

Natural Notes
L. R. M.
Crater Lake

Nature Notes From Crater Lake

produced by

National Park Service
Crater Lake National Park



Crater Lake Natural
History Association



Southern Oregon
State College



Cover Photo: W. Drew Chick displaying transom of the boat *Cleetwood* to Park founder Will G. Steel on July 19, 1931. Steel had organized the U.S. Geological Survey expedition which brought the *Cleetwood* to make soundings of Crater Lake in 1886.
Photo by Ansel Hall.

Nature Notes From Crater Lake

Volume XXIII-1992
90th Anniversary Edition

David K. Morris
Superintendent

Stephen R. Mark
Editor

Introduction

Crater Lake National Park celebrates its 90th anniversary this year. On May 15-17, 1992, the Crater Lake Natural History Association, Southern Oregon State College, and the National Park Service will cosponsor a symposium on the park to celebrate its birthday. The educational opportunity afforded by the event is the impetus behind reviving *Nature Notes from Crater Lake*.

At one time, most major national parks published their own "Nature Notes". *Nature Notes from Crater Lake* were first published in 1928 and twenty two issues followed, with the last publication in 1961. With this issue we hope to stimulate interest in producing future editions. 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 by Lincoln Constance. A seasonal naturalist in 1931 and 1932, Dr. Constance is an emeritus professor of botany at the University of California, Berkeley. Although his piece is an exception to the traditional policy of not using previously published work in *Nature Notes*, he has graciously allowed us to reprint the article because it sets the stage so well for the other contributors.

It is followed by submissions from permanent park staff, current and former seasonal interpreters, and one by two members of the Crater Lake Natural History Association's board of directors.

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

[This article first appeared in the *Oregon Education Journal* of February 1932, pp. 26-28. Although we are now 60 years hence, much of what Dr. Constance had to say at that time is still relevant today--Editor.]

Crater Lake National Park as a Field for Scientific Research

By Lincoln Constance

As an area of intense scenic beauty and great recreational interest, Crater Lake needs no introduction to the residents of Oregon, nor to the thousands of citizens of other states and nations, who yearly visit it. Every summer an increasing number of people give themselves the pleasure of motoring over the Rim Drive, which completely encircles the lake. The motorboat trips to Wizard Island and the Phantom Ship--one of the most unique water trips to be found anywhere in the world--are being included in the schedules of more and more tourists annually.

Field for Scientific Study

But the thrilling, fascinating beauty of the park is not more important than the manifold fields for scientific investigation which it offers. A greater familiarity with the outstanding features of Crater Lake--the Rim, Wizard Island, the Devil's Backbone, and many others--leads frequently to a thirst for information of various kinds. In the words of J.S. Diller, geologist of the United States Geological Survey, and one of the pioneers in the geology of Oregon: "Aside from its attractive features, Crater Lake affords one of the most interesting and instructive fields for the study of volcanic geology to be found anywhere in the world."

Undoubtedly the most interesting problem is the very old one of the method of formation of the caldera in which lies the lake itself. The question was **not** "settled years ago," or, at least, it has refused to **remain** settled.

Two important theories have been formulated to explain the unique position of Crater Lake. These are commonly designated as the Explosion Theory and the Engulfment Theory, respectively. The park area has only once undergone an extended and intensive geological inspection and interpretation, and that was more than a quarter century ago. The last twenty-five years have brought to light many discoveries, which seemed to cast upon, and to verify, the results obtained at that time. The results of the pioneer investigation were published in 1902 by J.S. Diller and H.B. Patton. From their findings, these geologists and petrographers have examined the revealed structures, and these have almost unanimously supported the Explosion Theory. Hence, we find that the most fundamental scientific problem of Crater Lake still awaits an ultimate solution.

Crater Lake a Geological Laboratory

Crater Lake is a geological laboratory par excellence, for here we find an immense mountain (the hypothetical Mount Mazama) dissected for us, and its core displayed. Here we have revealed to us all the evidence necessary to reconstruct the orogenic processes which formed Mount Mazama, and the clues to the activity of vulcanism and glaciation, which ultimately resulted in its destruction, are likewise exposed. As the Grand Canyon gives an unequalled calendar to the entire history of sedimentary processes upon the North American continent, so Crater Lake Rim exposes the history of the more recent volcanic forces, which so appreciably altered the topography of the Northwest.

In its capacity as a museum for the preservation of the effects of volcanic and erosive forces, the park possesses many prize exhibits. The most conspicuous is the caldera or basin within which the lake lies. Rising amazingly from this chalice is Wizard Island, a perfect volcano, a child of a secondary outbreak of vulcanism. The alternate layers of lava and of ash which form the substance of the rim, the frosting of pumice upon Cloud Cap and other promontories, the Devil's Backbone and other dikes, the plugged valleys (Llao Rock and the Palisades), the steam stains, and the widespread bombs, are samples of this colossal display.

Effects of Geological Erosion Manifest

While the fact is not widely appreciated, the existing remnant of old Mount Mazama affords an excellent field for the study of glacial erosion. Kerr Notch and Sun Notch are two of the most typical U-shaped valleys, although there are several others. Glacial deposits are abundant, for the park roads frequently cut through heterogenous morainal material, and the public camp ground is situated upon a terminal moraine. The rapid recession and change in angle of the rim, from an acute to an oblique angle with the lake surface, shows the action of erosional forces still at work, which will not rest until the immense rim is levelled. The presence and position of glacial deposits and cuttings, the lava flows, pumice beds, dikes, and the like, are the alphabetical blocks which must be assembled to complete the geologic history of this region.



