

## LESSON 1

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# Healthy Forests, Healthy Planet



*This lesson can be completed in the classroom or at home. Your teacher will explain to you how to participate in assignments and group discussions if you are completing the lesson at home.*

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## Today's Topic: Healthy Forests, Healthy Planet

### Introduction to Our Forests

Watch the video, [Healthy Forests, Healthy Planet](#), to start your exploration of California's forests. As you watch, think about the different types of areas you see in the forest. Also make note of all the living things you see. Discuss with your class forests you have seen in real life, in movies, and on television. Finally, discuss with your class the characteristics that make an area of land a forest.

### Read and Respond

Read the passages below about forests, then discuss with your group what you learned. Follow your teacher's instructions about how to be part of these group discussions.

### Our Forests

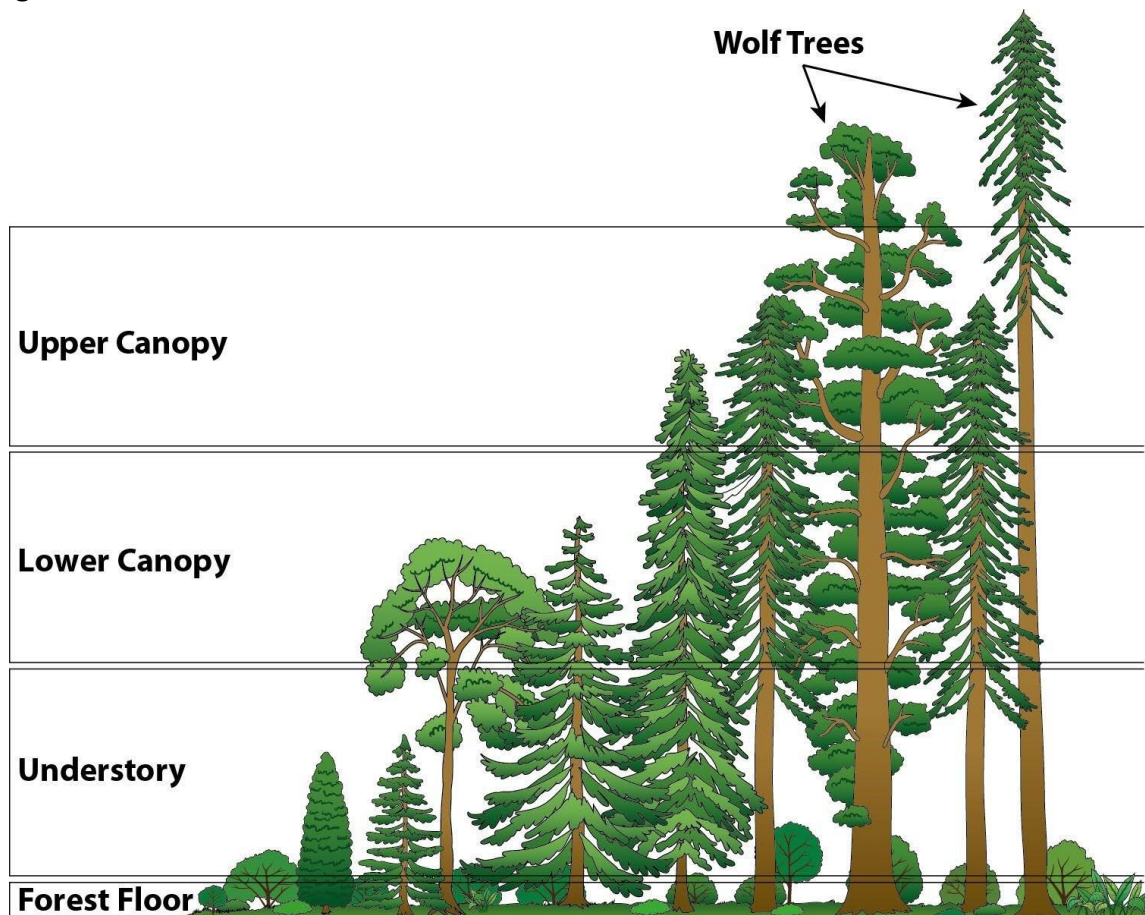
What is a forest? The first thing that you may think of is trees. Forests have many types of trees that come in lots of different sizes. Trees can grow very large as they get older. California is home to the largest trees in the world. Trees are not the only plants that grow in a forest. The forest is an ideal habitat for smaller plants and wildflowers too!

In California forests, some trees grow higher than the rest. These trees stick out over the other trees. These trees are called the **wolf trees**. These trees are usually larger than other trees in the same area. The smaller trees are newer in the forest. The layer of tree tops that the wolf trees stick out above is called the **canopy**. This layer is where the tops of most of the oldest

and tallest trees are found. Trees in the canopy get the most sunlight and provide shade to all the other parts of the forest.

The layer beneath the canopy is called the **understory**. Here, the tops of plants and new, younger trees can be found.

The lowest layer of the forest is the **forest floor**. The forest floor is where dead plants, leaves, and other decaying matter are found. It is also where plants, bushes, and flowers grow and where many animals roam. The forest floor also has rich soil perfect for new trees to start growing!



The Layers of a Forest

The forest is home to many types of animals. There are birds, lizards, deer, elk, bears, and many others. Bugs and insects also live in forests. **Fungi** are another important part of the forest. They are a different type of living thing. Mushrooms and mold are types of fungi. Fungi break down dead things to help make the soil rich with nutrients. Fungi can grow on the forest floor or on the trunks of trees. All of these types of living things rely on resources the forest provides.

Forests provide a number of things people need including water, wood, food, and shelter. Other less obvious things made with wood products are nail polish and LCD screens! You can learn more about wood in our lesson “Wonderful Wood – Nature’s most Adaptable Renewable Resource.”

Forests are also important to the environment. Forest trees act as natural filters to remove harmful pollutants from the air and water. Trees and plants help clean the air by taking in carbon dioxide. This helps reduce the impact of greenhouse gases on the planet. Trees also produce oxygen, which people and animals need to breathe.

### How Forests Are Managed

California has many forested areas. People are very protective of these areas. After all, most people living in the state use the forests in one way or another every day. Forests provide over half of the available fresh water for the state. Most of the rivers and streams that people use start in the forests. The forests provide places for wildlife to live. Forests also help clean the air. They do this by removing large amounts of carbon dioxide out of the air. They also provide the oxygen that people breathe.

To protect the forests, California lawmakers have put in place laws and action plans to properly manage the forests. These laws try to reduce the impact of wildfires, habitat destruction, and changes in climate. The action plans have details about how to restore areas that have been burned or cleared. When forests are cleared the trees are cut down. The population in California continues to grow. People cut down trees to make space for houses and other buildings. California grows more trees than it cuts down. Close to 75% of all wood needed in California comes from other areas like Oregon, Washington, and Canada. This helps to keep the forests in the state growing strong.

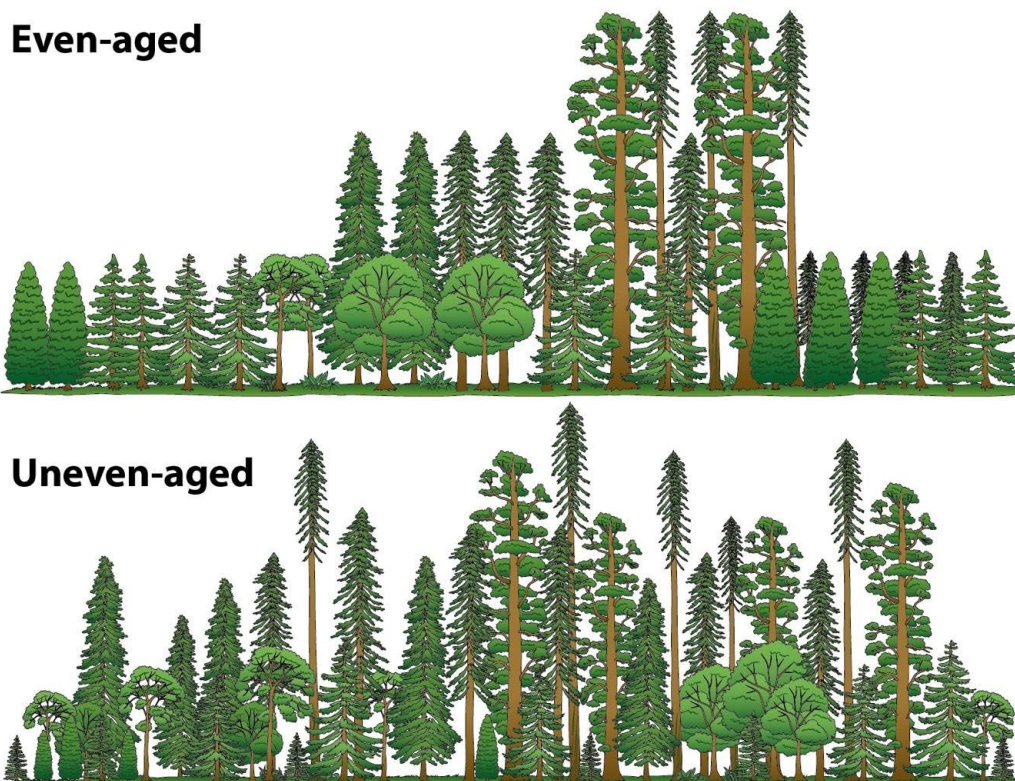
Protecting the soil in forests is extremely important. Forests help prevent **soil erosion**. Soil erosion is when the top layers of soil are washed away by rain or wind. The top layers of soil are where most of the nutrients are found that plants and trees need to grow. When a forest is managed well, soil erosion is more controlled.

Wildfires are also a problem in California. Less rainfall and warmer temperatures have made fires stronger and happen more often. Large areas of forests can get destroyed during a wildfire. One way that people try to prevent large and uncontrolled wildfires is to use **controlled burns**. This is when areas of the forests are burned on purpose to help keep the forest healthy and prevent larger wildfires. These controlled fires burn away the dry brush on the forest floor that can easily catch on fire. Using controlled burns to remove the brush on purpose makes it less likely for large fires to be as destructive.

Another way that forest managers prevent forest fires is by maintaining low **forest density**. Forest density is the number of trees that are found in a certain area of land. Forests that have high density have a lot of trees. A forest's density can be maintained by cutting down some trees to reduce how many trees are in an area.

Cutting down trees may seem like a bad idea, but this process actually helps to keep the forests healthy when it is done properly. **Harvesting**, or cutting down trees, helps to remove dead trees and reduce fuel in case of future wildfires. Forest managers must be careful when selecting trees for harvesting to prevent **deforestation**. Deforestation happens when too many trees are harvested by people or are removed by natural events such as wildfires. **Reforestation** is the process of replacing trees and plants in areas where they were harvested or destroyed in some way. As part of the forest management process, reforestation takes place within 12 months. This helps the forest grow and stay healthy.

Forest managers use harvesting methods to manage forests. Trees can be harvested individually or in groups. **Even-aged forests** have trees that are all similar in age. When trees are harvested in this type of forest they are cut down in the same area at the same time. Another type of forest is called an **uneven-aged forest**. Uneven-aged forests have trees that are different ages. Trees are harvested individually throughout the forest instead of in certain areas. How the forest is managed depends on the forest owner's goals.



Even-aged and Uneven-aged Forests

Everyone can help protect forests from fires by being careful when using fire near or in forests. Visitors to a forest should be extra careful when lighting a campfire and be sure to put it out before leaving. You can learn more about the impact of fires in the lesson “Fire and California Forests.”

A healthy forest is an ecosystem. Healthy forests are able to grow and resist diseases and damage from pests like insects. **Resiliency** is a word used to describe how forests are able to recover from fires, clearing, and other damaging events. Resiliency means being able to recover after a disturbance. Forests with a high resiliency are able to recover quicker and stronger than forests with a low resiliency. Forests are managed to be able to keep providing resources and habitats for one generation of people and living things to the next.

### Types of California Forests

Scientists group trees in many different ways. One way they can be grouped is **coniferous** or **non-coniferous**. Coniferous trees are trees that make cones. Pine, fir, and cedar trees are some types of coniferous trees. Non-coniferous trees, such as oak trees, lose their leaves in the fall.

Scientists also group trees as **deciduous** or **non-deciduous**. Deciduous trees lose their leaves, which are often flat and wide, all at once, leaving the tree bare. Oak and sycamore trees are some types of deciduous trees. **Non-deciduous** trees, such as the California pepper tree and southern magnolia, keep their leaves year-round.

Coniferous trees are sometimes called **softwood** trees. The leaves on softwood trees often look like needles. Pine, fir, and cedar trees are both coniferous and softwood trees. **Hardwood** trees, on the other hand, produce flowers. Oak, maple, and walnut trees are some examples of hardwood trees.



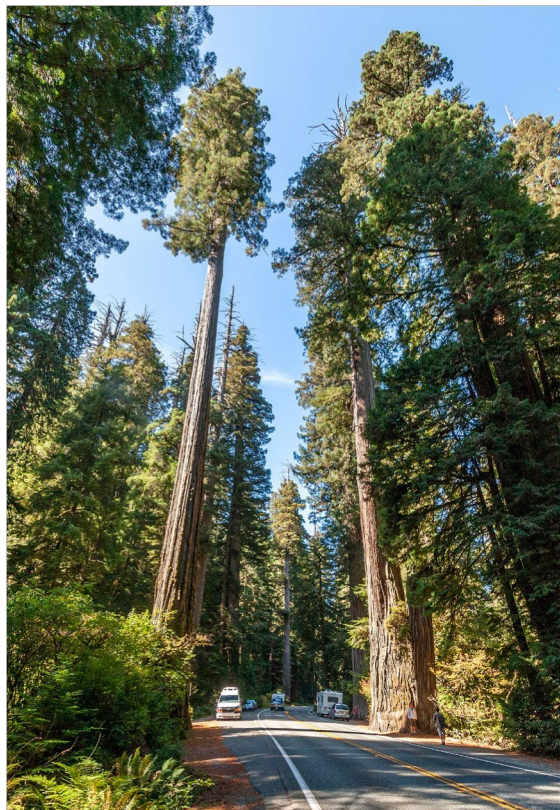
Softwood Leaves



Hardwood Leaf

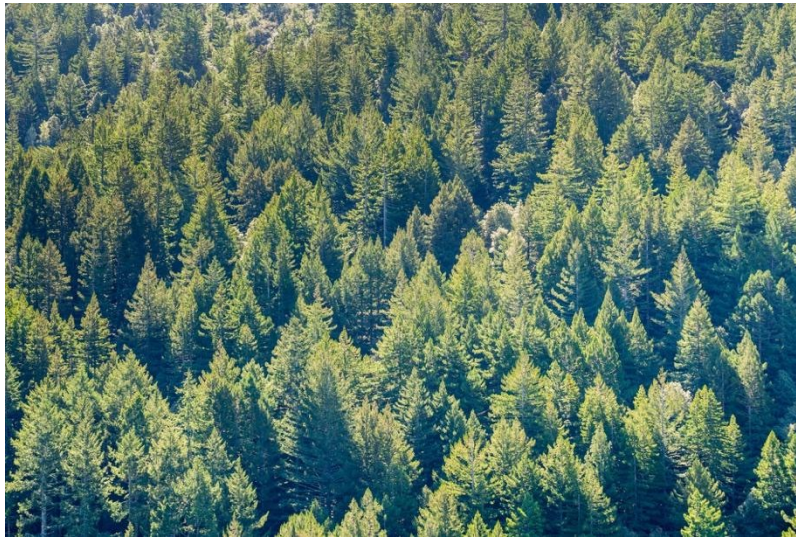
These plants can be found in the five main types of California forests. These are coast redwood, Douglas-fir, mixed conifer, oak woodland, and true fir. There is a sixth type of treed ecosystem in California called **chaparral**. This area is not technically a type of forest. Instead, it can have a combination of trees, shrubs, and grasslands.

