INTRODUCTION

Declaration of Emergency—
Asian Longhorned Beetle

Federal Register: March 15, 1999

DEPARTMENT OF AGRICULTURE

Office of the Secretary

Declaration of Emergency because of the Asian longhorned beetle

A serious outbreak of the Asian longhorned beetle, *Anoplophora glabripennis*, is occurring in Illinois and New York.

The Asian longhorned beetle, an insect native to China, Japan, Korea, and the Isle of Hainan, is a destructive pest of hardwood trees. It is known to attack healthy maple, horse chestnut, birch, rose of Sharon, poplar, willow, elm, locust, mulberry, chinaberry, apple, cherry, pear, and citrus trees. It may also attack other species of hardwood trees. ...If this pest moves into the hardwood forests of the United States, the nursery and forest products industry could experience severe economic losses.

In cooperation with the States of Illinois and New York, the Animal and Plant Health Inspection Service (APHIS) has initiated a program to eradicate the Asian longhorned beetle. ... However, APHIS resources are insufficient to meet the estimated $5.5 million needed for the Federal share. ...

Therefore, ... I declare that there is an emergency, which threatens the forest and maple syrup industries of this country.

Dan Glickman

Secretary of Agriculture

Can you imagine our cities with no maple trees lining the streets? Our hardwood forests with no poplar or birch trees? Our wetlands without willows? Our fruit tree orchards destroyed? This is the threat U.S. Secretary of Agriculture Dan Glickman felt was posed by a single species of insect—the Asian longhorned beetle. And many scientists agree with him.

How can a single species of insect pose such a threat to millions of acres of forests, orchards, and street trees? What can we do about the Asian longhorned beetle and other plants and animals that invade our farms, cities, and forests? The study of ecology helps us to find answers to these questions. Through applying ecological principles and conducting research, scientists are learning to manage *invasive species* such as the Asian longhorned beetle. Students can learn alongside the scientists and, in some cases, help them.

WHAT ARE INVASIVE SPECIES?

Invasive species **are organisms that become widespread and threaten other organisms and ecosystems.**

Invasive species are plants, animals, fungi, or microorganisms that spread rapidly and cause harm to other species. Sometimes invasive species threaten entire ecosystems. Although some invasive species are native to North America, most are brought in from other continents. The Asian longhorned beetle, for example, was introduced to the U.S. in wooden packaging material that traveled on ships from Asia. Because scientists and land managers fear this beetle will spread widely and kill many trees, they are taking radical measures to control it.

WHAT IS THE SCIENCE OF ECOLOGY?

You have undoubtedly studied biology and know that biologists are concerned with living things such as plants, animals, and bacteria. Some of you also may have studied Earth science, chemistry, or physics, all of which are referred to as *physical sciences* and focus on the nonliving parts of our environment.

Ecology combines the life sciences and physical sciences. It is concerned with how organisms interact with each other and with their physical environment. Organisms interact in a number of ways. For example, they may compete for physical resources such as water, light, space, and nutrients. Animals may prey on other animals, such as when a bird eats an insect, or feed on plants, such as when beetles feed on trees. In some cases, organisms have relationships that are mutually beneficial, such as when ants drink a plant's nectar and fend off insects that might feed on the plant's flowers, stems, or leaves.

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Organisms also may change the physical environment, such as when beavers build dams that create flooded wetlands or when earthworms create tunnels in the ground. Through these and other interactions, organisms affect how fast other organisms grow and reproduce.

Similarly, physical factors can determine how fast plants and animals grow and reproduce. For example, lack of water or light can slow down plant

growth. Animals that require large territories, such as bears, may suffer when the amount of land available to them is restricted.

***Ecology* is the study of how organisms interact with each other and with their physical environment.**

Ecology is important for all of us—not just those who live in the countryside. For example, understanding ecology can help us develop methods for controlling the Asian longhorned beetle and prevent it from killing trees in cities, suburbs, and rural forests.

