Crater Lake Outstanding Resource Water Designation

Support Document

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DEQ is a leader in restoring, maintaining and enhancing the quality of Oregon's air, land and water.

State of Oregon Department of Environmental Quality

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Executive Summary

Crater Lake is located in Klamath County, in south central Oregon. Crater Lake is the centerpiece of Oregon's only national park. Located in a volcanic caldera, it is the deepest lake in the United States and is exceptionally clear and pristine. In addition to its outstanding water quality, the lake is important for long-term research and recreation, and has great cultural significance to local Native American tribes.

The Northwest Environmental Defense Center (NEDC) submitted a petition to the Oregon Environmental Quality Commission (the commission) and Oregon Department of Environmental Quality Director Richard Whitman, dated April 22, 2019.The petition asked the commission to adopt rules designating Waldo Lake, another extremely clear lake in Oregon, an Outstanding Resource Water (ORW). In July 2019, the commission granted the petition and directed DEQ to initiate the requested rulemaking. At the same time, the commission directed DEQ to also initiate rulemaking to designate Crater Lake an Outstanding Resource Water.

Outstanding Resource Waters are high quality waters that have extraordinary or unique character or ecological value, or are critical habitat areas, such that they constitute an outstanding state or national resource. Oregon must protect the special water quality and ecological values of these waters under its antidegradation policy. Therefore, the proposed rules include a policy to protect Crater Lake's current high water quality and exceptional ecological values. The proposed rule amendments would prohibit new or expanded permitted wastewater discharges and limit activities that would degrade the current water quality. Exceptions are allowed to respond to emergencies and for restoration or enhancement activities.

1. Introduction and Background

This document provides supporting information for the Oregon Department of Environmental Quality's proposal to designate Crater Lake an Outstanding Resource Water and adopt a rule to protect Crater Lake's existing high water quality, ecological and recreational values.

Crater Lake, the centerpiece of Oregon's only national park, is unique. Located in a volcanic caldera, Crater Lake is the deepest lake in the United States and is exceptionally clear and pristine. Based on the outstanding quality of its water, the importance of the lake for long-term research and recreation, and the lake's cultural significance, the Oregon Environmental Quality Commission directed DEQ to initiate a rulemaking to designate Crater Lake an ORW.

DEQ is working with the Crater Lake National Park staff and other stakeholders to develop proposed rules and supporting information. In adopting the rules, DEQ must consider the statutory mandates and General Management Plan for Crater Lake National Park, in addition to federal and state water quality regulations.

DEQ is making this support document, together with the proposed rule language and the fiscal impact statement, available for public comment. Following public comment, DEQ will make a recommendation to the commission about whether to designate Crater Lake an ORW and about the proposed water quality protection rule to accompany the designation.

1.1 Brief History

In April 2019, NEDC and several co-petitioners submitted a petition to the commission requesting that the commission designate Waldo Lake, another extremely clear Oregon lake, an ORW. There was a large amount of public support for the Waldo Lake ORW designation. In July 2019, the commission granted the petition and directed DEQ to initiate a rulemaking process to consider the proposed rules. At the same time, the commission directed DEQ to include the designation of Crater Lake as an ORW in the rulemaking process. The citizen petition and the DEQ Staff Reports for Waldo Lake and Crater Lake may be found on the following website: https://www.oregon.gov/deq/wq/Pages/WQ-Standards-ORWO.aspx.

Oregon's first, and only ORW to date, is the North Fork Smith River in southwest Oregon. The commission designated this ORW in 2017 in response to a citizen rulemaking petition. The rule language proposed for Crater Lake is similar to the language adopted for the North Fork Smith River and proposed for Waldo Lake, but has been revised.

1.2 Outstanding Resource Waters

Oregon's water quality standards define three classifications of state waters: water quality limited, high quality, and outstanding resource waters. As stated in Oregon Administrative Rules 340-041-0004(8) and the associated definition in OAR 340-041-0002(45), Outstanding Resource Waters (ORW) are high quality waters that have extraordinary or unique character or ecological value, or are critical habitat areas, such that they constitute an outstanding state or national resource. Oregon rules identify waters in national parks as a priority for ORW consideration.