**Redwood Forests:** The coast redwood forests are probably the most famous in the state. This is because these trees are some of the tallest in the world! They can grow to be more than 100 meters tall and can live to be around 3,000 years old! The trees found in the redwood forests include the redwoods and the Giant Sequoias, which are the largest trees in the world. The wood of these trees resists rotting and can even take moisture out of the air.



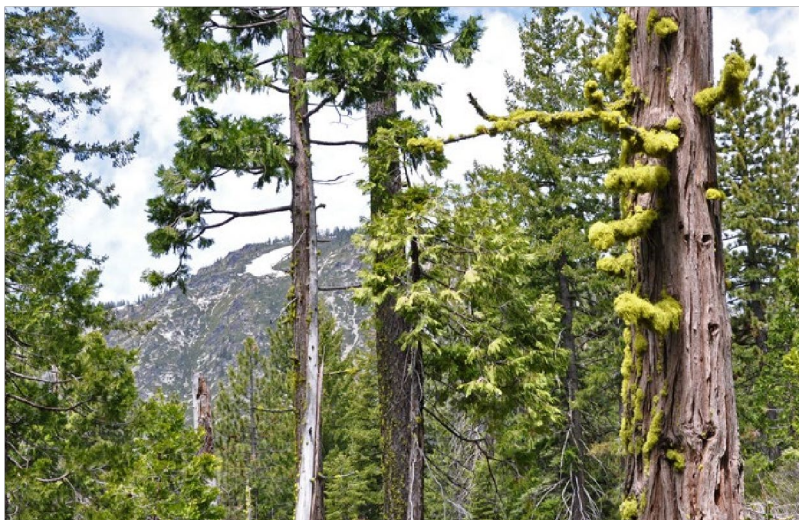
Redwood Forest

**Douglas-fir Forests:** The Douglas-fir forests are found along the coastal areas of California up to Canada. These trees can grow to be 76 meters tall. The Douglas-fir is an **evergreen** tree. This means that these trees are green all year long and do not lose their leaves in the winter.



Douglas-fir Forest

**Mixed Conifer Forests:** The mixed conifer forests are a collection of different types of coniferous and other hardwood trees. These trees can be between 30 and 60 meters tall. The specific trees that make up the mixed conifer forest include white fir, Douglas-fir, Ponderosa pine, sugar pine, incense-cedar, and California black oak.



Mixed Conifer Forest

**Oak Woodland Forests:** The oak woodland forests cover a large amount of land in the coastal mountains and Sierra foothills. These forests are found between grasslands and the mixed conifer forests that grow at higher elevations. Woodlands are smaller and tend to have more open space than forests. Oak woodland areas have mostly deciduous trees. California has 19 different species of oak. There are 9 species of oak that are trees and 10 species that are shrubs. These areas also have other small plants that live on the forest floor.



Oak Woodland Forest

**True Fir Forests:** There are several species of **true firs** that live in many California forests. Firs are considered “true” if their cones do not fall off in one piece. Instead, the scales fall off a few at a time. True firs can be easily identified by the way their cones sit on the very top branches.



True Fir Cone

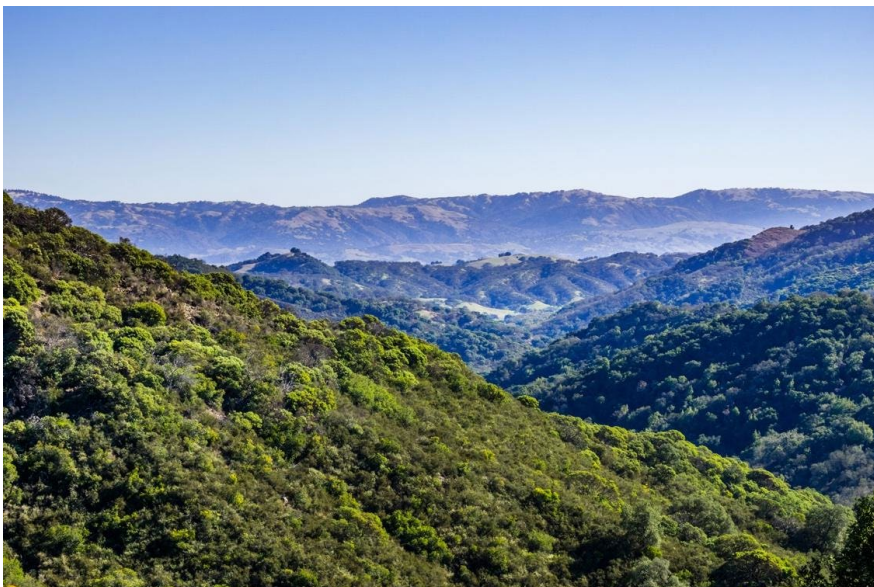
True firs include grand fir, Pacific silver fir, California red fir, and white fir. This forest type is separated from Douglas-fir forests because Douglas-firs are not true firs.





True Fir Forest

**Chaparral:** A unique type of woodland area found in California is **chaparral**. Chaparral is a thicket of brush-like plants that are typically less than 2 meters tall, and can include bushes and short trees. These plants can easily catch on fire during **droughts**. A drought is when there is a long period of time with little to no rainfall. Chaparral is found high up in the mountain areas of the state, usually higher than 1,520 meters above sea level. Chaparral grows in a Mediterranean climate. This means they are hot and dry in the summer and rainy in the winter. Plants living here include oak trees and shrubs. This area gets less rainfall than other forest and woodland areas. The trees and shrubs here have special leaves that help them to hold more water.



Chaparral

## Research

### Who Owns and Manages California's Forests?

More than 30% of California's land is forested. California forests may be managed by the federal government, like Sequoia National Park, but they may also be run by the state, other public entities, or private organizations. There are many forests in California owned by Native American tribes. Some forests are even owned by individual people. Use the data or websites provided by your teacher to fill in how much of California's forests are owned by each group.

- \_\_\_\_\_ % of California forests are national forests.
- \_\_\_\_\_ % of California forests belong to the State of California.
- \_\_\_\_\_ % of California forests belong to Native American Tribes.
- \_\_\_\_\_ % of California forests belong to industry (businesses).
- \_\_\_\_\_ % of California forests belong to individual people.

National forests belong to everyone—including you! People most often use these areas for recreational activities. Hunting, hiking, fishing, and camping are all activities that people can enjoy in national forests. One-third of the national forests are designated as timberland available for harvesting. Harvesting can improve the health and resiliency of our watersheds. We remove some trees so the ones we leave can thrive. The types and number of trees that can be removed at one time is something that is controlled by the federal government. National forests are managed by the laws and practices set by Congress to “provide the greatest good, for the greatest number (of people), for the long run.”<sup>1</sup>

California state-owned forests belong to the State of California. As with national forests, the state uses its forests to provide recreational activities like hunting, hiking, bird watching, camping, fishing, and canoeing. Harvesting can also happen in state-owned forests.

There are several Native American tribes that own and manage California forests. Some of these include the Klamath, Yurok, Karuk, and Hoopa. The ancestors of these indigenous peoples used forests as a source of food and shelter. They would also work to manage the forests to keep them healthy. They would set fires on purpose to promote new shoots on shrubs. This also kept the forest floor clear to reduce surprise attacks from other tribes. The forests remain an important part of Native American tribal heritage and culture. Today, Native American tribes continue to manage the forests using controlled burning.

Some California forests are owned by large companies. The management of these areas is up to the company. Most of the time, management of the forests is done by the owner or a board

of directors. A board of directors is a group of people who help make decisions for a company. The company still has to follow rules about how they can use a forest. The California State Board of Forestry sets the rules. These rules state that companies using their forests must have a plan to make sure they do not overuse the forest resources. There are other groups that decide whether or not companies are using their forests responsibly. Companies that own forests usually manage their land for wood products, habitat conservation, water quality, and other activities.

Lastly, some of California's forests are owned by individual people. These people own the land that has the forest on it and may even choose to build their homes there. Many people use their forests for hunting, hiking, camping, and other recreational activities. Forest owners must be aware of local and state laws that say how the land can be used. Because these areas are privately owned, they are not under the same rules as those owned by large companies.

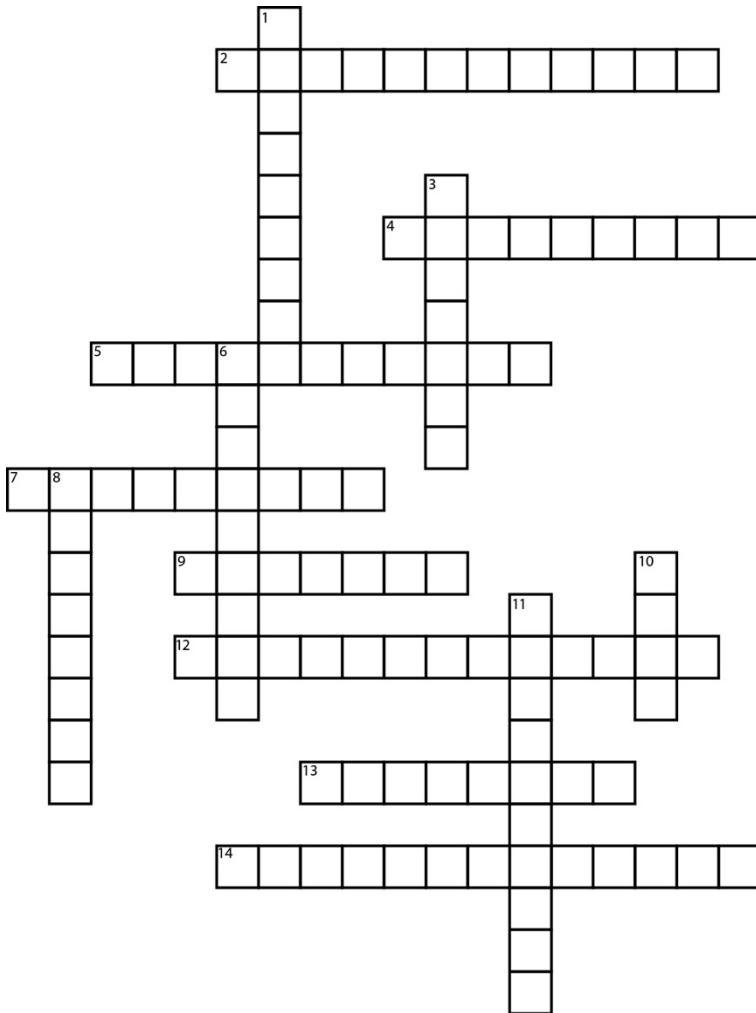
### The Forests and You

Forest managers and volunteers can plant new trees to help forests regrow faster after deforestation. Watch the video [Crystal Lake Tree Planting—It's All Yours](#) from the U.S. Forest Service to learn about what foresters do and the ways that people can volunteer in our forests.

Then, follow your teacher's instructions for researching other ways people and volunteers help maintain California's forests.

## Healthy Forests, Healthy Planet Crossword Puzzle

Answer the clues to fill out the crossword puzzle.



### Down:

1. These are the oldest trees in a forest that stick out above the rest.
3. This is the largest type of tree in the world.
6. These trees have green leaves all year round.
8. This type of tree produces flowers.
10. This product of forests can be used to build homes.
11. This is one term for cutting down trees and then using their wood.

### Across:

2. These trees do not lose their leaves all at once.
4. This type of tree loses its leaves all at once.
5. This layer of the forest is where small plants and animals can be found.
7. This grows in a Mediterranean climate.
9. These trees can be identified by their upright cones.
12. This is the planting of trees to regrow a forest.
13. These types of trees have cones.
14. This is the removal of trees so that people can use the land for other purposes.

## What Did You Learn?

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Answer the following questions to test your knowledge.

1. Why can it be good to remove trees from overgrown forests by cutting them down?
  - a. to make space for new buildings
  - b. to maintain desired forest density
  - c. to provide wood products for societal use
  - d. to start growing new forests
2. Which term or phrase is used to describe how well forests are able to recover from damaging events?
  - a. forest density
  - b. resiliency
  - c. even-aged forest
  - d. reforestation
3. Who owns the national forests found in California?
  - a. the federal government
  - b. the State of California
  - c. all people in the United States
  - d. private companies and individuals
4. How are controlled burns helpful in managing California forests?
  - a. by removing brush to prevent large wildfires
  - b. by removing all the trees before they can catch on fire
  - c. by clearing the land so new trees can replace old ones
  - d. by making more space for people to build homes
5. Which type of forest has rules on how owners can manage and remove trees?
  - a. national forests
  - b. California state forests
  - c. forests owned by companies
  - d. all of the above

## Apply to World

### Group Activity: Discussion

Your teacher will assign you to a group to work on your activity.

<sup>1</sup> <https://www.fs.usda.gov/greatestgood/press/mediakit/facts/pinchot.shtml>

## LESSON 2

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THE CALIFORNIA FOREST  
FOUNDATION

# Water: The Forest's Most Valuable Resource

*This lesson can be completed in the classroom or at home. Your teacher will explain to you how to participate in assignments and group discussions if you are completing the lesson at home.*

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## Today's Topic: Water from the Forest

### Introduction to California's Water

Watch the video, [Water: The Forest's Most Valuable Resource](#), to start your exploration of the water supplies in California. As you watch, pay attention to where California gets its water and, in particular, to the California watershed areas. Then, think about the watershed area where you live. Discuss with your classmates where the water you use comes from, and how far away it may start!

## Read and Respond

Read the passages below about how California manages its water supplies and how water is connected to the forests. Then, you will discuss in a group what you learned. Follow your teacher's instructions about how to be part of these group discussions.

