Exploring Your Park
10 Great Ways to Enhance Your Stay

Whether this is your first visit to the park or your 50th, seeing Crater Lake from the rim of the caldera is likely to be an awe-inspiring experience. But there is also much to see and do here after the initial view. If you’ve been to the park in pre-COVID times, you’ll notice that some services and experiences are not available this summer in the interests of public health. For example, boat tours and trolley tours are not operating, Crater Lake Lodge is open to overnight Lodge guests only, and the park film is not being shown.

Fortunately, the pandemic has not affected the park’s outstanding scenery, hiking trails, roads, overlooks, and other recreational opportunities—many of which are described in this visitor guide. To get you started, here are 10 ideas for making the most of your stay:

1. **Circle the Lake**
   Rim Drive is a 33-mile (53-km) paved road around Crater Lake. More than 30 pullouts offer excellent views of the park’s scenery. Allow 2 to 3 hours (see page 5).

2. **Find the Phantom Ship**
   Anchored near the lake’s south shore is an island that seems to be sailing away. To see it, walk to Sun Notch or drive to the viewpoint named in its honor (see page 5).

3. **Have a Picnic**
   The pullouts and picnic areas on the Rim Drive are perfect for outdoor eating. Stop by the Rim Village Café or Mazama Village Store for grab-and-go sandwiches.

4. **touch the water**
   Photograph the Pinnacles, Watchman Peak, and Mount Scott each offer spectacular—and very different—views of Crater Lake (see page 4).

5. **Savor the Sunset**
   Sunsets in the park can be spectacular—even from the top of Watchman Peak (see page 2).

6. **View the Milky Way**
   On moonless nights, the park offers some of the darkest night skies in America. Look up to see meteors, satellites, planets, and the starry arms of our galaxy.

7. **Watch for Wildflowers**
   From late June to early August, flowers line many of the park’s roads and trails. Take a short stroll on the Castle Crest Trail to view the park’s premier display (see page 6).

8. **Learn about the Climate**
   Most days in July, August, and September are warm and sunny. In May, June, and October, clear days alternate with periods of rain and snow. Winters are long. Storms from the Pacific Ocean dump an average of 42 feet (13 meters) of snow at Park Headquarters! The park’s tremendous snowfall is a result of its position at the crest of the Cascade Mountains.

9. **Look Inside!**
   Superintendents Craig Ackerman

10. **Recommended Reading**
    - Park established: 1902
    - Size: 183,224 acres (74,148 hectares)
    - Number of visitors last year: 670,500
    - Lake depth: 1,943 feet (592 meters)
    - Lake width: 4.5 to 6 miles (7 to 10 km)
    - Highest point: Mount Scott, elevation 8,929 feet (2,721 meters)

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**Park Profile**
Crater Lake National Park protects the deepest lake in the United States. Fed by rain and snow (but no rivers or streams), the lake is considered to be the clearest large body of water in the world. The water is exceptional for its clarity and intense blue color.

The lake rests inside a caldera formed 7,700 years ago when a 12,000-foot (3,600-meter) volcano collapsed following a major eruption. The eruption may have been the largest in North America in the past 640,000 years. Later eruptions formed Wizard Island, a cinder cone near the southwest shore.

Today, old-growth forests blanket the volcano’s slopes, harboring more than 700 native plant species and at least 72 types of mammals. The park is central to the cultural traditions of local American Indian tribes, whose ancestors witnessed the lake’s formation.

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**Climate Chart**
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Air temperature and snowfall averages are from Park Headquarters, 1931-1965. Water temperatures are from 1965-2019.
Activities

**Backpacking**
Over 95% of the park is managed as wilderness. Although some trails and locations are closed to backcountry camping (for example, there is no camping in the summer with a view of the lake), exploring the park’s old-growth forests and volcanic landscapes can be a rewarding experience. Generally, backpackers must travel at least 1 mile from their vehicle in order to camp.

Before setting out, all backpackers must obtain a permit, in person, from the Ranger Station at Park Headquarters. The one exception is through hikers on the Cleetwood Crest Trail, who may instead sign a trail register as they enter the park. Backcountry permits are free of charge and are available between 8 am and 4:30 pm daily. They are not available after hours or over the phone.

**Bicycling**
Bicycles are allowed on paved roads and the unpaved Grayback Drive. They are not allowed on trails, or off-trail. Helmets are required for riders under 16 years of age and are strongly recommended for all cyclists. The park’s paved roads are narrow with heavy automobile traffic. The most popular trip in the park is the 33-mile (53-km) Rim Drive, featuring spectacular views but also long climbs that gain a total of 3,800 feet (1,158 meters) in elevation.

**Pets**
Pets are welcome in the park, but only in certain areas. Pets on leash are allowed on the Godfrey Glen Trail, Lady of the Woods Trail, Grayback Drive, and Pacific Crest Trail (see page 4). Leashes must not exceed 6 feet, and only one pet per hiker is allowed. Pets are not permitted on other trails or off-trail. Pets on leash (or otherwise physically restrained) are also allowed in picnic areas, campgrounds, parking lots, on paved surfaces, and up to 50 feet (15 meters) away from paved surfaces. Popular places to walk a dog include the Rim Village and Mazama Campground. Pets are not allowed inside buildings, including Crater Lake Lodge and The Cabins at Mazama Village. The preceding rules do not apply to service animals here to assist people with disabilities. Solid waste must be picked up immediately and disposed of properly, in a trash can or toilet.

