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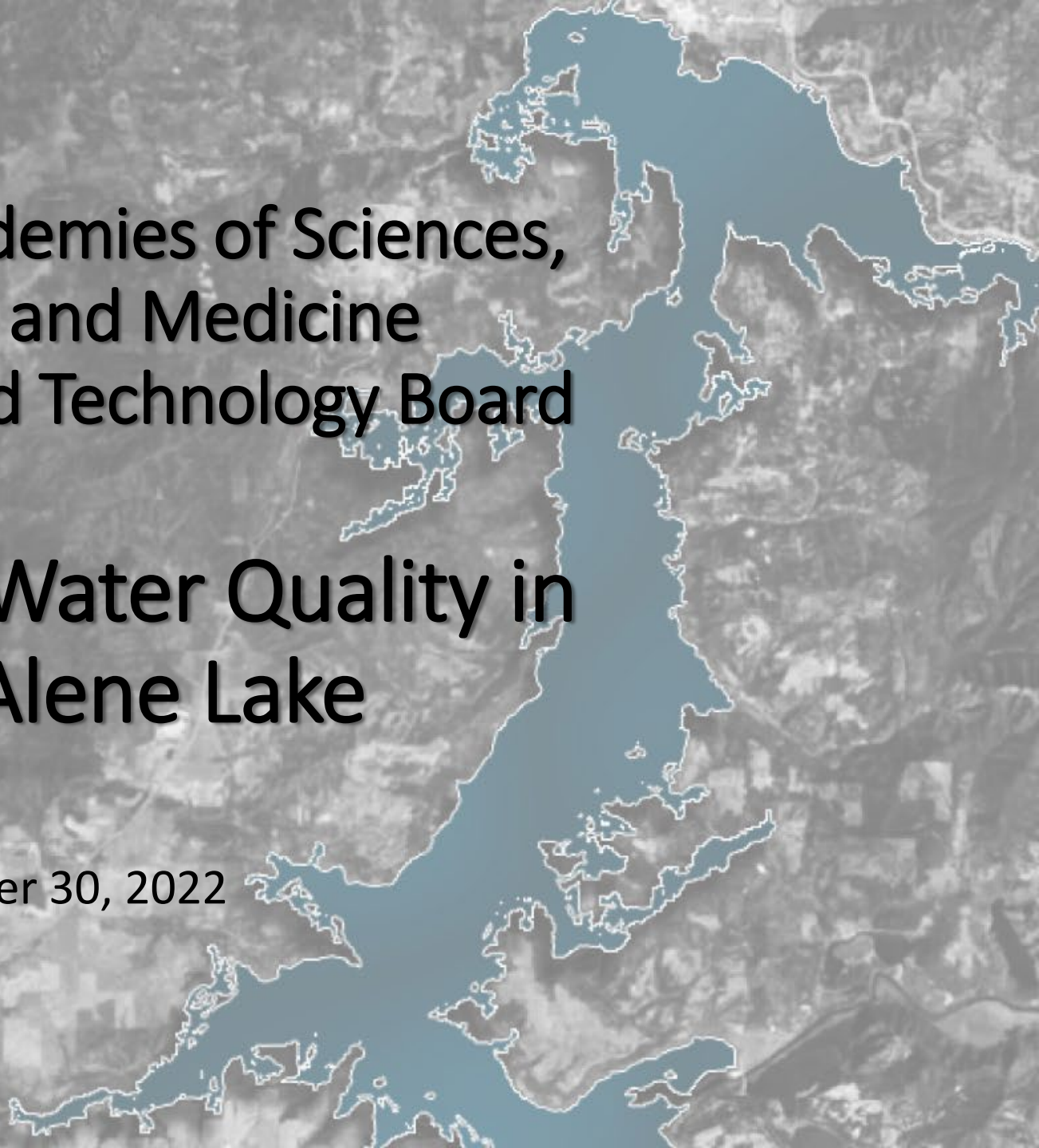
The National Academies of Sciences, Engineering, and Medicine Water Science and Technology Board

The Future of Water Quality in Coeur d'Alene Lake

September 30, 2022



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CDA Lake and Basin: A nexus of issues

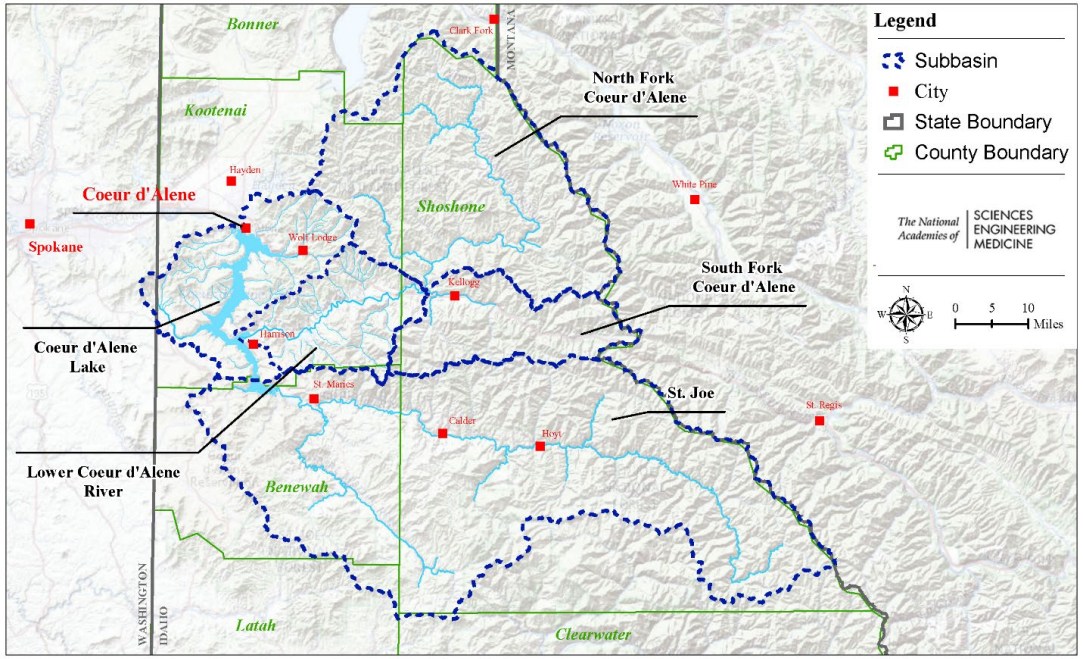
- CDA Lake is an **immensely valuable natural asset, locally and nationally**.
  - Oligotrophic, economic and aesthetic asset, ecosystem services

