

Tracking trends in selenium concentrations along the Upper Columbia River Basin

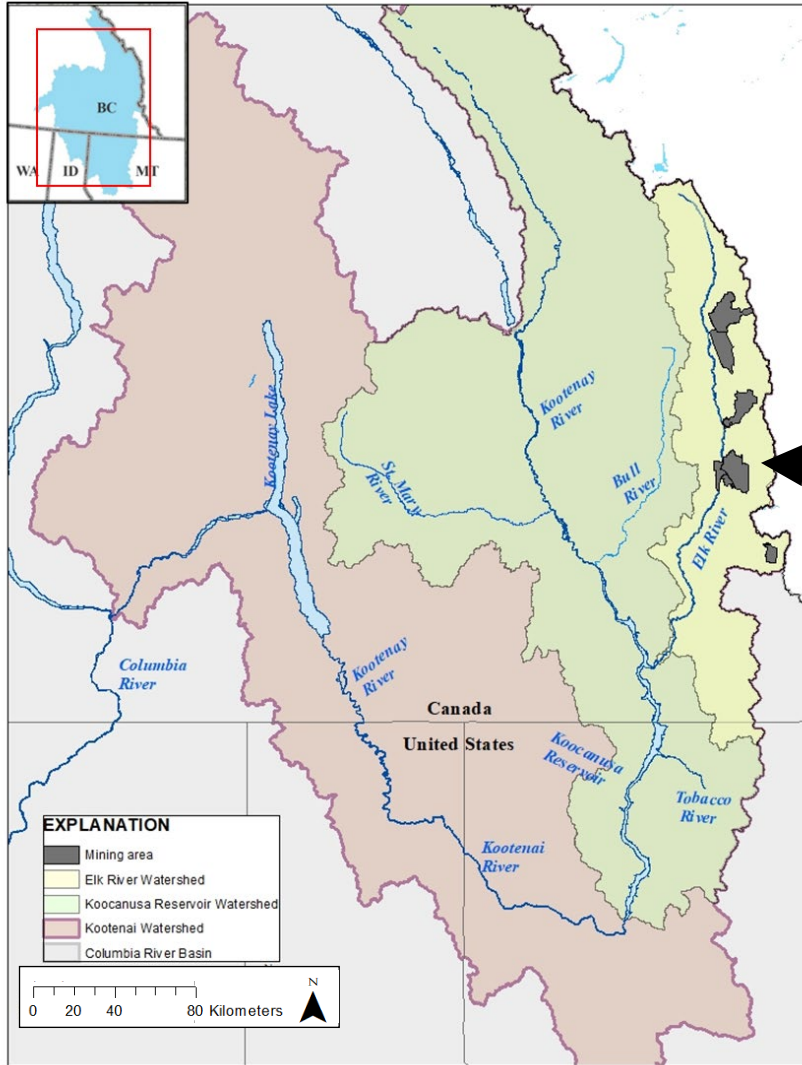
Montana AWRA 2023 Conference, Missoula, MT
Managing Water in the 21st Century

October 12, 2023

Madison Foster, Ashley Bussell, Travis Schmidt, Meryl Storb
Contact: mfoster@usgs.gov

