.

There are many marine organisms that are found in the ecosystems of North America that have not been included in this book. The most well-known fish and marine animals have been used here as representatives of the many other kinds of organisms that are found in marine environments.

LOOKING BACK

Saltwater fish and fauna include the fish and all of the other animals that live in estuaries and oceans. The sharks and rays are predatory cartilaginous fish. Several important food fish that live in ocean environments include the mackerel, tuna, marlins, and herring. All of these are surface feeders. Food fish that are bottom feeders include flounder, halibut, soles, codfish, sea bass, and groupers. Smelts are important fish in the marine food chain because they provide food to many of the larger fish. Mollusks and crustaceans include marine animals such as octopuses, squids, shellfish, crabs, lobsters, and shrimps. Some mollusks and crustaceans are microscopic animals called plankton.

Chapter Review

DISCUSSION AND ESSAY

1. Describe the characteristics of a marine biome.
2. List the major factors that contribute to differences among marine environments.
3. What functions do sharks and rays perform in marine environments?
4. Define the roles of mackerel, tuna, and marlins in the ocean environments.
5. Speculate about the kinds of environmental factors that may have contributed to the body shape and anatomy of flatfish.
6. Describe how the unusual anatomy of a flatfish contributes to its ability to compete in its ocean floor environment.
7. Explain the role of food fish such as herring and codfish in the food webs of marine ecosystems.
8. Specify the roles of smelts and similar fish in marine ecosystems.
9. Evaluate the roles of sea bass and groupers in saltwater habitats.
10. List the characteristics that distinguish mollusks from crustaceans and fish.
11. Name four important crustaceans and list their distinguishing characteristics.

MULTIPLE CHOICE

1. The largest biome in the world is the:
   a. Marine biome
   b. Forest biome
   c. Freshwater biome
   d. Desert biome
2. Which of the following environmental factors has the greatest effect on the food supply on the ocean floor?
   a. Water pressure
   b. Temperature
   c. Salt content
   d. Sunlight penetration
3. Which of the following is a cartilaginous fish?
   a. Mackerel
   b. Marlin
   c. Electric ray
   d. Codfish
4. A term that describes a shark that gives birth to live offspring is:
   a. Oviparous
   b. Viparous
   c. Viviparous
   d. Ovoviviparous

5. A term that describes a shark that lays eggs is:

   a. Oviparous
   b. Viviparous
   c. Ovoviviparous
   d. Viparous

6. A fish that inhabits the open ocean is known as a:

   a. Viviparous fish
   b. Hermaphrodite
   c. Cartilaginous fish
   d. Pelagic fish

7. A bottom-dwelling fish with both eyes on the same side of its head is a:

   a. Flatfish
   b. Pelagic fish
   c. Cartilaginous fish
   d. Skate

8. A flatfish that is right-eyed is known as being:

   a. Sinistral
   b. Cartilaginous
   c. Dextral
   d. Pelagic

9. The most important food fish in the world are the:

   a. Sharks
   b. Herring
   c. Flounders
   d. Codfish

10. A fish species that attaches its eggs to weeds on the ocean floor is called a:

    a. Sinistral fish
    b. Isospondylous fish
    c. Demersal spawner
    d. Dextral fish

11. Which of the following fish is not a food fish?

    a. Shark
    b. Smelt
    c. Herring
    d. Sunfish

Learning Activities

1. Divide the class into groups and have each of the groups prepare a wall chart that illustrates how each of the marine fish and animals fits into the food web. Display the charts on the walls of the classroom.
2. Provide opportunities for class members to earn class credit by visiting the fish counter at a local supermarket. Assign students to observe the kinds of seafoods that are available, and prepare a list of these foods. Make a chart listing important characteristics of the organisms and the habitats from which the foods were obtained.
3. Visit a public aquarium if such a facility is available, or obtain video materials on marine environments for viewing by students.

CHAPTER

19

Reptiles and Amphibians

Reptiles and amphibians are two distinct classes of organisms, see Figure 19–1. They are ectotherms, or cold-blooded animals, that depend on their surrounding environment for body heat. Endotherms, or warm-blooded animals, obtain heat from metabolism of their food. Reptiles are distinguished by their scales, plates, or shields covering their bodies. They also produce eggs with leathery skins, and they have claws on their feet. Young reptiles look like their parents except for their smaller size. Amphibians have moist skin with no visible scales, and their toes never have claws. Their eggs must be deposited in water to keep them from drying out. Young amphibians develop through an aquatic larval stage before they become adults. The change from juvenile to adult amphibian occurs through the process of metamorphosis.

After completing this chapter, you should be able to:

- distinguish between ectotherms and endotherms
- describe the differences between reptiles and amphibians
- compare the different kinds of reproduction that occur in reptiles
- illustrate the structure of an amniote egg, and describe the functions of the four embryonic membranes
- evaluate the roles of alligators and crocodiles in North American ecosystems
- distinguish between vipers and elapids
- analyze the roles of lizards and snakes in the ecosystems of North America
- explain how the tongue of a snake aids its sense of smell
- discuss the differences between turtles and tortoises and define their roles in the ecosystems in which they live
- identify the major steps in the metamorphosis of an amphibian
- compare the similarities and differences between frogs and toads
- appraise the roles of salamanders and newts in North American ecosystems.

KEY TERMS

ectotherm
endotherm
reptile
amphibian
metamorphosis
amniote egg
embryonic membranes
chorion
allantois
amnion
amniotic fluid
caiman
iguana
skink
gecko
ecdysis
viper
elapid
Jacobson's organ
constrictor
plastron
tortoise
terrapin
turtle
keel
herpetologist
tympanum
nare
tadpole
polliwog
eft
neotenic

Distinguishing between Reptiles & Amphibians		
Distinguishing Feature	**Reptile**	**Amphibian**
Blood supply:	Cold blooded Ectotherm	Cold blooded Ectotherm
Reproduction:	Internal fertilization Oviparous, Ovoviviparus	External fertilization Oviparous
Skin:	Scales, plates or shields	Smooth, soft, moist
Offspring:	Miniatures of parents	Larval stage with gills
Feet:	Claws	No claws

Figure 19–1 Distinguishing features of reptiles and amphibians.

REPTILES

Reptiles spend their entire lives within a short distance of the place where they hatched. They are not very mobile, and sometimes they are unable to survive environmental conditions different from their natural habitats. North American reptiles include two species of alligators, one species of crocodile, and turtles, lizards, and snakes.

Reptiles are found in a wide range of environments. They use heat from the sun to warm their bodies, and water and shade to cool them. They spend much of their time basking in the sunshine or floating just beneath the water's surface with only their eyes showing above water. The rise and fall in the body temperature of a reptile increases or decreases its rate of metabolism, see Figure 19–2.

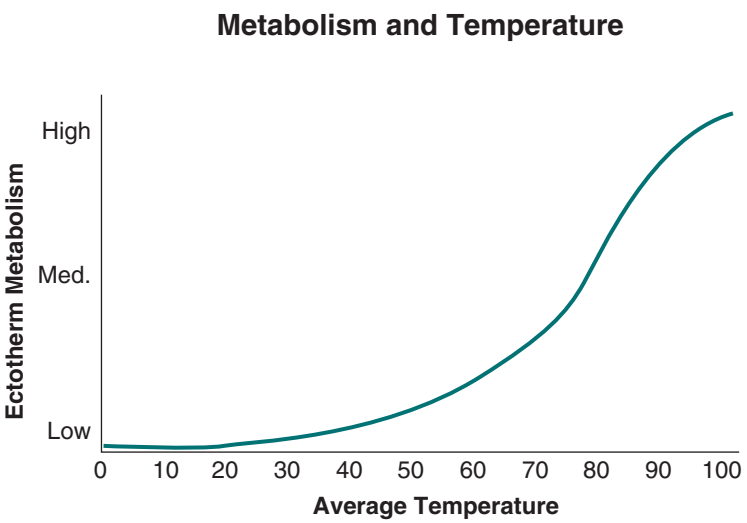


Figure 19–2 The rise and fall in the body temperature of a reptile increases or decreases the rate of reptiles' metabolism.

KEY INTERNET SEARCH WORDS

amniote egg

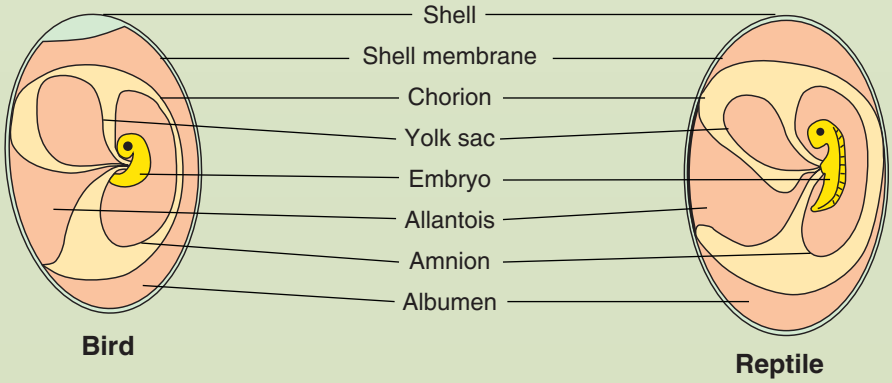
ECOLOGY PROFILE

The Amniote Egg

An **amniote egg** contains a protective membrane and a porous shell that surrounds the developing embryo. Such eggs are key elements in the reproduction of reptiles and birds. Four different membranes develop as a fertile egg is incubated. They arise from the developing embryo and are called **embryonic membranes**. Each of them is necessary for the survival of a growing embryo.

The **chorion** is a membrane that grows out of the embryo and surrounds it and the other three embryonic membranes. Gasses are able to pass through it quite freely. The **allantois** is a membrane that is filled with blood vessels. This membrane joins to the chorion, and it is the structure through which respiration occurs. The blood carries wastes and dissolved gasses away from the embryo and delivers dissolved oxygen into it. The **amnion** is the innermost protective membrane that surrounds the embryo. It contains a salty liquid called **amniotic fluid** in which the embryo floats. This liquid cushion also prevents the embryo from dehydrating. The yolk sac is an embryonic membrane that surrounds the yolk of the egg. It arises from the digestive tract of the embryo, and it releases digestive juices into the yolk. Blood vessels form in the yolk, and they carry the dissolved nutrients obtained from the yolk to the body of the embryo.

Amniote Eggs



Reproduction in reptiles requires internal fertilization of the eggs. Once the shell is formed, fertilization is impossible. Most reptiles are oviparous. They lay their eggs in nests that have been dug in earth, sand, or decaying vegetation. Some reptiles are ovoviviparous, and their young develop within the eggs inside the body of the female. After the eggs hatch, these females give birth to living offspring.

Reptile eggs are similar in many ways to the eggs of birds. Gasses are able to move in and out of them, enabling the growing embryos to obtain oxygen and to eliminate carbon dioxide as a waste product. The

outer shells of both reptile and bird eggs are impermeable to water. This prevents the embryos from drying out and dying before they hatch. The most obvious difference between reptile and bird eggs is that reptile eggs have leathery shells, and the eggs of birds have rigid, brittle shells.

KEY INTERNET SEARCH WORDS

Alligator

caimen, crocodile

Alligators and Crocodiles

The alligators, caimans, and crocodiles are similar in appearance to large lizards. They belong to the order Crocodilia. These animals are covered with plates and scales that protect their bodies, and they live in warm climates. These animals have existed since the age of the dinosaurs; however, their four-chambered hearts are more like those of mammals than those of other reptiles.

Crocodiles are represented by a single species in North America. They can be distinguished from alligators by their pointed snouts, by the arrangement of their teeth, and by their aggressive behaviors, see Figure 19–3. The snout of an alligator is broader and more rounded than that of a crocodile.

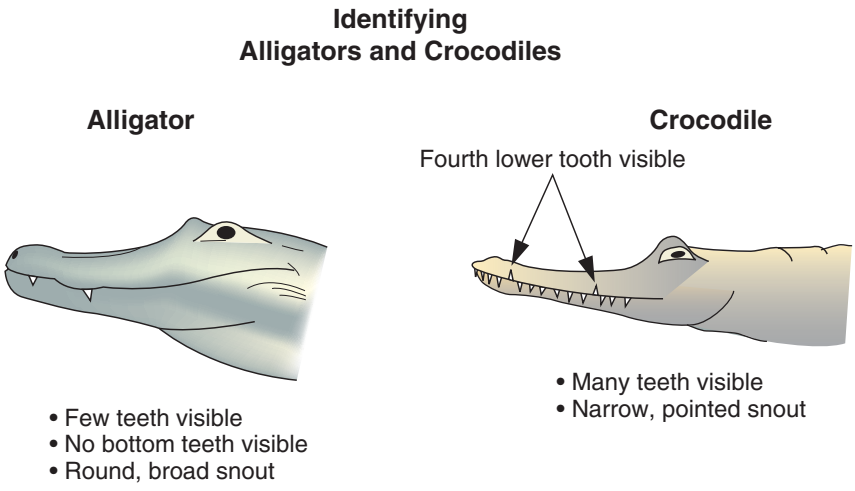


Figure 19–3 Identifying features of alligators and crocodiles.

The fourth lower tooth and many of the upper teeth of a crocodile are visible when its mouth is shut, but the teeth of an alligator are mostly hidden when it shuts its mouth. The teeth on the upper jaw of an alligator line up outside of the teeth on the lower jaw. The teeth on the upper and lower jaws of a crocodile are in line.

REPTILE PROFILE

American Crocodile *(Crocodylus acutus)*

In addition to the description of the crocodile presented above, its long tapering snout is characteristic of this species. Its tough, scaly skin is gray to greenish gray with dusky markings, and it matures at 7–12 feet in length, Figure 19–4. This animal is listed as an endangered species.

Figure 19–4 The American crocodile. *Courtesy Getty Images. Photo by Nancy Nehring.*

The American crocodile is found only in southern Florida, the Caribbean, southern Mexico and south on the coasts of Guatamala, Honduras, Nicaragua, Costa Rica, and Panama. It inhabits saltwater and brackish water habitats located along the coast. Mating occurs in January and February, and in April or May, females lay 35–50 eggs in mounds of loose dirt near the water. Incubation lasts 80–90 days depending on the temperature, with warm temperature contributing to a short incubation period. The mother guards the nest and helps the hatchings get to water by carrying them in her mouth. She does not continue to care for them as alligators do.

Alligators are represented in North America by two species—American alligator and caiman. The natural range of the **caiman** extends from southern Mexico to many parts of South America, and it has also been introduced into some parts of southern Florida.

KEY INTERNET SEARCH WORDS

American crocodile

Crocodylus acutus

American alligator

Alligator mississippiensis

REPTILE PROFILE

American Alligator *(Alligator mississippiensis)*

The American alligator is a large reptile that averages 7.5–12 feet in length. It is black in color with yellow crossbands that tend to fade away with age, see Figure 19–5. Its body is covered with large scales, and its snout is broad and round. Alligators are predatory animals that eat birds, fish, and small mammals. They inhabit mostly freshwater environments such as swamps, marshes, rivers, and southern coastal waters of the Atlantic Ocean and the Gulf of Mexico, see Figure 19–6. Alligators call to one another with loud bellowing roars that can be heard for great distances. The females lay 15–80 eggs in nest mounds made of mud and rotting vegetation. They communicate with their young using grunts. Alligators also hiss when they are threatened.

Figure 19–6 Distribution map of the American alligator.

Figure 19–5 The American alligator is a predator that eats birds, fish, and small mammals. *Courtesy Isabelle Francais.*

Alligators and crocodiles build large nests of vegetation in which they lay as many as 80 eggs. Female crocodiles return regularly to their nests, but they do not guard them as the alligators do. Both of these animals open their nests after the young have hatched. They carry their young to the water in their mouths. Alligators continue to protect their young from predators for several months.

Lizards

Lizards, along with snakes, belong to the order of animals known as Squamata. This order of reptiles includes more species than any other reptilian order. These animals are adapted to many habitats, and they can be found in most regions of the world. Most lizards are terrestrial animals, but some are adapted to marine environments.

Most of the lizards are small carnivores that eat spiders, insects, and other small animals. Some lizards grow to large sizes and eat large prey; a few species are herbivores. Lizards usually reproduce by laying eggs, but some species give birth to live young.

Many lizards have long slender tails that break off easily. This unusual trait helps lizards to escape their enemies by leaving their tails behind; the tail piece continues to wiggle, thereby distracting the predator. The tail of a lizard is regenerated when this happens.

Many North American lizards are **iguanas**. These lizards belong to eight separate families. They live in both temperate and tropical regions. The best known of these are probably the horned toads and the green anole, often called the American chameleon.

Seven species of anoles are established in the continental United States, but only one of these is a native—the green anole. A distinguishing feature of these animals is a throat fan, consisting of a fold of skin attached to the chest. When the fan is flared out, a bright color such as red, pink, orange, or yellow becomes visible. This fan is used by males to intimidate competing males and to attract females. Anoles have pads on their toes that help them climb, and they are adept at changing color.

INTERNET ADDRESS

http://www.wildtexas.com/wildguides/anole.htm

KEY INTERNET SEARCH WORDS

green anole
Anolis carolinensis

Figure 19–8 Distribution map of the green anole.

REPTILE PROFILE

Green Anole *(Anolis carolinensis)*

The green anole is a slender lizard, typically green in color, but color varies from green, to mottled green and brown, to all brown, depending on the color of its surroundings. The male usually has a pink throat fan, but in Florida, it is known to occur in white, pink, blue, and purple colorations. Adults are 5–8 inches long, see Figure 19–7. It requires a moist habitat, and lives in bushes and trees, although it is often seen on walls and fences.

Mating occurs from March to October and female anoles produce a single egg every 2 weeks. The young hatch in 5–7 weeks. The diet of the anole consists of small insects and spiders. The range of the green anole extends from North Carolina to the Rio Grande Valley of Texas, see Figure 19–8.

Figure 19–7 The green anole. *Courtesy Shutterstock.*

INTERNET ADDRESS

http://sevilleta.unm.edu/data/species/reptile/socorro/profile/texas-horned-lizard.html

KEY INTERNET SEARCH WORDS

Texas horned lizard

Phrynosoma cornutum

REPTILE PROFILE

Texas Horned Lizard *(Phrynosoma cornutum)*

The Texas horned lizard is usually called a horned toad. It has a spiny covering with two head spines that are larger than those on the rest of its body and has two rows of fringe scales along either side of its body. Most mature lizards are brown in color, and they blend in well with the environment in which they live, see Figure 19–9. These lizards live in arid and semi-arid areas of flat terrain with sparse plant cover. Their diet consists of ants and other insects, and they drink dew to obtain water. They escape their enemies by running quickly for cover in holes or under rocks and vegetation. It is listed as a threatened species in Texas. It is known to squirt a foul-tasting bloody mixture from its eyes when it is grasped by a predator. This unusual behavior is thought to be related to high blood pressure. The native range of this lizard is from the Plains states to the desert regions of the southwestern United States, see Figure 19–10. This lizard reproduces by laying eggs.

Figure 19–10 Distribution map of the Texas horned lizard.

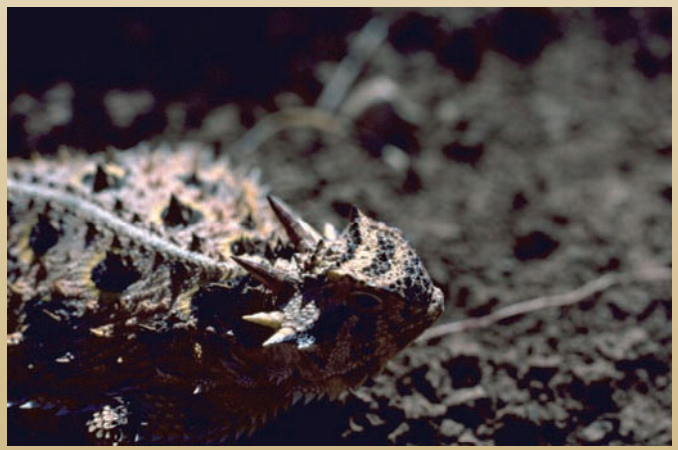


Figure 19–9 The Texas horned lizard feeds on ants and other insects. *Courtesy U.S. Fish and Wildlife. Photo by Gary M. Stolz.*

There are two species of poisonous lizards in North America: The gila monster and the beaded lizard. Both are easily recognized by the bead-shaped scales on their bodies. The gila monster is native to the southwestern United States and Mexico, see Figure 19–11. The beaded lizard lives in Mexico. These lizards kill their victims by biting them and chewing the wounded area. This draws poison to the wounds through grooves in their teeth. The venom paralyzes the nerves that control breathing, killing the prey.

INTERNET ADDRESS

http://library.thinkquest.org/C007974/2_3gil.htm

KEY INTERNET SEARCH WORDS

Gila monster

Heloderma suspectum

Figure 19–11 Distribution map of the gila monster.

REPTILE PROFILE

Gila Monster *(Heloderma suspectum)*

The Gila Monster is a poisonous lizard. Its body is covered with black bead-shaped scales interspersed with patches of yellow and pink scales. They are short-legged animals up to 2 feet in length with stout bodies, large heads, and muscular tails, see Figure 19–12. Gilas are relatively slow animals that eat insects, young birds, eggs, rodents, and other lizards. They live in burrows in the sand or under rocks, and they hunt mostly at night. The gila monster is oviparous, and the female lays up to a dozen tough-shelled eggs in a hole located in moist sand. The desert is its preferred habitat.

Figure 19–12 The Gila Monster. *Courtesy U.S. Fish and Wildlife. Photo by Gary M. Stolz.*

Skinks are the most widespread species of lizards found in the United States. They are ground lizards whose smooth, flat scales give their bodies a shiny, silky appearance. They have short legs, but are swift runners. Most of them are insectivores, but a few skinks are vegetarians. They are also known to eat spiders, worms, and small vertebrates. They are diurnal animals that are most active during the daytime, and they usually seek shelter at night in moist areas under rocks, debris, or decaying logs. Some skinks are known to live in trees. Skinks hibernate during the winter in debris, ground burrows, or under decaying logs.

During the mating season, the males display colored spots of red or orange on their heads. The males of some species are known to retain these colored spots throughout the year, but with some skinks, they disappear after the breeding season is over. Skinks are oviparous, and mating occurs before the females lay their eggs. The females lay eggs in sandy nests, and they guard the eggs during the incubation period.

INTERNET ADDRESS

http://www.inhs.uiuc.edu/cbd/herpdist/species/sc_lateral.html

KEY INTERNET SEARCH WORDS

ground skink
Scincella lateralis

Figure 19–14 Distribution map of the ground skink.

REPTILE PROFILE

Ground Skink *(Scincella lateralis)*

The ground skink is a small, shiny lizard that is brown in color with a dark lateral stripe extending along its back, see Figure 19–13. Its belly is white or yellow. Adults average 3–5.75 inches in length from nose to tail. Females lay several eggs in the sand and guard them while they incubate. The young are about 1.75 inches long when they hatch.

Figure 19–13 The ground skink is an insectivore that lives among fallen leaves and other decaying plant material. *Courtesy Getty Images. Photo by Jason Edwards.*

This lizard lives in wooded habitats, where it hunts among the fallen leaves and other decaying plant materials for the insects that make up its diet. It hides when it is disturbed, so it is seldom seen. It inhabits the central and southeastern regions of the United States and isolated locations in Mexico, see Figure 19–14.

Two different families of lizards are called **geckos**. They are able to climb with their claws or hold to surfaces like ceilings and walls with tiny suction cups located on the ends of tiny bristles on their feet. They are the only lizards that make loud calls. Some of the geckos have moveable eyelids, while others have lidless eyes that remain open all of the time.

The diets of geckos are mostly composed of insects and spiders; however, some geckos eat other lizards. Their preferred habitat is around and on buildings or other structures. Most geckos reproduce by laying eggs.

Some lizards look very much like snakes or worms because they have no legs. Unlike snakes, however, they have eyelids that can be closed over their eyes, and they have external ears. The most common of these lizards are worm lizards and glass lizards.

KEY INTERNET SEARCH WORDS

mediterranean gecko

Hemidactylus turcicus

REPTILE PROFILE

Mediterranean Gecko *(Hemidactylus turcicus)*

The Mediterranean gecko is pale colored, with both dark and light-colored spots, wart-like bumps on the head, and very large eyes see Figure 19–15. Adults are 4–5 inches in length, and their toes are equipped with broad pads. It is mostly nocturnal, and it is found in locations where the insects that make up its food supply are congregated. A familiar place to find this gecko is near lights.

Figure 19–15 The Mediterranean gecko. *Courtesy David Schleser. Photo Researchers, Inc.*

Figure 19–16 Distribution map of the Mediterranean gecko.

These animals are concentrated along the Gulf coasts of Texas and Mexico with small isolated populations in other areas of the south and southeastern United States, see Figure 19–16. The males call for mates with a series of rapid clicking sounds.

Snakes

The true snakes are the most numerous creatures in the reptile world, and they are all carnivores. They live in most environments in North America with 126 species found in the United States, and 22 species found in Canada. The diets of many snakes make them valuable to humans because they eat insects, mice, rats, and other rodents.

KEY INTERNET SEARCH WORDS

Eastern garter snake

Thamnophis sirtalis sirtalis

Figure 19–17 Distribution map of the Eastern garter snake.

REPTILE PROFILE

Eastern Garter Snake *(Thamnophis sirtalis sirtalis)*

The Eastern garter snake is widespread in the eastern half of North America, ranging from Canada to the Gulf of Mexico, see Figure 19–17. It is a small snake between 18 and 26 inches in length, and it occurs in a range of colors including black, brown, olive, and green. Three yellow stripes and a series of dark spots extend along the length of its body, see Figure 19–18.

Figure 19–18 The Eastern or common garter snake gives birth to live young. *Courtesy U.S. Fish and Wildlife.*

This snake lives in the vicinity of marshes, woodlands, stream banks, meadows, and parks. It preys upon fish, salamanders, frogs, toads, worms, small birds, and small mammals. Garter snakes are sometimes called garden snakes. Many species have been identified, and they are found in a wide variety of locations. The young are born alive, 20 or more at a time.

Water snakes are the most numerous snakes in North America and are found in abundance in many parts of the continent. Water snakes obtain most of their food near water, which is their preferred habitat. They prey upon frogs, salamanders, crayfish, fish, and other small aquatic animals. They have solid teeth and will strike and bite when they are threatened.

INTERNET ADDRESS

http://herpnet.net/Iowa-Herpetology/

KEY INTERNET SEARCH WORDS

Northern water snake

Nerodia sipedon sipedon

Figure 19–19 Distribution map of the northern water snake.

REPTILE PROFILE

Northern Water Snake *(Nerodia sipedon sipedon)*

Northern water snakes include several subspecies that occupy a range including much of the eastern United States, see Figure 19–19. These snakes vary in length from 24 to 42 inches, and they are known to range widely in color from light gray to dark brown. Markings are often visible on light-colored snakes, but they may be completely obscured in dark-colored ones, see Figure 19–20. These snakes inhabit swamps, marshes, streams, lakes, and other waterways. The females are usually larger than the males, and they give birth to live young.

Figure 19–20 The Northern water snake inhabits swamps, marshes, streams, and lakes. *Courtesy U.S. Fish and Wildlife. Photo by Gary M. Stolz.*

The bodies of snakes are covered with smooth, dry scales. As a snake grows, it molts by shedding its old skin. This process also is called **ecdysis**. Once the new skin has formed, the old skin is rubbed loose. Rattlesnakes add new rattle segments each time that ecdysis occurs. Each new segment is larger in size than the previous segment, and the rattle grows as the snake matures.

Two distinct kinds of poisonous snakes are found in North America. They are the vipers and the elapids, see Figure 19–21. **Vipers** include copperheads, cottonmouths, and rattlesnakes. These snakes have long fangs in the front of their mouths that are hinged. They fold back out of the way when the snake is not using them. The fangs of **elapids** are permanently fixed in place. These snakes include cobras, sea snakes, and coral snakes. The coral snake is the only elapid found in North America.

Figure 19–21 Features and common names of poisonous snakes.

Poisonous snakes		
	Vipers	**Elapids**
Features:	Long, hinged fangs	Short, permanently fixed fangs
Common names:	Copperhead Cottonmouth Rattlesnake	Cobra Sea snake Coral snake

KEY INTERNET SEARCH WORDS

Eastern coral snake

Micrurus fulvius fulvius

REPTILE PROFILE

Eastern Coral Snake *(Micrurus fulvius fulvius)*

The eastern coral snake is a brightly colored snake with red, yellow, and black alternating bands that completely encircle its body, see Figure 19–22. The snout is black followed by a yellow band on the head and a black band on the neck. After that a pattern of yellow, red, yellow, and black bands is repeated along the length of its body.

Figure 19–22 The eastern coral snake is identified by alternating bands of black, yellow, red, yellow, and black. *Courtesy Suzanne L. Collins. Photo Researchers, Inc.*

Figure 19–23 Distribution map of the eastern coral snake with Texas and Mexican subspecies.

The eastern coral snake inhabits a wide range of environments from pine woods to the lands bordering waterways. It is also found in hardwood forests with dense undergrowth. Another coral snake, known as the western coral snake, occupies similar habitats in the western United States. A Texas subspecies inhabits cedar brakes, rocky canyons, and hillsides, see Figure 19–23. These are diurnal snakes that hunt mostly during the daytime. Their diets are restricted to slender prey such as lizards and other snakes because their jaws do not open wide. The coral snakes are secretive in their habits, and they are seldom seen. They reproduce by laying 3–14 eggs.

Thirteen different species of rattlesnakes live in North America. Each of them is equipped with a rattle on the end of the tail. A young rattlesnake has only a single button, but by the time it is mature, it will have several segments on its rattle. A new segment is added on the rattle each time the snake sheds its skin. Two to four segments are added each year, so the number of rattles is an indicator of the age of the snake. Rattles are made of material that is similar to that of horns or claws. Segments are loosely attached together, and when they are shaken rapidly they create a buzzing sound similar to the sound of a cicada.

KEY INTERNET SEARCH WORDS

prairie rattlesnake

Crotalus viridis viridis

REPTILE PROFILE

Prairie Rattlesnake *(Crotalus viridis viridis)*

Prairie rattlesnakes and their western subspecies are brownish green to yellowish brown in color. They have blotches of dark brown rimmed with white extending along their backs and sides, see Figure 19–24. They eat rodents, birds, and other small animals.

These snakes are abundant in the grasslands of the Great Plains and in the arid desert regions of the western United States. Their range extends from southern Canada to northern Mexico and from Iowa to the Pacific coast, see Figure 19–25. The western variety is often found in rocky canyons and rock outcroppings at elevations below 8,000 feet. These snakes move into winter dens located in rocks and ledges when the cold nights of the fall season begin. This snake gives birth to live young, usually about 12 per litter.

Several species of rattlesnakes besides the prairie rattler are distributed across North America. They include the eastern and western diamondbacks, the pygmy rattlesnake, the timber rattler, the sidewinder rattlesnake, and several other species that are not very well known. All of them are poisonous and must be treated with respect.

Snakes hear through inner ears that are not visible externally. They do not hear the same way humans do, but rather their entire body picks up vibrations through the ground. They also have a good sense of smell that is enhanced by their forked tongues. A snake's tongue gathers molecules from the air, and transports them to a sensory organ in its mouth called **Jacobson's organ**. This organ is used for smelling.

A unique characteristic of many snakes is the flexible attachment of their lower jaws to their skulls. This enables them to swallow large prey and food particles that are bigger than their mouths, see Figure 19–26. To do this, the mouth and the body of a snake must expand to accommodate the size of the meal that is swallowed.

Figure 19–25 Distribution map of the prairie rattlesnake.

Figure 19–24 The prairie rattlesnake warns intruders by shaking the loose rattles on the end of its tail. *Courtesy U.S. Fish and Wildlife. Photo by Gary M. Stolz.*

Figure 19–26 The lower jaw of some snakes is flexible so that it can expand to accommodate large prey. *Courtesy Shuttestock.*

Reproduction in snakes requires internal fertilization. Oviparous snakes lay their eggs before they hatch, and the eggs of ovoviviparous snakes hatch internally before the young snakes are born or immediately after they are released from the mother. The embryos of all snakes are nourished by the yolks in the eggs from which they hatch. They are not nourished by the body of the mother snake.