Federal regulations also identify waters in national parks as a priority for state protection from water quality degradation:

> 40 Code of Federal Regulations §131.12(a)(3): Where high quality waters constitute an outstanding National resource, such as waters of National and State parks and wildlife refuges and waters of exceptional recreational or ecological significance, that water quality shall be maintained and protected.

The ORW designation may only be granted by the EQC through rulemaking. Along with the designation, the rules must also include a policy to protect and maintain the exceptional qualities and values of the waterbody.

2. Crater Lake

2.1 Description and Location

Crater Lake, the centerpiece of Oregon's only national park, is uniquely located in a volcanic caldera formed by the eruption of Mount Mazama roughly 7,700 years ago. Crater Lake is the deepest lake in the United States at 1,949 feet and is exceptionally clear and pristine. The following sections provide additional information on the lake's water quality and ecology.

Crater Lake is located in Klamath County, in south central Oregon, as shown in the following figures.

Figure 1: Location of Crater Lake in Oregon.

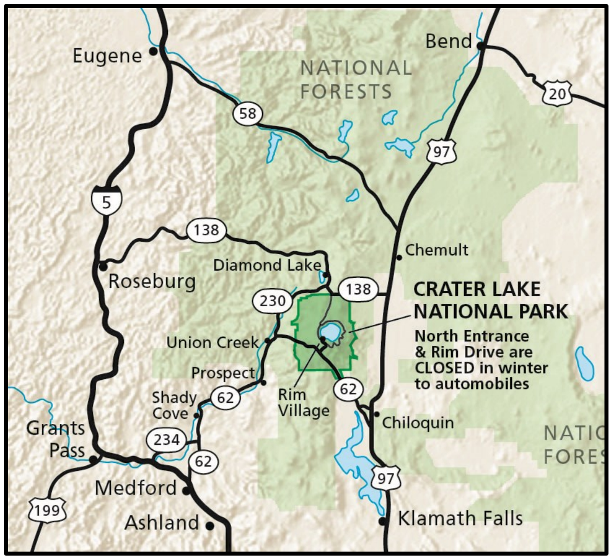

Figure 2: Location of Crater Lake in Oregon. [Source: National Park Service brochure]