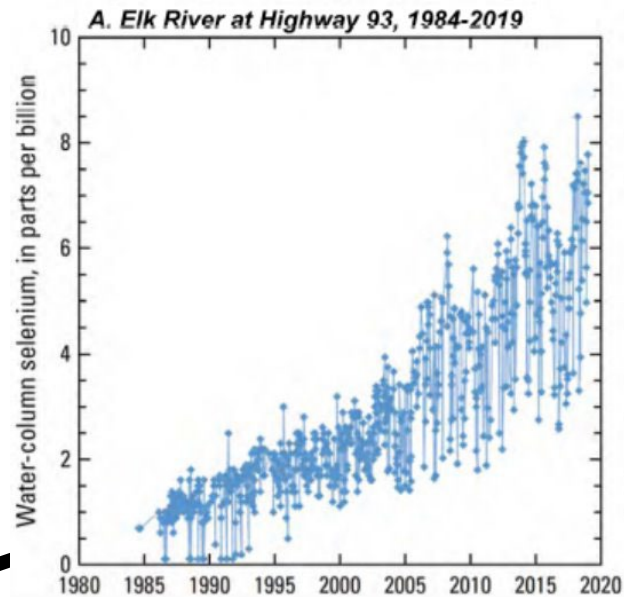
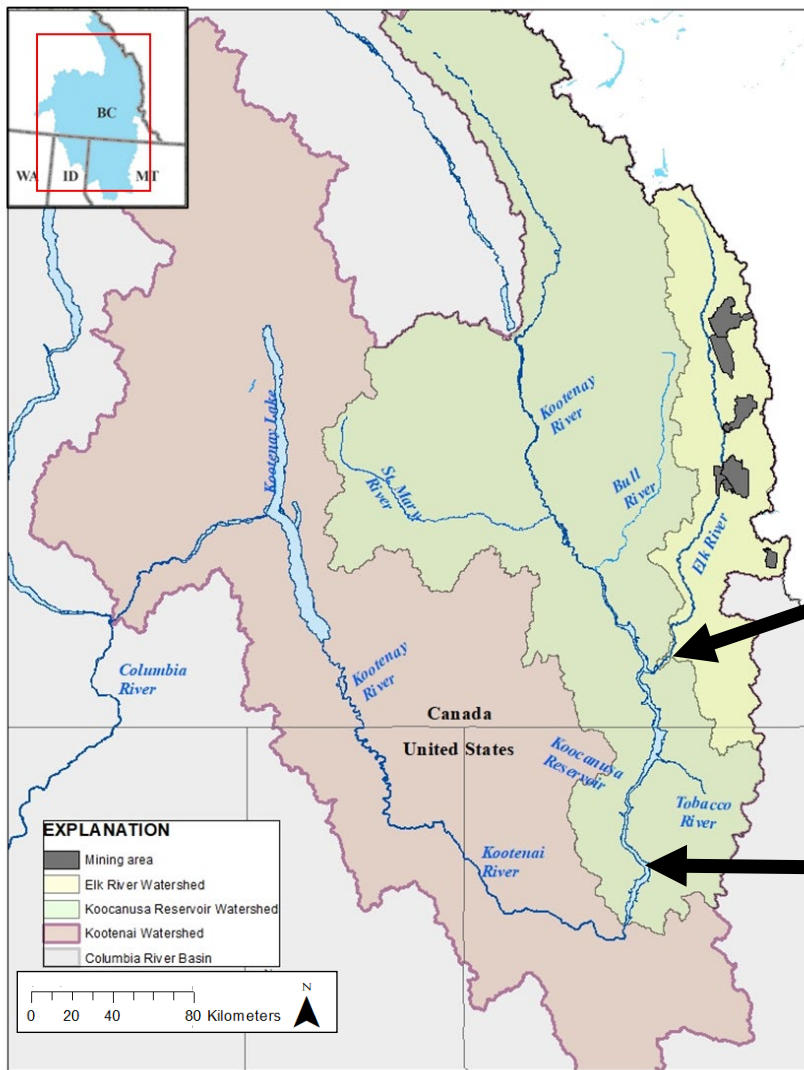


Elk Valley coal mining



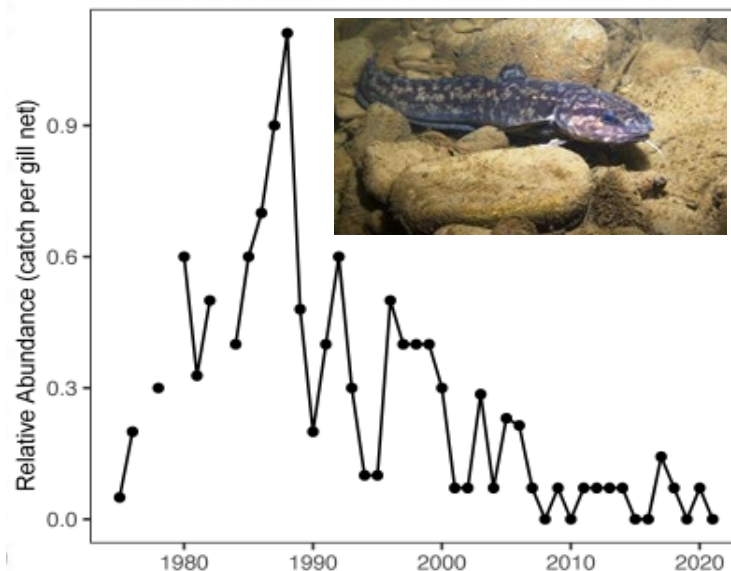
"This information is preliminary and is subject to revision. It is being provided to meet the need for timely best science. The information is provided on the condition that neither the U.S. Geological Survey nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the information."

