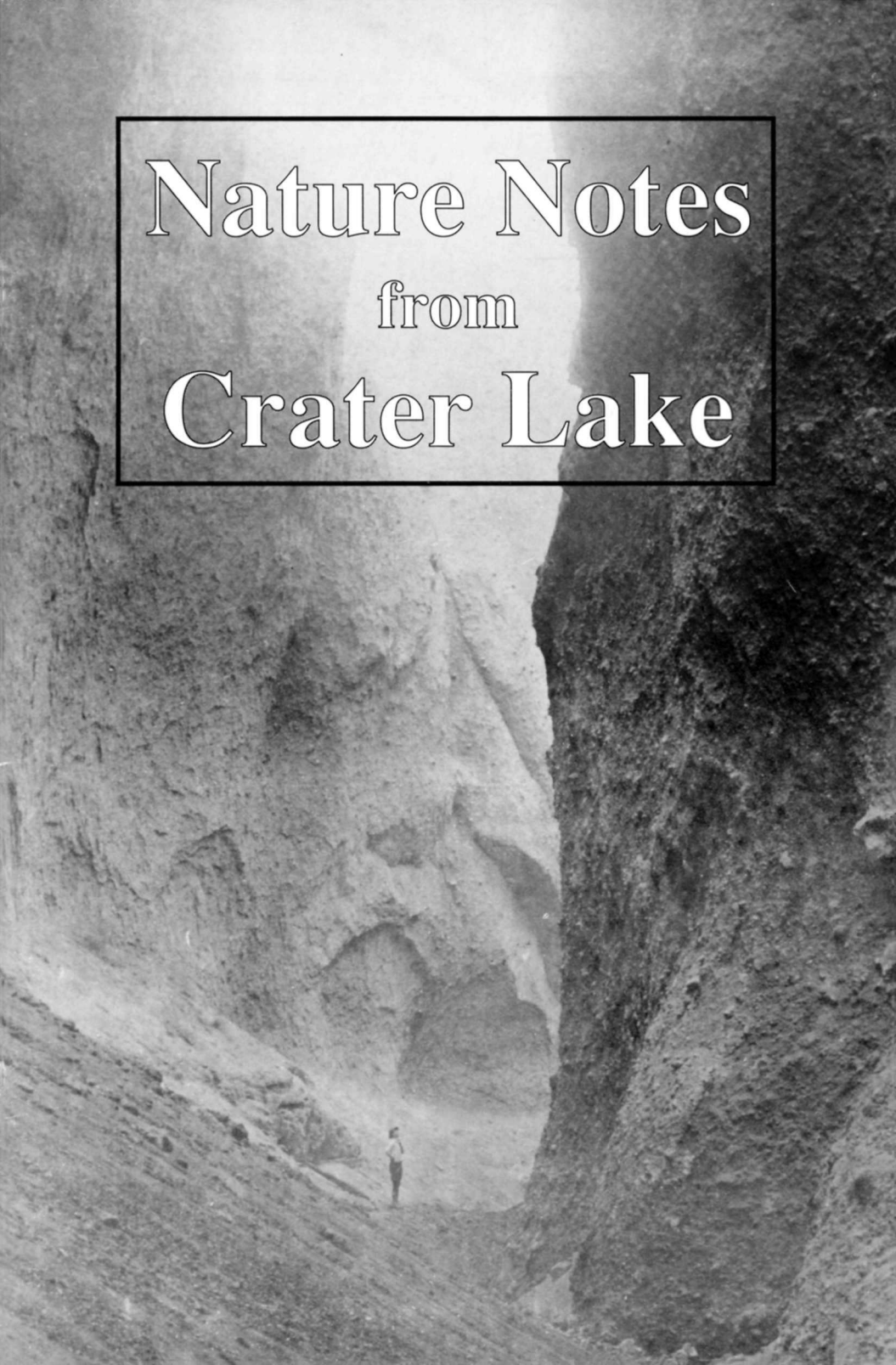


Nature Notes from Crater Lake



NATURE NOTES FROM CRATER LAKE

National Park Service
Crater Lake National Park

Crater Lake Natural
History Association

Volume XXIV - 1993

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Introduction

Last year's volume of *Nature Notes from Crater Lake* marked the first appearance of this publication in more than 30 years. The Crater Lake Natural History Association decided there was sufficient visitor interest for a 1993 edition because the limited number of copies in 1992 sold quickly. Contributors responded enthusiastically, so this volume is larger than last year's effort.

Nature Notes share a common characteristic of being original research or observation relevant to the visitor experience at Crater Lake National Park. In most cases these articles have not been published previously. All of the authors are employees of the National Park Service, but their contributions were made primarily on a volunteer basis. Reprinting *Nature Notes* articles is encouraged, as long as credit is given to the authors and the Crater Lake Natural History Association.

This volume begins with an article on the park's 1992 northern spotted owl survey. The results changed the way Crater Lake National Park has been viewed relative to the habitat it provides for the bird. Lori Stonum's piece and the others that follow it serve to underscore the point made in last year's lead article that Crater Lake National Park continues to be a vibrant field for scientific research.

The Crater Lake Natural History Association was established in 1942. Its purpose is to aid the National Park Service in educational, scientific, cultural, historical, and interpretive programs. Toward this end it sponsors this volume of *Nature Notes from Crater Lake*. The association operates three publication sales outlets, two at Crater Lake National Park and one at the Illinois Valley Visitor Center in Cave Junction, Oregon. Proceeds from sales items are used entirely to support the association's goals. A list of items for sale can be obtained by writing to the Business Manager, Crater Lake Natural History Association, P.O. Box 157, Crater Lake OR 97604.

Kent J. Taylor
Chief of Interpretation

Spotted Owl Survey

By Lori Stonum

The northern spotted owl (*Strix occidentalis caurina*) is one of three subspecies of spotted owls. It is a medium-sized forest owl distinguished by its large brown eyes and mottled brown and white breast. The spotted owl is a monogamous, long-lived species, that is mostly nocturnal. Ranging from southern British Columbia to northern California, it is found on the east and west slopes of the Cascade Range and on the Olympic Peninsula. Spotted owls live mostly in low elevation coniferous old growth forests and have a limited seasonal migration.

The first recorded observation of a spotted owl at Crater Lake National Park was in 1934. Between 1934 and 1978, there were several other sightings reported. The first surveys of the spotted owl at the park were conducted in 1978 in cooperation with the Oregon Department of Fish and Wildlife and the U.S. Forest Service. Sporadic studies have been conducted since then, but a complete census was never conducted. Until 1986, studies within the park concentrated on the west side of the Cascade Range. When the surveying resumed in 1990, the southern portion of the park was included. The 1990 and 1991 surveys, however, consisted only of two-day projects with limited coverage of the park's spotted owl habitat.

A more comprehensive survey of the northern spotted owl at Crater Lake National Park commenced in May 1992. This was the first year that a study of spotted owls in the park was conducted according to standard protocol. Survey sites were determined based on historic spotted owl sites, areas of good habitat, and the location of proposed construction within the park. Since the survey was started late in the season compared to others in the region, we concentrated on historic owl sites and future construction zones, making them our priority. New sites were added as time became available.

Overall, the number of owls found at Crater Lake in 1992 was unexpected. We now know that the park holds greater significance for spotted owls than previously thought. During the 1990 and 1991 surveys, two pairs and one single male spotted owl were found each year. By the end of the 1992 field season, we had located seven pairs of spotted owls. Six of the seven pairs had two juveniles. Three single owls of unknown reproductive status were also found, making a total of 29 owls found in the park. Of these, 12 owls were banded with the help of the Oregon Department of Fish and Wildlife so that the owls can be identified in future studies.

The 1992 spotted owl survey produced two significant findings. One was the large number of owls located on the east side of the Cascade Range. Four pairs of spotted owls found in the park this year were on the east side of the Cascades, which was somewhat unexpected when considering that most spotted owls are found west of the mountains. The second finding was the relatively high elevation at which several owl pairs were living. For two years in a row, Crater Lake National Park has held the state record for the highest elevation at which a spotted owl pair was found. The

Annie Creek site was the 1991 state record at 1829 meters (6000 ft.), and in 1992 it was the Crater Peak site at 1996 meters (6550 feet). In future studies we hope to be able to focus on these east side and high elevation sites to determine if there are factors influencing the owl's range and reproductive status, as compared to west side and lower elevation sites.