TYPES OF ECOLOGY

Ecologists are interested in lots of different questions. Some ecologists study where plants and animals are located across the landscape. Others investigate how organisms interact with each other. Still others are interested in how nutrients cycle between living organisms and the nonliving environment. Although there are many approaches to studying ecology, the three main branches are population, community, and ecosystem ecology.

Population ecologists study the changes in numbers and location of organisms. A population ecologist studying beetles might ask questions such as: How many beetles are there in a particular region? Is the number of beetles increasing or decreasing? Why? Where are beetles found within a forest or a city park?

The three main branches of ecology are *population*, *community*, and *ecosystem ecology*.

But beetles also interact with other animals and plants. For example, beetles live in and feed on trees. Birds and squirrels may eat the beetles, and fungi and bacteria decompose them after they die. The study of the interaction of different organisms is called *community ecology.*

Ecosystem ecologists ask questions about the interactions of living things with their nonliving environments. They may conduct research on how carbon, water, and nutrients move or cycle between the soil, organisms, and the atmosphere. For example, an ecosystem ecologist studying an area with an outbreak of beetles might wonder how trees killed by beetles will decompose and affect local carbon, water, and nitrogen cycles. Ecosystem ecologists also study how nutrients control the rate at which new plant material is produced. For example, if many trees die suddenly and decay, the nutrients that are released could cause a rapid increase in the amount of new plant material, or biomass, produced.

INTRODUCED, INVASIVE SPECIES

Ecologists hope that by learning about populations, communities, and ecosystems, they can help find solutions for environmental problems. One of the biggest environmental problems facing North America is the introduction of non-native species from other continents (also called introduced, nonindigenous, alien, or exotic species) that later become weeds or pests.

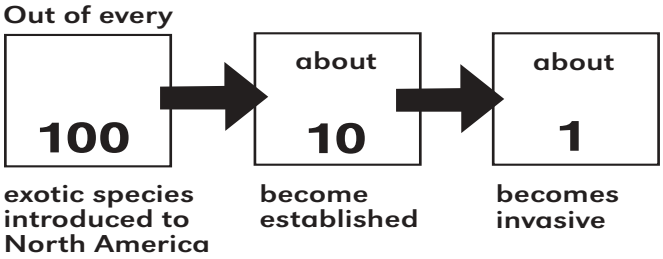
Most invasive species have been brought into North America from other continents.

But not all alien species become problems. In fact, many introduced species bring important benefits to agriculture. For example, 98% of the U.S. food supply comes from introduced plants and animals, including wheat, rice, cattle, and poultry.

Many introduced species bring benefits to agriculture. Only a few become invasive and cause problems.

Of every 100 exotic species introduced to North America, it is estimated that only 10 are able to survive outside of cultivation. About 1 in every 10 species that survives outside of cultivation turns into a serious pest. Thus, about 1% of the species that are introduced causes serious problems (Figure 1.1). These introduced species invade gardens, agricultural fields, urban parks, and natural areas such as wetlands, forests, and grasslands. They can cause great harm to desirable plants and animals and to entire ecosystems. In fact, the environmental damage caused by such species has been estimated at $138 billion per year. Although most invasive species that cause problems are introduced from other continents, native species, such as wild grapes and black locust trees, also may become invasive.

FIGURE 1.1
Number of Exotic Species That Become Invasive



What are some introduced species that have become invasive? Some of you may have heard of kudzu in the southeastern U.S., zebra mussels in lakes and rivers of the East and Midwest, and red fire ants in the South and in Hawaii. Many of these species have significant biological, economic, social, and even health impacts. We will discuss a few examples of introduced, invasive species below.

Zebra Mussels

Zebra mussels are a freshwater shellfish, similar to clams and oysters. They were introduced to the U.S. from Russia. The mussels first entered North America in about 1986 with ballast water dumped into the Great Lakes from a foreign ship. (Ballast water is used to provide balance for ships crossing the open ocean and is often dumped upon arrival in port.) Since then, zebra mussels have been transported by boats and boat trailers to numerous lakes and rivers. Within six years after entering North American waters, zebra mussels had spread to all the Great Lakes and had entered eight large river systems.