Park Has Other Geological Features

Passing away from the lake itself, we find at least two other classes of interesting geologic features worthy of notice and study. The park contains a large number of volcanic cones: Red Cone, Crater Peak, Timber Crater, Scott Peak, and others. In the case of two such cones--Union Peak and the Rabbit's Ear--the lava froze in the neck of the mountain. Upon the lower levels of the park confines, there are deposits of ash, pumice, and other ejectamenta of great depth. Last summer, Mr. D.S. Libby, park naturalist, studied the remains (some twenty miles west of the lake) of large logs, which were buried to a depth of sixty feet beneath ash, apparently from Mount Mazama! This igneous material is most apparent where it has been deeply channeled by the small streams, which have cut impressive canyons through its unresisting substance. Not only water, but wind, also, has lent a hand to erosion, and the finger-like Pinnacles of Wheeler Creek, and the medieval turrets and oriental minarets of Godfrey's Glen, Castle Creek, etc., are the result of the activity of these combined forces.

Flora and Fauna Abound

The geological interest is paramount, but the possibilities of research are by no means exclusively confined to the geological agencies and their products, for the park represents a teeming and diversified flora and fauna. Although the park contains but two hundred and forty-nine square miles, the enclosed area possesses an imposing array of life-forms. The altitude presents an approximate range of from four thousand five hundred to nine thousand feet.

We recognize that all life is arranged in definite latitudinal and altitudinal bands, or zones. Also, as was first shown by Alexander von Humboldt, the zones of altitude and of latitude correspond. The names are derived geographically rather than altitudinally. In the case of Crater Lake Park, we find the Hudsonian Life Zone, extending from the highest levels to about seven thousand five hundred feet; the Canadian Life Zone, from seven thousand five hundred to five thousand five hundred feet; and below five thousand five hundred feet, the Upper Transition Life Zone, so called because the southern and northern life-forms mingle here indistinguishably.

Each of these life zones possesses its own distinctive representatives of the plant and animal kingdoms, although the segregation is more obvious in the case of the plants than in that of the exceedingly mobile animals.

The larger animals are usually quite shy, but the black bear make the garbage-pits their especial soup-kitchen. Where wind and water have sculptured the ashen walls of the deep canyons, forming caves and over-hanging walls, the deer make their extensive nurseries. Porcupine and marmots are frequently seen, while coyotes are rather rare visitors. On Copeland Creek, several miles to the northwest of the lake, extensive workings of the mountain beaver were discovered this last summer. The small squirrels and chipmunks, especially the Golden-mantled Ground Squirrel, which is usually called a

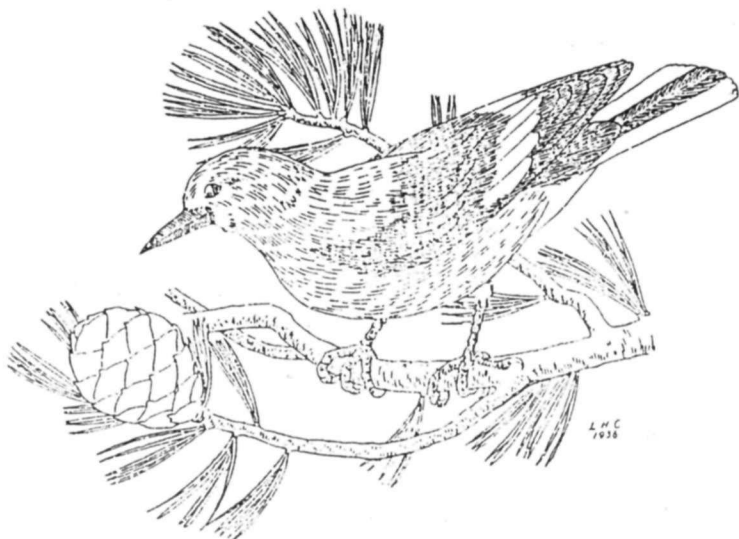
"chipmunk," are the favorites of the tourists, who seek to exhaust the local supply of peanuts.

Birds and Insects Abundant

Bird-life is abundant, and is met with at all elevations. Over seventy species have been described from the park. Some of the most beautiful are the Western Tanagers and the attractively-hued Grosbeaks. The Clark's Crow, whose raucous voice and magpie-coloring render him instantly noticeable, is the most conspicuous. Eagles occasionally nest upon the rocky crags of the higher points of the rim.

Insects are present in infinite number and variety, ranging from destructive wood-beetles to the handsome Lepidoptera. This past summer the park witnessed a migratory movement of an unbelievably vast number of California Tortoise-shell Butterflies (*Aglais californica*), whose orange and brown wings brightened the landscape for weeks.

Each of the three life zones contains a wide variety of quite different local habitats, ranging from rocky cliffs, talus slopes, and pumice flats, to morainal meadows, alpine swamps, stream banks, and the sheltered forests. Each habitat has its own characteristic inhabitants, and the relation of each group to its surrounding conditions presents a fascinating problem, or series of problems, to the ecologist. But although each special environment has its distinctive vegetation, there are certain species of plants--and animals, too--which occur almost constantly throughout a given zone, and yet are quite closely confined to that belt. These species are known as "zone indicators," or "zone markers."



Many types of vegetation are suitable for the role of markers, but those most available and conspicuous in the park area are the pine trees and their allies. In the Hudsonian Life Zone we find the White-bark Pine (*Pinus albicaulis*) and the Mountain Hemlock (*Tsuga mertensiana*) occurring constantly. The Western White Pine (*Pinus monticola*) and the Lodge-pole Pine (*Pinus contorta* var. *murrayana*) unmistakably denote the Canadian. In the Transition Zone we find the Western Yellow Pine (*Pinus ponderosa*), the Sugar Pine (*Pinus lambertiana*), the Incense Cedar (*Libocedrus decurrens*), the Douglas Fir (*Pseudotsuga taxifolia*), and other conifers.

