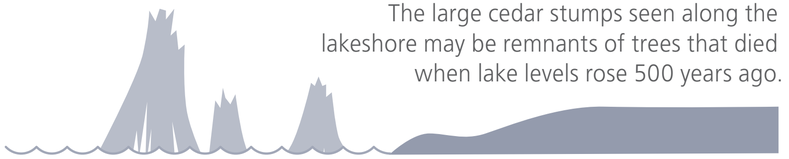
Geology and Lake Formation



Old Cedar Stumps

The large cedar stumps seen along the lakeshore may be remnants of trees that died when lake levels rose 500 years ago.

Merrill Lake is likely a relatively young lake. Geologists believe that Merrill Lake was created about 1,900 years ago by lava flowing from the southwest flanks of Mount St. Helens and along the Kalama River Valley. This event, called the Cave Basalt Flow, blocked a small drainage that fed the Kalama River, backing up a stream and creating Merrill Lake. The Cave Basalt Flow also created lava tubes, such as the well-known Ape Caves in Mount St. Helens National Volcanic Monument.

WATER FLOW

As fall and winter rains fill up the lake, water drains out the north end through lava tubes that flow to the Kalama River. As water levels drop, areas of sand and mud are exposed along the lake edge, giving the lake the appearance of a man-made reservoir.

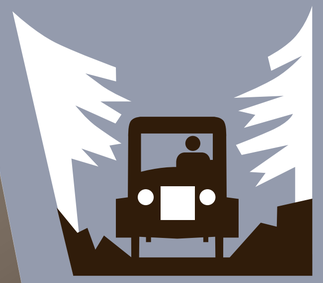
PAST GROWTH

Merrill Lake may have grown in size during the Kalama eruptive period that began in 1479 and continued for as long as 200 years. Sediments deposited during and after these eruptions probably clogged some of the lake's outflow.

GEOLOGY ILLUSTRATION BY ALEX STEELY, DEPARTMENT OF NATURAL RESOURCES, GEOLOGY AND EARTH RESOURCES DIVISION

Merrill Lake's Modern History

Current-day Merrill Lake was previously known as "*Trout Lake*" or "*Lake Merrill.*" Post-settlement visitors travelled to the lake with pack mules or horses until a rough road was built in the mid 1930s, which allowed tourists access by automobile. Even prior to road construction, rustic cabins sprang up around the lake, used by vacationers during the spring and summer months. A small camp store carried food and fishing tackle. These cabins were removed during the late 1960s.



▲ One of the first vehicles to make the trip to Merrill Lake was a Model T Ford that had its axles shortened to fit between the large trees along the trail.

LOGGING ▶

Most of the area around Merrill Lake has been logged once or twice. Some of the remaining old-growth trees show signs of this, such as the cable scarring near their bases.

If you look around this sign, you can see a scattering of old, high stumps with characteristic notches from the metal-tipped springboards loggers stood on as they cut the massive trees.

TODAY

Currently, the Department of Natural Resources manages this area for recreation and conservation. The Merrill Lake Campground was installed in 1967, and then restored after the floods of 1996.

SPRINGBOARD USED IN EARLY 1900s LOGGING

ILLUSTRATIONS BY LUIS PRADO / DNR

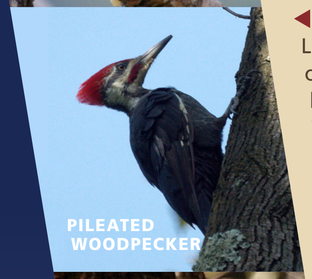
Birds of Merrill Lake

Birds are critical elements of ecosystems. They help control insect and small mammal populations, pollinate flowers and help disperse seeds. They are a vital part of complicated food webs.

FUEL FOR A JOURNEY

Merrill Lake provides nesting habitat for a number of Neotropical migratory birds including osprey, western tanager, and Vaux's swift. These birds spend the spring and summer here to nest and raise young, then return to the neotropics (Central, South America) for the winter. These migrants fly several thousand miles to and from their wintering grounds every year

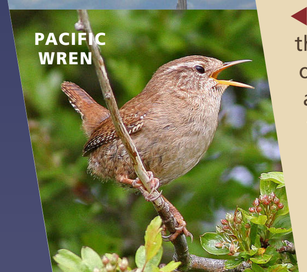
◀ It may take extra effort to find this spectacular, tropical-looking bird that tends to stay high up in the forest canopy. Western tanagers eat insects and fruit and build a shallow nest of twigs, grass, bark strips and hair. They winter in Central America.



