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Science Standard  
7.3.e.



# Responding to Environmental Change

## **California Education and the Environment Initiative**

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# The Coyote Success Story



Listen quietly in rural and suburban areas almost anywhere in California and you may be able to hear strange yips and howls filling the night air. These noises are from neighbors you may not even know you have: coyotes. Coyotes bark and howl to communicate with each other; their name comes from the Aztec word “*coyoty*,” meaning “barking dog,” a fact that makes sense since these animals come from the dog family.

Coyotes are also related to wolves and foxes. Scientists consider coyotes to be one of the most adaptable and successful mammals in North America. Coyotes now live in every part of the continent, in residential neighborhoods and along the outskirts of cities; their story is one of adaptation, success, and survival.

Experts disagree about how long coyotes have lived in California. Some believe coyotes came here in the 1900s; some say they followed the trail of the Gold Rush in the 1800s; others say they were here even earlier, and some evidence exists to support

this belief. Archaeologists often find coyote bones in American Indian sites, as well as coyote fossils in Southern California. Early explorers wrote about animals they called “prairie wolves” and they were probably describing coyotes, but no one knows for sure. Scientists know that when California’s population boomed after World War II, the coyote population also boomed. Coyote numbers grew, especially around cities. Today coyotes are common throughout California, living beside homes, schools, and parks.

## Living Around People

Why do some animals live around people while others die out? The answer is in an animal’s ability to survive change. After World War II, many people moved to California. Young couples settled into new communities and began raising families. As the number of people grew, human communities spread into the surrounding natural areas. This reduced the amount of natural habitat available for wild plants and animals. People needed food to eat, water to drink, materials to build and furnish homes, as well as resources to manufacture other goods and support local economies.



Housing development reduces natural habitat



Coyote with grey squirrel

Some animals cannot survive the effects of human development and their numbers drop close to extinction. Some leave the developed areas in search of wild landscapes. But others, such as the coyote, have the ability to change and survive.

### Adaptations

Coyotes are predators who hunt, kill, and eat other animals. They have a keen sense of smell, good eyesight, and excellent hearing. They have long legs that help them run fast and their thick fur is tan or gray, helping them blend in with native vegetation. These adaptations, developed over thousands of years of natural selection, allow coyotes to catch prey while avoiding enemies. For coyotes, such favorable traits make them more likely to mate and reproduce. These traits are passed on and become more common in successive generations, while unfavorable traits become less and less common. For example, a coyote with short legs and poor eyesight would have a difficult time catching

mice to eat. It would also be an easy target for a mountain lion. This unlucky coyote would most likely die before it reproduces. With time, the traits that allow any living thing to survive and reproduce successfully become more common in its population.

### Surviving Human-Caused Change

Coyotes survive human-caused environmental changes because they are flexible. These animals can eat many different types of food; although they primarily eat small mammals, they can also eat insects, lizards, fruit, seeds, pet food, and garbage. They can live alone, in pairs, or in groups. They can live in many different areas from deserts to mountains to human neighborhoods. All they need to make a den is a warm, dry place. Coyotes are also intelligent and they learn quickly in new situations. Twice in recent years, coyotes have broken into the flamingo enclosure at the Los Angeles Zoo. These smart animals recognized the easy access and an equally easy meal. Behavioral adaptability and intelligence are two adaptive traits that have come about from natural selection. However, the things coyotes learn are not passed down to other generations. This type of trait is similar to the human ability to learn to read. The intelligent brain humans need to read develops from natural selection. But every child still needs to learn to read anew. Even if a mother learns to read, her child will not be born with the ability to read—the child must be taught this skill.

In the same way, smart coyotes learn how to survive near humans. They learn to be active at night to avoid people. They learn to prey

on feral cats and roaming pets. They learn to scavenge garbage and find pet food. They learn neighborhood sources of water. They teach their young how to survive in human environments. Coyote pups raised in neighborhoods prefer neighborhoods because that is all they know. When scientists relocate these suburban coyotes into wild areas, the coyotes return to the neighborhood they know best.