By the means of such a framework, there can be arranged more than three hundred and fifty species of vascular plants (ferns, conifers, and flowering plants) which have been collected here. At one time it was thought that this was an "Endemic Area," i.e., one which contains highly peculiar species, to be found nowhere else--as the Redwood (*Sequoia sempervirens*) is "endemic" to the coast of northern California and southern Oregon. However, most of these pseudo-endemics have been subsequently reported from other stations, but they are still very rare and interesting. Some of the most unique are the Oregon Moonwort, or Pumice Grape-fern (*Botrychium pumicola*), the Pumice Sandwort (*Arenaria covillei*), and the Mazama Collomia (*Collomia mazama*)--a beautiful blue relative of the phloxes.

The Blueness Still Unsettled

In addition to the general and specific problems in geology, petrology, biology, and ecology, there are several miscellaneous questions of significance, which await definite settlement. In the first place: is the unsurpassed blueness of the waters of the lake due to dissolved minerals or to some light phenomena? A thorough chemical investigation should reveal whether the azure hue depends upon a colloidal solution of molybdenum or aluminum sulphate, or not. Also, no one has ever yet shown the existence of any outlet or inlet to the lake, and, while the existence of the latter does not appear to be necessary, the absence of the former would plunge us into a new mystery. If there are no outlets, why does not the water overflow its basin, since the precipitation exceeds the evaporation?

Only a brief presentation of some of the more obvious subjects of scientific interest has been attempted here. An ardent student of nature, in almost any field, will find that an investigation of the possibilities of research in the park brings to light an ample number. Any trained worker, devoting his interest and activity to this rich region, will benefit not only himself but all the knowledge-thirsty visitors to whom his findings become accessible.



A Century of Measuring Lake Levels

By Tom McDonough

In 1886 a group of men representing the United States Geological Survey measured the depth of Crater Lake in several places. Using piano wire and a lead weight, they determined that the greatest depth of Crater Lake to be 1,996 feet. Seventy-three years later, another U.S.G.S. survey corrected the earlier measurement by using sonar and established the greatest depth at 1,932 feet. This depth is referenced against a surface elevation of 6,176 feet. Because the lake loses water through evaporation and seepage, there are times when the lake depth is less than the 1959 calculation. Since inputs vary from year to year, there must also be periods when the 1,932-foot calculation is exceeded.

The primary input for Crater Lake is the annual precipitation the region receives. This is close to 69 inches on average, as measured at Park Headquarters. The lake level rises from October to April because input exceeds output, as seen in Fig. 1. As precipitation lessens in late spring, the lake's level stabilizes until mid June. This is due to the balance among evaporation, seepage, reduced precipitation, and run-off from melting snow. For the rest of the summer, the lake level falls at an average daily rate of .675 centimeters per day, or about 25 hundredths of an inch. The lake is usually at its lowest level at the end of September. For the lake to return to the same level year after year, the input as measured at Park Headquarters must be 66.9 inches. This amount is close to the long term average measured at this site.

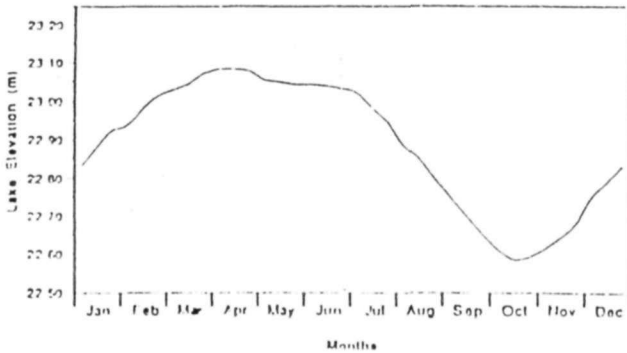


Figure 1. Annual cycle of water level. Fifteen-year composite of 1966-1971, 1975-1976, 1979-1985. Units: Elevation in meters minus 1859.28m.

The lowest lake level was recorded on September 10, 1942, when the lake dropped to a surface elevation of 6,163.20 feet. This reading is related to low precipitation amounts observed regionally during the 1930s. In 1975, the lake level reached a historic high when it rose to a level of 6,179.34 feet. There is some evidence that the lake may never get much higher than this 1975 meas-

urement. Lichen stains on rocks near shoreline indicate that the water may never have been above 6,180.50 feet. This evidence is also consistent with observations that live and dead trees have rooted just a few feet above the observed lake level maximum.

Since Crater Lake is thought to have no other significant input, lake level is subject to abrupt changes year to year when snowfall amounts vary. For example, the lake level rose two and a half feet between 1951 and 1952. Conversely, it fell 3.40 feet between 1976 and 1977. When snowfall accumulation reaches levels near historic averages, little change occurs to the lake level from year to year. As noted earlier, the range of lake level measurements has varied some 16.14 feet over the past century. The 30 year average for the lake's surface elevation is 6,175 feet. This is slightly higher than the average for the period of 1907 to 1988, which is 6,170 feet; the latter elevation reflects the low water level observed in the 1930s and early 1940s.

During the summer of 1991, the lake's surface elevation was estimated to be 6,170.80 feet on July 31. Assuming that there was no significant precipitation through September, the lake level might have been near 6,170 feet on September 30. This would be the lowest level since the early 1950s. Like the low lake levels recorded earlier this century, the present trend seems related to less than average precipitation amounts beginning in 1985.