There is still a lot of work to be done in the park on spotted owls. Less than 30 percent of the 50,000 acres of spotted owl habitat existing within Crater Lake National Park was surveyed. Considering the exciting results of the 1992 survey, the potential for even greater numbers of owls existing within the park is very high. If the spotted owl program at Crater Lake can continue to expand and survey more of the suitable habitat, perhaps the complete status of the spotted owls at Crater Lake could be better known.

Native Species Protection and Exotic Species Control: A Bull Trout Restoration Project in Sun Creek

by Mark Buktenica

Bull trout (*Salvinus confluentus*), and dolly varden (*Salvelinus malma*), were once considered to be the same species. They are now considered to be distinct species based on genetic, morphological and behavioral differences. In general, bull trout are an inland, freshwater form, whereas dolly varden spend much of their adult life history in the ocean before returning to freshwater to reproduce.

Although bull trout were once found in most major river systems in the Pacific Northwest and Canada, their distribution has been significantly reduced over the past 30 years, and many populations have become extinct. Habitat degradation and introduction of non-native and exotic fish species are believed to be the primary causes for the recent decline. The Klamath River Basin in Oregon is the southern limit of bull trout populations today. These populations are genetically distinct from other Pacific Northwest bull trout populations and qualify as a separate species for consideration under the Endangered Species Act. Bull trout are currently listed as a category 2 species (candidate species under the Endangered Species Act) by the U.S. Fish and Wildlife Service. The American Fisheries Society has petitioned the U.S. Fish and Wildlife Service to list the Klamath River Basin bull trout as an endangered species.

A 1947 stream survey in the park's Sun Creek drainage indicated that bull trout were well distributed in the headwater stream along with brook trout (*Salvelinus fontinalis*) that were stocked into the stream in the early part of this century. A survey of the fish populations and instream habitat in Sun Creek in the summer of 1989 revealed that the bull trout population was reduced to 130 adult fish and restricted

to a 1.9 km (1.2 mi) section of the stream (see map). Brook trout were distributed throughout the stream. Hybridization and competition with the introduced brook trout appeared to threaten the bull trout population with a high risk of extinction.

This alarming information led the park to draft a bull trout restoration plan in 1990. The objectives of the plan were to restore the remnant population of bull trout to historic numbers and distribution in Sun Creek, remove the introduced brook trout, and prevent the re-invasion of non-native species from waters outside of the park in the future. The plan called for additional research in 1990 and 1991 to verify the distribution and abundance of the bull trout, evaluate stream chemistry, temperature, flow, retention and travel time, and conduct surveys of amphibians and aquatic insects, with an emphasis on looking for rare, threatened and endangered taxa. Laboratory tests were conducted to determine the specific toxicity of the fish toxin Antimycin on trout in Sun Creek water. Alternative locations for a "back-up" population of bull trout were evaluated, including hatcheries and isolated creeks within Crater Lake National Park. Also evaluated were alternative methods for fish removal.

In October 1991, a peer panel and recovery team was assembled to evaluate the research to date and the recovery plan, as well as to offer recommendations on implementation of the plan. The peer panel included personnel from the National Park Service, U.S. Fish and Wildlife Service, U.S. Forest Service, Oregon Department of Fish and Wildlife, Oregon State University, and the Desert Fishes Council. Panel members had expertise in fish population restoration, fish toxins, electrofishing, fish barriers, genetics and fish and macroinvertebrate ecology.

The long-term goal of the plan was to eradicate brook trout from Sun Creek within the boundary of Crater Lake National Park. An immediate objective was to remove as many brook trout as possible from the portion of Sun Creek within the park. This would allow bull trout to increase in number and disperse downstream. The loss of any bull trout during the removal process was not an acceptable risk, as the viability of such a small population was already in question.

During the summer of 1992, a restoration program was initiated. Two log and rock fish migration barriers were constructed in Sun Creek near the park boundary to prevent the re-invasion of non-native fishes. The structures created an elevated stream channel and an artificial waterfall in a naturally constricted section of the stream. If the downstream barrier were to fail, the upstream barrier would prevent brook trout from immigrating further upstream into the park before the lower barrier could be repaired.

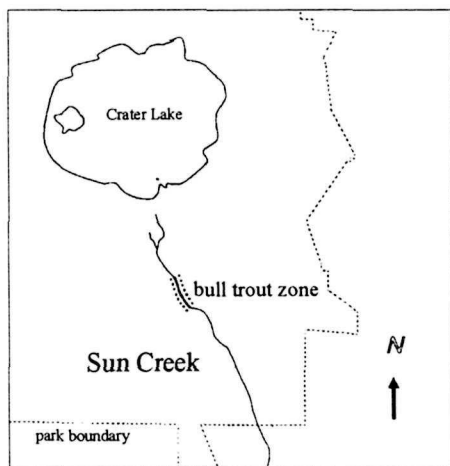
Brook trout were removed from Sun Creek with non-lethal electroshockers upstream of the bull trout population. Starting at the headwaters of Sun Creek, fifty meter sections of stream were blocked off with nets. Each section was electrofished until no fish were captured two out of three passes up the stream. This process was repeated two more times during the summer. Data were collected on fish weight, length, sex, abundance, biomass, and distribution.

Recent literature suggested that electroshocking may have higher injury and mortality rates on fish than previously believed. Therefore, electroshocking for brook trout in the bull trout section of the stream was tried with caution in 1992 and abandoned when the bull trout showed signs of stress. Alternative methods for removal of the brook trout in the bull trout section are now being evaluated. A special study was conducted in the fall of 1992 to evaluate rates of injury to brook trout from three different types of electroshockers. The data have not been evaluated at this time.

Non-lethal samples of fin tissue were removed from brook trout, bull trout, and brook trout-bull trout hybrids in 1992. These samples will be used for genetic analyses to evaluate hybridization and to compare the genetic make-up of Sun Creek bull trout with other populations located in the Klamath and Columbia basins. Results of the study are not yet available.

The recovery team agreed that electroshocking techniques would not be effective in fish removal downstream of the bull trout owing to increased stream flow and structural complexity of the stream channel. Therefore, brook trout were removed with Antimycin. This is an antibiotic that is extremely toxic to fish at dosages as low as 4 parts per billion. Antimycin is not toxic to mammals and birds, but is toxic to amphibians and to many species of aquatic insects. The Antimycin was successfully neutralized below the lower barrier and upstream of the boundary with potassium permanganate. Brook trout were collected at block net stations and by "dip-netters" along the stream. No amphibians were collected and preliminary observations suggested that insect mortality was low.

A sampling program will be initiated in 1993, supported by funding made available through the National Park Service. The objectives of the program are to monitor the recovery of insect and bull trout populations and to continue the removal of non-native brook trout.



Bull trout distribution in Sun Creek, Crater Lake National Park, Oregon



Falco peregrinus

Peregrine Falcons Soar Over Crater Lake

By Scott Stonum

Peregrine Falcons (*Falco peregrinus*) are crow-sized falcons that are distributed throughout the world. Their diet consists of other birds. Chemicals such as Dichloro Diphenyl Trichloroethane (DDT) tend to accumulate in their system because the peregrine is at the top of the food chain. DDT, which was banned in the United States in 1972, has caused thinning of egg shells and dehydration. The chemical continues to be a problem because the pesticide is still being used in Mexico and South America, where many peregrines or their food sources migrate.

The only known active peregrine eyrie in Oregon in recent years was at Crater Lake National Park. It was discovered in 1979, and remained active until 1983, when both adult birds disappeared. Although the birds in the eyrie successfully fledged young in 1979, they were unsuccessful in 1980. Each of the three eggs laid the second year showed high levels of a derivative of DDT. As a result, young peregrines were fostered into the nest in 1981 and 1982.