**Junior Ranger Program**
Are you between 6 and 12 years old? Pick up a free Junior Ranger activity booklet! They are available 24 hours a day at Park Headquarters and at two places in Rim Village (outside the Rim Village Visitor Center and on the front porch of the Community House).

To become a Junior Ranger and earn an official badge, complete at least 10 tasks. Junior Rangers can explore the park. Then show your book to a ranger on the back porch of the Rim Village Visitor Center (9:30 am–4:30 pm daily through September 6). Or, you can receive a badge through the mail if you put your finished book in the 24-hour drop box outside the Rim Village Visitor Center, mail it to the address on the book’s front cover, or ask an adult to scan or photograph the pages and email them to craterlake@nps.gov.

Other fun, Crater Lake activities are available online. Visit go.nps.gov/kids.

**Wildlife Viewing**
The park is home to a variety of animals, but they can be difficult to spot. Many are active primarily at night or shy away from humans. The most commonly seen animals are squirrels, chipmunks, marmots, ravens, jays, and deer. Lucky observers might spot a pika, porcupine, fox, coyote, wolf, martens (a type of weasel), bald eagle, owl, or herd of elk. Bobcats and mountain lions are present but are rarely seen. Approximately 50 black bears live in the park, but they also prefer to stay hidden. You might see one crossing a road. The only creatures that tend to pester people are mosquitos (from mid-June to mid-July) and yellowjacket wasps (in August and September).

**Fishing**
Fishing is allowed in Crater Lake, but the water is cold! Most people swim for just a few minutes. Swimming is permitted only at the bottom of the Cleetwood Cove Trail. The shoreline is rough and rocky, there are no beaches, and no lifeguards are on duty. Swimmers must stay within 100 yards (91 meters) of shore and not venture out of Cleetwood Cove. Long-distance swimming is prohibited. To prevent the introduction of non-native organisms, the use of equipment other than standard swimsuits is forbidden. Wetsuits, snorkels, fins, goggles, life jackets, and other flotation aids are not allowed, as well as other gear—such as rafts, canoes, kayaks, and paddleboards—that could serve as potential vectors for invasive species.

**Sky Gazing**
With clean air and unobstructed views, the rim of Crater Lake is a great place to observe astronomical events. Discovery Point is a favorite spot to watch the sunrise. For sunsets and moonrises, try Watchman Overlook, Cloudcap Overlook, or hike to the top of Watchman Peak.

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Ask the Ranger

How deep is Crater Lake?

Crater Lake is 1,943 feet (590 meters) deep. It is the deepest lake in the USA, 300 feet deeper than Lake Tahoe, which ranks 2nd—and the 9th deepest lake in the world. It is also the 21st deepest lake in the world formed by volcanic activity.

Where does the water in the lake come from?

About 83% of the water comes from rain and snow falling directly on the lake. The lake is refilled from spring snowmelt and rainfall each year. The rest comes from the Wizard Island cone—erupted out of the lake around 7,300 years ago. Three other eruptions have occurred in the lake since its formation:

- 250 feet of ash and pumice from the 1980 eruption at Mount St. Helens.
- 1980 eruption at Mount St. Helens. The eruption produced pyroclastic flows of ash and pumice that flattened the forests growing on the mountain. The age of the eruption has been determined by carbon-dating tree remains buried in the ash deposits.

Is Wizard Island the former summit of Mount Mazama?

Wizard Island is not the peak of the old mountain. It is a newer volcano—a crater cone—that erupted out of the lake around 7,300 years ago. Three other eruptions have occurred in the lake since its formation:

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Could Mount Mazama erupt again?

According to geologists, future eruptions are almost guaranteed. This is one of 18 volcanoes in the United States that the US Geological Survey considers to pose a “very high threat” to human life and property. A major eruption, however, is not likely to happen again for thousands of years; the last eruption of Mount Mazama was 7,700 years ago. Crater Lake has not had sufficient time to recharge itself.

Has the bottom of the lake been explored?

In the summers of 1988 and 1989, a one-person submarine called Deep Rover made 47 trips to the bottom of the lake. There, researchers collected organisms from the lake bottom. The lake’s bottom waters are cold and deep, with low oxygen levels. These conditions make it difficult for life to thrive in the lake. The researchers found that the lake bottom is covered with sediments, including volcanic ash and silt. These sediments provide a habitat for many of the lake’s organisms, such as shrimp and small fish. The sediments also contain nutrients that support the growth of phytoplankton, which form the base of the lake’s food web.

Does anything live in the lake?

Crater Lake is home to a variety of fish, insects, and amphibians, including a type of salaman- der found nowhere else in the world (the Mazama newt). The lake also contains a variety of invertebrates, such as crustaceans and mollusks. In addition, the lake contains a number of large predatory fish, including trout, salmon, and whitefish. These fish are an important part of the lake’s ecosystem, providing food for larger predators such as birds and mammals.

Is it clean enough to drink?

Yes, the water in Crater Lake is clean enough to drink. The lake is very clean and clear, with very little sediment or pollution. This is due to the fact that the lake is very deep and is isolated from other water bodies. In addition, the lake’s deep water and lack of inlets make it more difficult for pollutants to enter the lake.

Gasoline & EVs

Self-service, unleaded gasoline is available at the Mazama Village Store during business hours (see above left) from May 21–September 26 and then 10 am–5 pm from October 1–November 27. A charging station for electric vehicles is located in front of the Annie Creek Gift Shop, also in the Mazama Village Store. It has two level 2 connectors and one Tesla connector.

