3 Biomes

As you saw in Activity 1, "Ecosystems and Change," around 100 cane toads were introduced in the 1930s to Queensland in Australia. The current number of cane toads in Australia is more than 200 million. Would such a dramatic increase have occurred if the cane toad had been introduced to Anchorage, Alaska, or Las Vegas, Nevada?

For an organism to exist in an ecosystem it has specific traits that permit it to survive in that ecosystem. If an organism moves to a location that is similar to its native environment, it is more likely to survive than if it moved to a place entirely different, because its traits are likely to still be helpful to it in this new environment. The environment where an organism lives is influenced by both **biotic** (living) and **abiotic** (nonliving) factors. Abiotic factors include climate and type of soil. Across the world are regions with similar abiotic conditions, which are referred to as **biomes**. A biome features a range of conditions, and therefore various locations in the same biome will be similar but not identical. There is not complete agreement among scientists as to the exact number and types of biomes in the world.

In this activity you will examine several sets of information. You will then use these as evidence to identify the particular biomes of a variety of locations around the world. **Evidence** is information used to support or refute a claim. You will also use evidence to match a selection of organisms to these biomes.

Hungarian steppes (left) and Montana prairie (above) have very similar biotic and abiotic factors, even though they are on two separate continents.

Challenge

How do the characteristics of a biome determine the types of organisms found there?

MATERIALS

FOR EACH PAIR OF STUDENTS

- set of 8 Organism Cards
- pair of scissors
- container of glue or roll of transparent tape

FOR EACH STUDENT

- Student Sheet 3.1, "Climate Information for Locations"
- Student Sheet 3.2, "Biomes Match"

Procedure

1. Student Sheet 3.1 shows climate information for 16 locations around the world. Each graph contains two sets of data, average temperature and average precipitation per month. Cut the sheet into 16 separate climate graphs.
2. With your partner organize the climate graphs into eight groups by pairing each location with the one that has the most similar climate.
3. Read the descriptions of types of terrestrial biomes on the following pages. Write a short summary of each biome in your science notebook, leaving enough room between them to paste in the climate graphs when you are finished.
4. From the climate descriptions match each biome to one of the pairs of locations that you created in Step 2.
5. In your science notebook, paste each climate graph next to your summary of its corresponding biomes.
6. Using the information on the Organism Cards, match each organism to the biome in which the organism might be found. Match each organism to only one biome. Record your matches on Student Sheet 3.2, "Biomes Match," and make sure that all biomes are matched with one organism.
7. In your science notebook include your reasons for matching each organism with the particular biome you chose.

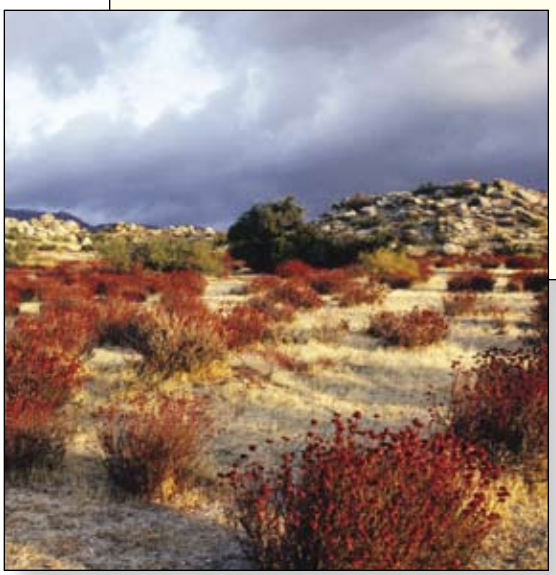
Tropical Rain Forest

A tropical rain forest is warm and humid all year. Temperatures are fairly constant in the 20°C–30°C (68°F–86°F) range. Total rainfall per year can vary from 2,000–4,000 mm (about 80–160 inches). In many tropical rain forests there is no dry season. The soil has limited nutrients, but the warm temperatures and abundant water support a wide variety of organisms. Plants can grow quickly, and dead matter decays rapidly. Trees can become very tall, and many are evergreen and do not shed their leaves. Plants compete for light. Many of these

forests are found near the equator where daylight length is about 12 hours throughout the year. ■