When both adult peregrines disappeared in 1983, a method of releasing birds into the wild known as hacking was initiated. Twelve young were hacked over the next four years. Roaming peregrines were seen at the hack site in all four years, and non-breeding peregrines were seen in other areas around Crater Lake. An active pair was present at the historic eyrie in 1986, but successful breeding did not take place.

Nesting again took place at Crater Lake in 1987. The nest was manipulated to ensure that the pair would successfully fledge young. Four eggs were removed from the nest, three of which hatched and were fledged in California. Two captive-bred young were fostered into the Crater Lake eyrie. Unfortunately, one of the young was

killed by a great horned owl (*Bubo virginianus Gmelin*). The other bird successfully fledged.

The peregrines again used the historic eyrie in 1988. They laid four eggs, of which three hatched. Approximately twelve days later all of the young and the adult female were killed by a great horned owl. In order to ensure fledging of peregrines in the Crater Lake area it was decided to cross-foster young peregrines into a nearby prairie falcon nest. This effort was successful in fledging two peregrines that year.

It is believed that the male returned with an immature female in 1989 and 1990, but monitoring during those years was limited. In 1991 the historic eyrie was again active. An adult peregrine pair was successful in fledging three young without any manipulation. Of interest was the male of the pair being identified as a released bird due to the band on its leg. The spring and summer of 1992 was also a successful breeding season for the falcons. Two eggs were produced in the eyrie with both young subsequently being fledged.

The successful fledging of young peregrines during the past two years is very promising and is the result of much effort and patience. The site will again be monitored during 1993. Should the falcons continue to nest at the same eyrie, steps may need to be taken to monitor great horned owls in the area and to evaluate the effects of predation on the peregrines. Although the hatching success in recent years has been good, analysis of the eggs shows significant thinning and that the female was subjected to pesticide contamination.

Air Quality at Crater Lake

By Heidi Lyn Ross and David Lee Fuller

Most people visiting Crater Lake find themselves in awe of the beautiful blue water. When they gasp at the beauty, they should also realize that they are breathing some of the cleanest air in the world.

The air is so pure at Crater Lake that on the clearest day you can see at least 190 miles, and occasionally to the 240 mile limit. Actual day to day visibility at Crater Lake averages about 105 miles.

There are some threats, however, to Crater Lake's air quality. Klamath Falls and Medford, each about 55 air miles from Crater Lake, are non-attainment areas in the state; this means that these cities do not comply with Oregon's goals for air quality in populated areas. Nevertheless, the small amount of pollution we do have is not directly associated with an urban or industrial corridor. Weather patterns in those areas usually trap the pollutants to the ground. At Crater Lake, air movement is generally characterized by westerly winds associated with the presence of weather systems formed over the Pacific Ocean. Air pollution over the park is usually particulate from slash burning, wildfires, and agricultural burning.

One big reason efforts are being made to protect our air is that preserving scenic vistas is a boon to tourism. Although fire danger is a compelling reason to prohibit slash burning during the summer months, land managers want to keep visibility at its best during the tourist season. Oregon hosts 11.8 million visitors every year who spend over \$1.4 billion in the state. Roughly \$17.4 million of that total is spent to visit the state's wilderness areas, including Crater Lake National Park.

The National Park Service and the Oregon Department of Environmental Quality monitor the air at Crater Lake in four different ways:

Standard Visual Range (SVR) data is collected by a 35mm camera which photographs a vista of known distance three times a day. Calculations are made of how far past, or in front of a known target the horizon can be seen in the photograph. Estimates of how many particles are in the air are made by calculating how well the target contrasts with the area in front of it and behind it. There are three SVR cameras in the park. One is located on Dutton Cliff and another is on Watchman; both are aimed at Yamsay Mountain to the east of the park. A third camera is at Rim Village, where it can view Mount Theilson to the north of Crater Lake.

The **Transmissometer** has a transmitting station at Rim Village that sends a light beam across the lake to a receiving station at Wineglass on the northeast side of the lake. By calculating how much light is sent and how much is received, the amount lost traveling from one site to another can be determined. The light is scattered by particles in the air, so the more light received, the cleaner the air.

The **Nephelometer** is an instrument that takes air into a vacuum tube and sends light through the sample. It then measures the intensity of light that is scattered by particles contained within the instrument's optical path. The less the light is scattered the cleaner the air. The park's Nephelometer is located at Rim Village.

Finally, the **Improve** pulls air through many different filters. Each filter is a different degree or size, meaning each filter will catch a different sized particle. To see what particles are in the air, each filter is chemically analyzed. This device is located at Park Headquarters.

Through use of this technology and other indicators, we know that the air quality over Crater Lake has been impacted by human activities. Presently, naked eye visibility at Crater Lake National Park is substantially impaired for 4.6 percent of all daylight hours. Nevertheless, this figure is impressive when compared with stations further north in Oregon. Crater Lake is, in fact, often the standard used when judging air quality in other areas. By contrast, Mount Hood's visibility is impaired 21 percent of the time, while Mount Washington's figure is 42 percent and Portland's is 85 percent.

Although a 4.6 percent impairment index may seem satisfactory when compared to other areas, this may rise to five, ten, or even 20 percent without the cooperation of people. We all have a responsibility to ensure clean air--our next breath depends on it.



Where Have the Whitebark Pines Gone?

By Steve Mark and Ron Mastrogiuseppe

Even a cursory glance at the landscape reveals that vegetation is not distributed at random, but occurs in mosaics as an expression of several interacting variables. The whitebark pine (*Pinus albicaulis*, meaning white-stemmed pine) is a tree found at Crater Lake National Park generally above 6500 feet on exposed slopes in dry, rocky soils. This tree is easily identified by its whitish-gray bark and often twisted branches. Although Crater Lake National Park has no true timberline, whitebark pine forms the elfinwood or krummholz of timberline in many western mountain ranges.

Whitebark pine is a pioneer species colonizing subalpine habitats as the first tree. An amazing example of its pioneering ability can be seen at the Newberry caldera where whitebark pine is the only tree established upon the relatively recent obsidian surface; even the nearby lodgepole pines (*P. contorta*, *subsp. murrayana*) abruptly end near the toe of the flow. At the Crater Lake caldera, whitebark pine may have been the first tree to colonize the pumice slopes of old Mount Mazama within the first century following the climactic eruption. Whitebark pine is generally encountered as a pioneer tree, as there are several places around the caldera rim where old mothere trees provided a favorable microclimate for the establishment beneath their canopy of subalpine fir (*Abies lasiocarpa*) or mountain hemlock (*Tsuga mertensiana*). Whitebark pine is arranged in ribbons or bands along the contours of Cloudcap and other habitats along the caldera's edge. These sites represent slightly higher, rocky substrate for the survival of whitebark seedlings since exposed areas devoid of snow earlier in the year have a significantly longer growing season.

Most pine seeds have wings for wind dispersal, but whitebark seeds have retained only a rudimentary wing. The dispersal agent has become the Clark's Nutcracker (*Nucifraga columbiana*). These birds have learned to retrieve whitebark seeds with their specialized beaks, storing a number in their sublingual pouch, and methodically storing seeds in soil caches. Only a fraction of the seed caches are retrieved, however, so some caches sprout seedlings in clumps which may grow into larger whitebark pine colonies.

Whitebark pine appears to be sensitive to a certain set of environmental conditions. Although it is often viewed only as an indicator of a short growing season and cold temperatures, this species occupies a niche in the subalpine forest that is far from simple. The tree can be found in relatively pure stands or in association with lodgepole pine and western white pine (*P. monticola*). The distribution of related species like limber pine (*P. flexilis*), bristlecone pine (*P. longaeva*), and foxtail pine (*P. balfouriana*) somewhat overlap that of the whitebark and can occupy what would often seem to be the latter's place forming the edge of timberline. Whitebark pine's distribution poses some nagging questions to dendrologists. For example, it provides the name for Nevada's Pine Forest Range but mysteriously remains absent in similar subalpine habitats on Steens Mountain in southeastern Oregon, only several air miles to the north. In southern Oregon, the whitebark pine may have disappeared on Mount Ashland in recent times and is presently almost gone from the top of Crater Lake's Wizard Island.

