Comparative Water Quality and Biological Activity Analysis of Two Northern California Lakes: Folsom Lake Reservoir and Woodlake Village Lake

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Abstract

Human activities and local environmental conditions significantly shape the physical and chemical dynamics of freshwater ecosystems. This study presents a comparative water quality analysis between two distinct Northern California bodies of water: Folsom Lake, a large, multi-use public reservoir with high recreational activity, and a small, restricted-access residential lake in the Woodlake Village community of Roseville. Municipal tap and purified water were also measured as baseline controls. Water samples collected in August 2026 were tested for physical parameters, heavy metals, nutrient concentrations, and biological indicators using multi-parameter test kits. Results indicated excellent safety baselines across all water sources for toxic heavy metals (lead, mercury, copper, iron, and manganese) and nitrates. Additionally, *E. coli* levels were found to be zero across all samples, indicating no detectable *E. coli* contamination in any of the tested water sources. Both tap water and Folsom Lake maintained standard municipal chlorination levels (0.5 PPM) and low hardness (25 PPM), with Folsom Lake exhibiting comparatively high dissolved oxygen (75 PPM), characteristic of natural open-water aeration. In contrast, Woodlake Village Lake displayed significant chemical deviations, including a strongly alkaline pH (9.0), elevated total alkalinity (60 PPM), high carbonate (120 PPM), and a prominent spike in phosphates (100 PPB). These chemical markers, alongside visual observations of abundant surface algae and organic debris, suggest heightened biological and photosynthetic activity driven by localized nutrient runoff or organic leaching. While primary health standards were maintained across both sites, the findings highlight the localized hydrological variations between larger open reservoirs and isolated residential retention ponds.

Introduction

Lakes are remarkably diverse ecosystems, varying dramatically in scale, vibrant color, surrounding landscapes, and the unique life they sustain.There are roughly 102,500 larger bodies of water in the United States, and over 3 million when including small ponds and seasonal waters in Alaska (World Atlas, 2026). California has only 3,000 of those named lakes, and a total of 4,036 bodies of water (Escalon Times, 2024). However, due to these features, bodies of water can be health hazards for humans and potentially the species that rely on them if not taken care of. The most common way any environment is ruined is through human activities (Population Connection, 2024). For lakes, this can range from swimming to boating to industrial inputs.

Human interactions can alter and shape lakes through pollution, physical modifications, species introduction, and climate change (Lund University, 2025). Farms wash nitrogen and

phosphorus from fertilizers and livestock waste into nearby lakes, causing agricultural runoff. Excess nutrients trigger large growths of algae, blocking sunlight and creating oxygen-depletion, killing fish and aquatic plants, a process known as eutrophication. Untreated wastewater can also occur through sewage and urban runoff that enter lakes directly, which escalates health risks and water degradation (Outreach International, 2025). Alongside this, chemical and plastic contamination occurs through a variety of different processes such as factories dumping heavy metals, toxic chemicals, and acid mine drainage into freshwater basins. Littering trash and plastic debris accumulate in lake water, heavily harming wildlife (Science Direct, 2024). However, humans have also wanted to restore wetlands, and installed aerators into deep layers of a lake to prevent oxygen depletion (PubMed, 2018). Boat wash stations have been implemented to decrease the amount of waste being put into the lakes (Tahoe Boat Inspections, 2026).

In this paper, we investigate water quality and algal growth within two distinct California bodies of water: one being a residential neighborhood in the Woodlake Village community of Roseville and the large man-made reservoir, Folsom Lake.

Background Information on Selected Lakes and Municipal Water Supply

The 2025 City of Roseville Water Quality Report indicated that drinking water provided by the city successfully met all state and federal safety standards such as total trihalomethanes and lead action level. Sourced from a mix of Sierra Nevada snowmelt via Folsom Lake, treated surface water from Placer County Water Agency, and local groundwater aquifers, the system underwent thorough monitoring from source to tap. All mandated water quality testing set forth by the Environmental Protection Agency (EPA) under the Clean Water Act for microbial, inorganic, and organic chemical contaminants revealed that no primary health standards were violated. While municipal testing did reveal a secondary non-harmful violation for odor threshold levels in Folsom Lake surface water, lead and copper distribution sampling remained below federal and state action limits across all tested sites, which confirms the overall safety and reliability of the municipal water supply.