Desert

Deserts have low precipitation of 15–300 mm (about 0.5–12 inches) per year. The low humidity allows temperatures to become cold at night. Hot deserts experience temperature variations from an average of about 10°C (50°F) in winter to 35°C (95°F) or more in the summer. The soil is often poor in nutrients but rich in minerals. To survive in the desert, plants and animals must be able to conserve water. Desert plants generally provide very little shade, and there are very few trees. ■



Savanna

The savanna has warm temperatures, generally around 25°C–35°C (77°F–95°F) year round. Temperatures are not as constant throughout the year as are those in the tropical rain forest. Total rainfall varies from 500–1,500 mm (about 20–60 inches) per year but is not evenly distributed. There is a long dry season and a rainy season. Trees are scattered, and grasses grow quickly when it rains. The soil is shallow and drains quickly. Fires can occur during the dry season and are important in maintaining biodiversity. When the fires kill small animals, the bodies of the dead animals provide food for other animals, such as birds. Other organisms survive the fires by running away, burrowing underground, or having deep roots. The parts of the plants that burn above ground nourish the soil. ■

Chaparral

The chaparral receives most of its precipitation as rain during the winter months. Rainfall totals vary from about 200–700 mm (about 8–28 inches) per year. Winter, spring, and fall are generally cool and mild with average temperatures between 10°C and 15°C (50°F–59°F). Summers are warm with average temperatures around 25°C (77°F) although on some days the temperature may rise as high as 40°C (104°F). Some areas of chaparral experience frost at certain times of the year, but there are usually six months or more of frost-free days. The dry summers often cause drought conditions and increase the chance of fires. Vegetation is diverse and sometimes dense. Shrubs, wildflowers, and grasses are common. There are a wide variety of small animals, including amphibians, birds, reptiles, insects, and small mammals. ■

Temperate Grassland

Temperate grassland experiences a wide range of temperature and precipitation through the year. Precipitation is moderate with a yearly average of 500–900 mm (about 20–35 inches). Most rain falls in late spring and in summer. The winter is cold, with average temperatures well below freezing, while summer temperatures average around 25°C (77°F). Five to six months of the year are frost-free. The soil is often fertile and dominated by tall grasses that have adapted to the cold winter temperatures, occasional summer droughts, and periodic fires. The

roots of these grasses help to hold the soil together. Many large mammals graze in these grasslands. ■

Taiga

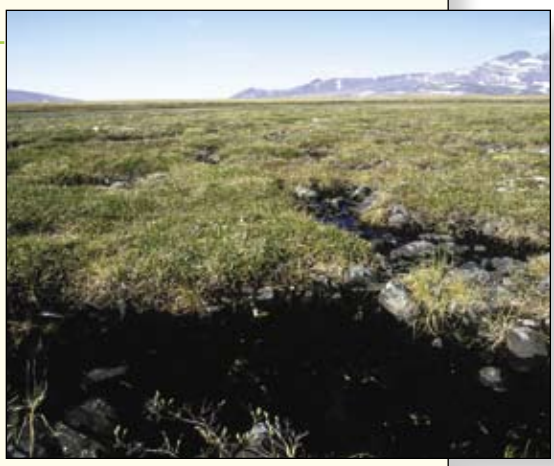
Taiga is an area of extensive forests where the ground is frozen for much of the year. The winters are long and cold with average temperatures around –15°C (5°F). Precipitation ranges from 300–850 mm (about 12–34 inches) per year. Summers are short, moist, and generally mild enough that the ground thaws. Average temperatures in the summer are around 15°C (59°F), but daily maximum temperatures occasionally rise as high as 30°C (86°F). About three months of the year are frost-free. The range of types of plants that grow here is quite narrow because many plants cannot access the nutrients in the frozen soil. Most of the trees are evergreen conifers. Many different types of mammals live in the taiga, including some very large ones. ■

Temperate Deciduous Forest

Temperate deciduous forests experience four distinct seasons with a total annual precipitation of 700–2,000 mm (about 28–80 inches) that is spread throughout the year. Temperatures vary a lot over the year and between locations. There are about 140–200 frost-free days each year, depending on the location. Average winter temperatures usually fall to below freezing, and summer averages are around 25°C (77°F). The generally fertile soil, year-round precipitation, and approximately six-month growing period support a wide diversity of plants. Most trees lose their leaves before winter, and some animals hibernate or migrate during the winter months. ■