One of the reasons that whitebark and other pines are often so puzzling is that species of *Pinus* display much variation as well as many similarities. For example, whitebark pine and limber pine (the rarest native coniferous species in Oregon, but more common in the Great Basin and northern Rockies) mimic each other in many characters. Similarly, the ponderosa pine (*P.*) found along Annie and Sun creeks, for instance, display a strong Washoe pine (*P. washoensis*) element. This is thought to be a high elevation variant of the ponderosa's northwestern distribution and may account for its presence at higher elevations inside the caldera. Genetic variability in the park's whitebark pine may not be as great as in the ponderosa forests, but the loss of a population as small as the one on Wizard Island may imperil a distinct local seed source.

What is disturbing about the whitebark pine of Wizard Island is their seemingly rapid decline. Photographs taken at various times through the 1960s show living trees on top of the island. By July 1991, however, the authors could find only one living specimen. This small population's relatively sudden nosedive may be due to one or several causes. Might it be human activity, air pollution, drought, mountain pine beetle, or blister rust infection? The whitebark's decline is more likely tied to a combination of these factors, which makes the testing of single hypotheses (a key to the application of scientific method to the problem) very difficult or, at best, inconclusive.

Efforts aimed at monitoring environmental change in national parks like Crater Lake are generally handicapped by the lack of critical baseline information. Material

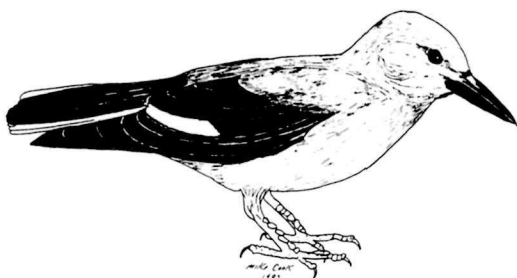
available to the historian may help to reconstruct past conditions, but investigators should be aware of their possible shortcomings. The documentary record is limited to the historic period, whether it is in the form of photographs or writings.

Repeat photography is constrained by the scale and resolution of the original photo, as well as by the identifiable background features that allow a view to be replicated. Observations about the condition of flora throughout the park are usually fragmentary. Some describe what would seem to be unlikely events, even though the journalist may otherwise be credible. One example is a newspaper article of 1903 where Klamath Falls hotelier and photographer Maud Baldwin noted that Wizard Island was “alive with grasshoppers.” Sufficient detail or locality data to verify an observation can be a problem, too. Much effort was expended by Crater Lake’s chief park naturalist in the 1960s trying to track down a colleague’s discovery of the prostrate juniper (*Juniperus communis*) specimen probably living near the Watchman in 1929.

Other changes that might have occurred during the historic period lack any form of documentation. Just one of many examples in the park is the poor condition of Sun Meadow’s vegetation when compared to the floral mosaic of Sun Notch. Simplistic explanations, such as sheep grazing prior to the park’s establishment or a poor soil nutrient budget, are often offered by park staff when the limitations of available evidence or funding seem to frustrate efforts to study the situation further.

What the whitebark’s disappearance on Wizard Island may illustrate, as have the attempts to understand fluctuations in Crater Lake’s clarity, is that we really understand very little about the park’s ecosystems. Certainly more research is essential, but the limitations of available data have to be accepted since causation may be due to a number of factors not easily separable into testable hypotheses. Instead of certainty, all history and science can yield is a prediction of possibilities if the limitations affecting available evidence can be overcome through sound methodology.

Explanations based on models of complexity rather than simplicity will have to be complemented, however, by a willingness to admit that sometimes we do not have all the answers. Since whitebark pine ring the summit crater which provides the lake’s name, what better symbol of uncertainty could there be for a phenomenon as complex as Crater Lake?



Drought and the 1992 Pond Survey

By Roger Brandt

Introduction

The summer of 1992 arrived with a combination of circumstances that may earmark this season as having the most extreme drought conditions ever recorded in the history of Crater Lake National Park. Two factors were instrumental in making this happen. First, Crater Lake National Park experienced a very dry winter and spring from December 1991 to May 1992, with snowfall for that period being 45 percent of the average amount. This has a historic significance because it marks the lowest accumulations of snowfall in the 60 year weather record of Crater Lake National Park. Second, the summer of 1992 marks the sixth consecutive year of drought in this region, though below average precipitation has been the rule for all but three years in the past fifteen. Inasmuch as the park's surface water resources were already under stress, the record low snowfall of this winter and spring intensified the scenario.

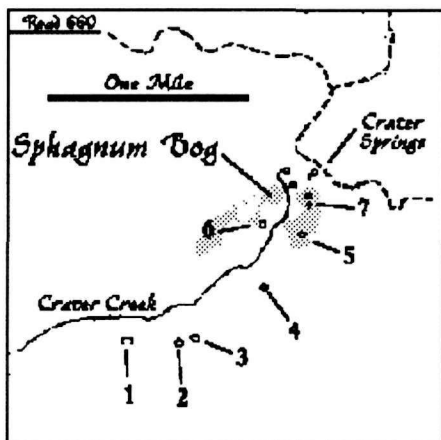
Six Ponds That Survived the Drought

Twenty eight ponds are located inside the boundaries of Crater Lake National Park, with most situated in the western half of the park. The majority of these ponds have depths of two to four feet when filled with water and have maximum diameters ranging from 30 to 200 feet. Spruce Lake is the largest of the ponds, with a maximum depth of about 12 feet and a length of over 300 feet. Several ponds in the Sphagnum Bog area and on Whitehorse Bluff have maximum depths of six to eight inches and diameters of 20 to 50 feet. All of the ponds appear to be filled only by direct rain or snowfall rather than by surface water. Some subsurface inflow is a possibility in a couple of ponds. The ability of these ponds to sustain appreciable water levels through the dry summer seems to be governed by the substrate that forms the basins where these ponds are located. Ponds which are poised in depressions on the surface of lava flows, like Quillwort Pond and Whitehorse Pond #3, for example, are the most persistent, whereas ponds poised in pumice fields from Mount Mazama's climactic eruption, like Spruce Lake and Lake West, are the least persistent.

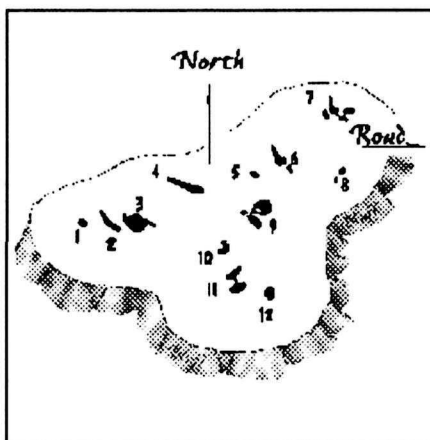
During the summer of 1992, it is likely that only six of the twenty eight ponds in Crater Lake National Park did not dry up before the first substantial storms came in mid October. These ponds are listed in the table and can be found on the 1:62,500 topographic map of the park published by the U. S. Geological Survey. The figures delineate the locations of ponds in the Sphagnum Bog and Whitehorse Bluff areas.

NAME/LOCATION OF POND	DATE OF SURVEY	WATER DEPTH	NOTES
Sphagnum Bog #2	9 Aug 1992	1 ft.	May have received subsurface water from Sphagnum Bog Pond #3
South of Castle Point	25 Aug 1992	8-10 in.	Large salamander population
Whitehorse #2	2 Sept 1992	1 ft.	May be receiving subsurface water from Whitehorse Pond #3
Whitehorse #3	2 Sept 1992	2+ ft.	Possibly the most robust pond in the park
Quillwort Pond	24 Aug 1992	2 ft.	Water level was about the same when observed by others in mid-October
North of Pumice Flat	10 Aug 1992	2+ ft.	Heavily used by elk

Most persistent ponds of Crater Lake National Park. (see maps for the numbering system used with ponds in the Sphagnum Bog area and on the Whitehorse Bluff.)