- **Homeland of the Coeur d'Alene Tribe**
  - **Cultural, spiritual, subsistence and recreational benefits**

- **Legacy of mining:**
  - **Massive metal contamination and landscape disturbance from mineral extraction that began in the late 1800's.**
  - **1983 designated Superfund site:**
    - **Begin to repair damage**
    - **CDA Lake not included in area to be remediated.**

- **Growing population: Risks to water quality and clarity.**

- **Multiple Jurisdictions**



Committee's Statement of Task

<u>Goal:</u> Understand future water quality conditions in the lake.
More specifically, the study will:

- **Evaluate current water quality in the lake** (Ch 5, 6)
- Focus on **trends** in nutrient and metals loading and concentration (Ch 3, 5, 6)
- Consider **how changes in temperature, precipitation & streamflow could affect those trends** (Ch 10)
- Consider the **impacts of current summertime anoxia** on the fate of metals and nutrients (Ch 5,7)
- Consider whether **reduced zinc** input to the lake as a result of upgrades to the Central Treatment Plant and other upstream activities **are removing an important control on algal growth** (Ch 5)
- Discuss whether **metals currently found in lake sediments will be released** into the lake (Ch7)
- **Identify the additional data** that are required to achieve an appropriate level of confidence (Ch 8, 10)
- Discuss the **relevance of metals** release in the lake **to human and ecological health risks** (Ch 9)

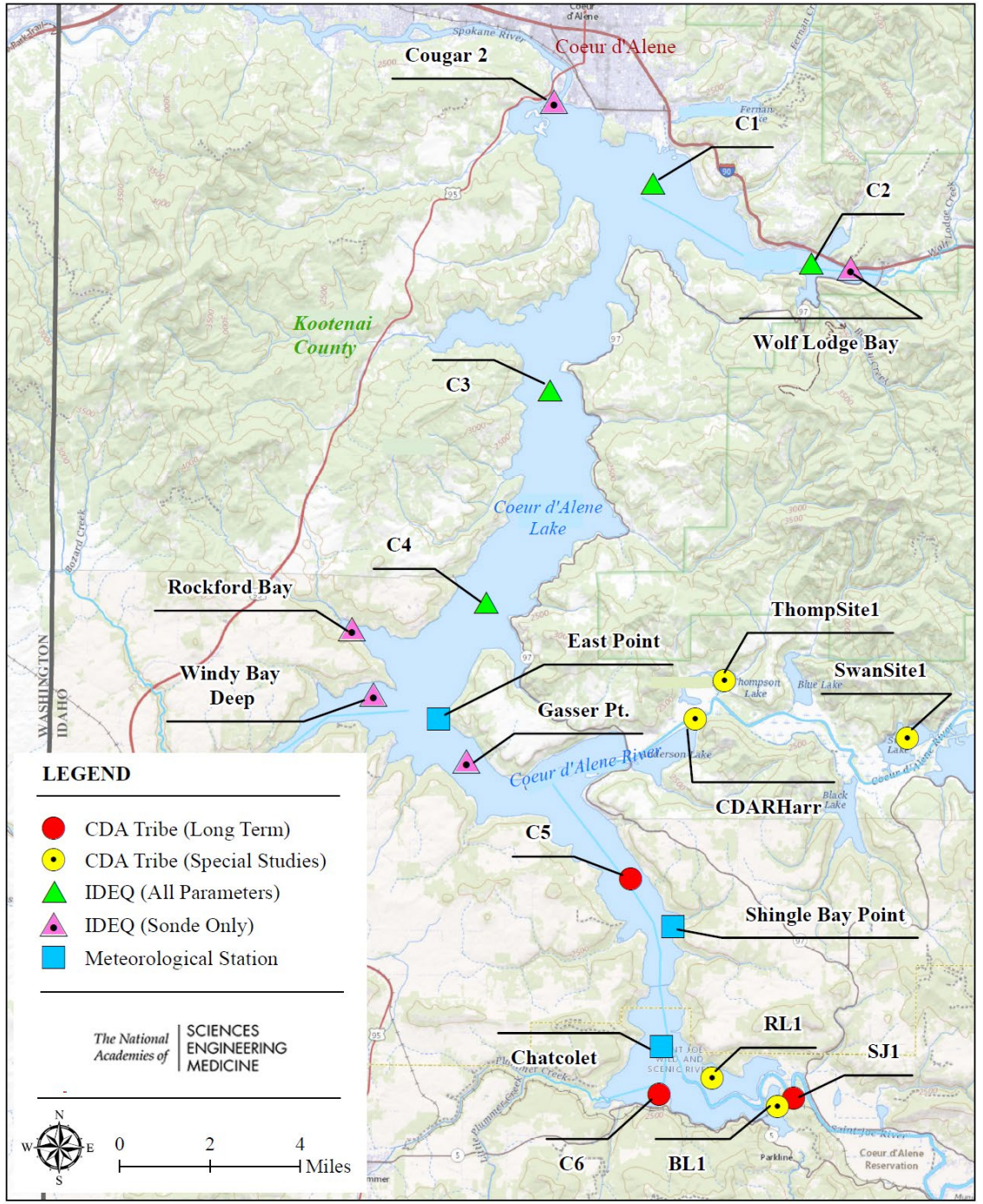
Current Water Quality

- CDA Lake is in violation of Idaho and CDA tribe water quality standards.
  - Zn: **20 – 85 µg/L in summer**
  - ≥ 36 µg/L (LMP Target) some months C1,C4,C5
  - Zn < 5 µg/L at C6, SJ1