◀ A year-round resident at Merrill Lake, pileated woodpeckers search for carpenter ants by making large rectangular holes in dead standing trees (snags). They excavate nest cavities which are later used by bufflehead, bats, American marten, northern flying squirrel and the tiny northern pygmy-owl.

◀ These robin-sized owls are one of the few owls you might see or hear during daytime. Listen for their high-pitched "toot" calls. Pygmy-owls feed on other forest birds, sometimes larger than themselves.

◀ These small birds nest in hollowed out dead trees, building nests with twigs plucked from branches as they fly past. They feed on spiders or flying insects. While similar to swallows, Vaux's swift is more closely related to hummingbirds. Listen for their rapid, high pitched "chips."



◀ Common in western forests, this tiny bird has a loud voice and one of the most highly complex songs of any North American bird. Listen for the Pacific wren's long stream of high pitched notes and trills that can last up to 10 seconds.

Osprey. These birds nest in tall, standing, dead trees and feed almost exclusively on fish. After catching one, they carry it headfirst to reduce wind resistance. Another common name for the osprey is "seahawk."

PHOTOS (CLOCKWISE FROM TOP RIGHT): OSPREY BY JOHN JAMES AUDUBON, PACIFIC WREN BY RON KNIGHT; VAUX'S SWIFT BY RICHARD CROSSLEY; NORTHERN PYGMY OWL BY DOMINIC SHERONY; PILEATED WOODPECKER BY MIKE'S BIRDS; WESTERN TANAGER BY KATI FLEMING.

Amphibians of Merrill Lake

▶ Western red-backed salamander.
Found west of the Cascade Range, this terrestrial amphibian spends much of its life under rotting logs and rocks. Its home range is typically smaller than 35 square feet.

Amphibians play an important role in nature as both predator and prey. Sadly, nearly 32 percent of known amphibians species are threatened with extinction.

THE AMPHIBIAN DECLINE

With complex reproductive needs and permeable skin, amphibians are often excellent indicators of ecosystem health. In recent decades, worldwide populations have declined dramatically. This has been attributed to habitat loss, invasive species, climate change, endocrine-disrupting pollutants, the fungal infection chytridiomycosis, and the destruction of the earth's ozone layer.

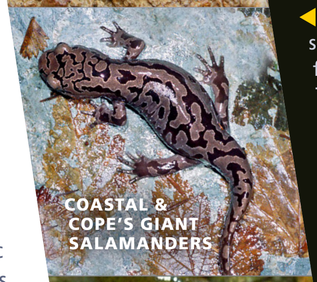
The invasive American bullfrog is native to the eastern US and Canada. It is a fierce competitor and predator of other amphibians and has contributed directly to the dramatic decline of native amphibians locally and abroad.

◀ Pacific chorus frog with parasite-induced limb malformation.

◀ Found in the Cascade Mountains between Mount St. Helens and central Oregon, this species inhabits the edges of streams and lives under rocks and gravel. Juveniles are entirely aquatic, while adults can be found under rocks, logs, and in the wet areas along streams.

◀ This disappearing species was formerly found over much of the state ,except the lowland Columbia basin in Eastern Washington. Their eggs are laid in shallow, still water where the tadpoles rear. The species is mostly terrestrial and males have no vocal sac, but they do produce a chirping sound.

◀ Resident of lakes, ponds and marshes, this frog migrates 0.5–2.0 miles between their spring breeding and summer ranges. It can live up to 15 years.



◀ Two of the largest terrestrial salamanders in North America, ranging from 8" (Cope's) to 14" (coastal), shown. The aquatic larvae and juveniles live in cold clear streams. Juveniles have bushy gills that are lost as they transform into adults and become terrestrial.

◀ Found in turbulent, higher elevation streams. Tadpoles use their sucker-like mouths to cling to rocks and feed on algae. While most frogs fertilize their eggs externally, tailed frog males use their unique, tail-like appendage to fertilize the female's eggs internally. It is thought to be one of the longest living frogs on the planet.

▼ ROUGH SKINNED NEWT
Found near ponds with its bright orange underbelly, it contains a powerful neurotoxin similar to that found in puffer fish. In humans, the reaction to the toxin can be severe or even fatal if swallowed. The common garter snake is thought to be the only predator of this newt since it has co-evolved to resist the toxin.