Sphagnum Bog ponds



Whitehorse Bluff ponds

Lake Level Bottoms Out

By Thomas McDonough

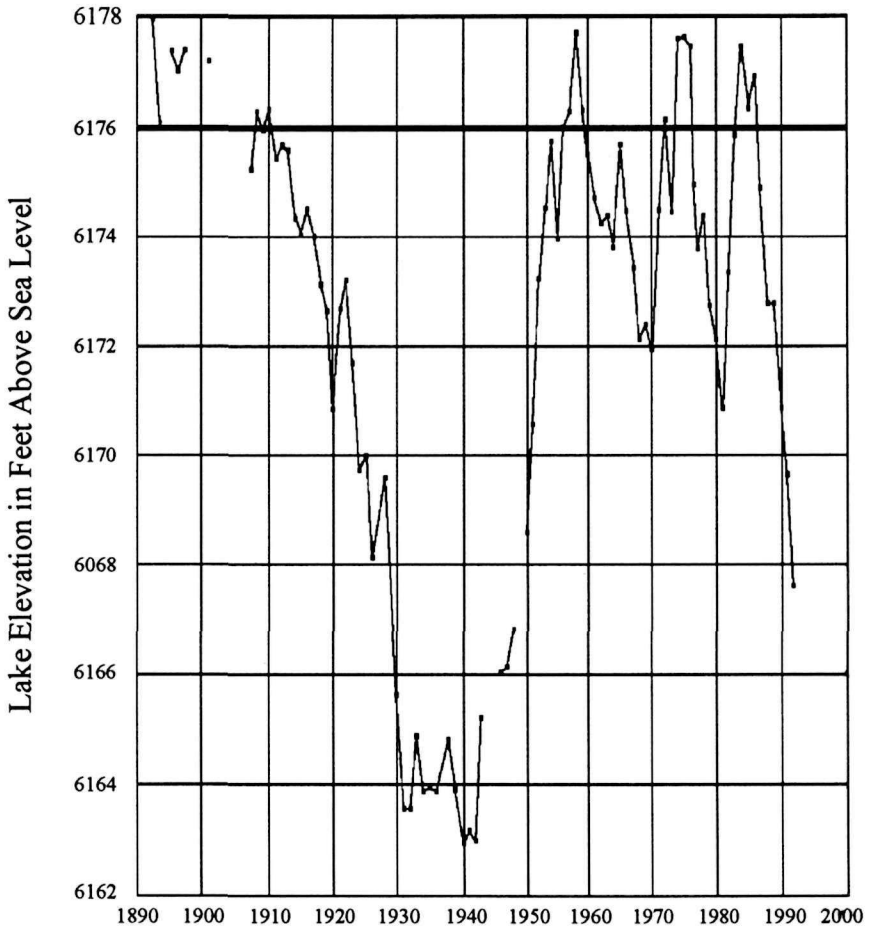
The lowering in the surface level of Crater Lake recorded during the last few years could be over. A return to a more average winter pattern where snowfall amounts exceed 500 inches has already been realized in 1992-93. This snowpack, and any additional precipitation, should all but stop the decline in lake level observed since 1986.

The rise and fall of Crater Lake's level this century is connected closely to the fluctuations in the region's weather. Lake levels have been observed and recorded since early this century. Crater Lake was at its deepest in March of 1975 when the lake level measured 6179 feet above mean sea level. This is 16 feet above its lowest point, which was measured in early September of 1942. In 1959, when the U.S. Geological Survey measured the depth of the lake and found it to be 1,932 feet deep, the lake level was 6,176 feet above sea level. This is a good indication that the lake level is always in flux.

Lake level is primarily affected by annual precipitation. For the lake to retain the same level observed the year before, 66 inches of precipitation must be recorded at Park Headquarters. This would come largely as snow and approximates to roughly 530 inches of annual snowfall. If more is received, the lake will be higher during the following summer. If less is recorded, the lake level will fall. A declining lake level has been the case for the last six years. Only 243 inches of snow fell from July 1, 1991 to June 30, 1992. In late September of 1992, at the end of the water year, Crater Lake's level fell below 6,169 feet. This is close to levels seen in the 1940s and therefore represents a fifty year low. Crater Lake has, however, not been alone among lakes in the region. Upper Klamath Lake and reservoirs throughout southern Oregon also dropped to levels not seen for decades.

If precipitation patterns observed earlier this century are used, Crater Lake will require six years of greater than average snowfall to regain the volume of water lost since 1986. It is likely that the lake will take many more than six years to reach higher levels again. Forecasting future weather patterns and associated lake levels is, at best, risky. Nevertheless, we seem to be at the end of a dry cycle that has been expressed by a drop in Crater Lake's surface level.

Crater Lake Surface Variation September 30th



Observed elevation of the lake surface this century. The surface elevation of 6,176 feet is 1,932 feet above the deepest part of the lake. Gaps in the chart are due to periods when measurements were not taken.

Annie Spring Responds to Long-term Drought and Municipal Water Use

by Mark Buktenica

Crater Lake National Park has recently experienced one of the most significant droughts in recorded history. The total precipitation of the past three water years is the lowest three-year sum since records began at Park Headquarters in 1931. Surface elevation of the lake itself has dropped from 6,178 feet in 1984 to less than 6,168 feet in 1992.

Water for park municipal use is drawn from Annie Spring, the headwaters of Annie Creek. The U.S. Geological Survey has maintained a gauging station on Annie Creek since 1977, shortly after the park moved its water intake facility from Munson Spring to Annie Spring. The gauging station is located directly beneath the road crossing several hundred feet below Annie Spring. Although the water intake is located at the spring origin, there are no discharge data for this site. The origin is not the creek's sole source of water, as stream discharge increases several fold between the spring and the road crossing. Nevertheless, discharge data is taken at the gauging station in cfs (cubic feet of water per second) during the water year, which runs from October 1 to September 30.

During the winter of 1993, Annie Creek discharge is expected to drop to its lowest level in the 16 year period for which records have been kept. A typical hydrograph, or flow pattern, for the creek shows flow decreasing through the fall and winter, reaching minimum values in March or April (see chart). Spring flow responds rapidly to snow melt increasing in April or May and peaking in June. Estimated flow values for December 1992 (.43 cfs) are 23% of the 1977-1987 mean for December (1.9 cfs). Discharge values for 1977 through 1991 are adjusted to include water withdrawal from the spring. Values for 1992 and 1993 represent gauge recordings plus estimated water withdrawal rates based on preliminary data analysis.

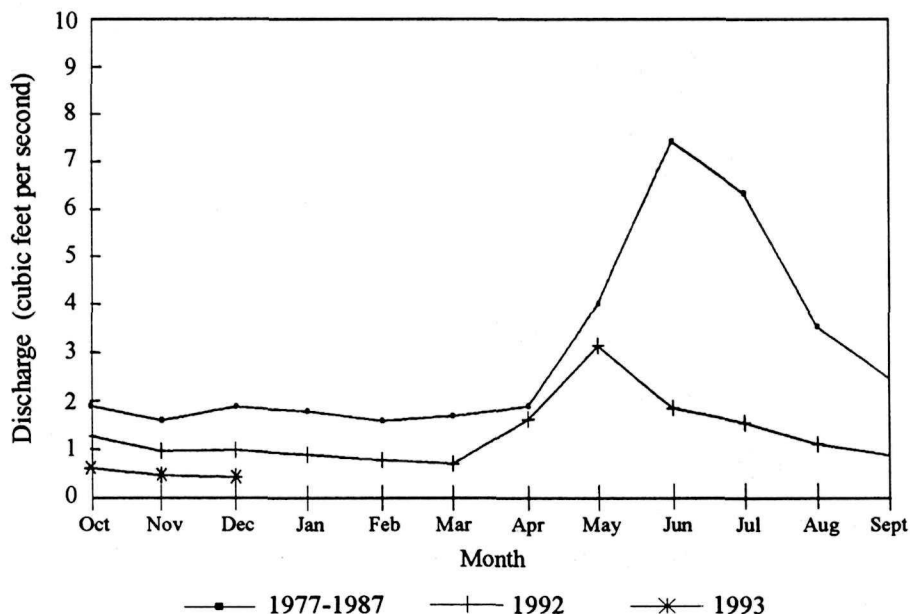
Although discharge is currently low, this is not the first time low flows have been recorded. Minimum gauge values of .41 cfs and .39 cfs were recorded on March 18, 1989, and April 29, 1991, respectively. No water intake problems were noted during 1989 and 1991. Municipal water withdrawal has increased from approximately nine million gallons in 1990 to over 13 million gallons in 1992, compounding trends in reduced spring discharge. Water use increased in each of the three developed areas that withdraw water from Annie Spring (Munson Valley, Rim Village, and Mazama Village). There were no dramatic increases in water use in Munson Valley, Rim Village and Mazama Village during fall and winter 1990-1992. Mazama Village was open, however, for the first time during the months of November and December in 1992. The most dramatic seasonal increases in water use occurred in Mazama Village and Munson Valley in June, July, and August. Water use increased in Mazama Village from approximately 500,000 gallons in July, 1990, to 1,100,000 gallons in July, 1992. In Munson Valley water use increased from approximately