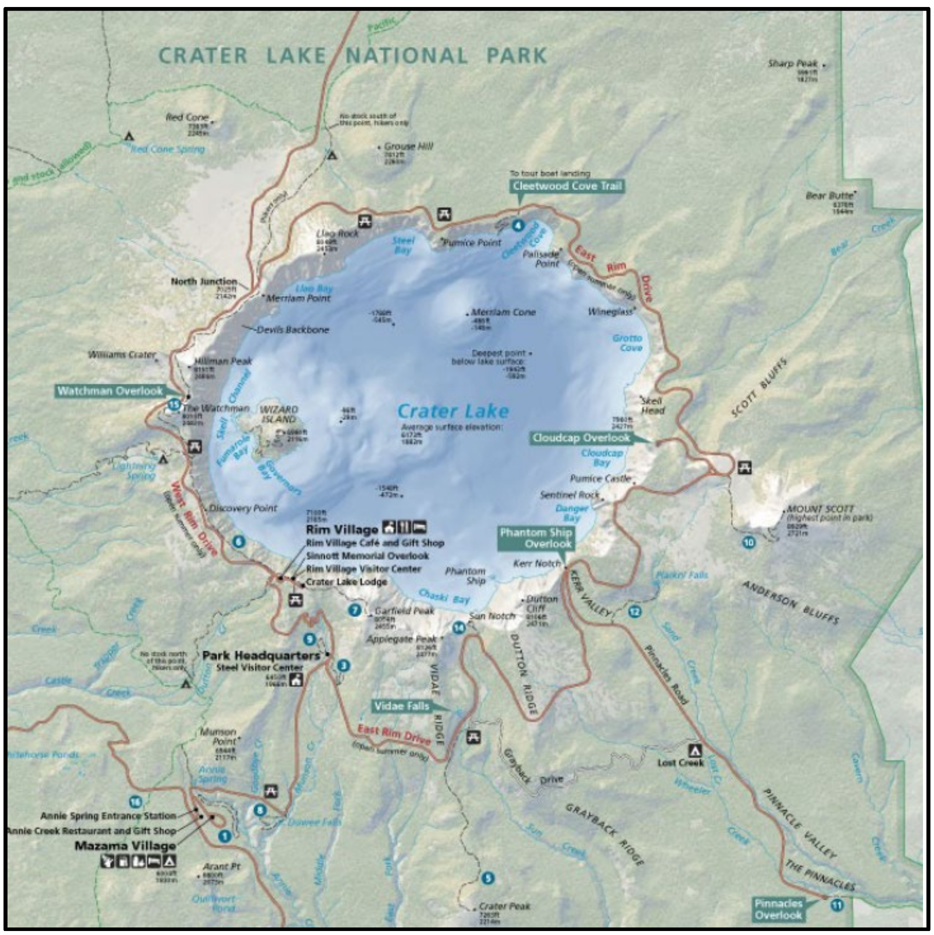

Figure 3. Detail of Crater Lake in Oregon. [Source: [http://www.craterlakeinstitute.com/what- to-do/directions-and-maps/more-of-crater-lake/]](http://www.craterlakeinstitute.com/what-to-do/directions-and-maps/more-of-crater-lake/)

2.2 Water Quality

Crater Lake is a very clear, deep lake contained within a volcanic caldera. No streams flow into or out of Crater Lake. All water entering the lake is from direct precipitation and snowmelt, and is eventually lost through evaporation or subsurface seepage. This means that very little sediment or organic matter is transported into the lake, making it extraordinarily clear, with low levels of nutrients and low productivity (i.e. ultra-oligotrophic). According to the U.S. National Park Service, the lake is one of the clearest, bluest, deepest, and most pristine lakes in the world.

Crater Lake maintains a long-term limnological monitoring program. The data from this monitoring program are summarized in the Crater Lake Long-term Limnological Monitoring Program *State of the Lake Report: 2018 (NPS, 2019).* Some highlights of the water quality data and information from this report are provided here.

The clarity and color of Crater Lake is due to the lack of particles suspended in the water column. One measure of water clarity is Secchi depth, a measurement of how deep an object (the Secchi disk) can be seen through the water. A large Secchi depth value is highly correlated with low particle density. Data from the NPS long-term limnological monitoring program (NPS, 2019) show the average summer Secchi depth is 30 meters (98 feet), and maximum Secchi depth is 41.5 meters (136 feet). Results of the long term-monitoring program show that water clarity has not declined through time and has even shown a slight improvement since monitoring began in 1978 (See Figure 4). Table 2 and Figures 7 and 8 show Secchi depth values for several Oregon lakes.

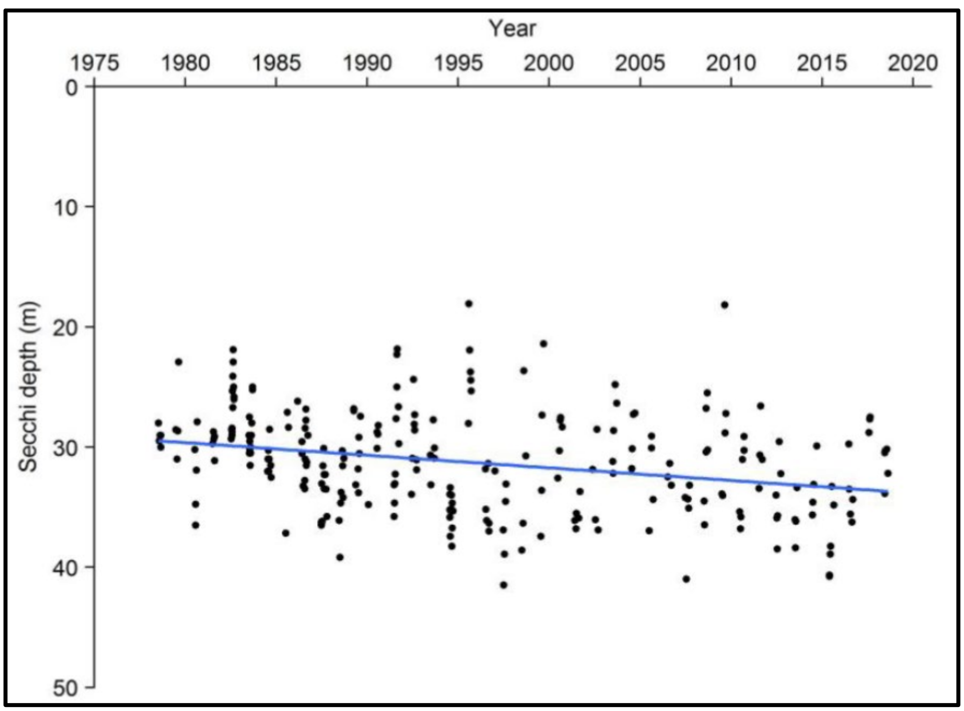

Figure 4 Crater Lake Secchi depths from 1978-2018. Figure taken from the State of the Lake Report, 2018 (NPS, 2019).

