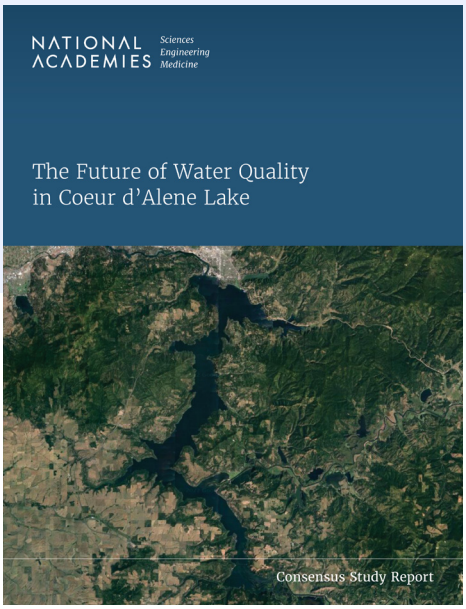
The Future of Water Quality in Coeur d'Alene Lake



Coeur d'Alene Lake (the Lake) in northern Idaho is an invaluable natural, recreational, and economic resource to residents of Idaho and eastern Washington and the nation. Starting in the late 1880s, the region upstream of the Lake, called the Silver Valley, was mined for lead, silver, and zinc. Mineral wastes, laden with heavy metals, were discharged to the South Fork of the Coeur d'Alene River and flowed downstream, eventually contaminating the Lake sediments with lead, cadmium, arsenic, and zinc. Although metal inputs to the Lake have declined since the cessation of mining in the late 1980s, metal concentrations are still orders of magnitude higher than in most lakes in the United States.

After mining stopped, the Bunker Hill mining district in the Silver Valley was designated as a Superfund site, and cleanup of the affected parts of the CDA basin began. However, the Lake itself was not included in the Superfund cleanup. Rather, protection of water quality in the Lake was described in a Lake Management Plan (LMP) implemented by the Coeur d'Alene Tribe, which owns the bed and banks of the southern third of the Lake, and the State of Idaho, which controls the northern two-thirds of the Lake (see Figure 1). A major focus of the Plan is to determine whether increased amounts of nutrients (e.g., phosphorous and nitrogen) from lakeshore development and other land use changes might promote anoxic conditions that could then release toxic metals from Lake sediments back into the water column.

This report analyzes water quality data collected from the Lake and the watershed over the past 30 years and other information to determine trends in water quality conditions over time. The analyses indicate that, although the Lake is still heavily contaminated, concentrations of metals in the major inputs to the Lake have declined. Although nutrient problems are a concern because of the growing population, there is no evidence that nutrient concentrations have been increasing in the last decade or that anoxic events in the Lake are becoming more common. However, the shallower portions of the Lake along the shoreline, where exposure to metals or harmful algae is more likely, are not currently monitored. The best preparation for the future will involve fortifying and expanding lake and watershed monitoring.

The Coeur d'Alene region appeals as a resort area for vacationers and for those looking to relocate to a rural and relatively inexpensive location.