Folsom Lake in Folsom, California, does allow swimming, boating, paddle boarding and other activities. This man-made lake was built in 1955 after the completion of the Folsom Dam in 1948 for managing and preventing floods, supplying hydroelectric power, and giving drinking and agricultural water. This is a freshwater lake that came from snowmelt and runoff from the Sierra Nevada mountains. The lake's surface area is 11,500 surface acres, and it has a capacity of 1,010,000 acre-feet of water, coupled with a 75 mile shoreline (Norse Notes, 2025). Folsom Lake is 466 feet above sea level, and contains cold water species of fish such as trout and salmon, as well as warm water bass and catfish (California State Portal, 2014).

On the contrary, in the neighborhood of Woodlake Village, there is a man-made lake that does not allow any human activity other than catch and release fishing. This lake has a volume of about 6,390,000 gallons, a surface area of 2.42 acres, and a shoreline of 1,382 feet. The top

of the shoreline elevation is found to be 110.0 feet, bottom elevation is 995 ft, and the normal water surface elevation is about 1095 feet. This lake was built between 2007-2013, and has houses and a trail surrounding it. Inside the lake, there are ducks, geese, and a few different species of fish. As mentioned earlier, there is absolutely no swimming, boating, and paddle boarding allowed in the lakes non-potable, treated reclaimed water. This lake was strictly built to provide a scenic environment to residents, and is taken care of through the company Waterworks, which maintains the lake's pumps and aerators. This information was ascertained from Salina McGow of the Woodlake Village neighborhood HOA.

Material and Methodology Section

Background information for the Introduction portion of this research paper was ascertained from select publications via Google Scholar. Key terms included, but not limited to, human activity in lakes, agriculture, folsom lake, City of Roseville Annual Water Quality Report, and lakes in the US.

The search engines most often used in this study were Google to research equipment and Amazon to purchase them.The items searched and used throughout the experiment are PH strips, a nitrate test kit, a dissolved oxygen kit, a phosphate testing kit, 50 ml centrifuge tubes, and a water temperature tester. The PH kit from ARKIZEN also came with nitrate, E. coli, chlorine, iron, and other testers. The dissolved oxygen kit came from the brand Generic, the phosphate testing kit is from AKSBET, the 50 ml centrifuge tubes are from Yunlnny, and the temperature tester is from Yacumama. These items were purchased on July 20th, 2026.

Water collection as well as testing occurred on August 6th, 2026 past 3 PM Pacific Standard Time (PST). Folsom Lake Water was collected at Biehls Point due to its high levels of human activity. Water testing kits were the most efficient and cost effective method to collect data and see key differences.

Experimental Procedure:

1) Take all supplies to Biehls Point in Folsom, California.
2) Grab a water sample from slightly below the surface using a centrifuge tube and immediately test the temperature of the water using the thermometer (zero it out, set it to celsius, and dip the thin metal piece in the water, take it out and record temperature in notebook (columns labeled by water sample, rows listing temperature in celsius))
3) Find a green patch above the water (or attached to a branch), and using gloves take a centrifuge tube and put algae samples with water inside.
4) Drive back to Woodlake Village at around 4 PM PST.
5) Repeat the same steps in the Woodlake Village lake.
6) Dispense filtered fridge water and take temperature, record it.
7) Dispense tap water samples into centrifuge tubes. Take temperature and record it.