Particles can be biotic (e.g. phytoplankton, zooplankton, pine pollen) or abiotic (e.g. dust, minerals, soil). Phytoplankton are the primary source of particles in Crater Lake. Phytoplankton are usually found in higher densities below 30 meters. Because nitrate concentrations are typically low at shallow depths in summer, the algae do not grow near the surface, which helps to maintain water clarity (see Figure 5). Total nitrogen values are also shown on Table 2. The clarity can be variable, however, due to variability in nitrate concentrations, which are closely linked to mixing events with the deep water. The vertical movement and storage of nitrate is closely monitored by the Park Service because it plays such a critical role in water clarity.

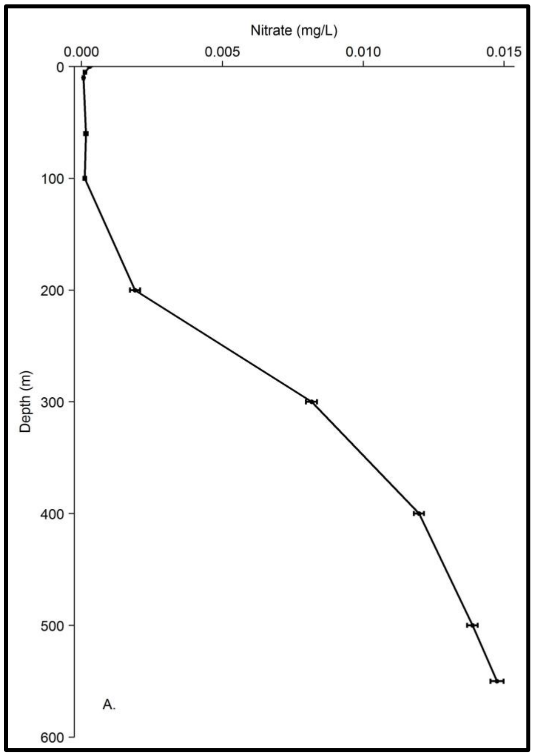

Figure 5: Nitrate dynamics in Crater Lake: Concentration throughout the water column. Figure taken from the State of the Lake Report, 2018 (NPS, 2019).

Crater Lake has periods of vertical mixing of the water column in fall and spring, thermal stratification in summer, and reverse stratification in winter. Thermal stratification in summer means there is warmer water floating on the lake's surface because warm water is less dense than the cold water below. This is important ecologically because surface waters are separated from the deeper waters where phytoplankton and zooplankton grow. Water clarity is typically highest after stratification begins when phytoplankton are limited to deeper depths. This is illustrated in Figure 6 below. The green color on the far left side of the graph indicates higher levels of chlorophyll at the lake's surface. When thermal stratification occurs in early July (shown by the white dotted line), algal concentrations shift to below 100 meters of depth. This contributes to the extreme clarity of the lake in the top 100 meters.

The lake's thermal structure is very important to chemical, physical, and biological processes in the lake's ecosystem and is impacted by air temperature. The Park Service's long term monitoring program has detected an increase in summer surface water temperature, earlier onset of stratification, and a reduction in the depth of the thermocline. Research is underway to investigate how increases in air temperature and other climate changes may influence the mixing processes critical to Crater Lake's water quality and ecology.