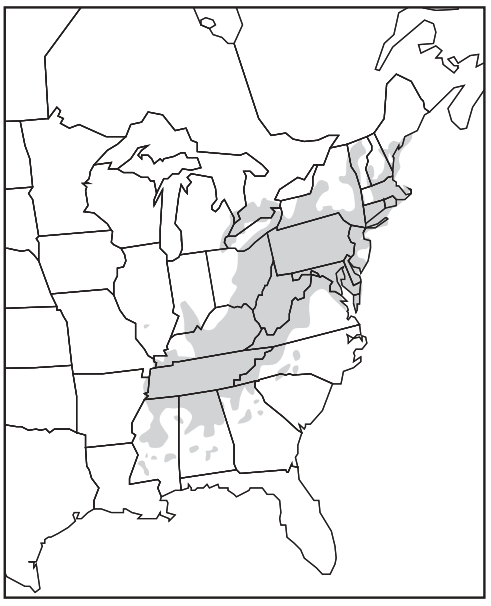
FIGURE 1.2
Zebra Mussels

Zebra mussels reproduce rapidly and coat rocky and other hard surfaces in the water, including the shells of native mussels. This reduces the populations of native mussels. Zebra mussels also clog intake pipes for power plants and water supplies. By 1991, just five years after they were introduced, zebra mussels had caused over $3 billion worth of damage. That figure continues to rise.

Chestnut Blight

Sometimes an introduced species can have major impacts on the way of life or culture of an entire group of people. At the beginning of the twentieth century, rural communities in the eastern U.S. depended on the American chestnut tree for many of their needs. In fact, it seemed as if their entire lives revolved around the chestnut. They used the nuts for food for themselves and their hogs. The wildlife they hunted—including squirrels, wild turkeys, white-tailed deer, bear, raccoon, and grouse—also ate chestnuts. Everything from homes to furniture, coffins, musical instruments, and tools was constructed from chestnut lumber. The wood also was made into charcoal for heating, and tannin, a chemical from the bark, was used for tanning animal hides to make leather. People in the rural mountain communities were poor and the American chestnut allowed them to live where few other resources were available (Figure 1.3).

FIGURE 1.3
American Chestnut Range



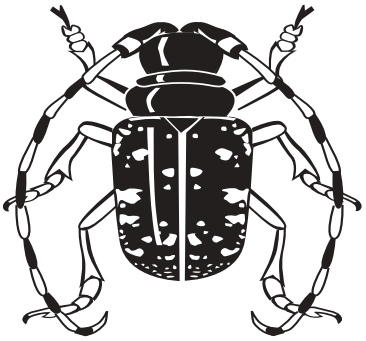
In 1904 a fungus was discovered at the Bronx Zoo in New York City. It had entered the U.S. accidentally along with Asian chestnut seedlings that people wanted to plant in this country. The Asian chestnut had evolved with the fungus for thousands of years and had developed the ability to resist the fungus. However, the American chestnut had never encountered this alien fungus and had not developed resistance. The fungus caused a disease known as the chestnut blight, which spread from New York City throughout the eastern forests, wiping out the American chestnut. Along with the chestnut went the rural, subsistence way of life that had depended on this species. Many people left the area or had to find other ways to survive.

Asian Longhorned Beetle

At the turn of the twenty-first century, we are again seeing an introduced species that has the potential to dramatically impact forests and a rural way of life that depends on these forests. In August 1996, a man noticed large holes in the bark of the Norway maples lining his street in Brooklyn, New York. He also reported seeing large black and white beetles with long antennae coming out of these holes.