PHOTOS (CLOCKWISE FROM TOP LEFT): CASCADE TORRENT, AND WESTERN RED-BACKED SALAMANDERS BY GARY NAFIS; ROUGH SKINNED NEWT BY THE HIGH FIN SPERM WHALE; TAILED FROG, AND COASTAL COPE'S GIANT SALAMANDER BY GARY NAFIS; PACIFIC CHORUS FROG BY BRETT A. GOODMAN; PETER G. JOHNSON; NORTHERN RED-LEGGED FROG BY CARLO ABBALSEZE / DNR; WESTERN TOAD BY WALTER SIEGMUND

MERRILL LAKE NATURAL RESOURCES CONSERVATION AREA

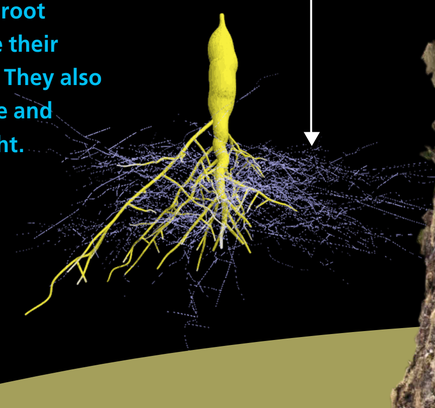
Fungi and Decomposition

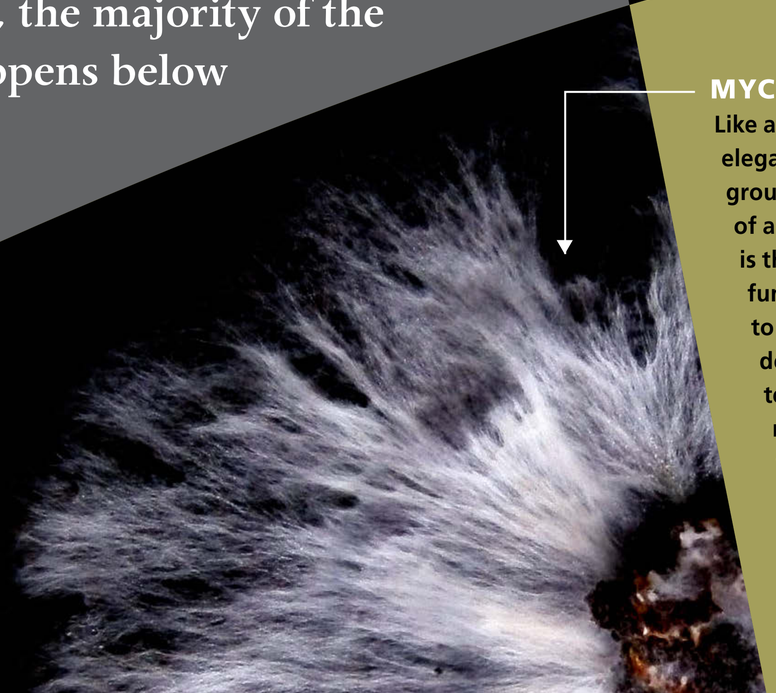
Did you know?
One of the largest organisms in the world, an individual network of honey mushroom mycelium (*Armillaria solidipes*) in the Blue Mountains of Eastern Oregon, is estimated to be 2,200 acres in size and 2,400 years old!

While walking through this forest, you will likely see several types of fungi. They play a critical role in the forest ecosystem, helping convert dead trees, branches, leaves and needles into soil. While the most obvious part of a fungus is the fruiting body, or mushroom, the majority of the growth happens below ground.

MYCORRHIZAL FUNGI

Most plants depend on a certain types of fungi in the soil for ideal growth. These mycorrhizal fungi colonize the root systems of plants and enhance their uptake of essential nutrients. They also help the plants resist disease and increase resilience to drought. In return, the host plant provides the fungi with carbohydrates harvested from its roots.





MYCELIUM

Like an apple on a tree, the elegant and often very colorful above-ground portions of fungi are the "fruit" of a much larger organism. Mycelium is the extensive underground fabric of fungal threads that weave together to consume organic matter and decompose forest debris. When soil temperature and moisture levels are right, the mycelium will start forming fruiting bodies that release spores carried by wind, animal fur and droppings, or water to colonize new areas.