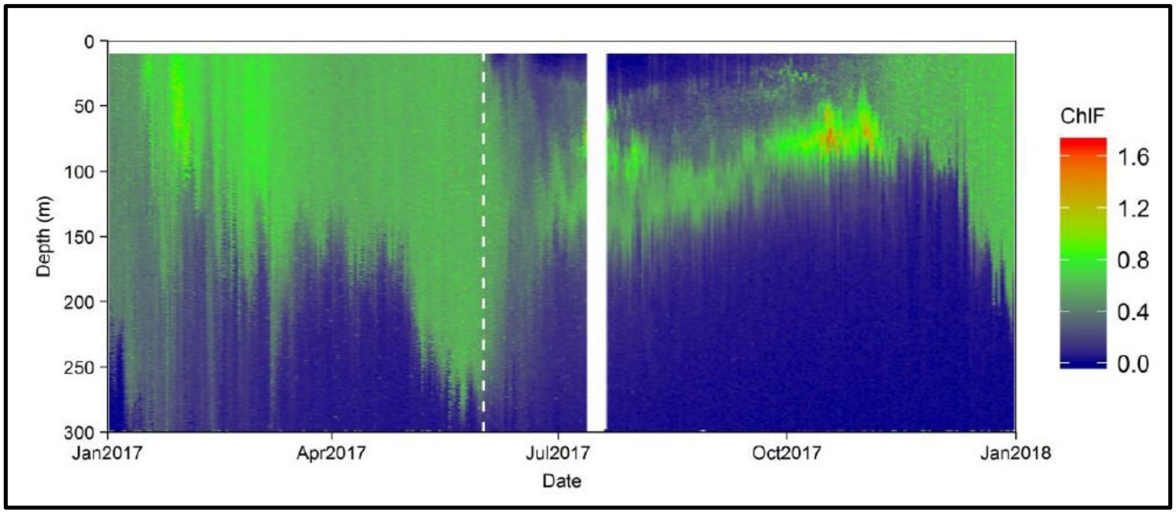

Figure 6: Chlorophyll fluorescence in Crater Lake from January 2017 until January 2018. Stratification is represented by the vertical dotted white line.

Figure taken from the State of the Lake Report, 2018.

2.3 Water Quality of Oregon Lakes

There are over 6,000 lakes in Oregon, with a combined surface area of over 500,000 acres. There are more than 1,400 named lakes in the state and thousands of unnamed lakes, reservoirs, farm ponds, mill ponds, marshes and sloughs ranging in size from less than 1 acre to more than 90,000 acres (Klamath Lake). Oregon's lakes are found in a wide variety of geographic settings ranging from coastal dunes, river oxbows, mountain settings and high desert locations.

The classification system most widely applied to lakes and reservoirs is the trophic classification system. Lakes are ranked according to their biological productivity: unproductive lakes are termed oligotrophic ("little nourished") and productive lakes are termed eutrophic ("well nourished"). The productivity of a lake is determined by a number of physical, biological and chemical characteristics – including light transparency (secchi depth), algal growth (chlorophyll a) and nutrients (phosphorus and nitrogen). Listed in Table 1 is a summary of the trophic statuses for 201 of the larger lakes and reservoirs in Oregon based on data in the Atlas of Oregon Lakes.

Table 1: Trophic Status of Significant Publicly Owned Lakes

From Atlas of Oregon Lakes (Johnson and others, 1985)

	Number of Lakes	Acreage of Lakes
Lakes Assessed	201	491,255
Ultra-Oligotrophic	**12**	**8,752**
Oligotrophic	46	26,528
Mesotrophic	72	75,212
Eutrophic	60	191,310
Hypereutrophic	11	189,453

Most of the ultra-oligotrophic and oligotrophic lakes are found in the Cascade and Wallowa mountains. Of these high quality waters, Crater Lake and Waldo Lake stand out as being very unique, particularly for lakes of their size. Both are extremely clear (high secchi depths) with low productivity (see Figure 6 below). Waldo is further unique in its low ionic strength (specific conductivity), which is similar to distilled water.

Table 2 below shows specific conductivity data and other water quality data for a several Oregon lakes. The classifications for the lakes in this table are: Waldo = ultraoligotrophic, Crater = oligotrophic, Odell = mesotrophic, Diamond and Tenmile – eutrophic; and Klamath = hypereutrophic.

Figure 7 shows how the water clarity of selected Oregon lakes compare. This figure illustrates how extraordinarily clear Waldo and Crater Lakes compare even to other Cascade lakes, such as Odell and Diamond Lakes. The data are also shown in Table 3 below.