Rat snakes are large nonvenomous snakes ranging from 24 to 96 inches in length. They eat mice, rats, small birds, lizards and frogs. They are good climbers, and they have adapted to a fairly wide range of habitats. They have stout bodies, and they kill their prey by constricting or squeezing them in their coils. For this reason, they are classed as **constrictors**.

KEY INTERNET SEARCH WORDS

black rat snake

Elaphe obsoleta obsoleta

Figure 19–27 Distribution map of the black rat snake.

REPTILE PROFILE

Black Rat Snake *(Elaphe obsoleta obsoleta)*

The black rat snake is the largest American rat snake averaging 42–72 inches long. The diet of this snake changes as it matures from lizards and frogs to mice, rats, and small birds. Its range extends through much of the northeast quadrant of the United States and in eastern Ontario, Canada, see Figure 19–27. Their preferred habitat includes rocky, timbered hills to farmlands with some of these snakes living in the cavities of hollow trees. This snake reproduces by laying eggs. It is shiny black in color with some evidence of a spotted pattern, especially in young snakes, see Figure 19–28. Its chin and throat are cream colored or white.

Figure 19–28 The black rat snake is distributed in the eastern region of the United States and eastern Ontario, Canada. *Courtesy Shutterstock.*

Only a few of the many North American species of snakes are discussed in this textbook. Many additional snakes are found living in nearly all environments. Those that are discussed here are representative of the different kinds of snakes that are most common.

Turtles and Tortoises

The turtles and tortoises are slow-moving reptiles whose bodies are surrounded by upper and lower shells known as scutes. The upper shell is called a carapace, and the lower shell is called a **plastron**, see Figure 19–29. The shell of a turtle is fused to its body, and the shells of most turtles are made of hornlike material that is very hard. Some turtles have shells that are made of a softer material that is similar to leather.

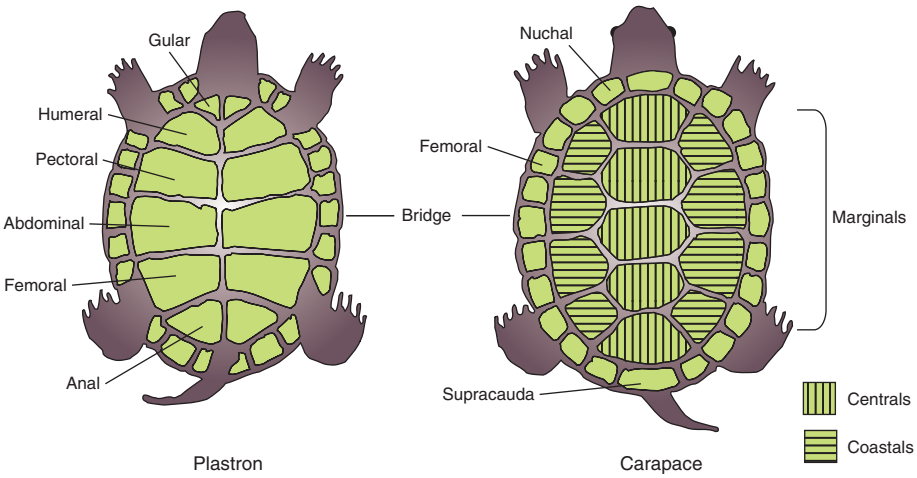


Figure 19–29 The scutes on a turtle's shell.

The **tortoise** is a turtle that lives on land. It is equipped with strong feet for walking, and its toes have claws that are used for digging. Nearly all of the tortoises are vegetarians, and several species live in desert environments.

Turtles that live in saltwater marshes are called **terrapins**, and those that live in freshwater habitats are called **turtles**. There are a number of instances in the southern regions of the United States, however, where freshwater turtles have been incorrectly called terrapins.

KEY INTERNET SEARCH WORDS

snapping turtle

Chelydra serpentina

REPTILE PROFILE

Snapping Turtle *(Chelydra serpentina)*

The snapping turtle is a freshwater reptile that usually measures 8–14 inches in diameter when it is mature. The carapace is brown to black in color with a rough surface on which three distinct ridges are evident. These ridges are called **keels**, and they become less prominent as the turtle ages. The tail of the snapping turtle is as long as the carapace, and the head is large, see Figure 19–30.

Figure 19–30 The snapping turtle is an omnivore that is distinguished by three distinct keels on its carapace. *Courtesy U.S. Fish and Wildlife. Photo by Gary M. Stoltz.*

Figure 19–31 Distribution map of the snapping turtle.

These turtles are omnivores that eat small invertebrates, fish, birds, small mammals, plants, carrion, and small reptiles. They are feisty animals that bite when they are threatened. They can live in almost any body of water where food is abundant, and they range from Canada to the Gulf of Mexico and from the Atlantic Ocean to the Rocky Mountains, see Figure 19–31. They reproduce by laying eggs.

Turtles have scales on their heads, necks, tails, and legs. The mouth of a turtle is much like the beak of a predatory bird, and a turtle has no teeth. The jaws of turtles are strong, and they are able to cut plants and meat into bite-size pieces.

INTERNET ADDRESS

http://www.tpwd.state.tx.us/nature/wild/reptiles/txtort.htm

KEY INTERNET SEARCH WORDS

Texas tortoise

Gopherus berlandieri

Figure 19–33 Distribution map of the Texas tortoise.

REPTILE PROFILE

Texas Tortoise *(Gopherus berlandieri)*

The Texas tortoise is a moderate-sized turtle that grows up to 8 inches in diameter when it is mature. The color of this tortoise varies from tan to brown. The carapace is broad and rounded over the top, and the plastron is quite long with an upward curve, see Figure 19–32.

Figure 19–32 Texas Tortoise. *Courtesy Gregory G. Dimijian, M.D. Photo Researchers, Inc.*

These tortoises are found in a small section of southern Texas and northern Mexico, see Figure 19–33. They live in a desert habitat where they feed on grasses and prickly pear cacti, in addition to other vegetation. They reproduce by laying eggs. The Texas tortoise has been protected since 1977 as a threatened species.

A few large sea turtles are found in warm waters of both the Atlantic and Pacific coasts. These animals spend most of their time in the water and seldom come ashore. The female comes ashore to lay her large clutch of eggs, see Figure 19–34. Sea turtles differ from land and pond species in several ways. For example, they have flippers instead of legs. The flippers are well adapted for swimming, but they don't walk well on land. Sea turtle populations have seriously declined because they have been hunted heavily or have drowned in fishing nets. They are now protected by law in many countries, and efforts are being made to help their populations recover. Such efforts include restricting public access to beaches where sea turtles lay their eggs.

Figure 19–34 A sea turtle comes ashore to lay its eggs. *Courtesy Shutterstock.*

Career Option

HERPETOLOGIST

A HERPETOLOGIST IS A SCIENTIST who specializes in the study of reptiles and amphibians. They are studied in their natural settings, as well as in the laboratory. A person who engages in this career sometimes devotes an entire lifetime to learning about the interrelationships between reptiles and/or amphibians and other living and nonliving elements found in their environments. This career involves outdoor field work, and it requires a graduate degree in the zoological or biological sciences. Many herpetologists are employed as faculty members at universities.

AMPHIBIANS

Two classes of amphibians are native to North America. One of these groups includes the frogs and toads. The other includes the newts and salamanders. All of these animals require moist living conditions because their skins are permeable to water. They will dehydrate in a dry environment. A characteristic of amphibians is that they mate and lay their eggs in water. Part of the life cycle of an amphibian is spent in larval form in a water habitat—the rest of the life cycle is spent on land. There are some species, however, that spend their entire lives in water. Amphibians hibernate during cold weather.

Frogs and Toads

Frogs and toads are the best-known amphibians in North America. They are widely distributed on the continent with the frogs living in or near water. Frogs are able to obtain some of the oxygen that they require by absorbing it through their moist skins from the water in which they spend much of their time. They also have lungs for respiration. Toads and some species of frogs live in terrestrial environments. The diets of frogs and toads consist mostly of insects, worms, and spiders, and they have long sticky tongues that they flick out to capture their prey. Frogs have round external eardrums located behind their eyes. The eardrum of a frog is called a **tympanum**, and it is quite sensitive to sound. Frogs have two breathing holes called **nares** located just in front of their eyes, and they often hide beneath the surface of the water with only the eyes and nares visible.

KEY INTERNET SEARCH WORDS

leopard frog

AMPHIBIAN PROFILE

Northern Leopard Frog *(Rana pipiens)*
Southern Leopard Frog *(Rana utricularia)*

The northern and southern leopard frogs are closely related species. They are brown or green in color with irregular rows of dark spots along their backs and sides, see Figure 19–35. Their rear legs are long and powerful, enabling them to leap long distances. The toes on the hind feet are webbed. The southern species has a light-colored spot in the center of the tympanum that distinguishes it from the northern species.

Figure 19–35 The leopard frog is identified by the irregular black spots on a brown or green body. *Courtesy Shutterstock.*

Figure 19–36 Distribution map of the leopard frog.

Leopard frogs live in many different kinds of freshwater habitats, see Figure 19–36. Many of them move into meadows and fields when sufficient vegetation exists to provide shelter. Mating calls are heard during the spring months in northern habitats and throughout much of the year in southern habitats. Reproduction is accomplished by laying eggs in standing water.

Toads are amphibians with short, compacted bodies and heads. They also have wart-covered skins. These warts help to protect them by secreting a white, milky substance that predators dislike, causing them to avoid toads in later encounters.

Toads live in areas that are too dry for most frogs, and they venture further from water than most frogs. They have short hind legs that are used for hopping, but they are unable to leap as frogs do. In arid regions, toads mate following seasonal rains, and their eggs are deposited in shallow standing water. These toads reproduce when there is enough water available to keep their offspring alive.

INTERNET ADDRESS

http://www.fs.fed.us/r4/amphibians/woodhousestoad.htm

KEY INTERNET SEARCH WORDS

Woodhouse's toad
Bufo woodhousii

AMPHIBIAN PROFILE

Woodhouse's Toad *(Bufo woodhousii)*

A common North American toad is the Woodhouse's toad. This species and several subspecies range across much of the United States and into parts of northern Mexico, see Figure 19–37. It is a large toad that grows up to 4 inches in length with yellowish brown to gray coloring on its back and sides. Its belly is usually white or yellow. Several dark spots are evident on its back with one or more warts located in each spot, see Figure 19–38. The southwestern Woodhouse's toad and the Fowler's toad are subspecies.

The diet of this toad is made up mostly of insects. It is able to survive in a variety of habitats ranging from grasslands to deserts.

Figure 19–37 Distribution map of the Woodhouse's toad and related subspecies.

Figure 19–38 The Woodhouse toad lives in habitats ranging from grasslands to deserts. *Courtesy U.S. Fish and Wildlife. Photo by Gary M. Stolz.*

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Many species of frogs and toads live in North America. They range from tiny tree frogs to large bullfrogs. Chorus frogs sing constantly during some seasons, but they are seldom seen. Gulf Coast toads are large toads that are found in fields, prairies, and towns where they live. Frogs and toads fill important roles in the North American habitats in which they live. They feed on insects, and they are preyed upon by many kinds of birds, reptiles, fish, and mammals.

Salamanders and Newts

Salamanders and newts are amphibians with long bodies and tails. They look a lot like lizards, but they lack scales on their bodies and claws on their toes. The skins of these small animals are moist. Some species are protected from their enemies by poisonous secretions that come from special glands in the skin. They molt from time to time by shedding their old skins.

Most salamanders live in damp environments, and some species live in water all of the time. Others only return to aquatic environments to breed. They breathe air, but they also absorb oxygen through their skins. Some aquatic salamanders, such as the mud puppies, never lose the gills they depended on during the larval stage of development. Most salamanders eat worms, insects, and slugs.

AMPHIBIAN PROFILE

Eastern Tiger Salamander *(Ambystoma tigrinum tigrinum)*

The eastern tiger salamander is a bright-colored amphibian with irregular yellowish or olive spots on a black or brown background, see Figure 19–39. Its belly is usually yellow with dark markings. Its diet consists of insects, worms, and slugs. Subspecies include the barred tiger salamander, the blotched tiger salamander, and the gray tiger salamander. Tiger salamanders are found in water habitats in many parts of North America, see Figure 19–40. They reproduce by laying eggs that float at the surface or submerge where they are attached to sticks or plants. Some larvae do not develop into land forms, but spend their entire lives in water. Some larvae mature sexually and reproduce before leaving the water as adults.

Figure 19–40 Distribution map of the tiger salamander.

Figure 19–39 The tiger salamander eats a diet of insects, worms, and slugs. *Courtesy U.S. Fish and Wildlife. Photo by Gary M. Stolz.*

KEY INTERNET SEARCH WORDS

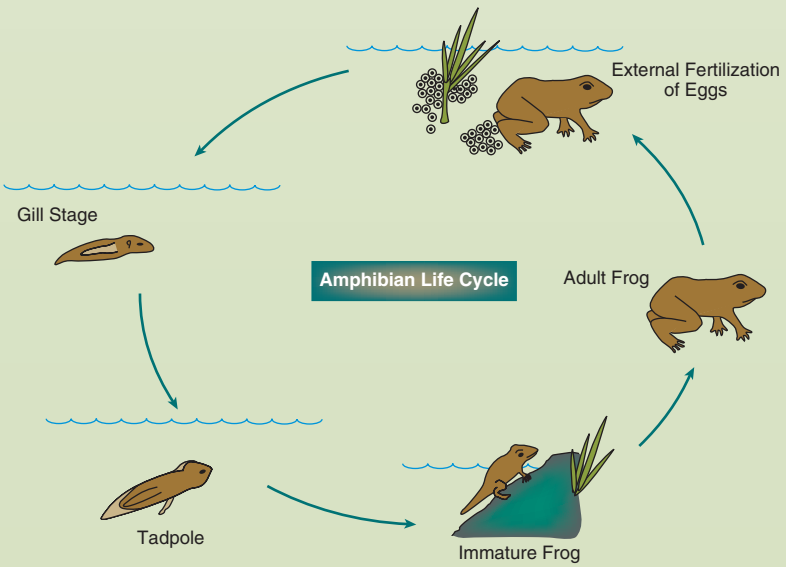
tadpole

polliwog

ECOLOGY PROFILE

Tadpoles

A distinguishing characteristic of amphibians is the larval stage of development. It occurs in nearly all amphibian species. Adult amphibians seek water during the mating season because their offspring must pass through the first part of the amphibian life cycle in an aquatic environment. The eggs of amphibians are fertilized externally. Male frogs and toads deposit sperm on the eggs as the females lay them. Male salamanders deposit small packets of sperm that the females collect and apply to their eggs. The eggs are incubated in the water, and they hatch into immature amphibians called larvae. The larvae of frogs and toads are called **tadpoles** or **polliwogs**, and they look nothing like their parents. The larvae of salamanders look like small adults with gills. The process of metamorphosis occurs during the larval stage of development. A number of changes occur in tadpoles' bodies as they grow into adults. Tadpoles are equipped with gills for respiration; however, as the larvae grow, they develop lungs for breathing and their gills disappear. Tadpoles have digestive tracts suitable for plant materials, but during metamorphosis, the intestines change to accommodate diets of meat. The legs also develop, and the tadpoles of frogs and toads lose their tails as they mature. Eventually, the tadpoles become young adults, and they leave the water to live on land.



Newts have long slender bodies like the salamanders, but their tails are long and flat instead of round. Many of them also have finlike frills that extend down their backs from their heads to their tails. Many newts live in terrestrial environments following metamorphosis, but they return to water environments to mate.

A male newt stimulates egg production in a female through his courtship behaviors. After displaying to the female, the male produces small packets of sperm. These packets are collected by the female and her eggs are fertilized externally.

INTERNET ADDRESS

http://museum.gov.ns.ca/mnh/nature/salamand/rspot.htm

KEY INTERNET SEARCH WORDS

red-spotted newt
Notophthalmus viridescens viridescens

AMPHIBIAN PROFILE

Red-Spotted Newt *(Notophthalmus viridescens viridescens)*

Red-spotted newts and their subspecies (central newts, peninsula newts, and broken-striped newts) go through a complex life cycle. Their appearances differ from one stage to the next, see Figure 19–41. In the adult stage, this newt is brownish yellow to olive green, with large red spots lining its sides. Small dark spots randomly adorn its entire body, tail, and yellow-colored belly. They average 2.25–4.25 inches in length. The hind legs and frills of males sometimes disappear following the breeding season, but they reappear later. During the breeding phase of life, these newts become aquatic animals laying their eggs in still water. The eggs hatch into larvae, and eventually, the larvae metamorphose into the land-based form called **efts**.

Figure 19–41 Red spotted newt. *Courtesy George Grall. Getty Images.*

In this phase of life, the color of the eft is red or orange, and its preferred habitat becomes a moist area in a forest. Up to 3 years may pass before the eft enters the aquatic stage of its adult life thus starting the cycle over again.

In some instances, the larval form of this newt does not leave the water, but it matures sexually and changes directly to the aquatic adult stage. A newt that develops in this manner is described as a **neotenic** newt. Red-spotted newts and their subspecies are found in numerous locations in the eastern United States and Canada, see Figure 19–42.

Figure 19–42 Distribution map of the red-spotted newt.

KEY INTERNET SEARCH WORDS

tiger salamander

Ambystoma tigrinum tigrinum

Newts are equipped with teeth for feeding on small crustaceans and insect larva while they are living in water habitats. They eat mostly insects, slugs, and worms when they are living on land. Salamanders and newts are important prey for fish. Other animals that are similar in appearance to newts are the mudpuppies and waterdogs. Unlike most newts, they remain aquatic animals throughout their lives.

LOOKING BACK

Reptiles and amphibians are cold-blooded animals classed as ectotherms. Reptiles are identified by the scales and plates of armor that protect their bodies and by the claws on their feet. Young reptiles closely resemble their parents. North American reptiles include alligators, turtles, lizards, snakes, and one species of crocodile.

Amphibians usually live on land for part of their life cycle before returning to water environments to reproduce. They have skin that is usually moist, and some amphibians are able to absorb oxygen through their skin. North American amphibians include frogs, toads, salamanders, and newts.

Major differences between reptiles and amphibians exist. Reptiles have dry skin covered with scales. Their eggs are covered with leathery shells and are fertilized internally. Amphibians have moist skins with no scales. Their eggs are fertilized externally, have thin and soft outer membranes, and must be deposited in water to survive.

Chapter Review

DISCUSSION AND ESSAY

1. Describe how ectotherms and endotherms differ from one another, and give examples of each kind of animal.
2. Identify the similarities and differences between reptiles and amphibians.
3. Compare the different ways that reptiles reproduce.
4. Illustrate the structures that are found in an amniote egg, and describe the functions of the four embryonic membranes.
5. Discuss the roles that alligators and crocodiles play in the ecosystems that they occupy.
6. Make a sketch that clearly illustrates the differences between vipers and elapids, and list some examples of each kind of snake.
7. Name some functions that lizards and snakes perform in the ecosystems where they live.
8. Explain how a snake uses its tongue as a sensing organ to help it smell.

9. Contrast the difference between turtles and tortoises, and describe ways that are similar.
10. Make a poster illustrating the life cycle of an amphibian such as a frog or salamander, and identify the changes that occur during metamorphosis.
11. Compare the similarities and differences between frogs and toads.
12. Identify the roles of salamanders and newts in the ecosystems they occupy.

MULTIPLE CHOICE

1. A term that describes an animal that depends on the surrounding environment for body heat is:
   a. Metamorphosis
   b. Endotherm
   c. Elapid
   d. Ectotherm
2. A term describing an ectotherm with a moist skin, no visible scales, and no claws on its toes is a/an:
   a. Amphibian
   b. Tympanum
   c. Reptile
   d. Plastron
3. Which of the following is not a characteristic of a reptile?
   a. Ectotherm
   b. Smooth, moist skin
   c. Claws
   d. Oviparous
4. Which of the following animals goes through a larval stage during its life cycle?
   a. Reptile
   b. Toad
   c. Snake
   d. Turtle
5. A live embryo located inside an amniote egg obtains nourishment from which of the following?
   a. Yolk
   b. Chorion
   c. Amnion
   d. Albumen
6. Which of the following structures differ most from those of birds in the eggs of reptiles?
   a. Yolk sac
   b. Albumen
   c. Shell
   d. Amnion

7. Which of the following characteristics describes the appearance of a crocodile?

a. Bottom teeth are visible
b. Round, broad snout
c. Bottom teeth are not visible
d. Few teeth are visible

8. Which of the following North American lizards is poisonous?

a. Texas horned lizard
b. Gila monster
c. Green anole
d. Skink

9. An example of a poisonous snake that is classified as an elapid is the:

a. Rattlesnake
b. Coral snake
c. Copperhead
d. Cottonmouth

10. The process by which a reptile sheds its skin during molting is called:

a. Ecdysis
b. Amniosis
c. Neotenic
d. Tympania

11. A turtle that lives on land is classified as a:

a. Terrapin
b. Tortoise
c. Constrictor
d. Keel

12. The lower shell of a turtle is the:

a. Carapace
b. Keel
c. Plastron
d. Tympanum

13. A term for the land-based form of a newt is:

a. Eft
b. Tadpole
c. Neotenic newt
d. Salamander

Learning Activities

1. Set up a classroom display with live tadpoles, snakes, and/or other reptiles or amphibians. Study the feeding habits of these animals, and obtain instructions for their proper care.
2. Make a survey of your town or a section of your city to determine which species of reptiles and amphibians live nearby. Invite guest speakers who are interested in herpetology to talk with your class about local species.
3. Assign individual students or groups of students to prepare presentations about the life cycles of particular reptiles or amphibians. Have each group share their reports with the rest of the class.

SECTION

V

Conservation and Management

Management and conservation of our wildlife resources is taking on a new urgency in North America. Private citizens, public institutions, and governments have become active participants as decisions are reached for management and conservation of these national treasures in the twenty-first century.

CHAPTER

20

Responsible Management of Wildlife Resources

Among our most valuable natural resources are the wild animals with which we share our world. They are valuable because they are part of a living environment in which living organisms are dependent on one another. The food chain links many different life forms together, and the rise or fall of a particular species impacts the other species with which it interacts. Responsible management of our wildlife resources will be critical in the effort to preserve them for the benefit of future generations.

After completing this chapter, you should be able to:

- describe the ways that private individuals and institutions can contribute to responsible management of wildlife resources
- list some positive and negative effects that farming has had on wildlife habitats in North America
- suggest ways that farmers and ranchers might improve the environment for wildlife
- evaluate the effects that modern industries have had on wildlife habitats, and suggest ways to resolve problems
- identify some sources of urban pollution, and describe the effects on wildlife environments
- propose ways that game farms, ranches, and preserves might profit from restoration and conservation of wildlife habitat
- define the roles of environmental organizations in preserving wildlife populations and habitats
- explain how some recreational activities contribute to damaged environments, causing stress to wildlife populations
- appraise the roles of government agencies in managing and protecting wildlife habitats and populations
- consider the value of national parks, monuments, and preserves in the effort to preserve wildlife populations and habitats

KEY TERMS

erosion
soil conservation
toxic waste
biodegradable
decomposer
nonbiodegradable
overgrazing
acid precipitation
point source pollution
nonpoint source pollution
multiple use
oversight
poaching
riparian zone
silt load

- define the role of national and international law in preserving wild animals and the environments in which they live
- explain the multiple-use concept of management for public lands
- discuss the effects of soil erosion on wildlife habitats and populations.

Some people believe that the extinction of a living organism is of little consequence unless it is directly linked to the loss of privileges or benefits formerly enjoyed by humans. Other people believe that the human race is morally obligated to protect all living things against population declines, irregardless of the costs.

Responsible management of a habitat, a biome, or the world at large is based on the premise that all living things have value to human society. It is probably unrealistic to expect that most people will voluntarily give up a lifestyle or make great personal sacrifices for the preservation of any species other than their own. Human societies are most likely to practice conservation when personal benefits are expected, see Figure 20–1.

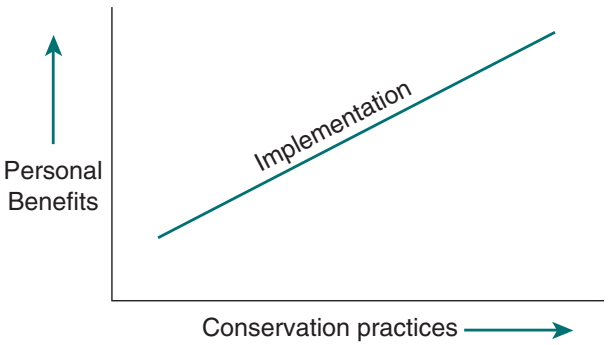


Figure 20–1 When personal benefits increase, so does the desire to implement conservation practices.

ROLE OF PRIVATE INSTITUTIONS

Individual landowners have a greater opportunity to improve the management of habitats and wildlife resources than any other segment of society, see Figure 20–2. They make the management decisions concerning the uses of the property they control. It is also true that property owners have a greater potential for damaging habitats through poor management than other members of society.

Figure 20–2 It is the responsibility of landowners to properly manage the habitat and wildlife resources on the property that they control. *Courtesy USDA*.

KEY INTERNET SEARCH WORDS
wildlife conservation

KEY INTERNET SEARCH WORDS
wildlife, agriculture

INTERNET ADDRESS

http://www.orst.edu/instruct/fw251/notebook/agriculture.htm

KEY INTERNET SEARCH WORDS
agricultural chemicals, wildlife

Farmers and Ranchers

There is a public perception in some areas that modern agricultural practices are not compatible with healthy wildlife populations, see Figure 20–3. It is true that some conflict does exist between wildlife and agriculture; however, most farmers and ranchers are as dedicated to protecting wildlife as anyone else. Agricultural practices that bring agriculture into conflict with wildlife include tillage practices that lead to soil damage, improper uses of pesticides and other agricultural chemicals, poor grazing practices on public lands, and conversion of wildlife habitats to fields, see Figure 20–4.

Figure 20–3 Spraying of pesticides and other agricultural chemicals must be properly managed to avoid damage to public lands and wildlife habitats. *Courtesy USDA*.

Figure 20–4 Extreme overgrazing such as the pasture on the left imposes major erosion hazards on the land.

Erosion is a destructive process that occurs when land is unprotected against the forces of flowing water or strong winds. Soil erosion is the number one cause of water pollution in North America. It damages wildlife populations by polluting water supplies, killing young fish and aquatic animals, and filling in reservoirs and lakes. It also destroys terrestrial habitats hindering plant growth, which ultimately has negative impacts on the food chain. **Soil conservation** is the practice of protecting soil from the destructive forces of wind and water, see Figure 20–5. Soil conservation practices are important to farmers and ranchers because abused land eventually loses the ability to produce profitable yields of crops.

KEY INTERNET SEARCH WORDS

soil conservation

water conservation

Figure 20–5 No-till corn coming up through wheat stubble in Maryland. *Courtesy USDA-Soil Conservation Service.*

Career Option

SOIL CONSERVATIONIST

A SOIL CONSERVATIONIST DEVELOPS PLANS and recommends practices for solving soil problems and controlling soil erosion. Other duties include land-use planning activities, and developing soil management plans such as crop rotations and reforestation projects. They also establish permanent vegetation and develop other practices that are related to soil and water conservation.

A career as a soil conservationist requires a bachelor of science degree in soil science, agronomy, forestry, or agriculture. A majority of time is spent doing outdoor fieldwork and communicating with land owners and managers.

Figure 20–6 It seems unreasonable to believe that farmers would endanger their own water supplies by being careless with agricultural chemicals. Their own children would be the first to suffer from such abuses. *Courtesy USDA.*

KEY INTERNET SEARCH WORDS

safe drinking water

Farmers and ranchers are stewards of most of the privately owned land and much of the public land in North America. Much of the potential farmland is now tilled, and it has been converted from wildlife habitat to sites for production of crops and livestock. As these changes in land use have occurred, animals such as waterfowl, bison, and other wildlife have been displaced, while other wild species such as songbirds have expanded into these regions.

Most agricultural producers are sensitive to the need to manage their property in a responsible manner, because they are likely to lose more than anyone else if the soil is damaged or lost due to poor management practices. Fields of growing crops provide excellent habitat for many birds and animals. Farmers operate farm businesses that are just as sensitive to economic losses as the businesses in towns and cities.

Improper uses of agricultural chemicals pose greater dangers to farm families than to anyone else. Abuses of toxic materials are carefully avoided by most farmers. They live on the land with their families and drink the water from farm wells. Their own children would be the first to suffer from chemical abuses, because they work and play in the fields, see Figure 20–6. Many farm families still eat meats, fruits, and vegetables that are homegrown, and improper use of chemicals would surely affect these foods, see Figure 20–7.

Figure 20–7 Many farm families still eat the fruits and vegetables that they grow, and improper use of chemicals would affect these foods and the health of the families. *Courtesy USDA*.

It seems unreasonable to believe that agriculturists would knowingly endanger their own water supplies by being careless with agricultural chemicals. There is no great conspiracy by farmers and ranchers to get rich at the expense of wildlife and other human beings by boosting crop yields through the use of poisonous chemicals. The chemicals that are used in agriculture have been tested carefully, and they can be safely applied when used according to the manufacturer's directions, see Figure 20–8. Agricultural chemicals that are left over from a job are considered to be **toxic waste** because they are poisonous to living organisms. Laws prescribe how they should be properly handled and disposed of. These materials should be safely stored until they can be delivered to a toxic waste treatment center or until they can be properly degraded. Chemical abuses, whatever the cause, must be corrected for the safety of living plants, animals, and people.

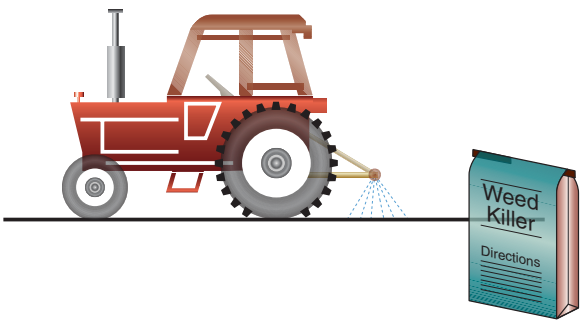


Figure 20–8 It is important to carefully follow manufacturer's directions when applying chemicals to assure that they are used safely.

ECOLOGY PROFILE

Biodegradable versus nonbiodegradable materials

Biodegradable materials are substances that can be eaten or broken down by living organisms to form nontoxic products, see Figure 20–9. Bacteria, fungi, insects, worms, and other organisms that are capable of breaking down complex materials into simple materials are called **decomposers**. Materials that cannot be broken down by living organisms are considered to be **nonbiodegradable**. Some agricultural and industrial chemicals are toxic in addition to being nonbiodegradable. They must be handled carefully by professionals who are trained to dispose of them properly, see Figure 20–10.

Figure 20–9 Biodegradable versus nonbiodegradable.

Biodegradeable
Reduced to non-toxic products by bacteria **Examples:** • Detergents • Paper products • Aq chemicals
Non-biodegradeable
Unaffected by bacteria **Examples:** • Plastics • Metals • Nuclear waste

Figure 20–10 Workers must wear protective clothing while working at a toxic waste disposal site. *Courtesy USDA*.

KEY INTERNET SEARCH WORDS
agricultural chemicals, safe use

Educational programs and government regulations that are designed to assure safe use of agricultural chemicals are being implemented in most regions of the United States and Canada. There is an increased awareness of the need to follow chemical labels carefully. Empty chemical containers continue to be a threat to the environment; however, major efforts have been made to educate those who use agricultural chemicals about the best ways to dispose of leftover chemicals and used containers.

KEY INTERNET SEARCH WORDS
land stewardship

It would be naive to believe that farmers and ranchers never abuse land and water resources, but it would be just as wrong to accuse them of destroying the environment with wanton disregard for their own families, neighbors, customers, and resident wildlife populations. The real issue is to find solutions to such environmental problems.