CHICKEN OF THE WOODS (*LAETIPORUS SULPHUREUS*)

FUNGI AS A FOOD SOURCE

While fungi play an important role in nutrient cycling and decomposition, they are also an important source of food for animals. The Douglas squirrel, above, a vocal resident of these forests, consumes a variety of fungi, as do many species of rabbits and mice. Deer and elk are also known to forage on certain kinds of fungi, especially in the winter when food is scarce. Some ants and termites will actually "farm" their own source of fungi within their nests to feed the colony.

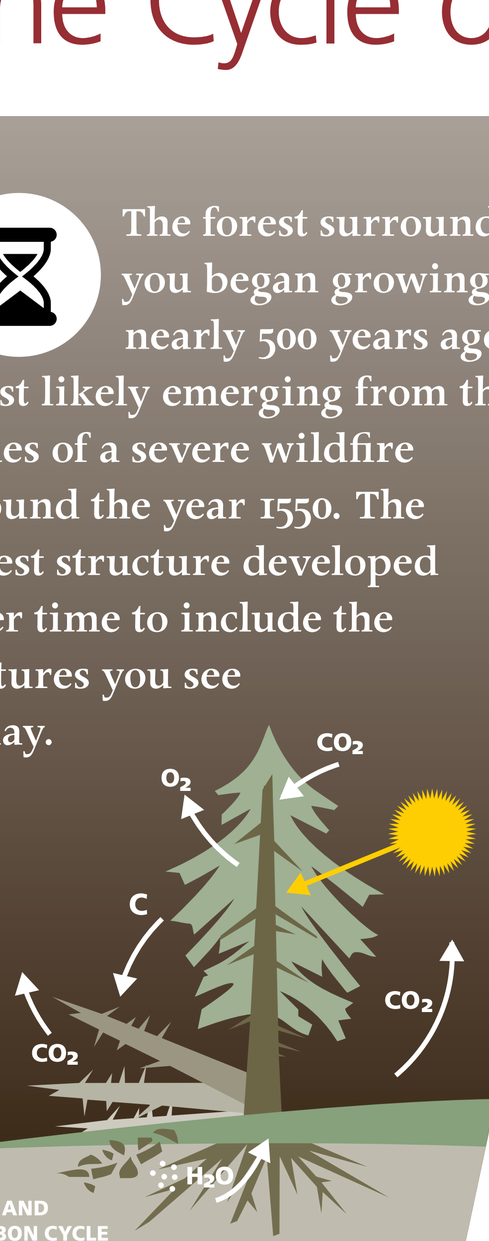
IMAGES (CLOCKWISE FROM TOP RIGHT): DOUGLAS SQUIRREL BY JOHN JAMES AUDUBON; TREE BY MATT VAN WEY / DNR; MYCELIUM BY TOBI KELLNER; MYCORRHIZAL FUNGI BY SCIVIT; MUSHROOM ICON BY MONIKA CIAPALA FROM THE NOUN PROJECT.

MERRILL LAKE NATURAL RESOURCES CONSERVATION AREA

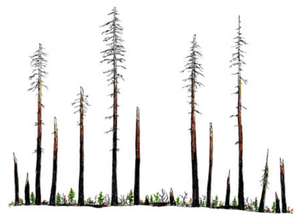
The Cycle of Forest Growth

Decline of old-growth forests in the Northwest
Stands of old-growth forest in the Northwest declined significantly in the 1900s due to extensive logging. Overall, 28% of these stands remain, and only 2% are left around the lower-lying areas of the Willamette Valley and the Puget Sound. Most of the remaining old growth in Washington exists on federal land in parks and wilderness areas.

The forest surrounding you began growing nearly 500 years ago, most likely emerging from the ashes of a severe wildfire around the year 1550. The forest structure developed over time to include the features you see today.



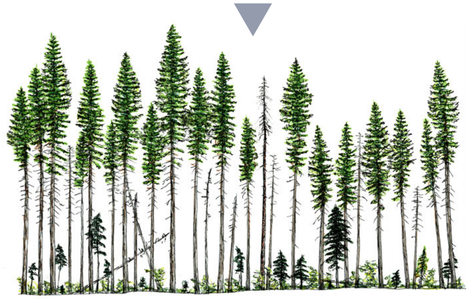
FORESTS AND THE CARBON CYCLE
Live trees capture and store atmospheric carbon, which can remain stored for hundreds of years as the trees grow, die, and become snags. During wildfire, this carbon is released into the atmosphere, then absorbed again by the next cycle.



YEAR 1-40
New trees establish amid the "legacies" left from the previous forest.