Figure 8 shows a histogram of Secchi data from the 2007 National Lakes Assessment, which includes 1184 lakes. This graph also shows how exceptional Waldo and Crater are in terms of clarity. The average secchi depth restoration target for Tahoe Lake is included for comparison. Tahoe Lake, in the Sierra Mountains in California is also known for its clarity and has been designated as an ORW by the state of California.

Table 2: Water Quality Data for Selected Oregon Lakes
(median values unless otherwise indicated)

Lake	Basin	Water Clarity (Secchi depth)		Total Nitrogen		Total Phosphorus		Chlorophyll-a		Specific Conductivity	
		meters	Samples[1]	ug/l	Samples[1]	ug/l	Samples[1]	ug/l	Samples[1]	ug/l	Samples[1]
Waldo	Middle Fork Willamette	32.6	N=82 1986-2019	40	N=47 2001-2014	0.5	N=104 2001-2014	0.1	N=72 2001-2014	3	N=379 1986-2019
Crater	Klamath	31.1 mean	N=222 1978-2019 Jul-Sep	12 mean	N= 412 1985-2004 Jul-Sept	25 mean	N=572 1985-2019 Jul-Sep	0.12	N=1218 1990-2018 Upper 200 meters	116 mean	N=1164 1983-2019 Jul-Sep
Odell	Deschutes	6.3	N=22 2004, 2019	183	N=11 2019	20	N=27 2004, 2019	6.2	N=27 2004, 2019	33	N=148 2004, 2019
Diamond	Umpqua	5.4	N=279 2007-2019	340	N=76 2007-2019	24	N=76 2007-2019	3.7	N=45 2007-2019	37	N=75 2007-2019
Upper Klamath	Klamath	0.8	N=11,660 1990-2015	1830	N=2699 1990-2015	136	N=2772 1990-2015	54	N=2486 1990-2015	111	N=9329 1990-2015
Ten Mile	South Coast	1.2-2.7	N unknown 2013-2014	51	N unknown 2013-2014	27	N unknown 2013-2014	1-260	N unknown 2013-2014	55-75	N unknown 2013-2014

[1]Number of samples; date range of samples.
[2]Chorohpyll fluorescence
Data from: Rich Miller, PSU Center for Lakes; Scott Girdner, Crater Lake National Park.

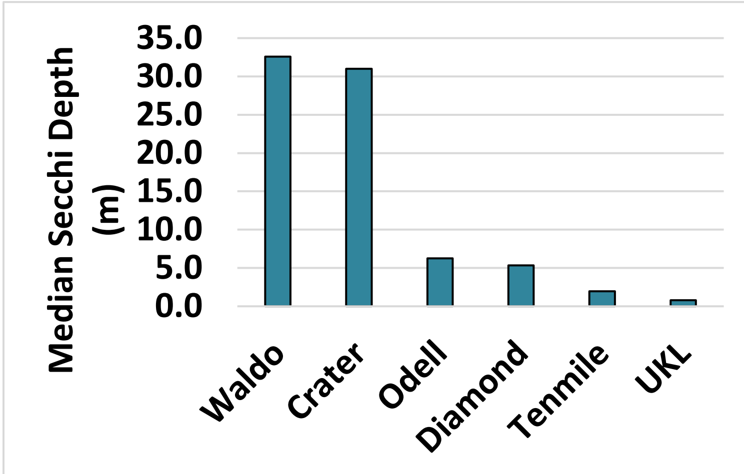

Figure 7: Secchi Depths of Selected Oregon Lakes.
From data provided by Rich Miller, PSU Center for Lakes.

Figure 8: Secchi Depths from the 2007 National Lakes Assessment

From: Lahontan Regional Water Quality Control Board, Nevada Div. of Environmental Protection (NDEP). 2010. Final Lake Tahoe Total Maximum Daily Load Report, http://www.waterboards.ca.gov/rwqcb6/water_issues/programs/tmdl/lake_tahoe/index.shtml.

U.S. Environmental Protection Agency. 2010. National Aquatic Resource Surveys. National Lakes Assessment 2007. Available from U.S. EPA website: http://www.epa.gov/national-aquatic-resource-surveys/data-national-aquatic-resource-surveys.

2.3 Ecological and Research Value

The National Park Service long-term limnological monitoring program (LTLMP) at Crater Lake began in 1983 and includes four major goals:

1. Developing a reliable database for the lake to be used for comparisons of future conditions.
2. Developing a better understanding of physical, chemical, and biological processes occurring in the lake.
3. Investigating the possibility of short- and long-term changes in the lake.
4. And if changes are found, and human-caused (e.g., pollution), recommending mitigation techniques.