### Adaptive Characteristics

The coyote's behavioral adaptability and intelligence help it survive in human environments, but these same traits put the coyote at risk of becoming too comfortable around people. The coyote can then become overly bold. This has already played out in many parts of California where newspapers tell of coyote attacks on people. These reports are often accompanied by "Lost Cat" signs posted in a neighborhood, often one of the first hints that coyotes live nearby. Scientists who study coyotes say that habituation is a people problem, not a coyote one. Sometimes people leave food out for coyotes because they see them as cute and want to attract them. More often, people are unaware of the bait they leave behind: pet food on a porch, unsecured trash bins, or overflowing bird feeders. Even allowing pets, such as cats, to roam neighborhoods can tempt coyotes.

Is there a limit to how much development coyotes can withstand? Some say yes. Scientists have shown that even coyotes in cities prefer areas that resemble natural habitats, such as public parks and greenbelts. Diet studies show that coyotes still eat mostly the same foods in cities as they do in natural

areas: small prey and plants. Human garbage and debris make up only a small fraction of their diet. Coyotes do well in many urban and suburban areas, but they still do not live in downtown Manhattan or downtown Los Angeles.

Coyotes have much to offer people. They kill rodents for free and they control the population of smaller predators. This activity increases the number of songbirds in cities and other habitats. Coyotes are the only large predator many of us will ever see. They teach us many lessons about how important large predators are to an ecosystem. They also teach us the valuable lesson of how important it is to be able to adapt to change.

As the human population continues to grow, we will interact more and more with this remarkable animal. Will coyotes survive by continuing to adapt to human development?



Coyote on road with cars



## Opossum

The opossum is nocturnal, meaning it is awake at night. Its main requirement is a safe, dark place to hide during the day. It fills this need in a wide variety of places: forests, farmlands, swamps, and marshes. Its digestive system can digest many kinds of foods, giving it many dietary options. The opossum eats insects, snails, rodents, dead animals, and fruit. It has a special way of protecting itself from predators. If an animal, such as a dog or fox approaches, an opossum rolls over, sticks out its tongue, and

grows stiff. Often the dog or fox goes away, thinking the opossum is dead!

In California, opossums have discovered that places where humans live contain lots of food and housing options. Opossums can build nests in attics, garages, and basements. Because they like to eat dead animals, they are also attracted to roadkill. Unfortunately, they sometimes get run over when they try to eat it. Opossums have also learned that garbage and leftover pet food are great sources of food.



## Canada Goose

The Canada goose is a large water bird with a stomach that can digest many kinds of food. With its large beak, it eats a variety of plants, such as grasses, grains, and berries. It lives in a variety of habitats but requires a water source and open grassy areas. Most Canada geese in California migrate north in the summer, but some geese live here all year long. Their feathers allow them to survive in many climates. They can fluff their feathers in the winter to keep warm, and flatten them in the summer to stay cool.

Humans have created a number of environments where the Canada goose can live. These environments include golf courses, parks, and developments with ponds and grassy areas.

These sites offer safe places for geese to live and eat. Geese also flock to farmlands where they eat young grasses and leftover grain.

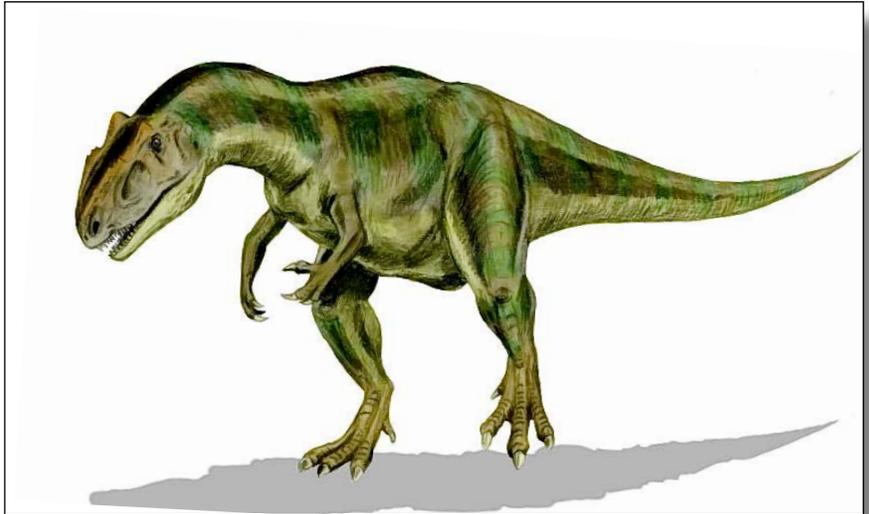
The Canada goose is the most common goose in North America. Approximately 220,000 Canada geese live in California and this number is growing. Some biologists predict as many as 450,000 geese will live here by 2010. In fact, the Canada goose is now so common that it is considered a pest. People do not like the mess from its droppings or its aggressive behavior. Many people have built barriers to keep geese out of ponds and lakes, but some geese have learned to go over the barriers. In cities, few predators bother geese and perhaps that is one reason this animal's population is growing in California.