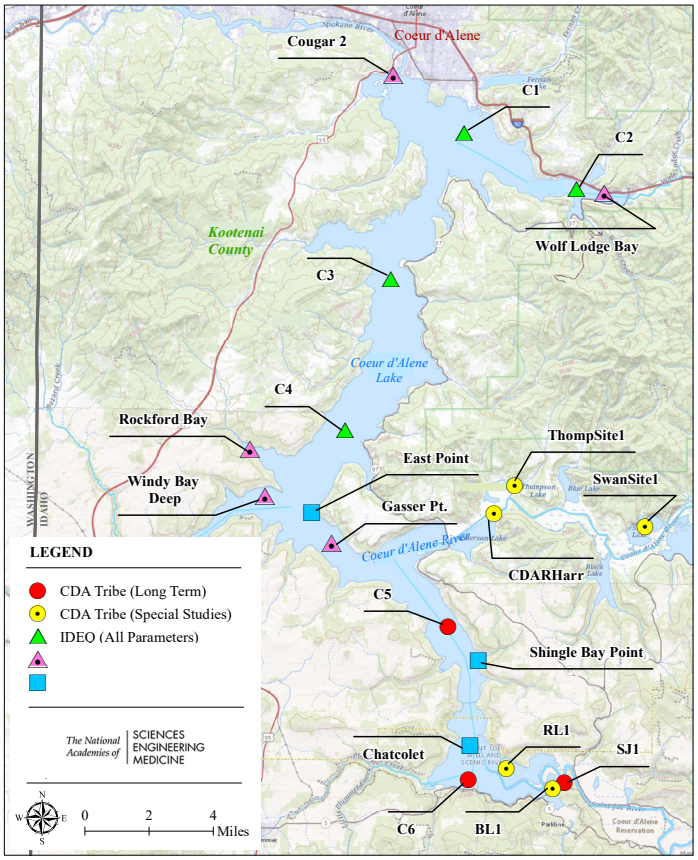


FIGURE 1. IDEQ and CDA Tribe long-term monitoring locations in CDA Lake. SOURCE: Generated by the Committee using data from IDEQ, CDA Tribe and the USGS National Map and associated datasets.

INPUTS OF METALS AND NUTRIENTS ARE DECLINING

For over 100 years, storms and resulting streamflow transported mining wastes downstream from the upper basin where mining activities were concentrated to the lower basin and to the Lake. Superfund remediation has reduced metal inputs from the upper basin, but the lower basin has a large amount of metal-enriched particulates poised for transport to the Lake. The report's analysis found the following trends in inputs to the Lake:

- Cadmium, lead, and zinc concentrations and loads into the mainstem Coeur d'Alene River from the South Fork are declining, but full recovery will take decades or more. Superfund activities have likely contributed to the ongoing decline.

- Reductions of total lead fluxes from the South Fork of the Coeur d'Alene River were offset by processes in the lower basin that released lead between 2000 and 2010, such that present-day inputs to the Lake are still substantial.

- There has been a downward trend in both zinc and cadmium concentrations and fluxes throughout the Coeur d'Alene basin, and fluxes of both metals to the Lake were lower in 2020 than in 1992 (by 63 and 45 percent, respectively).

- Over the past decade, total phosphorus fluxes and concentrations at monitoring sites along the Coeur d'Alene River, the St. Joe River, and the Spokane River below the Lake outlet have all been declining (typically 20–30 percent reductions during the 2010–2020 decade).

DISSOLVED OXYGEN AND NUTRIENT CONDITIONS ARE IMPROVING

Elevated nutrient inputs (e.g., phosphorous and nitrogen from sewage and fertilizers) to lakes can accelerate phytoplankton growth, which can lead to lake eutrophication that diminishes water clarity and reduces the amount of dissolved oxygen in the water. That, in turn, can create a chemical environment where the metals in the lake sediments dissolve back into the water column. The report's analysis of oxygen and nutrient conditions in the Lake found the following:

- Since about 2010, total phosphorus concentration in the Lake has generally declined, consistent with the declines in total phosphorus from the two major rivers entering the Lake.

- Low dissolved oxygen is not a current problem in the main body of the Lake nor is it expected to become a problem if current trends continue.

- The available field evidence does not support the concept that the current high zinc concentrations in the Lake suppress phytoplankton production as measured by chlorophyll *a*, but more research should be directed at this question.