Phone & Internet

Cell reception in the park is spotty. You may have luck at overlooks on the Rim Drive. Free public WiFi is available outside the Rim Village Café and the Mazama Village Community House. Passengers on a person submarine called Deep Rover made 47 trips to the bottom of the lake. (See the photo on page 7). The lake experiences twice as much precipitation as evaporation, but the caldera doesn’t fill up because water seeps out through a porous layer of rock along the shore. Water leaks out of Crater Lake at a rate of 2 million gallons every hour! The lake goes deep underground and does not feed any nearby springs or rivers.

Does the lake freeze?

Ice rarely forms on Crater Lake, except during the coldest of winters. The lake contains a tremendous amount of water (5 trillion gallons), but it has a very small surface area (21 square miles). The lake has not frozen over since 1949.

How did Crater Lake form?

Crater Lake occupies the shell of Mount Mazama, a collapsed volcano. The volcano began 12,000 feet (3,660 meters) tall, but its summit imploded after a major eruption 7,700 years ago. The eruption was about 100 times the mass of the 1980 eruption at Mount St. Helens.

How do we know the eruption was 7,700 years ago?

Mount Mazama’s caldera-forming eruption produced pyroclastic flows of ash and pumice that flattened the forests growing on the mountain. The age of the eruption has been determined by carbon-dating tree remains buried in the ash deposits.

Are there fish in the lake?

Crater Lake contained no fish until it was stocked for recreational fishing between 1886 and 1941. Six species were introduced, but only two have survived: rainbow trout and kokanee salmon. In 1915, crayfish were also added to the lake (as trout food). Recently, their population has exploded: 80% of the shoreline is now crayfish territory, and they’ve been found living at depths of up to 800 feet (250 meters). Like minnows and dragonflies, crayfish are important foraging resources for many native species. Unfortunately, crayfish are swiftly pushing the lake’s native species toward extinction.
Hi, I'm Ranger Stephanie. We have 90 miles (145 km) of hiking trails here at Crater Lake. Our most popular day hikes are listed on this page. If you are visiting in June or early July, be aware that some trails might still be closed by snow. Please help us protect this special place by following the important rules:

- **No hiking or climbing inside the caldera!** The walls are dangerously steep and unstable.
- **Leave all rocks, plants, animals, and artifacts undisturbed for the enjoyment of future hikers.**
- **Overnight backpacking requires a permit, available at Park Headquarters between 8 am and 4:30 pm. Some areas are not open to backcountry camping.**
- **Pets are allowed on the Godfrey Glen Trail, Lady of the Woods Trail, and Pacific Crest Trail. Pets must be leashed; only one pet per hiker is allowed.**
- **To protect vegetation and prevent erosion, please stay on the trails.**

### Let's Go for a Hike!

**Castle Crest**

- 0.5 miles (0.8 km) loop trail
- 100 feet (30 meters)
- 0.5 miles (0.8 km)
- 20 minutes
- Self-guiding brochures are available at the trailhead.

**Lady of the Woods**

- 0.7 miles (1.1 km) loop trail
- 120 feet (37 meters)
- 0.7 miles (1.1 km)
- 30 minutes

**Sun Shot**

- 0.8 miles (1.3 km) loop trail
- 150 feet (46 meters)
- 0.8 miles (1.3 km)
- 30 minutes

**The Pinnacles**

- Roundtrip 0.8 miles (1.3 km)
- Elevation Gain 10 feet (3 meters)
- 30 minutes

**Godfrey Glen**

- 1.1 miles (1.8 km) loop trail
- Elevation Gain 50 feet (15 meters)
- 1 hour

**Plaikni Falls**

- 2.0 miles (3.2 km)
- Elevation Gain 100 feet (30 meters)
- 1 hour

**Flowers, Meadow, Creek**

- Loop trail around Park Headquarters.
- Short uphill walk through a meadow to the rim of Crater Lake.
- Use caution near cliff edges.
- Accessible to all-terrain wheelchair users with assistance.

**Historic Architecture**

- Viewpoints of Phantom Ship
- Easy walk along the rim of Pinnacles Great views of volcanic spires.
- Use caution near cliffs.
- End of the Pinnacles Road, 6 miles (9.7 km) southeast of Park Headquarters.

**Peaceful Forest**

- Waterfall, Flowers
- Easy stroll through an old-growth forest, with some canopy views.
- Accessible to all-terrain wheelchair users with assistance.
- Self-guiding brochures are available at the trailhead.

**Self-guiding**

- Trails are their designs with the strong, all-terrain wheelchair.
- Brochures are available at the trailhead.

**Terrain**

- Accessible to all-terrain wheelchair users.
- Self-guiding terrain.
- Wheelchair users.

**Location**

- Plaikni Falls Road.
- Union Peak.
- Pacific Crest Trail.

### Easy

**Discovery Point**

- 2.0 miles (3.2 km)
- Roundtrip 1 mile (2 km)
- Elevation Gain 420 feet (128 meters)
- 1 hour

**Watchman Peak**

- 1.6 miles (2.6 km)
- Elevation Gain 200 feet (61 meters)
- 1 hour

**Annie Creek**

- 1.7 miles (2.7 km) loop trail
- Elevation Gain 400 feet (122 meters)
- 1 hour

**Boundary Springs**

- 5.0 miles (8.0 km)
- Elevation Gain 400 feet (122 meters)
- 3 hours

**Lake Views**

- Panoramic Views
- Moderate ascent to a fire lookout above Wizard Island.
- Spectacular views in all directions.
- Great place to watch the sunset.
- Trail may be closed until early July due to snow.