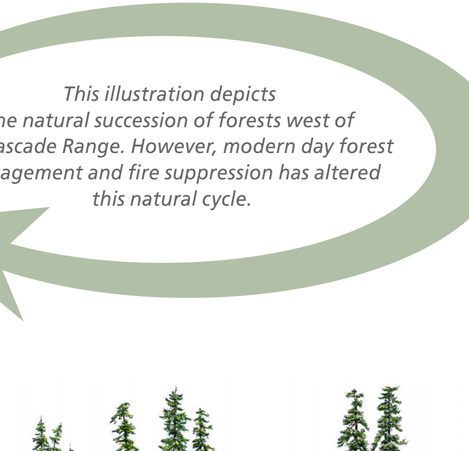
YEAR 40–80
Tree crowns merge, closing the canopy and limiting light reaching the ground.

YEAR 80–150
Trees compete with one another to gain height and biomass.

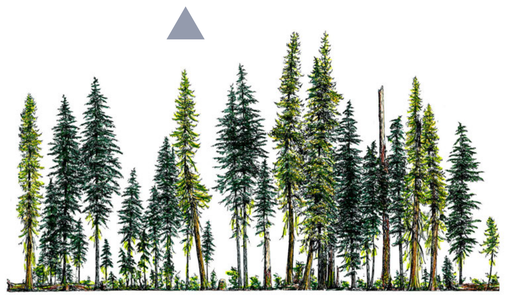


YEAR 150–200
Less competitive trees die and light reaches the understory.

YEAR 200–350
More overstory trees succumb to storms and disease, creating larger openings and allowing understory trees to grow up.



YEAR 350–800
Canopy openings become clumped and larger, creating diverse patches of different sized and aged trees. Large snags and logs are present due to death of old trees.



BEYOND 800 YEARS
Almost all of the originally established Douglas-fir trees have died, leaving only the shade-tolerant trees that established under the original canopy. Large snags and logs are abundant.

YEAR 0
Severe disturbance such as wildfire resets the forest.

This illustration depicts the natural succession of forests west of the Cascade Range. However, modern day forest management and fire suppression has altered this natural cycle.

FOREST GROWTH CYCLE ILLUSTRATIONS BY BOB VAN PELT; FOREST AND CARBON CYCLE ILLUSTRATION BY LUIS PRADO / DNR; HOURGLASS ICON BY LEMON LIU FROM THE NOUN PROJECT.

Washington's Old-Growth Forest

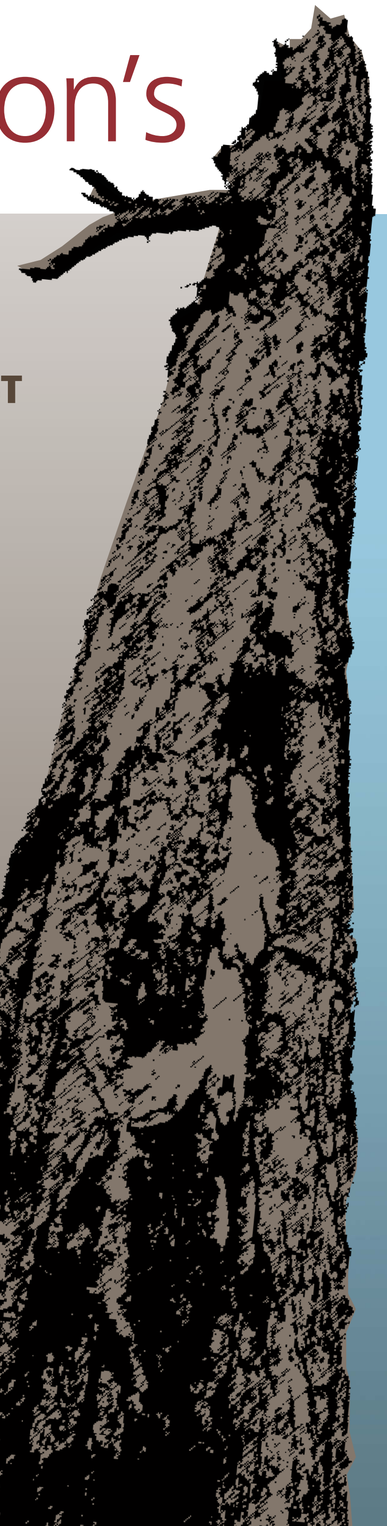
How old can these trees get?
Douglas-firs can live to be 1,300 years old or more, but such an old age is rare—most succumb to fire, diseases, wind or insect damage by about 700 years of age. The Grove of Patriarchs on the southeast flanks of Mt. Rainier contains several 1000+ year-old trees.