Ranchers who graze livestock on public lands are required to make improvements to the range. Water sources have been developed for use by livestock and wildlife populations, see Figure 20–11. New varieties of grasses have been seeded on many ranges. These produce much more forage than some of the native species they replaced, and they are equally nutritious to wild and domestic ruminant animals, see Figure 20–12. It is important for some wild species living on rangelands to leave significant amounts of native habitat intact for use by species that have limited ability to adapt.

Figure 20–11 Livestock owners who lease government owned rangelands are required to make improvements such as developing water sources for livestock and wildlife. *Courtesy NRCS. Photo by Tim McCabe.*

Figure 20–12 Reseeded rangeland is capable of higher production than some of the grasses they have replaced.

Public lands are managed for both wildlife and for domestic cattle and sheep. Range research has demonstrated that these uses are compatible with one another when grazing is properly managed. One key to proper management of rangelands is to graze an area quickly, and then remove the animals from the area to allow the plants to regenerate and build up their food reserves. Plants that are not allowed to build up food reserves in their roots are more easily killed during conditions of extreme drought or cold. Another key management practice is to avoid overgrazing forage plants. **Overgrazing** is a condition in which domestic livestock and/or wild animals destroy the plants in an area by harvesting them beyond their ability to recover.

Range management must also consider seasonal variations in plant growth and the different impacts of grazing by cows versus sheep versus wild species. Rangelands which are harvested in the summer by livestock will generally produce new growth in the late summer and fall in areas where sufficient moisture is available. The new forage growth is then available as winter feed for deer and elk, and it is usually of high quality. When spring growth is not harvested, it tends to become coarse and unpalatable, and its nutrient value is usually low.

Farming practices that do damage to wildlife populations include the tillage of every acre of land and the drainage of swamps and other wetland areas. Windbreaks, wooded areas, farm ponds, ditches, and fencerows provide habitat for birds and other small animals. Undisturbed grasses and weeds in these areas provide shelter and food for wildlife. As fields have become larger, these areas have disappeared on many farms.

Wildlife agencies and organizations are encouraging farmers to skip over small areas as they harvest their fields and to leave some areas untilled over the winter season. These small refuges provide winter cover for birds and other animals, helping them to survive on agricultural lands.

Agricultural producers who fail to use wise management practices that are friendly to wildlife populations are placing the entire agricultural industry at risk. A single farmer who applies chemicals improperly, thereby causing injuries or death to wildlife populations, is likely to create public sentiment against all farmers, including those who use chemicals safely. One rancher who is lax in his or her stewardship over a grazing allotment on public land can place all ranchers in jeopardy of losing their grazing privileges. Publicity tends to focus on problems instead of successes.

Farmers and ranchers should seriously consider the possible effects of all agricultural practices on populations of wild animals. Instructions for safe use of agricultural chemicals should be carefully followed, and empty containers should be disposed of properly. Agricultural organizations should police their own members to assure that abuses of public trust lead to the loss of privileges.

ECOLOGY PROFILE

Alternate Land Use Services (ALUS)

Farm groups in Canada are promoting a new concept in environmental conservation known as *ALUS*. This is a farmer-led initiative intended to preserve natural capital and environmental benefits. Its stated purpose is to "mobilize producers as conservationists."

One of the underlying principles is that governments and landowners have shared responsibility to exercise stewardship for natural environments and wildlife. A fair market value should be established for stewardship and conservation services provided by landowners who maintain existing natural assets (especially when the land could reasonably be converted to farm production). A 2005 report indicated that Canadian organizations in support of ALUS included the Ontario Federation of Agriculture, APAS in Saskatchewan, Wild Rose in Alberta, and the Canadian Federation of Agriculture. ALUS is expected to produce measurable environmental goods and services for the Canadian public.

Industry

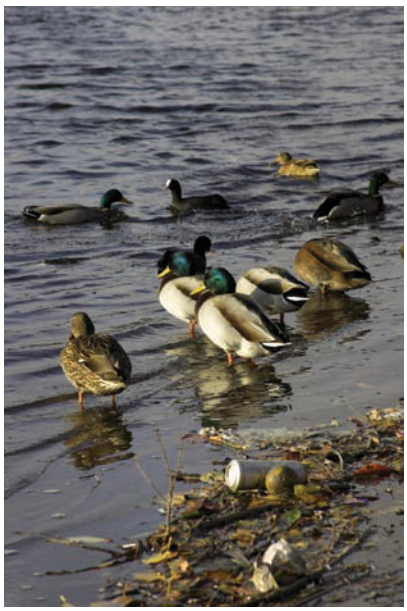


Figure 20–13 Some of our most valuable natural resources are seriously polluted by waste from cities, factories, and farms. *Courtesy Shutterstock.*

Industrial processes consume huge quantities of energy and raw materials, and they produce massive amounts of by-products and industrial wastes. Many species of wild animals in North America have suffered from the effects of industrial pollution. Responsible management by private industries is needed if we are to eliminate these negative impacts of pollution, see Figure 20–13.

One serious problem that has become evident in recent years is **acid precipitation**. It is caused when sulfur or nitrogen oxides are released into the atmosphere from coal-burning industrial furnaces, vehicle exhaust fumes, incinerators, and so forth. The rain becomes polluted with sulfur and nitrogen compounds, and weak acids are formed. Acid precipitation is very destructive to ecosystems, and some habitats, particularly those in areas of granite bedrock, are more vulnerable than others. Acid rain is capable of destroying both plant and animal life. Some streams that become polluted by acid precipitation no longer support life forms such as fish, aquatic insects, and plants.

The greatest single cause of acid rain is air pollution by car and truck exhaust gases. This problem is most evident near population centers where large numbers of vehicles are concentrated in a relatively small area. Responsible citizens should make sure that their engines are properly tuned to reduce emission levels of damaging exhaust gases.

Untreated industrial by-products and waste materials are sometimes spilled or dumped into streams, rivers, and lakes. Some of these materials have also been released into the ocean. The water in some industrial

areas has become so polluted that it is incapable of supporting life. Pollution that originates from a known location is called **point source pollution**, see Figure 20–14. **Nonpoint source pollution** is pollution where the pollutants cannot be traced to a single origin.

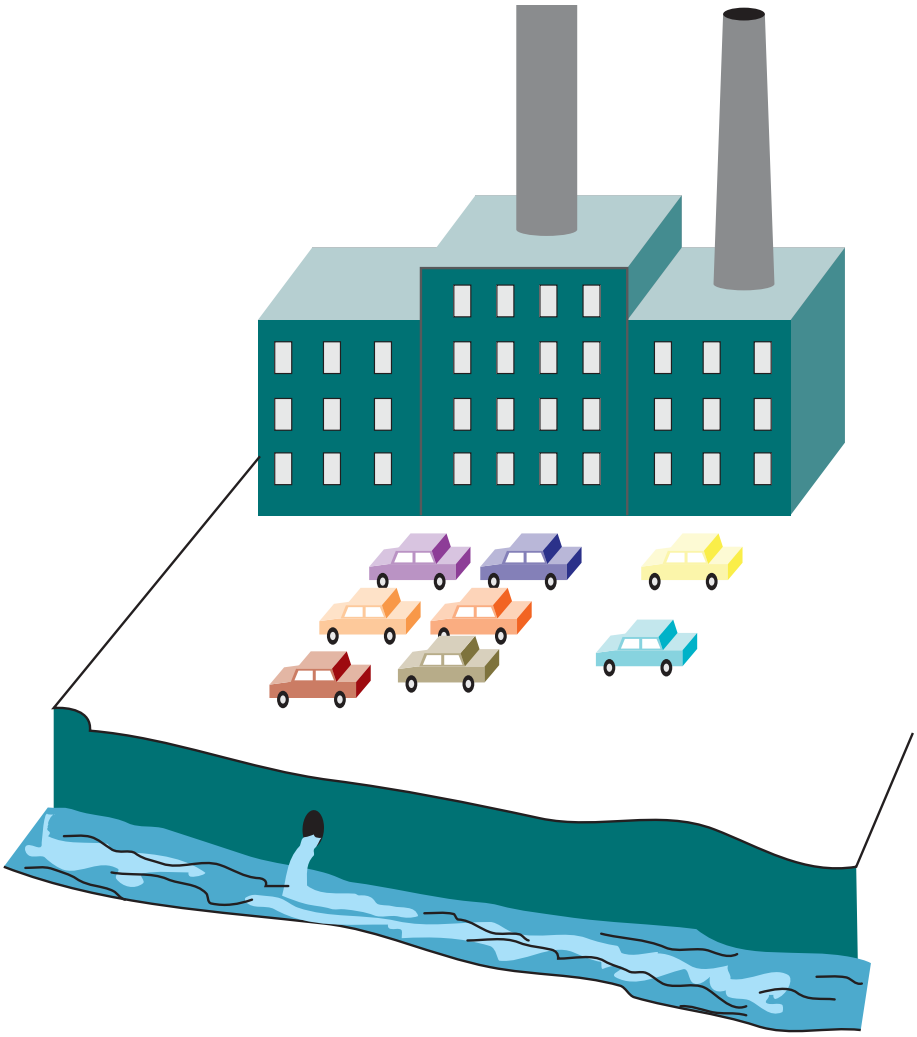


Figure 20–14 Releasing contaminated water into a stream is an example of point source pollution.

Many industries have responded to environmental laws by reducing pollution. A few have gone far beyond the requirements of the law in efforts to demonstrate to the public that their industries are environmentally responsible. Failure to properly treat industrial waste materials or to safely dispose of them shows irresponsibility.

Private Citizens

Some of the chemical abuses that are blamed on agriculture can actually be traced back to urban neighborhoods. They often come from lawn and garden chemicals that are applied at excessive rates. Part of this problem results from the difficulty in accurately measuring and mixing chemicals in small amounts and using small containers. It is also difficult to know

KEY INTERNET SEARCH WORDS
lawn and garden chemical safety

how fast one should walk when applying chemicals from a hand-held sprayer. Another problem that arises is how to properly dispose of chemicals that are left over at the end of the job. Too often, they are poured out on the ground or flushed down sewers.

Large commercial machines that are used to apply chemicals are usually carefully calibrated to avoid overapplication. Homeowners and small landscaping firms seldom have large mixing tanks or carefully calibrated equipment. Excessive chemical applications to yards and gardens have become a problem in many urban and suburban areas.

Excess chemicals often seep into storm drains and sewage systems during heavy rains. They create pollution problems in surface water, especially when storm drains empty directly into streams. Chemicals that pass through sewage treatment plants are also problematic because they can interfere with sewage treatment processes, and they are difficult to isolate, deactivate, and remove. Those who use lawn and garden chemicals should make sure that they precisely follow the instructions for the application and disposal of such materials.

Wildlife populations are directly affected by the encroachment of humans on their environments. Wild animals loose their habitats when streets are paved and natural plant cover is destroyed or removed. The presence of humans also disturbs many wild animals, and construction of homes, towns, and cities deprives them of their most basic needs of food and shelter. Domestic dogs harass and prey upon them. Human interference with wild animals and their habitats often has serious consequences on wild animal populations.

INTERNET ADDRESS

http://heinz.fws.gov/
http://www.ducks.org/

KEY INTERNET SEARCH WORDS

wildlife refuges, preserves
Ducks Unlimited
pheasants forever

Game Farms and Preserves

Privately owned game farms and ranches have been established in many parts of North America for a variety of purposes. Some of these are private efforts to preserve natural habitats for use by wild animals. However, most game farms and ranches must also earn a profit and be self-sustaining, see Figure 20–15.

Figure 20–15 Game farms raise wild species, such as this pheasant chick, in captivity for use in commercial sport. Government agencies often regulate this kind of enterprise. *Courtesy Shutterstock.*

Some game farms raise wild species in captivity, and then sell these animals to hunting preserves. Birds such as pheasants and quail are the most common species raised for this purpose. Fish are also raised at government-supported and privately owned fish hatcheries in support of public, private, and commercial sport fishing.

Some large farms, ranches, and hunting preserves depend on the sale of private hunting permits for a major portion of their income. Many such businesses charge fees to hunters for the privilege of hunting on private land. In some instances, large areas have been fenced to control the resident populations of big game animals, and the habitats are carefully managed to assure that the herds are healthy. In other instances, clients are charged a *trespass* fee for the privilege of hunting on private property.

Government agencies often regulate this kind of enterprise. Local fish and game laws must be followed, and permits may be required in order to operate commercial hunting operations. The success of a game farm or ranch depends on the ability of the owner to provide a quality hunting experience for his or her clients. Quality hunting is possible only when attention has been paid to the environmental needs of the wild animals.

Game preserves are of two general types. Some preserves are established to protect wild animals throughout the year, and they provide areas in which birds and animals are never hunted. Other game preserves are privately owned by an organization that sells memberships.

Members of game preserves are usually entitled to hunt within the boundaries of the preserve during regular hunting seasons; however, wild birds and other animals are protected during critical periods in their life cycles. One priority on game preserves is to establish critical wildlife habitat. Mammal and bird populations on the preserve are sometimes supplemented during hunting seasons by purchases of animals from game farms.

Figure 20–17 Construction of nesting sites is an innovative way to restore appropriate nesting habitats in critical management situations.

Game preserves have been operated by landowners in Europe for a long time, but it is a fairly recent concept in North America. Wild animals existed in great numbers when the first settlers came to America, and citizens have always been able to pursue their hunting interests. The decline in some bird and animal populations and reduced access to hunting areas has contributed to interest in private game preserves. Members and clients of such organizations are usually the only persons allowed to hunt on the property during the hunting season.

Some of the most common game preserves have been established by privately funded organizations such as “Ducks Unlimited.” Funds are raised for the purpose of purchasing land that is converted into wetlands or other wildlife habitat, see Figure 20–16. Restoration of wildlife habitat on private lands has greatly aided migratory waterfowl by providing safe places for them to rest during their annual migrations. Nesting areas have also been restored in critical areas to assure that safe nesting sites are available, see Figure 20–17.

Figure 20–16 Wetlands provide habitats for a wide variety of species. *Courtesy U.S. Fish and Wildlife. Photo by Bill Gill.*

ROLE OF SPECIAL INTEREST GROUPS

Public institutions are organizations whose membership is open to anyone who shares common interests and who desires to join. Some of these organizations have large memberships, and they are able to direct large sums of money to purposes that are priorities to their members. These organizations help support research, education, lobbying efforts, and court actions.

Environmental Organizations

The role of environmental organizations in North America is usually to create public awareness of problems or potential problems related to the environment. They also exert political pressure on lawmakers and resource managers through intense lobbying activities and through action in the courts.

Environmental organizations can contribute to improvements for wildlife by conducting unbiased research that leads to solutions for environmental problems. One challenge faced by all parties involved in environmental disagreements is assurance that their activities are based on honest science—not slanted toward the bias of those who pay for the research. The members of organizations who provide funds for research projects are sometimes quick to take their donations elsewhere when research outcomes do not support their bias.

Research activities must be conducted by competent scientists who follow proven scientific procedures and study results made available to the scientific community for peer review. This process validates the research procedures and scientific processes that were used. Good

research requires open minds and honesty in the way the research is designed, conducted, and reported.

Many environmental organizations spend their time and resources attempting to influence public opinion and to educate the public on issues that are important to their members. They do this by preparing printed materials and by developing videos for use by television media and private citizens. They visit schools and provide programs for public meetings. Environmental organizations have worked together to create a powerful lobby on environmental issues. These groups have widespread influence with legislators at all levels of government. They have expanded their influence by bringing numerous court actions in high profile legal disputes.

It is sometimes difficult for organizations to make choices that are based on science because the results of a scientific study may not always agree with the position of the organizations' members. Environmental and user organizations that base their initiatives on good scientific data are valuable conservation partners, see Figure 20–18.

Organizations whose decisions and initiatives are based on emotions or flawed science cause damage to the cause of wildlife and natural resource conservation.

Figure 20–18 Environmental organizations that base their initiatives on good scientific data are valuable conservation partners. *Courtesy USDA*.

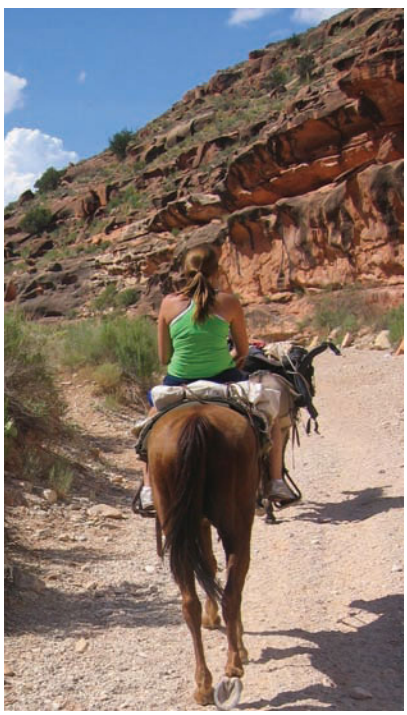


Figure 20–19 Horseback riding is a popular outdoor recreation. *Courtesy Michael Dzaman*.

Recreational Interests

Recreation is an important part of life in America. Many people spend part of their leisure time in outdoor recreation, such as hiking, boating, horseback riding, hunting, and fishing, see Figure 20–19. All of these activities take people into environments that are inhabited by wild animals.

It is the responsibility of all persons who use the outdoor environments to do so without abusing them. Trash that is left in recreation areas detracts

from the appeal of the site, and some materials such as plastics and metals can be dangerous to wildlife. People should be willing to clean up garbage that has been left by less responsible individuals.

Some forms of outdoor recreation are capable of damaging the environment when they are pursued excessively or under certain conditions. One of these is driving vehicles in erosion-sensitive areas, see Figure 20–20. Ruts in the surface of the terrain sometimes become channels for runoff water, and heavy rainfall can turn a rut into an eroded gully.

Figure 20–20 Rut damage caused by offroad vehicles. *Courtesy USDA.*

Outdoor sports take many people into the living environments of wild animals. Snowmobiles and All Terrain Vehicles (ATVs) make it possible for people to get into wintering areas that are used by big game animals such as deer, elk, and moose. Getting too close to these animals when they are stressed by harsh winter conditions can be fatal to them. They need all the energy they are able to consume just to keep warm during the cold weather. Chasing or causing undue stress to these animals not only depletes their limited energy reserves, but it is inhumane and illegal.

Illegal poaching is a temptation to some people and has become a serious problem in some areas. It can be controlled though, when responsible people who have observed suspicious activities report them to local law enforcement agencies. Hotlines have been established in many regions for this purpose, and they can be effective in bringing violators to justice.

ROLE OF GOVERNMENT

The role of government in the conservation and management of wildlife and natural resources is to manage public lands in a manner that is consistent with scientifically validated conservation practices. The government also plays a role in the management of private lands by providing expertise and financial support to natural resource conservation projects. Still another role of government is to enforce the laws that govern the uses of land, water, wildlife, and other natural resources.

INTERNET ADDRESSES

http://www.fs.fed.us/

KEY INTERNET SEARCH WORDS

U.S. Fish and Wildlife Service,
U.S. Forest Service

Government Agencies

Some government agencies are charged with the responsibility of managing wildlife and other natural resources. Federal agencies have been established to resolve resource problems of many kinds. Some of them also function as law enforcement agencies with responsibility for ensuring that laws concerning wildlife and natural resources are obeyed.

The U.S. Fish and Wildlife Service is responsible for maintaining wildlife populations and for operating the system of National Wildlife Refuges. One of the duties of this agency is to enforce the provisions of the Endangered Species Act. It is the primary purpose of this agency to protect and nurture wildlife species. The professionals who work for this agency evaluate declining animal populations and take steps to preserve them. They are expected to be skilled in the application of scientific methods to environmental problems and to subscribe to the highest standards of integrity in all aspects of their work. The health and safety of wild environments depend on their ability to correctly identify environmental problems and solutions.

The U.S. Forest Service is part of a large agency called the U.S. Department of Agriculture. The Forest Service is responsible for managing many of the forests and some of the rangelands that are owned by the federal government. Employees make decisions concerning timber sales and grazing allotments for livestock. The decisions of these managers sometimes have major impacts on wildlife populations.

The U.S. Bureau of Land Management is responsible for managing large tracts of arid and semi-arid lands in the western United States. Much of this land is used for grazing by cattle and sheep, see Figure 20–21. These areas also provide food and shelter for many wild species of birds and animals. This agency manages federal lands based on the concept of **multiple use**. This management strategy attempts to utilize natural resources in a way that considers the needs of different groups of users.

The U.S. Soil Conservation Service is a federal agency charged with the responsibility for developing plans to reclaim damaged soils and

Figure 20–21 The U.S. Bureau of Land Management is responsible for grazing land in the western United States.

to prevent soil erosion. This agency works with private landowners and government agencies to classify soils and to develop management plans. All of these activities affect the habitats of wild birds and other animals.

Many other government agencies have responsibilities for **oversight** or supervision of public and private lands and natural resources. The legislative branch of government is responsible to see that laws are enacted regarding the use and protection of natural resources. The executive branch of government implements the legislation. The judicial branch of government is responsible to ensure that the laws are fair.

National Parks and Monuments

National parks and monuments are areas that are set aside to preserve natural sites that are of scientific or historic interest. These areas are chosen because they are areas of scenic beauty or unusual geological features. Wildlife habitats and populations are protected within the boundaries of national parks and monuments.

The National Park Service is part of the U.S. Department of the Interior, and it was established by an act of Congress in 1916. It is responsible for conserving natural scenery, wildlife, and historic sites.

ECOLOGY PROFILE

Yellowstone National Park

Yellowstone National Park is one of the great treasures of North America. It was established in 1872 by the U.S. Congress, and it is the oldest and largest national park, see Figure 20–22. The park boundary encompasses 2,221,773 acres of land, and it is filled with unusual geological features such as geysers, hot water pools, petrified forests, and waterfalls. The land and water resources in Yellowstone are managed in such a manner that the environment is disturbed as little as possible. Hunting is not allowed inside the park, and rules governing fishing are strictly enforced. The park is filled with many wild animals, and they are often visible from the roads and trails. It supports one of the few remaining grizzly bear populations in the lower 48 states. It is one of the most popular vacation sites in North America.

Figure 20–22 Old Faithful at Yellowstone National Park. *Courtesy Shutterstock.*

Many different sites have been set aside as national parks and monuments in locations all over the United States. A strong effort is made within the national park system to preserve wildlife species in their natural habitats in such a manner that they are preserved for the enjoyment of future generations.

National and International Law

Laws and regulations are important tools in protecting wild animals and the environments in which they live. Without them, some populations of wild animals would soon be reduced beyond their ability to recover. This is because there are people in every society who will abuse the right to harvest wild game populations. Some of them abuse hunting and fishing privileges by ignoring laws that restrict these activities. Illegally taking or killing animals that are protected by law is known as **poaching**.

State and provincial governments have passed laws that set the rules for hunting and fishing. They have also established agencies to enforce these laws, see Figure 20–23. Fish and game agencies determine rules such as the number of fish, birds, or game animals that may be taken, the dates of the hunting and fishing seasons, and the number of permits that will be sold each year.

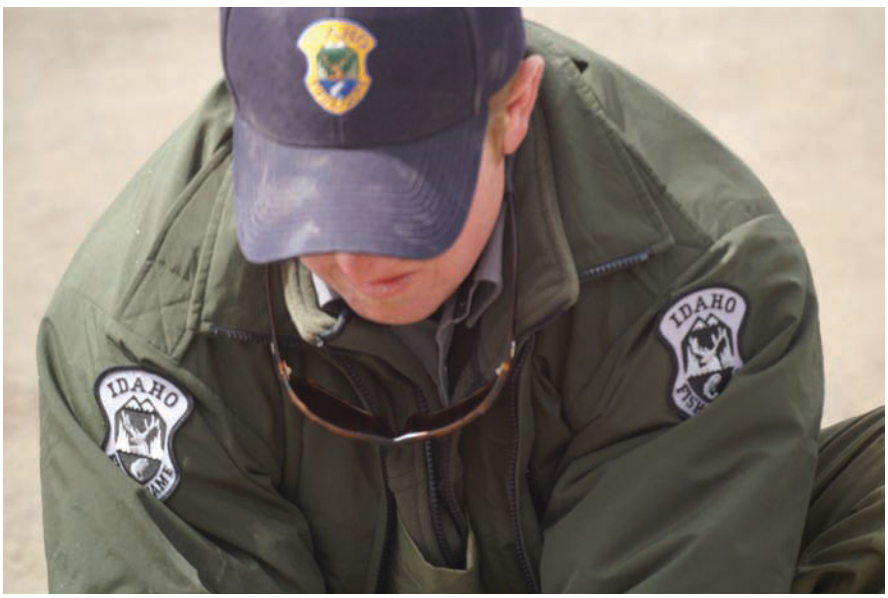


Figure 20–23 Fish and game agencies strictly enforce hunting and fishing rules and regulations. *Courtesy Shutterstock.*

Federal laws that are enacted to protect wild animals and their environments are often targeted at specific abuses, such as point sources of pollution of streams and lakes. Such laws have resulted in less raw sewage and toxic wastes being dumped into waterways than in years past. The results are encouraging, and some of our most polluted waters are beginning to recover in response to federal environmental laws.

INTERNET ADDRESS

http://www.nps.gov/

KEY INTERNET SEARCH WORDS

National Park Service

Multiple-use management

natural resources

The Endangered Species Act is a federal law that identifies declining or nearly extinct populations of specific plants and animals, and it requires changes in human behaviors that impact the survival of these animals. Laws of this kind have wide-reaching effects on human activities because they tend to require changes in the way we live and work, see Figure 20–24. For example, many families living in the Pacific Northwest have been forced to seek new employment as a result of logging restrictions that were designed to protect the endangered spotted owl. Many timber mills have closed and those that remain face the problem of an inconsistent supply of timber.

Figure 20–24 The logging industry has suffered from many reductions due to laws set forth by the Endangered Species Act. Many small towns are impacted by high unemployment since the lumber mills were closed. *Courtesy Michael Dzaman.*

International regulations have been negotiated among nations to restrict the harvests of whales, seals, sea turtles, dolphins, and other species of animals that live in international waters. Similar agreements protect some migrating species that regularly cross the borders between nations.

International laws have been implemented to restrict trade involving endangered species and their products; however, black markets continue to offer such items for sale. For example, the high value of ivory as an international trade item continues to encourage poaching of endangered wild elephant populations. Trade in rare exotic birds is another activity that has a negative impact on the ability of endangered populations to increase. International laws restricting these and similar activities have been difficult to pass. They are even more difficult to enforce, but without these laws, there would be no legal restrictions on trade practices involving animals and birds that are threatened or endangered. Such laws need to be strengthened.

MULTIPLE-USE CONCEPT OF MANAGEMENT

Multiple use is a management strategy that has been used for many years on public lands. It implies that land and other natural resources can be managed in such a way that people with different interests and needs can use the same resources without depleting them. To do this, all users must assume full responsibility for understanding and using the resources prudently.

Multiple use of resources is the best management strategy when all users exercise good judgment in managing the resource. Examples of proper use of resources are evident in many management units. Sheep that are grazed in units where tree seedlings have been planted help to reduce the competition from weeds and other vegetation without damage to the trees. Recreational water sports are completely compatible with the need to store irrigation water in reservoirs or man-made lakes. Migrating waterfowl also benefit from such resources. Nitrates and phosphates are removed from surface waters as they flow through restored wetlands and marshes. This purifies the water and benefits the birds and wildlife that inhabit the area.

On the opposite end of the spectrum, examples can be cited in which untimely use of a resource becomes abuse of the resource. A motorcycle enthusiast who rides his or her bike across dirt trails when they are wet is likely to contribute to erosion. Heavy fishing activity in prime spawning areas during the spawning season may significantly reduce threatened populations of wild fish. Hunting game animals illegally out-of-season has the potential to reduce breeding populations to dangerously low levels. These same activities conducted at other times may have little effect on either the environment or the wild animal populations.

KEY INTERNET SEARCH WORDS
riparian zone

The **riparian zone** is the land adjacent to the bank of a stream, river, or other waterway, see Figure 20–25. A rancher who allows his cattle to repeatedly overgraze the riparian zone may contribute to severe damage of the natural plant cover in the area. Loss of plant cover accelerates the loss of topsoil and increases the **silt load** of streams and rivers. Silt destroys spawning areas for fish, and it can kill young fish when the water is muddy for extended periods of time. Silt also fills in lakes and reservoirs as it settles out and sinks to the bottom.

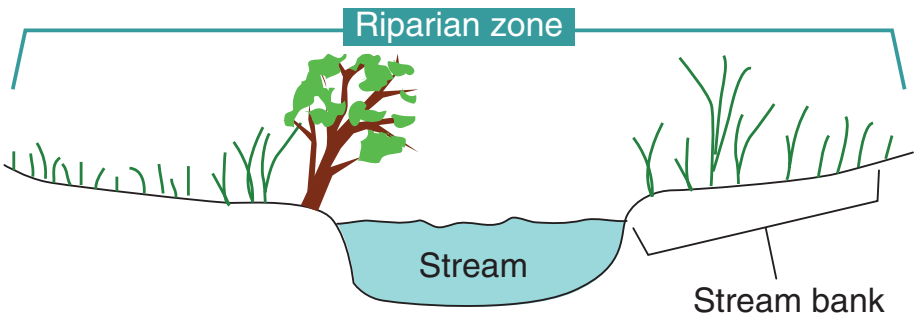


Figure 20–25 The riparian zone consists of the stream or river and the land adjacent to the stream bank.

A single abuser of a natural resource is likely to damage the trust relationship that is necessary for the multiple-use concept of management to work effectively. Blame for abuse to a natural resource is often assigned to all of the people who are known to use the resource. In some cases, they are considered to be abusers even when they can prove that they are responsible managers.

WILDLIFE CAREERS

Employment opportunities are diverse within the industries that support fish and wildlife. Professional managers and technicians are needed to manage wildlife, rangelands, and forests. Other employment opportunities exist in equipment sales, wildlife research, outdoor recreation, hospitality, and tourism. All of these career opportunities require some knowledge and understanding of the wildlife resources that are found in North America.

Education

A wide range of educational experience is required in order to prepare for a career in wildlife management. It is a good idea to plan your career education while you are still in high school. Wildlife management is based on science, and your high school education should include a strong math and science component. You should investigate the agricultural and natural resource programs in your high school to see whether it offers some hands-on courses that include wildlife management. Many agricultural science programs offer educational options in fish and wildlife.

Community colleges and technical colleges offer programs that prepare you to enter your career as a technician or transfer your college credits to a bachelor degree program at a four-year college or university. Whether you choose the technical education route or an academic education program, you should take full advantage of your education opportunities before you get too far along in your career. It is almost always easier to seek your education when you are young than it is to go back to college when you have family obligations that require your time and resources.

Supervised Experience Programs

Most good career education programs include work experience that is related to the classroom training. Some of the more common of these include internships, apprenticeships, co-op work experiences, entrepreneur and ownership experiences, and clinical experiences.

A supervised experience program consists of work-related experiences of several kinds that are provided outside of the regularly scheduled classroom or laboratory experience. Supervised experience programs provide opportunities to “learn by doing.” They provide the means for you to learn with the help of your parents, teachers, employer,

or other adults who have experience in the area of your interest. The supervised experience program is planned as an integral part of classroom instruction.

Planning is important in assuring that the supervised experience program is interesting and effective. Consider the following supervised experiences, and then expand the list as you prepare to participate in this phase of your career education:

- Purchase and raise a small flock of quail chicks or other game bird to be offered for sale or consumption by your family.
- Obtain a part-time job related to fish and wildlife. This might include employment at a fish hatchery, local park, zoo, fish/wildlife agency, or wild animal refuge.
- Become a volunteer with a local wildlife organization such as Pheasants Forever, Whitetail Foundation, Ducks Unlimited, the Bighorn Sheep Foundation, or another organization that promotes wildlife conservation.
- Determine who the local experts are in caring for injured wildlife, and volunteer your services.
- Conduct a wildlife survey of the area where you live. Seek opportunities to tell what you have learned about local wildlife issues by speaking to service clubs and other local organizations.
- Conduct a science project related to fish, birds, or other wildlife. Ask your science teacher or another knowledgeable adult in your community to help you identify a topic and plan the study. Enter your work in science fair competitions.
- Join the National FFA organization and enter your science project in the agriscience award program through your local FFA chapter.