Because of the relative lack of anthropogenic land use impacts, the lake is an important laboratory for studying long-term baseline water quality conditions. Researchers often use Crater Lake as a barometer to measure and describe human impacts on the environment (e.g. air pollution, climate change, invasive species, etc.) because of its pristine quality.

The following is a summary from the Crater Lake Institute about the lake's importance for research:

> "Crater lake is a world-class laboratory for studying lakes because of its pristine condition. Because it is preserved in a National Park it is expected that there will be minimal future onsite impacts from human activities. The lake provides scientists and park managers with a gauge for assessing changing environmental conditions external to the Park. Long-term monitoring of Crater Lake has been used to develop a baseline of information about the natural dynamics and complexity of the lake. This baseline will serve as a reference when studying the impacts of global climate change and human activities, such as agriculture and urban growth, on other lakes. Scientists working with the U.S. Geological Survey, the National Park Service, and Oregon State University have systematically studied Crater Lake for the last two decades. Long-term monitoring of this lake is a priority of Crater Lake National Park and will continue far into the future."
> http://www.craterlakeinstitute.com/general-natural-history-articles/natural-history-flora-and-fauna-articles/two-decades-of-research-at-crater-lake/2/

There have been 160 taxa of phytoplankton and 12 taxa of zooplankton documented within Crater Lake. Crater Lake is habitat for a rare endemic species of newt, the Mazama newt (*Taricha granulosa mazamae*) (Fig. 6), which has been genetically isolated within the caldera for generations. Researchers are very interested in studying their distribution within the Park and monitoring their population dynamics. Of particular interest is the effect of introduced species on the endemic species unique to the lake. Kokanee salmon, rainbow trout, and signal crayfish are larger non-native (i.e. introduced) organisms found within Crater Lake. There is also a deep-water moss community that exists between 26-140 meters which forms thickly on the slopes around Wizard Island and on the walls of the caldera.

Figure 9: Endemic Mazama newt in Crater Lake (NPS photos).
Figure taken from the State of the Lake Report, 2018.

Phytoplankton generally form the base of the food chain in deep lakes. They support larger organisms like zooplankton which in turn support fish. During the summer, phytoplankton form two distinct communities defined by the thermal stratification. The first community lives in the warmer surface water and is predominately comprised of a few species of large diatoms and dinoflagellates. The second community, found in deeper water, has a higher diversity of species. Researchers have noted the zooplankton community in Crater Lake is unusual because there are so few taxa compared to other lakes.

The eruption of the volcano, Mount Mazama, created the caldera that holds Crater Lake. This eruption greatly influenced the region’s landscape and ecology. The active hydrothermal features and volcanic activity over the last 400,000 years have contributed to the greater ecoregion. Crater Lake and its surrounding ecosystems are highly unique and largely unaltered by human activity. The park contains diverse communities of vegetation that are highly intact and provide a large degree of connectivity to surrounding areas. This encourages biological diversity and population growth for endemic aquatic and terrestrial species.

In addition to the lake itself, Crater Lake National Park also has several perennial (i.e. seasonal) lakes and ponds, about 250 wetlands, 24 year-round streams, one high elevation bog, and is the headwaters for more than one major river, including the Rogue River. These diverse aquatic habitats surrounding the lake contribute to the large amount of regional biological diversity.

2.4 Recreational Value

In 2019, there were 704,512 recreation visitors to the park and the park is considered a leading attraction in southern Oregon. Visits to Crater Lake contribute a significant amount of revenue to the regional economy. Recreational activities include hiking, biking, scenic vistas, camping, staying or dining at the historic Crater Lake Lodge, skiing, snow-shoeing, and boat tours on the lake.

There are three commercial services that operate in Crater Lake National Park, known as concessions. These include Crater Lake Hospitality LLC (providing lodging, scenic tours, retail operations, food service), Crater Lake Trolley (a shuttle company providing scenic and sightseeing tours), and Xanterra Parks and Resorts Inc. (providing retail, lodging, auto, gas and service stations). In the 2016 fiscal year, revenues for concessions were $13,413,607. In 2019, there were 54,223 overnight stays within or around the park.