8) For all four samples, take the 21-in-1 PH testing kit strips and submerge them into water samples, holding for 2 seconds before removing. Wait 30 seconds and look at the color of the strips and compare them to the testing kit's guide.
9) Using the sulfate strips that are included in the kit, dip the strips into the water samples for 5 seconds and shake off excess water, waiting another 120 seconds for results.
10) Add half of each sample into a separate centrifuge tube per sample.
11) Using the dissolved oxygen testing kit, add 3 drops of reagent #1 and 3 drops of reagent #2 to each sample, closing the centrifuge tubes and shaking firmly until a brown precipitate appears.
12) Open cap and add 3 drops of reagent #3 to each sample, close the cap and shake until the precipitate disappears.
13) Split each sample into another centrifuge tube each and titrate one by adding reagent #T drop by drop, swirling gently each time, counting the drops until the yellow colored sample has no color, and record it as "A".
14) Use equation dissolved oxygen (mg/l) = A/2 to get dissolved oxygen.
15) Take remaining untouched water samples (other half of the centrifuge tube) and open E. coli testing pack.
16) Fill water samples to the point of the dotted lines and seal bag. Keep the bag flat at all times and at room temperature for 48 hours.
17) After 48 hours, check samples. If the paper in the bag has no other color than a dark blue shade, it's negative, and if there are green spots or other colors, the test came out positive for E. coli.

Results were analyzed using google sheets.

Results

Water Observations

At Folsom Lake Biehls Point, the lake was visibly clean, with some algae at the surface and barely any littering, and about 10 birds flying in the immediate vicinity. There were approximately 20 people swimming in the lake with floaties and pool noodles. Many people were about 60 feet away from the lake and barbequing at the grills nearby. Woodlake Village's neighborhood lake had lots of algae at the surface of the water, some littering, and flies. There were many ducks and geese in the water, with some people walking around the lake's perimeter.

Swimming access is restricted to approximately 100 yards off the coastline from the Biehls Point communal coast. At the time of observation, there were no boats or other motorized water craft in the area.

Experimental Results of Water Quality

Figure 1: Water Quality Test Results					
Test Type	Test Range	Pure	Tap	Folsom	Woodlake
Hardness (PPM)	0 - 425	25	25	25	50
Free Chlorine (PPM)	0-10	0	0	0	0
Iron (PPM)	0-500	0	0	0	0
Chlorine (PPM)	0-10	0	0.5	0.5	0.5
Copper (PPM)	0-10+	0	0	0	0
Lead (PPM)	0-500	0	0	0	0
Zinc (PPM)	0-100	0	0	2	2
Manganese (PPM)	0-10	0	0	0	0
Mercury (PPM)	0-0.02	0	0	0	0
QIAC (PPM)	0-40	0	0	5	5
Fluoride (PPM)	0-100+	0	0	0	0
MPS (PPM)	0-20	1	2	2	2
Sodium Chloride (PPM)	0-500	0	50	50	75
Hydrogen Sulfate (PPM)	0-5	0	0	0	0

Figure 1: Water Quality Test Results					
Total Alkaline (PPM)	0-240	0	0	0	60
Carbonate (PPM)	0-240	0-40	0-40	40	120
pH	6.0-9.0	6	6.4	6.4	9
Phosphate Level (PPB)	0-1000	0	0	0	100
Nitrate (PPM)	0-500	0	0	0	0
Nitrite (PPM)	0-80	0	0	0	1
Sulfate (PPM)	0-25	250	250	250	250
Dissolved Oxygen (PPM)	0-15	27.5	37	75	40
Temperature of Water (C)	N/A	20.5	29.1	32.5	30.78
E. coli	N/A	0	0	0	0

Woodlake Village Lake water shows the highest contaminations and mineral levels, with distinct spikes in hardness, pH, alkalinity, sodium chloride, and phosphates compared to other sources. While tap, Folsom, and Woodlake share a baseline chlorine level of 0.5, open-water sources like Folsom Lake and Woodlake Village Lake introduce unique additives such as zinc and QIAC.

Discussion

The baseline safety levels for toxic heavy metals are optimal across all samples, since all four metals registered as 0 ppm: Lead, Mercury, Copper, Iron, and Manganese. This indicates that dangerous metal contamination was absent across all test locations. The nitrate level is also 0 PPM across every sample, indicating that there is likely minimal agricultural contamination from inputs such as fertilizers (U.S. Environmental Protection Agency (EPA)). Additionally, E. coli levels were found to be 0 across all samples, indicating that no detectable E. coli bacteria were present in any of the tested water sources. This suggests an absence of

detectable fecal bacterial contamination at the time of testing and indicates that all four water samples met this particular safety measure.