**Description**

- Moderate strenuous hike through a deep, stream-cut canyon.
- Lots of water, wildflowers, and sometimes wildlife.
- Self-guiding brochures are available at the trailhead.

**Trailhead Location**

- Watchman Overlook, 3.8 miles (6.1 km) northwest of Rim Village on the West Rim Drive.
- Mazama Campground, behind the amphitheater (between loops D and E). Limited parking in Loop F.

**Nature Note**

- Built in 1933, the peak's historic fire lookout is still used by rangers today.
- The canyon is carved into a layer of ash—200 feet (60 m) thick—fro the big eruption.
- The trail passes through a forest blackened by wildfire in 2015.

### Moderate

**Cleetwood Cove**

- 2.2 miles (3.5 km)
- Roundtrip 1.6 miles (2.6 km)
- Elevation Gain 760 feet (233 meters)
- 3 hours

**Garfield Peak**

- 3.6 miles (5.8 km)
- Roundtrip 2.0 miles (3.2 km)
- Elevation Gain 489,000 feet (149,000 m)
- 5 to 6 hours

**Mount Scott**

- 4.4 miles (7.1 km)
- Roundtrip 3.6 miles (5.8 km)
- Elevation Gain 1,250 feet (381 meters)
- 3 hours

**Crater Peak**

- 6.5 miles (10.5 km)
- Elevation Gain 1,250 feet (381 meters)
- 5 to 6 hours

**Union Peak**

- 9.3 miles (14.9 km)
- Elevation Gain 489,000 feet (149,000 m)
- 5 months

**Pacific Crest**

- 2.1 miles (3.4 km) loop trail
- 1-way

**Panoramic Views**

- Forest, Views, Solitude

**Description**

- Moderate to strenuous hike to the summit of a small volcano.
- No lake views, but fine views of the Klamath Basin to the southeast.
- A peaceful walk through forests and meadows.
- Long forest walk followed by a steep climb.
- Great views from the top and interesting geology, but no view of Crater Lake. Top section may be impassable until early July due to snow.

**Trailhead Location**

- East Rim Drive, 3 miles (4.8 km) east of Park Headquarters at the Vidette Falls Picnic Area.
- Highway 62 at the Pacific Crest Trailhead, 1 mile (1.6 km) west of the Crater Lake road junction.
- The Pacific Crest Trail makes two road crossings in the park. Each has a parking lot. See the map to the right.

**Nature Note**

- Upper Klamath Lake is the largest in Oregon, but its water temperature at the lake's surface is 60ºF (16ºC).
- To see Crater Lake, most PCT hikers leave the official trail and walk along the West Rim.

**Swimmers at Cleetwood Cove**

- Leveys Monkeyflower on the Pacific Crest Trail

**Plaikni Falls**

- 1.2 miles (1.9 km) east of Park Headquarters.
- Nature Note

**Hiker atop Garfield Peak**

- From the Steel Visitor Center, overlook.
- Headquarters.
- East Rim Drive.
- Headquarters.
- East Rim Drive. 4.4 miles (7.1 km) east of Park Headquarters.
- End of the Pinnacles Road, 2.4 miles (3.9 km) south of Park Headquarters.

**Nature Note**

- The Pinnacles are chimneys formed when hot ash cooled after the big eruption.
- Trail is named after William Godfrey, a ranger who died in a blizzard here in 1930.
- Snowmelt, not Crater Lake, is the source of Plaikni Falls' water.

**Easy**

**Swimming, Fishing**

- Panoramic Views

- Most popular PCT hikers pass through the park on their way from Mexico to Canada (or vice versa). To walk in their footsteps, visit one of the park's two trailheads.

- Long forest walk followed by a steep climb. Great views from the top and interesting geology, but no view of Crater Lake. Top section may be impassable until early July due to snow.

- Limited parking in Loop F.

- Pulloff on Highway 230 near milepost 19.5, 9 miles (15 km) west of the junction with Highway 138.

- The Pacific Crest Trail makes two road crossings in the park. Each has a parking lot. See the map to the right.
across what he called "Deep Blue Lake." In 1853, gold prospector John Hillman became near this spot, on the back of a mule in Discovery Point Park. The 33-mile (53-km) road around Crater Lake is one of America's most scenic byways. The full loop is typically open from early July to late October. It can be driven, without stopping, in about an hour, but plan to spend at least 2 to 3 hours to enjoy the varied sights. The road is narrow, so use caution and be alert for bicyclists, pedestrians, and wildlife. There are more than 30 scenic pullouts, many of which have roadside exhibits. Be sure not to miss these 7 “must-see” stops. For more information, pick up the excellent Road Guide to Crater Lake National Park (48 pages, $7.95) at the Crater Lake National History Association store in the Community House at Rim Village.

Discovery Point
Imagine seeing Crater Lake by accident. Near this spot, on the back of a mule in 1853, gold prospector John Hillman became the first European-American to stumble across what he called “Deep Blue Lake.”

Watchman Overlook
This pullout offers an unmatched view of Wizard Island, a cinder cone that erupted out of Crater Lake approximately 7,300 years ago. To find it, drive 3.8 miles (6.1 km) west of Rim Village and look for a viewpoint lined with wooden fences.

Cloudcap Overlook
This overlook sits at the end of a 1-mile (1.6-km) spur road, the highest paved road in Oregon. Whitebark pines cling for survival here, dwarfed and contorted by the harsh winds.