2.5 Importance to Native American Tribes

Crater Lake is highly significant to Native American tribes. The Klamath Tribes, which include the Klamath, Modoc and Yahooskin band of the Snake, knew Crater Lake as gii-was, meaning "a sacred place." The Cow Creek Umpquas also knew and respected Crater Lake. Native Americans experienced the collapse of Mount Mazama about 7,700 years ago, and have many stories about the creation of Crater Lake and its features. Crater Lake was used as a place for vision quests and prayer, and the surrounding areas were important for their resources and cultural traditions.

3. Lake Management

Crater Lake is a unique and highly valued natural resource in Oregon fully contained within Crater Lake National Park, the state's only national park. While there are few threats to Crater Lake at this time, the state's proposed ORW designation will complement and reinforce the National Park Service management objective to maintain the lake's pristine nature while allowing the public to enjoy the lake.

The Foundation Document for Crater Lake (NPS, 2015) articulates the Crater Lake National Park's purpose statement. The purpose statement, shown below, identifies the specific reasons Congress established the park in 1902 and lays the foundation for understanding what is most important about the park.

> ***CRATER LAKE NATIONAL PARK*** *forever preserves Crater Lake, scenic landscapes, volcanic features, and unique ecological and cultural heritage, and fosters understanding and appreciation through enjoyment, education, and inspiration.*

The Foundation Document also articulates the basis for the Park Service's management planning. The following is among the fundamental resource values for the park:

> "Crater Lake National Park's world-renowned caldera holds one of the clearest, bluest, and deepest lakes in the world. Its clarity and color is due in great part to the lack of suspended particulates and extremely low organic productivity. It contains significant and active hydrothermal features, which, among other lake qualities, have made it one of the most extensively monitored lakes of its size in the world. Its impressive scale and geographic setting within the high Cascade Mountains create lasting memories and inspire visitors."

The ORW designation for Crater Lake will reinforce the importance of management planning and monitoring by the Park Service to ensure the lake is protected over time.

4. Proposed Rule

The proposed rule amendments would designate Crater Lake an ORW and establish a policy to protect the lake's high water quality and ecological values. The proposed rules amend the Outstanding Resource Water policy within the state's antidegradation policy at OAR 340-041-0004(8) and the basin specific rules for the Klamath Basin at OAR 340-041-0185. DEQ's proposed rule language is intended to recognize that current levels of recreation and tourism activity are part of the baseline and establishes a policy to prevent degradation of current conditions due to additional activity or development. It is not the intent to reduce or remove current recreation and tourism activities, which are themselves one of the exceptional values of these lakes.

The proposed rule establishes the policy goal and prohibits permitted discharges that would degrade water quality. DEQ could allow short term construction stormwater permits where needed to maintain and improve recreation facilities and roads. Discharge permits are issued by DEQ, so DEQ would implement this portion of the rule. The National Park Service manages activities on the lake and in the watershed. Therefore, the park service would meet the ORW policy through its lake and watershed management.

5. References

National Park Service, 2015. Foundation Document for Crater Lake National Park.
https://www.nps.gov/crla/getinvolved/upload/CRLA_Foundation-Document_emailsize-508.pdf

National Park Service, March 2019. Crater Lake Long-term Limnological Monitoring Program *State of the Lake Report: 2018.* Scott Girdner, Mark Buktenica, Jeremy Mack.
U.S. Department of the Interior National Park Service Crater Lake National Park Crater Lake, Oregon

Appendix A, Federal ORW Regulations

Code of Federal Regulations §131.12 Antidegradation policy and implementation methods.

(a) The State shall develop and adopt a statewide antidegradation policy. The antidegradation policy shall, at a minimum, be consistent with the following:

> …(3) Where high quality waters constitute an outstanding National resource, such as waters of National and State parks and wildlife refuges and waters of exceptional recreational or ecological significance, that water quality shall be maintained and protected….

(b) The State shall develop methods for implementing the antidegradation policy that are, at a minimum, consistent with the State's policy and with paragraph (a) of this section. The State shall provide an opportunity for public involvement during the development and any subsequent revisions of the implementation methods, and shall make the methods available to the public.

[48 FR 51405, Nov. 8, 1983, as amended at 80 FR 51047, Aug. 21, 2015]