Once you have selected and planned a supervised experience program, it should be implemented carefully. Write a business agreement, and ask all of the participants to sign it. The agreement is your way of making sure that everyone knows and understands what he or she is expected to do to assure that the supervised experience program is successful. The agreement also gives each participant an opportunity to provide input into the program. The suggestions of each participant should be considered for incorporation into the business agreement.

It is a good idea to often meet with those who provide supervision to your project. In this way, you can make adjustments to the plan when things don't work out the way they were planned. The key to having a successful supervised occupational experience is to step up when unexpected problems arise. Learn to solve problems rather than becoming discouraged by them. Careers encounter unexpected problems, too, and it is more important to learn problem-solving skills than it is to conduct a perfect project that encounters no difficulties. In other words, the project should provide some of the actual experiences that you might expect to have during your career. This includes both positive and negative experiences. You are likely to learn as much from your problems as you will from your successes.

No project is complete until a final report has been prepared. The report should include a complete description of the planning and implementation processes that you followed in conducting the project. It should include a discussion of the results that were attained, the problems that were encountered, and solutions to those problems. Describe what went well and what you would do differently next time. A summary of what was learned is a fitting conclusion to a supervised experience program report.

Employer Expectations

Employers are looking for career-minded people who have learned some fundamental behaviors before they enter the job market. For example, they expect all of their employees to come to work every day that they are scheduled to work. It is not the right of any employee to call in sick when he or she wants a day off. This is a case of dishonesty in action, and it will get you fired no matter how good your technical skills may be. You do your employer no good if you don't show up to do the work.

One of the most common complaints that employers have about new employees is that they do not come to work on time. You will be expected to arrive a few minutes early every day, and a person who consistently does this will be noticed. You will also be noticed if you do not demonstrate punctual work habits. Once you show up at work, you are expected to complete the work assignments that are given to you. Life is not a coffee break! You must deliver a solid performance in completing your work and doing the job right the first time. Nobody is happy when you have to do the work over because mistakes were made. There may be no second chances to do the job right when you are working with endangered species.

Employers want their employees to be able to communicate with others. Don't be afraid to ask if you do not understand what is expected of you. Wildlife projects are usually managed by individuals working in teams, and each team member must do his or her part in order for the project to succeed. Communication between team members is vital to the project's success. A team member who works independently from other team members or who does not communicate with them is not likely to do well in a wildlife management career.

Every employer has the right to expect employees to demonstrate good citizenship, both in their work and in their private lives. Most job applications ask whether a candidate has been convicted of an illegal act. Failure to answer this question honestly is cause for termination from the job. In order for an organization to be productive, the element of trust is needed. Trust should exist between the employer and the employee, and it should also exist among the employees. Good citizenship is a positive employee trait. Poor citizenship leads to destructive behavior and poor performance.

Occupational Safety

Safe working conditions are among the most valued expectations of employees and employers. Regardless of the career field you have chosen, most people place great importance on personal safety. Safety training is an important part of preparation for work and careers in every aspect of fish and wildlife management. It is necessary to prevent injuries during the operation of machinery and equipment. Workers in isolated outdoor locations require training in order to avoid injuries to themselves and others and to respond appropriately to emergency situations when they arise.

Safe work habits are cultivated by thinking through each work situation in an effort to identify potential safety hazards. Safety training should include procedures that help workers select ways to approach dangerous work situations in ways that will reduce risk of injury. Safety conscious workers learn to recognize where they should position themselves to reduce risk in hazardous work settings. For example, wildlife careers often place workers by themselves in isolated places. When it is necessary to operate a chainsaw under such circumstances, it is important to take the time to analyze where a tree is likely to fall. Decide ahead of time where your best escape routes are. Falling trees do not always remain where they fall. Sometimes they are very unpredictable, bouncing toward the operator off forest undergrowth or heavy limbs. For reasons of personal safety, a seasoned worker should avoid standing in a direct line with a falling tree.

Workers who have developed safe work habits do not place their hands or any other part of their bodies near moving gears, chains, or pinch points of any kind. The high-powered nature of such a device has the potential to cause the loss of arms, hands, fingers, feet, legs, and life itself. Safe work practices contribute to successful careers, but indifference to safety often results in serious injuries to individual workers and those who work with them. The best protection against personal injury is to carefully avoid high-risk situations.

Fish and wildlife careers often involve the use of boats, trucks, aircraft, all terrain vehicles, and snow machines. Each of these vehicles is dangerous under some conditions, and people who work in these careers need to know the capabilities of their machines and equipment. They also must be capable of exercising good judgment. For example, it is almost always better to wait for conditions to improve than to put the lives of yourself and others in unnecessary danger. There is little chance to recover from an aircraft mishap, a backcountry snowmobile crash, or a water-related accident.

No amount of safety gear, high-quality equipment, government and company policies, or safety training can protect a worker who does not personally adopt safe work habits. These are the people who refuse to wear hardhats, safety glasses, hearing protection, and steel-reinforced shoes because they consider them to be ugly, uncomfortable, or inconvenient.

A glass eye meets all of these conditions. It does not contribute to a person's ability to see, and it is ugly, uncomfortable, unsanitary, and inconvenient to wear. Take your choice: The final decision to work safely is really up to individuals as they choose to adopt or ignore safety procedures.

LOOKING BACK

Conservation of wildlife resources is important because all of the members of the animal kingdom are linked together in a huge food web. They are either food animals that provide food for other animals or they are predatory animals that eat meat. The rise or decline of a particular animal population affects all of the other animals that interact closely with it.

Humans are the only living organisms that can choose to exercise control over animal populations by modifying their environments or by subjecting them to or protecting them from their natural enemies. Farmers, ranchers, government agencies, and special interest groups should make reasonable efforts to work together to preserve declining populations of wild creatures. This can be done by conserving habitats and managing wildlife resources in a responsible manner. Unbiased scientific research should guide all conservation efforts. Management decisions should also be balanced with the needs of humans to use natural resources.

Chapter Review

DISCUSSION AND ESSAY

1. Describe some ways that private landowners can contribute to responsible management of wildlife resources.
2. List some positive and negative effects that modern farming practices have on wildlife habitats.
3. Suggest ways that farmers and ranchers might improve wildlife environments.
4. Describe the ways that modern industries have affected wildlife environments, and suggest ways that such problems might be corrected.
5. Identify some sources of pollution that come from cities and towns, and describe the general effects of urban development on wildlife environments and populations.
6. Explain how the restoration and conservation of wildlife habitats affects the profit potential of game farms, ranches, and preserves.
7. Define the roles of environmental organizations in the conservation of wildlife populations and habitats.

8. Explain how some recreational activities contribute to damaged environments and cause stress to wildlife populations.
9. Suggest some practices that government agencies might use in managing and protecting wildlife habitats and populations.
10. Describe how national parks, monuments, and preserves contribute to the preservation of wildlife populations and habitats.
11. Propose ways in which national and international laws affect the preservation of wild animals and the environments in which they live.
12. Explain the multiple-use concept of management for public lands.
13. Discuss the effects of soil erosion on wildlife habitats and populations.

MULTIPLE CHOICE

1. Conservation practices are most likely to be implemented when the conservation practice:
   a. Requires people to change their practices without personal benefits
   b. Is favorable to the threatened species
   c. Results in personal benefits to those who implement
   d. Is promoted by special interest groups
2. Success in implementing conservation practices depends on individual landowners because:
   a. They have a greater opportunity than anyone else to affect conservation efforts
   b. They make the management decisions concerning the uses of the property
   c. They have a greater potential for damaging habitats through poor management
   d. All of the above
3. The number one cause of water pollution in North America is:
   a. Erosion
   b. Chemical contamination
   c. Pollution from factories
   d. Animal waste
4. The people most at risk from pollution due to misuse of agricultural chemicals are:
   a. People who live in cities
   b. Suburban communities
   c. Farm families
   d. Homeless persons
5. A toxic waste that can be broken down to harmless chemicals by living organisms is classified as:
   a. Biodegradable
   b. Decomposer
   c. Nonbiodegradable
   d. Persistent
6. A condition in which the plant population in a range area has been damaged because too much of the plant material has been consumed by animals is known as:
   a. Erosion
   b. Overgrazing
   c. Stewardship
   d. Multiple use

7. Pollution that is caused by sulfur and nitrogen oxides is called:

   a. Acid precipitation
   b. Nonpoint source pollution
   c. Point source pollution
   d. Fall-out

8. Waste materials that enter a stream or other body of water from a single location are referred to as:

   a. Fall-out
   b. Nonpoint source pollution
   c. Acid precipitation
   d. Point source pollution

9. Untreated runoff water from cities and suburban areas often contains high levels of lawn and garden chemicals that become serious pollutants to:

   a. Watersheds
   b. Surface water
   c. Forests
   d. Crops

10. The federal agency that has the greatest responsibility for maintaining wildlife populations is the:

   a. U.S. Forest Service
   b. U.S. Fish and Wildlife Service
   c. U.S. Department of Agriculture
   d. U.S. Bureau of Land Management

Learning Activities

1. Invite a resource specialist to instruct the class on the correct procedure for conducting an environmental impact study. (Names of such people can be obtained from government agencies such as the Environmental Protection Agency, Bureau of Land Management, Forest Service, and so forth.) Choose an area near your school where the class can conduct a limited study of the environmental impacts that might be expected if a subdivision or other development were to be constructed there. Use this exercise to demonstrate to the students that developing land affects the suitability of the area as wildlife habitat.

2. Contact the local Soil Conservation Service district office and request the help of their professionals in locating an area where severe soil erosion has occurred. Take a field trip to the area and observe the damaged site. Measure the depth of the soil layers and compare your findings to a soil map of the area. Discuss ways the soil might be managed to prevent further topsoil losses.

CHAPTER

21

Conservation of Natural Resources

Conservation is the practice of protecting natural resources against harm and waste. It involves using less of a resource than is available, so that future generations may also benefit from its use. Conservation of resources does not necessarily mean that the resources are not used, but that they are not used in a wasteful or careless manner.

After completing this chapter, you should be able to:

- define conservation and provide examples of conservation practices affecting natural resources
- distinguish between renewable and nonrenewable resources
- identify the major destructive forces that contribute to soil erosion
- explain the relationship between soil erosion and water pollution
- describe some serious consequences that soil erosion imposes on wildlife resources
- suggest some conservation practices that are known to reduce soil losses due to erosion
- name the most common pollutants of water supplies, and describe their effects on wildlife
- suggest some ways through which surface water can be protected against pollution
- discuss the effects of air pollution on wild animals and the environments in which they live
- list the sources that contribute most to air pollution
- discuss the ways that air pollution can be reduced or eliminated
- describe some conservation practices that are used to preserve and restore wildlife populations and habitats
- appraise the use of biotechnology as a tool in reclaiming damaged and polluted resources.

KEY TERMS

conservation
renewable resource
nonrenewable resource
silt
alluvial fan
nitrate
phosphate
algae
adaptive behavior
smog
imprinting
biotechnology
genetic engineering
catalytic converter
wet scrubber
electrostatic precipitator

Natural resources fit into two broad categories. Resources that can be replaced by natural ecological cycles or by sound management practices are known as **renewable resources**. They include such resources as forests, water, and wildlife, see Figure 21–1. Resources that are depleted by use are called **nonrenewable resources**, see Figure 21–2. These resources include such things as soil, oil, coal, and mineral deposits.

Conservation practices for renewable resources should restrict their use to ensure that they are used no faster than they are regenerated. This rate of use should sustain a constant supply of such resources for as long as they may be needed.

Conservation of nonrenewable resources is accomplished by reducing the rate at which these resources are used to make them last longer. This can involve recycling metals or even plastics (derived from petroleum) to reduce the necessity for extracting new materials. Conservation of these resources must ensure that they are not used up before we learn to replace them with other resources.

Figure 21–1 Renewable resources include water, plants, forests, and wildlife. *Courtesy Wendy Troeger*.

Natural Resources	
Renewable	**Non renewable**
Forests	Coal
Water	Oil
Plants	Soil
Wildlife	Minerals

Figure 21–2 Renewable versus nonrenewable natural resources.

CONSERVING THE SOIL

KEY INTERNET SEARCH WORDS
renewable natural resources

Soil that is protected from damage is important in maintaining wildlife habitats. Without good soil, it is impossible for the plants to grow that are required by people and wild animals for food and shelter. It is important to maintain farmland soils to support the production of crops, because it slows the tendency to convert wildlife habitat to new farmland.

KEY INTERNET SEARCH WORDS
soil conservation

Soil conservation was defined in Chapter 20, "Responsible Management of Wildlife Resources," as the practice of protecting soil from the destructive forces of wind and water. The erosion of soils also was cited as the greatest source of water pollution known to man. Many tons of soil are lost from the land each year through the combined effects of erosion by wind and by flowing water, see Figure 21–3.

Both wind and water carry soil particles to new locations. Massive amounts of **silt** consisting of tiny soil particles become suspended in water as it flows over exposed soil surfaces. When the streams enter lakes and ponds, the rate of flow is reduced and the particles settle to the bottom, forming large deposits of silt that eventually fill the lake or pond. Some ancient civilizations benefited from upstream erosion because the rivers flooded their farms each spring depositing new silt. This kept their soils fertile and productive. Our problem today is that some land management practices result in too much silt being carried and deposited downstream beyond the natural flood plains.

KEY INTERNET SEARCH WORDS
soil erosion

Erosion of soil is not a new problem. It is a natural process, as evidenced by the river channels and canyons that have been cut through the surface of the land over thousands of years. Erosion is also evident in the formation of **alluvial fans** where streams enter from a gorge into a plain or where a tributary stream joins with the main stream. Alluvial fans are composed of rocks, gravel, sand, and silt that have been carried

Figure 21–3 When the wind is particularly strong at the ground level, it can cause serious damage to the soil. *Courtesy USDA.*

Figure 21–4 Topsoil contains most of the growing nutrients and must be maintained to ensure a good crop. *Courtesy USDA.*

to the area by streams of rapidly flowing water. They consist of huge soil deposits formed from materials that eroded from the soil surface further upstream. They are deposited where the flow rates of the streams and rivers slow down. Such events occur over long periods of time.

Erosion of soils reduces their capacity to produce crops. The topsoil is the most affected layer, and it contains most of the nutrients that are needed by plants, see Figure 21–4. Soils are formed over long periods of time and should be treated as nonrenewable resources. We must conserve them by reducing or eliminating erosion losses.

Erosion is a very destructive force that has serious consequences for crop production and for fish and other wildlife. Fish spawning grounds that are filled with silt may prevent fish eggs from getting the oxygen necessary to sustain life. Eggs become coated with silt particles and the fish embryos soon die. Young fish may also be injured by water polluted with silt.

Erosion becomes more intense when the plant cover is removed from soil surfaces, see Figure 21–5. As the North American continent was colonized, most of the land considered suitable for tillage was

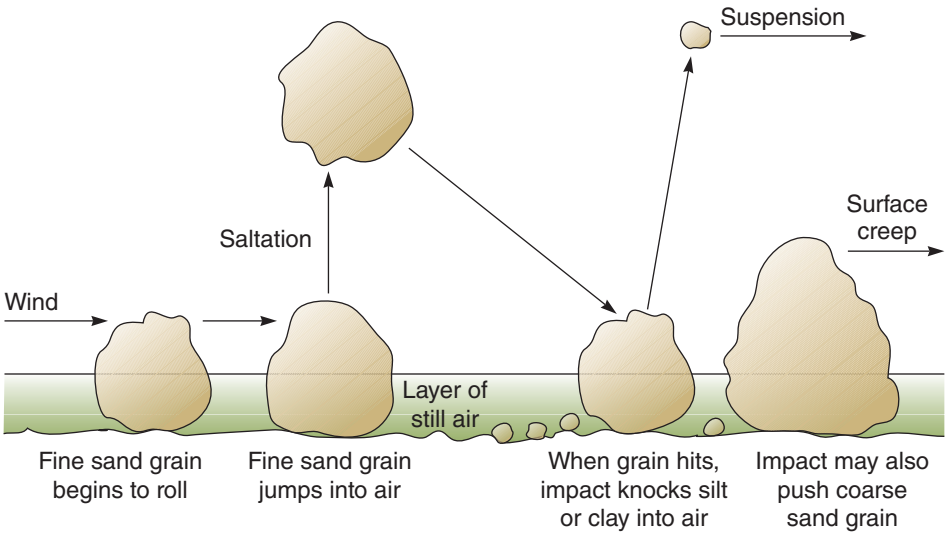


Figure 21–5 The lack of plant cover often results in soil erosion in areas where strong, gusty winds prevail.

developed for the production of crops. Some of these farmlands are located on slopes that are vulnerable to erosion. Tillage practices that remove plant cover during the winter season leave the soil exposed to the forces of erosion from wind, heavy seasonal rains, and flowing water from snowmelt.

Serious soil erosion often follows range, forest, or grassland fires, see Figure 21–6. This is due partly to the loss of the plant cover that protects the soil surface. Fire also breaks down soil structure and causes it to be more easily damaged. Special conservation measures are necessary following fires that cover large areas. One important practice is to reseed the area with grasses and other cover plants to stabilize the soil as quickly as possible.

Figure 21–6 Serious erosion often follows devastating fire in areas where steep slopes and loss of ground cover converge.

Forest lands are protected following timber harvests by gouging holes in the forest floor to trap runoff water. In this manner, water is held on the surface until it is absorbed into the soil. This practice effectively prevents excess water from flowing across the soil surface where it might cause erosion. Properly constructed logging roads prevent water from running down the road surfaces in large streams. The water is channeled off the road and into areas that have stable ground cover.

Soil conservation practices for farms include many practical ways of protecting soil surfaces and slowing the movement of water or wind across the soil. Examples of such practices are planting windbreaks, creating dikes along the contours of fields and hills, adapting no-tillage or minimum tillage farming practices, planting grass waterways, and planting high-risk fields to permanent cover crops, see Figure 21–7.

Figure 21–7 Windbreaks are created to reduce wind erosion by slowing down the speed of the wind across the surface of the soil. Courtesy USDA.

MAINTAINING A PURE WATER SUPPLY

KEY INTERNET SEARCH WORDS
water quality

Pure water is one of the most important resources required by fish and wildlife, see Figure 21–8. It provides drinking water and living environments to many of the animals that make up natural ecosystems. Pollution of aquatic resources can have serious consequences for fish and wildlife.

Water pollution occurs when any foreign substance is dissolved or suspended in water. Suspended silt particles are the most frequent pollutants of water supplies, but many other substances also pollute water. Some of the most common pollutants are industrial wastes, excess fertilizers, pesticides, oil, chemical spills, and sewage. Each of these substances can be found in the water supplies of North America, and all of them damage wildlife populations.

Figure 21–8 Clean watersupplies benefit all of the animals that share rangeland resources.

Clean water can be maintained only when everyone acts in a responsible manner to protect it. Legislation has been enacted to penalize people and institutions who are negligent in protecting water resources, but it is sometimes difficult to locate the exact source of water pollution. However, laws have helped to reduce industrial pollution of lakes and rivers in recent years.

INTERNET ADDRESS

http://www.ncsu.edu/sciencejunction/depot/experiments/water/lessons/np/

KEY INTERNET SEARCH WORDS
nitrates
phosphates
algae

Pollutants that sometimes occur in surface water are nitrogen and phosphorous compounds. The most common nitrogen pollutants exist in the form of **nitrates**. Phosphorous pollutants usually form compounds called **phosphates**. These compounds are found in fertilizers and organic matter. They are also found in residues from detergents. They are found in water supplies when inadequately treated sewage is released into

lakes and rivers or when fertilizers are dissolved in runoff water from fields, lawns, golf courses, parks, and gardens.

A high phosphate or nitrate content in water promotes the growth of tiny water plants called **algae**. Large growths of algae in a water supply use up the dissolved oxygen required by fish and other aquatic organisms. Sometimes, large numbers of fish die from suffocation. Severe algae blooms release toxins or poisons into the water supply that can kill animals that drink it or live in it, see Figure 21–9.

Water pollution can be reduced in several ways. All industrial wastes and raw sewage must be treated using proven methods to remove pollutants before the treated water is released into surface waters. Water runoff from fields must be trapped when possible, and recycled back to the fields to prevent it from carrying dissolved pesticides and fertilizers into streams and lakes. Buffer zones should be created between human activities and streams to prevent erosion and accidental contamination of surface waters.

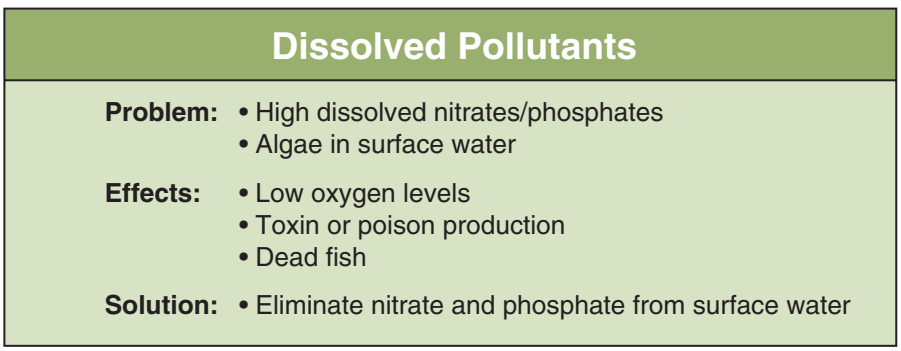


Figure 21–9 The problems, effects, and solutions of dissolved pollutants.

Runoff water from streets in cities and towns must be treated before it is released back into the environment, see Figure 21–10. Toxic chemicals and their containers should be properly disposed of to prevent contamination of water resources. Garbage must no longer be dumped into oceans and waterways. Greater care must be taken to prevent oil and chemical spills from ships, railcars, and trucks, and better methods are needed for cleaning up the spills that do occur.

Individual citizens must learn to appreciate the importance of preserving water resources and maintaining water purity. Until this happens, we will always be faced with pollution problems caused by the careless or irresponsible actions of people.

Figure 21–10 A view of a water treatment facility. *Courtesy Shutterstock.*

PRESERVING AIR QUALITY

Air is a natural resource upon which plants and animals depend for survival. The greatest hazard to wild animals and fish, however, comes from the effects of acid rain on the surface waters and plants that provide them food and shelter.

The weak acids that are formed when rain combines with pollutants in the atmosphere are capable of killing forests and destroying living organisms in streams and lakes. These problems are evident in North America and in many other industrialized nations. The exhaust gases from cars and trucks are the greatest sources of atmospheric pollution, see Figure 21–11, but factories and electrical power plants that burn coal and petroleum products also emit large amounts of polluted gases into the atmosphere. Ultraviolet light from the sun reacts with atmospheric pollutants, adding to the atmospheric haze. The result of this atmospheric pollution is a great cloud of polluted air called **smog**. Part of the problem has eased since the development of vehicles that burn unleaded gas. However, exhaust gases continue to pose a threat to the environment near large population centers because people tend to drive more cars and travel longer distances each year.

Figure 21–11 Exhaust gases from cars, buses, and trucks are the greatest sources of air pollution. *Courtesy USDA.*

Career Option

ENVIRONMENTAL ANALYST

AN ENVIRONMENTAL ANALYST USES science and engineering principles to find ways to prevent and remove pollutants from the environment. This career requires integrity, good research skills, and an ability to gather data and analyze it properly.

Data is gathered from samples of air, soil, water, plants, animals, and other sources. A college degree is required that combines the disciplines of science, engineering, and mathematics (statistics).

One serious aspect of air pollution is that pollutants are carried by the wind to other areas. This creates damage to the environments of wild animals and fish, particularly those that live near large cities. Some regions along the eastern and western coasts of North America have sustained considerable amounts of damage from acid rain.

The solution to these problems is to remove as much of these pollutants from emission gases as possible before they are released to the atmosphere. We would also be wise to cut back on the amount of gases that are produced. One possible way to do this is to create effective mass transit systems in our cities that reduce dependence on personal cars. In addition, we should also research new industrial processes that require less energy.

As people begin to experience the effects of pollution on the atmosphere in the form of lung and skin diseases, there will be greater motivation to solve the problems created by harmful atmospheric gases. Human nature is to ignore problems that do not appear to affect us directly. It is unlikely that people will do much to improve air quality for wild animals; however, wild creatures will benefit when humans take steps to improve air quality for themselves.

Laws have been enacted by the U.S. Congress that are intended to prevent loss of air quality and to clean up air quality problems that we already have. The first significant laws for this purpose were the Clean Air Act of 1963 and the Air Quality Act of 1967. These laws required reductions in pollutants that were getting into the atmosphere as a result of industrial pollution. These laws have been expanded and updated several times since they were first enacted.

The Clean Air Act of 1970 and the Clean Air Act of 1990 are the most far-reaching of the air quality laws. From these versions of the law, a series of clean air amendments has been approved. New federal and state agencies have been created to interpret and enforce the laws. Among these are the Environmental Protection Agency (EPA), the Office of Air Quality Planning and Standards, the Alternative Fuels Data Center, and the Commission for Environmental Cooperation. Each of these government offices has created new regulations and standards for air quality.

Among the federal standards that have been implemented are the Clean Air Act National Ambient Air Quality Standards, the Clean Air Act New Source Performance Standards, the Prevention of Significant Deterioration, Air Guidance Documents from EPA, and Updated Air Quality Standards for Smog (Ozone) and Particulate Matter. Each of these air quality standards is intended to reduce air pollution and improve air quality.

PRESERVING AND RESTORING WILDLIFE POPULATIONS AND HABITATS

KEY INTERNET SEARCH WORDS

preserve wild life

The settlement and colonization of North America by European immigrants opened new frontiers to the European nations. They saw an abundance of natural resources and raw materials in America that eventually attracted new industries to the New World. Forests were cut to provide homes and fuel, land was cleared, and swamps were drained to produce crops, and wild animals were harvested to supply food and clothing.

This pattern continued as settlements moved westward. Industries were established to process raw materials, and vast acreages of land were converted from wildlife habitat to farms, see Figure 21–12. Many wildlife populations were reduced, and some animals became extinct as land was converted for new uses. Some species were completely eliminated from the ranges that they occupied before settlement of the land.

Wildlife habitats can never be restored as they were when the Native Americans were the only people who occupied the land. Herds of bison will never roam the Great Plains as they once did, and the rivers will probably never have the abundance of fish and other wildlife that once existed there. All of this is in our past; however, some wildlife habitats and populations can be restored, and those that still exist can be preserved.

Several proven methods are available to restore fish and wildlife to suitable habitats. They include transplanting birds or other animals from areas where they are abundant to areas where populations have been depleted or no longer exist. Some of the most successful of these programs have moved species such as elk, bighorn sheep, and wild turkeys to suitable locations where they are no longer found or where they have never existed.

Figure 21–12 As the industries' need for raw materials increased, so did the conversion of wildlife habitat to farms.

Many different species of fish are raised in hatcheries for the purpose of transplanting them to streams, rivers, and lakes, see Figure 21–13. This is done to supplement wild fish populations and for the purpose of providing adequate numbers of fish for sport fishing. Large numbers of game birds are also raised each year for the purpose of releasing them into the wild for hunting. Birds and fish that are raised in captivity are released with the intent of harvesting them. This is because they are likely to have a hard time surviving without the skills that wild fish and birds have learned.

Figure 21–13 Many species of fish are currently being raised in hatcheries for the purpose of supplementing populations of wild fish.

KEY INTERNET SEARCH WORDS

California condor recovery

ECOLOGY PROFILE

California Condor Recovery Effort

One of the most interesting recovery efforts ever undertaken by scientists is the attempt to save the California Condor from extinction, see Figure 21–14. Condor eggs have been removed from the nests of wild breeding pairs, and the young birds have been raised in captivity. Young birds are fed by a puppet-like foster parent from the time of hatching until they learn to gather their own food. This practice was adopted to keep them from imprinting on human parents. Several birds have been returned to the wild with mixed results. Some of the birds have been recaptured because they were not adapting well to life in the wild. Others appear to be adjusting, but long-term survival may prove to be difficult for them.

Figure 21–14 The endangered California condor has been preserved from extinction, at least for now, through the recovery efforts of science. *Courtesy U.S. Fish and Wildlife Service.*

Some endangered species of birds are raised in captivity with the intention of adding them to wild flocks. The people who care for young birds must take steps to prevent them from **imprinting** or learning to mimic behaviors of humans. It is important that they learn to recognize and be attracted to birds and not to humans. If they are to survive in the wild, they must learn to act like the birds of their species and not like the people who raised them.

RECLAIMING DAMAGED OR POLLUTED RESOURCES

Pollution of a resource is usually quite difficult to overcome. It requires finding the origin of the pollutants and preventing their release at the source. It may also be necessary to remove the pollutants from the contaminated area, see Figure 21–15. When this cannot be done, ways must be found to dilute or to break down the pollutants into nontoxic substances.

The science of **biotechnology** is relatively new, but it has important environmental applications. Scientists in this field are altering the genetic composition of some living organisms. They have, for example, found ways to change bacteria to enable them to ingest and detoxify pollutants. Through a biotechnology practice known as **genetic engineering**, the genes of bacteria are modified to enable them to ingest and break down pesticides and other chemicals. This is an important scientific advancement that may help reclaim damaged resources.

INTERNET ADDRESS

http://response.restoration.noaa.gov/Kids/spills.html

KEY INTERNET SEARCH WORDS

clean up oil spills

Figure 21–15 Clean up of an oil spill is a long and difficult process that is improved by using engineered bacteria to detoxify pollutants. *Courtesy U.S. Fish and Wildlife Service. Photo by R. Will Roach.*

INTERNET ADDRESS

http://www.epa.gov/air/caa

KEY INTERNET SEARCH WORDS

Clean Water Act

Most of the pollution of our water resources comes from untreated sewage and industrial waste. Since the Clean Water Act was first passed by Congress in 1972, billions of dollars have been spent to build treatment plants to reduce waste discharges into waterways. This law, which was strengthened in 1987, is administered by the EPA. The goal of the Clean Water Act is to clean wastewater well enough that it will be safe to swim and fish in it. It is illegal for cities to dump sewage that has not been treated, and industries are required to stop pollution by using the best practicable technology that is available, see Figure 21–16.

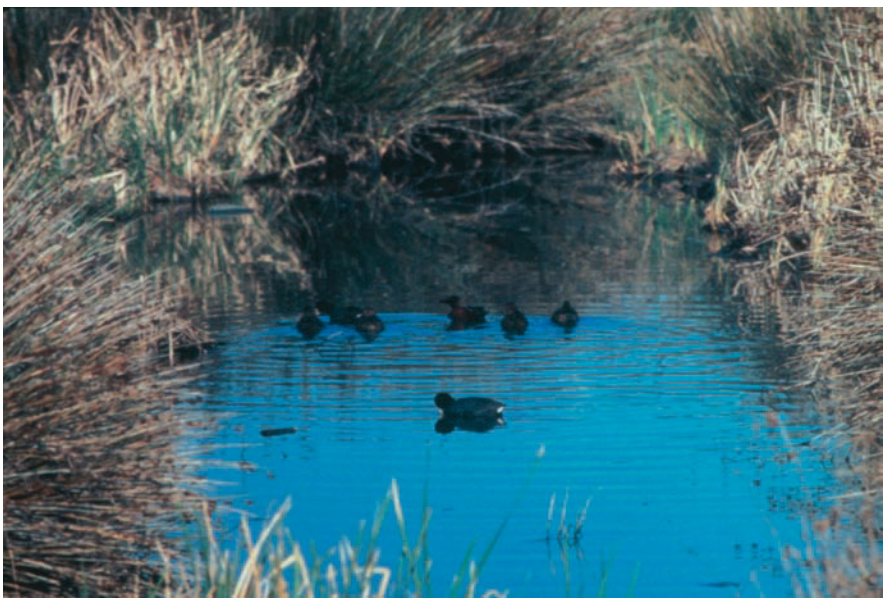


Figure 21–16 The goal of the Clean Water Act is to clean wastewater well enough so we will be able to swim and fish in it.

INTERNET ADDRESS

http://www.epa.gov/air/caa

KEY INTERNET SEARCH WORDS

Clean Air Act

Water that contains nitrates and phosphates can be cleaned by bacteria and/or plants before it is released back into streams. This process is known to occur naturally as water passes through marshes and swampy areas, see Figure 21–17. It is also possible to create man-made marshes that are capable of performing the same function.