### Water: Where It is Found

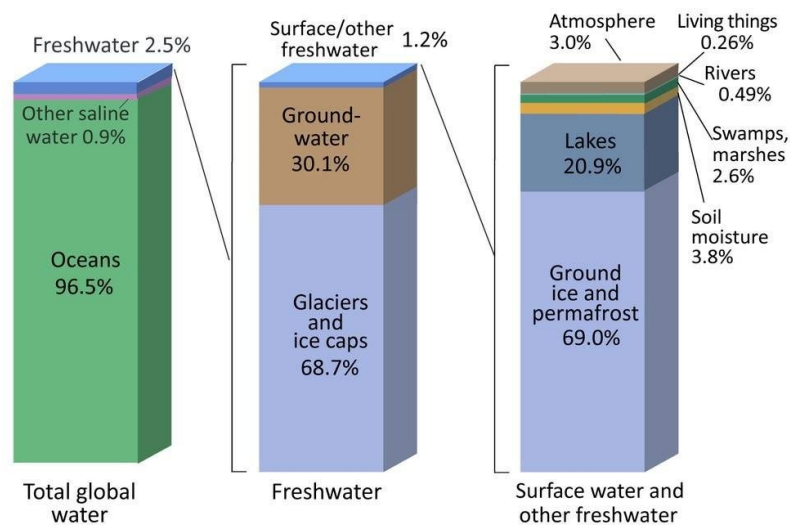
When you think about water, what is the first thing that comes to mind? It might be puddles. It might be the oceans. It might even be what falls from the sky. However you think of water, it is important to know what it is and where you can find it.

Water is the reason life exists on Earth. Your body (and the bodies of most living things) is made up of mostly water. Living things need water to survive. People need water to stay healthy.

Plants need water to grow. As you can see, this “liquid of life” is pretty important! How many times in a day do you use water?

Almost everywhere you look on Earth there is water. But, where do you have to look to find it?

### Where is Earth's Water?



Earth's Water  
Image Credit: USGS

Almost all of Earth's water is found in the oceans. In fact, 96.5% of all of the water on Earth can be found in oceans. Ocean water is too salty for drinking or watering plants. In fact, if you drink ocean water you will actually be thirstier than if you did not drink it at all.

People mostly use fresh water. Fresh water is not salty. Only 2.5% of Earth's water is fresh. Most of this is found frozen in glaciers and in the ice caps (the North and South Poles). The second largest amount of fresh water is found underground. This freshwater source is called groundwater. **Groundwater** is water found underground in the cracks and spaces between soil, rocks, and sand. Areas with large amounts of groundwater are called **aquifers**. An aquifer is a space between underground rocks where water collects. The rest of Earth's freshwater sources come from surface water. **Surface water** is water found on the top of Earth's surface and includes lakes, streams, rivers, ponds, and swamps. Surface water is mostly the result of precipitation and extra water runoff.



California has a long coastline. It stretches 1,352 kilometers along the west side of the state. This entire length borders the Pacific Ocean. There have been some efforts to use ocean water by taking the salt out of it, but most of the water used in California comes from surface water or groundwater. California has more than 3,000 lakes and reservoirs. It also has more than 100 rivers. This might bring you to ask, “Where does California’s fresh water come from?”

### California’s Water and Forests

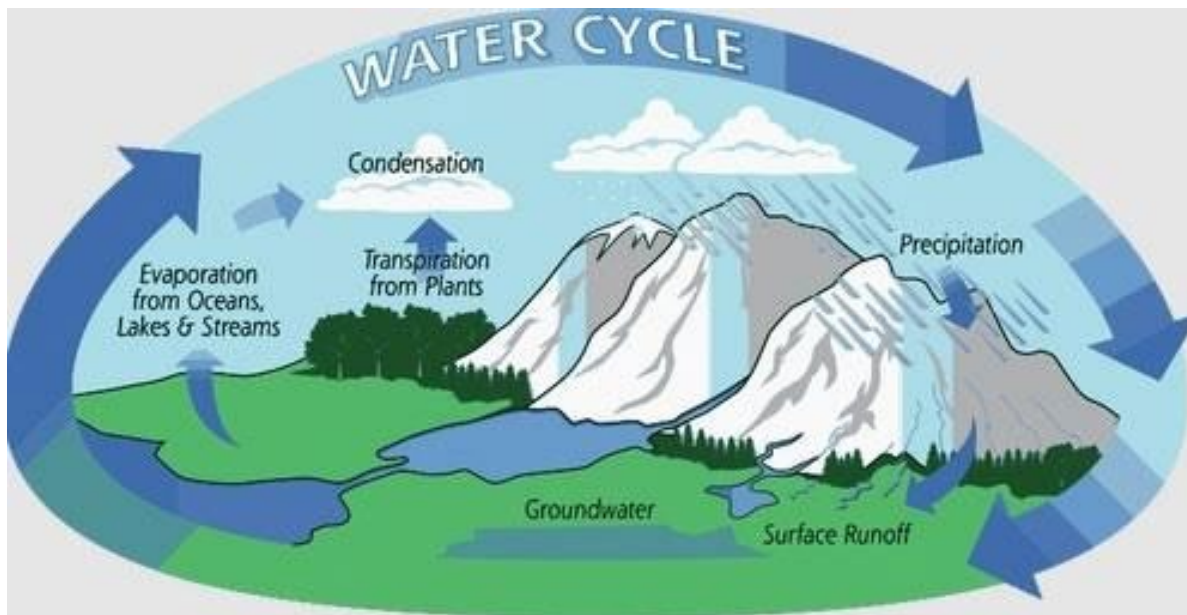
Believe it or not, most of California’s water comes from the forests in some way. Water starts as rain, snow, or ice falling from the sky. This is called **precipitation**. Precipitation happens when water vapor in the air cools and falls back to Earth as rain, snow, or ice. Precipitation can sink into Earth’s surface. It can also collect in reservoirs, watersheds, lakes, and ponds. The sun can heat up the water on Earth’s surface.

When the surface water heats up enough it returns to the atmosphere as water vapor. This process is called **evaporation**.

When water vapor cools it becomes liquid water again. This process is called **condensation**. The atmosphere is cooler than Earth’s surface, which causes the water vapor to fall back to Earth as precipitation.

Plants also release water back into the environment. This process is called **transpiration**. Transpiration is when plants lose water through their leaves and stems.

**Evapotranspiration** is a term used to describe the combination of water being evaporated from Earth’s surface and being transpired by plants. All of these processes happen over and over again in what is called the **water cycle**.



The Water Cycle

Image Credit: NASA

The key parts to the water cycle are:

- **Condensation** - when water vapor becomes liquid water
- **Precipitation** - rain and snow coming down from the sky
- **Runoff** - when water moves across Earth's surface
- **Evaporation** - the movement of water from Earth back to the atmosphere
- **Transpiration** - when water evaporates through the leaves and stems of plants

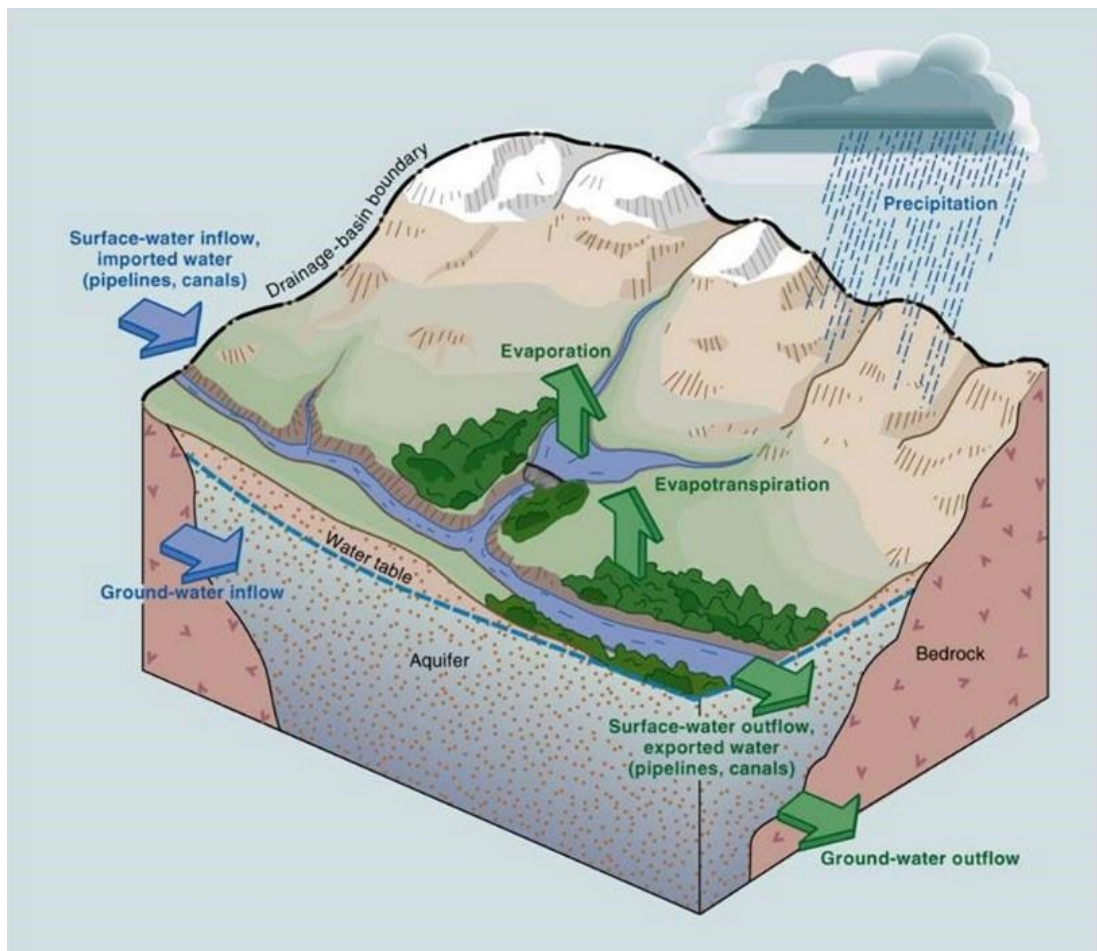
The Sierra Nevada mountain range causes precipitation to fall from the clouds. As air moves over the top of the mountains, the water vapor cools and condenses and falls back to Earth as precipitation. In fact, the forests surrounding the Sierra Nevada mountains supply 65% of the fresh water in California. The trees and soil slowly filter, or clean, the water as it makes its way to streams, rivers, and lakes. Trees and soil can also help filter the water removing debris and pollutants as the water flows through the ground. Trees and soil are able to filter water by trapping pollutants and debris, preventing it from reaching water supplies, and trees can also help prevent flash floods. Forests reduce the flow of water across the surface of the land. It is important to remember that there are large differences in how each region gets and uses water. While the northern part of the state receives heavy precipitation, the southern part is very dry.

## California's Watersheds

California gets most of its water from mountain ranges and forests. Snow and ice melt, and the water travels across the land and through the soil to fill the lakes and reservoirs. A **watershed** is an area of land that drains water into a specific area. Normally these areas are rivers or lakes. Watersheds can be different sizes. For example, a small mountain stream may have a small watershed, but river systems can have large watersheds that span hundreds of miles.

Watersheds are very important. Some of the things they do are:

- collect water from rain and melting snow and ice
- release water as runoff
- clean water
- provide habitats for many plants and animals



Parts of a Watershed

Image Credit: USGS

One of California's major watersheds is found in the Sierra Nevada mountain range. There are 16 water systems in this area that provide water for about two-thirds of all of the state. This watershed covers nearly one-fourth of the state's area and is home to much of the state's forests. The forests serve as the source of water for the watershed areas. The melting rain and snow from the tree-covered mountains flow through the forests, which act as filters for all the water passing through them.



Sierra Nevada Watershed

Another area of California's watershed is found in the central part of the state, near San Francisco Bay. This area covers more than 75,000 square miles and includes the San Francisco Bay.

It runs from the Cascade Mountains in the north to the Tehachapi Mountains in the south. This watershed provides water for a large percentage of the state. It also has many different habitats. These include freshwater and saltwater areas. These habitats are especially important for migrating salmon and birds.



San Francisco Bay Watershed

The rivers and streams that flow from the forests produce most of the surface water that is used for drinking and farming. Snow and ice are stored in the winter. When the snow and ice melt in the spring, they turn into runoff, which flows into streams. The water flows into streams and rivers. A lot of this water is used in the big cities and on farms throughout the rest of the year. The forests keep the water clean. They reduce erosion of soil into streams. They also filter pollution out of the runoff.

## Managing Water Sources in California

Water is very important to life in California. So are forests. The forests and water supplies are connected to each other. Residents need to do everything they can to protect the forests and waterways in the state. The headwaters of most of California's water sources (lakes, rivers, etc.) are located in the forests. Many of these areas provide habitats for animals and plants in addition to freshwater supplies. Water usage in the state can be divided into three different categories: environmental, urban, and agricultural.

Environmental water usage includes the waters protected by both state and federal laws. These waters are important for maintaining wetlands and other water habitats, wildlife preserves, and sport and recreational usage. These water sources are largely isolated from the major urban and agricultural areas of the state.

**Urbanization** is the process that occurs when populations shift from rural to urban environments. Urbanization is one factor that can cause interruptions to California's water supply. Urbanization, however, can happen in environmentally sustainable ways so that urban water supplies can provide people and businesses with the water they need. For example, urban forests are often planted and maintained in many areas. Urban forests can include city parks, tree-lined streets, landscaping, and many other types of planned green spaces.

Even though urban populations in California have been growing, the urban water usage for the state overall has been declining over the past two decades. Water conservation efforts have encouraged residents to continue to save water and choose to use water supplies thoughtfully. Small changes in how water is used can have a large impact on conservation efforts. Some efforts to conserve water include watering lawns and gardens after dark or in the early morning, running full loads of dishes and laundry, and having water-saving devices like low-flow toilets and showerheads. California has enacted laws that promote the safe and responsible use of water.

As the population in urban areas increases, the flow of rivers and streams in the area is affected. People put up roadways and other structures that could interrupt the flow of natural waterways. These barriers, including fences, can impact the movement of animals from one place to another.

One way to remedy the effect of these structures on waterways is to build a **culvert**. A **culvert** is a structure that allows water to flow under or around a road. To learn more about culverts, watch the video: [Culvert and Road Restoration by the U.S. Forest Service](#).



Culvert Under a Road

Image Credit: Pi.1415926535

All man-made structures affect the land and wildlife, culverts included. Some culverts can prevent animals from going upstream or moving between different habitats. While the presence of human-made structures may prevent the loss of soil through erosion (because the land is covered with concrete), putting up any structure can cause the loss of habitat for many plants and animals. The water provides places to live, food sources, drinking water, safe passage and migration routes, and breeding grounds for many living things. When these get taken away there is a large effect on nature.

One way to mitigate some of the environmental impacts of urbanization is by building **wildlife corridors**. Wildlife corridors are built to connect wildlife populations that are separated by human-made structures. The corridor can be a bridge, tunnel, or an open space that is off limits to humans to allow animals to freely roam. Corridors connect areas of forest, grasslands, meadows, or waterways. These corridors allow animals to continue to feed, reproduce, and find shelter, increasing their chance of survival. Wildlife corridors also help contribute to conservation efforts. Allowing space for native vegetation to grow allows gas emissions from things like factories and vehicles to be captured by native plants and supports waterways. The corridors are also helpful in forestry and farming efforts.