Elk Valley coal mining impacts to Lake Koocanusa and Elk River



NO_3^- and SO_4^{2-} also increasing, see Storb et al. 2023, *ES&T*

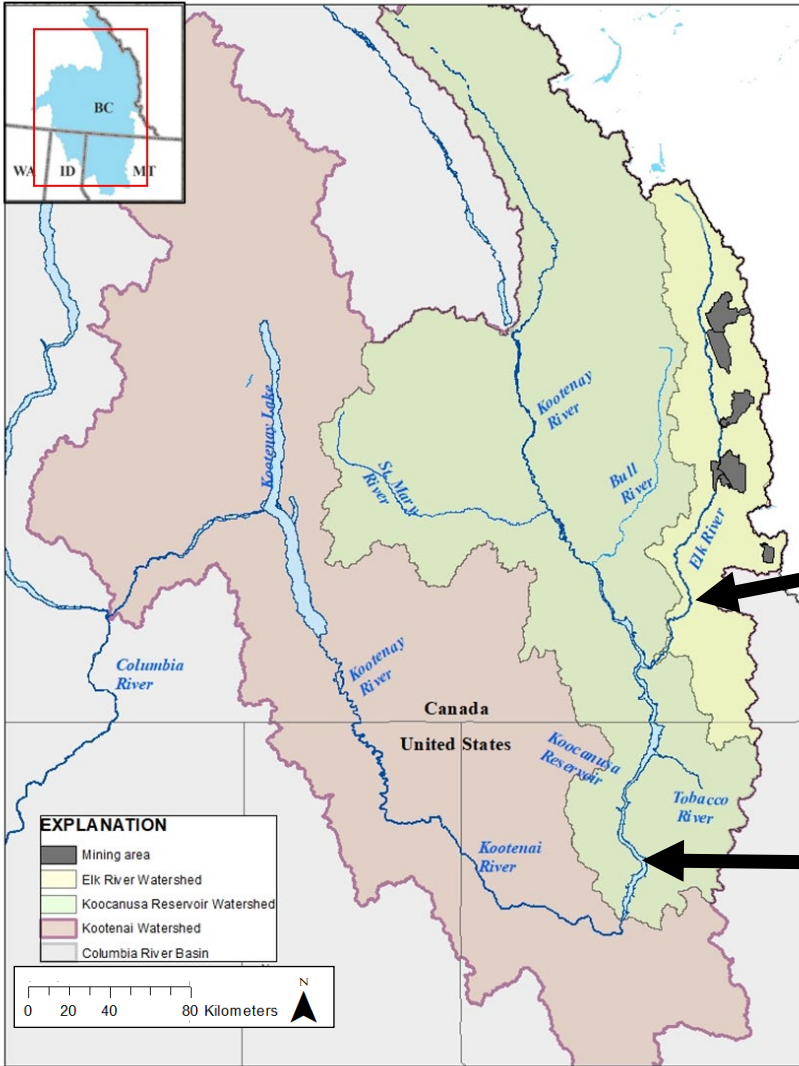
B. Lake Koocanusa Burbot relative abundance