A lagoon is a man-made pond where wastewater is stored for three or four weeks. During this period, bacteria and algae metabolize dissolved nutrients and many of the solids. Several lagoons linked together in a series are capable of cleaning water sufficiently to enable it to be released into streams and rivers.

As with water, the first step in reclaiming polluted air is to eliminate the source of the pollution. The Clean Air Act was first passed by Congress in 1970. This act requires that air pollutants such as nitrogen oxides, hydrocarbons, sulfur oxides, and carbon monoxide be reduced. The responsibility for setting clean air standards was assigned to the EPA.

EPA standards require newer vehicles to be fitted with emission control equipment that removes significant amounts of pollutants from exhaust fumes. A **catalytic converter** is installed to convert dangerous emissions to harmless materials. Engines have also been designed to operate smoothly while burning unleaded gasoline. This reduces lead

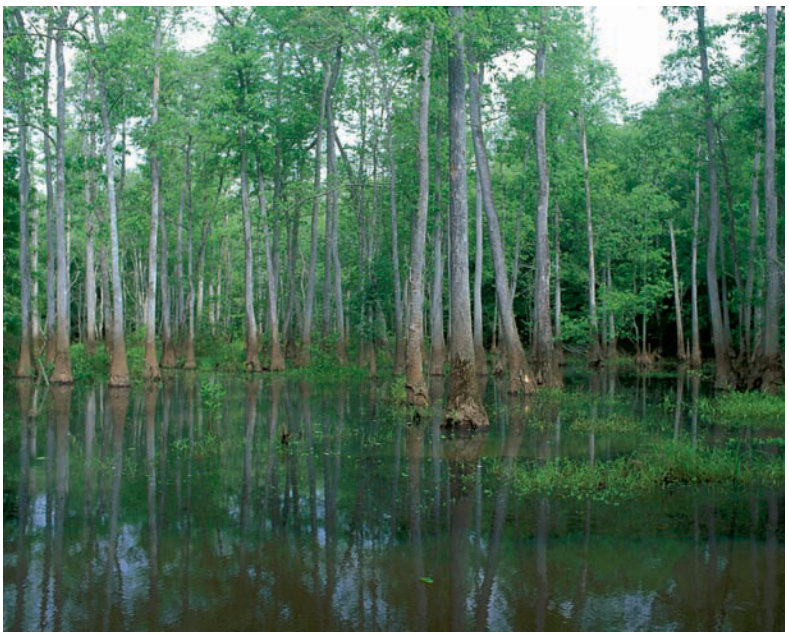


Figure 21–17 Marshes and swamps act as natural water purifiers. *Courtesy U.S. Fish and Wildlife Service. Photo by John and Karen Hollingsworth.*

contamination in the air and protects the catalytic converter in the exhaust system. Lead forms a coating on the catalyst metal when it is present in gasoline. This coating prevents the catalyst from reacting with exhaust gases to reduce exhaust emissions of pollutants—especially nitrogen oxides and hydrocarbons.

Smoke and gases from factories are cleaned in several ways. Catalytic converters decrease nitrogen oxide and hydrocarbon emissions into the atmosphere. A **wet scrubber** is a device that sprays water into a chamber through which polluted gases are passed. It washes particles from the gases and absorbs water soluble materials such as sulfur dioxide. A new technology known as fluidized-bed combustion enables conversion of sulfur dioxide to gypsum by mixing limestone with coal in a controlled combustion chamber.

Particles can also be removed from gases by passing the gases over two electrically charged fields of opposite charges. The first field charges the particles in the gases, and the second electrical field attracts and holds suspended particles, see Figure 21–18. These devices are called **electrostatic precipitators**.

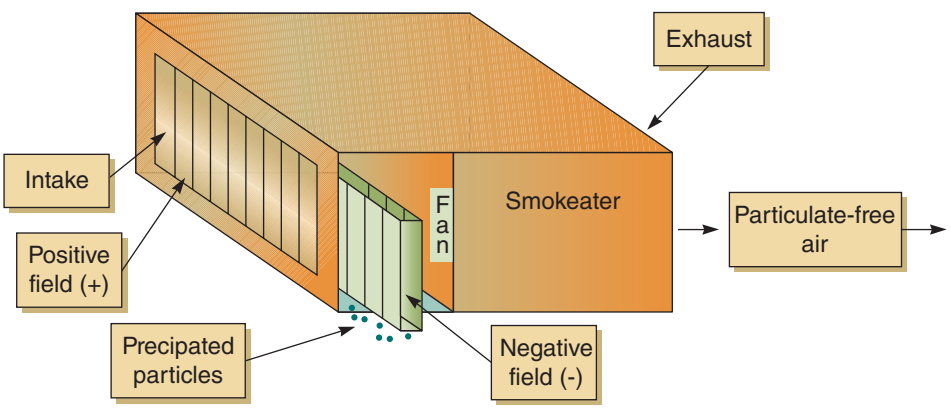


Figure 21–18 Electrostatic precipitators remove particles from the air.

The 1970 Clean Air Act has helped to reduce air pollution. Tall smoke stacks that disperse harmful gases over larger areas instead of eliminating their release are no longer legal for pollution control. The current law requires each state to develop a state implementation plan (SIP) that describes how the state will meet the Act's requirements.

LOOKING BACK

Conservation of natural resources is the practice of using resources carefully to avoid waste. Renewable resources are regenerated, and wise use of them will ensure a constant supply of these resources for the future. Nonrenewable resources are those that cannot be replaced. Conservation of these resources involves using them in limited amounts to slow the rate at which they are depleted. Wildlife resources are usually considered to be renewable.

Soil resources are eroded by the forces of wind and flowing water. Water pollution occurs when silt and other pollutants contaminate water supplies. Air becomes polluted by waste gases and suspended particles from the combustion of wood, coal, and petroleum products. All of these resources can be protected, and attempts to reclaim damaged or polluted resources are being made using the technologies available through modern science.

Chapter Review

DISCUSSION AND ESSAY

1. Define conservation as it relates to wildlife and natural resources.
2. Distinguish between renewable and nonrenewable resources, and give examples of each.
3. Identify the major destructive forces that contribute to soil erosion, and describe how these forces erode soil.
4. Explain the relationship between soil erosion and water pollution.
5. Describe some of the damaging effects of soil erosion on wildlife resources.
6. List some conservation practices that are known to reduce erosion, and explain why those practices are effective.
7. Name the most common pollutants of water supplies, and describe ways that they may affect wildlife.
8. Suggest ways of protecting surface water against pollution.

9. Discuss the effects of acid precipitation on wild creatures and the environments in which they live.
10. Name the most significant sources of air pollution.
11. Suggest ways that air pollution can be reduced or eliminated.
12. Describe some conservation practices that are used to preserve and restore wildlife populations and improve habitats.
13. List ways that genetic engineering is used to reclaim damaged and polluted resources.

MULTIPLE CHOICE

1. The practice of protecting natural resources against harm and waste is called:
   a. Conservation
   b. Preservation
   c. Resource renewal
   d. Biotechnology
2. A term describing a resource that is capable of replacing itself through reproduction or new growth is:
   a. Recycling
   b. Conservation
   c. Renewable resource
   d. Nonrenewable resource
3. Which of the following is not a renewable resource?
   a. Coal
   b. Water
   c. Soil
   d. Oil
4. Which of the following is not a renewable resource?
   a. Wildlife
   b. Soil
   c. Forest
   d. Plants
5. Select the term that most accurately describes the loss of soil from the land:
   a. Alluvial fan
   b. Silting
   c. Soil conservation
   d. Erosion
6. Which of the following contributes to soil erosion?
   a. Wildfires
   b. Construction of wind breaks
   c. No-till farming practices
   d. Too much fertilizer

7. The presence of phosphates or nitrates in surface water is dangerous to fish because:

   a. The chemicals poison the fish
   b. Algae and other plants use up the supply of dissolved oxygen from the water
   c. High phosphate levels in water are damaging to fish bones
   d. The presence of these chemicals creates hard water

8. Air becomes polluted by waste gases and particles from the combustion of wood, coal, and petroleum products. All of these resources can be protected, and attempts to reclaim damaged or polluted resources are being made using the technologies available through modern science.

9. An example of a wild species that has been successfully restored to an environment from which it had previously been lost is a/an:

   a. Passenger pigeon
   b. Ocelot
   c. Loggerhead sea turtle
   d. Bighorn sheep

10. Marshes and swamps act as natural water purifiers by:

   a. Converting pollutants to plant nutrients
   b. Causing water pollutants to evaporate
   c. Trapping pollutants in the mud beneath the water
   d. Straining the water through the marsh plants

Learning Activities

1. Prepare a demonstration of the effects of slope on erosion. Fill several trays with soil of the same type and texture. Raise one end of each tray to a different height to represent variations in slopes. Release a measured amount of water over the surface of each tray, making sure that the water is released at the same rate in each tray. This may be done by pouring the water through a gallon can with holes poked in the bottom. Collect the water that runs off the end of each tray using a plastic bag or other device. Filter the silt out of each water sample, and weigh the dried filter to determine the amount of soil that was eroded from each tray. Create a graph that summarizes the amount of erosion that occurred at each slope.

2. Invite a soil technician or scientist from the U.S. Soil Conservation Service to discuss the soil conservation practices recommended for your region. A field trip might be arranged to view some of the practices at the sites where they have been implemented.

3. Working in student teams, identify the major air pollution sources in your community or region. Research how the pollution sources have changed over the past 10 or 20 years, and what the relative contributions of industry, motor vehicles, incineration of trash, and so on have been to the pollution problem. Repeat the exercise for water pollution.

CHAPTER

22

The Human Connection to Wildlife and Natural Resources

After completing this chapter, you should be able to:

- explain how the dependence of humans on wild animals and plants became the basis for modern agriculture
- describe how medical science has benefited from plant materials
- appraise the importance of tropical forests as a source of new medicines for the relief of human ailments
- explain how a watershed functions to reduce flooding and to supply a constant flow of water in rivers and streams
- analyze the importance of natural cycles in renewing and cleansing the environment
- identify some recreational activities that are associated with wild animals and their environments
- relate the importance of wildlife and outdoor sports to commerce
- explain the principle of stewardship as it relates to outdoor environments and wild animals
- speculate on the importance of human ethics in maintaining natural resources.

Humans have always used natural resources and wildlife for their own purposes. We developed our food plants from wild plant varieties, and our domestic breeds of livestock and poultry came from wild animals and birds. Therefore, our very existence is possible because of wild plants and animals as most of our food and clothing can be directly linked to them. Wildlife and other natural resources also are valuable to humans for recreational and other purposes. It is difficult to imagine a world where the songs of birds did not exist or where wild creatures were gone from the landscapes. Wild animals bring pleasure to humans and they add to our own enjoyment of the world we share.

KEY TERMS

biota
domestic
transpiration
watershed
intrinsic value
pristine
steward
ethics

The total population of living organisms that is naturally found in an area is known as its **biota**. The biota of North America includes the forms of life that are found there, see Figure 22–1. Many different products and life-sustaining materials such as medicines are derived from the biota of North America.

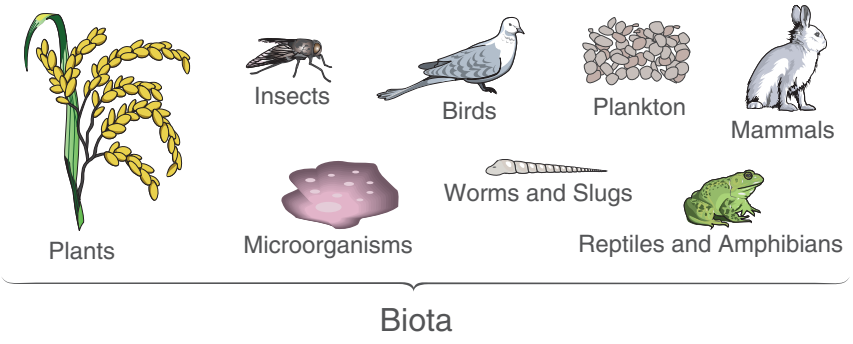


Figure 22–1 The biota of a specific area consists of all the species of plants and animals that are found there.

FOUNDATION FOR AGRICULTURE

Agriculture would not exist without wildlife, plants, and other natural resources. The first **domestic** animals were obtained from wild animal populations. They were tamed by our human ancestors and used to provide dependable sources of food and clothing. Later, they were also used as draft animals to pull farming implements.

Wild plants were also gathered by our early ancestors. Some of these plants were eventually raised near the homes of the people who used them. This concentration of food plants in the area made it easier to harvest them. The domesticated plants and animals that are used by farmers and ranchers today are quite different from their early ancestors, see Figure 22–2. Meat animals were selectively bred to bring about the genetic changes that are required to produce desirable meat

Figure 22–2 Through selective breeding, the shape and genetic makeup of meat animals is quite different from their early ancestors. *Courtesy NCRS.*

INTERNET ADDRESS

http://www.bonap.org/

KEY INTERNET SEARCH WORDS

biota

Figure 22–3 Recombinant DNA technology makes it possible to introduce genes from native species of plants and animals to introduce disease and pest resistance to domestic animals and plants. *Courtesy Utah State University Extension.*

Figure 22–4 Marshes and swamps are some of our most valuable resources because they are capable of purifying polluted surface water while providing a wildlife habitat.

in a short time. Dairy goats and cattle were selected for their ability to produce large amounts of milk, and different genetic lines of poultry were selected to produce eggs and meat. Less attention was paid to vigor because domestic animals were protected from severe conditions. As a result of selective breeding, domestic animals no longer have the vigor or the resistance to parasites that is evident in their wild relatives. Wild animals and plants are selected mostly for their ability to survive in the environments they live in. As a result, wild animals and birds do not produce as much meat, eggs, or milk as domestic breeds; however, they have the genetic ability to withstand severe conditions in their natural environments.

Wild animals that do not have this trait do not survive to reproduce large numbers of offspring. Scientists are examining the genetic makeup of many wild species of animals and plants in their search for natural resistance to diseases and parasites. It would be wise to investigate the potential genetic value of wild species to our domestic species of plants and animals. Genetic engineers are likely to find many important genetic traits among wild species of animals and plants that can be transferred to domesticated species, see Figure 22–3.

SOURCE OF MATERIALS FOR MEDICINES

Many of the medicines that we use today were originally derived from plant materials. Among them are old herbal remedies that have been used by native peoples around the world because of their medicinal value. Plant extracts contain many chemical compounds that are useful in treating human ailments.

One of the most common medicines for treating headache, arthritis, and heart attacks is aspirin. This is a trade name for a natural plant material called salicylic acid. This medicine is now produced in chemical laboratories, but it is also found in nature in the fruits, blossoms, and stems of many different plants such as willows. It was the active ingredient in plant materials used by some native "medicine men."

The insulin that is needed by people who suffer from the disease called diabetes is obtained from the pancreas of meat animals. Other human drugs obtained from these animals include estrogen, epinephrine, heparin, and thrombin in addition to many more.

Scientists tell us that only a few of the plants that exist in tropical rain forests have been examined for their medicinal qualities. They also tell us that many of these plants are likely to become extinct before we know their value if we continue at the present rate to destroy the forests in these regions. Consider the value to the human race that might be derived from the cure of a single human disease using one of these plants or animals.

MECHANISM FOR NATURAL CYCLES

Some of the most valuable resources in nature are marshes and swamps, see Figure 22–4. These areas are natural water treatment facilities, and they remove contaminants from our surface waters. They require no supplemental energy sources and function without human interference.

INTERNET ADDRESS

http://www.gmushrooms.com/HEALTH.HTM

KEY INTERNET SEARCH WORDS

source new medicine

marsh water treatment

The cleansing agents in these areas are plants, bacteria, and other aquatic organisms.

Water is also cleansed by plants as they take in contaminated water and release clean water vapor into the atmosphere through the process of **transpiration**, see Figure 22–5. Air is cleansed as the water cycle operates. Contaminants are trapped by falling rain or snow, and they are carried to the ground. As water moves through the water cycle, contaminants are left behind and clean water vapor enters the cycle.

Vast expanses of forest and other vegetation are required in order to regulate a uniform flow of water in rivers and streams. Precipitation on land surfaces can cause severe soil erosion unless plants are available to slow the flow of water over the land. Slow-flowing water infiltrates into the soil and comes out of the earth purified from most contaminants.

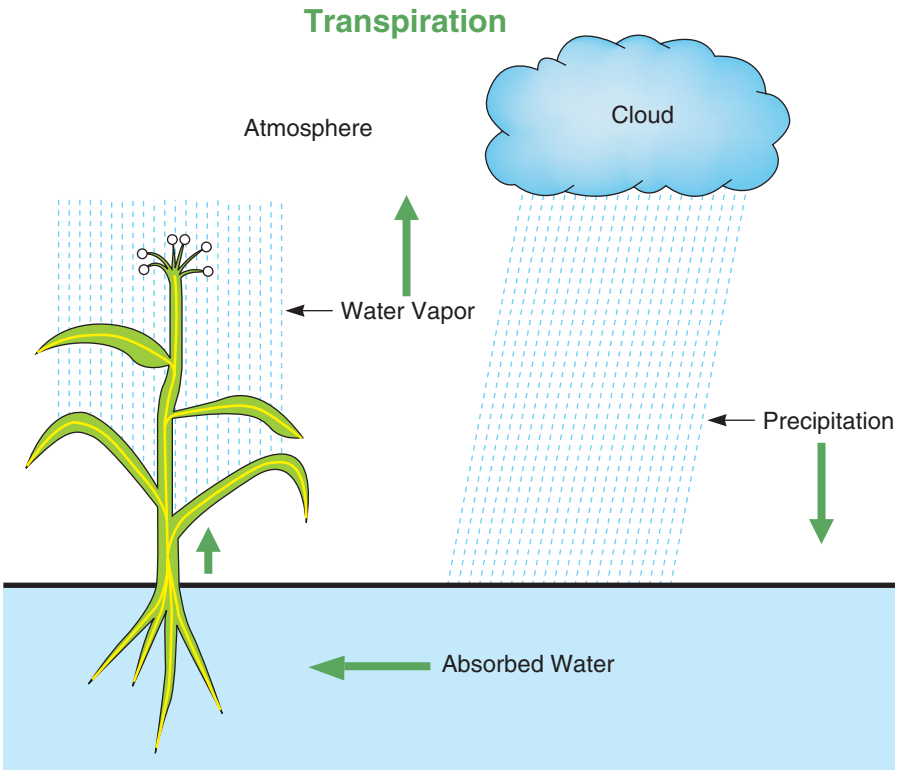


Figure 22–5 The process of transpiration contributes to a cleaner atmosphere.

Figure 22–6 A watershed is an area in which rainwater and melting snow is absorbed to emerge as springs of water or artesian wells at lower elevations. *Courtesy Shutterstock.*

An area where precipitation is absorbed in the soil to form groundwater is called a **watershed**, see Figure 22–6. Each watershed is separated from other watersheds by natural divides or geological formations, and each is drained to a particular stream or body of water. Watersheds are valuable because they act like huge sponges, soaking up water from precipitation and melting snow and releasing it slowly.

The elemental cycles were discussed in Chapter 2, "Principles of Ecology." Elements tend to cycle from plants to animals through the food chain. When an animal dies, these elements may be transferred to

INTERNET ADDRESS

http://www.msdeer.com/larry_castle_05.html

KEY INTERNET SEARCH WORDS

hunter, wildlife

nonhunter, wildlife

a scavenger or released to the soil or to the atmosphere by bacteria and other organisms. Eventually the element is taken up again by plants, and the cycle begins again. How can we calculate the value of elemental cycles to human and wildlife populations? The elemental cycles are of infinite value!

RECREATION

Wildlife and other natural resources have recreational value to humans. Much of our leisure time is spent in outdoor activities involving the use of natural resources and wildlife. Fishing and hunting are sports that focus on the use of wildlife resources, see Figure 22–7. Camping, boating, hiking, riding, birding, and wildlife observation are activities in which humans interact with the environment, see Figure 22–8. These uses are appropriate human activities that can be engaged in with minimal effects on the environment as long as people are careful to exercise good stewardship.

Intrinsic Value

The **intrinsic value** of fish and wildlife resources is the worth or value that exists within them. Although it is hard to measure, it is very real. Millions of people visit outdoor recreation areas and national parks each year to enjoy nature. They place value on their interactions with natural resources.

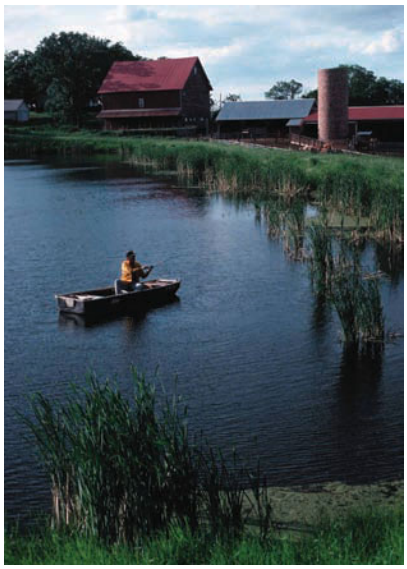


Figure 22–7 Boating is an activity where humans interact with water environments. *Courtesy NRCS.*

Figure 22–8 Horseback riding is a sport enjoyed by many in outdoor environments. *Courtesy Shutterstock.*

Some wild animals are very difficult to view in their natural habitats. This is because many of them are wary of people and avoid contact with them. The only large wild animals that many people will ever see are animals that live in a zoo, see Figure 22–9. Some zoos attempt to place their animals in realistic outdoor settings that resemble their natural habitats. This helps people to understand the habitat needs of animals. Most people do value wild animals or they would never pay to go see them in a zoo.

Figure 22–9 Most people will never see a large predator in the wild; however, a zoo gives them a chance to observe them at close quarters. *Courtesy Shutterstock.*

Bird-watching is an important leisure activity for many people. Birds are some of the most visible wild creatures, and they often adapt to living near people. Bird-watchers have formed societies since ancient times. Audubon Societies are modern organizations composed of people who appreciate birds and other wildlife. Birds have an intrinsic value to many people.

Wild animals of many kinds draw crowds of people who simply want to watch them. The annual migrations of whales often bring them near to shore where people can observe them. Large commercial boats are often filled to capacity with people who want to see the whales from a better vantage point. People find excitement and fulfillment through observing wild animals, see Figure 22–10. Many visitors hike along trails in Glacier and Yellowstone National Parks hoping to see large wildlife such as elk, moose, bison, and bears.

Figure 22–10 People experience excitement and fulfillment as they observe wild animals. *Courtesy U.S. Fish and Wildlife.*

Hunting and Fishing for Sport

Large numbers of people participate in the outdoor sports of fishing and hunting. North America has healthy populations of wild game species—mammals, birds, and fish—and this has contributed to the popularity of these sports. Fishing has long been considered to be a family activity, and large numbers of fish are raised in government hatcheries each year to supplement the wild fish populations.

Hatchery stocks of fish are placed in popular fishing waters with the expectation that they will be harvested during the season, see Figure 22–11. Most fish and game agencies are partially funded by the sales of hunting and fishing licenses. It is in the best interest of these agencies to assure that adequate populations of game species are available for hunting and fishing.

Unrestricted hunting nearly destroyed the populations of many game animals in the early years of the twentieth century. The U.S. Congress passed the Pittman-Robertson Act in 1937 that taxed the sale of guns and ammunition. It also required that money from hunting licenses be used to restore wildlife and wildlife habitats. This has been accomplished to some degree in many areas. The act still provides the continuing funding base for state wildlife programs. Funds from this source are used to support research, land acquisition, construction, maintenance of state wildlife areas, and management of wildlife programs.

Figure 22–11 Hatcheries help stock popular fishing waters for recreational use. *Courtesy U.S. Fish and Wildlife.*

One of the challenges of wildlife agencies is to accurately assess the carrying capacity of wildlife habitats. Sport hunting is a tool that is used to reduce game populations to the level of the food supply. This is necessary in areas that lack natural predators in order to prevent suffering and starvation of these animals during the winter. Hunting is a relatively humane way to control game populations in comparison with the mass starvation that occurs when winter food supplies are inadequate. Hunting seasons and bag limits are regulated for the purposes of harvesting excess wildlife and establishing a balance between game animal populations and their food supplies, see Figure 22–12.

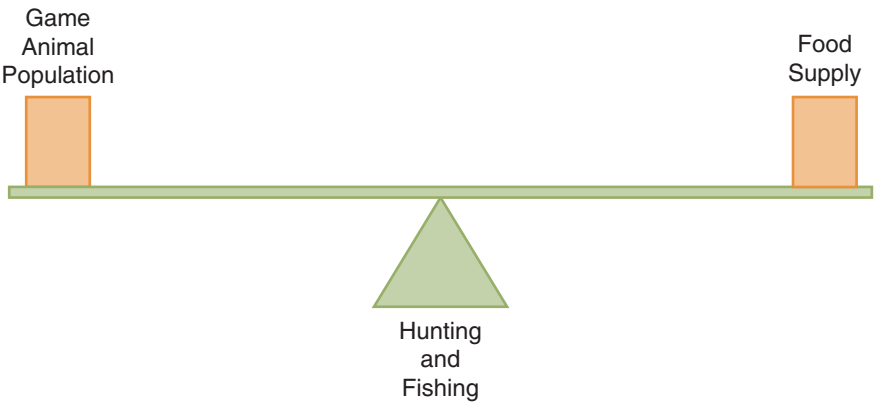


Figure 22–12 The balance between game animal populations and the food supply is maintained by regulating the number of animals that hunters are allowed to harvest.

Hunting has become a more controversial issue in recent years. People who are against hunting cite different reasons for their opposition to this activity. Some people believe it is immoral to kill wild animals. Others believe that humans should not interfere with the laws of nature. They prefer that natural forces such as predators, starvation, and diseases should control excess animal and bird populations.

Game Laws and Regulations

Laws and regulations are enacted by state and federal legislative bodies for the purpose of managing wild game populations. Laws also provide protection for wild animals against people who kill or injure them with no regard for their ability to survive as a species. There are plenty of examples from the past to illustrate this point. For example, the vast flocks of passenger pigeons are now extinct, and the huge bison herds that inhabited North America were reduced to a very small population before they gained protection under the law.

Most states and provinces have enacted laws to control the ways that citizens are allowed to interact with wild animals. Fishing regulations control where fish may be taken, when fishing is legal, how many fish may be taken, and how many fish may be in possession. In many cases, the regulations are different for each species of fish. The limit on trout may be a maximum of six, while the limit on whitefish or crappie in the same waters may be as high as fifty.

Hunting laws and regulations establish the rules for harvesting big game animals. These laws define what kind of gun or bow may be used, what baits may be used to attract wild animals, and how the carcass is to be dressed to establish the sex of the animal. In some areas, the number of hunters is restricted to allow more animals to survive. In areas where the animals cause damage to crops, shrubs, and trees, special hunts are often organized to allow additional animals to be harvested for human consumption.

State and provincial governments usually appoint boards or commissions to regulate fishing and hunting. Contact the appropriate agency in your area to obtain current laws and regulations for hunting, fishing, and trapping. Most of these agencies also maintain Web sites from which wildlife regulations may also be obtained.

Fishing and hunting privileges are sometimes abused by people who take fish and game animals illegally. Some of these people take more game than the law allows. Others take game when the hunting or fishing seasons are closed. These illegal activities are known as poaching. Irresponsible behaviors such as poaching and harassing game animals are difficult to control, but they must not be ignored by law-abiding citizens. Poachers should face the consequences of their illegal activities.

Using Campgrounds, Trails, Roads, and Waterways

There is such a great demand for outdoor recreation in North America that government agencies and private businesses have established camping areas, many equipped with restroom facilities and drinking water. A small user fee is often charged for the use of government-owned camping areas to help defray the costs of maintaining these facilities. Commercial campgrounds take advantage of the popularity of outdoor recreation and establish attractive outdoor facilities as profitable business ventures.

A number of large tracts of wilderness have been set aside in North America. Some of these areas are remote from civilization and are often restricted to backpacking and horse travel. Trails into these areas are maintained by government employees, and a strong effort is made to maintain wilderness areas in **pristine** or primitive condition, in their

pure, original form, see Figure 22–13. People who use wilderness areas should take responsibility for carrying their trash out with them when they leave.

Figure 22–13 Hiking is a sport enjoyed by many year round. *Courtesy U.S. Fish and Wildlife.*

Many of the forests in North America are in areas where it is difficult to build and maintain roads. It has also been demonstrated that road surfaces are major sources of silt that pollutes streams and rivers flowing out of these regions. This problem is compounded when recreational vehicles create ruts in the roads by using them when conditions are too wet.

The agencies that manage government-owned land often close logging roads when they are no longer needed. This reduces the cost of maintaining roads in remote areas, and it helps to reduce erosion and silting problems. It is important for people to keep their vehicles off roads that have been closed to motor vehicles. Responsible use of backcountry roads is necessary to protect the environment and the wild animal populations that live there. Irresponsible behavior by a few owners of recreational vehicles often leads to road closures in environmentally sensitive areas.

Many people who enjoy outdoor recreation gain access to natural environments by using boats. Numerous rivers, reservoirs, and lakes provide excellent boating opportunities. More people own boats today than at any time in our history, and large numbers of people make

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KEY INTERNET SEARCH WORDS

outdoor recreation
commercial fishing

recreational use of our waterways each year, see Figure 22–14. Access to waters should also imply responsibility to respect the animal species that live there. Motorboats have become serious threats to the survival of such diverse species as the loon, the manatee, and many other animals that live in water habitats.

Figure 22–14 More people own boats today than at any time in our history. It is important that boaters respect the animal species that live in the waters. *Courtesy U.S. Fish and Wildlife.*

Recreation safety is a serious issue, and it becomes more important as our citizens spend more leisure time in outdoor recreation activities. Motorized vehicles such as boats, snowmobiles, all-terrain vehicles, motorcycles, and jet skis have contributed significantly to recreational injuries and deaths. Many recreational injuries are the result of poor judgment on the part of the participant. For example, many deaths occur each year because people enter rivers and streams during periods of high water runoff when it is not safe to be on the water. Boats capsize during storms, and snowmobiles run into trees or fall over steep embankments. Jet skis are sometimes operated near other people resulting in crashes, injury, and death. In many of these instances, the operator has made the decision to enter a dangerous situation.

Off-road vehicles are often restricted from traveling on hiking trails, particularly in outdoor areas designated as wilderness. In many states, recreational vehicles are required to be licensed, although individual citizens are not usually required to be licensed to operate a snowmobile, jet ski, boat, or off-road vehicle.

Laws cannot force people to practice recreational safety, but they can act as reminders of safe recreational practices. Safety zones are established to prevent dangerous activities from occurring within the zone. For example, swimming areas are off limits to boats and jet skis. The state of Vermont has an extensive law entitled Vermont Boating Safety. Among its provisions are (1) restrictions on dumping sewage into the water, (2) fire extinguishers are required on-board, (3) mufflers are required on boat engines, (4) distance requirements are established with respect to swimmers, divers, and other boats, (5) restrictions are in place against operator use of drugs or alcohol, (6) operators are required to be at least 16 years of age, (7) operations rules govern interactions between vessels, and (8) use of personal floatation devices is required. The U.S. Coastguard regulates boats along the coasts, and in some cases, states have adopted these regulations on inland waters.

Snowmobiles may be restricted from operating in known avalanche areas. They may also be restricted to groomed trails, particularly in national parks or in wildlife wintering areas. Maine snowmobile law requires operators to submit to alcohol and drug tests. Penalties are established for endangering another person or personal property. Speed is restricted on public trails and public rights-of-way to speeds that are reasonable and prudent. Snowmobile operators are required to be at least 14 years of age, and an adult is guilty of breaking the law when he or she allows an unaccompanied child under age 10 to operate the machine. Snowmobiles are also subject to noise limits (78–82 decibels). Snowmobiles are required to have appropriate lights mounted front and rear. Snowmobiles may not be operated in cemeteries, on railroad tracks, or near a hospital, nursing home, or church.