Wildlife Corridor Under a Highway

Image Credit: United States Department of Transportation



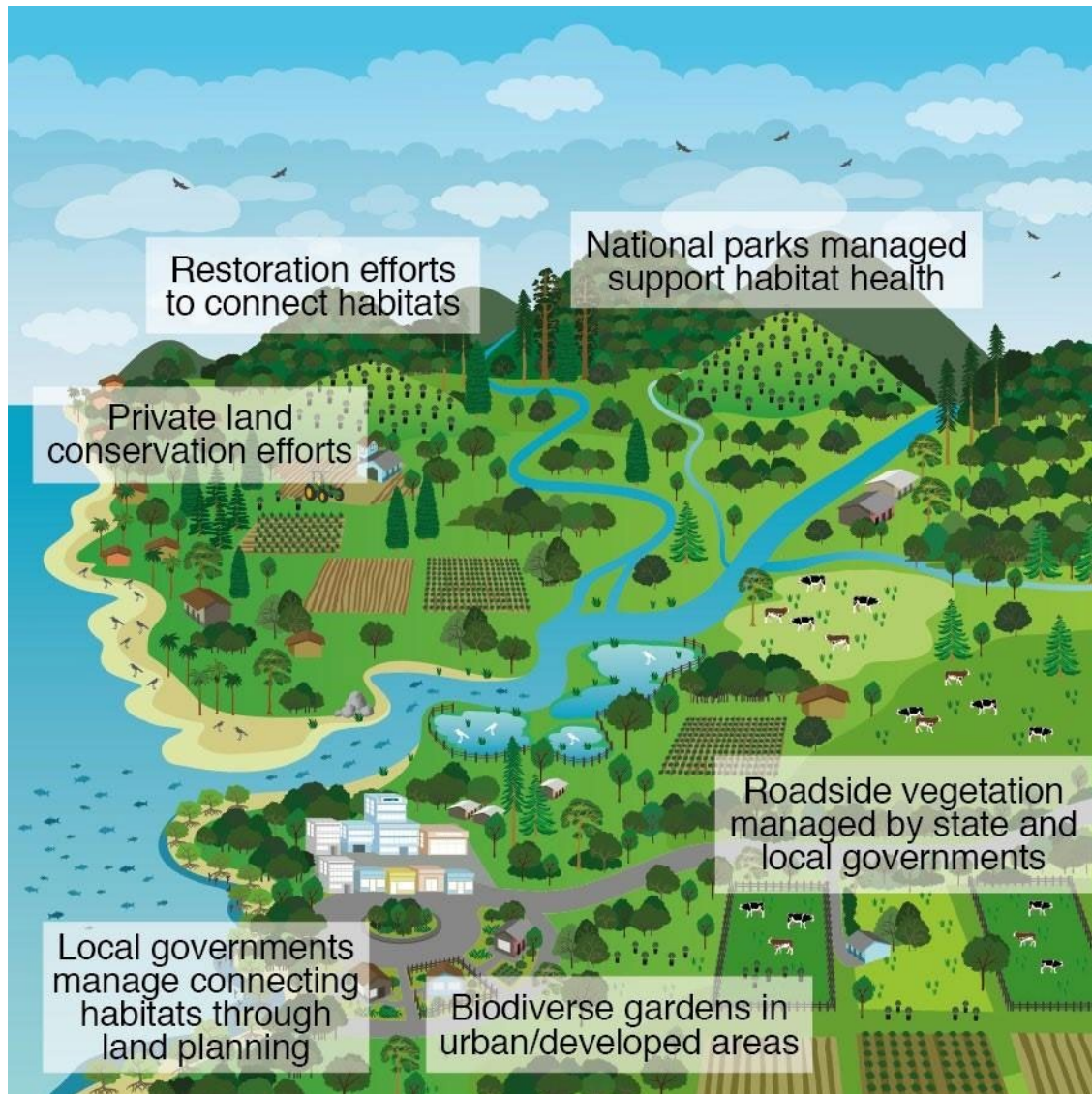
Wildlife Corridor Over a Highway

Image Credit: Benjamin P. Y-H. Lee, University of Kent

The size and scope of wildlife corridors varies greatly from a small area along a river bank to large areas that cover miles of land. An example of a small corridor might be a small area along a forest creek that has been revegetated to connect two patches of forest land. Community groups and individuals often help maintain and build these smaller-scale corridors.



Larger-scale corridors that span miles and often cover multiple landscapes often require collaboration between many groups to build and manage. Large-scale corridors often work to connect several smaller-scale corridors as part of a larger effort. To learn more about wildlife corridor efforts in California, read about [habitat connectivity from the California Department of Fish and Wildlife](#).



How Wildlife Corridors Connect Areas

In addition to urban water use, California also uses water for agriculture. An increase in high-yield groups such as nuts and fruits has increased the economic return on agricultural water usage in the state, even with an overall decrease in water use for agricultural purposes.

In order to continue to maintain California's water supply and to plan for drought, additional measures to maintain groundwater supplies are needed. California state law now requires groundwater basins in the state to have long-term balance plans by the early 2040s.

California has the nation's largest human population, the most diverse and economically important agricultural industry, and the greatest diversity of environmental resources. With all of these competing interests, the proper allocation and sustainable management of water—the most limiting resource—is crucial for the future of the state. California forests, both publicly and privately managed, play a critical role in the storage, purification, and transportation of this precious resource. The collaborative planning processes among all competing users of water is the key to proper conservation for beneficial uses, with forests playing a central role in this process.

## Research

### Who Owns and Manages California's Forests?

More than 30% of California's land is forested. California forests may be managed by the federal government, like Sequoia National Park, but they may also be run by the state, other public entities, or private organizations. There are many forests in California owned by Native American tribes. Some forests are even owned by individual people. Use the data or websites provided by your teacher to fill in how much of California's forests are owned by each group.

- \_\_\_\_\_ % of California forests are national forests.
- \_\_\_\_\_ % of California forests belong to the State of California.
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National forests belong to everyone—including you! People most often use these areas for recreational activities. Hunting, hiking, fishing, and camping are all activities that people can enjoy in national forests. One-third of the national forests are designated as timberland available for harvesting. Harvesting can improve the health and resiliency of our watersheds. We remove some trees so the ones we leave can thrive. The types and number of trees that can be removed at one time is something that is controlled by the federal government. National forests are managed by the laws and practices set by Congress to “provide the greatest good, for the greatest number (of people), for the long run.”<sup>1</sup>

California state-owned forests belong to the State of California. As with national forests, the state uses its forests to provide recreational activities like hunting, hiking, bird watching, camping, fishing, and canoeing. Harvesting can also happen in state-owned forests.

There are several Native American tribes that own and manage California forests. Some of these include the Klamath, Yurok, Karuk, and Hoopa. The ancestors of these indigenous peoples used forests as a source of food and shelter. They would also work to manage the forests to keep them healthy. They would set fires on purpose to promote new shoots on shrubs. This also kept the forest floor clear to reduce surprise attacks from other tribes. The forests remain an important part of Native American tribal heritage and culture. Today, Native American tribes continue to manage the forests using controlled burning.

Some California forests are owned by large companies. The management of these areas is up to the company. Most of the time, management of the forests is done by the owner or a board of directors. A board of directors is a group of people who help make decisions for a company. The company still has to follow rules about how they can use a forest. The California State Board of Forestry sets the rules. These rules state that companies using their forests must have a plan to make sure they do not overuse the forest resources. There are other groups that decide whether or not companies are using their forests responsibly. Companies that own forests usually manage their land for wood products, habitat conservation, water quality, and other activities.

Lastly, some of California's forests are owned by individual people. These people own the land that has the forest on it and may even choose to build their homes there. Many people use their forests for hunting, hiking, camping, and other recreational activities. Forest owners must be aware of local and state laws that say how the land can be used. Because these areas are privately owned, they are not under the same rules as those owned by large companies.

### Finding Your Watershed

Everyone in California lives in some kind of watershed. Use [this webpage](#) from the U.S. Geological Survey to find out more about the one where you live.

After you find the watershed where you live, click on the related links to learn more about it.

Write down some general information (location, amount of water, sources of water, etc.) and then share what you learned with your class.

## Build Your Own Watershed

Now it's time to make a model of a watershed! Your model will help you to see how water flows through a watershed.

### Supplies needed:

- Paper
- Marker (nonpermanent)
- Spray bottle
- Water

### Steps:

1. Start by crumpling a piece of paper.
2. Smooth it back out most of the way. It should still be a bit crumpled, showing small ridges (high points) and valleys (low points).
3. Imagine that this paper is a section of land and find the ridgelines (the tops of the fold-lines).
4. Use a marker (nonpermanent) to color along the ridgelines on your watershed.
5. Use a spray bottle of water to create a gentle "rainstorm" over your watershed.
6. Observe and record what happens after the misting.
7. Repeat this a couple of times.
8. As your "rainfall" accumulates, observe the pathways where the water travels and collects.

Once you have some water in your watershed, trace a stream back up to where it starts at the top of the ridge. The top is the edge of the watershed for your stream and lake. Trace the entire edge of the watershed with your finger, by following the ridgeline.

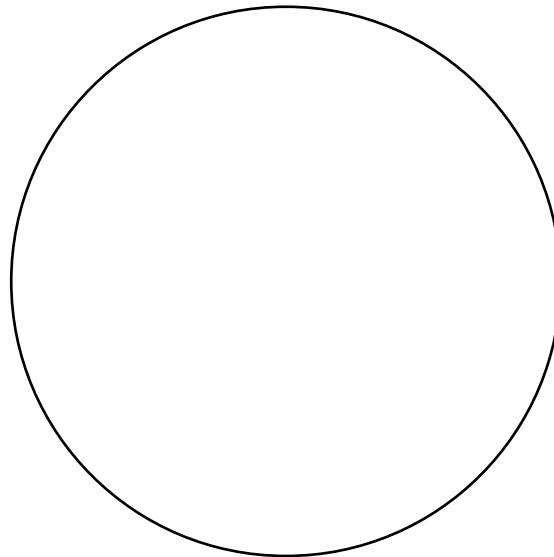
How does your model simulate water flow in a real watershed area? What land features do you notice in areas where water collects in pools instead of traveling downstream?

## How California Uses Fresh Water

California's freshwater supplies are used in many ways throughout the state. Use the data in the table to make a pie chart to compare how fresh water is used in the state.

**Table 1: How Fresh Water Is Used in California**

Use	Percentage of supply
Irrigation for agriculture	40%
Urban use	10%
Environmental	50%



Take a look at Earth's water diagram from earlier in the lesson and compare that to the pie chart you just created.

Make a claim about the amount of fresh water available for use compared to how fresh water is used. Use evidence from what you have learned in the lesson and your pie chart to support your claim.

## What Did You Learn?

Answer the following questions to test your knowledge.

1. Which statement explains how forests support water supplies in California?
  - a. Forests provide an additional source of water to add to the groundwater.
  - b. Forests clean the runoff by filtering the water through soil.
  - c. Forests prevent flooding by absorbing all precipitation.
  - d. Forests keep surface water levels constant by adding more over time.

2. Match each area of surface water with how much is found on Earth.

_____ Atmosphere	a. 0.49%
_____ Lakes	b. 3.0%
_____ Rivers	c. 3.8%
_____ Soil moisture	d. 20.9%

3. Through what process do trees and plants release water vapor into the atmosphere?
  - a. Precipitation
  - b. Condensation
  - c. Transpiration
  - d. Evaporation
4. California gets most of its fresh water from \_\_\_\_\_ in the northern part of the state.
5. Why is collaborative water planning and conservation important in California?

## Apply to Real World

### Group Activity

Your teacher will assign you to a group to work on your activity.

<sup>1</sup> <https://www.fs.usda.gov/greatestgood/press/mediakit/facts/pinchot.shtml>

## LESSON 3

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THE CALIFORNIA FOREST  
FOUNDATION

# Wonderful Wood: Nature's Most Adaptable Renewable Resource

*This lesson can be completed in the classroom or at home. Your teacher will explain to you how to participate in assignments and group discussions if you are completing the lesson at home.*

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## Today's Topic: Wood and What It's Used For

### Introduction to California's Wood

Watch the video, [Wonderful Wood: Nature's Most Adaptable Renewable Resource](#), to start your exploration of wood and the things that are made from it. As you watch, pay attention to all the different kinds of things that can be made from wood. Also take note of how harvesting and thinning of trees creates a healthier forest. Discuss with your class ways to protect the forests and their wood supplies, while still making the products people need.

### Read and Respond

Read the passages below about the aspects of wood, then discuss with your group what you learned. Follow your teacher's instructions about how to be part of these group discussions.

### Things Made of Wood

Wood is an important resource. Take a look around you. How many things do you see that are made from wood?

Your list might include chairs, tables, paper, or even a bookshelf. Wood is so common that you probably do not think about it much, but wood is an amazing material! People have been using wood to build things for thousands of years. Wood is a **renewable resource**. A renewable

resource is a resource that remains available for use in the future and at levels not lessened by how it is used in the present. As long as forests are managed properly, wood will be available to use.

Wood comes from trees. Many parts of California are covered with dense forests. These forests have many kinds of trees, most of which can be harvested to produce wood and wood products. Wood is the part of the tree under the bark. Wood has many uses. Removing some of these trees for products we use is a sustainable way of managing the forests. This is different from the products used to make plastics because the forests regrow.

Most houses in California are made of wood. Have you ever seen a new house being built? The first step is to pour a foundation for the house. Next, the basic frame of the house is put up. This frame is made of wooden beams. These beams form the shape of the house. Once the frame is built, it is covered with flat sheets of wood. These sheets make up the outside walls. Since wood is a natural substance, it can be damaged by the weather. To protect it, the house will be covered with other materials, like vinyl siding, stones, bricks, or wood shingles.



A Wooden Building Under Construction

Image Credit: paulbr75

Wood is used to build more than just buildings. Furniture is made from wood. Decorative pieces, picture frames, instruments, toys, and many other things are also made from wood. Wood has been used for a very long time, but we are still finding new ways to use and improve

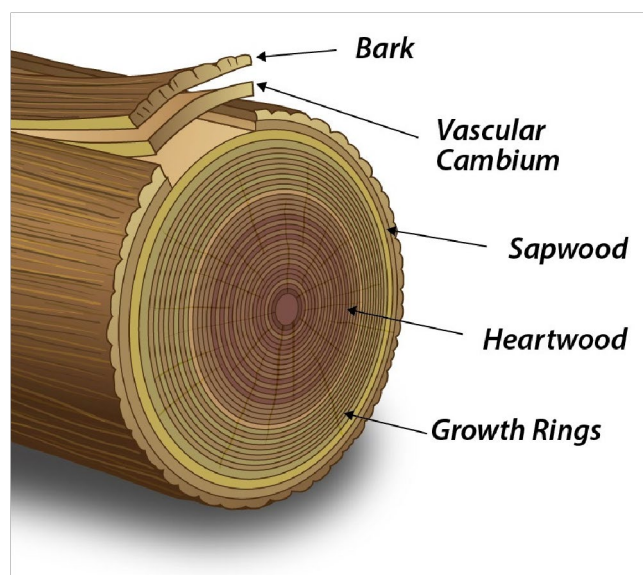


wood! Science is working on ways of improving wood. **Nanotechnology** is a part of science and technology that focuses on very small particles to see how they can be combined to do new and helpful things. Many areas of science like chemistry, biology, physics, and engineering are using nanotechnology to make improvements to common items—even wood! One of the ways science is using nanotechnology to improve wood products is to make it lighter and stronger at the same time. This could help by making things like paper and lumber less expensive to produce. **Lumber** is a type of wood that has been processed into beams or planks to make it ready to use for building. Technology could also increase or change the ways in which wood can be used.