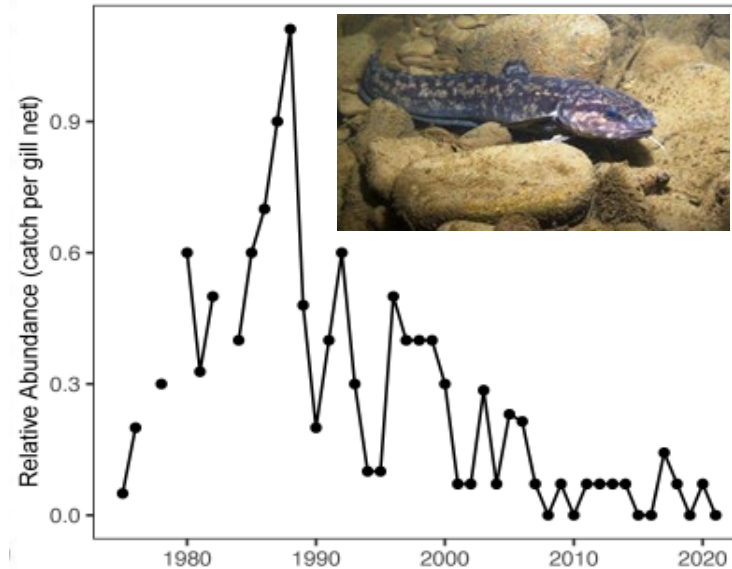
James Dunnigan, FWP

"This information is preliminary and is subject to revision. It is being provided to meet the need for timely best science. The information is provided on the condition that neither the U.S. Geological Survey nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the information."

Elk Valley coal mining impacts to Lake Koocanusa and Elk River



B. Lake Koocanusa Burbot relative abundance

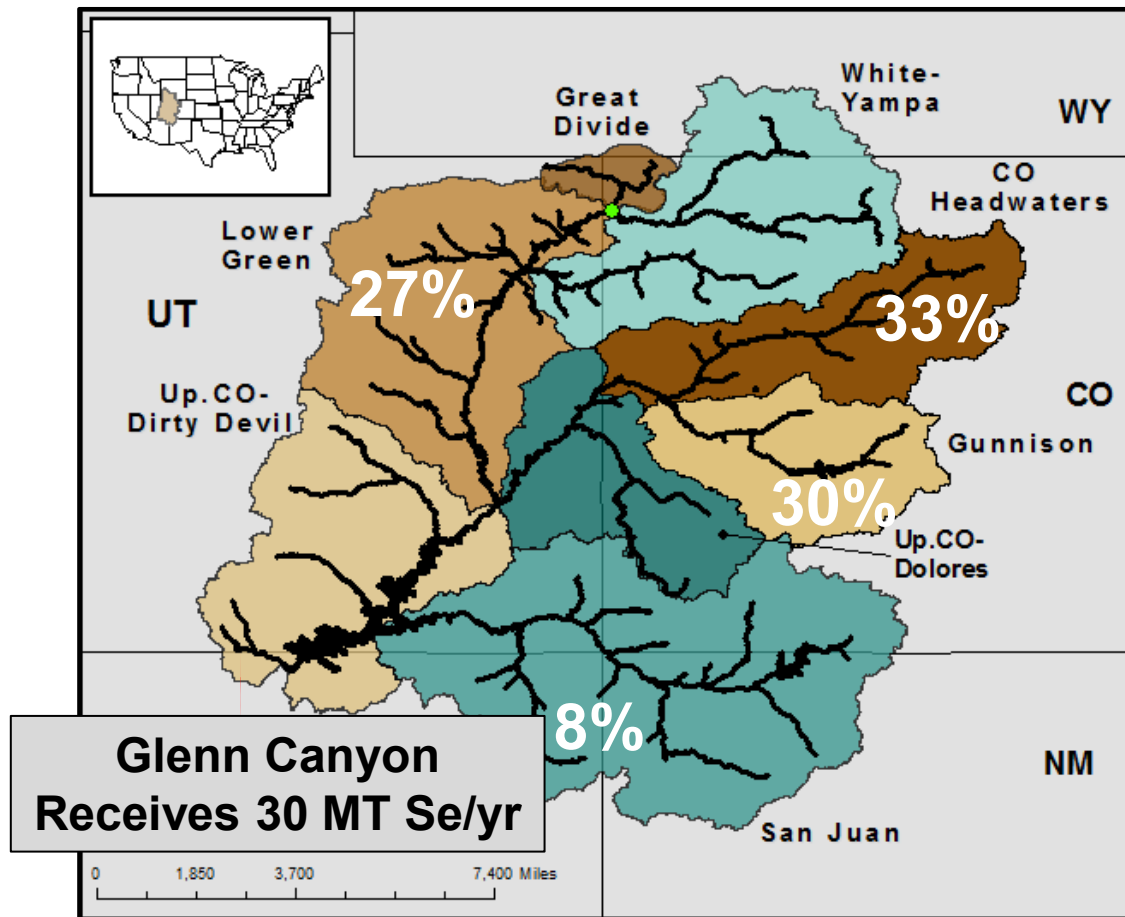


James Dunnigan, FWP

"This information is preliminary and is subject to revision. It is being provided to meet the need for timely best science. The information is provided on the condition that neither the U.S. Geological Survey nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the information."