Tundra

Very cold temperatures and low precipitation, with yearly totals between 120 and 250 mm (about 5–10 inches), are characteristic of tundra. Winters are long with average temperatures of –30°C (–22°F) or lower. The soil is thin and covers a permanently frozen layer of subsoil called permafrost. The permafrost makes it difficult for plants to extend roots deep into the ground. The permafrost also prevents water from seeping deep into the ground during the short summer when the soil at the surface thaws. Animals usually have fat and fur to help cope with the cold temperatures. Some animals hibernate to survive the harsh winters, and some migrate. Average summer temperatures can reach 10°C (50°F). The growing season for plants is very short with only about two months of the year being frost-free. Plants that do well in tundra tend to grow close to the ground. ■



Analysis

1. Which biome has the most extreme conditions? Explain your answer.
2. Which biome has the most constant conditions over the course of the year? Explain your answer.
3. Make a climate graph using the data in the table below.

Climate Data for Location Q

MONTH	AVG. TEMP. (°C)	AVG. PRECIP. (mm)
January	29	37
February	28	41
March	25	31
April	20	17
May	16	19
June	12	14
July	12	14
August	14	9
September	19	8
October	23	21
November	26	29
December	28	38

   a. Which biome is Location Q likely to be in? Explain your choice of biome.
   b. What else do the climate data indicate about where Q might be? Explain your answer.

4. **Biodiversity** is the number of species found in a given ecosystem or area. Based on what you learned in this activity, why do you think levels of biodiversity differ from biome to biome?
5. Review the description of *Monarda fistulosa* from Procedure Steps 6 and 7 in your student notebook. In which other biome could *Monarda fistulosa* most likely be found? Explain your answer.
6. *Cyclorana platycephala* is a frog that is found in Australia. Like all frogs, it needs to keep its skin moist. During periods of drought it digs a chamber in the ground and lines it with mucous, which hardens and seals the chamber from water loss. The frog settles into the chamber, its metabolism slows down, and it becomes inactive. The frog can survive in this state for up to five years. Describe how this trait will determine the types of biome that the frog might live in.

7. How might ecologists use the frog described in Question 6 as an indicator for change within a biome?

8. What might be two of the reasons that scientists do not agree about the number and types of biomes that exist in the world?

KEY VOCABULARY

abiotic	**biotic**
biodiversity	ecosystem
biomes	**evidence**

4 Invasive Species

Species enter new areas in several ways. In the case of the cane toads, people intentionally introduced them to Australia for pest control. In some cases an organism is carried accidentally with cargo that is being transported from one place to another. In other cases, organisms are carried on the wind and on currents in rivers, lakes, and oceans. If a species is introduced to an area where it is not naturally found, it is referred to as **nonnative**, and is also known as *exotic* or *non-indigenous.* The specific location where an organism lives within an ecosystem is its **habitat**. This is different from an ecosystem, which refers to all of the biotic and abiotic factors interacting in one location. Within an ecosystem, the population of a native species may decline, and even become locally extinct when an introduced species begins to take over the same role in a habitat. This, in turn, decreases the native biodiversity of the area.

Many crops and animals currently found in the United States are nonnative, including wheat, potatoes, soybeans, honeybees, cows, sheep, and goats. In fact there are approximately 50,000 nonnative species of organisms in the United

a

b

c

d

Many species commonly found in the United States are non-native and invasive, such as the brown tree snake (a), honey bees (b), ice plant (c), and eucalyptus trees (d).

States today, of which about 4,300 are regarded as invasive. For a nonnative species to be considered **invasive,** it must cause harm to the economy, the environment, or human health. Invasive species often diminish the sustainability of an ecosystem by consuming resources and upsetting the typical interactions between species.

Challenge

How do certain characteristics increase the likelihood that a nonnative species becomes an invasive species?