A hundred years of lake measurements have taught us that we should not assume that the level of Crater Lake does not change. Thirty-year or even hundred-year averages can be very misleading. What we observe one year or over one decade is no indication of what can happen the next. Furthermore, since lake level changes are related to regional climatic events, it is impossible to forecast the next season's lake level accurately. When the figure of 1,932 feet is cited as Crater Lake's depth, this is only one observation made at a given time during the recent past. As with any dynamic system, the depth of Crater Lake and its elevation above sea level is never a fixed value. Each rise and fall is a response to forces imposed by nature from outside the caldera.

Clouds, Precipitation, and Snow

By Gregg Fauth

The weather at Crater Lake interests park visitors and employees alike. Everyone has their idea about what is "normal" when it comes to precipitation, whether it is rain or snow. Much of the literature about Crater Lake and its "averages" is dated and therefore inaccurate. Incorporation of recent data into calculations based upon the park's weather records reveals some significant changes with respect to what we consider average.

Yearly precipitation averages were recalculated on December 31, 1991. Data from 63 years of records shows an annual average for precipitation of 64.31 inches. It is more accurate, however, to use only the totals recorded since

1930, when the weather station was moved from Annie Spring to its present location at Park Headquarters. The average for the 56 years of complete records at headquarters is 66.8 inches. (Data for the years 1930, 1942, 1943, 1944, 1945, and 1946 is not available). The "new" average is more than two inches below the "old" average of 69 inches, which is a figure based upon a 30 year running mean calculated by the U.S. Weather Service.

Yearly snowfall averages were recalculated at the end of the snow year, July 1, 1991. Beginning with the winter of 1930-31, and ending with the 1990-91 winter, the yearly average from accumulated snowfall is 533 inches. (This was obtained from 57 years of data, as the period of 1943-46 is not available). The "new" yearly average is 44.42 feet, significantly below the 600 inch and 50 foot figures that have been used to characterize snowfall at Crater Lake.

One should also be cautious in regard to equating "average" with "normal". Crater Lake is in southern Oregon, a region whose climate more closely reflects the eccentricities of northern California's Mediterranean regime than the temperate conditions found north of Diamond Peak. Dry cycles lasting a number of years are par for the park, both in the recent and geologic past. These droughts can be suddenly interrupted by "wet" years which may keep the park snowbound well into July or August. An enormous snowfall during one or several years has the effect of adjusting averages upward of course, sometimes planting a deceptive image to people who have not looked further than the overall average of 533 inches. What is really "normal" is variation.

A "New" Date for Mount Mazama's Climactic Eruption

By Ron Mastrogiuseppe and Steve Mark

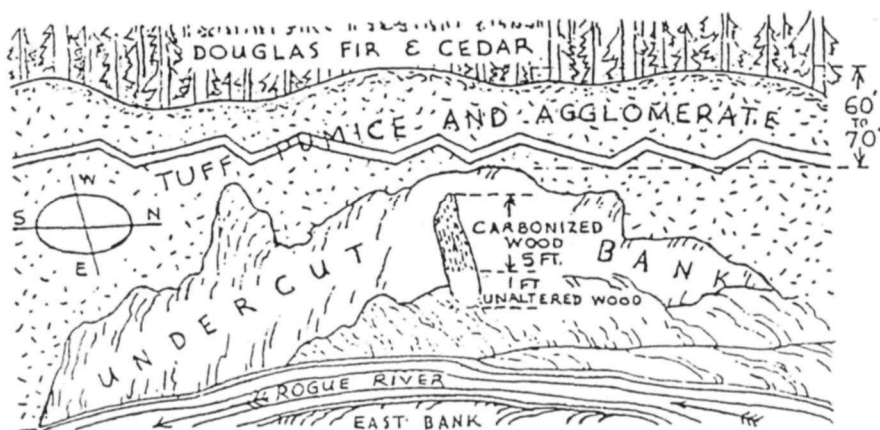
One of the most commonly asked questions at the Park concerns the length of time since Mount Mazama's climactic eruption, an event which resulted in the creation of the caldera known as Crater Lake. The answer has been given in "radiocarbon years", usually without explaining what is meant by this term. Geologists have determined the radiocarbon date of Mazama's eruption to be $6,845 \pm 50$ B.P. This is translated as 6,845 **radiocarbon** years, plus or minus 50 years, before "present" (which has its zero value set at the year 1950, the closest date following publication of the first radiocarbon determinations). Although we all think in terms of calendar years, the calibrated radiocarbon date (which aligns radiocarbon years with calendar years) has generally been overlooked.

Radiocarbon or C-14 dating is based upon a measurement of residual carbon 14 content. Use of this method is limited to specimens containing carbon that have lived within the past 50,000 years. It was developed by Willard F. Libby in the late 1940s and has allowed investigators to better reconstruct prehistoric environments and to place geologic events within a chronological sequence. A C-14 date is estimated from the amount of Carbon 14 present in

a sample. The sample's C-14 content is compared to the percentage of carbon in modern organisms (wood has generally been one of the more reliable types of materials tested). Its content can then be translated into an approximate date because C-14 atoms disintegrate proportionately over time. An estimated date is accompanied by what is called the standard error, or measure of the sample's reliability. The date for Mazama's eruption was derived from numerous samples and has been fixed at 6,845 radiocarbon years, plus or minus 50.

Until 1937 it was thought that the Mazama eruption had occurred about 25,000 years ago. Discovery of several archeological sites beneath pumice deposited by the mountain provided conclusive evidence that man was residing in the area at the time of the eruption. The most famous excavations were made by a team led by L.S. Cressman at the Fort Rock Cave, where sandals made of sagebrush bark were found. These and several other types of artifacts were found under a layer of Mazama ash, which serves as an important marker layer in buried soils throughout the northeast fall zone. As a result, the estimated date of the eruption was revised to sometime between 4,000 and 10,000 years ago.