## Allosaurus

*Allosaurus* lived between 155 and 145 million years ago. Scientists have found *Allosaurus* fossils in many parts of the western United States. These fossils tell us that *Allosaurus* was a large dinosaur, up to 38 feet long, and was a carnivore. *Allosaurus* may have hunted in packs and eaten large plant-eating dinosaurs, such as *Stegosaurus*, which lived at the

same time. Larger predators, like *Tyrannosaurus rex*, did not live at the same time as *Allosaurus*.

*Allosaurus* lived mainly in open plains that had a wet season and a dry season. Scientists are not sure why *Allosaurus* became extinct, but they have several ideas. One idea is that the climate began to get warmer, changing the kinds of plants and animals that lived on the plains. Perhaps *Allosaurus* could not adapt to these changes. Another theory is that new predators that may have been better adapted to the climate arrived in North America. Perhaps they competed for food with *Allosaurus*. Although *Allosaurus* lived for millions of years—much longer than humans have existed—it could not adapt to changes in its environment and became extinct.



## Passenger Pigeon

When Europeans first came to America they saw their first passenger pigeons, which seemed to be everywhere! As many as five billion passenger pigeons lived in the eastern part of North America. Some scientists believe that up to 40% of all birds in the country at that time were passenger pigeons. Early explorers reported that they could hear flocks of the birds from miles away.

Passenger pigeons lived in large flocks. At one nesting site in Wisconsin, 136 million passenger pigeons nested together in a site covering 850 square miles. They built their nests in many trees in large forests. The birds ate nuts, seeds, and berries from the woods.

By the early 1900s, only one passenger pigeon existed. Where did the others go? Passenger pigeons faced two big problems when Europeans came to America. First, settlers hunted



passenger pigeons to sell and eat. The birds were easy to kill because they all nested together. Hunters could net them, knock the chicks out of nests with sticks, or burn sulfur to daze the birds and watch them fall from the tree branches above. At one nesting site in Michigan, hunters killed 50,000 pigeons a day for five months straight. In addition, as more people moved to the United States, they cut down more and more forests for timber and fuel. These two factors led to the complete extinction of passenger pigeons in fewer than 100 years. In 1896, people killed the last remaining large flock of passenger pigeons.

## Woolly Mammoth

Woolly mammoths lived from more than one million years ago until about 11,000 years ago, when they became extinct. Scientists call this time period the “Ice Ages.” During this period, mammals roamed the northern parts of Europe, Siberia, and North America. These cold places contained grasses and shrubs that mammoths could eat.

Woolly mammoths had thick coats of hair that kept them protected from the cold. Underneath the coat they looked slightly familiar. “If you gave them a shave, they are very much like a modern elephant,” says one scientist. Woolly mammoths also had giant teeth, each as large as a shoebox, to help them tear through their food. Their tusks helped them dig, fight, and protect themselves from predators. Woolly mammoths reached as much as 11 feet in height and weighed six to eight tons. Scientists estimate these animals needed to eat 500 pounds of plants each day to survive.

What happened to woolly mammoths? Scientists disagree, but several hypotheses are popular. One hypothesis suggests that the woolly mammoth could not adapt to a warming climate. When glaciers receded and plant life changed, the mammoths may not have had enough food.

Another hypothesis suggests that humans hunted woolly mammoths until none were left. After all, human arrival in North America took place around the time of the mammoth’s disappearance. Still other scientists believe that humans brought with them new diseases that killed off the mammals. Perhaps a combination of these factors caused the mammoths to die out.