Pumice Castle Overlook
Stop here to see one of the park’s most colorful features: a layer of orange pumice rock that has been eroded into the shape of a medieval castle. Watch carefully for this unmarked viewpoint, located 1.1 miles (1.8 km) west of the Cloudcap Overlook road junction and 2.4 miles (3.9 km) east of the Phantom Ship Overlook.

Phantom Ship Overlook
Nestled against the shore, Crater Lake’s “other island” escapes detection by many park visitors. Though it resembles a small sailboat, the island is as tall as a 16-story building. It’s made of erosion-resistant lava, 400,000 years old—the oldest exposed rock within the caldera.

Pinnacles Overlook
This overlook is well worth the 6-mile (10 km) detour from Rim Drive. Colorful spires, 100 feet (30 meters) tall, are being eroded from the canyon wall. These “fossil fumaroles” are the result of volcanic gas that rose up through a cooling ash deposit from the eruption that formed Crater Lake.

Vidae Falls
This spring-fed, roadside waterfall tumbles over a glacier-carved cliff and drops 100 feet (30 meters) over a series of ledges. In summer, wildflowers flourish in the cascade’s spray.
Whitebark pines have long stood sentinel on the rocky rim of Crater Lake. Twisted and gnarled, they are able to withstand cold temperatures, strong winds, and heavy snows. Lately, however, these hardy trees have been dying at an alarming rate. Drive around the lake this summer and you’ll witness the carnage: half of the park’s whitebark pines are dead, half of the rest are dying, and the fate of the entire species is in jeopardy. “At this point,” says park botanist Jen Hooke, “what seems irreversible.” What’s behind the destruction of these majestic trees, and can anything be done to save them?

While climate change is playing a big role (causing whitebark pines to suffer from increased insect damage, competition from other tree species, and more intense wildfires), the primary culprit is actually a lethal fungus (Cronartium ribicola), although human beings are really to blame. We imported the non-native fungus by accident in 1910, when contaminated tree seeds from a nursery in France were shipped to a landowner in British Columbia, Canada. Now a permanent resident of North America, the fungus travels short distances on the wind via microscopic spores, infecting all pines that have 5 needles per bundle, including sugar pines, lodgepole pines, and western white pines. Trees infected with the fungus develop a disease called “white pine blister rust,” evident by orange cankers that form on the branches and trunk. The disease has no cure; death follows infection in 5 to 15 years.

Whitebark pines (Pinus albicaulis) are particularly susceptible to blister rust. Across their range, from California east to Wyoming and north to British Columbia, their numbers are in rapid decline.

December of 2020, the US Fish & Wildlife Service announced that the tree is on a path toward extinction and initiated proceedings to list it as a threatened species under the Endangered Species Act of 1973.

If we lose our whitebark pines, we’ll lose more than just some picturesque trees. An entire forest community is at risk. “The whitebark pine is a ‘foundation species’ at Crater Lake,” explains Hooke. “A lot of other creatures depend on it.” Whitebark pines are the only trees that grow at the park’s highest elevations. They stabilize the soil on steep slopes, helping wildflowers and other plants to gain a foothold. They provide nutritious seeds and sheltered habitat for squirrels, grouse, and other creatures. And by shielding snowbanks from the sun, they retain soil moisture and reduce spring flooding at lower elevations.

Now for the good news: within most populations, a few individuals seem to possess an inborn, genetic resistance to the blister-rust fungus. Some trees are able to shed their infected needles (on which the fungal spores germinate) before the beetle larvae can spread from the needles to the branches. Other trees are able to quarantine the disease in a section of bark and prevent it from spreading further. Fewer than 1% of whitebark pines express these traits, but researchers such as Hooke are trying to identify and utilize them. By locating resistant trees, collecting their seeds, and planting their offspring throughout the park, we might be able to accelerate the natural selection process in order to regenerate our whitebark pine forests before the current groves die off.

Scientists first harvested seeds at Crater Lake in 2003, from 10 trees at Rim Village. The seeds were germinated in a nursery at the Deschutes National Forest, a US Forest Service facility 20 miles (32 km) south of Eugene that studies how trees defend themselves from disease. At the age of two, the seedlings were exposed to the blister-rust fungus and were checked, over the next 5 years, for signs of resistance. “The parent trees are given letter grades, just like grades in school,” describes Hooke. “Unfortunately, we got one C, five Ds, and three Fs.” Seedlings that are resistant since then, from trees elsewhere in the park, have shown better resistance. “They include some As and Bs,” Hooke reports.

Offspring from these parent trees began to arrive in 2009, when 332 nursery-grown seedlings from 16 parent trees were planted in Rim Village. You can examine these trees yourself by walking along the paved paths between the Rim Village Gift Shop (between the Gift Shop and the edge of the caldera). Most are between 3 and 6 feet tall. “To protect them, we planted them next to boulders,” says Hooke. “That’s where to look.” So far, pocket gophers have eaten some of the seedlings, and a few have succumbed to blister-rust infection, but 80% are still alive.

Since 2011, Hooke and her crew of seasonal workers have continued to harvest seeds from trees that, in the field, appear to be staying off or coping with blister-rust infection. About 40 fungus-resistant parent trees have been identified (although 7 of them have since died), and a total of 6 “restoration plantings” of their progeny have taken place in the park. Botanists at other national parks— including Yellowstone, Mount Rainier, and Glacier— have also been planting nursery-grown seedlings as well. “A whole community of people is working hard to save this tree,” says Hooke. “We are not alone in our efforts.”

