Assessing Water Quality of the Deschutes River: A Snapshot of Ecological Health.

Tyler McGuire

Lab mates: Brittany Holland, Sam Sharpes

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Introduction

The Deschutes River flows from the high desert of central Oregon, all the way through Washington, where it eventually joins the Columbia River. Freshwater ecosystems like the Deschutes are important for maintaining the area's biodiversity by providing habitat for aquatic organisms and regulating water cycles. Not only is the Deschutes an important ecological environment, but it also supports economies in the region through fishing, agriculture, and recreational uses. However, this ecosystem has to face growing challenges like increased pollution, agricultural runoff, and climate change.

The Deschutes runs through Olympia, WA, and has been the focus of many water quality studies. There are parameters given to samples of water from the river that help determine the water quality. Key parameters used to assess water quality are: Dissolved oxygen (DO), PH, Biochemical Oxygen Demand (BOD), turbidity, fecal coliform, and nitrate concentration. The analysis of these parameters is important for understanding the river's ability to support aquatic biodiversity. It is vital to ensure the health of keystone species like salmon, which are essential in maintaining the balance of the ecosystem [1].

Oxygen is important to fish, so a low DO level can lead to hypoxia, which can gravely affect aquatic life. Research has shown that conditions that lead to hypoxia are defined as having less than 2 ppm of DO, which can gravely affect aquatic life by causing stress and reducing reproductive success, leading to mass die-offs [2]. Hypoxic conditions can disrupt the balance of the ecosystem, which is detrimental to keystone species which heavily rely on well-oxygenated water for survival [1]. These conditions can result in organic matter decomposition, thermal pollution, and nutrient loading, even if the conditions are only temporary. Hypoxia can also disrupt predator-prey interactions, impair fish growth, and alter the entire ecosystem's dynamics [2], which brings to light the importance of monitoring the DO levels in aquatic systems.

Turbidity is a measure of water clarity and is determined by the amount of suspended particles from silt and/or pollution in the water. High turbidity can reduce light penetration through the water, which can affect photosynthesis conducted by aquatic plants, which disrupts the food web [3]. When photosynthetic plants and algae cannot produce enough energy, it can lead to a decline in oxygen levels which negatively affects fish and other marine organisms that depend on the oxygen-rich water [3]. Turbidity can also cause sedimentation that buries habitats like spawning locations for fish, which is further affecting the ecosystem. High turbidity historically has come from agricultural runoff, construction site erosion, or urban stormwater drains which all introduce nutrients and contaminants into the ecosystem. Turbidity acts as a visual indicator of human impact and the health of the aquatic system.

Fecal coliform bacteria are used as a bio-indicator of pathogenic contamination from the feces of surrounding animal or human populations. Elevated levels can cause increased health risks to animals who rely on the water source, and fecal contamination in recreational areas has been linked to outbreaks of gastrointestinal disease [4]. The sources of fecal coliform include agricultural runoff, dogs, and untreated wastewater. Regular testing of fecal coliform is important to keep the public safe and to find sources of pollution.

BOD is used to measure the amount of organic matter that is consuming oxygen in the water, which can deplete oxygen levels. Fish and invertebrates need dissolved oxygen to survive; decreased levels can lead to dramatic shifts in the ecosystem. High BOD values indicate high nutrient pollution and organic waste [5]. The sources of high BOD are agricultural runoff (fertilizers), wastewater treatment, and decaying plants. Analyzing trends in BOD helps us better understand how nutrient loads are affecting aquatic systems over time.

PH is a measurement of how acidic or alkaline the water is, with extreme values on the PH scale being harmful to aquatic life. Aquatic life is adapted to specific pH ranges - some organisms with even a

slight change in their environment can disrupt their physiological processes. Water that is more acidic can cause the leaching of toxic metals, like aluminum, from the soil which is harmful to fish [6]. In alkaline water the solubility of certain nutrients is reduced, leading to a nutrient-deficient environment. The pH levels of water can change due to human activity and pollution but also can fluctuate from natural processes like erosion or photosynthesis. Measuring pH is important for seeing the impacts of human activities and natural changes on river water chemistry.