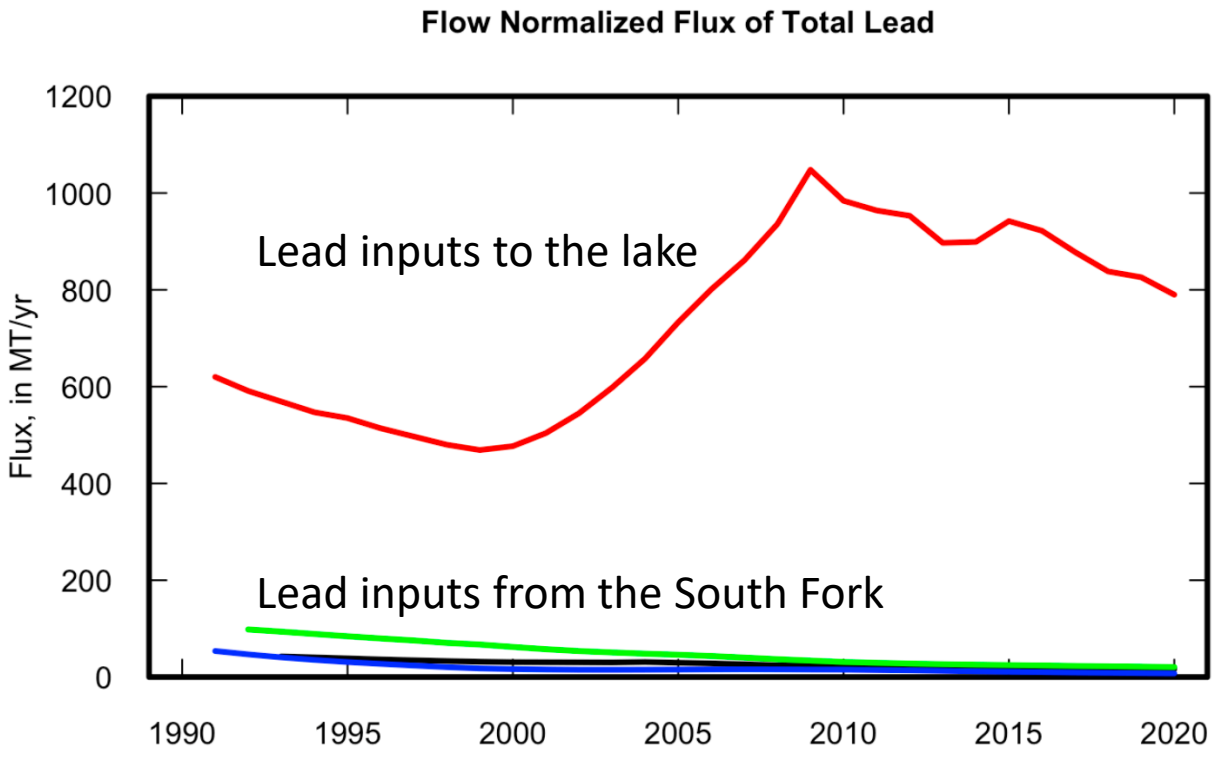
- Zn, Cd, and Pb in CDA Lake are >10X higher than most other large lakes, many with urbanized or industrialized watersheds.

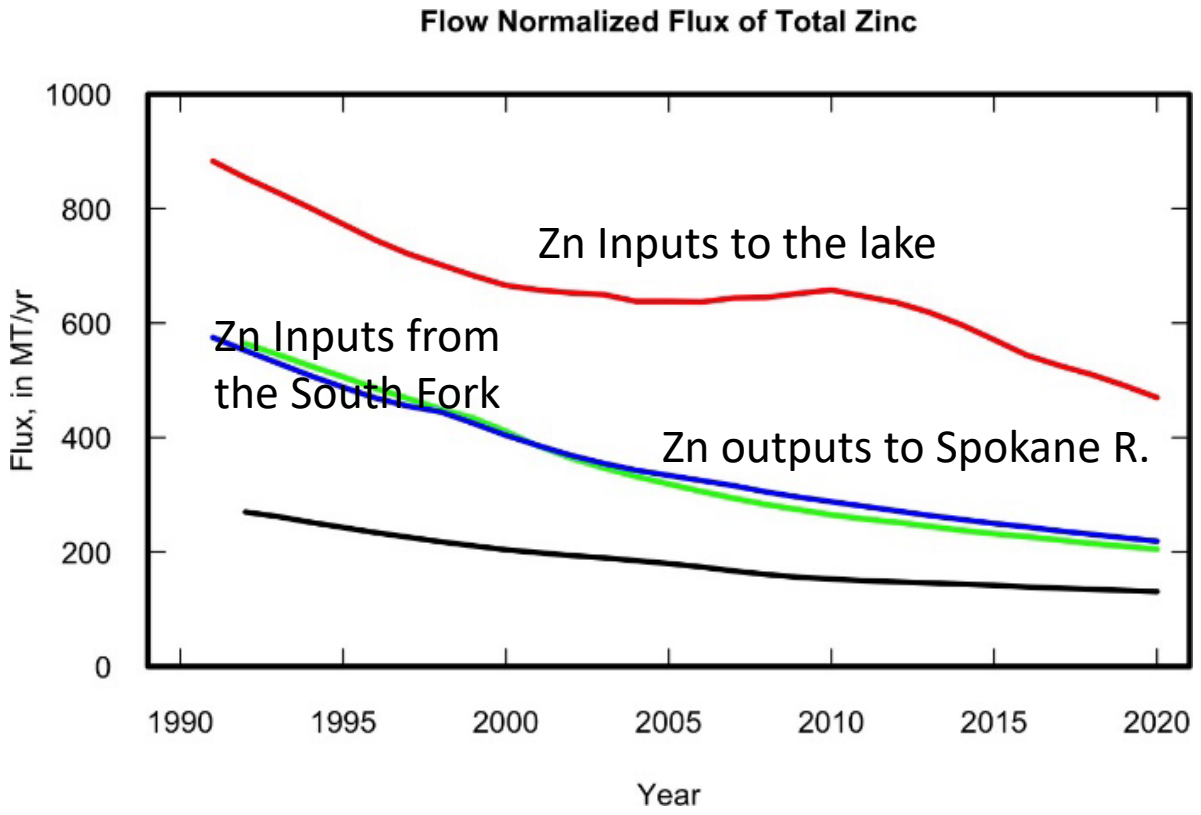
- CDA Lake is not currently listed as nutrient impaired.

- The Lake in violation of mercury water quality standards, based on fish tissue concentrations.



1. Trends in metal inputs into the lake are generally downward….but a large reservoir of sediment-bound metals and phosphorus remains in the lower basin, potentially poised for transfer to the lake.