The use of firearms is a favorite activity for many outdoor enthusiasts. Laws restrict how and where guns are fired. Most communities restrict guns from being fired within the city limits. The projectiles from bullets remain deadly after traveling for a mile or more. Some hunting regulations allow the use of shotguns near populated areas, but care must be observed to make sure that guns are fired only in areas where they are unlikely to endanger or damage human life and property. It is critical that gun owners know their local gun use laws, and they should observe them.

It is illegal to use any firearm in a threatening manner, and doing so is certain to result in arrest and detention by law officers. **Students who bring guns to school for any reason will be expelled from school and turned over to the courts. If they fire a gun at school, it becomes extremely likely that security officers will use deadly force to stop them**. Federal gun laws are in place to protect students and teachers, and there is no tolerance for firearms at school. Those who fail to obey this law endanger themselves as well as others, and they put all of their future opportunities at risk.

The states and provinces of the United States and Canada have established laws for outdoor recreation that are similar to those previously cited. To learn more about the laws where you live, contact the local police or public safety departments.

SAFETY EDUCATION

Outdoor recreation requires preparation and good planning to ensure that participants are safe from harm. Many hazards exist in outdoor settings that can seriously injure or kill. Understanding potentially dangerous situations is an important step toward enjoying outdoor activities in relative safety. The best way to assure recreational safety is to learn from the experts who understand it. For example, a river guide is a good source of information on boat and water safety. Outdoor sports participants should receive all the training that is available before engaging in potentially dangerous activities.

Recreational training activities are often available through community college programs and education classes. These training activities will help you prepare for unexpected and potentially dangerous events that you might experience in outdoor environments. It is always best to be prepared.

Many states require first-time hunters to successfully pass a gun safety program. This is a certification program that provides safety training in the use of guns before a hunting license is issued. This program also includes instruction in the principles of hunter ethics. Since the program was implemented, it has become evident that hunter safety has improved. Anyone who shoots a gun can benefit from a gun safety course.

Every outdoor sportsperson should prepare to respond properly to an emergency. Therefore, it is a good idea to become certified in first aid and cardiopulmonary resuscitation (CPR). The American Red Cross provides a widely recognized first aid certification that is known around the world. Another set of certification standards for first aid is available through the Occupational Safety and Health Administration (OSHA). These standards were developed by a federal agency that is primarily responsible for safety in the workplace. These standards are widely accepted and serve as the basis for several first aid training programs. Other first aid certifications are available from many sources. One of these is an on-line certification provided by an organization known as *Save a Heart*.

Other certifications for outdoor recreation are available at beginner and professional levels. Among these are the Wilderness First Aid Certification, Basic Boating Safety Certification, Advanced Emergency

Medical Certification, Canoeing Certification, and Swiftwater Rescue Certification. These are some of the most common certifications that are available. Standards for most of these certifications can be obtained from the Internet.

Hunter Education Safety Standards

The following standards provide the basis for hunter education programs in many states and provinces:

1. Explain and demonstrate the four primary rules of firearm safety: point muzzle in safe direction; treat every firearm with respect; be sure of target and what is in front of the target and beyond; keep finger off the trigger until you are ready to shoot.
2. Explain and demonstrate proper loading, unloading of safety mechanism while handling at least two firearms with separate types of actions and "dummy ammunition" supplied by instructor: acknowledging and accepting firearm with action open; gun pointing in safe direction at all times; knowing action type; correctly carrying and matching ammunition; knowing the location of the safety mechanism.
3. Correctly match at least three caliber/gauges of ammunition with their respective shotguns/rifles/handguns among an assortment of other unrelated ammunition and firearms.
4. Demonstrate making a firearm safe for transportation in a vehicle (car, boat, ATV) or while entering an elevated stand or ground blind: always pointed in a safe direction; unloaded; checked; cased; ammunition separate; hauling line; sling.
5. Demonstrate two safe methods of crossing an obstacle or hazardous terrain, one method alone; the other method while with a partner.
6. Demonstrate safe zone of fire and appropriate carrying method(s) using a shoulder gun, while walking two/three abreast and while walking two/three in a single file.
7. Demonstrate safe shot selection (i.e. various backgrounds, vital zones, angles of shots/animals, skyline animals, flock shooting, clothing of hunters/others, foreground, zones of fire) present safe/unsafe and/or unethical shot opportunities.
8. Demonstrate how to determine whether barrel is free from obstruction (always point in a safe direction, open action, check to be sure chamber/magazine is unloaded, check from breech and/or use appropriate accessories such as a barrel light).
9. State why hunters should wear blaze orange clothing for most hunting situations and/or why it is better than other colors while in the outdoors (to be seen).
10. State one or more senses or skills of hunters that can be negatively impaired by alcohol and drugs, before or while hunting (coordination, hearing vision, communications, and good judgement).
11. Demonstrate cleaning procedures for rifle/handgun and a shotgun and make them safe for storage (always pointed in a safe direction, unloaded, checked, cased, and/or placed/locked in a gun safe, ammunition stored and locked separately, gun locks/accessories in place, etc.).

KEY INTERNET SEARCH WORDS

first aid certifications

CPR standards

BASIS FOR COMMERCE

The commercial fishing industry is completely dependent on healthy and abundant populations of fish. The fish that are harvested from the oceans are important sources of high protein food for people in many parts of the world. Commercial fishing fleets operate along both coasts of North America, and this industry would cease to exist if our fish populations were lost.

Outdoor sports are the basis for a large segment of the tourism industry. Outdoor sporting goods stores meet the demand for outdoor sports equipment and supplies, see Figure 22–15. Among their products are hunting and fishing supplies and equipment, boats, recreational vehicles, camping gear, binoculars, backpacks, guidebooks, bikes, and motorcycles.

Figure 22–15 Outdoor sporting goods stores meet the demand for outdoor sports equipment and supplies.

Figure 22–16 Under the guidance of a professional outfitter, these rafters can enjoy a ride down the rapids of a wild river. *Courtesy Shutterstock.*

An entire industry has developed to support sport fishing and hunting. Professional guides and outfitters provide their equipment and services to fishing and hunting clients for a fee, see Figure 22–16. These business people earn livings as outdoor recreation consultants. They use their expert knowledge of an area and the habits of the game species that live there to help their clients achieve fishing and hunting successes.

KEY INTERNET SEARCH WORDS

stewardship

natural resources

THE PRINCIPLE OF STEWARDSHIP

A land **steward** is an administrator or supervisor who manages property for someone else. Federal, state, and provincial governments own large tracts of land in North America, and they depend on professional managers to oversee these lands in a responsible manner, see Figure 22–17. Stewardship consists of responsible management of land, property, or resources, and it should be practiced by all of the people who use such resources.

Figure 22–17 Responsible stewardship must be practiced in order to maintain habitat requirements of plant and animal communities.

The principle of stewardship as it applies to natural resources implies that the agencies and people who have responsibilities to manage wildlife and other natural resources should perform their duties with a long-term view and commitment to the resources that are being managed. The ability to exercise good stewardship requires the knowledge of proven management practices and the wisdom and skills to implement them to prevent habitats or resources from damage. Stewardship also requires knowledge of the ecology and habitat requirements of the plant and animal communities in the area.

Wise stewardship occurs when managers of natural resources make management decisions based on dependable information. This requires them to distinguish facts from fantasies and dependable research from biased research. It will also require that researchers know what questions to ask in order to access the research information necessary to make sound management decisions. Wise managers will adjust their management practices to protect natural resources against uses that cause damage to them. The principle of stewardship requires resource managers to use resources in ways that will preserve them for our children and grandchildren.

Career Option

HUNTING/FISHING OUTFITTER

Outfitters for hunting and fishing expeditions are business people who provide equipment and professional guide services to those who hunt and fish. Hunting outfitters often provide horses and vehicles such as trucks, boats, and airplanes to transport nonresident hunters and game to and from base camps or hunting lodges, see Figure 22–18. Outfitters are usually excellent horse-people who are adept at transporting supplies and game animals with pack animals. They spend a lot of time scouting out areas where big game animals are located.

Figure 22–18 Outfitters often use airplanes to assist them on their expeditions. *Courtesy Shutterstock.*

The clients of outfitters are usually unfamiliar with the areas where they plan to hunt. They depend on the outfitter/guide to furnish food, supplies, transportation, and expert consultation services. It is the duty of the outfitter to get his/her client in position to legally collect a game animal or fish for which the client has a permit. The outfitter also accepts the responsibility of properly dressing and transporting wild game.

ETHICS, PRIVILEGES, AND RESPONSIBILITIES

Ethics is defined as the code of morals of a particular person or group of people. It is important that people who use our wild environments and natural resources should adopt a "code of ethics" that governs their personal behavior. An example of such a code has been provided.

The Outdoor Sportsman's Code of Ethics

I am a sportsman with a love for outdoor environments and wild creatures. I treasure the privilege of using the trails and roads, of camping and hunting in the deserts, woods, and forests, and of fishing and boating on the rivers, streams, and lakes. I appreciate the beauty of a sunrise on a high mountain peak, and the glory of a sunset over a restless sea.

I will respect each wild creature and protect the land that supports life. I will do more than my share to keep my world clean, and I will encourage others to do the same. I will teach my children to enjoy and use our natural resources as responsible citizens. I will protect my personal privilege of using natural resources by becoming an informed and responsible steward of the environment. I am a sportsman with a love for outdoor environments and wild creatures.

Figure 22–19 Rules and regulations must be followed in order to protect our natural resources. *Courtesy U.S. Fish and Wildlife Service. Photo by John and Karen Hollingsworth.*

Ethical behavior depends on the will of individual citizens to act responsibly, even when other people do not. The opportunity to use public lands and natural resources is a privilege, not a right. It is a privilege that must be earned by demonstrating responsible and ethical behavior. There is no statute or constitutional rule that gives anyone the right to abuse public lands, natural resources, habitats, or wildlife.

North America is endowed with an abundance of wildlife and natural resources. Citizens are allowed to use public lands for many purposes. Those who claim the privilege of using public resources must be willing to obey the regulations that have been established to protect these resources, see Figure 22–19. Anyone who cannot be trusted to act in an ethical manner should lose their privilege. We cannot sustain our natural resource base over an extended period of time unless individual citizens become wise and fair stewards who care for the land, its plants and wildlife, and the environment.

WILDLIFE MANAGEMENT

Wildlife management has meant different things to different generations of citizens. People who lived in the first two centuries after North America was colonized tended to view wildlife populations as a resource that would never be used up. Early attempts at wildlife management were for the purpose of killing wolves and other predators. No regulation of hunting and fishing occurred until it became evident in the mid-1800s that animal populations could be completely destroyed. The last buffalo found east of the Mississippi River was killed in Wisconsin in 1832. Wild turkeys soon followed as populations disappeared county by county and state by state from 1840 to 1860.

The first game laws were enacted by the states beginning about 1850, and by the 1870s, game wardens were actively enforcing wildlife regulations. Prior to this time, market hunting was done commercially and a large amount of game meat was harvested and sold in the cities. The first game laws restricted hunting seasons on deer, quail, prairie chickens, grouse, and fur animals. Migratory bird refuges began to appear in the late 1800s as conservation-minded citizens began to be concerned about the duck and goose populations. States began to establish licensing for sportsmen and bag limits for some species of wildlife during the 1870s; however, this did not occur in some states until much later. Deer tags were implemented as a method of making hunters accountable. Once the tag was attached to an animal or marked, it could not be used again.

The Forest Reserve Act of 1891 is highly significant to the history of wildlife management because many species of wildlife live in the forests. This legislation led to the establishment of national parks such as Yellowstone National Park. The national parks are among our best known game preserves. Many of the forests that were set aside under the Forest Reserve Act of 1891 later became the national forests that we know today.

By 1908, there was such concern about declining wildlife pop-ulations that President Theodore Roosevelt convened a conference of the governors, and the organized conservation movement was born. Conservation commissions were established in many states during this era. Conservation education became part of the curriculum in many of the nation's schools. In 1915, federal rules were established for migratory game animals. Game farms were established for the purpose of restocking depleted populations of game animals and introducing nonnative game species in appropriate areas. During this period, game seasons were closed for some species of game animals due to low population numbers.

Two men rose to prominence in the conservation movement during the late 1920s and early 1930s. The first is Aldo Leopold, who later became known as the "father of wildlife ecology," He was educated as a forester at Yale and eventually served as associate director of the U.S. Forest Products Laboratory in Madison, Wisconsin. He also started his teaching career at the University of Wisconsin in 1928. During the same year, he became the chair of an American Game Association policy committee that was charged to develop a guide to state wildlife agencies in order to identify solutions to wildlife management problems. He rose to national prominence when he published a book in 1933 titled *Game Management*. His book created a new science that integrated the principles of agriculture, biology, forestry, zoology, ecology, communication, and education. He later published another book, *A Sand County Almanac*, promoting his philosophy that people must live in harmony with the land.

J. N. "Ding" Darling was a political cartoonist for most of his professional career, but for twenty months he was appointed by President Franklin D. Roosevelt in 1934 as chief of the Bureau of Biological Survey in the Department of Agriculture. In that short time, he instilled the scientific method in the agency and promoted the construction of wetlands and wildlife refuges. He financed much of this work with the income from the sales of duck stamps. After returning to civilian life, he organized what is now the National Wildlife Federation and became its first president. His greatest interest was conservation education.

During the Great Depression of the 1930s, the Civilian Conservation Corp (CCC) was created. The federal government made funds available to hire workers for the purpose of constructing projects related to conservation. Thousands of young men were hired throughout the country, and many of their construction projects are still in use today. This labor force made it possible to create many of the wildlife refuges and game preserves that were developed during this period.

World War II dominated nearly all aspects of American life between 1941–1945. After the war ended, the Federal Water Pollution Control Act was passed in 1948. It was an early attempt to protect the nation's water resources. This was the first of many legislative actions to reduce the incidence of water pollution. Bounties on wolves, lynx, coyotes, and other predators continued to be popular game management activities during this decade.

The 1950s and 1960s became more focused on game management and less focused on law enforcement. The National Environmental Protection Act was passed in 1969. Its purpose was to eliminate human activities and practices that could be shown to be damaging to the land, water, and air. A common chemical that had been used for many years to control insects was banned during the late 1960s. It's trade name was DDT. Among other things, it was discovered that it contributed to weak egg shells among predatory birds such as eagles and hawks. It was also found to persist in the environment for many years.

Perhaps the most significant conservation legislation ever created was passed in 1969. It was the Endangered Species Act, and it was intended to protect animal species that were declining in numbers. The act was reauthorized in 1973, and classifications were created for species that were considered to be at risk. Those that were in immediate danger of becoming extinct were identified as "endangered species." Species that were in less danger of extinction but which were at risk of becoming endangered were classed as "threatened species." This Act protects both the species and its habitat. Species that are protected under this act cannot be killed, hunted, or disturbed, and use of critical habitat is severely restricted.

The first Earth Day celebration took place in 1970, and it continues to the present time. Citizens' groups began to play a much more active role in public wildlife policy during this decade. Organizations such as Ducks Unlimited and the Rocky Mountain Elk Foundation gained favor and influence with the public. Game animals such as turkeys, deer, elk, bighorn sheep, and fish were widely introduced into their former ranges and in many other compatible habitats. Steel shot became mandatory for hunting waterfowl due to the danger to ducks and geese from ingesting lead shot for grit.

The Conservation Reserve Program (CRP) returned marginal farmland to permanent cover crops in 1985. This was highly favorable

to deer, songbirds, and game birds. The permanent plantings provided food and shelter for many species of wildlife.

By the mid-1980s, many of the predators that had formerly been destroyed were finding protection under the law. Wolf recovery efforts were started by some conservation groups, and much controversy was generated. By the late 1990s, gray wolves had been reintroduced in Yellowstone Park and in the Frank Church Wilderness of central Idaho. Their numbers have expanded rapidly in recent years. In the new millennium, controversy rages over a plan to reintroduce the grizzly bear into the mountains of Montana and Idaho.

OUTDOOR RECREATION MANAGEMENT

The American lifestyle makes it possible for many people to enjoy out-door leisure time. Some people like to experience outdoor environments as they existed before civilization encroached on the wilderness; however, many people prefer to enjoy modern conveniences in their recreation sites. For example, they like trails to be groomed and free from fallen trees. They expect toilet facilities to be conveniently located, and they require drinking water and even shower facilities in campgrounds. Many developed outdoor sites have garbage service and recreational vehicle hook-ups. There might even be a spa and a nearby golf course.

Modern outdoor conveniences exist because private businesses and public agencies plan and implement the improvements that are requested. The U.S. Forest Service and the national park system invests large sums of money to build picnic tables, toilet facilities, campsites, and roads in the nation's forests. Boat ramps and docks have been constructed near lakes and streams. Water sources have been developed, and cooking areas have been constructed for the express purpose of making the outdoor experience more convenient. Nearly all of the modern outdoor conveniences have been developed since the Civilian Conservation Corp was organized during the Great Depression years of the 1930s. State and federal agencies employ a large number of people to manage outdoor facilities, and entrepreneurs have created a new outdoor industry based on golf courses, condominiums, ski resorts, water sports, and leadership camps. Sporting goods stores offer outdoor equipment of every kind to go with their more traditional product lines, consisting of hunting and fishing equipment and supplies.

Colleges and universities offer programs in recreation management that prepare students to become employed in the outdoor recreation industry. Students study such topics as outdoor leadership, community recreation management, recreation programming, and outdoor recreation. Graduates of such programs find gainful employment in the hospitality and recreation industries.

LOOKING BACK

Humans have always depended on wildlife and natural resources for their own existence. We continue to do so today. While the use of the skins of wild animals for clothing has declined, and few of us depend on wild animals for food, we do depend on domesticated plants and animals for these necessities of life. Modern agriculture has evolved from man's dependence on wild plants and animals.

We continue to obtain medicines from plant and animal products. The natural elemental cycles that function in nature continue to clean our world and replenish our supply of clean water and air. We use outdoor environments and observe wildlife for recreation, and we fish and hunt for sport. Many people earn their livings through the sale of goods and services related to outdoor sports. It is important that we demonstrate ethical behavior and exercise wise stewardship in our relationships with wild plants and animals and the environments in which they live.

Chapter Review

DISCUSSION AND ESSAY

1. Explain how domestic livestock and crops evolved from the dependence of early human societies on wild animals and plants for food, clothing, and shelter.
2. Name some medicines that are obtained from plant and animal materials to treat human diseases and ailments.
3. Explain why preserving tropical forests is important to medical science.
4. Describe what a watershed is and explain why it is important to humans.
5. Analyze the importance of natural cycles such as the water cycle, the nitrogen cycle, and the carbon cycle in renewing and cleansing the environment.
6. List several recreational activities that are associated with wild animals and outdoor environments.
7. Identify some ways that human interests in wildlife and outdoor sports affect commerce.
8. Explain the principle of stewardship as it relates to outdoor environments and wild animals.
9. Speculate on the importance of human ethics in preventing abuses to wildlife and other natural resources.

MULTIPLE CHOICE

1. The total of all organisms found in an area is called its:

   a. Species
   b. Biota
   c. Biomass
   d. Population

2. A population of plants or animals that is controlled and managed for agricultural purposes is described as being:

   a. Pristine
   b. Acclimated
   c. Dominant
   d. Domestic

3. Marshland is a valuable tool in maintaining a clean environment because:

   a. It is capable of removing pollutants from the water.
   b. Wildlife habitat is improved.
   c. It functions as a watershed.
   d. The environment for water-tolerant plants is improved.

4. Which of the following is involved in cleaning pollutants from the atmosphere?

   a. Marshlands
   b. Transpiration process
   c. Watershed
   d. Exposure to sunlight

5. The enjoyment of wild animals and natural environments by people is considered to be an example of an:

   a. Intrinsic value
   b. Extraneous value
   c. Extrinsic value
   d. Intellectual value

6. The concept that a manager of natural resources should use proven management practices in caring for the resource is an example of:

   a. Entrepreneurship
   b. Ownership
   c. Stewardship
   d. Protectionism

7. An illegal activity in which a person takes wildlife out-of-season or in greater numbers than the law allows is known as:

   a. Stewardship
   b. Poaching
   c. Trespassing
   d. Ethics

8. A term that describes an area that exists in its wild or primitive condition is:

   a. Pristine
   b. A managed habitat
   c. A restored habitat
   d. A national park or monument

9. Which of the following industries does not depend on natural populations of fish and wildlife?

   a. Professional guides and outfitters
   b. Commercial fishing industry
   c. Outdoor sporting goods sales
   d. Aquaculture industry

10. A term that describes a personal code of morals and behaviors a person is willing to adopt in their lives is called (a):

   a. Monroe doctrine
   b. Natural law
   c. Ethics
   d. Law of diminishing returns

Learning Activities

1. Assign each class member to write a code of ethics for some form of outdoor sport. Limit their choices to no more than two or three separate sports. Examples might include "A Code of Ethics for Deer Hunters," or "A Code of Ethics for Off-Road Vehicles." A single paragraph of three to four sentences from each student will be adequate. Combine the papers together for each sport, and use the ideas from the students' papers to write a single code of ethics for each outdoor sport that was assigned.

2. Divide the class into two groups. One group will play the part of the U.S. Senate. The other group will play the role of the U.S. House of Representatives. Assign each of the groups to write a bill that will regulate the use of motorized vehicles on land that is managed by the U.S. Forest Service. When each group has passed a bill, assign two or three students from each group to create a compromise bill that is acceptable to both houses of Congress. Print a final copy of this bill for each class member.

Glossary

A

Accipiter. A woodland hawk belonging to the genus Accipiter.

acid precipitation. Precipitation that has become polluted with sulfur or nitrogen compounds that form weak acids when they are dissolved in water, and that may damage plants and animals.

adaptive behavior. A learned behavior that improves the survival skills of an animal.

adipose fin. A fin on some fishes that stores fat.

aerated water. Water that contains high levels of dissolved oxygen.

aerie. The nest of a raptor located in a high location such as a cliff or mountain top.

alevin. A tiny fish that has recently emerged from the egg.

algae. Tiny plants that are suspended in freshwater and which multiply rapidly when high levels of nitrates and/or phosphates are present, thus depleting the supply of dissolved oxygen in surface water.

alien species. A species that is not native to an environment and competes with native species for food and shelter.

allantois. A membrane found in a developing egg that is filled with blood vessels, through which respiration gases and wastes are exchanged.

alluvial fan. A geological formation of gravel, clay, sand, and silt that has been deposited by water, and is often seen near a location where a stream slows down as it enters a plain or where a tributary joins with a main stream.

amnion. The innermost protective membrane in an egg that surrounds the embryo and contains the fluid in which the embryo is immersed.

amniote egg. An egg with an inner membrane and a porous shell that surrounds a developing embryo and its food supply.

amniotic fluid. A salty liquid in which a developing embryo of a bird, reptile, or mammal is suspended as it matures.

amphibian. A cold-blooded vertebrate with a moist skin that changes in its body form from a gilled, aquatic larva to an airbreathing adult through the process of metamorphosis. Their eggs must be laid in water.

anadromous fish. A fish that migrates up a river from the sea to spawn.

anadromy. The process in which migrating fish return to their home waters to spawn.

anal fin. A fin that is located on the underside of a fish between the anus and the tail.

anaphase. A stage in cell division when chromosome pairs pull apart and migrate to opposite sides of the cell.

anatomy. The physical structure of an organism.

antenna. A sensing organ or feeler (usually paired) on the heads of organisms such as insects and crustaceans.

antler. Paired, bony, branching horn-like structures found on male and some female members of the deer family.

aquaculturist. A person whose career is raising fish or shellfish for human consumption or use.

aquatic species. Organisms that live in water habitats.

auklet. A small penguin-like bird of the North Pacific coast that is capable of flight.

avian. Of, relating to, or deriving from birds.

avocet. A large, long-legged shorebird whose long bill curves upwards.

B

baleen whale. A whale that has whalebone in its mouth instead of teeth. This whale uses it to strain plankton and other small organisms from the water for food.

barbel. A whisker or feeler that is located on the lips of certain fishes such as catfishes.

barging. A practice in which migrating smolts are collected above a dam, loaded in barges, and then transported around the dam in an effort to help them avoid being killed in the turbines that are used to generate electricity.

beard. An unusual tuft of feathers that dangles from the breast of a bird such as a wild turkey.

billfish. A fish, such as a marlin, spearfish, or sailfish, that has a long upper jaw shaped like a sword, which is used to strike and kill its prey.

billy goat. A male goat.

biodegradable. Capable of being broken down by living organisms to form nontoxic products.

biological succession. Changes that occur as living organisms replace other lower order organisms in an environment.

biologist. A person whose career involves the scientific study of the characteristics, life processes, needs, and habits of plants and animals.

biology. The science that deals with the life processes and characteristics of plants and animals, including the origin, history, and habits of the many forms of plant and animal life.

biome. A group of ecosystems within a region that have similar types of vegetation and climatic conditions.

biosphere. Consists of all of the ecosystems of the earth capable of supporting life.

biota. The community of living organisms that is naturally found in an environment or area.

biotechnology. A scientific field that applies principles of science to organisms that modify them to meet specific purposes.

biotic potential. A measurement of the ability of an organism to reproduce sufficient numbers of offspring in order to maintain a stable population.

bison. A large member of the cattle family, commonly known as a buffalo, that is native to the Great Plains region.

bivalve. An organism with a two-part hinged shell, such as a clam, that strains food particles from water sucked through its body.

blowhole. A nostril located on the top of the whale's head.

blubber. A thick layer of fat that is found in the bodies of whales and other sea mammals.

boar. A mature male pig or bear.

botany. The branch of biology that deals with plants.

brood. A family of young birds.

buck. A male deer, pronghorn, goat, or rabbit.

bull. An adult male elk, moose, whale, walrus, bison, or musk ox.

bullhead. Any of several common freshwater catfishes found in North America.

C

caiman. A species of alligator whose range extends from southern Mexico and southern Florida to South America.

calf. The young of various large animals such as the elk, moose, whale, and bison.

camouflage. The use of protective coloration that blends in with an animal's surroundings to help it avoid detection by enemies.

cannibalistic. The tendency of an animal to eat other members of its own kind.

canopy. The highest level of vegetation in a forest, consisting of the branches and foliage of the tallest trees.

carapace. A protective outer coat of bony or chitinous armor, such as the external covering of a turtle, crab, or armadillo.

carnivore. An animal that eats meat.

carp. One of the most common fishes in the world that has been widely found in North America, and that is often included in the human diet in other parts of the world.

carrion. The rotting flesh of a dead animal.

carrying capacity. A measurement of the maximum number of animals that a habitat can support based on the amount of available food and shelter.

cartilaginous fish. A group of fishes, including sharks and rays, whose skeletons are composed of hard cartilage instead of bone.

catadromous fish. A freshwater fish that migrates to the ocean to spawn.

catalytic converter. A device that removes significant amounts of pollutants from exhaust gases of motor vehicles or wood stoves.

catkin. The flowering parts of some trees that are used as food by squirrels, grouse and other birds during the winter season.

caviar. The eggs of sturgeon, often considered a delicacy food by humans.

centriole. A cell structure found at either end of a cell that anchors the fibers drawing chromosomes apart during cell division.

centromere. The point of attachment in a cell nucleus for a pair of chromatids.

Cephalopoda. A class of marine mollusks with 8 to 10 arms which are equipped with suction organs that are used to capture prey. The class Cephalopoda includes the squids, octopuses, and cuttlefishes. These animals have sacs containing ink, which is released to hide them from their enemies.

cetacean. Any members of the order Cetacea. It includes the dolphins, porpoises, and related forms that have one or two nares opening at the top of their heads and a horizontally flattened tail for swimming.

char. Brook trout and other closely related fishes.

chemical energy. Energy that is stored in plant tissues as sugars, oils, and starches during the process of photosynthesis.

chorion. A protective membrane that grows out of the embryo, surrounding it and the other three membranes.

chromatid. Half of a replicated chromosome.

class. An intermediate division in the taxonomy of living organisms into which organisms of the same phylum are divided. It ranks above the order and below the phylum or division.

climax community. The plants that occupy an environment when the succession of species is complete and the plant populations become stable.

cloven-hoofed. A condition where the hoof is divided into two parts, such as in sheep.

clutch. A nest of eggs or a brood of chicks.

color phase. A variation in the color of fur, skin, or feathers due to seasonal changes or the degree of maturity of an animal.

community. All living organisms within a defined area such as a log, a woodland, or a marsh. It can be as small as a rotting log or as big as an entire forest.

competitive advantage. A condition that exists when one organism is more able to survive in an environment than another.

competitive exclusion principle. A principle of ecology that states that no two species of plants or animals can occupy the same niche in the environment indefinitely.

compound eye. A complex eye found in insects that is made up of many simple eyes functioning together.

conical bill. A shape of a bird's bill that is particularly well adapted for shelling grass and weed seeds.

conifer. A tree that produces its seeds in cones.

coniferous forest biome. A group of evergreen forest ecosystems made up of larch, pine, spruce, and other cone-bearing trees located mostly in the northern regions of North America.

conservation. The practice of protecting natural resources against waste.

constrictor. A snake that squeezes its prey to death in its coils.

continental shelf. Land submerged beneath the ocean's surface that slopes gradually away from the shore toward deeper water.

cormorant. A long-necked seabird that dives for fish from the ocean's surface, and pursues them underwater by swimming with both its wings and its feet.

covey. A small flock of quail or partridges that are often members of the same family group.

cow. An adult female of various large animals such as an elk, moose, whale, walrus, bison, or musk ox.

crop. An organ located in the digestive tracts of birds and some other organisms where food is stored before it is digested.

creeper. A small, brown bird that is usually observed climbing up tree trunks probing for insects with its long curved bill.

crustacean. A shellfish, such as a lobster, crab, or shrimp, that has a hard outer shell on its body. These are arthropods in the class Crustacea.

cub. The young of certain mammals such as the fox, bear, wolf, and lion.

cud. A small portion of plant material from the rumen of an animal that is

regurgitated, chewed thoroughly, and swallowed again.

cuttlefish. A squid-like cephalopod mollusk with a hard internal shell and ten arms equipped with suction devices.

cygnet. A young swan.

D

dabbling duck. A duck that feeds on or near the water's surface by submerging its head as it feeds.

darter. A small, bottom-dwelling food fish related to the perch, upon which many larger fish prey.

deciduous forest biome. A group of ecosystems in which broadleaf trees are abundant and the annual precipitation exceeds 30 inches per year. It includes only those broadleaf trees that shed their leaves each year.

decomposer. Bacteria, fungi, insects, worms, and so forth that are capable of breaking down complex substances to form simple elemental components, thus making them available to plants.

delayed gestation. A condition in which a fertilized embryo does not attach to the inner surface of the mother's uterus until conditions favor the survival of the offspring.

demersal spawner. A fish, such as the herring, that attaches its eggs to weeds or other materials on the ocean floor.

denitrification. A natural process where nitrates are broken down by bacteria to release nitrogen gas into the atmosphere.

desert biome. A terrestrial environment where the annual precipitation is less than 10 inches. It is inhabited by drought-tolerant species of plants and animals.

dextral fish. A flatfish whose eyes are always located on the right side of its head.

diadromous fish. A fish that migrates in either direction between freshwater and marine habitats.

diploid. A cell containing both homologues from each chromosome.

dipper. A small, wren-like bird with a habit of bobbing up and down continuously. It eats aquatic insects that it catches by walking beneath the water on the bottoms of swiftly moving streams.

diurnal. The tendency of an animal or bird to be active only during periods of daylight.

doe. A female deer, pronghorn, goat, or rabbit.

dog. Any member of the dog family, or a male fox, coyote, or wolf.

dolphin. A small, predatory, toothed whale (family Delphinidae) with a beaklike snout that is found in warm ocean waters.

domestic. A condition in which a plant or animal is raised in captivity or in controlled conditions.

dorsal fin. A large prominent fin located on the backs of most fish.

down. The soft, fluffy feathers beneath the outer feathers of a bird that insulate it from heat and cold.

duckling. A young duck.