The range of 6,000 years was subsequently refined when three investigators collected a charcoal sample west of the park for radiocarbon dating in 1949. A road cut on Muir Creek along state highway 230 had exposed charred trees embedded in the pumice. Samples were sent to Libby's laboratory at the University of Michigan which returned a date of $6,453 \pm 250$. Libby's original assumption, however, that the C-14 presence in the Earth's atmosphere had remained constant through time, was subsequently shown to be invalid. Cosmic ray output by the Sun is variable and thus C-14 present in living organisms had not remained uniform during the 50,000 year time scale.



Calibration of the C-14 estimate with a date based on calendar years was made possible when an 8,000 year cross-dated tree ring master chronology was constructed by Wes Ferguson and others of the University of Arizona's Laboratory of Tree Ring Research. The discovery of record longevity in Great Basin bristlecone (*Pinus longaeva*) allowed investigators to assign actual calendar year dates to sensitive tree rings in both living and non-living samples. Once the actual calendar dates were known and assigned to a tree ring chronology, it was then possible to subject known decade-aged samples of wood from bristlecone pine to C-14 dating. This was achieved independently by three different C-14 dating laboratories. The data were utilized to draw a graph that plots variation between the C-14 tree ring record and residual C-14 in samples, thus allowing researchers to obtain calibrated values for the past 8,000 years.

The radiocarbon age of $6,845 \pm 50$ estimated for Mazama's eruption can be calibrated to a calendar year date of 7,668 B.P. When an additional 42 years are added (remembering that 1950 is used as the zero point B.P.) to arrive at the 1992 date, 7710 calendar years is the result and will fit within the parameters of statistical reliability. An approximation of 7,700 calendar years is sufficiently close to date Mazama's eruption, mainly because other variables can affect an exact calculation. One of these is the half-life of Carbon 14, which is 5,730 years. Imagine an hourglass where some of the sand has gone into the bottom half and then compare the ratio of what has gone through the glass with the top half. If we use this analogy to illustrate the decay of radioactive C-14, it would take 5,730 years for half the sand to pass through the glass, and another 5,730 years for half of what remains to pass, and then another 5,730 years for half of that amount to pass, and so forth. Some variation in residual C-14 is expected among samples, so the calibration to calendar years will also be affected.

Some hope that further refinement of the calendar date may occur was raised when the "Mazama Tree" was discovered in 1991. This tree is an eight foot section of a 7,700 year old ponderosa pine, found under 35 feet of ash flow pumice near Chemult, Oregon (some 25 air miles from Crater Lake). It was encased in a tree well created by a fifteen foot deposit of air fall pumice beneath the 35 foot ash flow deposit. The tree was originally approximately two feet in diameter but only the inner one foot diameter was well-preserved. Many "empty" tree wells were found adjacent to the one containing the Mazama Tree, so its presence is something of a mystery and it remains the only uncharred tree remnant so far discovered from the time of Mazama's climactic eruption.

Investigators hoped that the Mazama Tree's youngest growth would have been preserved since its burial occurred. If the outer rings were present, a more accurate date for the climactic eruption might have been obtained. Nevertheless, researchers remain optimistic that this can be accomplished by discovering wood within another tree well. If they do, there is a great possibility of obtaining a more exact date for Mount Mazama's climactic eruption.

Earthquakes in the Crater Lake Area

By Dave Somers

Since 1865, there have been 44 earthquakes within a 100 kilometer (62 mile) radius from the center of Crater Lake. The highest magnitude of any quake occurring within the 100 km circle during this period was 4.3 on the Richter Scale. This reading was obtained on three occasions over the past 125 years: period: in 1920 (38km from the lake), in 1931 (77km), and in 1948 (55km). There are no magnitude records for 15 quakes occurring within the circle. They include the closest one, a quake that took place in October 1947, just eleven kilometers from Crater Lake.

Crater Lake does not appear to be the center of any significant seismic activity over the past century. Not only were the magnitude readings of lesser intensity, but there were only three quakes during the period that had their epicenters closer than 20km from the center of the lake. The next five closest quakes ranged from 35 to 39 kilometers; other quakes were 45km or further from Crater Lake. Average distance of the earthquakes from the lake was 55 km.

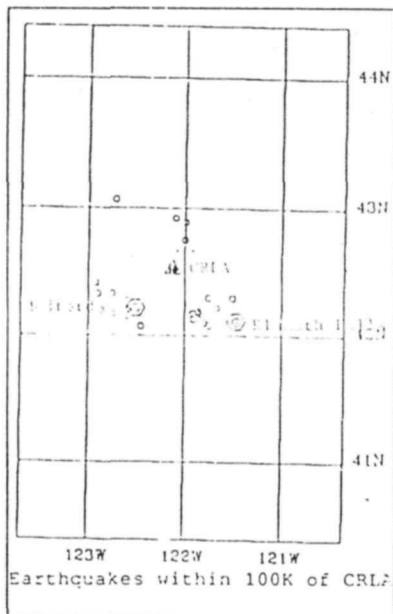
One chart shows their spatial distribution, with the center of Crater Lake being 42.57 north latitude and 122.07 west longitude. The other charts delineate epicenter distance from the park and quake magnitude.