World Population Estimates	
Date	Population Estimate (in millions)*
1650	660
1700	610
1750	760
1800	950
1850	1210
1900	1630
1950	2520
2000	6000

\*1,000 million = 1 billion

Source: <http://www.uwsp.edu/geo/faculty/heywood/geog358/endanger.htm>

Known Bird and Mammal Extinctions	
Date	Known Bird and Mammal Extinctions (Per 50-Year Period)
1650-1700	7
1700-1750	7
1750-1800	9
1800-1850	13
1850-1900	20
1900-1950	67
1950-2000	95

Source: <http://www.uwsp.edu/geo/faculty/heywood/geog358/endanger.htm>



Offshore oil drilling rig

## Crude Oil

Millions of years ago, animal and plant life filled the oceans. When organisms died, their bodies fell to the bottom of the ocean floor where they were covered with mud. Heat and pressure slowly turned these remains into crude oil. Humans now drill deep wells underground to retrieve this important natural resource.

Once crude oil is pumped out of the ground, pipelines, oil tankers, and barges transport it to refineries, where it is separated into different materials. Refineries produce

gasoline, diesel fuel, and jet fuel for transportation, and propane to heat people's homes. Other products created from crude oil include plastics, tires, and medicines.

## Resource Reading: Crude Oil

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The methods humans use to find, remove, and process crude oil alter ecosystems and can put species at risk of extinction. Drilling for oil can disturb both ocean and land habitats. For example, underwater testing for oil creates loud noises, which can affect whales' ability to find food or mates because they use sound to find their way through the ocean. Searching for oil on land often requires building new roads, putting in power lines, and creating oil wells in places where animals and plants live. These activities can destroy birds' nesting sites and food supplies, and cause individuals to die before they can reproduce. In Kern County, oil companies have purchased and protected land as natural spaces. The companies aim to protect some individuals of endangered species in these preserves to make up for the ones that die as oil companies search for oil.

Transporting oil also affects the environment. When oil tankers spill their contents, oil can coat sea birds and otters. When birds, such as the California brown pelican, get crude oil on their wings, they become too heavy to fly. When they try to clean their wings with their bills they may consume the oil, which can poison and kill them. Oil spills have decreased in recent years since laws have been created that requires ships to have double hulls. These thicker tankers are stronger and less likely to leak in an accident.

How people use oil-based products also influences ecosystems. When fuel is burned to make cars run or to warm homes, carbon dioxide gas is emitted into the atmosphere. This gas traps heat in the atmosphere, increasing the average temperature at the surface of Earth and potentially causing



Oil tanker

global climate change. Significant changes in global climate may put some species at risk of extinction. For example, polar bears raise their young and rest between feedings on large icebergs. If global warming causes icebergs to melt, polar bears, which cannot swim far enough to reach other food sources, will drown. If polar bears cannot survive and reproduce, the species will go extinct. Similarly, corals in the ocean die when the temperature changes a few degrees.

Scientists and politicians are debating how to change our use of oil to reduce global warming. Some are working on resource conservation, making more efficient engines so cars and trucks use less oil and give off less carbon dioxide gas. Others are inventing better ways to recycle plastics, which are made from crude oil. Another idea is to reduce the need for crude oil products by switching from nonrenewable resources and using more solar energy. Such changes would reduce the effects on ecosystems, thereby preventing the extinction of many species and preventing an increase in the rate of extinctions.



Surface coal mining

## Coal

Hundreds of millions of years ago, large swampy forests covered parts of Earth. Over millions of years, layers of dead plants on these swamp floors became covered with mud and water. Heat and pressure slowly turned these remains into coal.

Humans obtain coal from the ground using two methods: surface mining and underground mining. Surface mining uses large machines to dig up the dirt and rock that covers coal. People use this method when coal is close

to the ground's surface. To reach coal that lies several hundred feet below the surface, miners build underground mines with deep elevators and tunnels that burrow into Earth. Once miners remove the coal, they take it

## Resource Reading: Coal

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to a preparation plant for cleaning. People primarily use this coal in power plants to make electricity, though a small amount of coal provides energy to make goods, such as steel, iron, and paper.

The methods humans use to remove, process, and burn coal alter ecosystems and can put some species at risk of extinction. Historically, surface mining has altered large amounts of land, because this technique removes entire ground surfaces to access the coal underneath. Mountaintop removal mining, a newer example of surface mining, uses explosives to blast off as many as 1,000 feet of land covering the coal. Miners dump the leftover dirt and rock into valleys below, which introduces more minerals into streams in the valleys. Such changes affect many different species and habitats. By the time the mining is done, trees, songbirds, and amphibians have often disappeared from the mined area. The diversity of species found in nearby streams is reduced to the species of fish that can tolerate high levels of minerals in the water.