THE FOUR MAIN STRUCTURES OF OLD-GROWTH FOREST

1

BIG TREES
▲ They bring the sun's energy into the forest through photosynthesis and store many tons of organic material and nutrients that are eventually recycled back into the ecosystem. The tallest known Douglas-fir is called the "Doerner Fir," located in Coos County, Oregon, and measures 327 ft. tall.

IMAGES (CLOCKWISE FROM TOP LEFT): BIG TREE BY GILLIAN; MULTI-LAYERED CANOPY ILLUSTRATION BY BOB VAN PELT; LARGE FALLEN TREE BY ROMANOWA.



The large Douglas-fir trees you see around you are nearly 500 years old. They were already well over 50 years old when the Mayflower sailed from England with her pilgrim passengers in 1620.

3

MULTI-LAYERED CANOPY
◀ From the smallest shrubs on the forest floor to the towering branches of the largest trees, old-growth forests have a multitude of layers. These complex, overlapping layers of branches often form a continuous canopy. Huge quantities of lichens and mosses living on these branches survive on rainwater and moisture from the air.

2

LARGE SNAGS
◀ Trees become snags when they are killed by diseases, lightning strikes, wind/snow storms or insect damage, but remain standing. Snags provide habitat for a variety of species, including cavity-nesting birds that nest in holes dug into the soft decaying wood.

4

LARGE FALLEN TREES
Trees and snags that fall to the ground take years to decay, becoming homes to a diversity of living creatures in the process. Salamanders, termites, carpenter ants, spiders, centipedes, and small mammals are only some of the residents of these decaying trees. This woody debris hosts a variety of fungi and plants as well, including the next generation of trees.

MERRILL LAKE NATURAL RESOURCES CONSERVATION AREA

Wildflowers and Ferns of Merrill Lake

Merrill Lake plants emerge each spring after being covered by several feet of winter snow. They provide food, shelter and oxygen for a variety of animals.

INDIAN PIPE
Monotropa uniflora

◀ Unlike most plants, Indian pipe does not contain chlorophyll. Instead, this plant is a parasite of mycorrhizal fungi (fungi that grow in conjunction with tree roots). This complex relationship allows Indian pipe to indirectly get its energy from photosynthetic trees.

PACIFIC BLEEDING HEART
Dicentra formosa

◀ This attractive flower is the primary food source for the Clodius Parnassian butterfly. Its seeds are primarily dispersed by ants which collect them to eat the nutritious, fat globules on the seed.

WESTERN RATTLESNAKE PLANTAIN
Goodyera oblongifolia

◀ This member of the orchid family is commonly found in mature and old-growth forests. It is named for the markings on the leaves that resemble snakeskin.

INSIDE-OUT FLOWER
Vancouveria hexandra

◀ This tiny, white flower was named after early explorer, Captain George Vancouver. The plant is sometimes called duck's foot which comes from the shape of the leaf.

FRINGECUP
Tellima grandiflora

◀ When crushed and made into a drink, fringecup was used by Native Americans to relieve illnesses and stimulate appetite.

DEER FERN
(*Blechnum spicant*)
Deer fern provides important winter forage for deer and elk. It has two types of fronds, and only the erect fronds produce the spores.

SWORD FERN
Polystichum munitum
Western sword fern spores have many medicinal uses, including relieving pain caused by stinging nettle. It's often used in restoration projects for bank stabilization, revegetation and creation of amphibian habitat.