E

eaglet. A young eagle.

ecdysis. Molting or shedding an outer layer of skin.

ecologist. A scientist who studies relationships between living organisms and their environments.

ecology. The branch of biology that describes relationships between living organisms and the environments in which they live.

ecosphere. (Same as biosphere.) All the ecosystems on the earth capable of supporting life.

ecosystem. A community of living organisms in addition to all of the nonliving features of the environment such as water, air, sunlight, and soil.

ectotherm. A cold-blooded animal that depends on the surrounding environment for its body heat.

eel. A long, snakelike fish with a long dorsal fin that extends around its tail.

eft. A land-based stage in the metamorphosis of a newt that occurs between the aquatic larval and adult stages, during which the newt changes in color to red or orange.

egg. A reproductive cell or ovum produced by a female organism.

egg case. A pouch-like container filled with fertilized eggs that is expelled from the body of an oviparous female shark.

elapid. A poisonous snake with fangs that are permanently fixed in place.

electrical energy. Energy that is in the form of electricity.

electrostatic precipitator. A device that removes particles from smoke by charging the particles as they pass through an electrical field composed of small wires, and then attracting them to a similar electrical field having the opposite charge.

elemental cycle. The recurring circular flow of elements from living organisms to nonliving materials.

elver. A young freshwater eel that has just emerged from the larval stage.

embryonic membrane. Any of the four different membranes that develop around an embryo as it matures.

endangered species. A legal designation assigned to a species or subspecies that is in immediate danger of becoming extinct due to small numbers of survivors in the population. This classification is assigned for the purpose of providing protection to such organisms.

endotherm. A warm-blooded animal that obtains its body heat from the metabolism of its food.

energy. The ability to do work or to cause changes to occur.

erosion. The loss of topsoil from a region due to the forces of flowing water or strong winds.

estivation. A state in which an animal spends the hot summer in a dormant condition similar to hibernation.

estuary. An aquatic environment in which freshwater and saltwater mix in areas where rivers and streams flow into the oceans.

ethics. The code of morals that governs the behavior of a person or group of people.

evolution. A process in which physical changes occur in organisms over long periods of time, during which those physical traits that help the organism survive in the environment become predominant and are expressed more frequently.

ewe. A female sheep.

extinct. No longer existing due to the deaths of all the members of a population.

eyrie. See *Aerie*.

F

facial disk. An arrangement of feathers in a circular pattern on the face of an owl.

family. An intermediate division in the taxonomy of living organisms into which organisms of the same order are divided. Family ranks above the genus and below the order.

fauna. Animals that are found in a particular region or environment.

fawn. A young deer or pronghorn.

fecundity. A fertile, prolific, or productive trait in an animal.

fertilization. The process in which the male and female gametes join together in a single cell.

finfeet. Another name for seals that acknowledges the development of fins for locomotion instead of feet.

fingerling. A young fish that is less than a year old.

first law of energy. A law of science stating that energy cannot be created or destroyed, but it can be converted from one form of energy to another (for example, light to heat).

flatfish. A flat fish, such as a flounder, that lives on the ocean floor, and whose eyes are both located on the same side of its head.

fledge. To grow enough feathers for a young bird to be capable of flying.

flora. The plants that are found in a particular region or environment.

food chain. A series of steps through which energy from the sun is transferred to living organisms. Members of the food chain feed on lower ranking members of the community.

food pyramid. A series of organisms that are arranged in ranking order according to their dominance in a food web.

food web. A group of interwoven food chains.

forest floor. The layer of decaying plant materials on the soil surface. It acts as a mulch which preserves moisture.

fossil fuel. A fuel that comes from the deposits of natural gas, coal, and crude oil, which are formed in the earth from plant or animal remains.

freshwater. Water that is not high in salt content.

freshwater biome. A set of similar ecological communities found in or near water that is not salty.

frontal shield. A red or white, fleshy growth that extends from the top of the bill to the foreheads of some birds that is used by strong males to intimidate their rivals.

fry. A tiny fish that has recently hatched from an egg.

G

gallinaceous. Of an order of birds (galliformes) such as pheasants and grouse that build nests on the ground. Females of this order lay large clutches of eggs in comparison to other birds.

gamete. A haploid reproductive cell.

Gastropoda. A class of mollusks such as snails and slugs that move about on a muscular foot.

gecko. A lizard belonging to either of two families in North America with suction pads on its feet, that is capable of making loud mating calls.

genetic engineering. Human modification of the genetic makeup of organisms.

genus. An intermediate division in the taxonomy of living organisms into which organisms of the same family are divided. The genus ranks above the species and below the family.

gestation. The period of pregnancy during which the young are carried in the uterus of the female.

gizzard. A muscular organ in the digestive tracts of birds, reptiles, and other organisms that use small rocks and pebbles to grind food into small particles.

gosling. A young goose.

grassland biome. A terrestrial environment (sometimes called a prairie) that is located in the middle of the continent and lacks tree cover. The dominant plants are grass and broadleafed herbs.

grebe. An aquatic diving bird with lobes on its toes to facilitate swimming that eats insects and small aquatic animals.

gregarious. The tendency of some animals to prefer the company of their own kind, and to spend their time together in flocks, colonies, or herds.

grit. Small rocks and pebbles that are swallowed whole by birds for use in grinding seeds and other food materials in the gizzard.

groundwater. Water that is located under the earth's surface in underground streams and reservoirs.

H

habitat. An environment in which a plant or animal lives.

haploid. Cells that contain a single chromosome from each homologous pair.

harrier. A genus of hawks that are excellent hunters in heavy vegetation such as tall grass or marsh reeds, and that nest in groups of several pairs instead of defending individual territories.

hatchery fish. A fish that has been spawned and raised in the artificial environment of a fish hatchery.

hazardous material. Chemicals or poisonous materials that are dangerous to living organisms.

herbicide. A pesticide that is used to kill unwanted plants.

herbivore. An animal or other organism that eats plants.

herb layer. The bottom layer of vegetation in a forest consisting of ferns, grasses, and other low plants that grow on the forest floor beneath the shrub layer.

hermaphrodite. An organism that possesses both male and female sex organs at the same time.

herpetologist. A scientist who specializes in the study of reptiles and amphibians.

hibernate. To spend the cold winter season in a resting state, in which the body temperature is reduced, body processes slow down, and nutrition is derived from stored body fat.

homologous chromosome. Each chromosome of an identical pair of chromosomes.

homologue. Each chromosome of an identical pair of chromosomes.

horn. Hard, bony projections on the heads of some hoofed animals that are used for fighting with rivals and for protection against predators.

hybrid. The offspring of a mating between two different species or subspecies.

I

ichthyologist. A scientist who studies fishes.

ichthyology. The branch of zoology that is concerned with the classification, structure, and life cycles of fishes.

ideal environment. A habitat where all of the living conditions are compatible with the needs of a particular organism.

iguana. Any of several tropical American lizards with a serrated dorsal crest and that eat insects or plants.

imprinting. A learning process whereby young animals learn to mimic the behavior of a parent or trusted caregiver to establish a behavior pattern, such as recognition of and attraction to its own kind.

incubation. A process by which fertilized eggs are warmed by the body of a parent to create a constant temperature until they hatch.

industrial waste. Harmful chemicals, poisonous metal compounds, acids, and other caustic materials that are left over from manufacturing processes.

insecticide. A pesticide that is used to kill insects.

insectivore. An animal whose diet consists of insects.

interphase. A resting or non-reproductive stage in the life cycle of a cell.

intertidal zone. An area near the shore of the ocean that is covered with water during high tide and is exposed above the water level during low tide.

intrinsic value. Appreciation for wild creatures and the environments in which they live.

isospondylous fish. A fish whose vertebrae are essentially the same near its head as they are in its tail.

iteroparous fish. A fish that is capable of spawning more than one time.

J

Jack. Male fish that returns to freshwater to spawn after only one year in the ocean.

Jacobson's organ. A sensing organ located in the mouth of a snake that is used for smelling.

jaguar. The largest predatory cat in North America with a range extending from Texas to Argentina. Its prey consists mostly of deer, peccaries, and domestic livestock.

jaguarundi. A predatory cat that prefers dense undergrowth and ranges from the southwestern United States to South America.

javelina. (Same as the peccary.) A cloven-hoofed mammal, also known as a peccary, that is incorrectly called a wild pig but belongs to a different family.

K

keel. A ridge on the carapace of a turtle.

kestrel. An American falcon that is able to hover in a fixed position above the ground by flying into the wind.

kid. A young goat.

kinetic energy. Energy that is associated with motion and movement in animals.

kingdom. The highest division in the taxonomy of living organisms ranking above the phylum.

kite. One of several species of hawks with a forked tail and long, pointed wings that is found in warm climates.

krill. Tiny, shrimplike crustaceans that make up much of the diet of baleen whales.

L

lamb. A young sheep.

lamellae. Small, comblike projections on the bills of some ducks that they use to strain small food particles out of the water.

larva. Immature forms of some fishes, insects, salamanders, frogs, and animals.

laterally compressed. A description of a fish that is deeper from its back to its belly than it is from side to side.

law of conservation of matter. A basic law of physics that states that matter can be changed from one form to another, but it cannot be created or destroyed by ordinary physical or chemical processes.

lemming. A small, arctic rodent that resembles a mouse or vole, and that has a short tail and fur-covered feet.

lentic habitat. An aquatic environment characterized by still water, such as a marsh, swamp, pond, or lake.

leptocephali. The marine larval stage of development of various eels.

limnologist. A person who studies freshwater habitats.

lobe. A fleshy growth on the sides of the toes of some birds that enables them to swim.

loon. A solitary diving bird with webbed feet and a sharp bill found in northern habitats that captures and feeds on fish.

lotic habitat. An aquatic environment characterized by actively moving water, such as a stream or river, where the flowing water restricts plant growth and food for fish and other aquatic animals is transported from a distant source.

M

mammal. Warm-blooded animals that have bony skeletons, protective hair coats, and mammary glands that produce milk to nourish their offspring.

mammary gland. A mammalian organ, which in the female gender, secretes milk.

manatee. A large, aquatic, herbaceous mammal that ranges in warm coastal waters along the coast of Florida.

margay. A predatory cat that resembles the ocelot and ranges from the southern tip of Texas to South America.

marine biologist. A person who studies the aquatic organisms that live in oceans.

marine biome. An aquatic environment that makes up the world's largest biome, and consists of the oceans where the salt concentration ranges from 3 to 3.7 percent.

marine mammal. A mammal whose body is adapted to living in the ocean.

marsupial. An unusual order of mammals, such as the opossum in North America, that gives birth to offspring before they are fully developed and rears them in an external abdominal pouch.

marsupium. The external pouch of a female marsupial where the mammary glands are located and the offspring are reared.

martin. Any of several birds that are members of the swallow family; a predator belonging to the weasel family.

meiosis. A cell division process where the number of chromosomes is reduced by half during the formation of male and female gametes.

metabolism. The process in which food is digested and used by the cells of the body to release energy.

metamorphosis. A process in which immature organisms such as insects and amphibians change in their physical structure and appearance to become more like adult members of their species.

metaphase. An intermediate step in cell reproduction where the chromosomes become aligned at the center of the cell.

milt. The sperm-containing fluid of a male fish.

mitosis. A type of cell division that occurs in an animal or plant, resulting in growth.

mollusk. A shellfish of the phylum Mollusca, such as a clam, oyster, mussel, or snail, with a soft, unsegmented body enclosed totally or in part by a hard outer shell.

molt. A process in which an animal loses it old outer covering such as feathers, skins, shells, and so forth, and replaces them with new ones.

monogamous. A mating behavior in which a male and a female bond as a pair and mate.

multiple use. A management strategy for natural resources that considers the needs of the different groups of people who use or desire to use the resources.

musk. A foul smelling fluid that is secreted from specialized glands in some mammals, such as in the case of the weasel or musk ox.

N

nanny goat. A female goat.

nares. Nostrils or nasal passages of vertebrates.

narwhal. An unusual whale found in the northern seas that has a long, hollow, twisted tusk in the left upper jaw of the male.

naturalist. A person who studies nature by observing plants and animals.

neotenic. A tendency of newts and other organisms to metamorphose directly to the sexually mature adult stage from the larval stage, without entering a land-based stage of development.

neritic zone. The area of the ocean beyond the intertidal zone that extends to the outer edge of the continental shelf.

nestling. A young immature bird that has not yet left the nest.

niche. A specific role or function within a habitat that is performed by an organism enabling different organisms to occupy different niches in the same habitat.

nightjar. A nocturnal bird with a harsh call and a large mouth lined with bristles that aid in capturing insects during flight.

nitrate. An important plant nutrient that becomes a pollutant when it is present in groundwater or in surface water in excessive concentrations.

Nitrogen cycle. The circular flow of nitrogen from free nitrogen gas in the air to nitrogen compounds in soil, water, and organisms, and back to atmospheric nitrogen.

nitrogen fixation. A process in which nitrogen gas from the atmosphere is converted to nitrates by soil microorganisms.

nitrogen-fixing bacteria. Bacteria that live in soil, water, or in nodules or colonies on the roots of certain plants. These bacteria are capable of changing nitrogen gas to nitrates.

nocturnal. A tendency of some mammals or birds to sleep during the day and forage for food during the night.

nonadaptive behavior. Failure of an organism to adapt to a changing environment.

nonbiodegradable. The resistance of a substance or material to being broken down by living organisms.

nonpoint source pollution. Pollution that comes from several sources and cannot be traced back to a single point of origin.

non-renewable resource. A resource such as minerals or oil that cannot be replaced when it is lost due to excessive use or abuse.

O

oceanic zone. An area beginning at the outer edge of the continental shelf that includes the deep ocean region extending to the continental shelf of the opposite shore.

oceanography. The scientific study of ocean environments, including the chemistry and physics of water, plants, animals, reefs, and other oceanic features.

oceanologist. A scientist who studies ocean environments.

ocelot. A spotted predatory cat that ranges from Texas to South America.

omnivore. An animal that eats both plants and other animals.

order. An intermediate division in the taxonomy of living organisms into which organisms of the same class are divided. The order ranks above the family and below the class.

organism. An individual plant, animal, or other life form with organs and parts that function together.

ornithologist. A scientist who studies birds.

ornithology. The branch of zoology that deals with the study of birds.

overgrazing. A condition in which domestic or wild animals destroy the vegetational cover in an area by harvesting or trampling the plants beyond their ability to recover. This occurs when the carrying capacity of the area is exceeded.

Oversight. Responsible care and management of public and private lands, and natural resources.

oviparous. Reproducing by laying eggs that develop and hatch outside the female's body.

ovoviviparous. Reproducing from eggs that remain inside the female until they have hatched.

ovum. A mature female egg that is capable of developing into a new member of the species after it has been fertilized.

P

parasitic bird. A bird that lays its eggs in the nests of other birds.

peccary. (Same as javelina.) Sometimes incorrectly called a wild pig but belonging to a different family.

pectoral fin. A fin that fish use to control their direction of travel. It represents the forelimbs in most fish.

pelagic. Inhabiting the surface waters of the open ocean (as in some fishes, birds, and other organisms).

pellet. A small, compressed ball of food.

pelvic fin. A fin that occurs in pairs on the lower rear of a fish. It corresponds to hind legs in vertebrates.

pesticide. A chemical that is used to kill insects, weeds, rodents, fungi, or other pests. Pesticides include herbicides, insecticides, rodenticides, and fungicides.

petroleum. An oily, flammable liquid that occurs naturally in underground deposits.

phalarope. A bird that is unusual because the females are brightly colored, and the drab-colored males incubate the eggs.

phosphate. An important plant nutrient that becomes a pollutant in groundwater or in surface water when it is present in excess amounts.

photoperiod. The recurring cycle of daylight and darkness that favorably influences an organism to mature or develop physical functions such as sexual maturity.

phylum. An intermediate division in the taxonomy of living organisms into which organisms of the same kingdom are divided. The phylum is above the class and below the kingdom.

phytoplankton. Microscopic plants that float on the water's surface.

pigeon milk. A food that is composed of cells secreted in the crops of both parents, having the appearance and food value of cottage cheese.

pika. A small, short-eared rodent with two sets of upper incisor teeth that is found in the rocky uplands of western North America.

pinniped. Carnivorous aquatic animals, such as seals and walruses. The limbs of these animals are modified flippers.

placenta. A vascular organ consisting of a fluid-filled sac that is connected to the blood supply of the mother's uterus. It encloses the babies of most mammals, protecting them from injury, eliminating wastes, and nourishing them inside the mother's body until they are born.

placental mammal. A mammal whose offspring develop inside the mother's uterus surrounded by the placenta.

plankton. Microscopic plants and animals that float in surface waters, and are food for fish and other aquatic animals.

plastron. The lower shell of a turtle or tortoise.

plover. A family of small- to medium-sized precocial shore-birds that feed on insects and small aquatic animals.

plumage. All the feathers of a bird.

Plume. A showy feather that develops upward and curves forward on the head of a quail or other plumed bird.

poaching. To take anything, especially wild game, by illegal methods.

pod. A group of whales that live together.

point source pollution. Pollution of the environment that can be traced back to its point of origin.

pioneer. The first plants to grow in an environment.

pollutant. A waste material or harmful chemical that is discharged into the environment.

polliwog. (Same as a tadpole.) The larval stage of development in the metamorphosis of a frog or toad that is sometimes called a tadpole.

polyandry. A mating behavior in which a female mates with more than one male.

polygamous. A mating behavior in which an animal has more than one mate at a time.

polygynous. A mating behavior in which a male mates with more than one female.

population. A group of similar organisms that is found in the same area.

precocial. Of a type of animal whose young are covered with down, and that become active at the time of hatching or birth. They are capable of a somewhat independent life from birth.

predator. An animal that kills and eats other animals.

prehensile. Adapted for grasping as in the tail of the opposum.

primary consumer. An animal that eats plants.

primary succession. The development of an ecological community in an area where living organisms were not previously found, such as on a newly formed volcanic island.

pristine. Of or constituting a pure or undamaged resource.

producer. A green plant that converts solar energy to starches and sugars.

prolific. Having the capacity to produce large numbers of offspring.

promiscuity. (promiscuous) A mating behavior wherein animals mate with numerous members of the opposite sex, and they do not form pair bonds.

pronghorn. Only remaining member of a family of mammals with hollow, two-pronged horns. It resembles an antelope and lives in the deserts or plains of western North America. It also is called a pronghorn antelope.

prophase. The first stage of active cell division.

puma. A large predatory cat that also is known as a cougar, panther, or mountain lion.

R

race. A division in the taxonomy of living organisms into which organisms of the same species are divided.

radiant energy. Energy that comes from the sun.

rail. A group of small to medium wading birds. Some are flightless and live in the reeds that line the shores of wetlands. They have long toes that enable them to walk on soft mud.

ram. A male sheep.

range of tolerance. The limits within environmental conditions that an organism can survive and function.

raptor. A bird of prey such as a hawk, owl, or eagle.

redd. The spawning nest of trout or salmon.

renewable resource. A resource such as a forest or wild animal population that is capable of being replaced as it is used.

reptile. A cold-blooded animal with scales, plates, or shields on its body and claws on its feet. Most reptiles lay eggs with leathery shells.

riparian zone. The land adjacent to the bank of a stream, river, or other waterway.

rodent. A small, gnawing animal that is identified by the four large incisor teeth located in the front of its mouth.

rodenticide. A chemical poison that is used to kill rodents such as mice or rats.

roe. Clusters of fresh fish eggs enclosed in ovarian membranes.

rumen. A large stomach compartment in a ruminant animal where high-fiber plant materials are soaked, warmed, and digested with the aid of bacteria.

ruminant. An animal such as a deer or bison that has a series of four stomach compartments which are capable of digesting food that is high in fiber.

rut. The breeding period for some of the large North American ruminants, during which the males become aggressive in their behavior.

S

salinity. A measurement of the salt concentration in water affecting the survival of organisms living in aquatic environments.

salmonid. A family of freshwater and marine fishes including salmon, trout, and whitefishes, that migrates upstream to spawn.

scavenger. A bird or mammal that eats any kind of food it can find, including the carcasses of dead animals and garbage.

school. A large group of fish that live together in the same habitat.

scrape. A shallow depression that has been scratched out of the ground. It is sometimes lined with dry vegetation for a nest.

scute. A large, bony plate that is found on the head, back, or sides of an animal, such as the outer covering on a sturgeon.

secondary consumer. A carnivorous animal that obtains its nutrition by eating primary consumers and other carnivores.

secondary succession. The gradual change in species of plants that live in an area during the time that a damaged ecosystem is returning to its original stage of ecological development.

second law of energy. A scientific law stating that each time energy is converted from one form to another, some energy is lost in the form of heat.

shad. Anadromous fishes that are members of the herring family.

shellfish. An animal with a soft body and hard outer shell, such as a mollusk or crustacean.

shrike. Black and white birds with shrill voices that gather insects and store them for later meals.

shrub layer. Vegetation consisting of short woody plants that occupies the stratum between the herb layer and the understory of a forest.

silt. Tiny soil particles that are easily eroded by becoming suspended in flowing water or blown as dust in the wind.

silt load. The amount of eroded soil that is carried in the flowing waters of streams and rivers.

simple stomach. A digestive system in which digestion is accomplished in a single stomach compartment.

sinistral fish. A flatfish whose eyes are always on the left side of its head.

skink. Any of several lizards that have shiny bodies, short legs, and smooth scales.

smelt. A small, slender, food fish found in large schools in most coastal regions, upon which many larger fishes prey.

smog. Pollution of the atmosphere due to a poisonous mixture of fog and smoke.

smolt. A young fish whose body is changing to enable it to leave its freshwater habitat and enter the saltwater environment of the ocean.

soil conservation. The practice of protecting soil from erosion caused by strong winds or flowing water.

solitary. Living alone.

solid waste. Includes most of the waste materials that are thrown away as garbage. However, it does not include liquid waste materials or gaseous effluents.

sow. An adult female pig or bear.

spawning. The process of reproduction in fish in which females deposit eggs on the bed of a stream, pond, or lake, and males discharge sperm on the surface of the eggs.

species. A division in the taxonomy of living organisms into which organisms of the same genus are divided. The species is below the genus, and it is comprised of organisms or populations whose members can interbreed and who share a common gene pool.

sperm. Male reproductive cells.

spindle. A bundle of fibers that functions to separate chromosome pairs during cell division.

squab. A young pigeon or dove.

steelhead. A race of large anadromous rainbow trout.

steward, land. An administrator or supervisor who manages land resources and/or property.

stewardship, land. Exercising responsible and careful management over land resources and/or property entrusted to one's care.

stoop. A fast dive by a predatory bird to capture a prey in flight.

stratum. Consists of one of several levels or layers of plant growth in an ecosystem such as a forest.

strata. Several levels or layers of vegetation or water.

surface water. Water that is located on the earth's surface in rivers, streams, ponds, and lakes.

swift. A migratory bird resembling a swallow with long wings, a slightly forked tail, and weak legs and feet that feeds on insects. It remains in flight almost continuously except for the nesting season.

swimmeret. A small swimming appendage occurring in pairs that is located on the abdomen of some crustaceans, and that function in reproduction and locomotion.

symbiosis. A relationship between two organisms in which each organism receives benefits from its association with the other organism.

T

tadpole. The larval stage of development in the metamorphosis of a frog or toad that is characterized by a long, rounded body and external gills. It also is called a polliwog.

talon. The toe and sharp claw of a bird of prey that it uses to grasp and kill its prey.

tanager. A brightly colored songbird that prefers habitats along streams near willow and cottonwood trees.

Tapetum lucidum. A special tissue located in the eyes of walleye and other animals fish that gives them night vision.

taxonomist. A scientist who classifies living organisms and defines their relationships with other organisms.

taxonomy. The field of science that classifies living organisms and defines their relationships with other organisms.

telophase. The last stage of cell division where cell cytoplasm is divided as the two new cells begin to form.

temperate forest biome. (Same as deciduous forest biome.) A group of ecosystems in which broadleaf trees are abundant and the annual precipitation exceeds 30 inches per year.

temperate rain forest. A forest that exists in regions having four distinct seasons along with normal annual precipitation of 68–78 inches.

terrapin. Any of several turtles that live in freshwater habitats or saltwater marshes.

terrestrial biome. A large community of plants, animals, and other living organisms that live on land.

terrestrial. To live on land.

territorial. A behavior in which birds and other animals establish and defend living and hunting areas against other competing members of their species.

thermal energy. Energy that is released as heat when fuels or nutrients are burned or digested.

thermal stratification. Differences in water temperatures at various depths with deep water being colder than water near the surface.

threatened species. Species that are at risk due to declining numbers in their population, and that can reasonably be expected to survive if immediate steps are taken to protect the remaining populations and their habitats. It is a legal status that is established through the Endangered Species Act which provides extra protection and management.

toothed whale. A whale with a large mouth and sharp teeth it uses to attack large prey and bite it into pieces that can be swallowed. They include dolphins, porpoises, and killer whales.

torpedo. A Pacific electric ray.

torpid. To be in a dormant condition due to cold temperatures.

Torpor. A physical state similar to hibernation that occurs in some animals during periods of cold weather. At this time, their metabolism slows down and they require little or no food.

tortoise. A turtle that is adapted for living on land.

toxic waste. Waste products that are poisonous to living organisms.

transpiration. The loss of water to the atmosphere from plant leaves.

Tundra biome. A group of ecosystems located in the frozen northern regions of the continent where evaporation rates are low, precipitation is minimal, and swamp-like conditions exist during the summer because water cannot penetrate the frozen soil.

turbid. Muddy or cloudy water conditions.

turtle. A reptile with a toothless beak and a soft body inside a two-part shell, into which it can withdraw its head, legs, and tail.

tympanum. The vibrating membrane in the middle ear, or the round external eardrum of a frog or toad.

U

understory. Short trees in a forest that fill an intermediate stratum of vegetation beneath the canopy created by the branches and foliage of the tallest trees.

ungulate. A mammal with hooves.

uterus. An internal female organ where the placenta becomes attached, and which encloses the growing fetus as it develops prior to birth.

V

velvet. The soft skin containing blood vessels that nourishes and protects the developing antlers of deer.

vertebrate. An animal with a segmented backbone that surrounds the spinal cord.

vertebrata. The subphylum of animals that have a segmented spine, including all mammals, fishes, birds, reptiles, and amphibians.

viper. A poisonous snake with hinged fangs in the front of its mouth that fold back out of the way when they are not in use.

viviparous. To give birth to live offspring.

vixen. A female fox.

vole. A small mouse-like rodent with a stout body and short tail.

W

water cycle. The movement of water in the form of vapor from the oceans to the clouds to the earth as precipitation, and back to the oceans through rivers and streams.

waterfowl. Swimming game birds that live in water habitats.

watershed. An area bounded by geographic features where precipitation is absorbed in the soil to form groundwater, which eventually emerges to become surface water and ultimately drains to a particular water course or body of water.

wattle. Red tissue on the face of a bird, such as a turkey, that swells with blood and takes on a bright red color during the mating display.

wetland. Land areas that are flooded during all or part of the year.

wet scrubber. A device that sprays water through a chamber to remove particles and water-soluble materials from polluted gases and smoke fumes before they are released into the atmosphere.

whalebone. A comb-like bony structure in the mouths of some whales that is used to strain food such as plankton and other small organisms from ocean water.

White coat. A baby harp seal that has a white fur coat at birth.

wild fish. A strain of fish that reproduces naturally in the wild.

Y

yolk. A yellow substance found in eggs containing protein and fat for the nourishment of embryos and newly hatched fish, birds, and reptiles.

yolk sac. A pouch-like organ found in young fish, reptiles, and birds, containing a highly nutritious material called yolk that nourishes the young before and after hatching.

yolk-sac fry. A recently hatched fish that still has a yolk-sac attached to its underside from which it draws nourishment.

Z

zoology. The branch of biology that deals with animal life.

zooplankton. Microscopic animals that live at or near the surface of a body of water.

zygote. A fertilized egg.

Index

Page numbers in *italics* indicate images.