Is there evidence of long-range transport of selenium?

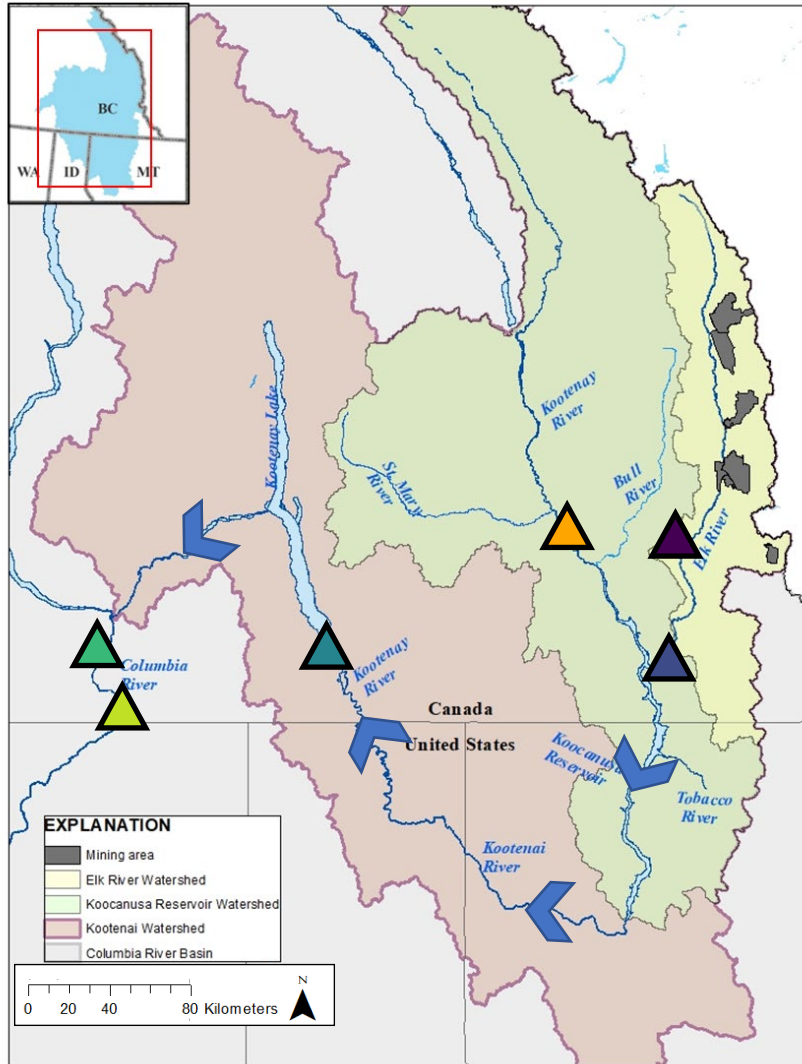


Data: Engberg 1999, JAWRA
Figure: Travis Schmidt

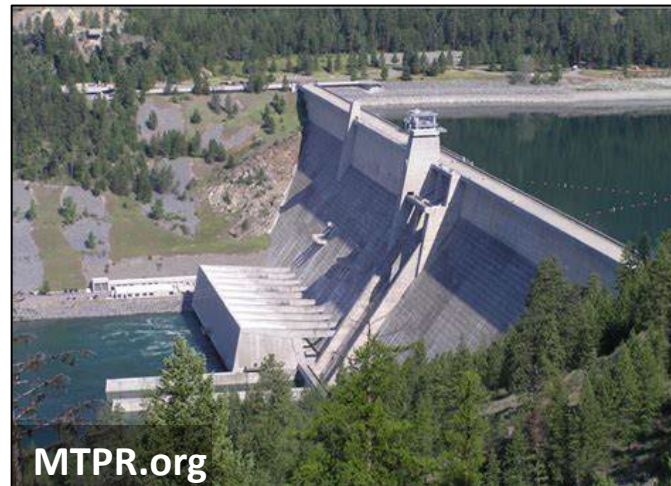
- Most Se is dissolved as selenate (SeO_4)
- Selenate is typically conservative
- Recent focus on restoration in Columbia River Basin