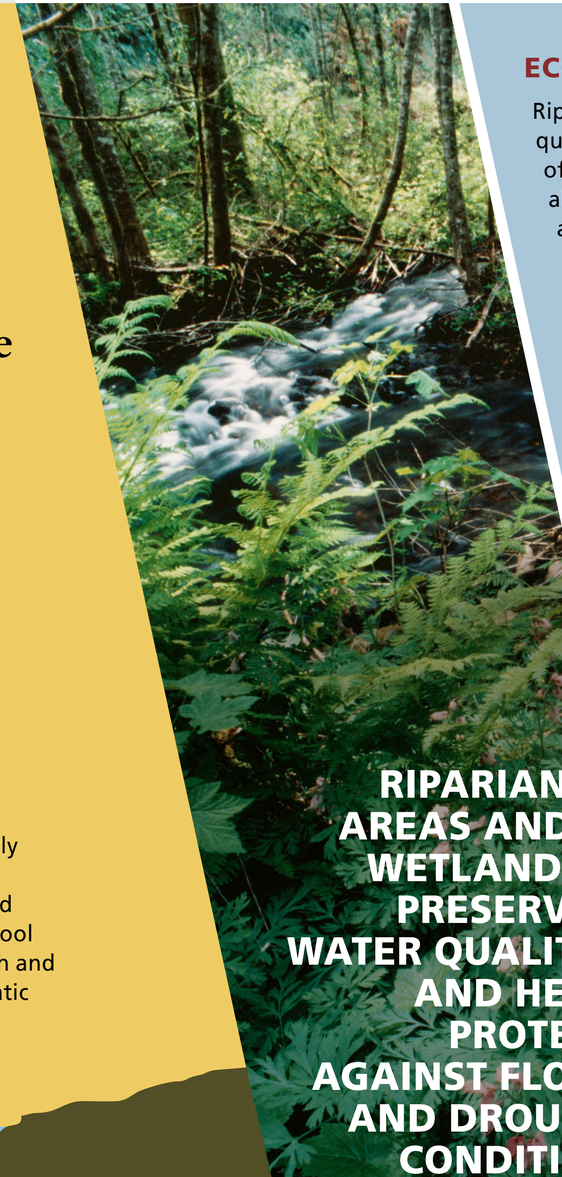
REDWOOD SORREL
Oxalis oregana
When direct sunlight strikes its leaves, they fold downward. As shade returns, they reopen. Taking only a few minutes, this movement is observable to the eye.

LICORICE FERN
Polypodium glycyrrhiza
These ferns are often found growing on the trunks and branches of deciduous trees. The roots were used by Native Americans as a tonic for sore throats.

IMAGES (CLOCKWISE FROM TOP LEFT): FLOWER ICON BY EDWARD BOATMAN FROM THE NOUN PROJECT; INDIAN PIPE BY WALTER SIEGMUND; SWORD FERN BY NWPLANTS.COM; REDWOOD SORREL BY WALTER SIEGMUND; LICORICE FERN BY BREWBOOKS; FRINGECUP BY WALTER SIEGMUND; DEER FERN ILLUSTRATION FROM SOURCE: WWW.BIOLIB.DE; INSIDE-OUT FLOWER BY WALTER SIEGMUND; WESTERN RATTLESNAKE PLANTAIN BY BREWBOOKS; PACIFIC BLEEDING HEART BY LESLIE SEATON.

The Riparian Zone

Riparian zones are lands along streams, lakes and other bodies of water. They are among the most ecologically diverse and productive habitats, providing a mix of food and cover for aquatic species, and acting as a filter to protect water quality.