370,000 gallons in August 1990, to 990,000 gallons in August 1992. There is a trend toward increased water use during the winter months. This trend is expected to continue during the winter of 1993 (without water conservation) as Sleepy Hollow housing area at Park Headquarters is near full occupancy.

Accumulated snow fall as of January 12, 1993, was above the long-term average for that date. If snow fall trends continue, Annie Spring will recharge and attain average or higher flow rates corresponding closely in time with snow melt. The timing of snow melt, however, can only be approximated

In summary, during the winter of 1993, Annie Spring will likely reach the lowest recorded discharge values since the gauge was installed in 1977. Compounding this problem is increased municipal water use and water withdrawal from the spring. The creek appears to have adequate flow to meet water demands, though the current catchment and withdrawal system is probably not adequate to capture enough flow if current water use and spring flow trends continue. The design of the water system obviously warrants re-visiting, especially with more park development proposed and increased visitor use projected. In light of this new information, it is advisable to make new projections of future water use to determine if Annie Spring can support water withdrawal projections without violating water right allocations or instream flow requirements for channel processes and stream biota.

Annie Creek Mean Monthly Discharge (cfs) By Water Year



Ground Squirrel Activity at Rim Village

By Roger Brandt

Sixty Years of High Density Squirrel Populations

The feeding of ground squirrels by visitors in the Rim Village area probably began before the Crater Lake Lodge was constructed in 1909, at a time when camping was allowed anywhere along the rim. In all probability, this further increased after 1928, when the parking lot and cafeteria at Rim Village were constructed in their present locations and the Crater Wall trail was opened (the latter served as the access to the lake until 1959 and is now closed; its trailhead was along the promenade in front of the cafeteria). By the late 1930s, squirrel populations were high at Rim Village and were mentioned by Kenneth Gordon in his The Natural History and Behavior of the Western Chipmunk and Mantled Ground Squirrel, published in 1943. Obviously impressed with the unusual density of ground squirrels at Rim Village, he wrote "...a peanut concession at one of these points should net a tidy sum..."



Feeding Ground Squirrels

Visitors and ground squirrels meet at the historic location of the Crater Wall trail.

Dr. Gordon's impression of the squirrel populations at Rim Village may have been based on research he conducted on golden mantled ground squirrel populations in several campgrounds located in Washington State. He concluded in those studies that a population density of five squirrels per acre was well above the population density found under natural conditions. This can be put into perspective by the figure cited in a 1947 paper by Orthello Wallis titled Mammals of Crater Lake National Park. Wallis wrote "...in 1938, there were 150 squirrels, by actual count of marked specimens, between the lodge and the head of the lake [Crater Wall] trail." Since most of the squirrels live inside the caldera rim within 200 feet of the promenade, this area of roughly four acres provided habitat for approximately 37 squirrels per acre at that time. This figure is equivalent to a population density over seven times that of what Kenneth Gordon considered as "crowded".

In 1951, seasonal naturalist Ralph Heustis conducted a ground squirrel study along the promenade between the Crater Wall trail and the lodge. His study area was equivalent to that of 1938. Dr. Huestis captured and marked 79 squirrels, a population density considerably less than that found 13 years earlier. Nevertheless, his count showed a density of almost 20 ground squirrels per acre in the Rim Village area. This is easily four to five times larger than what Gordon expected under natural conditions. Heustis also stated that the greatest density of ground squirrels in the study area was located at the head of the Crater Wall Trail. He noted that a dozen squirrels could often be found there begging for food.

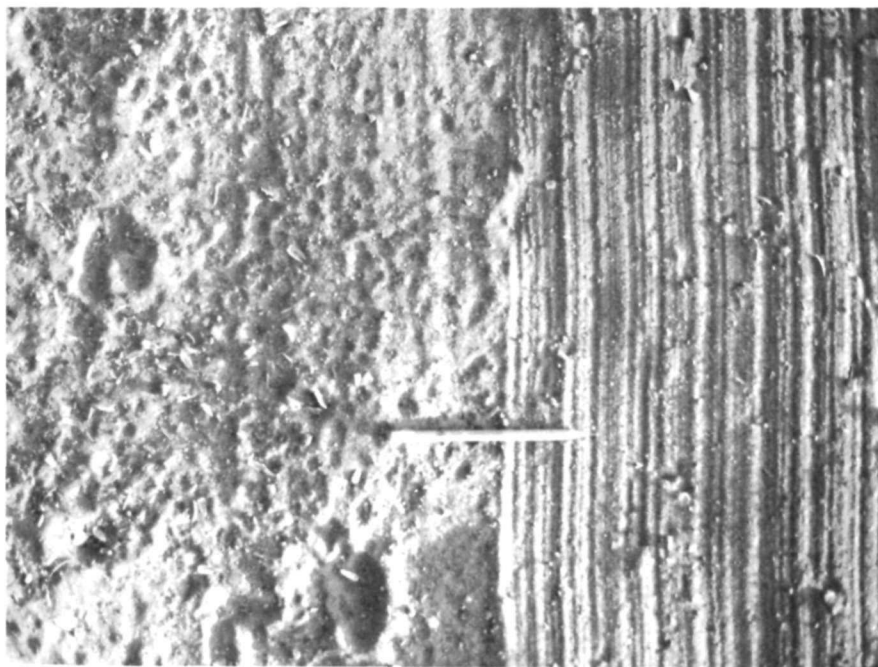
In 1984, S. Kent Schwarzkopf conducted a study on The Feeding of Golden Mantled Ground Squirrels at Crater Lake National Park. The study site was located at the head to the Crater Wall Trail, probably because this was still the location of the highest squirrel activity in the area. I personally spent time counting squirrels at this same location, a place that present park staff call "Squirrel Row" due to the obviously pronounced activity of squirrels in this area. Periods of observation varied, but at all times of the day I could easily count eight to twelve squirrels and once counted fifteen. In light of past studies and the observations I made, it is fair conclude that large numbers of squirrels have been present at this site for 60 years at a minimum.

Nocturnal Activity Along the Promenade

Gordon observed that "...Ground Squirrels typically accept as much food as possible from visitors, run a short distance to a location where they dig a hole and bury the contents of their pouches before quickly returning for more handouts". During my surveys, I have noticed that squirrels at the rim in 1992 were no different than those observed in the late 1930s. Most of the food that is accepted from visitors is taken into the caldera, usually about 50 to 60 feet from the promenade, and buried. These squirrels quickly return for more handouts. Their instinct to gather and store food makes golden mantled ground squirrels surprisingly efficient in cleaning up the handouts given to them along the promenade. On several occasions I looked for food scraps in the vicinity of "Squirrel Row" at the end of a busy day and found that even the crumbs were absent.