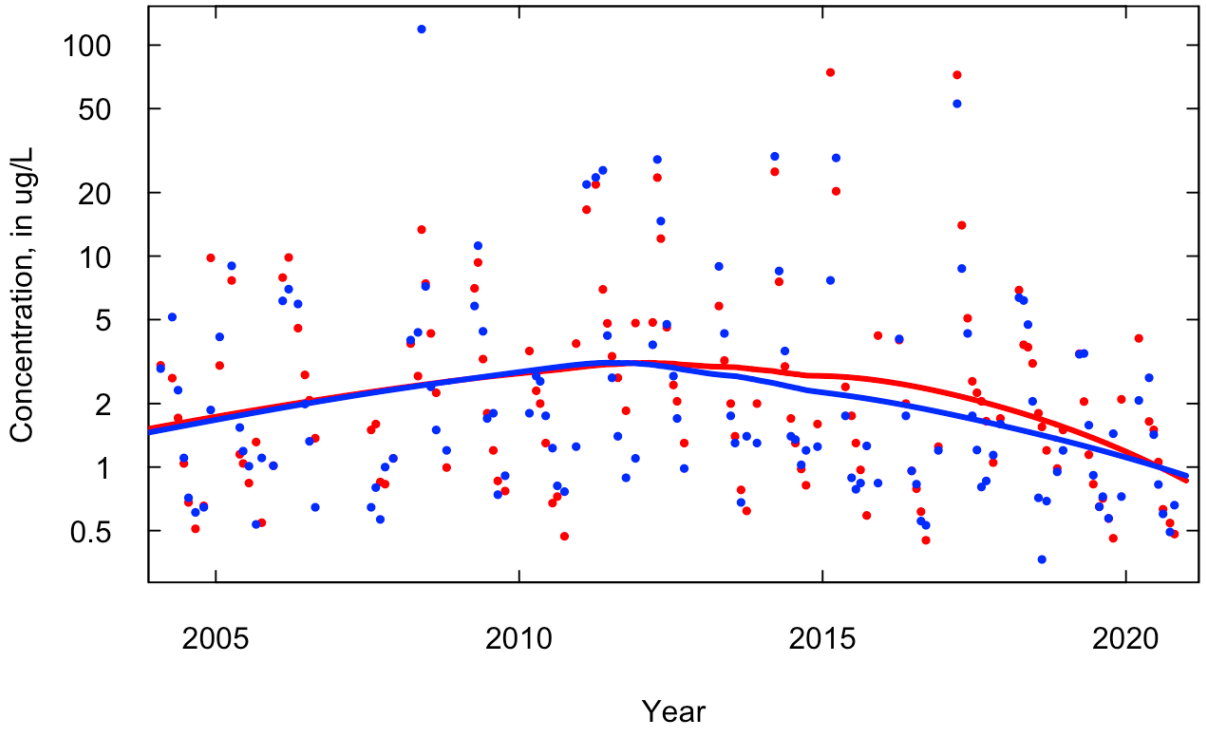
South Fork CDA River at Elizabeth Park
South Fork CDA River near Pinehurst
CDA River near Harrison
Spokane River near Post Falls

2. Recent <u>metal trends in Coeur d'Alene Lake:</u>

Downward trends in zinc, cadmium and lead….but concentrations remain high.