Nanotechnology is also being used by scientists to study the parts of tree and plant cells that make them strong. Plant cells have a rigid structure that surrounds the cell called a **cell wall**. These cell walls are made of a sugar called **cellulose**. Cellulose gives plant cells strength and is often the part of wood that is used to make paper products. Scientists are now researching how these tiny cellulose particles can be added to wood products to make them even stronger. They are adding them to fabrics and plastics too. This opens up whole new ways of using wood. In addition to lumber used to build houses, it can be applied to electronics, sensors, and even some medicines.

## Anatomy of Wood

Have you ever taken a close look at the trunk of a tree? You may have noticed the rough bark that covers the trunk. But have you ever looked beneath the bark?



Parts of a Tree trunk

Image Credit: USDA

If you look inside the tree you will see many different structures. Each of the structures you see has a purpose.

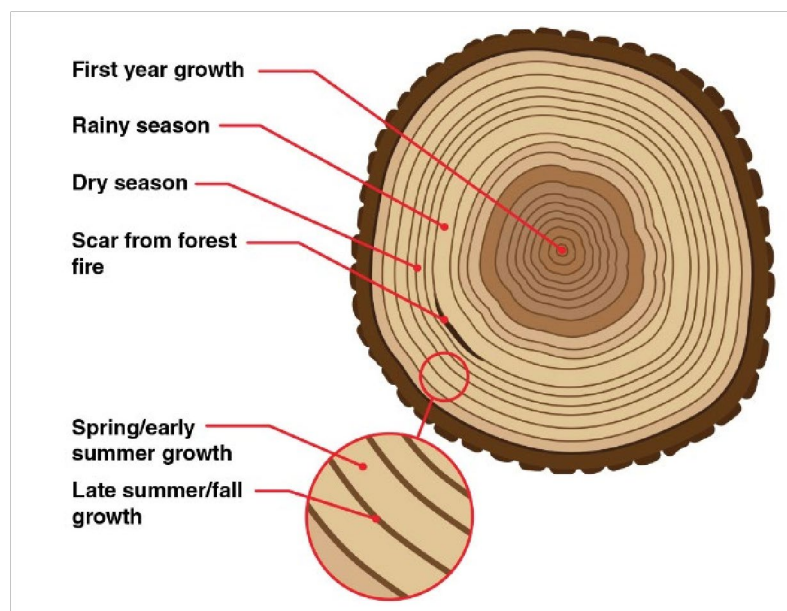
**Bark** - It has an outer layer of dead cells. It also has an inner layer of living ones that are dividing. Bark protects the tree. It works to keep insects out. It also helps to stop the inside of the trunk from drying out.

**Vascular Cambium** - This layer lies beneath the tree bark. It is responsible for making the woody tissue that forms in branches, stems, and roots.

**Sapwood** - This is the living, outermost part of the woody stem. This part of the tree is usually lighter in color and brings water up the tree and sugars down from leaves to the roots.

**Heartwood** - This is the dead, inner part of a woody stem. It makes up most of the wood seen in a cross-section and is generally darker in color.

**Growth Rings** - It looks like the wood has rings to it. Each of these rings shows one year of the tree's growth. Each ring has thin-walled cells (the paler wood) and thick-walled cells (the dark circular lines). A new layer of wood is added each year in a very thin region between the inner bark and the sapwood.



Growth Rings in a Tree

Image Credit: NASA

The rings of a tree trunk can be used to determine the age of the tree. The rings also show what the weather was like over the years the tree was growing. Trees add new rings every year. Counting them can tell you how old the tree is. The thickness of each ring tells what the weather was like. Thin rings suggest there was not a lot of water or nutrients in the soil available for the tree to grow, or that the forest was too dense for trees to grow rapidly. Thick rings show the tree had access to a lot of water and nutrients in the soil, perhaps by being spaced far apart to permit rapid growth. The rings also provide clues as to what the climate was like during the life of the tree. You can learn more about forests and climate in our lesson “Climate and the Forest.”

### Wood and Management of the Forests

There are a lot of trees in California’s forests. Trees are a valuable resource. It is important that people carefully manage the forests and their resources that come from forests. Sometimes forests have so many trees that they become unhealthy and more susceptible to wildfire. Sometimes trees are harvested from forests to help manage them. The wood from the trees that are cut down is not wasted. Some parts are left to serve as habitats for wildlife, while others help to promote soil health. The large trunks can be used for making lumber or other wood products. The smaller branches are turned into wood chips for landscaping or production of biomass energy.

Forests are also affected by fires. When forest fires happen, the flames can spread easily when trees are too close together. To try to stop the forests from being destroyed this way, forest managers take down certain trees on purpose. This process is called **forest thinning**. Managers remove dead trees that can burn very easily. They also try to thin out the forests by making more space between groups of trees. This way, should one tree catch on fire, the flames will not spread as easily to the other trees. This way of managing the forests works well to protect them. You can learn more about how fires affect forests in our lesson “Fire and California Forests.”

Forest thinning is not an excuse to cut down more trees. It serves a very important purpose in protecting the forests and their valuable resources, including wood and wildlife habitat. You can learn more about managing forests in our lesson “Healthy Forests, Healthy Planet.”

### Using Wood Can Help the Environment

Wood is used for many things. What’s amazing is that using wood can help the environment.

- **Wood is better for the environment.** Burning it releases less greenhouse gases than other sources of fuel. And, using wood instead of steel and aluminum for buildings uses less energy and produces less greenhouse gases.
- **Wood improves how energy efficient a building is.** Wood is an **insulator**. This means it traps heat. The cells that make up wood tissue have tiny pockets around them that trap heat. This keeps structures made of wood warmer during the winter months and cooler during summer months.
- **Wood is a great storer of carbon.** Wood helps to reduce the impacts of carbon in the atmosphere. Trees take carbon dioxide (a greenhouse gas) out of the air. Trees use carbon dioxide to make food for themselves. Wood is also a natural resource.
- **Using wood helps keep forests healthy.** When we properly manage forests and replant trees to replace trees that get cut down, forests remain a renewable resource.
- **New sources of wood can always be grown.** This makes using wood a sustainable and dependable source of material.
- **The removal of mature trees in timber production areas makes space for new trees to grow.** Some mature trees are kept to serve as homes for wildlife and to help protect nearby streams. This helps to stabilize the ecosystem.

## Research

### Who Owns and Manages California's Forests?

More than 30% of California's land is forested. California forests may be managed by the federal government, like Sequoia National Park, but they may also be run by the state, other public entities, or private organizations. There are many forests in California owned by Native American tribes. Some forests are even owned by individual people. Use the data or websites provided by your teacher to fill in how much of California's forests are owned by each group.

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There are several Native American tribes that own and manage California forests. Some of these include the Klamath, Yurok, Karuk, and Hoopa. The ancestors of these indigenous peoples used forests as a source of food and shelter. They would also work to manage the forests to keep them healthy. They would set fires on purpose to promote new shoots on shrubs. This also kept the forest floor clear to reduce surprise attacks from other tribes. The forests remain an important part of Native American tribal heritage and culture. Today, Native American tribes continue to manage the forests using controlled burning.

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Lastly, some of California's forests are owned by individual people. These people own the land that has the forest on it and may even choose to build their homes there. Many people use their forests for hunting, hiking, camping, and other recreational activities. Forest owners must be aware of local and state laws that say how the land can be used. Because these areas are privately owned, they are not under the same rules as those owned by large companies.

### Design Something Out of Wood

Make a list of items in your house that are made from wood or contain wood products. These can be things you use every day, or things you have seen or read about in books.

Many objects are made from wood or have been made from wood in the past. Think about the objects that you use every day. How many are made of wood or could be made from wood?

1. Choose an object. Everyday objects work best, like cups, silverware, shoes, toothbrushes, etc.
2. Draw a new design for the object where wood or wood products are used to make it.
3. Use the websites provided by your teacher to research to find out if your object was ever made of wood in the past and if anyone is trying to make your object out of wood in the present!

## Create a Food Web

The trees found in California's forests are an important part of the environment. Trees provide the wood necessary for many products used by humans and also provide shelter and food for many creatures that call California's forests home.

In order to grow, trees need energy. The primary source of all energy in an environment is the sun. Trees take in sunlight through their leaves to make sugar. This sugar is their food. This ability to make their own food using the energy from the sun makes trees **producers**. Trees also take in nutrients from the soil and soak up water with their roots to help them grow. As the tree grows taller and taller it is able to provide more wood for wood products. In addition to providing wood for harvesting, trees also provide shelter and food for the animals of the forest.

All of these living things need energy to grow and survive. Animals like deer and mice eat parts of the trees. This makes these animals **consumers**. They are specifically **primary consumers** because they are directly eating plants.

Other animals like snakes, wolves, or foxes might eat primary consumers. They are also consumers, but in this case, they are **secondary consumers**. If an owl eats a snake, the owl would be a **tertiary consumer**.

All living things eventually die and break down into nutrients found in the soil. **Decomposers** are organisms that break down dead matter. Dead matter can include dead trees, fallen leaves, and animals that have died. Decomposers help supply the soil with nutrients that help trees grow!

As one living thing eats another, energy and other matter get passed on. This passing of materials in a specific environment is called a **food web**. A forest food web relies on trees as one of its producers. Typically, energy and matter are cycled through a food web because as a living organism dies, decomposers break down the matter and supply the soil with nutrients. If a tree is harvested for its wood, usually only the stem is removed from this cycle, while the branches, leaves, and roots remain. Managing forests helps ensure that the first food web is healthy while also providing the wood necessary to make wood products.

Think about a local forest ecosystem and build a food web to represent it! First you will need to do some research on the types of trees, plants, and animals that live in California's forests. Your teacher will provide you with some websites to help you learn more.

When you are ready to begin your forest ecosystem follow these steps:

1. Get a large piece of paper and draw the sun in the upper corner. Then draw a large tree with roots in the center of the paper.
2. On the left side of the tree, draw an example of a forest food web. Include each type of consumer and decomposers in your model. Draw arrows to show how the matter and energy cycle from the Sun and through all the living organisms in the food web.
3. On the right side of the tree, draw examples of wood products that might be built using trees. Draw a single-sided arrow going from the tree to the wood products to indicate that once these products are made, the tree is removed from the food web.
4. Either on the back of your drawing or on a separate sheet of paper, write 3 to 4 sentences about how the tree fits into the forest ecosystem. In your description, include how animals, humans, and other plants might interact with the tree.

Some organisms you might include are: plants, foxes, owls, rabbits, mice, seed-eating birds, insects, spiders, toads, and snakes.

## What Did You Learn?

Answer the following questions to test your knowledge.

1. Describe one advantage of using wood over using steel as a building material.
2. Which gas do forests help to remove from the air?
  - a. Nitrogen
  - b. Carbon dioxide
  - c. Oxygen
  - d. Methane
3. Fill in the blank: The \_\_\_\_\_ is the outermost layer of the tree trunk.
4. Why is wood considered a renewable resource?
  - a. It stores a lot of energy.
  - b. It breaks down very easily.
  - c. It gets used up quickly.
  - d. It can replace itself as it is used.
5. Fill in the blank: \_\_\_\_\_ is one of the ways science is improving wood products to make them lighter and stronger at the same time.

## Apply to Real World

### Group Activity: Discussion

Your teacher will assign you to a group to work on your activity.

<sup>1</sup> <https://www.fs.usda.gov/greatestgood/press/mediakit/facts/pinchot.shtml>



## LESSON 4

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# Fire and California Forests



*This lesson can be completed in the classroom or at home. Your teacher will explain to you how to participate in assignments and group discussions if you are completing the lesson at home.*

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## Today's Topic: Fire and California Forests

### Introduction to Fire and California Forests

Watch the video, [Fire and California Forests](#), to start your exploration of how wildfires affect California forests. As you watch, think about why wildfires can be beneficial to forests. Also make note of the different ways wildfires can start and why California forests are experiencing more fires now than in previous years. Discuss with your class ways that a forest can be restored after a wildfire.

### Read and Respond

Read the passages below about wildfires, then discuss with your group what you learned. Follow your teacher's instructions about how to be part of these group discussions.

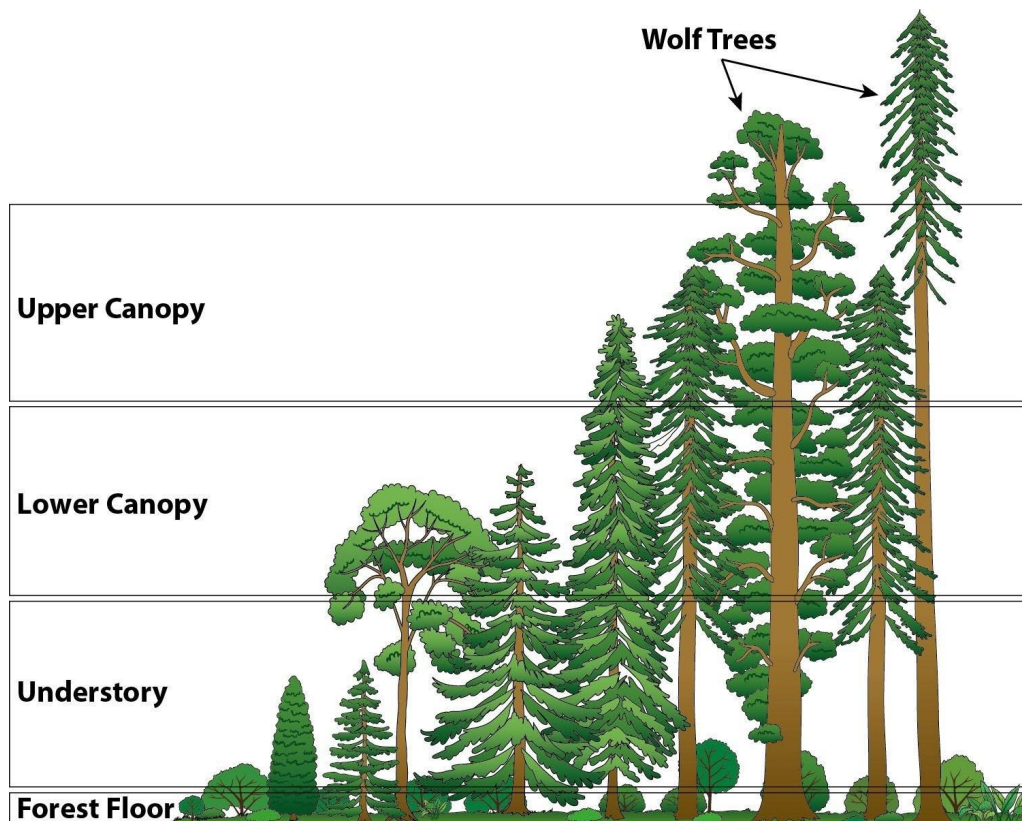
### Fires and Forests

A **wildfire** is a fire that is not planned. When a wildfire occurs in an area of forest that has been well managed, the results are normally less catastrophic than if a wildfire occurs in an area of forest that is not well managed. Fires that occur in unmanaged forests can spread faster and be much more destructive than managed forests due to the amount of fuel that remains.