Considering the generous handouts that are provided to these rodents by visitors to the park, it would be interesting to determine how many pounds of food is cached each day by these squirrels. Whatever the amount may be, there is no doubt that a substantial quantity of food is moved from the promenade to shallow storage sites inside the caldera. Although these caches may seem secure to the squirrels, shallow hiding places are hardly safe from the prying noses of nocturnal residents like mice and woodrats. As a result, ground squirrels are unintentional conduits of food for a host of other animals in the Rim Village area. It would not be surprising that ground squirrel activity during the day is matched by an equal amount of activity at night by nocturnal animals.

In an attempt to assess the level of nocturnal activity and the associated population densities of animals in the Rim Village area, I went there one evening around nine and used a broom to gently smooth down the dirt at "Squirrel Row". At roughly six o'clock the next morning, I returned to see what had happened. The area I swept



Nocturnal Activity

The feeding of ground squirrels probably impacts nocturnal rodents who feed on their food caches. In an attempt to estimate the population density of nocturnal rodents, the soil along the promenade wall was swept (right side of picture) at about 9:00 pm. At 6:00 am the next day, the swept area was heavily trampled by nocturnal rodents (left side of picture). (Note: broom marks in the picture were made at 6:00 am for contrast needed in the photo.)

was heavily trampled by small rodents like mice and wood rats. Deer tracks were also noted as were some tracks of ravens that I scared away when I arrived. The total number of individual rodents that had been active here during the night was not something that I could determine but I could easily say that activity was intense. The level of activity along the promenade was surprising, especially in light of the efficiency with which ground squirrels gather every scrap that they can find and transport it to cache sites inside the caldera. If the nocturnal activity along the promenade was as pronounced as it was with only a few morsels of food available and a poor selection of shelter, I could only imagine what activity must be like 50 to 60 feet below the rim where squirrel caches abounded and shelter is abundant! It seems reasonable to speculate that nocturnal rodent activity must easily match, if not exceed, the activity of the ground squirrels that people feed on days during the summer.

Accumulations of Animal Feces

The high density of rodents in the Rim Village area means that there is also an appreciable amount of rodent excrement being deposited there, too. I trapped several squirrels and collected the feces that was excreted during the active period of their day. All these samples were dried and weighed on a triple beam balance that was accurate to a hundredth of a gram. I found that the average weight of a squirrels daily excrement (excluding urine) was about 1.5 grams (dry weight). Assuming that golden mantled ground squirrels are active for five months out of the year (May to September) and estimating that there are about 20 squirrels per acre in the Rim Village area, then the calculation of 4.5 kilograms (10 pounds) per acre is a reasonable approximation for the accumulation of their body waste over one summer season. This means that over the past 60 years or more of historically high ground squirrel population densities in Rim Village, at least 270 kilograms (600 pounds) of feces per acre has been produced there by ground squirrels alone. Much of this 600 pounds was probably deposited inside the caldera wall. If one adds in the waste products deposited by enhanced populations of birds, mice, rats and deer that feed on squirrel caches and if this includes the waste deposits contributed by an assortment of predators that feed on the dense populations of rodents, the total fecal deposit in the Rim Village area over the past 60 years is probably close to or more than 900 kilograms (one ton) per acre.



Mustelids in Crater Lake?

By Michele Cardinaux

The term mustelid comes from the zoological family name *Mustelidae* and is used to refer to the group of animals in that family. Included in this group are martens, fishers, weasels, ferrets, mink, wolverines, badgers, skunks, and otters. Representatives of this group are found all over the world and in almost every type of habitat.

Most members of the mustelid family are relatively small, with long, low-slung bodies, short legs, short rounded ears, and a thick silky coat. Primarily nocturnal (active at night), all mustelids are solitary and remain alert throughout the year. Mustelids are mainly carnivorous, eating small mammals, fish, birds, eggs, amphibians, and some plant matter such as berries. Most of the species in this family have paired anal scent glands, which in skunks are highly developed for defense. In most other mustelid species, the secretions are used more as social and sexual signals. Animals such as otters and wolverines spend a great deal of time marking their "space" by rubbing their scent glands on surfaces throughout their territory.

Mustelids exhibit a fair amount of play behavior. Otters, for example, are noted for their "playful" behavior and spend time with other otters when engaged in "play." Of course, we have to be careful about crediting animals with human attributes. Many of these perceived "games" animals play are actually excellent training exercises for survival because they strengthen muscles and sharpen reflexes. It is interesting to note that the primate family (which includes humans) is the only other group of mammals that consistently exhibits such behavior.

Recently there have been several sightings of mustelid-like animals in Crater Lake. At this point, however, we have no confirmed reports of mustelids using the lake but most of the human activity on Crater Lake is centered on a relatively small portion of the caldera. The surface of Crater Lake covers 21 square miles, so there is plenty of room for an animal to remain undetected. Since mustelids tend to be shy creatures and avoid human contact, the difficulty in confirming sightings is probably further compounded.

Crater Lake could be an attractive food source for mustelids. Introduced fish and shellfish, as well as native salamanders and invertebrates, are all possible mustelid foods. The lake is also well within the ranges (which can extend from five to fifteen square miles) of these animals.

What kind of mustelid may be using Crater Lake? River otters are a dim possibility since they are known to fish and swim. Otter sightings are rare in the park (none have been recorded in recent years), so the most likely mustelid is the pine marten. These animals are regularly sighted in the park and along the shores of Crater Lake, but are not known to fish or swim. Although smaller in size than otters or martens, the long-tailed weasel and short-tailed weasel swim and are strong possibilities.

An example of a wildlife observation form is shown below. The National Park Service needs well-documented observations of the park's wildlife as a first step toward perpetuating their existence. Studies conducted outside of the park can provide better scientific understanding about mustelid species, but they cannot determine if these animals are using Crater Lake. Only with detailed observations (including length, color, shape or head, behavior, and location) can gaps in the park's wildlife records be filled. Please ask for forms at Crater Lake National Park's visitor information centers.

Form 10-257 "R" 5/83			DEPARTMENT OF THE INTERIOR NATIONAL PARK SERVICE NATURAL HISTORY FIELD OBSERVATION		
OBSERVATION:					
LOCATION:					
DATE (Month, Day, Year)		TIME (a.m., p.m.)		WEATHER	
Description, Behavior, Number, Sketch, Map, Etc. (use reverse if necessary)					
BE ACCURATE – DO NOT GUESS					
PARK:					
OBSERVER: (include name, address, phone number)					



The Mysterious Clams of Crater Lake National Park

By Roger Brandt

High on a remote, dry ridge, 700 feet above the surrounding valleys, is a small pond. It is not very big, perhaps 40 feet in diameter. The shore is lined by thickets of huckleberry and shaded by tall pines. Silence seems to be its dominant attribute. If its surface was not occasionally rippled by the quick scamper of a water skipper or the lazy flip of a salamander's tail, one would find it easy to assume that this quiet pond was completely uninhabited. Nevertheless, this small pool of water is actually home to hundreds of aquatic creatures, most of whom are hidden in the pond's soft mud. It only takes a moment of sifting through this mud to reveal a horde of these kicking, squirming invertebrates. Of all the strange creatures you will find in this community, however, by far the most puzzling ones are white, pebble-sized, fresh water clams. They are not necessarily rare, since populations can be found in Upper Klamath Lake as well as in the Rogue and Umpqua river basins. But how have these clams come to exist in a pond located on a dry, remote ridge high above the surrounding river basins? Looking at the physical capabilities of these clams does not make this mystery any easier to solve.



Mysterious clams

The adults rarely get larger than a fourth of an inch in diameter

Clam Presence an Anomaly

The clams found in the small remote ponds of Crater Lake National Park are small in size, in most cases less than a fourth of an inch in diameter. They are sedate creatures, and for the most part, spend their lives in the pond's mud siphoning microscopic organisms out of the water. Despite their small size and sedate habits, they are known to crawl at a speed of about eight inches per hour. This means that if they were to crawl for 24 hours a day, it would take about three weeks for one of these clams to crawl the length of a football field and almost a year to crawl a mile. While highly unlikely, these clams could have crawled to this pond from the nearest stream. In the case of the small and isolated pond, the stream is located about a mile away. The problem with this scenario is that these clams have gills and must remain

in the water as they move. Since this pond is filled with snow and rain that falls directly into its basin, there is not much runoff from it. What little it does leave flows over a rocky ledge and is promptly absorbed by the forest floor below. Without a distinct and permanent water course, the possibility that clams could have crawled to this isolated pond is small. For the clams of Crater Lake National Park, their presence in remote ponds might be better explained if their reproductive abilities are examined.