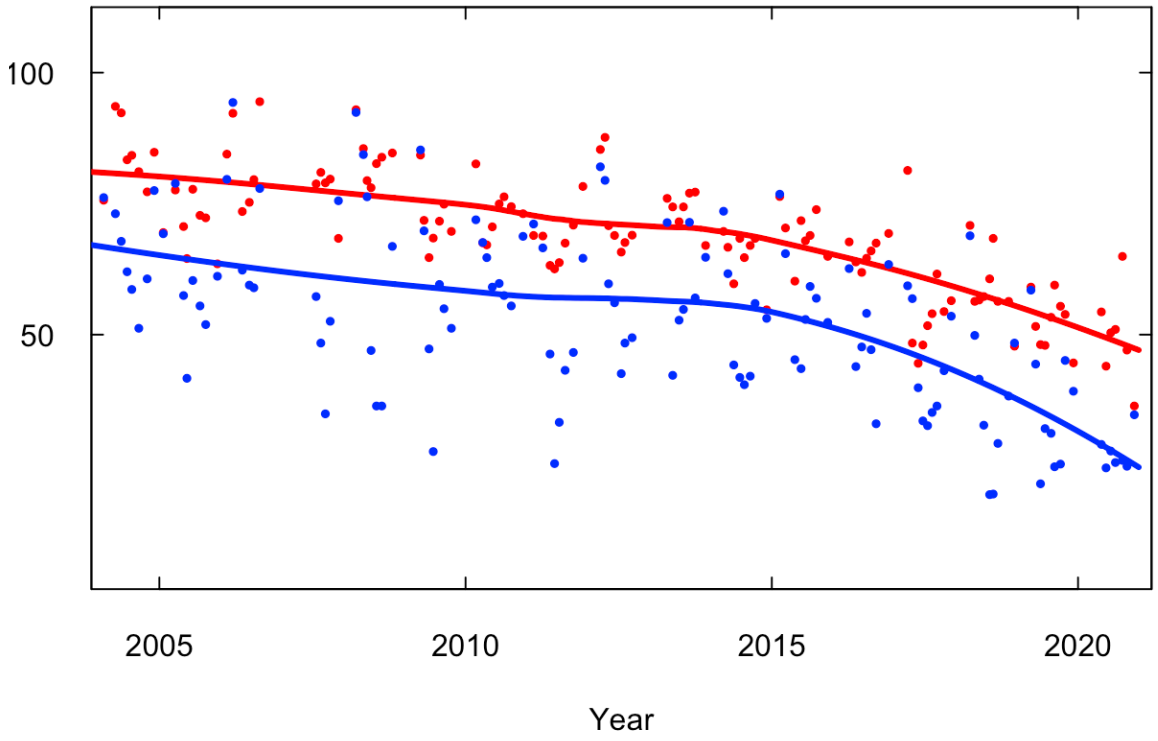
Total Lead at C4

sample depth: below 21 meters in red, shallower in blue

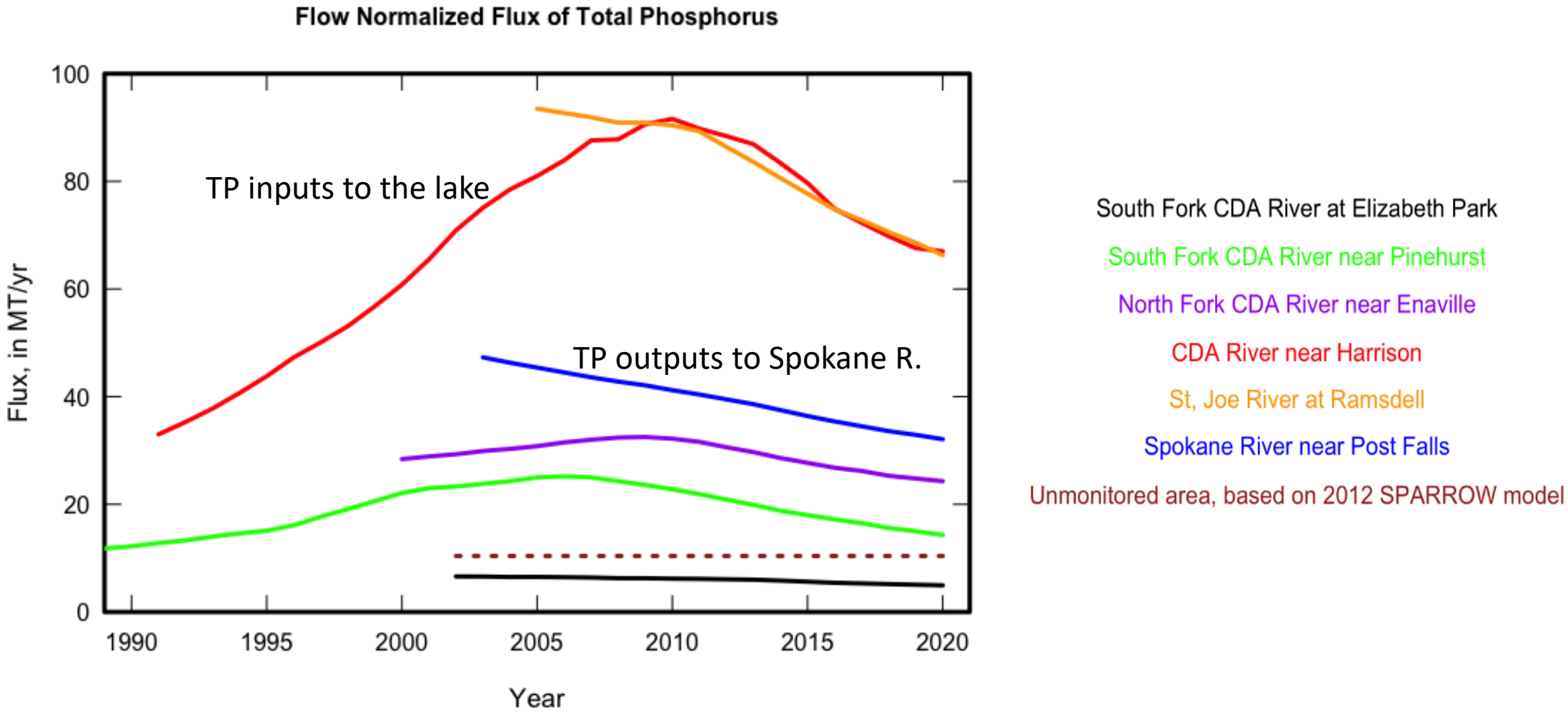


Dissolved Zinc at C4

sample depth: below 21 meters in red, shallower in blue

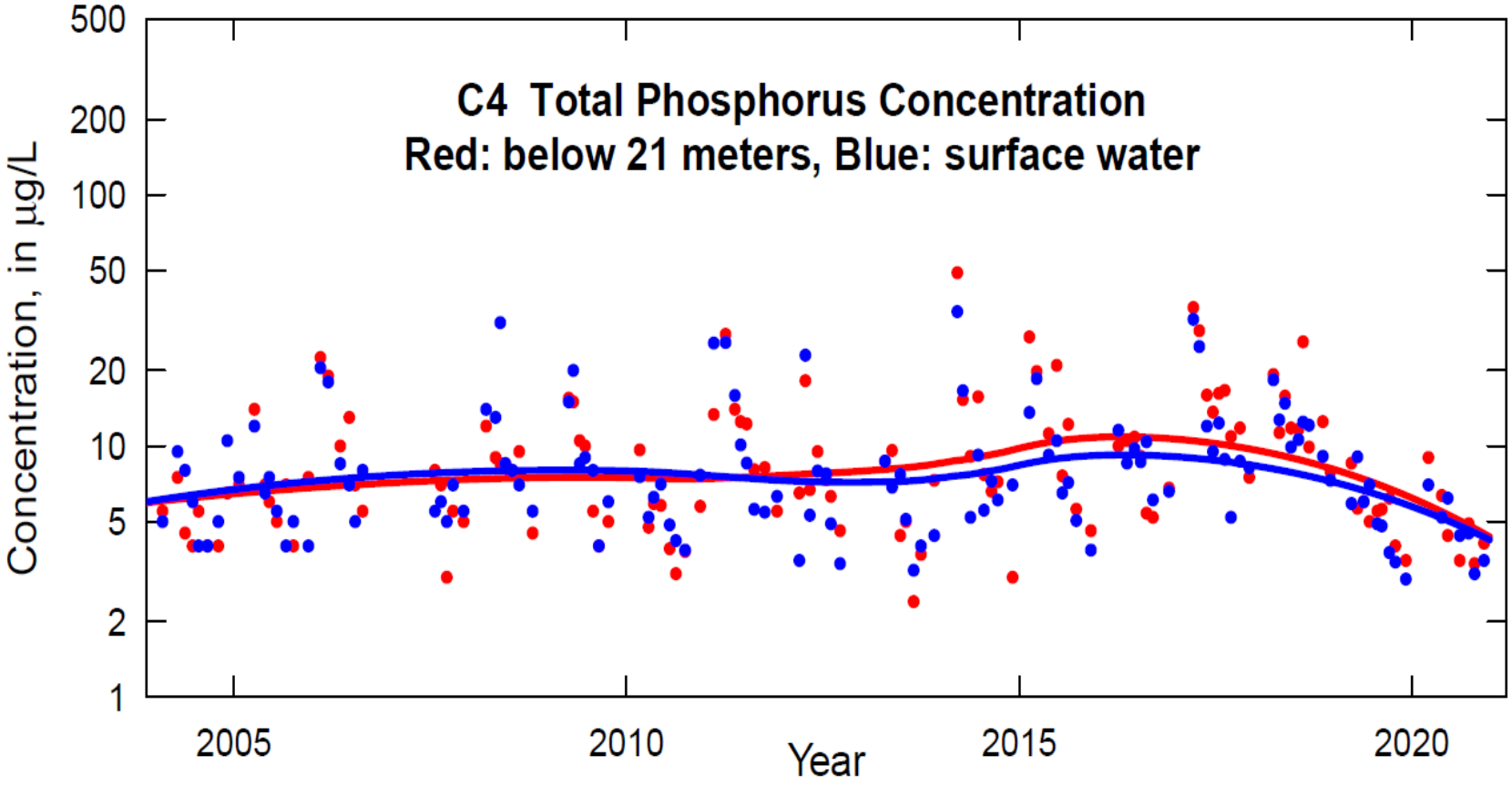


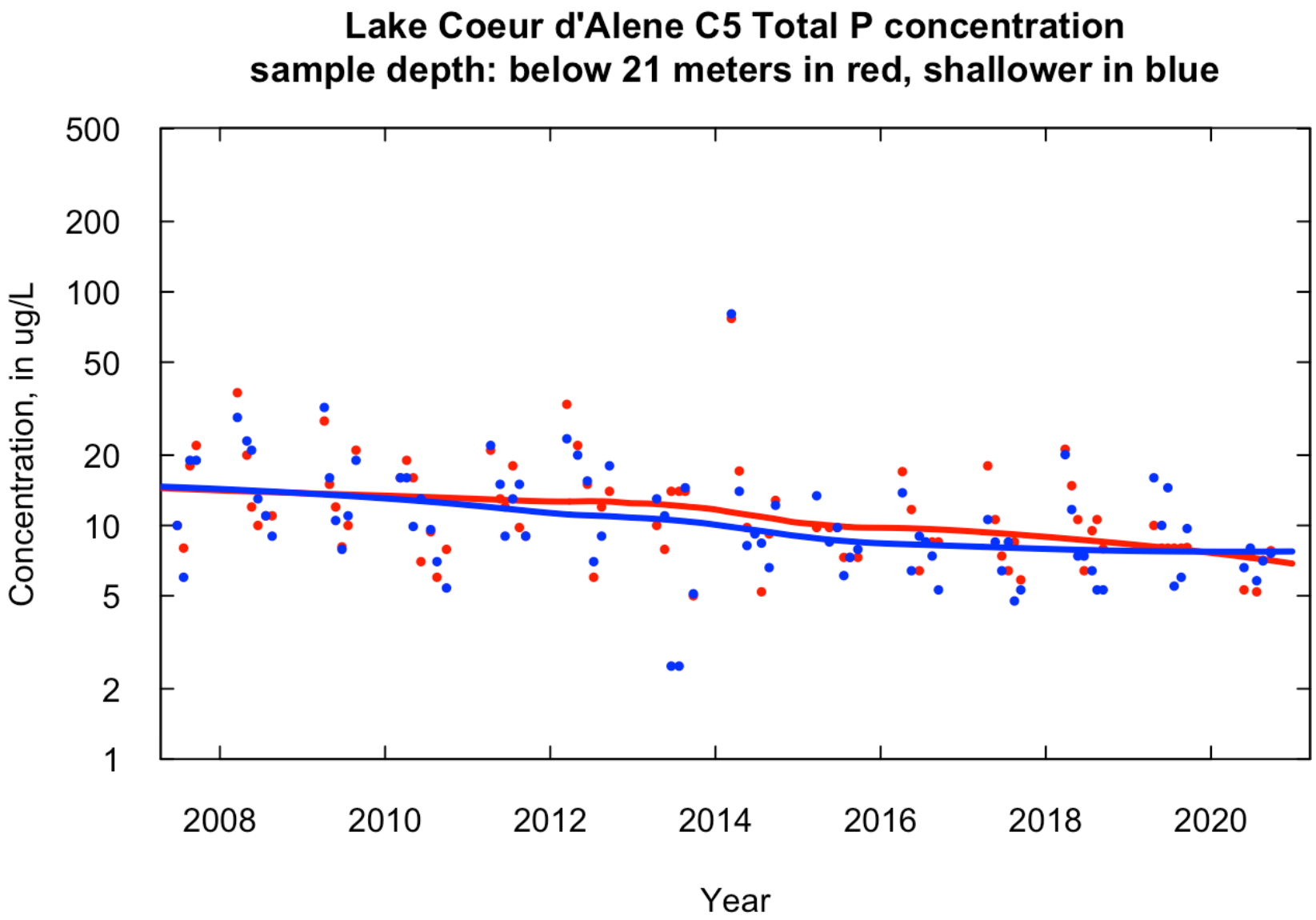