There is a sense of urgency you try to think about the whitebark pine species. Many cones are quite produce many cones until age 50, and it’s not until age 100 that they enter their prime reproductive years. Raising a forest of genetically resistant trees will take time. If we wait too long, few of the current trees have died—the few survivors will be at a disadvantage. Raising beetles as to blister rust. An even bigger concern is that they may not even bother to visit them before the beetles get to them first. Beetle attacks are swift and deadly. Female beetles swarm in huge numbers at latitudes and higher elevations.

Bee attacks are swift and deadly. Female beetles swarm in huge numbers at latitudes and higher elevations. The eggs hatch, the larvae dine on the tree’s innermost layer of bark, tunneling horizontally around the trunk. Within a few weeks, the tree can’t support a larger population. By attaching pouches containing a synthetic form of verbenone to the trunks of trees we’d like to protect, we can trick the beetles into thinking that those trees have already been attacked. The method isn’t foolproof, and the pouches must be replaced annually to be effective, but it’s our best hope of prolonging the lives of the diseased trees whose seeds hold the key to the long-term survival of our whitebark pine communities.

Fortunately, we can protect some individual trees from beetle infestation. Shortly after adult beetles overwinter a tree, they emit a pheromone that alerts other beetles in the area to stay away. Much like a “no vacancy,” sign, this pheromone adds chemical signal that alerts beetles to the blister-rust fungus. By attaching pouches containing a synthetic form of verbenone to the trunks of trees we’d like to protect, we can trick the beetles into thinking the trees have already been attacked. The method isn’t foolproof, and the pouches must be replaced annually to be effective, but it’s our best hope of prolonging the lives of the diseased trees whose seeds hold the key to the long-term survival of our whitebark pine communities.

This summer, Jen Hooke’s crew will be stapling pouches of verbenone to 66 whitebark pines in an effort to ward off beetles. These trees are potential candidate parents whose seedlings might have a degree of natural resistance to the blister-rust fungus.

Complicates Whitebark Pine Restoration

The non-native fungus described above is not the only one facing the whitebark pine. A native insect, the mountain pine beetle (Dendroctonus ponderosae), is hastening the decline of the species. Over the past few decades at Crater Lake, nearly as many whitebark pines have succumbed to beetles as to blister rust. An even bigger concern is that the beetle attacks are like the few trees that have the genetic tools to combat the fungus. Scientists are now in a race to identify and protect these important individuals before the beetles get to them first.

What’s behind the beetle epidemic? For millennia, mountain pine beetles have thrived in the forests of western North America. In the past, however, their intolerance of cold weather generally safeguarded high-elevation trees. Lower-elevation species, such as lodgepole pines and ponderosa pines, were the beetles’ main targets. That all changed as of the 21st century. Across the western US and Canada, beetles have turned their attention toward whitebark pines. Our warming climate, it seems, is allowing them to survive winter at higher latitudes and higher elevations.

Bee attacks are swift and deadly. Female beetles swarm in huge numbers at latitudes and higher elevations. The eggs hatch, the larvae dine on the tree’s innermost layer of bark, tunneling horizontally around the trunk. Within a few weeks, the tree can’t support a larger population. By attaching pouches containing a synthetic form of verbenone to the trunks of trees we’d like to protect, we can trick the beetles into thinking the trees have already been attacked. The method isn’t foolproof, and the pouches must be replaced annually to be effective, but it’s our best hope of prolonging the lives of the diseased trees whose seeds hold the key to the long-term survival of our whitebark pine communities.

Can we stop the decline of the whitebark pine? Just think: every whitebark pine you see at Crater Lake (except those established since 2009 by the park’s botany crew) was carefully planted by a Clark’s nutcracker! That explains why they tend to grow in clusters, with several trunks emerging from the same spot. Each cluster indicates where an industrious nutcracker, years ago, buried a small cache of seeds.

Whitebark pine cones sit horizontally at the tops of trees, providing perfect perches for the Clark’s nutcracker.

Unlike most pine cones, those of the whitebark pine remain tightly closed, on the tree, after the seeds ripen. The seeds are freed and planted with the help of the Clark’s nutcracker, which uses its sharp bill to pry out the large, nutritious seeds. Some seeds get eaten immediately, but most are hidden a few inches deep in the soil, in small caches of 3 to 5. One nutcracker can stash up to 100,000 seeds in a single season. By October, about 9 months, it will use its precise spatial memory to retrieve more than half of its caches. Unclaimed seeds eventually germinate and grow into trees.

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The size of a grain of rice, pine beetle eggs go unnoticed by even the most observant of us. (The eggs are this size at 8 times its actual size.) Except for a few days in summer, when adults fly from their home tree to a new host, they spend their entire life cycle beneath the bark.

This summer, Jen Hooke’s crew will be stapling pouches of verbenone to 66 whitebark pines in an effort to ward off beetles. These trees are potential candidate parents whose seedlings might have a degree of natural resistance to the blister-rust fungus.
First-time visitors to Crater Lake are often surprised to discover such a clear lake in the belly of what once was a dirty, smelly, violent volcano. Early park naturalist Arthur Hasler may have been only slightly exaggerating when he observed, 85 years ago, that "The unusual transparency of the water, in addition to its apparent blue color, sends the sightseer into ecstasies." Ectatic or not, most sightseers today react by instinctively reaching for their camera, as though compelled to capture proof that such a remarkable lake exists. What accounts for the lake's stunning clarity? How do we quantify it? And how does the transparency of the water affect the lake's ecology and broader scientific significance?