Nitrates are important for plant growth, but in environments that historically have lacked nitrates, they can disrupt the nitrogen cycle of an ecosystem. Increased nitrates in an ecosystem can lead to eutrophication. This is where increased nutrients cause algal blooms which block sunlight, and once the alga die they consume oxygen. This causes a “dead zone” where life cannot survive in the water system with the lack of oxygen. The disruption of the nitrogen cycle can set the stage for an increase in invasive plants that can out-compete native plants [7]. Tracking nitrate levels helps us understand how to balance plant success and maintain a healthy ecosystem.

Water quality monitoring is a cornerstone of aquatic ecosystem research; it gives insight into how human activity and natural processes shape the river system. By studying these parameters, researchers can determine potential stressors of the aquatic system and find strategies to mitigate their impact. Understanding seasonal trends in turbidity, pH, or nutrient levels also helps policymakers develop better management practices to prevent pollution and protect aquatic habitats.

This study aims to assess the water quality of the Deschutes River by analyzing these parameters and connecting their influence on the ecosystem to the broader challenges brought by climate change and human activities. Based on prior studies, we expect the water quality of the Deschutes River to provide evidence that the waterway can support a healthy aquatic ecosystem and is capable of sustaining keystone species like salmon. However, elevated BOD and fecal coliform levels can be expected due to local

impact from human activity. Parameters such as DO, pH, turbidity, and fecal coliform were analyzed using water quality testing protocol to evaluate the current health of the Deschutes. These methods were adapted to provide an ecological snapshot of the river's health.

Methods

The water samples used to test were collected at the Deschutes River Ranch on October 16, 2024. Three students were present who each filled eight 1000 mL sampling bottles with river water and ensured no air was present in the bottles. Water and air temperatures were also taken at-site with thermometers and were logged. Four of the collected sampling bottles were wrapped in aluminum foil and stored in a cooler to maintain darkness for 5 days. Then dissolved oxygen tests were conducted with the river water on site using a LaMotte™ DO testing kit, following the manufacturer's instructions. Day 1 DO results were logged to be compared with day 5 DO results to find the BOD using **Eq 1**. The sample bottles were also placed in the cooler to ensure the temperatures did not fluctuate, which was then returned to Saint Martin’s campus.

The next day on October 17, the in-lab tests were done with a lab group of students in Ernsdorff Hall on Saint Martin’s campus. Each of the four tables in class was instructed to perform and log DO, pH, turbidity, and nitrate tests. All of the water quality tests were done using LaMotte™ testing kits with instructions provided by the manufacturer for each kit. The results of each test were then written down on the whiteboard in the front of the lab so there could be a comparison of averages with the entire lab group.

Once the data was collected, each student in the lab group then conducted a fecal coliform test following instructions adapted from the *Water Quality Training Manual* by Hartman (2024). The experiment was conducted by adding nutrient broth to a petri dish, then with sanitized forceps, we inserted sterile filter paper inside of a filtration system membrane to avoid contamination with outside bacteria. A syringe was used to pass 100 mL of water slowly through the sterile filter paper. With

resanitized forceps, the paper was then taken out of the filtration system and carefully placed inside the petri dish with the nutrient broth. With these steps done, we then placed the petri dish in an incubator and waited for the fecal coliform bacteria colonies to grow [8]. For this experiment, a full 24 hours was given for incubation, and students could then count the amount of colonies grown the next day on October 18. On October 21, the lab instructor conducted a second DO test to collect the day 5 DO value, which we can then use to find the BOD with **Eq. 1.**

Eq. 1: $X_1 - X_2 = BOD$

X_1 = Day 1 DO

X_2 = Day 2 DO

Results

Table 1: Results of DO, BOD, Fecal coliform, pH, Nitrate, and turbidity test.