The next day, a New York City forester sent the unknown insects to Cornell University to be identified. A scientist identified them as Asian longhorned beetles. It is assumed that they arrived in the U.S. on container ships in wooden packaging material from China. A second infestation was discovered in Long Island, New York on infested trees that were sold as firewood. During summer 1998, Asian longhorned beetles were discovered in Chicago. Since then, new infestations have been found, including Central Park in New York City. All trees known to be infested have been destroyed, but it is possible that beetle larvae may be living undetected in nearby trees or other areas.

FIGURE 1.4
Asian Longhorned Beetle



Because ecologists do not understand everything about invasive species, we cannot predict whether the Asian longhorned beetle will expand its populations rapidly. However, if the Asian longhorned beetle became invasive, it could destroy hardwood trees throughout the northeastern U.S. and eastern Canada, and it seems to particularly favor maple trees. Similar to the American chestnut, maple trees are a source of food (maple syrup) and timber for rural residents. Sales of maple syrup often provide the extra income that allows farmers to keep their farms. Thus, the Asian longhorned beetle has the potential to cause major economic impact in a manner similar to the chestnut blight.

INVASIVE SPECIES THREATEN BIODIVERSITY

Biodiversity **refers to the variety of organisms living in an area.**

Zebra mussels, chestnut blight, and Asian longhorned beetles are all examples of invasive species that have major social and economic impacts. Invasive species also are a major cause of loss of *biodiversity*. Biodiversity refers to the variety of organisms living in an area. The higher the number of species, the higher the biodiversity. Although we often hear about loss of biodiversity in the Tropics, it is also a problem in North America.

Why does biodiversity matter? Many people value biodiversity for its own sake. These people feel there is value in having a diversity of species on Earth,

regardless of whether we get any direct benefit from these species. In fact, Harvard biologist E.O. Wilson has coined the term *biophilia* to describe the sense of connection to nature that many humans feel.

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There are also practical reasons for maintaining biodiversity. Humans have always depended on the world's organisms for food, shelter, and medicine. If biodiversity decreases and species become extinct, we may lose important resources. For example, many of our important medicines come from plants. In the 1970s, scientists discovered that a small plant in Madagascar, the rosy periwinkle, contains chemicals that inhibit cancer cell growth. If this periwinkle had become extinct before 1970, researchers would not have discovered its properties, and doctors would be less effective in the fight against cancer. It is possible that endangered plants throughout the world have benefits not yet discovered by scientists.

Current extinction rates are one thousand to ten thousand times higher than before extensive human influence. This massive loss of biodiversity may threaten entire ecosystems. For example, bees are important pollinators of many agricultural and wild plants. Recent declines in the numbers of native bees might result in a loss of pollinators for plants. If a pollinator becomes extinct, the plants it pollinates also may be lost from the ecosystem. This in turn could impact the insects and other animals that rely on the lost organisms for food or shelter. Loss of the plant and animal species could impact how nutrients are cycled from plants to other organisms, and to the soil and atmosphere.

When the American chestnut disappeared from eastern forests, we lost an important component of biodiversity. Similarly, when zebra mussels take over the habitat of native species of mussels, the native shellfish disappear and biodiversity declines. Currently, about 950 species are on the U.S. Threatened and Endangered Species List. About 400 of these are at risk of extinction due to the impacts of introduced species. In fact, introduced, invasive species are the second major cause of loss of biodiversity in North America. The most important cause of declining biodiversity is loss of habitat due to development by humans (e.g., draining wetlands, paving over natural areas).

Introduced, invasive species are the second major cause of biodiversity loss in North America.

Invasive species cause a loss of biodiversity in a number of ways, including competition, predation, herbivory, and changing habitats and ecosystems. *Competition* refers to the negative impact one species or organism has on another species or organism, when they both rely on the same resources, which are in limited supply. For example, introduced plants, such as purple loosestrife or garlic mustard, may outcompete native plants that depend on the same light and space resources. *Predation* refers to the way an animal (predator) feeds on another animal. Rats and snakes are predators of bird species, for example. On the Hawaiian Islands, introduced rats and snakes have caused a number of native bird species to become extinct. *Herbivory* occurs when animals, such as the Asian longhorned beetle, eat plants.