The ways people use coal also affect ecosystems. When coal is burned to make electricity, it emits carbon dioxide into the atmosphere. This gas traps heat in the atmosphere, causing global warming. The warming of many parts of the planet puts some species at risk of extinction. For example, corals in the ocean often die when the temperature changes even a few degrees. Penguin populations are also declining as rising temperatures cause their food sources to move to different areas. Many other species may not be able to survive temperature changes. Of course, other species may increase in number as their competitors or predators die out.

Burning coal for electricity also releases other gases into the air. These gases cause nitric and sulfuric acids to mix with precipitation, such as rain, snow, or fog resulting in acid rain. Acid rain can kill trees. When acid rain falls into lakes and streams, it poisons many species, such as crayfish, clams, and fish. When species, such as birds, eat poisoned

animals they are affected as well.

Many scientists and politicians are debating ways to change the way people use coal to reduce global warming. Some are working to increase energy efficiency. Others are investigating new energy sources to reduce human demand for coal. Such changes would reduce the effects on ecosystems, thereby preventing the extinction of many species and preventing an increase in the rate of extinctions.



Diver with bleached coral



Paper processing plant

## Paper

The average American uses nearly half a ton of paper each year. Think of all the things made of paper: shopping bags, newspapers, printer paper, food packaging, and more. The ways people get wood to make paper affects many forest ecosystems and the species in them.

Paper comes from trees. To make paper, people cut trees, grind wood, mix it with chemicals, dry it, and bleach it. In the past, natural forests were clearcut—logged completely—to make paper, which altered

forest ecosystems and removed the habitat and food sources for many animal species. In addition, clearcutting leaves the soil exposed and easy to erode, which further affects habitats and waterways downstream. For

## Resource Reading: Paper

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example, loggers in eastern Tennessee have cut approximately 200,000 acres of natural forests to make paper, destroying the habitat of animals, such as the eastern cougar and the Virginia big-eared bat—increasing their risk of extinction.

Now most trees used for paper come from tree farms planted by people. Tennessee forests used to support many species of trees, but after the natural forests were cut, the areas were replanted with just one species of tree: the loblolly pine. This pine grows faster and provides more pulp for paper than other trees; however, this species is also susceptible to the southern pine beetle. When pines were part of a diverse forest, there were not enough pines to cause a massive outbreak of beetles. When Tennessee forests were transformed into pine farms, the beetle population grew dramatically. Over the past decade, the southern pine beetle has eaten more than half of the planted loblolly pines in the region. Beetle outbreaks have resulted in loss of many pines in the remaining natural forests as well, further altering habitats for the cougar and big-eared bat. This example shows how harvesting trees for paper can change the population numbers of many different species.

After people harvest trees, they turn the wood into paper. This process requires large amounts of energy. Burning fuel to obtain the energy to make paper emits gases, such as carbon dioxide, into the atmosphere. The gas traps heat in the atmosphere, causing global warming, which alters environments and places many species at risk of extinction. For example, many harlequin frog species in Central and South America, where

heavy logging of rainforests occurs, have disappeared over the past few decades because global warming has created perfect conditions for a fungus that kills the frogs.

Many people now choose to use paper that comes from sources other than newly-growing trees, such as recycled paper. Americans recycle approximately 50% of the paper they use. Making new paper from old paper instead of from trees requires less energy and reduces the number of trees cut down in forests. Reducing the unnecessary use of paper is another way to conserve forest resources. By not cutting trees, humans reduce the effects on ecosystems, thereby preventing the extinction of many species and preventing an increase in the rate of extinctions.



Tree farm harvesting



Shrimp farm in mangrove swamp

## Fish

People catch more than 90 million metric tons of fish a year to eat. They catch another 30 million metric tons to feed fish and shrimp on aquatic farms (called aquaculture). Humans are now catching fish faster than the populations are able to recover, and overfishing has become one of the biggest threats to many species in the ocean.