Parameter	**Result**
Day 1 DO (mg/L)	9.45
Day 5 DO (mg/L)	9.75
Water Temperature (℃)	14.25
Air Temperature (℃)	17.0
Biochemical Oxygen Demand (mg/L)	-0.30
Fecal Coliform Range (colonies per 100 mL)	12-55
pH	7.5
Nitrates (mg/L)	0
Turbidity (JTU)	10

The results seen in **Table 1** show the averages found between all of the four lab groups; each of the tests conducted alongside the range of colonies counted per 100 mL of river water. The day 1 DO level was observed at 9.45 mg/L, and day 5 DO level is 9.75 mg/L, which is a high oxygen concentration in the water. The river water and air temperatures show a medium difference of 14.25℃ and 17.0℃ respectively.

BOD value was calculated as -0.30 mg/L, which is not possible because BOD cannot be negative. This discrepancy stands out since it is not expected from typical results in this kind of experiment, including prior years of conducting this study noted by the instructor. The fecal coliform varied from 12 to 55 colonies per 100 mL of water showing variability in bacterial colonies present across samples. The pH level remains neutral at 7.5, while the nitrate concentration is found to be 0 mg/L, showing no detectable nitrates across all the samples collected. Lastly, the turbidity of the water sample was measured to be 10 JTU giving an estimate of water clarity. The results give insight into the river's ability to sustain aquatic life, these findings are explored in the following discussion.

Discussion

The data that was collected gives us important insight into the overall water quality of the Deschutes River. The Dissolved Oxygen (DO) level on day 1 is 9.45 mg/L and on day 5 is 9.75 mg/L, which means that the river is well oxygenated. High DO is good for supporting aquatic life in the river which is great for biodiversity. The river water and air temperatures were measured at 14.25℃ and 17.0℃ respectively. Previous studies conducted by Kovach et al. (2018), found that water temperatures between 10°C and 18°C support salmon growth and survival [10]. BOD was measured to be -0.30 mg/L, which is not scientifically possible because BOD represents how much oxygen is consumed which cannot be negative. The discrepancy may be a result of experimental error, such as contamination during sample handling, or inaccuracy in DO measurement. More investigation and repeat measurements should be conducted to ensure more accurate results, these discrepancies could obscure trends in nutrient pollution if they are not accounted for.

Furthermore, the fecal coliform colonies per 100 mL of water, range from 12 to 55 colonies. Elevated fecal coliform levels may result from agricultural runoff, wildlife, and dogs brought by humans [9]. The range of 12 to 55 colonies could raise questions about health concerns if the water is ingested, but for swimming and recreational purposes, the U.S. Environmental Protection Agency (EPA) recommends

that fecal coliform levels should not exceed 200 colonies per 100 mL of water [4]. The fecal coliform found in the sample is indicative to be under the EPA's guidelines, ensuring it is safe for recreational activities.

The pH level of the sample was measured at 7.5, which is neutral and ideal for the broadest range of aquatic organisms. Neutral pH promotes a balanced chemical environment that supports a large range of species. The absence of nitrates at 0 mg/L is a positive sign that there is minimal pollution from agricultural runoff. Lastly, there was the turbidity measurement of 10 JTU, which means the water is clear and has low levels of suspended particles throughout. Low JTU supports sunlight's ability to penetrate through the water, which is needed for photosynthesis in the aquatic plants within the river.

Based on the collected data, the overall quality of the Deschutes River supports the theory that the waterway can support a healthy aquatic ecosystem and is capable of sustaining keystone species like salmon. The speculation of fecal coliform levels being present is supported by the test results, this possibly is from human activity along the Deschutes River. High DO levels and neutral pH are signs of a healthy aquatic system, but the presence of some samples having higher fecal coliform bacterial colonies per 100 mL poses a potential impact from pollution.

Continuous, dedicated monitoring of water quality in the many critical rivers of the Pacific Northwest is essential in maintaining the health of the rivers' ecosystem and preventing further contamination from pollution. This study not only gives us a snapshot of the Deschutes rivers current health, but it also highlights the need for continuous monitoring to protect aquatic ecosystems. The Deschutes River has long been a lifeline for the region, offering resources that have sustained both the land and the people who have depended on it. In turn, those who live off its waters and surrounding land must play their roles as stewards in preserving the health of the river and fostering a cycle of care and protection that ensures its continued place as a cornerstone of the ecosystem for future generations.

Citations

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