The reproductive cycle of clams in the *Sphaeriidae* family is surprisingly similar to what is seen in the marsupials. As the zygotes of the clam pass out of the sexual ducts, they are collected in a brooding zone of the gills called a marsupia. Here the young grow until they have developed into a miniature version of the adult. Mature clams are known to contain from one to twenty of these juveniles in various stages of development. It is this brood inside the adult clam that represents the key in the clam's ability to travel extensive distances.

Distribution by Birds

Most investigators have attributed the presence of clams in remote or isolated ponds to transport by birds. This is because ducks and great blue herons, for example, relish these pill sized clams for food. When they are eaten by the bird, the adult clam usually perishes in the upper part of the bird's digestive tract. The brood of young clams inside the adult, however, are protected from this acrid environment until the adult dies. Many of these young clams survive the lower digestive tract, too. If the bird that ate them should happen to fly to a different location that is suitable for these clams, then the survivors that pass out of the bird's digestive tract will find themselves in a new home that is often far removed from their former one.

Distribution of clams by birds is the most common mode of transportation mentioned in references on these aquatic invertebrates. What is rarely mentioned, though, are the details on how these clams might be transported by mammals. This is important at Crater Lake National Park because animals of this park probably have their own way of moving these clams from pond to pond in ways that have not been thoroughly investigated. A clue to this other type of transport can be found near the park's west boundary, in a wet meadow called Sphagnum Bog.

Distribution by Mammals

Sphagnum Bog is a broad, wet, open field bordered on all sides by a wall of hemlock trees. Low stands of shrubs and grass grow in the mud of countless seeps and puddles. This area is a haven for clams, as evidenced by the shells from past generations found scattered throughout the area. High concentrations of these shells can be found in mud holes that form wide craters in several places around the bog. These mud holes are not just coincidental in nature, nor do they occur randomly. They represent locations where elk come at various times to wallow in the deep, soft mud of the bog.

Wallowing is most often observed in mid-August to late September while bull elk are in their rut. It is common to see these bulls covered with mud as they wander about in search of mates during this time. With the high density of clams observed in areas used for wallowing, it is conceivable that tens or hundreds of clams may be carried away from wallow areas in the mud on the backs of these bulls. Since these clams are known to live out of the water for three to four days, if temperatures are cool enough, it is probable that clams “hitch hiking” a ride in the mud on these elk could be distributed from wallow to wallow and from pond to pond. Since these clams are hermaphrodites, it would only take one clam to establish a new colony in ponds “seeded” by the elk. Because elk use the park as a summer home, migration route, and reproductive domain, it is also reasonable to conclude that these mammals are probably more important than birds in the distribution of clams at Crater Lake National Park.



Loaded with clams

An elk wallow on the south end of Sphagnum Bog. Empty clam shells could be found all over the surrounding areal. During wet periods, the clams probably crawled where they pleased. The wallow was the only source of water for several yards in any direction during the drought of 1992 (when this picture was taken).

Further Study Needed

In a recent survey of the ponds in Crater Lake National Park, clams were found in almost every pond in the park. These clam populations reflect the historic use of the ponds by birds and elk. More information is needed about their role in the park’s food chain and how populations of larger animals are affected by the distribution of clams. No less important, however, is the fact that these clams are a subtle reminder of the many mysteries that wait to be discovered throughout the park.

Crater Lake...Unique?

By Ted Haeger

The word "unique" is slippery. If defined as meaning "one of a kind," we must answer the question, "One of what kind?" Although "unique" is commonly used in our language, it can become trite the more we consider what it is describing. After all, isn't everything in some way unique?

Many people ask "Are there any other lakes in the world like Crater Lake?" The answer usually surprises them. It often disappoints as well. Typically, I answer "Plenty."

Considering that Crater Lake was formed by a volcanic collapse, one wouldn't expect this answer. Most believe that any big hole inside a volcano has resulted from an enormous blast. Few have ever heard of a volcano collapsing.

Volcanoes sometimes collapse. The results of such events are calderas, which are found in volcanic regions throughout the world. It is also fairly common for calderas to fill with water and form lakes. Examples are found in Japan, Greece, Peru, Sudan, New Zealand, and many other countries around the globe. Here in the western United States, one of our best known examples is Yellowstone Lake, which partially resides in the Yellowstone Caldera--a depression over 25 miles across.

Closer to Crater Lake, in the Cascade Range, there are also many caldera lakes. To the south of the park is the Mountain Lakes Wilderness Area. Many of the lakes found there resulted from a large caldera collapse followed by later glacial activity. The glacial sculpting tells us that the Mountain Lakes caldera is easily older than 10,000 years, which marked the terminus of the last ice age.

Not far to the north of Crater Lake, we can find Paulina and East Lake at Newberry Volcanic National Monument. These two lakes are found within the Newberry caldera which collapsed about 500,000 years ago. (This was about the same time that Mount Mazama, Crater Lake's volcano, began to form). What's more, Newberry shows evidence that it has collapsed several times, leaving a series of "nested" calderas.

Perhaps our most intriguing caldera lake can be found in another national park far from Crater Lake. Katmai National Park in Alaska is the home to Katmai Peak, which had a huge caldera-forming eruption in 1912. This same eruption formed the famed Valley of Ten Thousand Smokes. The destroyed summit of Katmai Peak is now a depression of roughly one-half the diameter of Oregon's Crater Lake. Since the collapse, Katmai's caldera has been slowly filling with water. Naturally, the developing body of water has been aptly named Crater Lake.

Alaska has another caldera that is even more fascinating, though it is mostly "dry bottomed." An eruption 3,500 years ago created Aniakhak, a six mile wide, 2500 foot deep caldera that is remarkably similar to Crater Lake in size and age. The

caldera has many post-collapse volcanic features, including a peak very similar to Crater Lake's Wizard Island. In addition, study reveals that many of the post-collapse eruptions actually occurred underwater. This tells us that Aniakchak once had a deep caldera lake that would have been remarkably like Crater Lake--complete with its own Wizard Island! The lake is gone today, however, having left behind a 1,500 foot cut where the lake breeched the side and eroded away the caldera wall.

Currently, the Aniakchak caldera contains a minute lake known as Surprise Lake, a two and one-half mile long remnant of Crater Lake's former rival. Along the shoreline of this lake are many small springs--evidence that all is not quiet at Aniakchak. These springs may have once been active below the formerly larger lake, much like the springs currently found in the depths of Crater Lake.

So is there anything "unique" about Oregon's Crater Lake? Is the world simply rife with crater lakes?

Let us consider the lake's non-geologic characteristics. There are some that set Crater Lake apart from other lakes. Intensive research conducted over the past ten years revealed that Crater Lake has unsurpassed water clarity, record depths for aquatic species, and some organisms found nowhere else in the world. Certainly these aspects make Crater Lake unique, don't they?

To a degree. Once again we run into problems with the concept of "unique". Taking the water clarity as an example, it is true that Crater Lake holds the world record for clarity. But it is important to recognize that the clarity of Crater Lake, like that of all lakes, fluctuates.

John Salinas is a researcher whose work was instrumental in initiating the congressionally mandated, ten year research program at Crater Lake. At Oregon's second deepest lake, Waldo Lake, Salinas recently obtained readings that indicated extremely high clarity, easily rivaling Crater Lake's average clarity. Salinas took these readings at a time when Crater Lake's clarity cycle was at a low--well below average. Therefore, on that given day, Waldo may have been the clearest lake in the world!

I personally dislike the word "unique", as it seems to be an abysmally nebulous term. Truly, there is only one Mount Mazama, and within it is the world renowned Crater Lake. But in nature all things, including all lakes, are unique.