For example, people have fished so many bluefin tuna from the ocean that this fish is now endangered and may become extinct. Overfishing also affects other species in the food web: when humans take most of one species of fish, the larger fish and mammals

that relied on that species for food no longer have enough food to survive and reproduce. Consequently, these larger species may also go extinct. Overfishing may cause the extinction of most fish and mammals in the ocean within 50 years.

## Resource Reading: Fish

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Fishing methods also affect ecosystems. Some professional fishermen use explosives to kill fish; these explosives also kill other species and destroy habitats. Some fishermen leave longlines (fishing lines up to 50 miles in length with many hooks) in the water, which can catch seabirds, turtles, and other animals, killing them. Both of these methods reduce populations of some species, either directly by killing individuals of those species, or indirectly, by altering habitat or disrupting the food web so many individuals fail to survive and reproduce. When populations decline, the risk of species becoming extinct increases. In some countries, the government sets limits on the number and size of fish that can be caught. These governments hope the limits will leave enough fish in the ocean to reproduce successfully and produce future generations.

Humans have farmed fish for nearly 4,000 years. In the last decade, fish farming has increased dramatically. Now aquaculture provides about one-third of all the seafood people eat. Creating farms to raise fish and shrimp requires changing coastal habitats. For example, in Africa and Southeast Asia, farmers clear mangrove swamps to make room for shrimp farms. Mangrove swamps provide habitat for many species, such as birds, fish, and turtles. Without this habitat, many of these species no longer have a place to protect their offspring and find food. Consequently, fewer individuals of these species survive and reproduce, and the species is more likely to go extinct. Other species thrive around shrimp farms. For example, some kinds of algae grow well in



Fishing boat with purse seine net

water mixed with the waste that comes from shrimp farms. When the algae dies, it becomes food for bacteria. The bacteria thrive, consuming the oxygen in the water in the process. Without oxygen, fish and other marine animals die.

The types of fish that people buy also affect ecosystems. Some types, such as Alaskan salmon, are not overfished, so that the population size remains relatively constant, despite fishing. Some people choose fish based on how they were caught: “Dolphin-safe” tuna are caught in nets that are designed to avoid catching dolphins. By choosing to purchase fish from populations that are not declining and from fishermen who do not harm other animals when they fish, we reduce the likelihood that species will go extinct due to human effects on ecosystems.

## Game Rules

### Changes in Ecosystems Game

#### Setup Instructions

1. Divide your group of four into teams of two. Roll the die to see which team goes first. The team with the highest number gets to play first.
2. Have each team place a game token on the “Start Box.”
3. Place the **Coastal Dunes, Kelp Forest, and High Desert Game Cards** on their correct spots on the game board.
4. Read the **Coastal Dunes Background** aloud within your group.

#### Instructions for Play

1. The first team rolls the die and moves that number of spaces on the board.
2. The team that is not playing selects a card from the **Coastal Dunes Game Cards** pile and reads the question to the first team. The first team must discuss the question and agree on an answer. Remember to provide a complete explanation in order for your team’s answer to be counted. Keep in mind that you can look at the “ecosystem background” to help you answer the questions.
3. If the team answers correctly, it gets to move its token one additional space. If the response is incorrect, the team does not move forward one more space.
4. Play switches to the other team. The second team rolls the die, moves forward, then gets a chance to answer a question from the **Coastal Dunes Game Cards** pile. If the team answers correctly, they can move forward one additional space.
5. When all of the cards for an ecosystem are used, reshuffle them and use them again.
6. When a team in your group reaches a new ecosystem on the game board, pause the game and read the related “ecosystem background” aloud.
7. The first team to reach the “Finish Box” wins.

background” to help you answer the questions.

After both team members agree and offer an answer, the opposing team reads the answer from the game card.

# Coastal Dunes

Coastal dunes usually contain two to three sets of dunes. The one closest to the water is called the foredune. The dunes farther back are called the back dunes. Sand blows from the foredune to build and support the back dunes.

Wind and water constantly move sand into, out of, and between the dunes. Winter storms erode, or wash away, the sand from the beach, forming sandbars offshore under the surface of the ocean. Rivers move water from land out into the ocean and move sand to the sandbars in the process; this makes the sandbars grow. These sands are washed back to shore by the tides and end up on the dunes in the calm summer season, creating a cycle of building and eroding of the dunes. Dams on rivers prevent much of the sand from flowing from land to the ocean to the coastal dunes, which reduces the amount of sand available to rebuild the dunes.