MATERIALS

FOR EACH STUDENT

Student Sheet 4.1, "Invasive Species Information"

Literacy Student Sheet 6, "Discussion Web"

Procedure

Part A

1. On the following pages are four case studies of particular invasive species. Decide in your group who will read each case study.
2. Use the information from the case studies to complete Student Sheet 4.1, "Invasive Species Information," as you read about your assigned species.
3. Compare your results with those of the members in your group who studied the other three invasive species. In your science notebook, write down any similarities that you see among the case studies.
4. As a group, use these similarities to develop a list of characteristics that you think increase the potential of a nonnative species to become invasive. Write the list in your science notebook.
5. Follow your teacher's directions on when and how to share your group's thinking with the rest of the class. As a class, decide on the characteristics that increase the likelihood that a nonnative species will become invasive.

CASE STUDY 1

The Round Goby

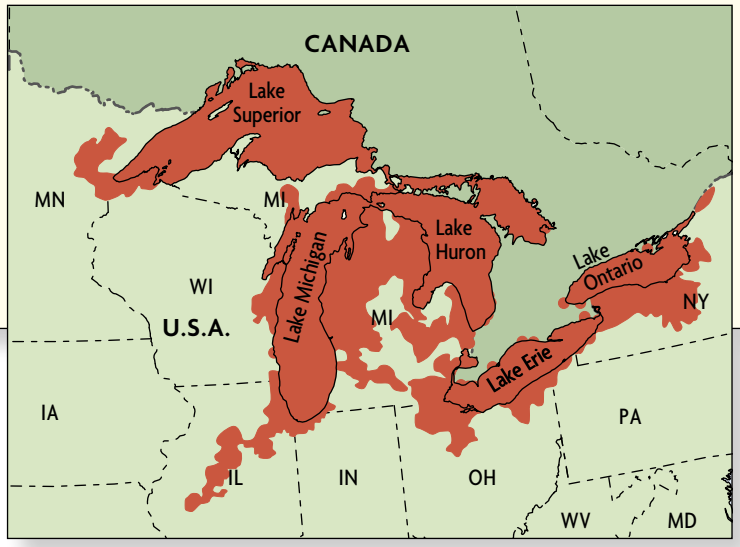
THE ROUND GOBY is a freshwater fish that grows to between 10 and 25 cm in length. Originally from central parts of Eurasia, it was discovered in the Great Lakes in the 1990s and is thought to have been accidentally discharged in the ballast water from oceangoing cargo ships visiting ports in the Great Lakes. The goby is no longer limited to the Great Lakes and is spreading throughout the region's rivers and canals.

Round goby (Neogobius melanostromus)

The round goby is an aggressive fish, especially when protecting its spawning grounds. It consumes great quantities of food and can eat clams, mussels, plankton, large invertebrates, fish eggs, small fish, and insect larvae. The round goby can feed in total darkness due to a well-developed sensory system that allows it to detect water movement.

It can also feed in fast-moving water by attaching itself to the bottom of a stream or river with a suction-like disk on its underside.

The round goby is capable of rapid population growth and spawns repeatedly during the summer months, with the female producing up to 5,000 eggs each time. It can live in a variety of habitats and compete with native species for food and space. Often the round goby is the only fish that fishermen see in a section of water. This can make many riverbank or lakefront towns less appealing to visiting sport fishermen, who are trying to catch such fish as trout and salmon. One positive side effect is that the round goby eats another invasive species, the zebra mussel. Native predatory fish, such as the walleye, eat round gobies. ■



The top map shows locations where the round goby was documented in 2000. The bottom map shows data from 2009.

CASE STUDY 2

The Indian Mongoose

Indian Mongoose (Herpestes javanicus)

THE INDIAN MONGOOSE grows to around 60 cm (24 inches) and lives as long as 13 years, although 3–4 years is more common in the wild. It is fast moving, and although it mainly eats insects, it will also eat crops, fruits, seeds, birds, eggs, small cats, snakes, frogs, and crabs. Usually solitary creatures, they sometimes live in groups, and their habitat ranges from scrubland to different types of forest to areas where humans live. They breed rapidly, with males able to father offspring when they are only four months old. Each female can produce two to five pups every year.