Fires may not be first on your list of how to keep a forest healthy, but many plant and animal species actually depend on occasional fires to thrive. In fact, frequent, low-intensity fires are a natural part of forest management in California. **Managed burns** are fires that are purposefully set by fire experts and are carefully watched over by them so they help clear out dead matter. This dead matter makes up part of the fuel for larger fires in forests. Sometimes these fires are called controlled burns and are an important part of forest management. Managed burns are one way to prevent out-of-control or large wildfires.

Forest management is more critical today than ever before. An increasing number of **droughts**—periods of time with little to no precipitation—in California have resulted in millions of trees dying. The dead trees burn more easily and quickly than living trees, causing the fire to spread quickly. This places a much greater importance on properly managing forests, including utilizing managed fires to clear out the trees and plants that have died.

Over the past several years, drought and increasing plant diseases have affected the health of trees in California’s forests. These dead trees result in increased fuel, making forest management, including the use of fire, a critical component to maintaining healthy forests.



The Layers of the Forest

Each forest in California has layers. The **forest floor** is the lowest layer of the forest. It contains small plants and bushes. It also contains dead and decaying matter such as plants and leaves. The decaying matter makes the soil very rich, which helps new trees and plants to grow. In order for new trees to grow, they need sunlight. In densely grown forests, little sun makes it through to the forest floor.

In California forests, some trees grow higher than the rest. These trees stick out over the other trees. These trees are called the **wolf trees**. These trees are usually larger than other trees in the same area. The smaller trees are newer in the forest. The wolf trees stick out above a layer of tree tops called the **canopy**. This layer is where the tops of most of the oldest and tallest trees are found. Trees in the canopy get the most sunlight and provide shade to all the other parts of the forest.

The layer beneath the canopy is called the **understory**. Here, the tops of plants and new, younger trees can be found.

Wildfires, as well as managed fires, burn the matter on the forest floor and some of the understory. This burning clears the forest floor and makes more room for new plants to grow and live. The burning of the dead and decaying matter releases the nutrients stored in the matter. These nutrients are then returned to the soil to help trees and plants grow. Wildfires also burn parts of the canopy. This can allow more sunlight to reach the forest floor so that new trees can grow. Some trees, such as Lodgepole Pine, need fire in order to reproduce. They keep their seeds in protective pinecones sealed with a thick resin, which is like a strong glue. The seeds remain dormant while in the pinecones. **Dormant** means that the seeds are not starting to grow. It is similar to a long, deep sleep. The heat of wildfires allows the pinecones to open, releasing the seeds. Then, the seeds can grow quickly with the increased soil nutrients and sunlight.



Immature Lodgepole Pine (*Pinus contorta*) Cones

Image Credit: Art Poskanzer

Wildfires, as well as managed fires, also clear out diseased and dead trees, making room for new, healthy trees. In addition, fires remove **invasive species** from the environment. An invasive species is a plant or animal that is not native to the natural habitat of the forest. The invasive plant or animal competes with the native plants and animals for resources such as space, water, and food. Removing invasive plant species from the environment makes more room for native species to thrive.

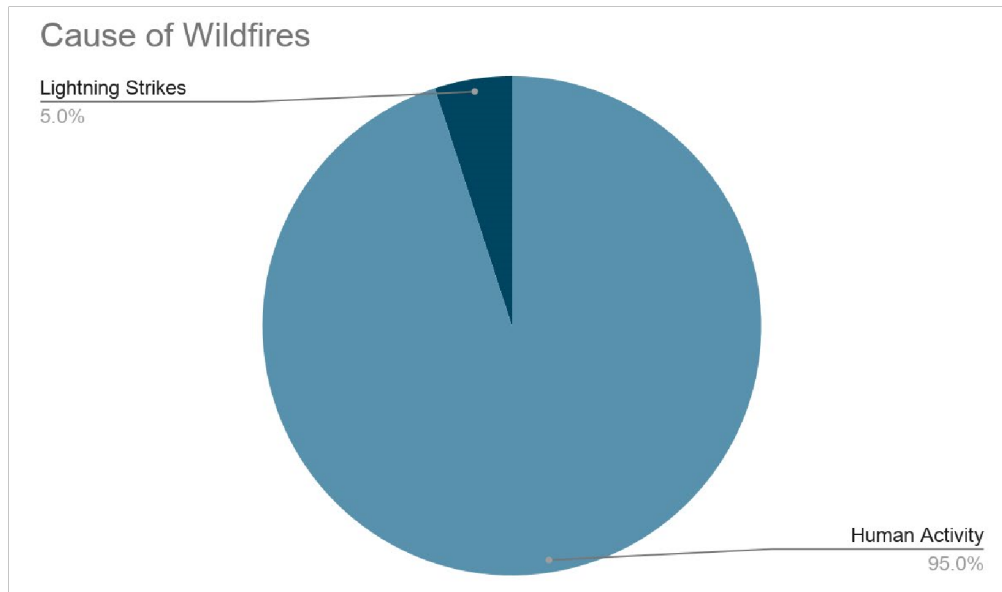
Many animals and birds that live in the forest have adapted to wildfires and survive by burrowing underground or temporarily moving to protect themselves from the fire. The new growths after the fire provide even more shelter and food for the animals.

While occasional fires keep forests healthy, the number and intensity of wildfires have greatly increased in California. More and larger areas of the forests are burning more often, which does not give the forests time to regrow.

### Humans and Wildfires

Over the past several decades, more people in California have been moving closer to or into forests or chaparral. The increase in human population in forested areas increases the likelihood of fires. For example, a spark from a power tool can lead to a wildfire if the spark lands on dry matter of the forest floor. A campfire that is not properly put out can also cause a wildfire. About 95% of all California wildfires are caused by humans, with just 5% starting from

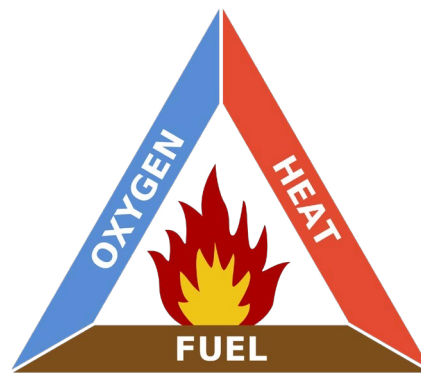
lightning strikes. Other examples of fires started in communities are powerline failures, debris burning, and arson.



Graph of Causes of Wildfires in CA<sup>1</sup>

### Fire Triangle

The **fire triangle** is made up of the three components that allow a fire to burn: fuel, oxygen, and heat.



The Fire Triangle  
Image Credit: Gustavb

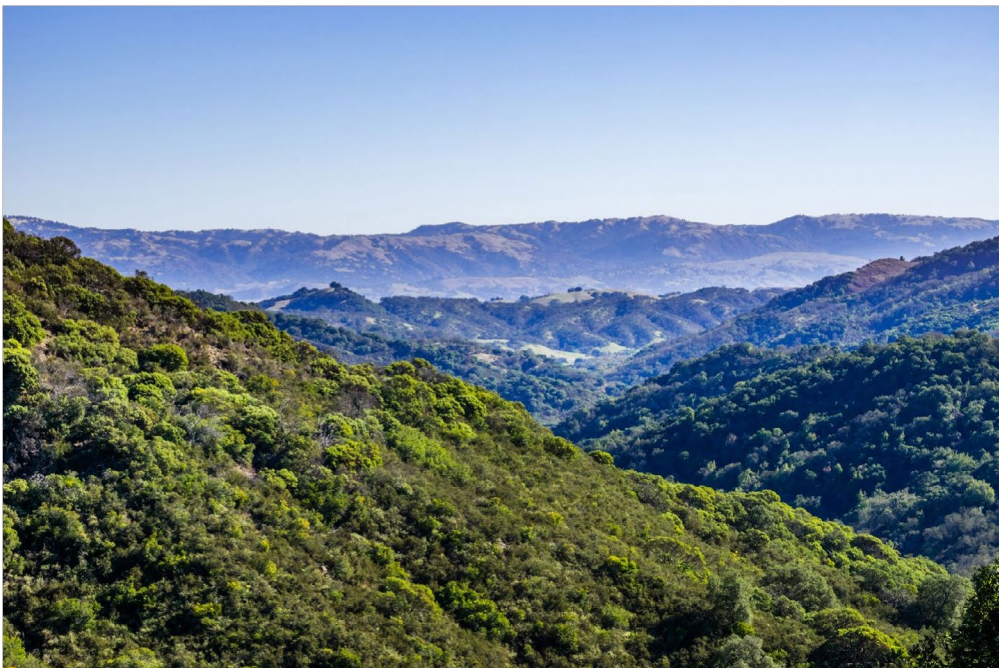
Fire needs **fuel** to burn just like a car needs fuel to drive. The fuel usually consists of dry material such as dead leaves or brush. Drought conditions—periods with very little rain—in California have greatly increased the amount of dry and dead plants in each layer of the forest, increasing

<sup>1</sup> <https://www.pbs.org/newshour/science/californias-catastrophic-wildfires-in-3-charts>

the amount of fuel that is available. The smallest spark can grow very quickly when there is enough fuel. One spark that lands on a dry leaf can spread to another and then another. This is called a **chain reaction**. When conditions are exceptionally windy or hot, the chain reaction speeds up and the fire spreads faster.

In addition to fuel, fire needs enough **heat** to be able to **ignite** the fuel and start a fire. Fires also require **oxygen** to keep burning. Fuel, heat, and oxygen all have to be in balance for a fire to occur. If any one of those factors were removed, the fire would be extinguished. And if any of those factors were to increase, the spread of fire could increase as well. Dry conditions and warm temperatures in California are among the reasons that wildfires are increasing. Fuel is the part of the fire triangle that is easiest for humans to change in order to reduce the negative impacts associated with wildfires. Most fires in Southern California are in **chaparral**, which burn naturally every few decades.

Chaparral is a thicket of brush-like plants that are typically less than 2 meters tall and can include bushes and short trees. Urbanization into chaparral areas has increased the number of wildfires.



Chaparral

With the population spreading into forest areas, there is an increase in both sparks and fuels. The houses and other buildings being built in the forest are also considered to be fuel.

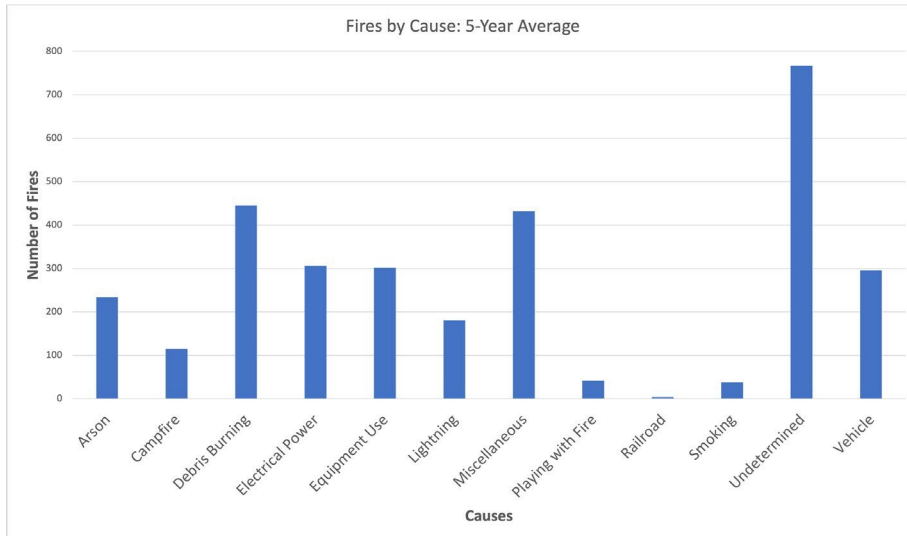


Smoke from a Wildfire Blocking Out the Sun

Image Credit: Sara Giles, USFWS

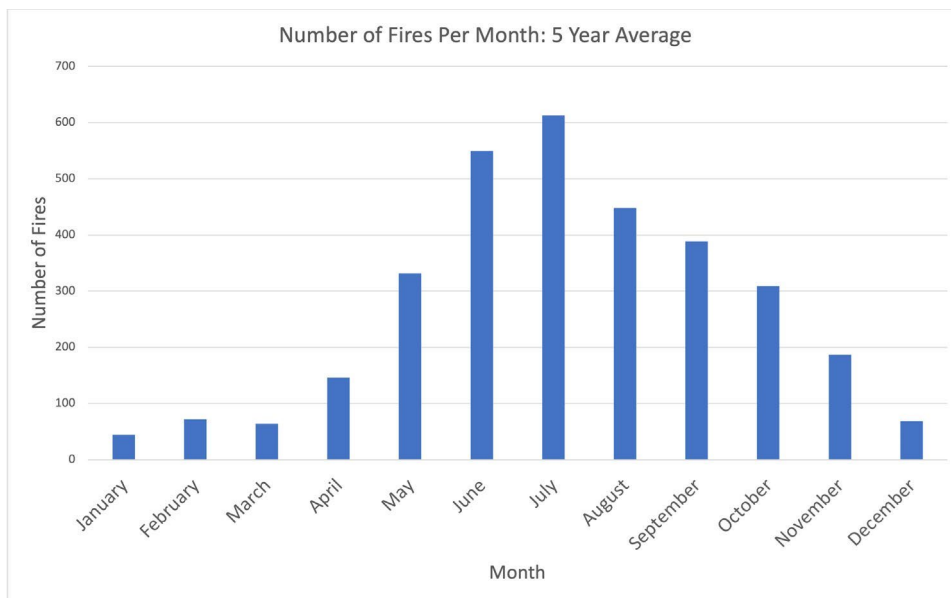
### Looking at trends

As of spring 2021, 17 of the 20 largest wildfires have occurred since the year 2000. Six of those fires occurred in 2020 alone. The typical causes of recent wildfires were related to human activity. The charts below show the average number of fires during a 5-year period based on the causes, month, and area burned, as well as the total acreage burned per year between 2009 and 2019.



This graph shows the 5-year average (2014–2019) of causes of wildfires in California.