Believe it or not, the water in Crater Lake is cleaner than the water that pours from your faucet at home. That's because roughly 85% of it comes from rain and snow falling directly on the lake's surface. (The rest is runoff from precipitation landing on the slopes inside the caldera.) No rivers or creeks carry silt, sediment, or pollution into Crater Lake. The other reason the lake is so pure is that its volcanic basin is currently dormant. The last eruption occurred some 4,800 years ago, when an underwater lava dome east of Wizard Island grew to within 95 feet (29 meters) of the surface. Since then, volcanic activity has ceased, at least for the time being. Some dissolved gases and minerals do enter the lake through hydrothermal vents on the lake's floor, but in very small amounts.

With so few particles suspended in the water, Crater Lake is exceptionally clear—certainly one of the cleanest lakes on Earth. When an 8-inch (20-cm) Secchi disk is lowered into the water, the average depth at which it disappears is nearly 31 meters (103 feet)![1]. On a good day, Secchi disk readings surpass 130 feet (40 meters). In the early 1980s, however, worry began to grow that Crater Lake's clarity was diminishing. Secchi disk depths from 1978-81 were noticeably shallower than the previous measurements that had been taken, a decade earlier, in 1968-69. So concerned was the United States Congress that it passed a law directing the Secretary of the Interior to investigate. Happily, the resulting Limnological (lake research) Monitoring Program, which continues to this day, found that the 1978-81 readings fell squarely within the normal range of variation. Clarity fluctuates quite a bit (see the graph above), but Crater Lake is as clean as ever.

Park scientists also monitor transparency with more sophisticated instruments. At least once a month each summer, they lower a proof of light meter into the lake to study the degree to which different wavelengths of light are able to penetrate. On average, they find that 1% of the sun’s visible rays penetrate to a depth of 130 feet (100 meters). That might not, at first blush, sound impressive. But even 1% of the sun’s visible rays are more than enough to support the survival of aquatic plants. Moss, for example, hangs from underwater cliffs as deep as 460 feet (140 meters) below the surface. Nowhere else in the world has moss been found thriving at such tremendous depths.

The ultraviolet (UV) part of the spectrum also permeates deep into Crater Lake. In fact, scientists in 2003 were amazed to discover that UV rays penetrate deeper into Crater Lake than was believed to be theoretically possible even in the purest of water. A benchmark of physics had to be reset! Crater Lake's transparency to UV light has a huge impact, it turns out, on its living organisms. Just as ultraviolet rays are harmful to humans—giving us sunburns and skin cancer—they are also hazardous to aquatic life forms. Moss doesn’t grow within 85 feet (26 meters) of the lake’s surface. Most of the lake’s 163 species of phytoplankton (tiny algae that form the basis of the food chain) hide out even deeper. You’d need to travel 260 feet (80 meters) below the surface to find them at their maximum abundance.

In a lake as clear as this one, small changes in water quality are easy to detect, especially compared with other lakes that aren't as clear. (continued on next page)

The Journeys of Deep Rover, Remembered

Visitors to Crater Lake often find themselves wondering if anyone has explored its depths. The answer is yes! In the summers of 1988 and 1989, a one-person submersible made 47 separate dives to the bottom. They were not sightseeing trips— their purpose was to collect data on the lake's hydrology, biology, and geology to resolve a controversy over geothermal energy development that was brewing on the borders of the national park. Today, the journeys of Deep Rover stand as a milestone in our understanding of the lake's ecology and our efforts to protect it. Let's revisit the discoveries and examine the legacy of this fascinating and important expedition.

Mark Buktenica was the park's aquatic ecologist from 1985 through 2017. Seen here at the controls of Deep Rover, he remembers the expedition as the experience of a lifetime: "What we found was not only scientifically interesting, it was spectacular—as spectacular as the scenery above the lake's surface." Beneath Crater Lake National Park lies a reservoir of restless magma. In the mid-1980s, a company from California announced its desire to build a power plant on public lands adjacent to the park. The plan was to use geothermal heat (in the form of steam) to spin turbines to produce electricity for San Francisco. They drilled an exploratory well, half a mile outside the park's eastern boundary, and reported temperatures above the boiling point of water just 1,350 feet (410 meters) below ground. The project aroused widespread concern. Might it adversely affect the plumbing of Crater Lake? The United States Congress stepped in, authorizing the Department of the Interior to suspend all drilling while the park investigated two unknowns: Are there any hydrothermal inputs into Crater Lake? And if so, are they significant in any way to the lake's ecology?

The National Park Service, US Geological Survey, and National Geographic Society teamed up to lease a submersible named Deep Rover from Vancouver, Canada. Flown by helicopter onto the lake, it was powered by batteries and could stay underwater for six hours as long as there was room for another occupant, who served both as pilot and scientist. Three men—an oceanographer from Oregon State University and Mark Buktenica, the park's aquatic ecologist—alternated dives. "At 83 feet below the surface, I was engulfed in blue that eventually turned to darkness," recalls Buktenica of his half-hour commutes to the lake floor. "The only sounds in the submarine were the creaking and popping of the hull as it adjusted to the increasing water pressure and the persistent hum of the carbon dioxide scrubbers cleaning the air." Fortunately, a radio allowed the men to communicate with the surface, and headlights on the sub allowed them to see. What they found was surprising—and spectacular! Clusters of yellow-gold bacteria grew in vast, fluffy mats, often around pools of aqua-blue water (see photo at right). Probes inserted into the bacteria mats registered temperature as high as 66°F (18.8°C), much warmer than the surrounding 38°F (3.5°C) lake water. The bacteria were surviving in the darkness by oxidizing iron for energy—iron introduced to the lake in warm, hydrothermal fluids from below. Some of the fluids then trickled into the aqua-colored pools, where, laden with minerals, they could not mix freely with the waters above. The fluids were greatly enriched in elements such as manganese, radon, lithium, and helium-3, indicating that they had once been in contact with hot, subterranean rock. Elsewhere in the lake, the team found 30-foot-tall (9-meter) (continued on next page)
Decline of the Whitebark Pine (continued from page 6)