The pure water sample contains 0 PPM chlorine and 0 PPM free chlorine which reflects filtration such as reverse osmosis and distillation. The tap, Folsom, and Woodlake samples all maintain a uniform 0.5 PPM chlorine level, which reflects a standard, safe municipal chlorination level that is designed to sanitize water without creating terrible odors or tastes (EPA).

Both Tap and Folsom Lake share identical values in hardness at 25 PPM, sodium chloride at 50 PPM, and a pH of 6.4. However, Folsom shows slightly elevated dissolved oxygen, which is 75 PPM versus Tap at 37 PPM, as well as traces of zinc (2 PPM) and QIAC (5 PPM). High dissolved oxygen is a characteristic of fresh surface water aeration, while trace minerals may come from localized pipe material interaction (EPA and World Health Organization (WHO)).

Finally, the Woodlake Village results show clear deviation from the other three sources of water across many parameters. Woodlake has a high pH of 9.0 which is strongly alkaline compared to 6-6.4 pH range of the pure, tap and Folsom lake levels. This can be driven by elevated carbonate (120 PPM vs. 0-40 PPM elsewhere) and total alkalinity at 60 PPM vs 0. Alkaline water with high carbonate levels usually indicates ground water passing through limestone or alkaline bedrock (EPA). The hardness also doubles to 50 PPM and sodium chloride rises to 75 PPM. Woodlake Village's lake also contains 100 PPM of phosphate in comparison to 0 PPM in the 3 other samples, alongside a trace 1 PPM of nitrate. High phosphate levels often point to localized environmental factors such as mineral leaching and fertilizer exposure (EPA).

A higher pH level may also be linked to greater photosynthetic activity from plants or algae because photosynthesis removes CO2 from water. The combination of higher pH, phosphate, and carbonate may be from a more eutrophic or biological active area.

However, Woodlake Village's lake is inherently a very different water system than Folsom lake and the water distribution from tap and filtered water so it would be tough to draw any specific conclusions--such as greater human inputs are creating a more eutrophic condition in the woodlake.

Conclusion

In conclusion, the water quality analysis demonstrates that all tested sources maintain high baseline safety standards for toxic heavy metals including lead, mercury, copper, iron, and manganese. Nitrates also remain entirely non-detectable across all samples as well as the E. coli levels. Standard principal chlorination (0.5 PPM) was consistently observed in tap and lake water samples, while pure water confirmed thorough filtration. Folsom Lake also exhibited high dissolved oxygen levels which is typical of natural open-water aeration, whereas Woodlake Village displayed significant deviations, including an alkaline pH of 9.0, elevated total alkalinity of 60 PPM, elevated carbonate of 120 PPM, and a marked surge in phosphate (100 PPM). These chemical markers in Woodlake Village suggest heightened biological and photosynthetic

activity, localized runoff, or exposure to nearby fertilizer. However, because Woodlake Village has an isolated lake that can mainly be accessed by residents of the neighborhood, it represents unique hydrologic dynamics compared to Folsom lake and municipal tap water. These variations cannot be definitively attributed solely to human impact without further controlled long-term monitoring.

Limitations & Future Research

This study has limitations such as how it is difficult to make concrete conclusions from the data set above (figure 1) due to small sample size. The accuracy and sensitivity of sampling equipment and media is also questionable due to the quality of the products, as they came from Amazon compared to a proper lab. The dissolved oxygen levels are also higher than the specified range on the packaging due to human error in counting the drops. Consumer-grade materials often lack the strict quality control, standardized calibration, and batch-to-batch consistency required for precise scientific testing, which can compromise the detection threshold of the assay. Consequently, these limitations increase the potential for both false negatives—if low-concentration targets fail to register due to poor sensitivity—and false positives, which may occur from contaminated media, non-specific binding, or improper storage during non-specialized shipping.

Ultimately, the results should be taken cautiously. In the future, multiple samples should be taken from all variables, including both water and algae to average out the data and to see if the data is constant through multiple trials. If budget was not an issue, then EPA methods such as Inductively Coupled Plasma Mass Spectrometry (ICP-MS) could be used to find copper, lead, zinc, iron, manganese, and mercury levels. Ion Chromatography (IC) could also be used to find nitrate, nitrite, sulfate, phosphate, chloride, and fluoride levels (U.S Environmental Protection Agency, 2026).

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