ECOSYSTEMS BENEFITS

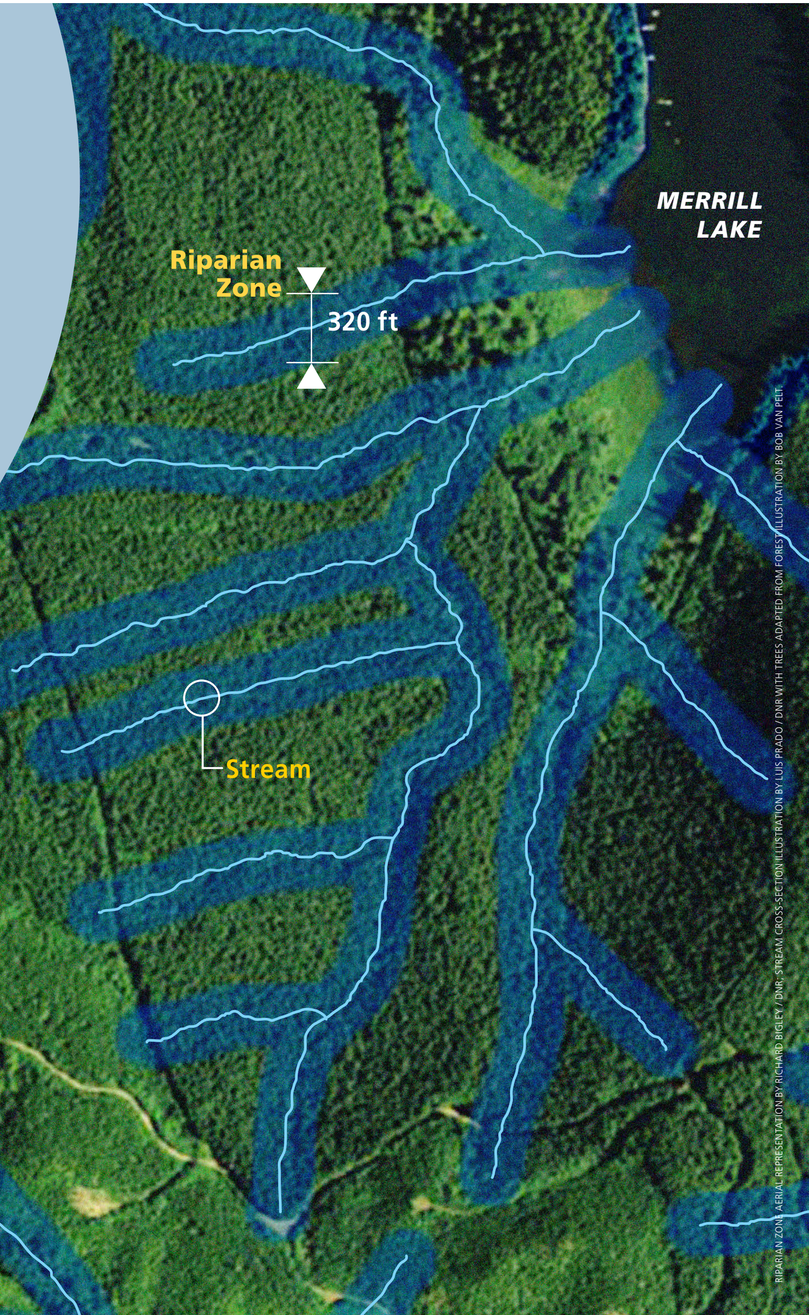
Riparian zones help protect water quality by slowing the horizontal flow of excess nutrients and pollutants, allowing time to settle and be absorbed by vegetation.

Plants also stabilize stream and lake banks and prevent soil erosion through extensive root systems.

Some riparian zones at Merrill Lake experience periodic flooding, especially in the winter, when much of its shore is under water or its streams swollen from snow melt or storms.

RIPARIAN AREAS AND WETLANDS PRESERVE WATER QUALITY AND HELP PROTECT AGAINST FLOOD AND DROUGHT CONDITIONS.

▼ Riparian Ecosystem
Fish-bearing streams on state-managed lands have buffers averaging 160 feet on each side of the stream to protect all riparian-associated life and processes.



Lake Ecosystem: Who Eats Whom?

A healthy lake ecosystem is all about relationships, and it starts with the sun. From algae—a primary producer, to bacteria—a decomposer, they all matter to the health of the lake. If any of the relationships are broken, the lake ecosystem can grow out of balance and cause its diversity to decline.

OUT OF BALANCE
When excess nutrients such as agricultural runoff enter aquatic ecosystems, primary producers reap all the rewards. This can lead to an overabundance, or bloom, of algae (shown on photo) and reduce the biological diversity of the lake. This process is called Eutrophication and can often be identified by the dominance of a thick green layer of algae on the surface.

LAKE SHORE PHOTO BY ALEXANDR TRUBETSKOY, LAKE CROSS-SECTION ILLUSTRATION BY LUIS PRADO-PEREZ

PLANTS AND ANIMALS ARE INTIMATELY TIED TO ONE ANOTHER IN WAYS THAT WE ARE JUST BEGINNING TO UNDERSTAND. IT'S IMPORTANT TO PROTECT ALL SPECIES WITHIN THESE DELICATE FOOD WEBS.

D
DECOMPOSERS
Everything organic that ends up in the lake—the leaves that blow in from the forest, the dead fish that sink to the bottom—will soon be food for bacteria and fungi. They break down the organic material into small particles and nutrients that are now accessible to the bottom of the food chain, completing the circle.

E
TERTIARY CONSUMERS
They include larger fish, such as trout. These fish eat smaller fish and invertebrates. Otters, osprey, and eagles feed on these larger fish.

A
PRIMARY PRODUCERS
Phytoplankton, such as algae, are the bottom of the food chain in a lake ecosystem. Like all photosynthetic plants, they depend on the sun to grow.

B
PRIMARY CONSUMERS
Zooplankton are the tiny, free floating animals that consume the phytoplankton, bacteria, and organic debris that falls into the lake.

C
SECONDARY CONSUMERS
Bottom feeding fish and invertebrates (like larval dragonflies and diving beetles) feed primarily on the zooplankton.