

## What Roles Do Species Play in Ecosystems?

### CONCEPT 4-6A

Each species plays a specific ecological role called its *niche*.

### CONCEPT 4-6B

Any given species may play one or more of four important roles—native, nonnative, indicator, or keystone—in a particular ecosystem.

## Each Species Plays a Role in Its Ecosystem

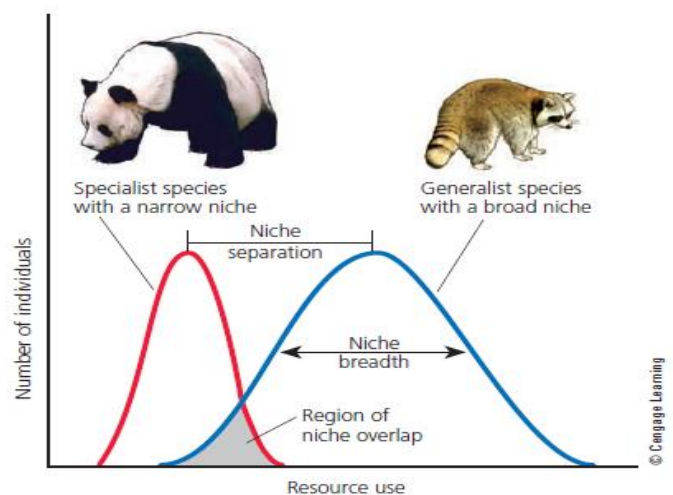
An important principle of ecology is that *each species has a specific role to play in the ecosystems where it is found* (Concept 4-6A). Scientists describe the role that a species plays in its ecosystem as its **ecological niche**, or simply **niche**.

It is a species' way of life in a community and includes everything that affects its survival and reproduction, such as how much water and sunlight it needs, how much space it requires, what it feeds on, what feeds on it, and the temperatures and other conditions it can tolerate. A species' niche should not be confused with its **habitat**, which is the place where it lives. Its niche is its pattern of living. Scientists use the niches of species to classify them mostly as *generalists* or *specialists*. **Generalist species** have broad niches (Figure 4-15, right curve).

They can live in many different places, eat a variety of foods, and often tolerate a wide range of environmental conditions.

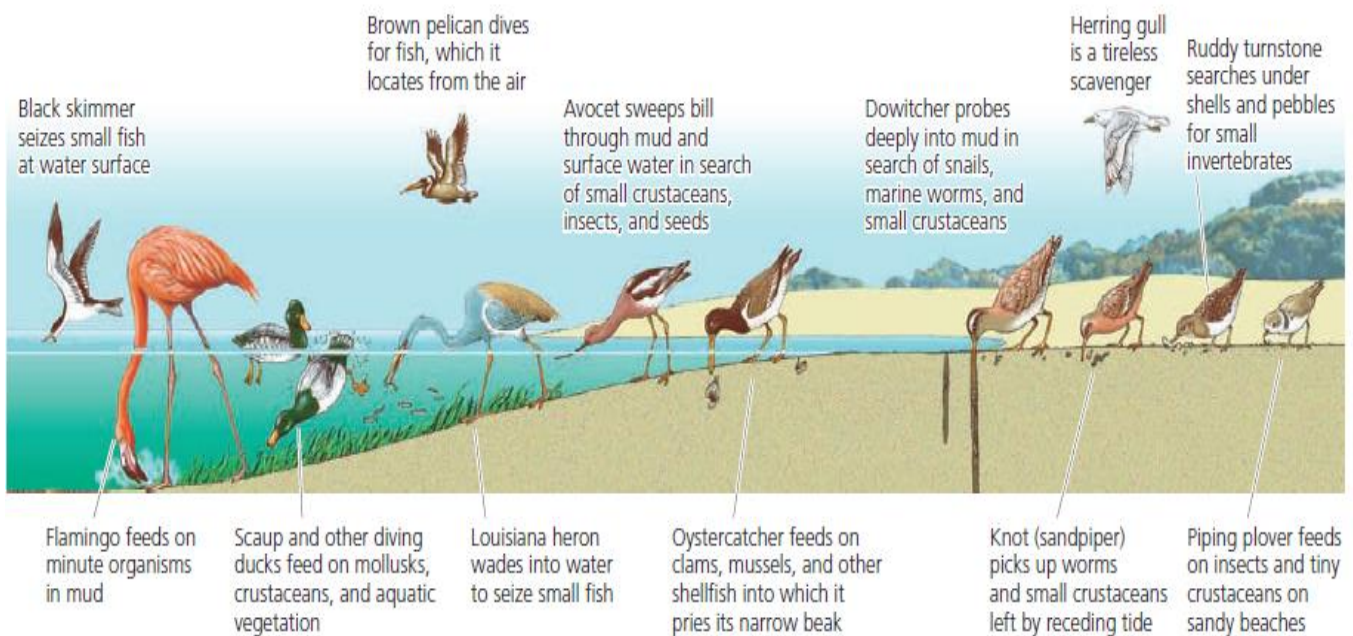
Flies, cockroaches, mice, rats, white-tailed deer, and humans are generalist species.

In contrast, **specialist species** occupy narrow niches (Figure 4-15, left curve).



**Figure 4-15** Specialist species such as the giant panda have a narrow niche (left curve) and generalist species such as the raccoon have a broad niche (right curve).