Native plants, such as dunegrass and beach strawberry, live on coastal dunes. The roots of these plants hold the sand in place and prevent erosion of the dunes, but the plants grow sparsely enough that wind still blows sand to the back dunes. The open sand of the foredune provides nesting habitat for the western snowy plover, a small endangered shorebird, which builds its nests in depressions in the sand and relies on the open habitat to see predators.

The back dunes provide spaces for wildflowers to grow, which in turn provide habitat for butterflies, deer mice, and black legless lizards.

In the 1930s, people planted European beachgrass to prevent the dunes from eroding. This grass is highly invasive and outcompetes native plants for resources. Beachgrass grows very densely so that it covers the dunes, leaving few areas of open sand. With little open sand, the western snowy plover cannot find places to build its nests, while the dense grass allows its predators to hide. The density of the root system of this grass also holds the sand in place on the foredunes so it does not blow to the back dunes. When sand does not blow to the back dunes, they are not rebuilt and back dune habitat is also reduced.

The dune system has not been able to recover naturally from the human introduction of beachgrass. Efforts are now underway to remove beachgrass, which will allow the system to return to its natural state of constantly moving sand, open foredune habitat, and diverse back dunes which provide habitat for a wide variety of animals.

# High Desert

The high desert is a dry environment with little biomass, which means the number of living things per area is small. This climate and lack of biomass makes natural processes in the desert occur slowly. It takes longer for something to rot or decay in the desert because that process requires water.

Decay also requires living organisms that can eat dead animals and plants. If people litter in the desert, it takes a long time for that trash to decay because there are not many decomposers living there.

The desert tortoise is a threatened species that lives in the high desert. It digs an underground burrow to keep away from the heat. It travels slowly through large areas to find food and water to survive. The tortoise has difficulty crossing roads safely because it travels slowly, so tortoises are sometimes killed by cars. When people drive off-highway vehicles through the desert they can crush tortoise burrows and sometimes the tortoises themselves. The raven is a newer arrival to the desert that is able to survive there because it eats the garbage left by humans. Ravens are attracted to the landfills and sewage plants people have built in the desert. However, in addition to human garbage, ravens also eat baby desert tortoises, contributing to the decline of this species. Ravens more easily find and eat tortoises because humans have built tall power line poles that the ravens use as perch sites for spotting food below.

Some areas of the high desert contain small amounts of water. Rare pools house fish, most of which are at risk of extinction because when the amount of water in these pools drops, the

water becomes too hot for the fish. Trees, such as native cottonwoods and willows live near water sources. Occasional desert floods help the cottonwoods and willows survive by clearing the soil and spread seeds that can grow in the damp ground left by the flood waters. Humans have built dams that capture water upstream and reduce flooding in the desert. Cottonwoods and willows cannot survive when the soil gets dry.

In the 1800s, people brought nonnative tamarisk trees to the western United States. People used tamarisks for erosion control, as windbreaks, and as ornamentals (plants that look attractive). Tamarisks are well-adapted to the desert environment; they have long tap roots and consume large amounts of water from deep in the ground. This also means that tamarisk are able to dry up water sources and leave the soil around them too dry for the cottonwoods and willows to grow.

Humans also alter the desert environmental conditions. Driving off-highway vehicles through the desert compacts the soil and prevents plant roots from taking hold. Water does not seep into compacted soil so it runs off and is not available for plants and animals. In addition, people use the desert's limited water supply to meet their daily needs, reducing the amount of available water for other species.

# Kelp Forest

The kelp forest is an ocean ecosystem located off the coast of California. Kelp are large algae that attach to the bottom of the ocean floor and grow to the surface of the ocean. Storms occasionally rip kelp from the floor, but algae grow fast and healthy forests often recover. Giant kelp can grow as many as two feet per day!

People harvest kelp by cutting off the tops of the algae, leaving the rest still attached to the ocean floor. The remaining kelp can continue to grow. People use kelp for food processing and making products, such as paints and cosmetics.

Many species make their home in the kelp forest. Thousands of invertebrates live on or near kelp, some of which graze on the kelp itself. Many species of rockfish live in the kelp forests, where their young eat the barnacles and snails that live on the kelp. Sea lions, sea otters, and harbor seals take shelter in the kelp forests and feed on species that live on or near the kelp. Gray whales use the kelp forest to hide from orcas (killer whales) during their annual migration. Seabirds and mammals use the kelp forest for protection during storms because the current is not as strong in the forests.