Data source: <https://www.fire.ca.gov/stats-events/>

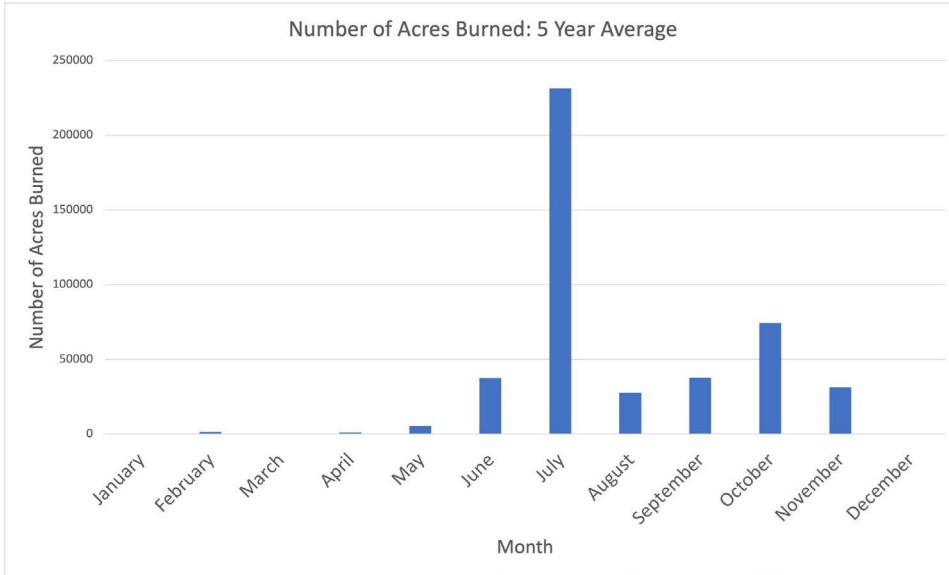


This graph shows the 5-year average (2014–2019) of the number of wildfires per month in California.

Temperatures in California have been increasing over the last several decades. The increasing temperatures also lead to an increase in drought. The fire season typically peaks during the summer and early fall, but the season has been growing longer. Dry conditions plus the increase in population in California’s forested areas have increased the number and severity of fires.

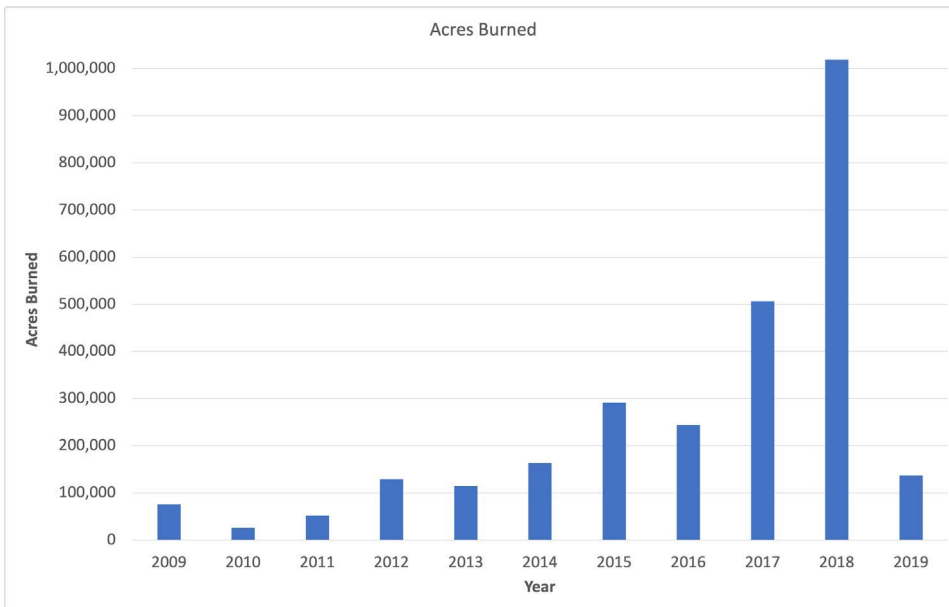
Data Source: <https://www.fire.ca.gov/stats-events/>





This graph shows the 5-year average (2014–2019) of acres burned per month in California.

Data Source: <https://www.fire.ca.gov/stats-events/>



This graph shows the total acres of land burned per year in California.

Data Source: <https://www.fire.ca.gov/stats-events/>

## Fire Management

When wildfires begin, the first thought is to put them out or suppress them. **Suppression** means to contain the fires to a particular area so they will not spread and then will eventually be put out. Suppression methods use a number of tools such as water, fire retardant, and fuel breaks. All of these methods remove one part of the fire triangle. Water and fire retardant are sometimes dropped from helicopters or small airplanes, which can remove heat and oxygen from fires. **Fire retardant** is made primarily of water, some fertilizer, and a small percentage of chemicals. Fire breaks are created on the ground by hand and machines to remove fuel so that the fire will not spread. Fire suppression methods are expensive and require a lot of work. However, they are sometimes necessary. When forests are proactively managed, less fire suppression methods are required.



An Airplane Dropping Fire Retardant on a Southern California Wildfire

Image Credit: Staff Sgt. Daryl McKamey, U.S. Air Force

In addition to trying to suppress wildfires when they are already burning, steps can be taken to try to prevent the growing number of catastrophic wildfires in California. This is what is called **fire management**. As you saw before, occasional wildfires keep forests healthy. One of the best ways is by doing prescribed burns.

**Prescribed burns**, also called **controlled** burns, allow the built-up matter on the forest floor to burn and promote new growth. Prescribed burns are very carefully planned before they are

carried out, including waiting for the right weather conditions. These types of fires can clear out the forest floor so that there is little to no dry material left to act as fuel for larger wildfires.

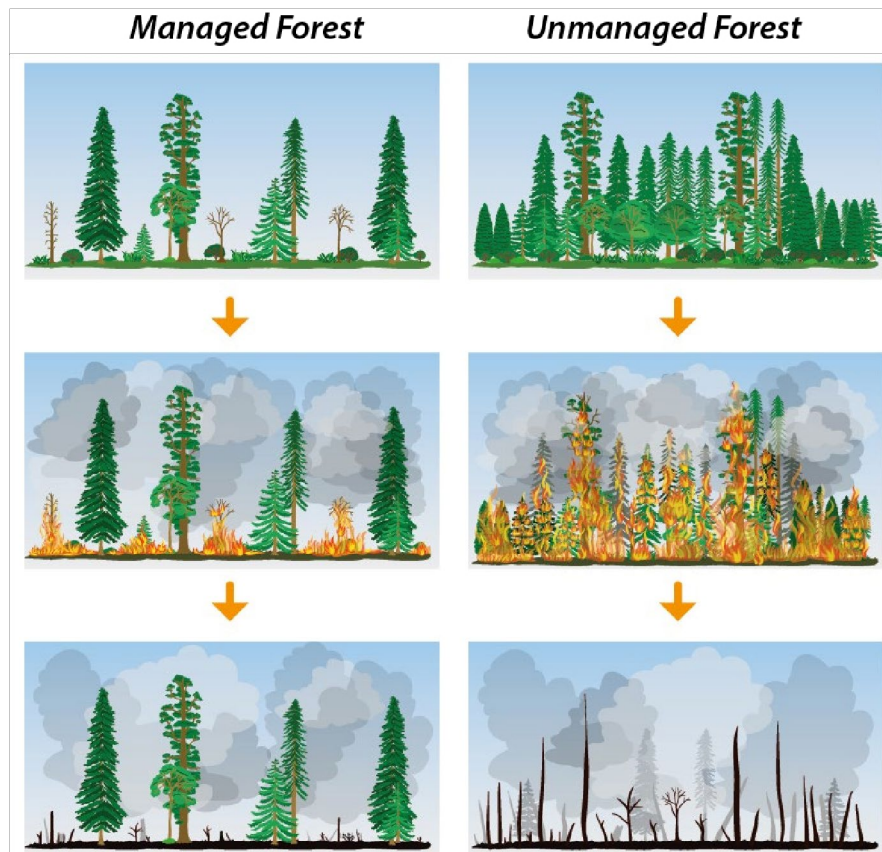


A Prescribed Burn in California

Image Credit: Pacific Southwest Forest Service, USDA

Prescribed burns are also done to create a border around an active wildfire to prevent it from spreading. This is called **backburning**. As the wildfires move closer to the backburned area, the fuel runs out and the fire dies out.

Another way to help control wildfires is by **thinning** out trees. This involves removing dead and diseased trees to leave gaps in between. Sometimes healthy trees are also removed. The oldest trees and the diversity of trees and plants are prioritized so that they are protected when a wildfire moves through. The larger gaps between the trees make it more difficult for the fires to spread from tree to tree.



Wildfire in a Managed Forest Versus Unmanaged Forest

Thinning the forest also creates breaks in **ladder fuels**. Like the steps of a ladder, fire spreads from the forest floor, up to the understory layer, to the canopy (where most of the oldest and tallest trees are), and then to the wolf trees (the tallest trees that stick through the top of the canopy). When the steps in the ladder are broken or moved further apart, the spread of fire slows and the older trees and diversity of the forest is protected.

### Restoration After a Wildfire

After a wildfire, it is important to begin restoration efforts. Even though some trees such as *Pinus contorta* release seeds with the heat of the fire, they and other species sometimes need help to grow quickly.

Wildfires do more than burn trees, bushes, and the matter that is on the forest floor. The ash and debris typically contaminate the water supply, which can impact the regrowth of plants and trees in the forest. The topsoil can also be burned and damaged, which can block the nutrients or water in the soil from reaching plants. And the root system that once held the soil in place is severely weakened, which can lead to dangerous floods and mudslides.

Reseeding quick-growing native plants such as grasses and small plants allow the forest to begin healing as the new trees take time to grow. Continued efforts can also discourage invasive plant species from moving in and competing for the limited resources such as water, nutrients, and space.



A Forest Regrowing After a Wildfire

Image Credit: Hannu

Scientists help determine the types of trees and plants that should be replanted after a wildfire. They begin by looking at the amount of fire damage to the soil, water supply, plants, and trees. They also take into account ladder fuels and the fire triangle to figure out how to best regrow the forest while lowering the chances of another catastrophic wildfire.

## Research

### Who Owns and Manages California's Forests?

More than 30% of California's land is forested. California forests may be managed by the federal government, like Sequoia National Park, but they may also be run by the state, other public entities, or private organizations. There are many forests in California owned by Native American tribes. Some forests are even owned by individual people. Use the data or websites provided by your teacher to fill in how much of California's forests are owned by each group.

- \_\_\_\_\_ % of California forests are national forests.
- \_\_\_\_\_ % of California forests belong to the State of California.
- \_\_\_\_\_ % of California forests belong to Native American Tribes.
- \_\_\_\_\_ % of California forests belong to industry (businesses).
- \_\_\_\_\_ % of California forests belong to individual people.

National forests belong to everyone—including you! People most often use these areas for recreational activities. Hunting, hiking, fishing, and camping are all activities that people can enjoy in national forests. One-third of the national forests are designated as timberland available for harvesting. Harvesting can improve the health and resiliency of our watersheds. We remove some trees so the ones we leave can thrive. The types and number of trees that can be removed at one time is something that is controlled by the federal government. National forests are managed by the laws and practices set by Congress to “provide the greatest good, for the greatest number (of people), for the long run.”<sup>1</sup>

California state-owned forests belong to the State of California. As with national forests, the state uses its forests to provide recreational activities like hunting, hiking, bird watching, camping, fishing, and canoeing. Harvesting can also happen in state-owned forests.

There are several Native American tribes that own and manage California forests. Some of these include the Klamath, Yurok, Karuk, and Hoopa. The ancestors of these indigenous peoples used forests as a source of food and shelter. They would also work to manage the forests to keep them healthy. They would set fires on purpose to promote new shoots on shrubs. This also kept the forest floor clear to reduce surprise attacks from other tribes. The forests remain an important part of Native American tribal heritage and culture. Today, Native American tribes continue to manage the forests using controlled burning.

Some California forests are owned by large companies. The management of these areas is up to the company. Most of the time, management of the forests is done by the owner or a board of directors. A board of directors is a group of people who help make decisions for a company. The company still has to follow rules about how they can use a forest. The California State Board of Forestry sets the rules. These rules state that companies using their forests must have a plan to make sure they do not overuse the forest resources. There are other groups that decide whether or not companies are using their forests responsibly. Companies that own forests usually manage their land for wood products, habitat conservation, water quality, and other activities.

Lastly, some of California’s forests are owned by individual people. These people own the land that has the forest on it and may even choose to build their homes there. Many people use

their forests for hunting, hiking, camping, and other recreational activities. Forest owners must be aware of local and state laws that say how the land can be used. Because these areas are privately owned, they are not under the same rules as those owned by large companies.

### Fighting Fire with Fire

Wildfires can be beneficial and catastrophic for forests, but there are many ways that potentially catastrophic fires can be fought with fire. Prescribed burns are often used to help control larger fires and to help maintain the forest. Learn more about prescribed fires by watching [“The Story of Prescribed Fire - A Vital Part of Western Landscapes”](#) by the US Forest Service.

As you watch the video, consider the following questions:

- What is the purpose of prescribed fires?
- How has the landscape of the forest ecosystem changed due to fire?
- How did the forest service show that prescribed fires are beneficial to fighting wildfires?
- How are prescribed fires used to keep forests healthy?

Next, use the websites provided by your teacher to research more about the role of prescribed burns in managing California’s forests.

Take the ideas from the discussions and what you learned in research to write a letter to your local and state government officials about why prescribed burns are important in protecting California forests and can help reduce the overall cost and damage from large, quick-spreading wildfires. Be sure to include details from your research to convince the government officials why taking steps to keep forests healthy is vital not only to the forest itself, but to the spread of catastrophic wildfires.

## Fire and California Forests Word Scramble

Complete the sentences by unscrambling the underlined vocabulary terms.

1. The lowest layer of the forest is called the \_\_\_\_\_.  
Vocabulary term: FSROTE ORFLO
2. Almost all major wildfires are due to \_\_\_\_\_.  
Vocabulary term: AHMNU SCEAUS
3. Together, oxygen, heat, and fuel make up the \_\_\_\_\_.  
Vocabulary term: IFER NRITGLEA
4. \_\_\_\_\_ means to smother a wildfire.  
Vocabulary term: PRSUSNOEPIS
5. Firefighters may perform a \_\_\_\_\_ near the perimeter of a fire to prevent it from spreading.  
Vocabulary term: KNRBBUAC
6. Thinning the understory and forest floor provides a break in \_\_\_\_\_.  
Vocabulary term: LRDDAE UELFS
7. \_\_\_\_\_ help manage a forest by removing the dead and decaying matter on the forest floor.  
Vocabulary term: PRCESIEDBR BSUNR

## What Did You Learn?

Answer the following questions to test your knowledge.