They may be able to live in only one type of habitat, use just one or only a few types of food, or tolerate a narrow range of climatic and other environmental conditions. For example, some shorebirds occupy specialized niches, feeding on crustaceans, insects, and other organisms found on sandy beaches and their adjoining coastal wetlands (Figure 4-16). Because of their narrow niches, specialists are more prone to extinction when environmental conditions change. For example, China's giant panda is highly endangered because of a combination of habitat loss, low birth rate, and its specialized diet consisting mostly of bamboo. Is it better to be a generalist or a specialist? It depends. When environmental conditions are fairly constant, as in a tropical rain forest, specialists have an advantage because they have fewer competitors. But under rapidly changing environmental conditions, the more adaptable generalist usually is better off than the specialist.



**Figure 4-16** Various bird species in a coastal wetland occupy specialized feeding niches. This specialization reduces competition and allows for sharing of limited resources.

## Species Can Play Four Major Roles within Ecosystems

Niches can be classified further in terms of specific roles that certain species play within ecosystems. Ecologists describe native, nonnative, indicator, and keystone roles. Any given species may play one or more of these four roles in a particular ecosystem (Concept 4-6B).

**Native species** are those species that normally live and thrive in a particular ecosystem. Other species that migrate into, or are deliberately or accidentally introduced into, an ecosystem are called **nonnative species**, also referred to as invasive, alien, and exotic species.

People often think of nonnative species as threatening. In fact, most introduced and domesticated plant species such as food crops and flowers and animals such as chickens, cattle, and fish from around the world are beneficial to us. However, some nonnative species can compete with and reduce a community's native species, causing unintended and unexpected consequences. In 1957, for example, Brazil imported wild African honeybees (Figure 4-18) to help increase honey production. Instead of helping, the bees displaced some native honeybee populations, which had the effect of reducing the honey supply.

Since then, these nonnative honey bee species—popularly known as “killer bees” have moved northward into Central America and parts of the southwestern and southeastern United States. The wild African bees are not the fearsome killers portrayed in some horror movies.



**Figure 4-18** Wild African honeybees, popularly known as “killer bees,” were imported into Brazil and their populations have since spread widely.

However, they are aggressive and unpredictable and have killed thousands of domesticated animals and an estimated 1,000 people in the western hemisphere, many of whom were allergic to bee stings.

**Nonnative species** can spread rapidly if they find a new location with favorable conditions. In their new niches, these species often do not face the predators and diseases they face in their native niches, or they may be able to out-compete some native species in their new locations.

### **Indicator Species Serve as Biological Smoke**

Alarms Species that provide early warnings of damage to a community or an ecosystem are called indicator species. For example, in the Core Case Study that opened this chapter, we learned that some amphibians are classified as indicator species. The decline of an amphibian

population can indicate the presence of parasites, disease-causing Figure4-17 This giant panda is eating a stalk from a bamboo tree. Bamboo stalks and leaves make up about 95% of the diet of this specialist species.



**Figure 4-17**  
This giant panda is eating a stalk from a bamboo tree. Bamboo stalks and leaves make up about 95% of the diet of this specialist species.

Figure 4-18 Wild African honeybees, popularly known as “killer bees,” were imported into Brazil and their populations have since spread widely. microbes, or pollution in the local environment, as well as habitat destruction and fragmentation.



It can also be a sign of the effects of climate change (see Figure 4-13).



Michael P. Fogden/Bruce Coleman USA

**Figure 4-13** This male golden toad lived in Costa Rica's high-altitude Monteverde Cloud Forest Reserve. The species became extinct in 1989 apparently because its habitat dried up.

Birds are excellent biological indicators because they are found almost everywhere and are affected quickly by environmental changes such as the loss or fragmentation of their habitats and the introduction of chemical pesticides. Some butterflies are also indicator species because their association with various plant species makes them vulnerable to habitat loss and fragmentation. The populations of many bird and butterfly species are declining .

### **Keystone Species Play Critical Roles in their Ecosystems**

A **keystone** is the wedge-shaped stone placed at the top of a stone archway. Remove this stone and the arch collapses. In some communities and ecosystems, ecologists hypothesize that certain species play a similar role. Keystone species are species whose roles have a large effect on the types and abundance of other species in an ecosystem. Keystone species often exist in relatively limited numbers in their ecosystems, but the effects that they have there are often much larger than their numbers would suggest. And because of their often-smaller numbers, some

keystone species are more vulnerable to extinction than other species. Keystone species can play several critical roles in helping to sustain ecosystems. One such role is the pollination of flowering plant species by butterflies, honeybees (Figure 4-A), hummingbirds, bats, and other species. In addition, top predator keystone species feed on and help to regulate the populations of other species.



Darhnye A. Murawski/National Geographic Creative



Dr. Morley Read/Shutterstock.com

**Figure 4-A** Importance of insects: Bees (left) and numerous other insects pollinate flowering plants that serve as food for many plant eaters, including humans. This praying mantis, which is eating a moth (right), and many other insect species help to control the populations of most of the insect species we classify as pests.

Examples are the wolf, leopard, lion, some shark species, and the American alligator which consider as keystone and the loss of a keystone species can lead to population crashes and extinctions of other species in a community that depends on them for certain ecosystem services. This is why it so important for scientists to identify and protect keystone species.



**Figure 4-19** Keystone species: The American alligator plays an important ecological role in its marsh and swamp habitats in the southeastern United States.  
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