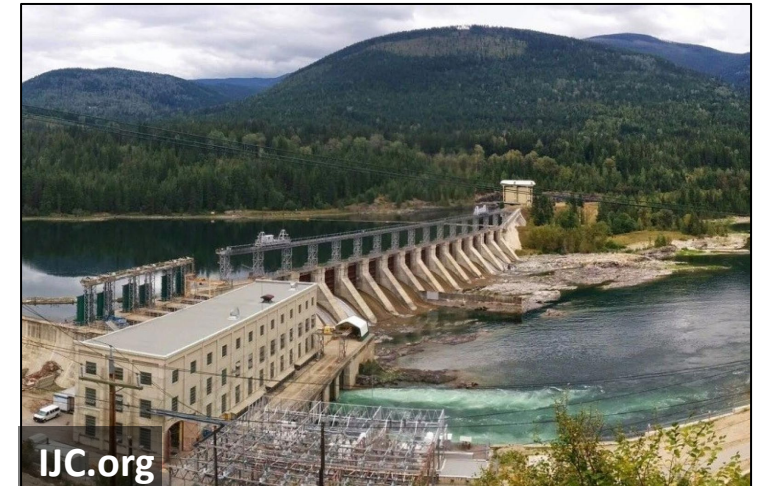
Upper Columbia River Basin



- 6 sites on Kootenay, Elk, Columbia Rivers (Environment and Climate Change Canada)
 - 1 reference and 5 mine-affected
- Transboundary watershed
- 2 dams: Kootenay Lake and Lake Koocanusa
- 2 major known Se sources: Elk Valley mines and Trail smelter