When humans affect one species in the kelp forest, they affect the entire ecosystem. For example, the sea otter eats sea urchins that graze on the kelp. Sea urchins can eat large amounts of kelp, although they also eat other foods, such as mussels and sponges. When the sea otter was hunted nearly to extinction, sea urchin

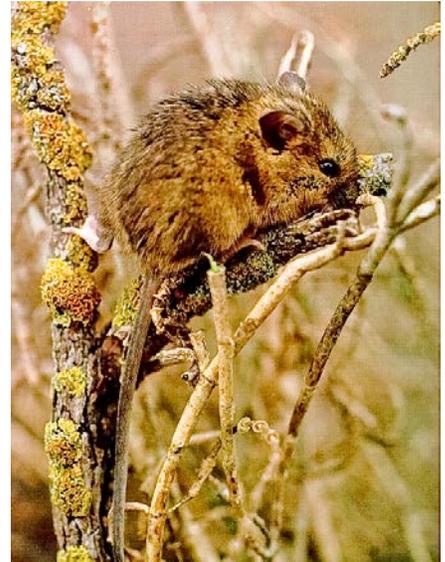
populations went up. Large populations of sea urchins nearly destroyed entire kelp forests. A similar problem occurs when humans catch the rockfish that live in the kelp forest; when rockfish are not around to eat the barnacles and snails, the population of barnacles and snails goes up and these animals eat all the kelp. When most of a kelp plant has been eaten by urchins, barnacles, or snails, it has a harder time growing and is more likely to be ripped off the ocean floor by a storm.

When humans removed top predators, they changed the ecosystem. For example, efforts to help sea otter populations recover have led to a reduction in sea urchin populations and the return of the kelp forests. An increase in kelp forests have helped the populations of many other species recover. Unfortunately, humans continue to threaten the survival of sea otters; when oil is spilled in the ocean, it coats the otters' fur and prevents them from keeping warm. Some get sick and die, decreasing the otter population. Fewer otters can mean more sea urchins, which can cause a decrease in kelp forests.

### **Salt Marsh Harvest Mouse**

The salt marsh harvest mouse lives in the marshes in the southern part of the San Francisco Bay. This mouse has specific habitat needs. It lives in a salty environment among the leaves of pickleweed, which it eats. It needs a large area to survive. Not only does it live in the marsh, it also needs higher dry ground around the marsh as a place to escape rising water from high tides or storms. This higher ground must also provide plant cover, so the harvest mouse can hide from predators.

The mouse is endangered because of habitat loss. When marshland is developed, predators come in, including nonnative species, such as the red fox and house cats. Development also brings an increase of fresh water pumped into the marshes from wastewater treatment plants.



### **Coyote**

Coyotes live throughout the state of California. The coyote has a digestive system that can process many different kinds of foods. The only thing this animal needs for its den is a warm and dry place. The coyote can learn to find new foods or avoid new dangers.



### **California Least Tern**

The California least tern is a bird that lives along the coast of California. It nests in San Francisco Bay and from San Luis Obispo to northern Mexico. It has specific nesting needs and it only nests on open, flat beaches.

The California least tern is endangered because of habitat loss. Development has destroyed nesting areas and has allowed humans and predators, such as raccoons, cats, and dogs, to enter the nesting areas. The tern's feeding areas are also affected by development and pollution.



## Species Background

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### Raccoon

Raccoons live throughout the state of California. Raccoons can live in most areas as long as a source of water is nearby. It has a digestive system that can process practically anything, including insects, birds, eggs, fish, nuts, fruits, vegetables, and grains. The raccoon can also learn not to fear people; in fact, this animal now associates people with food.



### Fresno Kangaroo Rat

The Fresno kangaroo rat lives in Fresno County and in other parts of the San Joaquin Valley, which stretches from south of Sacramento to Bakersfield. This animal lives in colonies in dry habitats. It cannot survive in places that are irrigated or cultivated.

The kangaroo rat is endangered because its habitat is now being farmed. Other threats to this animal include urban development, poisons used to kill rodents, and domestic predators, such as cats.









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