An example of the way invasive species may change ecosystems comes from the southwestern U.S., where the introduced tamarisk tree takes up so

much water that it lowers the water table and makes it difficult for the roots of native trees to reach vital groundwater. In the Northeast and Midwest, zebra mussels change aquatic habitats by filtering microscopic particles from the water. This makes the water in lakes and rivers much clearer, affecting which organisms can live there.

WHAT ABOUT *NATIVE* INVASIVE SPECIES?

So far, we have been talking about invasive species that were introduced from other continents. Can you think of any native species that cause problems similar to those caused by introduced, invasive species? White-tailed deer are native to the eastern U.S., but over the last fifty years their populations have skyrocketed in many suburban and rural communities. A recent census in Gettysburg National Park, Pennsylvania, estimated an incredible 447 deer per square mile.

Although most people value deer—they enjoy watching or hunting them—when deer become invasive, they can cause a number of problems. For example, high deer populations cause numerous car accidents and devastate gardens and ornamental plants. Deer also eat tree seedlings and native flowers in forests, thus reducing forest biodiversity.

Some species native to North America, such as the white-tailed deer, become invasive.

Are deer populations really too high? Or is it just that because humans are invading deer habitats, we think there are too many deer? It is interesting to note that even in prehistoric times, deer populations most likely did not reach the high levels we see today. Do you have any ideas about how humans might have changed our ecosystems to favor deer? For example, might we have reduced the number of deer predators? Or could we have increased the numbers of plants that deer like to eat?

You can see from the deer example that the problem of invasive species is not limited to plants and animals introduced from abroad. However, the majority of species that become invasive are introduced from other continents. Ecology can help us understand why introduced species are more likely than native species to become invasive. The science of ecology also can help us understand how humans have changed North American ecosystems so that native species, such as deer, are able to reach such high numbers.

CONTROLLING INVASIVE SPECIES

When we think of pollution, we usually think of factories spewing chemicals into the air or toxic spills in rivers and oceans. This is referred to as *chemical pollution*. Ecologists studying invasive species sometimes use the term *biological pollution* to bring attention to the problems caused by these species. Biological pollution is extremely difficult to control. This is because the biological pollutants, or introduced species, reproduce on their own.

A number of methods are used to control invasive plant species. Chemical herbicides can be sprayed. We can pull up individual stems by hand. Some

species are controlled by mowing. Fire also is used to reduce populations of unwanted species. In the chapters that follow, you will learn about *biological control*, which involves using predators to control invasive species.

Each of these methods has advantages and disadvantages. For example, chemicals may pollute the water and fires may cause air pollution, but these methods generally take less time than pulling by hand. Biological control requires years of research to avoid introducing predators that feed on valuable species but it may be more effective than other methods in the long run. Regardless of what method is used, an understanding of the science of ecology is essential in planning control methods and evaluating their success or failure.

It is very difficult to control invasive species once they are present in an ecosystem.

In the next three chapters, we present three different approaches to studying ecology—population, community, and ecosystem. We will use these three branches of ecology to help us understand invasive species in natural areas and how we might control some of the most destructive of these species. Invasive species also are a problem in agricultural lands where they usually are called weeds or pests. However, in this book we focus on invasive species in natural areas, such as wetlands, lakes, and forests, rather than on farms.

FOR DISCUSSION

What are some invasive species in your area?

What are some of the problems invasive species are causing in your area or elsewhere?

Why do humans value biodiversity?

A number of wildlife species that were once rare are making a comeback. For example, finding groups of up to six white-tailed deer in the middle of suburban yards in Ithaca, New York, is not uncommon. Elk are commonplace and can be seen downtown in smaller cities, such as Banff, in the Rocky Mountains. Coyotes are known to eat pet cats in Portland, Oregon, and other western cities. And mountain lions are a concern to suburban communities in South Dakota, Colorado, and elsewhere. Why might some of these native animals be invading "human territory"? Which is the problem—the wildlife or the humans?