3. Phosphorus inputs to the lake increased between 1993 and ~2010… but have declined since then.



4. Total phosphorus trends in Coeur d'Alene Lake:

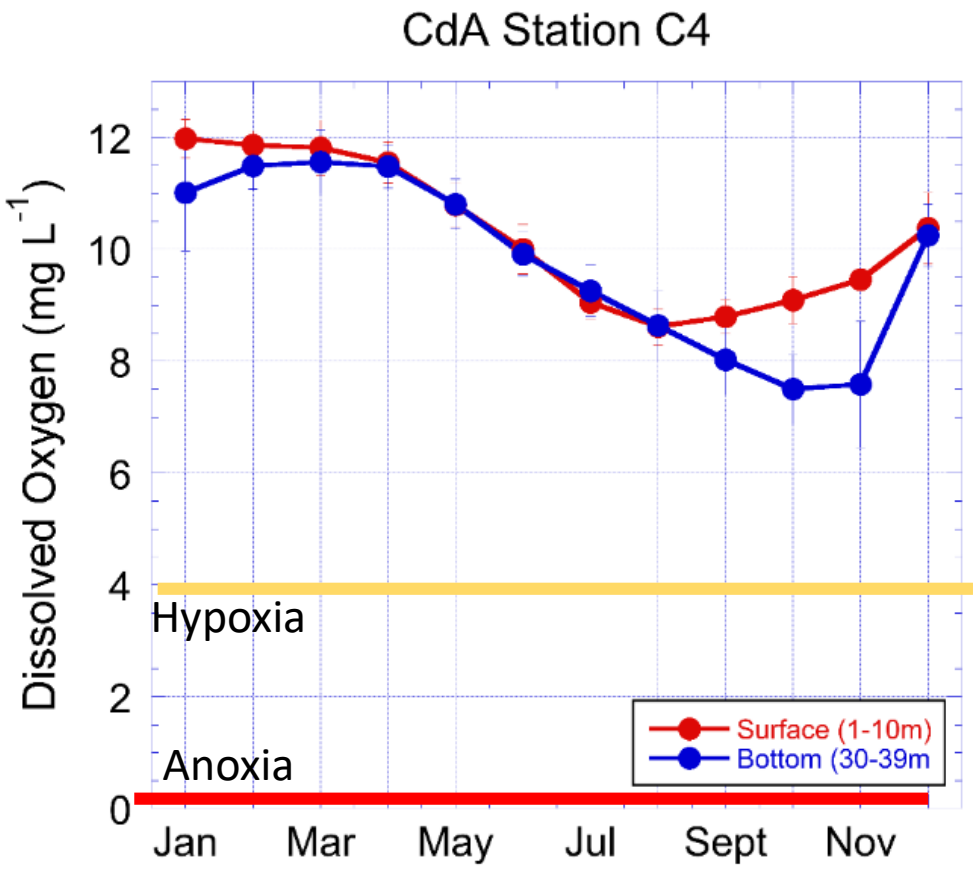
- **For the most recent decade, the data indicate declines in total phosphorus concentration in CDA Lake…but inshore bays and littoral waters are not monitored.**