The decline of the whitebark pine, and of the high-elevation forest community it supports, illustrates the importance of preventing the introduction of non-native species in the first place. Prevention, early detection, containment, and quick eradication of non-natives are key to avoiding costly and difficult mitigation efforts. It’s also a reminder, says Hooke, that “Even the most remote places are vulnerable to our impacts. The whitebark pine is a basically a wilderness species, but it’s in decline because of humans.”

Even so, Hooke remains optimistic. “We need to maintain hope,” she says. “Collective hope and action are very important, even if it’s in decline because of humans.”

Journeys of Deep Rover (continued from page 7)

rock spires, chameyros made of silica that had precipitated out of upwelling fluids at some point in the past. Bacteria were not the only life forms found thriving at great depths in Crater Lake. A variety of worms, insects, and tiny crustaceans were spotted as well. Although not dependent on the hydrothermal vent, they were remarkable for their ability to tolerate the extreme water pressures found in the lake’s deepest basin, 1,943 feet (392 meters) below the surface. Some were also notable for their life history. Adult flies of the genus Heterotrissocladius, for example, drop their eggs into the lake. The eggs sink slowly to the bottom, hatch into larvae, feed on lake floor sediments for perhaps two to three years, swim back up to the surface (pupating along the way), then emerge as winged adults. Two to three days later, the adults lay eggs and die, and the cycle starts again.

The discoveries of Deep Rover allowed Crater Lake to join the ranks of more visible species. The Crater Lake National Park Service units deemed to have “significant thermal features” worthy of protection under the Geothermal Steam Act, a law passed by Congress in 1970. Any future drilling or geothermal development on nearby public lands won’t be permitted if it’s likely to adversely affect those features. Deep Rover also furthered, by leaps and bounds, our understanding of the lake’s evolution and ecology. For the first time, the sub visited only 2% of the lake floor. Many secrets surely remain in the dark, watery depths of this collapsed volcano. Hopefully, someday, humans will return to explore the rest of the bottom of our nation’s deepest lake.

Volunteer Your Time

Looking for a hands-on way to help the park? Consider sharing your time and talents as a Crater Lake VIP (Volunteer-In-Parks). Full-time volunteers are needed to help staff visitor centers and present interpretive programs. Opportunities are advertised several times each year at www.volun- teer.gov. Volunteers are provided free housing in exchange for 3 months of service. To volunteer periodically, join The Friends of Crater Lake, a nonprofit whose members help with special events and operate a winter information desk at Rim Village. Learn more at www.friendsofcraterlake.org. Or join the Crater Lake Ski Patrol, whose members assist winter visitors and maintain the park’s cross-country ski trails. For more information, visit www.craterlakeskiplotal.com.

Report Your Wildlife Sightings

Scientists need your help! If you spot any interesting animals during your visit or witness any unusual behavior, please let us know! Your observations will help us learn which animals live in the park and how they use it. Species reported in 2020 included the northern saw-whet owl, police-car moth, pine marten, mountain lion, and gray wolf. To share your sighting, email craterranger.lovejoy@usda.gov. Let us know the date and precise location of your encounter, a detailed description of what you saw, and your name and contact info, in case we have follow-up questions. And if you captured any photos, send them along (ideally with permission for us to use them for reports and publications). Photographic evidence is very important for confirming the identity of some species. Just remember that approaching, feeding, or disturbing wildlife is strictly prohibited — so please keep your distance. Thanks for your participation!

Buy Crater Lake License Plates

If you live in Oregon, consider choosing Crater Lake license plates for your vehicle. For a one-time charge of $10, you can outfit your car with these beautiful plates while supporting park projects. You can purchase them at any time, not just when buying a new vehicle or renewing your registration. Visit any DMV office or www.oregon.gov/odot/dmv for details. Proceeds go into an endowment that funds the operation of the park’s Science and Learning Center, which provides living and working space for visiting scientists, teachers, and artists. The Center draws researchers and educators to Crater Lake from around the world, encouraging them to use the park as an outdoor laboratory and classroom. For more information, visit go.nps.gov/dlc.

Contribute to the Crater Lake Trust

The Crater Lake National Park Trust is a nonprofit that raises private funds to support park projects and protect the park with success stories, for example, it helps fund field trips here for more than 5,000 students. In a program called “Classroom at Crater Lake,” kids engage in hands-on science and learn about wildlife, old-growth forests, and winter ecology. Learn more at www.craterlaketrust.org. Share your love of the park by making a tax-deductible gift.

Share Your Comments

Whether you have a compliment, concern, or suggestion, we’d like to hear from you! This is your park, and we value your input on how best to manage it. To provide feedback, send an email or letter to the park’s Superintendent (see addresses on page 2).