Distance from lake No. Quakes

less than 10 km	0
≥ 10 km < 20 km	2
≥ 20 km < 30 km	1
≥ 30 km < 40 km	5
≥ 40 km < 50 km	9
≥ 50 km < 60 km	7
≥ 60 km < 70 km	6
≥ 70 km < 80 km	8
≥ 80 km < 90 km	3
≥ 90 km	3

Magnitude No. Quakes

no records	15
less than 1.0	0
≥ 1.0 < 2.0	4
≥ 2.0 < 3.0	14
≥ 3.0 < 4.0	9
≥ 4.0	3



Biodiversity in Red Blanket Canyon

By Steve Mark

Virtually all of the canyons in Crater Lake National Park are worth exploring. Many contain pinnacles or other interesting geological formations, but all of them are good hikes. As stream habitats, they harbor a greater diversity of life than the meadows, nonriparian forests, or pumice fields. The term biological diversity has been used to express the variety and variability among living organisms and the ecological complexes in which they occur. Diversity can be defined as the number of different items and their relative frequency. These items are organized at many levels, ranging from complete ecosystems (ecosystem diversity) to the chemical structures that are the molecular basis of heredity (genetic diversity).

Between ecosystem and genetic diversity lies species diversity, which refers to the variety of living organisms on earth. The most commonly accepted definition of a species is a population of organisms that can at least potentially breed with one another but that do not breed with other populations. Species diversity is a function of what the surrounding habitat allows. Wetlands and streams have long been known to harbor the greatest species diversity among the various habitat types. This is particularly evident as one hikes along the streams within Crater Lake National Park. For example, one could contrast the stream that originates at Boundary Springs with the adjacent lodgepole pine (*Pinus contorta*) forest.

Of all the habitats within Crater Lake National Park, species diversity is greatest in Red Blanket Canyon. Only a small fraction of the canyon is within the park's boundaries, but this is an environment very different from the subalpine, snow-adapted forest of Mountain hemlock (*Tsuga mertsensiana*) and true firs (*Abies concolor*, *A. lasiocarpa*, and the *A. magnifica-procera* complex) that dominate so much of the park. The 4200 foot elevation of the park's southwest corner is suitable for the growth and development of a mixed conifer forest. Its presence in the vicinity of Red Blanket Canyon was largely determined before 1900 through historic fire disturbances and the habitat type common to the Prospect area.

Some of the forest at the lower elevations in the canyon can be labeled old-growth, the kind of forest which once dominated the area between the Pacific Ocean and the crest of Oregon's Cascade Range. Exact ecological definitions for these forests remain elusive, yet several of their structural components are easily discernable: large live trees, large snags, large logs on the ground, and large logs in streams. Greater structural diversity is evident than in younger stands, as old-growth trees have a much greater range of diameters, tend toward more heterogeneous spacing, and exhibit greater patchiness with respect to their understory vegetation.

The upper three miles of Red Blanket Canyon have a different species composition and function than the heavily logged forests of the lower Red Blanket drainage and the Prospect Flat area. As an old-growth forest, the

upper canyon also displays differences in the rate and paths of energy flow. Likewise, it is distinct from stands further downstream in water and nutrient cycling. Maintenance of a large conifer overstory is critical to the survival of species not found in the younger forests, such as the Northern spotted owl (*Strix occidentalis caurina*) and the Pacific yew (*Taxus brevifolia*). These species are fairly easy to discern and relatively large, characteristics which have been used as indicators in gauging the health of an increasingly fragmented life support system.

Red Blanket Canyon is accessible from Prospect or by using the trail system in Crater Lake National Park south of Highway 62. Most visitors go east of Prospect on Red Blanket Road to Forest Service Road 6205. The head of the canyon is roughly four miles up the gravel road, past a gate which is closed during the winter months. As one proceeds toward the Red Blanket trailhead located at road's end, several regenerating clearcuts are periodically apparent near the stream. Roughly two miles short of the Red Blanket trailhead is a sign marking one end of the Varmint trail, which climbs through an old-growth forest and up the canyon's north wall. Lightly used, the Varmint trail allows hikers to see the last roadless area adjacent to Crater Lake National Park not having legal wilderness designation.

The southwest corner of the park is encountered within a half mile of the Red Blanket trailhead. At just over 4,000 feet in elevation, the corner marker is located in a lush old-growth forest. The trail straddles the park boundary for its first mile and a quarter, generally staying above Red Blanket Creek but occasionally beckoning the walker to explore small tributary drainages on the



canyon's north side. The most prominent stream drains the southwest slope of Union Peak, which is an unseen promontory from the canyon floor.

In its second mile, the Red Blanket trail veers away from the park and hugs a side of the creek as the canyon narrows. Red Blanket Falls is one of the most spectacular places in the Sky Lakes Wilderness, an area adjacent to the park and is under national forest administration. At an elevation of about 5,000 feet, the falls are the head of Red Blanket Canyon. The transition to a subalpine forest where prolonged snow conditions are the rule is apparent once out of the canyon. As hikers continue along the trail toward Stuart Falls and the park boundary, trees are more often twisted into the pronounced L-shape so common along the Cascade Divide.

There are fewer resident plant and animal species at the higher elevations, largely because of the approximately one degree celsius decrease in average annual temperature for every thousand feet gained in elevation. Yet a hiker will more often obtain sweeping views of the surrounding area. Bald Top is one of the points in the park from where the entirety of Red Blanket Canyon can be seen. Little known even among park rangers, Bald Top is a product of the once active Union Peak volcano. That volcano preceded Mazama and its glaciers carved Red Blanket Canyon, as evidenced by the distinctive U-shape. The other canyons in the park are more recent and bear the mark of Mount Mazama's climactic eruption to a far more obvious degree. Nevertheless, they also play a important role in perpetuating the biodiversity of the greater Mount Mazama ecosystem.