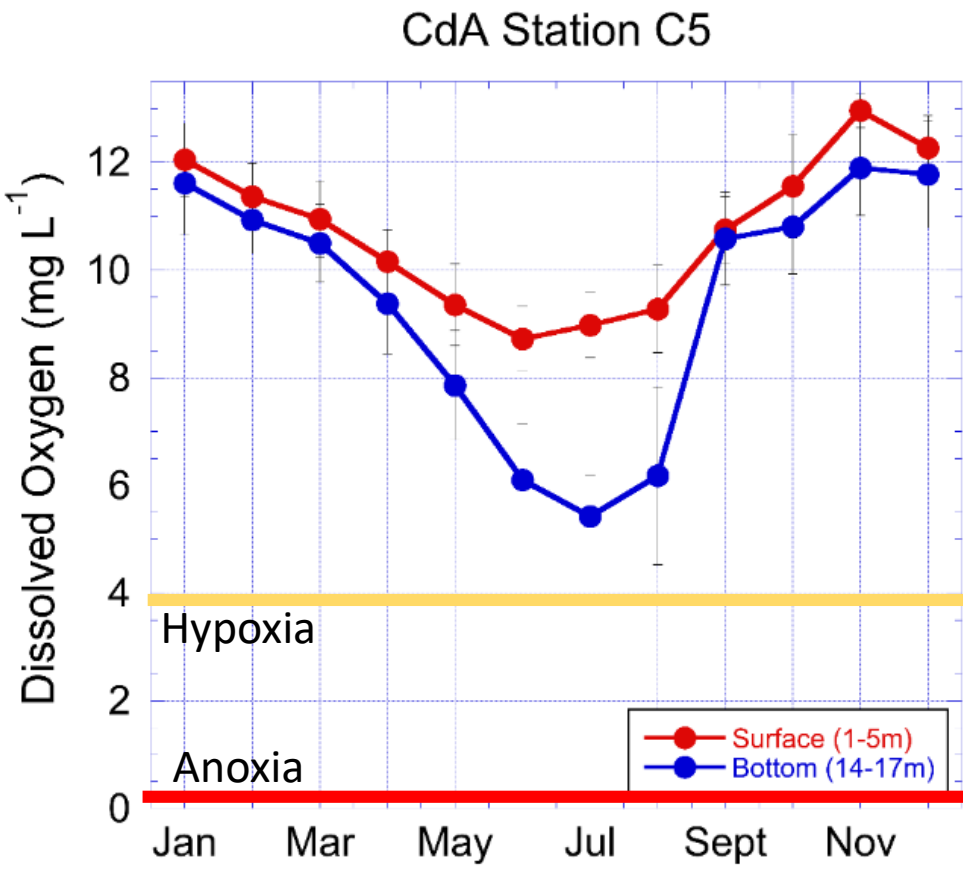



Lake Coeur d'Alene C5 Total P concentration
sample depth: below 21 meters in red, shallower in blue
Concentration, in ug/L
500
200
100
50
20
10
5
2
1
2008
2010
2012
2014
2016
2018
2020
Year

5. Dissolved oxygen trends:

Concern about depleting oxygen in bottom waters is prudent… but trend analysis do not support a worsening of depletion between 1995-2020.





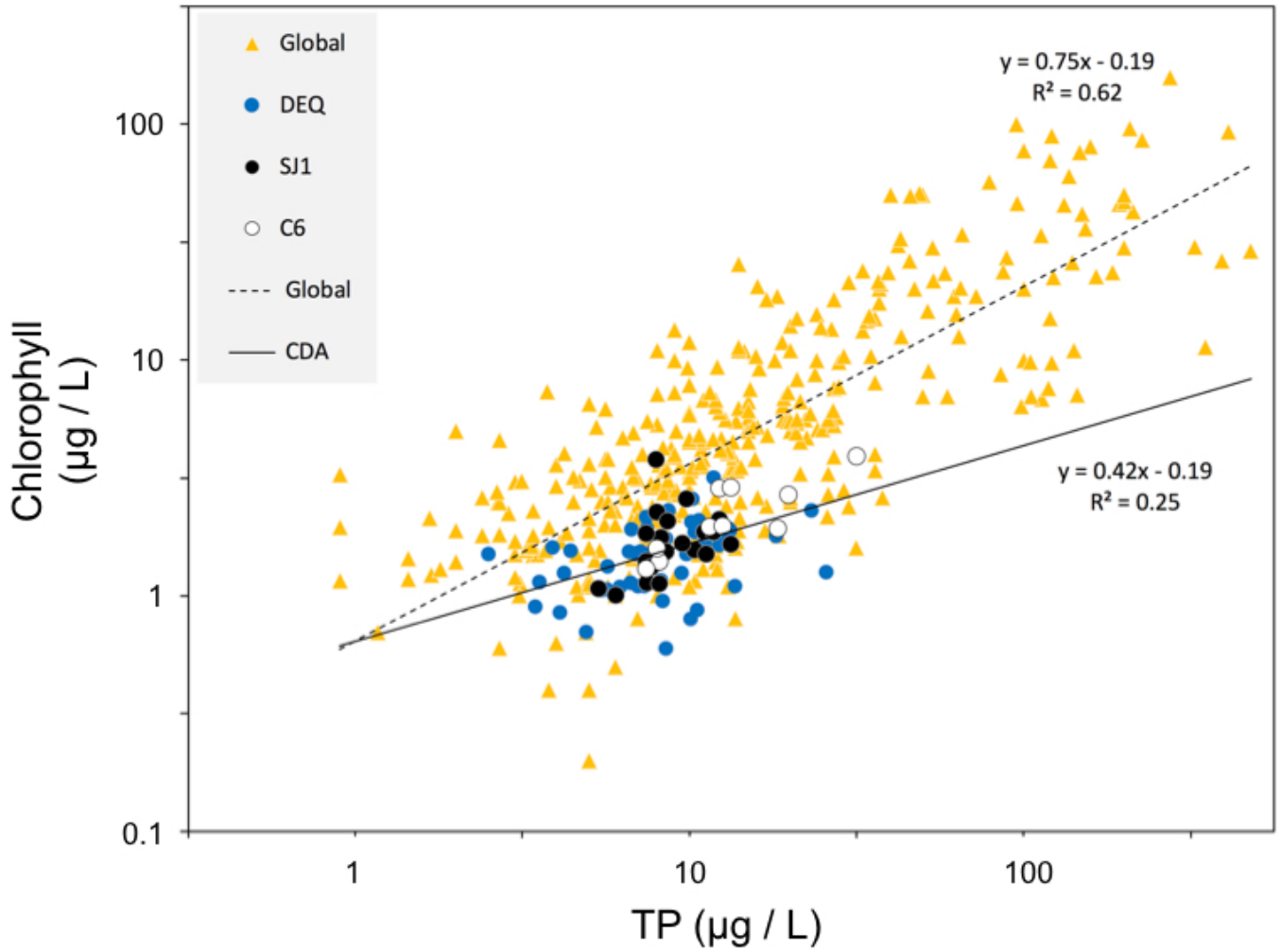
..but trend analysis do not support a worsening of depletion between 1995-2020.