A

accipiter, 268–270
acid precipitation, 439
Acipenseridae family, 353
adaptation, 187, 273
adipose fins, 341
aeration of water, 348, 350
aeries, 264, 265
agriculture, 39–50, 60, *77*, 167, 363, 432–434, *432*, *435*, 440–441, 476–477, 493, 496
  chemicals of, 44–45
  impact on ecosystems, 43–48
air pollution, *19*, 21, 465–466, 472
albacore, 384, *384*
alevins, 360
alewife, 389
algae, 463
alien species, 85–86
allantois, 402, *402*
alligators, 403–405, *403*, *405*
alluvial fans, 460–461
American alligator, 405, *405*
American bittern, 311, *311*
American coot, 325, *325*
American dipper, 291, *291*
American eel, 374, *374*
American kestrel, 271, *271*
American robin, 292, *292*
American shad, 373, *373*
ammonia, 29
amniote egg, 402
amniotic fluid, 402
amphibians, 401, 419–425, *476*
anadromous, catadromous, and diadromous fish, 360–375, *362*
anadromy, 365–366
anal fins, *339*
anaphase, 11, *10*
anatomy of animals, 6–7, 339–340
anchovies, 387
animal control officer, 166
antenna, on shrimp, 394
antlers, 135, 137–138
aquaculturists, 349
aquatic biologists, 63, *63*
aquatic species, 19–20
arctic fox, 163, *163*
arctic grayling, 351, *351*
arctic hare, 120, *120*
Arctic tern, 316, *316*
armadillo, 218–219, *219*
Arthropoda phylum, 394
Atlantic salmon, 367, *367*
auklets, 317, *317*
auks, 316
Aves class, birds, 225
avians, 225
avocets, 323

B

backbone, 4, *4*
badger, 177, 178, *178*
balanced vs. unbalanced ecosystems, 41, *41*
bald eagle, 263, *263*
baleen whales, 197–198, 199, 206
band-tailed pigeon, 255, *255*
bandicoots, 210
barging, 361–362, *362*
barn owls, 281–282, *282*
barn swallow, 327, *327*, *329*
barren-ground caribou, 138, *138*
barriers, 53
bass, 342, 343, *343*, 371–372, *372*, 391–392, *392*
bats, 214–218, *216*, *217*
beaded lizard, 407
beard, turkey, 253–255, *243*, *254*
bears, 71, 101, 135, 137, 139, 167–171, *179*, 362, 480
beaver pond, *31*
beavers, 124–127, *127*
behavior and habits, animal, 4–6
belted kingfishers, 304, *304*
benefits vs. conservation, *433*
big brown bat, 217, *217*
bighorn sheep, *9*, 48, *48*, 145–146, *146*, 452
billfishes, 384
billy goats, 148
biodegradable materials, 436
biological succession, 46–50
biologists, 88
biology, 2
biomes, 53–71, *64*
biosphere, 41, *41*
Biosphere II project, 42, *42*
biota, 476, *476*
biotechnology, 469
biotic potential, 87
bird counts, 294
bird nesting area, *443*
bird watching, 287, 294, 480
birds, 223
birds of prey, 97, *97*, 211, 232, 245, 261–282, *262*
birth, 13
birth rates, 216, *217*
bison, 69, 142–144, *144*, 166–167, 482
bittern, 311, *311*
bivalves, 392–393
black bear, *34*, 167–168, *168*
black-billed magpie, 302, *302*
black-chinned hummingbird, 305, *305*
black crappie, 344, *344*
black-footed ferret, 174, *174*
black market in animal parts, 83
black rat snakes, 415, *415*
black-tailed deer, 142, *142*
black-tailed jackrabbit, 122, *122*
black-tailed prairie dog, 117, *117*
black vulture, 273
blackbirds, 296–298
blowholes, 196–197
blubber, 181, 196
blue jay, 302, *302*
blue marlin, 385, *385*
blue whale, 197, *197*
blue-winged teal, 232, *232*
bluebird, 293, *293*
bluegills, 342, 345, *345*
boars, 169

boating, 444, 479, *479*, 484–486, 491
bobcat, 98, 108, 123, 140, 158, *158*
bobwhite, 245, *245*
body heat, 25, *26*, 225, 328
botany, 2
bottle-nosed dolphin, 204, *204*
bounties, 494
brain, *4*
Brandt's cormorant, 318, *318*
broods, 250
brook trout, 350, *350*
brown bear, 170
brown creeper, 333, *333*
brown-headed cowbird, 298, *298*
brown thrasher, 295, *295*
brown trout, 348, *348*
brucellosis, 143
bucks, 135
bullfrogs, 422
bullhead, 340, 341
bulls, 135
burning of wastes, 21
burros, 48, 50, 131, 150–151, *151*
burrowing owl, 281, *281*

C

cardiopulmonary resusicitation (CPR), 487
caiman, 404
calf, 135
California condors, 273, 274, 468, *468*
California ground squirrel, 112, *112*
California gull, 315, *315*
California quail, 244, *244*
California sea lion, 189, *189*
camouflage, 387
camping, 479, 483–487
Canada geese, 235, *235*
Canada lynx, 157–158, *157*
canopy, 69–70
carapace, 218, *218*, 416, *417*
carbon cycle, 27–29, *28*
carbon dioxide, 27, 28
carbon monoxide, 21, 470
cardinal, 289, *289*
career options
  aquaculturists, 349
  aquatic biologists, 63, *63*
  ecologists, 40
  environmental analyst, 465
  environmental scientist, 22
  fish and wildife biologists, 88, *88*
  game bird farm manager, 248
  game wardens, 140
  herpetologists, 419
  hunting/fishing outfitter, 491
  ichthyologists, 372
  marine biologists, 388
  oceanologists, 195
  ornithologists, 225
  predatory animal control officer, 166
  science teacher, 8
  soil conservationists, 434
  taxonomists, 96
  wildlife mitigation specialist, 276
  wildlife technician, 213
caribou, 67, 71, 135, 138–139, *138*, 166, 179
carnivores, 96, 391
carp, 354, *354*
carrion, 168, 282
carrying capacity, 107
cartilaginous fishes, 379
Cassin's auklet, 317, *317*
catadromous fish, 359
catalytic converter, 470–471
catbird, 296, *296*
catfishes, 340–341, *340*, *341*
catkins, 249
cats, 156–160
cattle, 131, 136, 142, 143, 160
caviar, 353
cell division and growth, 10, *11*
centipedes, 394
Centrarchidae family, 343
centrioles, 11
centromere, 11
Cephalopoda, 393
cetaceans, 196
channel catfish, 340, *340*
char, 347
chemical energy, 25
chemicals of agriculture, 434–435
chickenlike marsh birds, 324–325
chimney swift, 329, *329*
chinook salmon, 368, *368*
chipmunk, *105*, 113, 116
chorion, 402
chromatid, 11
chromosomes, 11, 12
chub mackerel, 383, *383*
chukar partridge, 247, *247*
chum salmon, 368
circulatory system of marine mammal, *187*
citizens as conservationists, 440–441
Civilian Conservation Corps (CCC), 494
clam, *393*
Clark's nutcracker, 303
class, 3, 40
classification of animals, 3–4, 40
Clean Air Act, 466, 472
Clean Water Act, 470
climate, 54, *54*
climax communities, 47
clouds, 31
cloven-hoofed mammals, 131, *131*
Clupeidae family, 373
clutch, 243
cobras, 412
codfish, 389–390, *389*, *390*
Coho salmon, 370, *370*
colonies of birds, 328
coloration, in birds, 280
combustion, 28
comfort zones, 50
commerce, 489
common crow, 301, *301*
common dolphin, 203, *203*
common eider, 231, *231*
common flicker, 330, *330*
common merganser, 228, *228*
community, 40
competitive advantage, 47–48
competitive exclusion principle, 48–50
compound eyes, 395
conical bills, 288
coniferous forest biome, 70–71
conifers, 70
conservation education, 493
conservation of matter, 18–23
conservation of natural resources, 458–472
Conservation Reserve Program (CRP), 494–495
constrictor snakes, 415
continental shelf, 62–63, *62*
Cooper's hawk, 268, 269, *269*, 270
coots, 324, 325, *325*
copperheads, 412
coral snakes, 412–413, *413*
cormorant, 318, *318*, 390
Corvidae family, 301, 303
cottonmouths, 412
cottontail rabbit, 118, *118*
cougar, 159
coveys, 244
cowbird, 296, 298, *298*
cows, 135
coyote, *46*, 66, 69, 98, 121, 134, 140, 161, 162, 165, 165–166, *165*, 167, 177, 211, 494
crabs, 187–188, *188*
crakes, 324
crane, 313, *313*
crappie, 342, 344, *344*
creepers, bird, 329, 332–333, *333*
crocodiles, 403–405, *403*
crop, in birds, 9, 256
crow, 301, *301*
crustaceans, 187, 370, 374, 383–384
cuckoos, 303
cud, 132
curlew, 322, *322*
currents, ocean, 61
cuttlefish, 392, 393
cygnets, 237, 238
Cyprinidae, 354

D

dabbling ducks, 231, 238
Dall's sheep, 145, 147, *147*
Darling, J.N. (Ding), 493
darters, 345
DDT, 44, 272, 273, 494
deciduous forests, 64
deciduous forest biome, 69–70
  canopy, 69
  forest floor, 70
  herb layer, 70
  shrub layer, 69
  strata, 69
  understory, 69
decomposers, 33, 436
deer, 43, *45*, 70, 96, 131, 135–140, 151, 159, 492
delayed gestation, 156, 172
demersal spawners, 388
denitrification, 29
desert biomes, 64–66, *65*
dew, 66
dextral fishes, 386

diadromous fish, 359–375
diploid cells, 13
dipper, 291, *291*
disposal of hazardous wastes, 45, *45*
diurnal, 262
division, 40
doe, 134
dogs, 161–166
dolphin, 187, 199–202, 203–204, *203*, *204*, 449
domestic animals, 476–477
donkeys, 150, 151
dorsal fins, 341
Douglas squirrel, 106, *106*
Dover sole, 386, *386*
doves, 255–258
down, 236, 244
drawdown plan for salmon, 363
ducklike birds, 318–319
ducklings, 229–230, *229*
Ducks Unlimited, 59, 442, 452, 494
ducks, 59, 227–233
dumping, 486
Dutch Elm disease, 294

E

eagles, 140, 247, 262–264, *263*, 282, 362, 494
eaglets, 263
eared seals, 188, *188*
Earth Day, 494
Eastern coral snakes, 413, *413*
Eastern cottontail rabbit, 118, *118*
Eastern fox squirrel, 108, *108*
Eastern garter snake, 411, *411*
Eastern gray squirrel, 107, *107*
Eastern tiger salamander, 422, *422*
ecdysis, 412
echo navigation in bats, 215, *215*
ecologists, 40
ecology, 1, 17–36, 40, 77–78, 493
ecosphere, 40
ecosystems, 40, 43, 54–55, *55*, 95
  agricultural impact on, 43–50
  balanced vs. unbalanced ecosystems, 41, *41*
ectotherms, 400, 401
education, 451
eels, 373–374, *374*
efts, 424
egg, 13, 402–403
egg cases, 381
eider, 231, *231*
elapids, 412
electric rays, 382
electrical energy, 25
electrostatic precipitators, 471, *471*
elements, 27, 478–479
elephant seals, 189
elf owl, 279, *279*
elk, 71, 135–137, 141, 143, *135*, 159, 166, 438, 467
elvers, 375
embryonic membrane, 402
embryos, 14
emissions, 470–471
employer expectations, 453
endangered animals, 14
endangered species, 78–89, 160, 404, 449
Endangered Species Act, 78–89, *79*, 446, 449, 494
endotherms, 400
energy, laws of, 24–27, *25*
  first law of, 25, *26*
  second law of, 26, *26*
English sparrow, 287, *287*
environmental analyst, 465
environmental organizations, 443–444
Environmental Protection Agency (EPA), 466, 470
ermine, 67
erosion, 433, 445, 451, 460–464, *461*, *462*
estivation, 115
estuary, 64, *64*, 396
ethics, privileges, responsiblities, 491
evaporation, 31, 32, *32*
Everglade snail kite, 267, *267*
evolution, 108
ewes, 145
exhaust gases, 439, 465, *465*, 471
experience programs, 451–453
extinction, 78, 83, 85–86, *87*, 324, 494
Exxon Valdez Oil Spill, 24

F

facial disk, 277, *277*
falconiformes, 262
falcons, 247, 257, *263*, 270–271
family, 3, 40
farmers as conservationists, 432–438, *433*
fauna, 3
fawn, 5, 135
feathers, 226
Federal Water Bank Program, 59
feeding habits, 83, 112, 124, 136
ferret, 174, *174*
fertilization, 13
field mouse, 33
finfeet, 187
fins, *339*
fires, *26*, 461
first aid, 487–488
first law of energy, 25, *25*
fish, 491
fish and game officer, 140
fish and wildife biologists, 88, *88*
fish hatcheries, 363–364, *364*, 442, 452
fish hawk, 275
fish trap, *364*
fisher, 176, *176*
fishes, 378–396
fishing, 479, 409, 481–482, 483
flamingo, 314, *314*
flatfishes, 387
fledge, 257
flicker, 330, *330*
flippers, *187*
flounder, 385
flycatchers, 305
food chains, 33–36, *33*, *56*, 294
food pyramid, 34
food web, 34, *34*, 273
forest fires, 49, *49*
forest floor, 70
Forest Reserve Act, 493
forests, 446
fossil fuels, 25, 28
fox squirrel, 108, *108*
foxes, 70, 71, 84, *84*, 98, 140, 161–164, *163*, *164*, 232, 245
freshwater biomes, 55–59, *55*
freshwater eels, 373–375, *374*
freshwater fishes, 338–356, *340*
freshwater, 339–340, *339*
frogs, 420–425
frontal shield, 324
fry, 360, *360*
fuel tank leaks, 23, *23*
fur, 180, 181
fur seal, 190–192, *191*

G

gallinaceous birds, 243–244
gallinule, 324, *324*, 325
game bird farm manager, 248
game birds, 242–258, *243*, 325
game farms and preserves, 441–442, *441*
game fish, 346, 349
game laws and regulations, 482–483, 492
game wardens, 140
gametes, 11–12
garden chemicals, 440–441
garter snake, 411, *411*
Gastropoda, 392
geckos, 409
geese, 233–236, 238
genetic engineering, 469
genus, 3, 40
gestation, 156, 163
Gila Monster, 408, *408*
gills, 187
gizzard, 7, 9, 236, 256
global warming, 28
gnatcatchers, 305
gnawing mammals, 94–127
goats, 144, 148, *148*
golden eagle, 264, *264*
goldeneye, *23*
goldfish, 354
gophers, 124–125, *125*
goshawk, 269–270, *269*
goslings, 234, *234*
government in conservation, 445–449
grackle, 297, *297*
grass carp, 354
grassland biome, 68–69, *68*, *69*
gray catbird, 296, *296*
gray fox, 162, *162*
gray jay, 303
gray or Hungarian partridge, 246, *246*
gray squirrel, 107, *107*
gray wolf, 166, *166*
grayling, 351, 351
grazing rights, 150, *150*
Great Basin, 66, 119

great blue heron, 310, *310*
great gray owl, 277, *277*
great horned owl, 278, *278*
great tailed grackle, 278, *278*
greater prairie chicken, 252, *252*
grebes, 318, 320, *320*
green anole, 406, *406*
gregarious birds, 288
grit, 236
grizzly bear, 169, *169*, 447
ground nesting, 230, 232
ground squirrel, 105, *105*, 109, 111–112, *111*, *112*, 116
groundhog, 114, *114*
groundwater, 20
groupers, 391, *391*
grouse, 249–250, *250*
growth, animal, 10–14
Guadalupe fur seals, 190
gulls, 314–316

H

habitat, 43, 78, 85, 107, 431
habitat preservation and restoration, 430–451
habits, animal, 4–6
halibut, 385–386, *387*
haploid cells, 13
harbor porpoise, 205, *205*
harbor seal, 193, *193*
hares, 71, 117–118, 165, 165, 263
harp seal, 189, 192, *192*
harriers, 268, *268*
hatchery stock, 363–364
hawks, 71, 97, 216, 247, 262–282
hazardous wastes, 23
  disposal of, 45, *45*
heat, 25
heath hen, 252
herb layer, 70
herbicides, 22
herbivores, 33, 96
hermaphrodites, 391
heron, *58*, 310, *310*
herpetologists, 419
herring, 387–388, *388*
Heterosomata family, 385
hibernation, 99, 110, 113, 114
hiking, 444, 479, *484*
hoary marmot, 116, *116*
homing instinct, in anadromous fish, 366, *366*
homologous chromosomes, 12
homologues, 12
hoofed mammals, 131–151
horned lizard/toad, 407, *407*
horseback riding, *444*, 479, *479*
horses, 131, 141, 150, *150*, 159, 160
house finch, 288, *288*
house mouse, 98, *98*
house sparrow, 287, *287*
house wren, 290, *290*
human connection to wildlife and natural resources, 475–496
human dominance of food chains, 33–35, *35*
hummingbird, 304–305, *305*
humpback whales, 198, *198*
hunting, 86, 226, 236, 248, 442, 444, 447, 448, 450, 468, 481–483, *482*
hunting/fishing outfitter, 491
hybrids, 344
hydrocarbons, 470
hydrogen, 27

I

ichthyologists, 372
ichthyology, 372
Icteridae family, 296–298
iguans, 406
imprinting, 468
incubation, 269, 272
industrial waste, 19–20
industry as conservationist, 439–440
insecticides, 22
insectivores, 212, 326
insects, 394
instinctive behavior, 5–6
intensive cropping system, 43, *43*
international conservation law, 448–449
interphase, 10–11, *10*
intertidal zone, 61–62, *62*
intrinsic value, 479–480
isospondylous fishes, 387
Izzak Walton League, 226

J

jack salmon, 370
jackrabbit, 66, 122, *122*
Jacobson's organ, 414
jaguar, 160
jaguarundi, 160
javelina, 131, 149
jays, 302–303
jet skis, 485

K

kangaroo mouse, 99
kangaroos, 210
keels, 417
kestrel, 270, 271, *271*
key deer, *7*
kids, 148
killdeer plover, 323, *323*
killer whale, 189, 194, 197, *201*, 203
kinetic energy, 25
kingdoms, 3, *3*
kingfishers, 304, *304*
kit fox, 164, *164*
kites, 262–263
krill, 197

L

lagoons, 470
lambs, 145
lamellae, 227
landfills, 20, *21*
largemouth bass, 342, *342*
larva, 423
laterally compressed fish, 342
lava flow, 46–47, *47*
lawn chemicals, 440–441
laws of conservation, 448–449
lead poisoning of waterfowl, 236
learned behavior, 6
least chipmunk, 113, *113*
lemmings, 67, 97, 104–105, *104*, 163
lentic habitat, 58, *58*
leopard frogs, 420, *420*
Leopold, Aldo, 493
leptocephali, 374–375
light penetration in aquatic environment, *57*
lightning, 29, 68–69
litter, *217*, 383
little brown bat, 218, *218*
livestock grazing, *437*
lizards, 405–410, *407*
lobster, 395–396, *396*
loggerhead sea turtle, 82, *82*
loggerhead shrike, 292, *292*
logging industry, 281, 449, *449*, 462, 484
long-billed curlew, 322, *322*
long-tailed weasel, *172*
loons, 318, 319, 485
lotic habitat, 58–59
lynx, 67, 71, 98, 121, *133*, 140, 147, 157, *157*, 494

M

mackerel, 383, *383*
magpie, 302, *302*
mallard, 229, 230–231, *229*, 230
mammals, 94, 130
mammary glands, 94
manatees, 194–195, *195*
margay, 160
marine biologists, 388
marine biome, 60–63, *60*, 379, *379*
marine food chain, *56*
marine mammals, 186–206, *187*
marlin, 383, 385, *385*
marmots, 113–116
marsh birds, 324–325
marsh hawk, 268, *268*
marsupials, 210–211, *211*
marsupium, 210
marten, 173, 175, *175*
masked shrew, 214, *214*
mating, 161, 220
meadow jumping mouse, 99, *99*
meadow vole, 103
meadowlarks, 296, 299, *299*
medicines, 477
Mediterranean gecko, 410, *410*
meiosis, 12–13, *12*
merganser, 228, *228*
metabolism, 212
metamorphosis, 423, *423*
metaphase, 11, *10*
Mexican freetail bat, 216, *216*
mice, 97–105, 178
migration, 59, 67, 84, 104, 136, 217, *217*, 225, 288, 311, 321
  anadromous, catadromous, and diadromous fish, 360–375, *362*

millipedes, 394
milt, 340
Mimidae family, 294
minerals, *459*
  in water, 56
mink, 71, 98, 173, *173*, 232
minnows, 354–355
mitosis, 10, *10*
mockingbird, 294, *294*
mole, 212–213, *212*
mollusks, 187, 227, 392–394
molt, 232
monogamy, 244, 266
moose, *6*, 71, 135, *135*, 167
Moronidae family, 371
mountain bluebird, 293, *293*
mountain goats, 148, *148*
mountain lion, 96, 123, 127, *133*, 137, 140, 147, 150, 159, *159*, 179
mountain whitefish, 350, *350*
mourning dove, 257, *257*
mule deer, 71, 141, *141*
multiple use concept, 446, 450–451
murres, 316
musk, 175
musk hog, 149
musk ox, 67, *133*, 142, 145, *145*
muskellunge or musky, 352
muskrat, 102, 103, 104, *104*
mustangs, 150, *150*

N

nanny goats, 148
nares, 420
narwhal, 202, *202*
National Birds of Prey Center, 274
national conservation law, 448–449
National Environmental Protection Act, 494
National Park Service, 447–448
national parks and monuments, 447–448
natural cycles, 27–33, 477–479
natural disasters, 85
natural selection, 83
naturalists, 76–77
Nature Conservancy, 59, 226
neotenic newts, 424
neritic zone, *62*
nesting boxes, *88*
nesting sites, *443*
nestlings, 302
newts, 422–424
niche, 47
nightjars, 325–326
nitrates, 29, 450, 463–464, 470
nitrogen cycle, 27, 29–30, *30*
nitrogen fixing bacteria, 29, *30*
nitrogen oxide, 439, 470
no-till agricultural practices, *433*
nocturnal, 99
nonbiodegradable materials, 436
nonpoint source pollution, 440
nonrenewable resources, 459, *459*
nonadaptive behavior, 87, *85*
Northern cardinal, 289, *289*
Northern harrier, 268, *268*
Northern oriole, 296, 300, *300*
Northern pike, 352, *352*
Northern shoveler, 230, *230*
Northern spotted owl, 80, *80*
Northern swift fox, 84, *84*
Northern water snake, 412, *412*
Norway rat, 101, *101*
nutcrackers, 303
nuthatch, 329, 332, *332*
nutrition and digestion, animal, 8–10

O

Occupational Safety and Health Administration (OSHA), 487
occupational safety, 454–455
oceanic zone, 62–63
oceanologists, 195
oceanology, 195
oceans, 378
  carbon dioxide and, 28
  currents, 60–61
  light penetration into, 61
  water cycle and, 31, *31*
ocelots, 160, *160*
octopus, 392, 393–394, *394*
offroad vehicle damage, *445*, 484–485
Old Faithful geyser, 447, *447*
omnivores, 168, 177
opossums, 70, 210–211
opportunistic feeders, 280
order, 3, 40
organisms, 40, *78*
oriole, 296, 299, 300, *300*
ornithologists, 225
ornithology, 225
Osmeridae family, 390
osprey, 262, 275, *275*
otters, 179–180, 205
outdoor recreation management, 495
overgrazing, 438
oversight of government for land, 447
oviparous, 225
ovoviviparous, 381, *382*
ovum, 13
owls, 71, 80, *80*, 101, 277–282
oxygen, 27
  in water, 57, *58*
ozone, 466

P

Pacific electric ray, 383, *383*
Pacific salmon, 369, *369*
Pacific sanddab, 386, *386*
packs, 167
panther, 159
parasitic birds, 297, 303
partridges, 246–247, 249
passenger pigeon, 70, 86, *86*, 257
peccary, 149, *149*, 151
pectoral fins, *339*
pelagic fish, 383, *383*
pelicans, 318, 319, *319*
pellets, owl, 277
pelvic fins, *339*
perch, 345–346, *346*
perching birds, 286–306
peregrine falcon, 272, *272*
permafrost, 67
pesticides, 18, 22
petroleum/oil, 465
petroleum/oil spills, 18, *18*, 23–24, *23*, *24*, 463, *469*
phalaropes, 323
pheasant, *9*, 243, 247–249, *441*
phosphates, 463–464, 470
photoperiod, 172
photosynthesis, *26*
phylums, 3, 40
phytoplankton, 56
pigeon milk, 256
pigeons, 255–258
pigs, 131
pikas, 117–118
pike, 352, *352*
pileated woodpecker, 331, *331*
pine vole, 100, *100*
pink salmon, 367, 369, *369*
pinnipeds, 187–188, *188*
pintails, 231
pioneers, 47
pipits, 305
placenta, 210
placental mammals, 210
plankton, 54, *56*, 61, 63, *188*, 373, 380, 383, 384
plastics for recycling, *21*
plastron, 416, *416*
Pleuronectidae family, 386
plovers, 322
plumage, 322
poaching, 448, 449
pocket gophers, 124, *125*
point source pollution, 440
poisonous vs. nonpoisonous snakes, 99
polar bears, 163, 171, 190, 192, 194
polliwogs, 423
pollution, 3, 19, *19*, 433, 439–441, 448
polyandry, 264
polygamous, 243–244, 296
polygynous, 244, 249, 254, 297
populations, *41*
porcupines, 71, 123–124, *124*, 159
porpoises, 203, *203*
prairie dogs, 69, 113–117, *117*
prairie rattlesnake, 414, *414*
prairies, 68
precocial birds, 321
predators, 33, 34, 71, 82, 96, 118, 137, 155–182, *156*, 212, *213*, 261–282, *347*, 482
predatory animal control officer, 166
prehensile tails, 211
pressure, at ocean depths, 61
primary consumers, 33, 96
primary succession, 46–47
pristine, 476
private citizens as conservationists, 440–441
private institutions in conservation, 431–432
producers, 33
prolific, 214

promiscuous birds, 298
pronghorn, 66, 69, *69*, 131, 133–134, *134*, 144, 145
prophase, 10, *10*
ptarmigan, 252, 253, *253*
public land management, 432
puffin, 316, 317, *317*
puma, 159
pygmy rabbit, 119, *119*

Q

quails, 243, 244–245, 442

R

rabbit, 117–123, *119*, *156*, 165, 167, 172, 276
raccoons, 181–182, *182*
races, 370
radiant energy, 25
rails, 324
rainbow trout, 349, *349*
rams, 145
ranchers as conservationists, 432–438
range of tolerance, 50
rangeland, *437*
raptors, 261
rat snakes, 415, *415*
rat, 101, *101*
rattlesnakes, 412–415, *415*
rays, 379, 382
reclaiming damaged or polluted resources, 469–472
recreation management, 495
recreation, 483–487
recreational interests, 444–445
recycling, 18–21, *21*
red-breasted nuthatch, 332, *332*
red fox, 161, *161*
red-spotted newt, 424, *424*
red squirrel, 110, *110*
red-tailed hawk, 265, *265*
red wolf, *83*, 167, *167*
redd, 360
reindeer, 138
renewable resources, 459, *459*
reproduction, 11–14, *12*, 87, 132, 172, 213, 214, *225*, 264, 381
reptiles, 337, 400, 401–419
research, 443–444, *444*
responsible management of wildlife resources, 430–455
Rhincodontidae family, 379
ribbon seals, 189
Richardson's ground squirrel, 111, *111*
right whale, 199, *199*
ring-necked pheasant, 248, *248*
riparian zones, 450, *450*
river otter, 180–181, *181*
roadrunner, *66*, 327, *327*
roads, 483–487
robin, 292, *292*
rock dove, 256, *256*
rock ptarmigan, 253, *253*
Rocky Mountain Elk Foundation, 494
rodenticides, 22
rodents, 94–96, *95*, 161, 163, 165, 167, 172
roe, 340
Roosevelt, Franklin D., 493
Roosevelt, Theodore, 493
ruffed grouse, 249
rumen, 8–9, 132
ruminants, 8–9, 132–133, *132*, *133*
rut, 132

S

safety, 454–455, 485–488
sage grouse, 251, *251*
salamanders, 422–425, *422*
salinity, 60, *61*
salmon recovery plan, 363
salmon, 363–366
salmonids, 387
saltwater fishes and fauna, 378–396
sand tiger shark, 381–382, *382*
sanddab, 386, *386*
sandhill crane, 313, *313*
sandpipers, 321, *321*
sardines, 387
sawfish, 382
scavengers, 263, 263, 314–315
schools, of fish, 350
science teachers, 8
scorpions, 394
scrape, 250
screech owl, 280, *280*
scutes, 353
sea bass, 391
sea lion, 189, 190, *190*
sea otter, 181, *181*, 205
sea snakes, 412
sea turtle, 82, *82*, 418, *419*, 449
seals, 187–189, 191, 192–193, 201, 362, 449
seasons, in temperate zone, 70
second law of energy, 26, *26*
secondary consumers, 33, 96
secondary succession, 47, *48*, *49*
sewage, 463–464
shad, 373, *373*, 384
sharks, 13, 189, 203, 379
sharp-shinned hawk, 270, 271
sheep, 131, 144, 145–147, 159, 165, 264, 446
shellfish, *206*, *227*
shiners, 354
short-tailed shrew, 213, *213*
short-tailed weasel, 172
shoveler, 230, 231, *230*
shrews, 98, 212–214
shrikes, 291, *291*
shrimp fishing, 82
shrimp, 367, *367*
shrub layer, 69
silt, 360
silt load, 450
simple stomach, 8
sinistral fishes, 386
skates, 379, 382
skinks, 408, *408*
skipjack herring, 389
skull, *5*
skunks, 70, 98, 176, 177, *177*, 232
slugs, 392
smallmouth bass, 343, *343*
smelts, 390, *390*
smog, 465, 466
smolt, 361, 362, *362*
snails, *188*, 392
snakes, 13, *13*, 70, 99, 374, 401
poisonous vs. nonpoisonous, *414*
snapping turtle, 232, 417, *417*
snow cover trapping bird, *246*
snow goose, 234, *234*
snowmobiles, 445, 486
snowy egret, 312, *312*
snowy owl, 279, *279*
sockeye salmon, 84–85, *85*, 363, 369
soil, 433
soil conservation, 431, 433–434, 460, 462
soil conservationists, 434
solar energy, 24–25, *25*
sole, 385
solid waste, 20
solitary birds, 304
songbirds, 286–306
Southern cavefish, 55
sows, 149, 169
sparrow hawk, 271, *271*
spawn, 340
special interest groups, 443–445
species, 3, *40*
sperm, 13
sperm whale, 200, *200*
spiders, 394
spinal cord, *4*
spindles, 11
sporting goods, *489*
spotted owls, *281*
spotted sand bass, 392, *392*
spotted sandpiper, 321, *321*
spruce grouse, 250, *250*
squabs, 256
Squamata order, 405
squawfish, 361
squids, 392, *393*
squirrel, *8*, 70, 96, 105–111, *105*, *106*, *107*, *108*, *109*, *110*, *111*, 116
Starkey Research Station, 136
starlings, 300, *300*
State Water Bank Program, 59
steelhead, 371, *371*
Steller's sea cow, 195
Steller's sea lion, 190, *190*
stewardship, 88, 439, 479
stingray, 382
stoop, 272
strata of vegetation, forest, 69
striped bass, 372, *372*
structure or anatomy of animals, 6–8
sturgeon, 353, *353*
subphylum *veterbrata*, *4*
sucker fish, 81, 354–355, *355*
sulfur dioxide, 21
sulfur oxide, 439, 470
summer tanager, 289, *289*
sunfishes, 342–345
supervised experience programs, 451–453
surface waters, 19–20
surrogate mothers, 14

Swainson's hawk, 266, *266*
swallows, 327–328, 327
swans, 236–238, *237*, *238*
swifts, 327–328, *328*
swimmerets, 396
symbiosis, 132

T

tadpoles, 423, *423*
talons, 267
tanager, 289, *289*
tapetum lucidum, 346
tarpon, 387
tassel-eared squirrels, 109, *109*
taxonomists, 96
taxonomy, 3, *3*, *40*
teal, 232, *232*
teeth, *6*
telophase, 11, *10*
temperate forest biome, 70
temperature, water, 56
terns, 315
terrapins, 416
terrestrial biomes, 64–71, *65*
territorial behavior, 287, 311
Texas horned lizard, 407, *407*
Texas tortoise, 418, 418
thermal energy, 25
thermal stratification, 58
threatened species, 79, 88
thrushes, 292
tiger musky, 352
tiger salamander, 422, *422*
titmice, 305
toads, 420–421
toothed whales, 199–200, 202
topsoil, *461*
torpedo, 383, *383*
torpid, 328
torpor, 328
tortoises, 416–418
Townsend's mole, 212, *212*
toxic materials, 434–436, 448, *436*, *465*
trails, 483–487
transpiration, 32, *32*, 478, *478*
trapping, 165
tree clinging birds, 329–330, 333
tree frogs, 422
trogons, 305
trout, 347
true seals, 188–189, *188*
trumpeter swan, *87*, 237, *237*
tuna, 383–384, *384*
tundra biome, 66–67, *67*, 263
tundra swan, 238, *238*
turbid water, 56–57
Turdidae family, 292
turkey vulture, 273, *273*
turkeys, 70, 249, 253–255, *254*, 467
turtle, 82, *82*, 416–419, *417*
tympanum, 420

U

U.S. Bureau of Land Management, 446
U.S. Department of Agriculture, 446
U.S. Endangered Species Act, 78–86, *78*, 449, 494
U.S. Fish and Wildlife Service, 79, 196, 446
U.S. Forest Service, 446, 495
U.S. Soil Conservation Service, 446–447
understory, 69–70
ungulates, 134
upland ground birds, 325–326
uterus, 210

V

velvet, on antlers, 140
vertebrates, 4, *4*, 94, *95*
vipers, *412*
vireos, 305
viviparous, 225, 382
vixen, 161
volcanic vents, oceanic, 63
vole, 97, 100, *100*, 102, 103
vultures, 273–274, 282

W

wading birds, 310–312, *310*
wagtails, 305
walking catfish, 340
walleye, 347, *347*
walrus, 171, 187–189, *188*
wapiti, 136
see also elk
warblers, 305
wastes, 18, *19*
water cycle, 30–33, *32*, 478
Water Pollution Control Act, 494
water pollution, *18*, 19, 56, 433, 460, 461, 463–464, 494
water snakes, 411–412, *412*
water sources, *20*
water treatment plant, 465, *465*
waterbirds, 316–320
waterfowl, 59, 67, 224–239, *234*, 434
Watershed Protection and Flood Prevention Act, 59
watershed, *31*, 478, *478*
waterways, 483–487
wattles, 254
waxwings, 305
weasels, 98, 103, 171–182
wet scrubber, 471
wetlands, 44, *44*, 58–60, *59*, 226, *227*, 438, *442*, *443*, 493
whale shark, 380, *380*
whalebone, 187
whales, *7*, 171, 196–206, *201*, 449
whip-poor-will, 326
whistling swan, 238, *238*
white shark, 381, *381*
white sucker, 355, *355*
white tailed deer, 139, *139*
white tailed prairie dog, 116–117, 117
white throated swift, 328, *328*
white throated woodrat, 102, *102*
whitefish, 347, 350, *350*
whooping crane, 44, *44*, 313, *313*
widgeons, 231
wild cats, 156–160
wild dogs, 161–167
wild stock, 363
wildlife, 430
wildlife careers, 451–453
wildlife management, 492–495
wildlife mitigation specialist, 276
wildlife resources, 75–89, *75*
wildlife technician, 213
wind erosion, *462*
windbreaks, *462*
wolverines, 71, 127, 140, 171, 179, *179*
wolves, *46*, 71, 83, 134, 135, 137, 139, 143, 161, 163–167, 179, 492, 494
wombats, 210
wood duck, 233, *233*
woodchuck, 114, *114*
woodhouse toad, 421, *421*
woodland hawks, 268
woodpecker, *5*, 329–331
woodrat, 102, *102*
wrens, 290
wrentits, 305

Y

yellow bellied marmot, 115, *115*
yellow billed cuckoo, 303, *303*
yellow perch, 346, *346*
Yellowstone National Park, 69, 142, 447, *447*, 480, 493
yolk sac, 360
yolk sac fry, 360

Z

zoology, 1, 2–14
zooplankton, 56
zygote, 13