Seventy-three Indian Mongooses were intentionally introduced to the Hawaiian Islands in 1883. They were imported to eat rats that were destroying the sugar cane crops. However, rats tend to be most active during the night, whereas mongooses are most active during the day, so the plan did not work very well. The Indian Mongoose is suspected in causing the extinction of at least one species of bird in Hawaii, and it has killed significant numbers of other native species. As do many other animals, mongooses can carry rabies and leptospirosis. Leptospirosis is a bacterial disease that causes symptoms ranging from rashes to kidney and liver failure. Mongooses may transfer it to humans if the animals' urine mixes with water supplies. ■

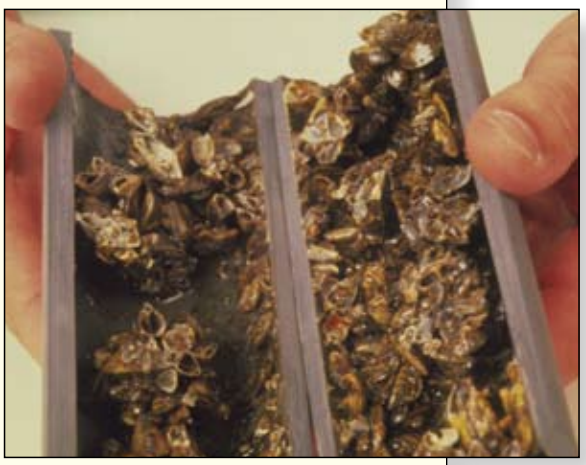
Leptospirosis can be passed on to humans.

CASE STUDY 3

Zebra Mussel

ZEBRA MUSSELS are native to Eastern Europe. They generally live for four to five years and grow to 5 cm (about 2 inches) in length. The females can reproduce at around two years old and are capable of producing up to one million eggs per year. Adults survive out of water for several days if the temperature is low and humidity is high. Young zebra mussels swim freely and are spread easily by water currents. Adult mussels spread when they attach themselves to objects that have hard surfaces, such as hulls of boats. When the object is moved to a different location, the zebra mussels move with it.

Zebra mussels first appeared in the Great Lakes in 1988, most likely having been flushed into the lakes when ocean going cargo ships discharged ballast water. Zebra mussels feed by filtering algae and plankton from water, with each mussel filtering up to one liter per day. In areas where there are millions of zebra mussels, two major changes to the ecosystem have occurred: the water has become clearer, which is beneficial for some organisms but not others; and the food for native larval fish has decreased. The clearer water can benefit plants that live on the bottom of the lakes because they have more access to light and thus grow more. Fish that prefer this type of habitat have actually increased in the Great Lakes. The decrease in food for native larval fish causes fewer of the larval fish to survive, creating a food shortage for the animals that feed on these fish. Zebra mussels also attach themselves to native mussels, clams, crayfish, and turtles, sometimes in such great numbers that these organisms have trouble functioning. Several native species of fish eat zebra mussels, but not enough of them to keep the mussel populations down. Sometimes the colonies block water-intake pipes, restricting water flow and causing problems at power plants and water-supply facilities. ■



Zebra mussels (Dreissena polymorpha) *can clog the insides of pipes.*

CASE STUDY 4

Giant Salvinia

Giant salvinia
(Salvinia molesta)

GIANT SALVINIA IS an aquatic plant native to South America that was first found in the United States in 1995. It forms mats as it floats freely on the surface of slow-moving or still freshwater and reproduces asexually when fragments break off to form clones. The plant can double in size in as little as two days, and its mass can double in a week. As the mats grow they form layers as much as a meter thick. The buds of giant salvinia can withstand dry conditions, and the plants can tolerate freezing air temperatures—but not ice—on the surface of the water where they grow.

Giant salvinia can spread on moving water or by clinging to boats and other recreational craft. A single plant can spread over an area of more than 100 sq km (about 40 sq mi) within a three-month period.

The floating mat formed by giant salvinia blocks sunlight from the water and prevents oxygen mixing at the surface. This change in conditions reduces the number and variety of microorganisms living in the water, which in turn means less food for the organisms that feed on them. The rapid spread of giant salvinia can threaten crops, such as rice, and clog irrigation and drinking-water lines. The thick mats can clog waters to the extent that swimming, boating, and fishing become impossible. The mats are also breeding grounds for mosquitoes. ■

This pond has been taken over by a population of giant salvinia.