Dissolved Oxygen trends by month, deep water only
Period evaluated: 1995 – 2020
(except for Jan, Feb, Mar at C1 & C4 extends to 2021

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
C1	*	+0.02	+0.04	+0.02	+0.00	+0.03	+0.02	+0.03	+0.02	+0.01	+0.00	0.02	+0.02
C4	*	+0.04	+0.04	+0.04	+0.02	+0.02	+0.02	+0.02	+0.01	+0.00	+0.29	+0.06	+0.02
C5	+0.20	+0.09	+0.08	+0.10	+0.10	+0.07	+0.04	+0.04	+0.14	+0.12	*	+0.16	+0.09
C6	*	*	+0.18	+0.12	+0.09	+0.05	-0.03	-0.02	+0.05	+0.10	+0.11	*	+0.04

6. The weight of field evidence does not support an overall influence of zinc, at present, on the Lake's trophic status…but further analysis, monitoring and experiments could provide clarification.

- CDA Lake: less chl *a* per unit P than generally observed for lakes worldwide…both the northern (Zn-enriched) and southern (Zn-poor) part of the Lake.
- Multiple regression analysis: positive, significant association between chl *a* and TP, not an association between chl *a* and total zinc.
- Low chlorophyll occurred consistently when zinc concentrations were greater than 60 µg/L. Zinc concentrations are now below that level.
- Zn suppression of individual species of phytoplankton cannot be discounted.



7. Concern about lake sediments and benthic food web: immense reservoir of potentially toxic cadmium, lead , zinc, and arsenic in sediments.

a. Anoxia could release arsenic and phosphorus…but no anoxia at present where lake sediments are contaminated;

b. lower pH in bottom waters will release zinc…but this has not slowed recovery of the lake.

	Cadmium	Lead	Zinc
	µg/g dw	µg/g dw	µg/g dw
Criteria range	3.1 to 12.0	110 to 530	270 to 960
Median in Lake CDA	23 to 56	1,800 to 3,850	2,690 to 3,500
Magnitude of difference	7.4X to 4.7X	7.3X to 16.4X	3.6X to 10.0X

The Future

1. CDA Lake is beginning to recover from a century of mining waste inputs but full recovery will take one to multiple decades (depending upon location, depth).

2. Changing climate and setting.....many changes could slow or reverse recovery of the Lake.
   a. Committee considered:
      i. Increasing lake temperature
      ii. Forward shift in timing of flow
      iii. Increase magnitude and frequency of high flow events
      iv. Fires
      v. Population growth

3. Air temperature warming, as much as 2.5–3°C (4.5–5.4°F) by 2050.
      i. Surface water temperatures at C4 increasing…significant in August.
      ii. Decrease in snow-water equivalent past 30 years.

4. Precipitation, flow and flood trends more ambiguous in CDA region… greater PNW: extreme precipitation events will become 5–34 percent more intense by 2080.

Recommendations

1. **Prepare for an uncertain future:**
    a. **Better understand the processes controlling nutrient inputs, flux from sediments, and cycling within the Lake….important details are missing.**
2. **Increase frequency and locations where inputs are monitored**
3. **Expand lake monitoring to selected bays and inshore locations**
4. **Better understand food webs of the lake (zooplankton, fisheries, bottom communities)**
5. **Expand advanced wastewater treatment**
6. **Make crucial data sets and syntheses widely available**

Summary

- **Inputs are declining and the lake is responding:**
  - **CDA Lake is beginning to recover from the effects of mining, as of 2020, and is maintaining against the pressures of population growth.**

- **There are uncertainties about the future…but the best preparation for an uncertain future:**

  i. **fortification and expansion of monitoring to provide an early warning of deteriorating conditions**

  ii. **regular syntheses of data and targeted studies—all coordinated among interest groups— and apply those results to managing the Lake.**

Chapter 10 Future Considerations wrt WQ Trends

- **Future climate change may slow/reverse the trends** in metals and P loading to CDA Lake (Ch 3) and the trends in DO, P, and metals concentrations within CDA Lake (Ch 5 and 6), and it may increase the potential for metals release from Lake sediments (Ch 7). The changes in climate considered by the committee were:
  - (1) increased frequency and magnitude of large runoff events
  - (2) a forward shift in the timing of flow to the Lake
  - (3) warming of Lake water
  - (4) increased frequency and size of fires
  - (5) Committee also considered with increases in lakeshore populations.

  No evidence yet in the CDA region of climate effects (1), (2), and (4)—**emphasizing the importance of monitoring, data analysis, and further process studies into the future.**
- Zn in surface waters is approaching the Lake Management Plan goal of 36 µg/L in some months and at some locations. If trends from the last decade continue, it will take bottom waters **10 to more than 100 years to reach the Zn goal**. Dissolved Pb in CDA Lake already below the LMP goal of 0.54 µg/L in the measured locations, except C4 during the spring. Cd already below the LMP goal.
- **Recovery from the legacy of mining will be a decades-long project at best**.
- Jim's figure...