IN-LAKE METAL CONCENTRATIONS ARE DECREASING

The report analyzed the concentration of heavy metals of concern, particularly lead, zinc, and cadmium, in the Lake. In addition to revealing trends in metals concentrations over the last 30 years, the analysis attempted to elucidate seasonal trends that are indicative of various processes occurring in the water column, such as hydrodynamics, benthic flux, and biogenic cycling. The analysis concludes that:

- Downward trends in dissolved zinc concentration in the northern Lake at sites C1 and C4 over the past 30 years are highly significant.
- Dissolved cadmium concentrations at C1 and C4 declined from 2004 to 2020, with virtually all of the decline occurring after 2014.
- From about 2003 to 2012, total lead concentrations in the Lake rose slowly but they have declined over the past eight to ten years.

POTENTIAL FOR RELEASE OF METALS IN SEDIMENTS

The report's authoring committee applied reactive transport and diagenetic modeling and examined data collected on lake sediments to evaluate the conditions under which zinc, lead, cadmium, and arsenic might be released from lake sediments to the bottom waters. The committee concluded that iron(III) (hydr)oxides in the sediment control metal and arsenic concentrations in the Lake sediments. The greatest threats of enhanced anoxia, if it were to occur, are release of arsenic and perhaps phosphorous into bottom waters. Another concern is the potential release of zinc from sinking particles and sediments when pH in bottom waters falls below 7, as they do most summers.

IMPROVEMENTS NEEDED FOR WATERSHED MONITORING

Improvements are needed in several aspects of the Lake and river monitoring programs, such as when and where monitoring occurs, which compounds should be monitored (including questions of detection and precision), and how samples should be collected. The program would benefit by adding monitoring for physical and ecological parameters and taking additional sediment cores as well as by improving methods for sampling of phosphorus and metals. Other specific findings include:

- Understanding the water quality of the Lake would be improved by increasing the spatial and temporal intensity of sampling in the Lake and the rivers.
- Lake monitoring would benefit by expanding to encompass selected bays and inshore areas, where the early signs of nutrient enrichment and nuisance algal growth are most likely to appear.
- An efficient sampling strategy designed to better understand inputs of nutrients from the lakeshore tributaries would benefit Lake management as the population in lakeshore areas grows.
- Important ecological components of the Lake are understudied.

The agencies involved in data collection are encouraged to make the relevant water quality data available to the wider community of stakeholders, agencies, and scientists. The river data are already available through such a system, but the Lake data are not. Furthermore, to succeed at adaptively managing the Lake for decades into the future, a scientific and institutional structure for carrying out data synthesis, coordinated among jurisdictions and interest groups, is needed.

FUTURE WATER QUALITY CONSIDERATIONS

The report reviews the recent climate history of the Coeur d'Alene region, examines climate projections that have been made for the next 50 years, and considers how future changes in climate, population, and land use could affect the trends discussed above. The report concludes that:

- Air temperature warming could reach as much as 2.5–3°C (4.5–5.4°F) by the year 2050, depending on the month. Lake water temperatures have been

increasing in the northern lake at station C4 over the last 30 years.

- Although there are no apparent precipitation trends in the Coeur d'Alene region over the last 30 years, studies in the greater Pacific Northwest suggest that extreme precipitation events could become more intense in upcoming decades.

- Climate changes like those above may slow or reverse the trends in metals and phosphorus loading to the Lake and the trends in dissolved oxygen, phosphorus, and metals concentrations within the Lake, and they may increase the potential for metals release from Lake sediments.

- If trends in declining zinc concentration from the last decade continue into the future, it will take bottom waters 10 to more than 100 years to reach the LMP goal.

In summary, CDA Lake is beginning to recover from more than a century of mining in its watershed. The mainstem CDA River and its watershed, along with Lake sediments, contain an immense reservoir of sediment-bound metals. If changes in climate, population growth, or remediation activities result in greater metal inputs to the Lake or metal releases from Lake sediments, recovery of the Lake could be slowed or reversed. Protecting the water quality of Coeur d'Alene Lake will require that monitoring efforts be fortified and expanded to provide an early warning of deteriorating conditions, regular syntheses of data, and targeted studies followed by application of those results to managing the Lake.

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