Part B

In this section you will read about the benefits and risks of the possible introduction of a nonnative species to try to replenish a fishery. The balance between these benefits and risks is known as a trade-off. A **trade-off** is an exchange of one thing in return for another, giving up something that is a benefit or an advantage, in exchange for something that may be more desirable.

6. Read the summary of a report about the possible introduction of nonnative oysters into Chesapeake Bay.
7. Use a Discussion Web to analyze the statement "nonnative oysters should be introduced into Chesapeake Bay as soon as possible." In the Discussion Web, make sure to discuss the characteristics of invasive species the class listed in Step 5. For the Discussion Web, have two members of your group take the role of fishermen who make their living from harvesting oysters in the Bay, and two should act as conservationists who wish to return the Bay to its original state.
8. When you have completed the Discussion Web, with your same-role partner, compare your comments and conclusions with the members of your group who took the other role. In your science notebook, write down any questions that you would want answered before making a final decision on whether to introduce the nonnative oyster species into the Bay.
9. Under your teacher's direction, discuss as a class the questions that you recorded for Step 8.

Oysters are growing on floats in a creek near Chesapeake Bay as part of an aquaculture education project.

Analysis

1. What characteristics increase the likelihood that a nonnative species will become an invasive species?
2. What conditions in an ecosystem are likely to allow a species to become invasive there? How might scientists use biomes to study this?
3. Biological control involves the introduction of a natural enemy to control the spread of an organism that is considered a pest. What are the trade-offs in introducing a nonnative species to control an established invasive species?
4. Summarize the position taken by either the fishermen or the conservationists about the oysters in Chesapeake Bay. Include the evidence that supports that position. Weigh the evidence to make a recommendation for or against the introduction of the nonnative oysters into Chesapeake Bay. Include at least two trade-offs associated with your recommendation.

KEY VOCABULARY

ecosystem	**invasive species**
evidence	**nonnative species**
habitat	**trade-off**

REPORT SUMMARY

Chesapeake Bay Oysters

ONE HUNDRED YEARS ago Chesapeake Bay was the world's largest oyster-producing region, with fishermen harvesting more oysters than all other countries combined. Slowly but surely the oyster catch has declined and is now only 1% of what it was at the start of the 20th century. Among the factors causing this huge drop are destruction of habitat, reduction in water quality, disease, and overharvesting. The decrease in oysters has had a devastating effect on both the environment and the local economy. Without large numbers of oysters, the water in the bay is not filtered sufficiently. This, along with increased runoff rich in nitrogen and phosphorous, has allowed more algae to grow in the waters of the bay. As a result the oxygen levels in the bay are lower. "Dead zones" sometimes form as a result of eutrophication, with lethal consequences for many organisms, including the oysters. More and more families that have traditionally made a living from the oyster and fishing industries are leaving the area every year or having to find a different form of employment.

Nonnative oysters, Crassostrea ariakensis *(left), are much larger than the native oysters,* Crassostrea virginica *(right).*

Numerous efforts have been made to improve the Chesapeake Bay ecosystem and to restore the oyster resources of the bay. One proposal made in the early years of this century involved the potential introduction of a species of oyster that is native to the coasts of Asia, *Crassostrea ariakensis.* The hope was that this species would thrive, and filter the polluting algae from the bay's waters, improving conditions sufficiently for native oyster populations to begin to recover.

Crassostrea ariakensis is larger and tends to reproduce more quickly than the native oysters *(Crassostrea virginica)*. It also grows much more rapidly than native oysters during the winter months. It can be harvested and sold and would provide a much-needed economic boost to the oyster fishing industry.

Crassostrea ariakensis can survive in a wide range of conditions, including those currently encountered in Chesapeake Bay. However, recent research has indicated that the nonnative species does not reproduce or grow as well when space is limited, for example when it has to compete with other species. *Crassostrea ariakensis* has been shown to have some resistance to the diseases that killed many of the native oysters, but they are susceptible to, and may carry, other diseases and parasites. These diseases, however, are not currently common in the Chesapeake Bay. The nonnative Asian oysters that would be introduced to the bay through the proposal would come from oyster farms in Oregon. ■