1. Which statement explains why wildfires are generally harmful to the forest and human society?
  - a. Wildfires spread quickly and can destroy everything in their paths.
  - b. Wildfires remove dried matter on the forest floor and put nutrients back in the soil.
  - c. Wildfires burn faster in forests with young trees and slower in forests with old trees.
  - d. Wildfires remove the native trees, making room for invasive species to thrive.



2. Fill in the blanks. Wildfires can be reduced in severity by using the \_\_\_\_\_ method to clear away the dead and dry matter and by \_\_\_\_\_ out the forest by removing dead and diseased trees.
3. How can making a break in ladder fuels help preserve older trees during a wildfire?
- \_\_\_\_\_
- \_\_\_\_\_
4. Which statement(s) about fire suppression are true? Select all that apply.
- a. Suppression is used for slowing quickly moving fires.
  - b. Suppression tools include creating fire breaks and dropping fire retardant.
  - c. Suppression tools are always used from helicopters or small airplanes.
  - d. Suppression removes one part of the fire triangle to put out the fire.
5. The top cause of wildfires in California is:
- a. Lightning
  - b. Drought
  - c. Humans
  - d. Climate

## Apply to Real World

### Group Activity: Discussion

Your teacher will assign you to a group to work on your activity.

<sup>1</sup> <https://www.fs.usda.gov/greatestgood/press/mediakit/facts/pinchot.shtml>

## LESSON 5

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# Climate and the Forest



*This lesson can be completed in the classroom or at home. Your teacher will explain to you how to participate in assignments and group discussions if you are completing the lesson at home.*

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## Today's Topic: Climate and the Forest

### Introduction to Climate and the Forest

Watch the video, [Climate and the Forest](#), to start your exploration of how forests are connected to California's climate. As you watch, note the different aspects of climate and how the forest fits into climate conditions. Also, make note of how the forests are affected by the climate. Discuss with your class how the different spheres (atmosphere, biosphere, geosphere, and hydrosphere) interact with forests.

### Read and Respond

Read the passages below about climate and the forest, then discuss with your group what you learned. Follow your teacher's instructions about how to be part of these group discussions.

### What Is Climate?

Some areas of California are warmer while some are colder. Some are wetter and some are drier. **Climate** describes the typical weather conditions of an area. Coastal climates typically have mild winters, while higher-up mountain climates have cold and snowy winters. Summers in the deserts are hot and dry, while in a temperate forest summers are typically warm and humid.

Climate is different from **weather**. Weather explains the changing day-to-day conditions, such as being rainy and cold one day and sunny and warm the next.

There are many reasons why forests affect the climate. There are also many ways that the climate can affect forests. Forests also influence the climate in their local areas.

### Water and Climate

Forested areas are typically cooler than non-forested areas in the summer. Not only do trees provide shade, but they also release water through their leaves. This process of releasing water through leaves is called **transpiration**. Transpiration has a cooling effect on the surrounding atmosphere.

In winters and typically cooler climates, trees can actually warm their surroundings. Forests have a low **albedo**, which means that they can absorb more heat from the sun. Snow is white and has a high albedo. This means that it reflects most of the heat from the sun back into the atmosphere. Trees are darker colors and absorb a lot more heat than snow. Transpiration also increases the amount of water vapor in the air. The amount of water in the air is called **humidity**. When the humidity of an area is high that means it has higher amounts of water vapor. Water vapor in the air helps to hold heat in the atmosphere.

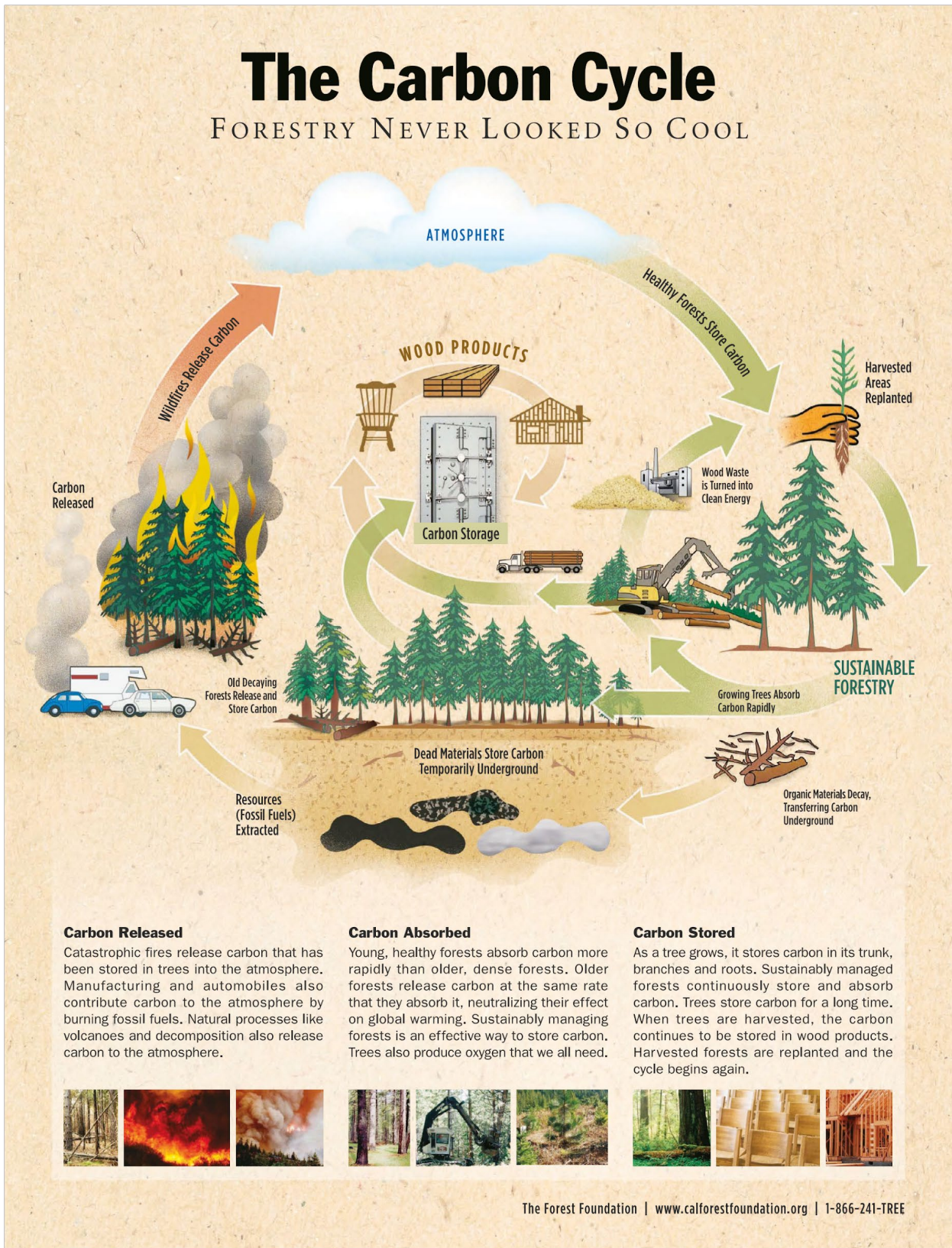
### Carbon and Forests

The amount of carbon in the atmosphere has an enormous effect on climate. More carbon in the atmosphere means that more heat from the sun is held onto in the atmosphere, warming it and the surface. Less carbon in the atmosphere means that more heat is able to escape Earth's atmosphere and be released into space, keeping the climate cooler.

Forests are a major part of the carbon cycle on Earth. Like water, carbon cycles through the atmosphere, everything on land, and underneath the surface. Trees take in, or **sequester**, carbon from the atmosphere in the form of carbon dioxide to make food for themselves. The carbon is then released back into the atmosphere when the trees are decaying, dead, harvested, or burned.

# The Carbon Cycle

## FORESTRY NEVER LOOKED SO COOL



The Forest Foundation | [www.calforestfoundation.org](http://www.calforestfoundation.org) | 1-866-241-TREE

### The Carbon Cycle

Image Credit: California Forest Foundation

Large, healthy forests can sequester large amounts of carbon dioxide from the atmosphere. The trees store the carbon and release oxygen back into the atmosphere. The carbon storage of trees is called a **carbon sink**. Trees store the carbon in their trunks, roots, branches, and leaves. About half of the total weight of a tree is carbon. But not all trees take in and store carbon at an equal rate.

Older trees are able to hold much more carbon than younger trees. In fact, the redwood forests in northern California are one of the top forests in the world for carbon storage. The trees are some of the tallest in the world, growing more than 100 meters tall, and can live for around 3,000 years. This makes them able to sequester and store a great deal of carbon over their lifetimes.

The ages and distribution of the trees in the forest are very important. Older trees absorb and store a greater amount of carbon, and younger trees absorb carbon at a faster rate. This difference in old and young trees means there needs to be a balance of both in a forest. Thinning a forest helps foresters manage the oldest, largest trees while also planting new trees in cleared areas. Well-managed forests with a combination of old, tall trees and young, small trees are able to sequester more carbon than an unmanaged forest that is all the same age.

Forests of younger trees that are more densely planted together can take in carbon at a high rate. The young trees are much smaller than the older trees, and it takes about 250 young trees to equal a single, older redwood tree. As the trees continue to grow in tight spaces, the competition for sunlight, water, and space causes some of the trees to die, releasing carbon back into the environment. Some of the carbon is released back into the atmosphere and some is stored underground as fossil fuels.

When fossil fuels are extracted from the ground and wood from trees is burned, carbon is released into the atmosphere. Forests are able to absorb the carbon from the atmosphere in a continuing cycle.

Carbon can also be stored in wood products, such as structures for buildings, furniture, and even paper. The carbon remains in the wood until that product decays or is burned. Then, the carbon reenters the atmosphere. As you can see, carbon cycles continuously!

## Climate Variations

Climates can vary and change. Sometimes climates change over many years, but it is possible for short-term changes to occur too! Changes in the climate can alter a forest.

**Drought** causes less water resources to be available for trees. A drought happens when there is a long period of time with little to no rainfall. If trees do not have enough water they can start to die at a faster rate. With less water available, it is also less likely that new trees will start to grow. As trees die, more carbon gets released back into the environment. This can cause the climate to continue to warm and cause the drought to continue, killing more trees. Drought can also lead to an increase in wildfires. This can kill even more trees and release even more carbon back into the environment.

Rainy conditions make for less competition for water between trees. This allows more trees to grow and the forest to spread. But too much water can cause soil erosion, especially in areas where the trees are young and their roots have not spread as much as older trees. This can cause trees and other plants that do not yet have strong roots to be washed away. An increase of water can also cause more **invasive species** to come into the environment. An invasive species is a plant or animal that is not native to the natural habitat of the forest. The invasive plants or animals compete with the native plants and animals for resources such as space, water, and food.

Healthy forests are more able to keep up and adapt to changing climate conditions than unhealthy forests. Trees help the climate of an area. For example, the natural cooling or warming properties of forests can help slow changing climate conditions. Trees even have built-in mechanisms for conserving water during periods of drought that limit the amount of water they transpire.

## Earth's Spheres

Earth is made up of four spheres: the **atmosphere**, **biosphere**, **geosphere**, and **hydrosphere**. Each of these spheres works together in all aspects of nature:

- The atmosphere contains all of the air that envelopes the planet.
- The biosphere contains all living things—every single type of plant and animal.
- The geosphere contains all rocky material above and beneath the surface.
- The hydrosphere contains all water on Earth—solid, liquid, and gas.



Redwood Forest with Fog Between the Trees

Image Credit: Michael Schweppe

In the image of a redwood forest in California, all four spheres can be seen. The trees are part of the biosphere. So are all of the other plants along the forest floor. The soil on the ground is part of the geosphere. The fog drifting through the trees is made of tiny water particles and is part of the hydrosphere. The atmosphere, which is invisible to our eyes, surrounds the trees and carries the fog with it.

All of Earth's spheres interact and balance each other to keep forests healthy. And healthy forests balance the carbon cycle and the climate.

## Research

### Who Owns and Manages California's Forests?

More than 30% of California's land is forested. California forests may be managed by the federal government, like Sequoia National Park, but they may also be run by the state, other public entities, or private organizations. There are many forests in California owned by Native American tribes. Some forests are even owned by individual people. Use the data or websites provided by your teacher to fill in how much of California's forests are owned by each group.

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## California Forests and Earth's Spheres

Forests are a major part of all of Earth's spheres. The balance of the atmosphere, biosphere, geosphere, and hydrosphere is very important to the overall health of the forest. Use websites and/or books recommended by your teacher, such as [CalFire Forest Health](#), to find out the role each sphere plays in California forests.

- The role of the atmosphere in a forest is:
- The role of the biosphere in a forest is:
- The role of the geosphere in a forest is:
- The role of the hydrosphere in a forest is:

Each of the spheres does not exist on its own in a forest. All spheres are linked together and changes in one sphere can affect all of the other spheres. Using the resources provided by your teacher, write down at least two ways that each of the spheres interact with each other in California's forests.

### Atmosphere/Biosphere Interactions

- 1.
- 2.

### Atmosphere/Geosphere Interactions

- 1.
- 2.

### Atmosphere/Hydrosphere Interactions

- 1.
- 2.

### Biosphere/Geosphere Interactions

- 1.
- 2.

### Geosphere/Hydrosphere Interactions

- 1.
- 2.

## Make a Poster of Earth's Spheres

Next, use the interactions that you thought of in the research portion of the lesson to draw a picture or a poster modeling how all of Earth's spheres interact in California's forests. For example, you might include fog, a rain storm, plants and animals, etc. Use arrows and keywords in your drawing to describe parts of each sphere and the interactions between the spheres.

After completing your model (drawing or poster), display it. Then view all the posters created by your classmates. Discuss the similarities and differences between your model and the models of your classmates.

## What Did You Learn?

Answer the following questions to test your knowledge.

1. What kind of forest stores the most carbon over longer periods of time?
  - a. A forest that is primarily made of old trees
  - b. A forest that is primarily made of young trees
  - c. A forest that is a combination of young and old trees
  - d. A forest that is very densely packed with any type of tree
2. Which phrase describes climate?
  - a. Day-to-day conditions of an area
  - b. Changing of conditions in an area
  - c. Typical conditions of an area
  - d. Extreme conditions of an area
3. How can forests affect the climate? Select all that apply.
  - a. Carbon sequestration
  - b. Transpiration
  - c. High albedo
  - d. Underground water

4. Write two examples of each sphere found in a forest environment.

Atmosphere \_\_\_\_\_

Biosphere \_\_\_\_\_

Geosphere \_\_\_\_\_

Hydrosphere \_\_\_\_\_

5. What is described in the carbon cycle?

- a. Storage of carbon in forests
- b. Flow of carbon throughout the atmosphere
- c. Amount of carbon trees can absorb
- d. Movement of carbon through the spheres

## Apply to Real World

### Group Activity: Discussion

Your teacher will assign you to a group to work on your activity.

<sup>1</sup> <https://www.fs.usda.gov/greatestgood/press/mediakit/facts/pinchot.shtml>