Saving Bull Trout in Sun Creek

By Mark Buktenica

Bull trout (*Salvelinus confluentus*) and dolly varden (*Salvelinus malma*) were once considered to be the same species. They have been separated because of genetic, morphological, and behavioral differences. In general, bull trout are the "inland" form, while dolly varden migrate to the ocean (where they spend much of their adult life) and return to reproduce in freshwater. This makes the dolly varden an anadromous fish, similar in behavior to salmon.

Once found in most major river systems in the Pacific Northwest, bull trout distribution has been significantly reduced over the past 30 years and many local extinctions have occurred. Oregon's Klamath River Basin represents the southern limit of present day bull trout distribution. The Klamath populations are genetically distinct from other populations in the region and are now restricted to cold headwater streams. Habitat degradation and introduction of non-native fish species are believed to be the primary causes for the decline. Bull trout have been listed as a Category 2 Species (candidate species under the Endangered Species Act of 1973) by the U.S. Fish and Wildlife Service (USFWS) and is listed as a sensitive species by the State of Oregon.

Bull trout were probably the only fish species present in Sun Creek, a high elevation, second order stream, prior to early introductions of non-native salmonids. National Park Service (NPS) and Oregon Department of Fish and Wildlife (ODFW) records indicate repeated stocking of rainbow trout (*Oncorhynchus mykiss*) and brook trout (*Salvelinus fontinalis*) in Sun Creek between 1928 and 1971. The only park-wide stream survey conducted during this period took place in 1947. A seasonal naturalist named Orthello Wallis (who later became the first aquatic biologist ever employed by the NPS) found bull trout, rainbow trout, and brook trout in Sun Creek.

A resurvey of Sun Creek was made in the summer of 1989 to investigate the distribution and abundance of fish relative to habitat characteristics. The survey was funded as part of Klamath River Basin water rights adjudication. Sun Creek was surveyed from its headwaters to the park boundary. Bull trout, brook trout, and hybrids from the two species were collected. No rainbow trout were collected in the portion of Sun Creek within the park and may no longer exist in the stream.

Investigators observed that habitat utilization by bull trout and brook trout was very similar. Competition and hybridization with brook trout have probably reduced the distribution of bull trout in Sun Creek. Bull trout were restricted to a 1.9 km reach of the stream and the total number of adult bull trout was estimated at 130 fish. Such a low population density is alarming, since it suggests that local extinction could occur within the next few years.

The NPS is developing a bull trout management program whose goals are to remove brook trout from Sun Creek, build a barrier to prevent re-invasion, and to re-establish a self-sustaining population of bull trout in Sun Creek within Crater Lake National Park. During 1991, park staff convened a "Bull Trout Recovery Team" to develop recommendations on how to best achieve these goals. It consisted of representatives from the NPS, USFWS, ODFW, U.S. Forest Service, California Department of Fish and Game, and Oregon State University. A final report from the group is expected in early 1992 and will form the basis for the first active fish management project ever undertaken in the park. An environmental assessment will be available for public comment before any management action is taken.

Visitors should note that fishing for bull trout in Crater Lake National Park and throughout south central Oregon is prohibited by state law. Bull trout within the park are also protected by federal regulations. Fishing for other species in most park streams is permitted. Copies of fishing regulations are available at the park's visitor centers. Fishing in Crater Lake for kokanee salmon (*Oncorhynchus nerka*) and rainbow trout (*Oncorhynchus mykiss*) is allowed. No state license is required and fishing on the lake has been good in recent years.

Mammals of the Pumice Desert

By Ruth Monical and Stephen P. Cross

Much of the Crater Lake National Park is covered in forest. One visible exception is the Pumice Desert on the road to the park's north entrance. At first glance this 5 1/2 mile square, nearly flat opening appears to be quite barren except for a few scattered lodgepole pine (*Pinus contorta*). A closer look reveals that many forms of life, including several mammals, use this landscape as a habitat.

At a mean elevation of 5,960 feet, the Pumice Desert is in the Klamath River drainage basin. Yet it is but two miles from the Umpqua River and Rogue River tributaries. Elizabeth Mueller Horn studied the ecology of the Pumice Desert and described the vegetation, which largely consists of herbaceous plants with very sparsely scattered lodgepole pine. She found only 14 plant species with total cover of 4.6 percent. All plants except the lodgepole pine are small herbaceous or woody stemmed forms with various adaptations for surviving in the absence of summer surface moisture and relatively high temperature. The poorly developed soil is relatively porous and deficient in several minerals, a further cause of the depauperate flora. The resulting lack of cover increases daytime summer temperatures, creating a relatively unique park habitat resembling parts of the Great Basin Desert to the east.

Interestingly enough, several animals are adapted for living in the Pumice Desert's rather harsh micro-habitat. Mammals are an excellent example of the way in which some animals cope with the conditions of extreme temperatures and seasonally restricted food and water. The mammals that occupy the Pumice Desert are either well adapted for living in these restrictive conditions, or are highly mobile, and use the area on a temporary basis, or are simply passing through during movement to more preferred habitat. Field studies by one of us (Monical) indicate that only three mammal species appear to be permanent residents, far fewer than in other park habitats. The Great Basin pocket mouse (*Perognathus parvus*) and the deer mouse (*Peromyscus maniculatus*) occur in significant numbers. One summer's live trapping (168 traps set for ten nights) resulted in the capture of 54 individual pocket mice and 46 deer mice.

The Great Basin pocket mouse, a seed-eating specialist, is common in the high desert habitat of western North America. It carries food in its fur lined cheek pouches for storage in a burrow. The ability to metabolize moisture from its food allows the pocket mouse to survive with no free water. This nocturnal species also closes its burrow during the day to help maintain a moist environment. When conditions become too severe, it will estivate in the summer or become inactive during the winter.

The deer mouse is the park's most ubiquitous species, utilizing many different habitats. A highly omnivorous animal, it is able to survive on a variety of vegetative parts, insects, and has even been known to eat other small mammals. Though mostly nocturnal, the deer mouse at times can be seen just

before dark when it begins its search for food. An additional adaptation leading to its continuing survival in harsh conditions is its high reproductive rate.

A third, less abundant, resident is the western pocket gopher (*Thomomys mazama*). Its mounds are seen on the periphery of the desert near the forest edge, where the texture of the pumice soil is more conducive to its underground habits. Gophers are active in the winter and sometimes fill their above-ground burrows under the snow with soil. After melt, these serpent-shaped ridges are evidence of the previous winter's activity.

Other captured or observed rodents, considered transients, are the yellow-pine chipmunk (*Tamias amoenus*), golden mantled ground squirrel (*Spermophilus lateralis*), bushy tailed woodrat (*Neotoma cinerea*), and porcupine (*Erethizon dorsatum*). It is also likely that snowshoe hares (*Lepus americanus*), mule deer (*Odocoileus hemionus*), and perhaps elk (*Cervus elaphus*), occasionally venture into this area of marginal habitat. Some species of bats that roost in the nearby forest use the open areas for foraging. Predators are rare but could include the red fox (*Vulpes vulpes*), coyote (*Canis latrans*), ermine (*Mustela erminea*), and long-tailed weasel (*Mustela frenata*). The pronghorn antelope (*Antilocapra americana*), sometimes sighted in the park, is known to use open areas such as the Pumice Desert. This location represents one of the westernmost extremes of the current range for this species, usually a Great Basin inhabitant.

Mammals utilize the Pumice Desert for a variety of reasons, even though the harsh environmental conditions preclude most as residents. The presence of the Great Basin pocket mouse as a permanent inhabitant there creates a unique combination of species for Crater Lake National Park.



Heresies of an Interpreter

By Ted Haeger

The presumed purpose of interpretation in the national parks is to add depth to the scenery. Not visual depth, but the depth of **understanding**. Interpretation is meant to give visitors a new, more informed context to accompany the scenery; a context which transcends the veil of beauty to expose the interaction of natural and human history within the scenery. Good interpretation leaves the visitor with a better base of knowledge, an enticed sense of curiosity, and an interest in the continuing preservation of the place that has inspired them.

Any discussion about interpretation in the national parks is destined to come across the name of Freeman Tilden. As the "father" of modern interpretation, one of Tilden's most important points was that interpreters should not make things up to fill gaps in their knowledge. Falsifying information reduces interpretation to mere theatrics, perhaps giving the interpreter an ego boost, but certainly not giving visitors an honest impression of the park.

The difference between factual and fictional interpretation gets muddled with the inclusion of what I call non-facts. These are more misinformation than they are lies. When important information is allowed to go unexamined over a long period of time, it can easily become misinformation in light of subsequent research or other changes in the understanding about park resources.

A prime example of how information has to be reexamined is provided in the article by Ron Mastrogiuseppe and Steve Mark. They point out the difference between radio-carbon dates and calendar years. This is significant because the date of the climactic eruption serves as the watermark for the recent geological past in Oregon and elsewhere. It has been used in the reconstruction of prehistoric environments and to place other geological events within a chronological sequence. Differences between radiocarbon dates and calendar years are important to the interpretation of Mazama's climactic eruption because the roughly 800 year "correction" puts this event at 7,700 calendar years ago. Previously we had been using the radiocarbon date of 6,845 years and **assuming** that estimate was equivalent to calendar years.

Correcting misinformation is one aspect of strong communication. It is also evident to me that interpreters need to be strong communicators and involved researchers. The emphasis in the National Park Service over the past three decades, however, has been on the communication side of interpretation. Facts are now merely what the interpreter communicates, not something in which they are directly involved. This is particularly true for interpreters hired for the summer season because their job is so heavily structured toward communicating information in a variety of settings, leaving little time for research or participation in resource management.

Another reason for the weakened relationship between communication and research is the formal bureaucratic separation of interpretation from

resource management within the National Park Service. At Crater Lake, interpretation is its own division while resource management is part of a division that houses law enforcement functions. Most of the scientific research in the park takes place through the auspices of resource management staff who are given little incentive within the structure of their job to frequently update interpreters about what they are doing.

In the interest of updating our knowledge about the park and its resources and keeping it current, I think it is time for a closer relationship between resource management and interpretation. This would allow interpreters to give equal attention to the facts, as well as being better able to effectively communicate them without misinformation. If this strong link is not provided, interpretation will fail to add much depth to the scenery.

Illustrations

- p. 3 "The Trailside Speaks," L. Howard Crawford, *Nature Notes*, Vol. VII, No. 2, August 1934.
- p. 5 L. Howard Crawford, *Nature Notes*, Vol. IX, No. 1, July 1936.
- p. 6 "Crater Lake Currant," L. Howard Crawford, *Nature Notes*, Vol. VIII, No. 3, September 1935.
- p. 10 "A Buried Log in Rogue River Tuffs and Agglomerates," W. D. Smith, *Nature Notes*, Vol. VII, No. 3, September 1934.
- p. 14 Karl J. Belser in *Blue Interval*, Ernest G. Moll, Metropolitan Press, Portland, 1935.
- p. 18 L. Howard Crawford, *Nature Notes*, Vol. VIII, No. 3, September 1935.
- p. 20 L. Howard Crawford, *Nature Notes*, Vol. IX, No. 1, July 1936.



Back Cover Photo: *Cleetwood* on Crater Lake, July 1886. Photo courtesy of the Oregon Historical Society.