Lake Koocanusa

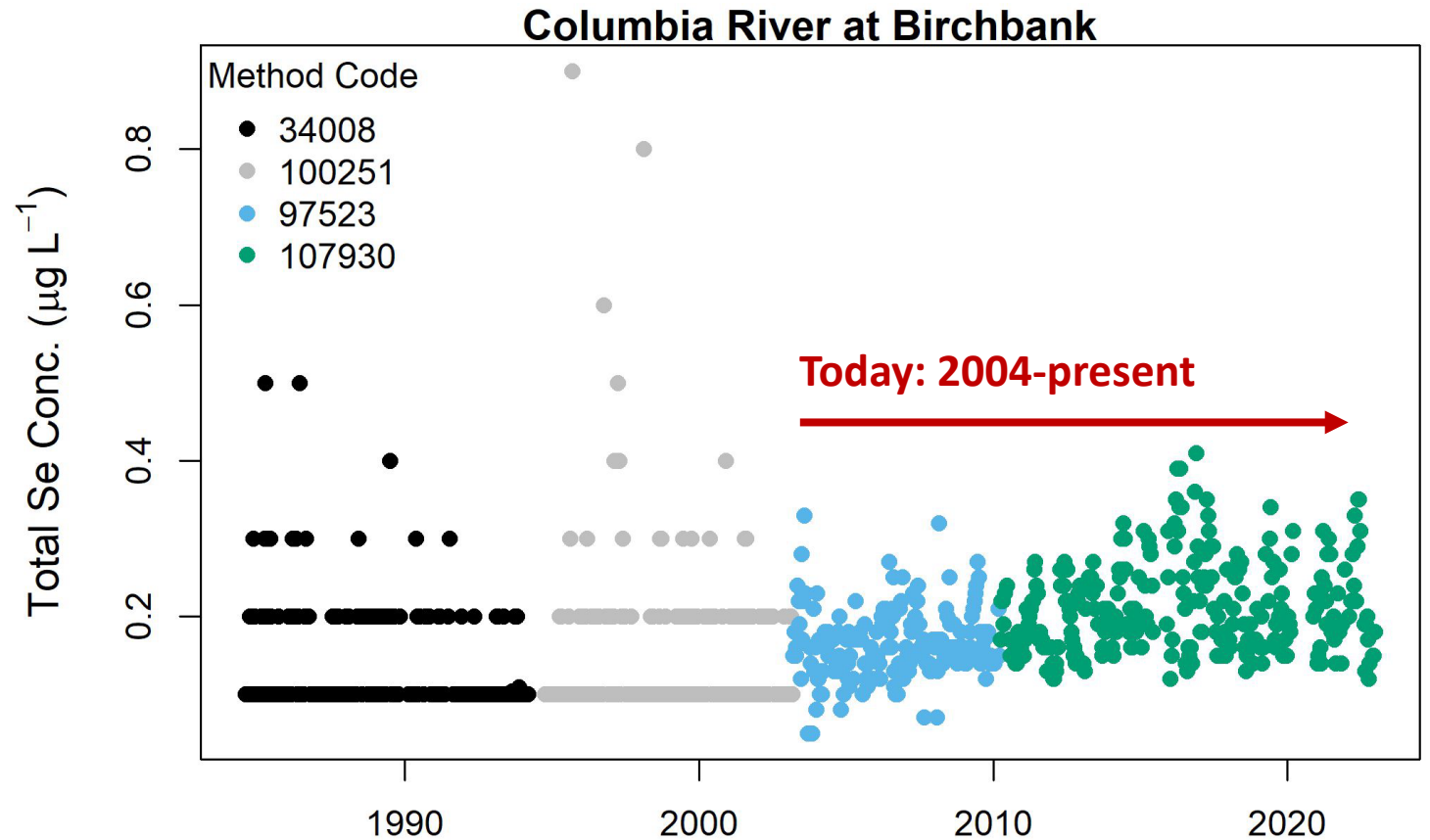
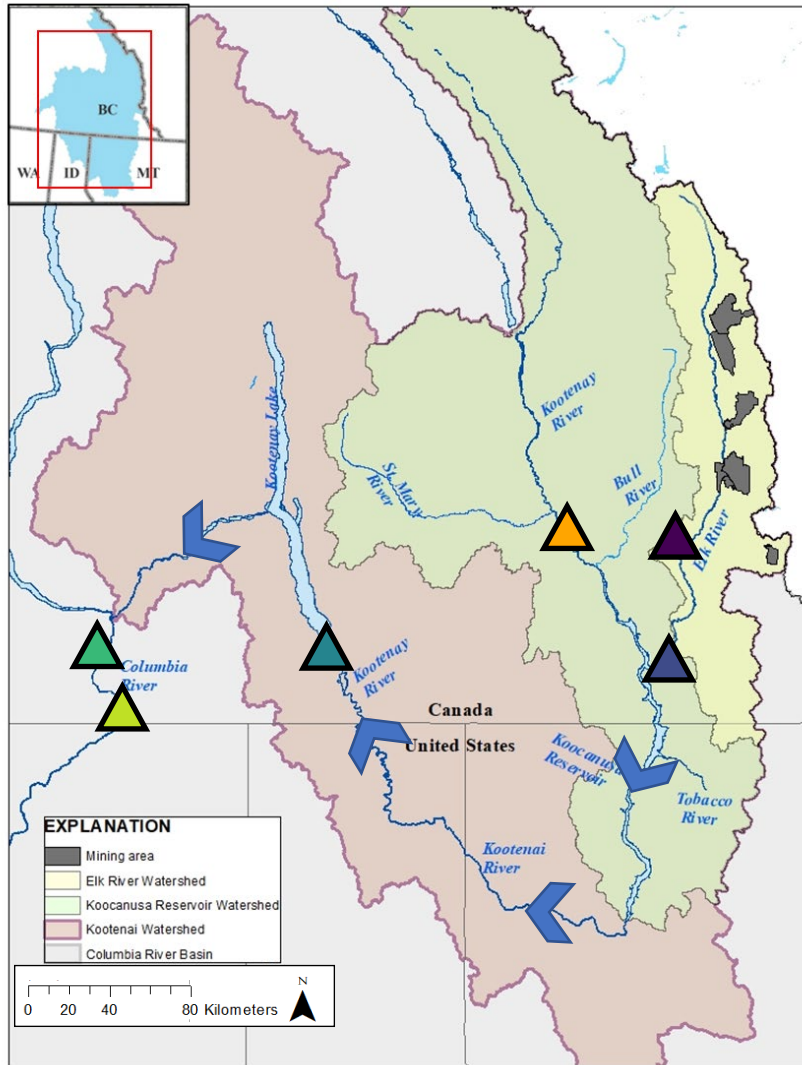


Kootenay Lake

"This information is preliminary and is subject to revision. It is being provided to meet the need for timely best science. The information is provided on the condition that neither the U.S. Geological Survey nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the information."

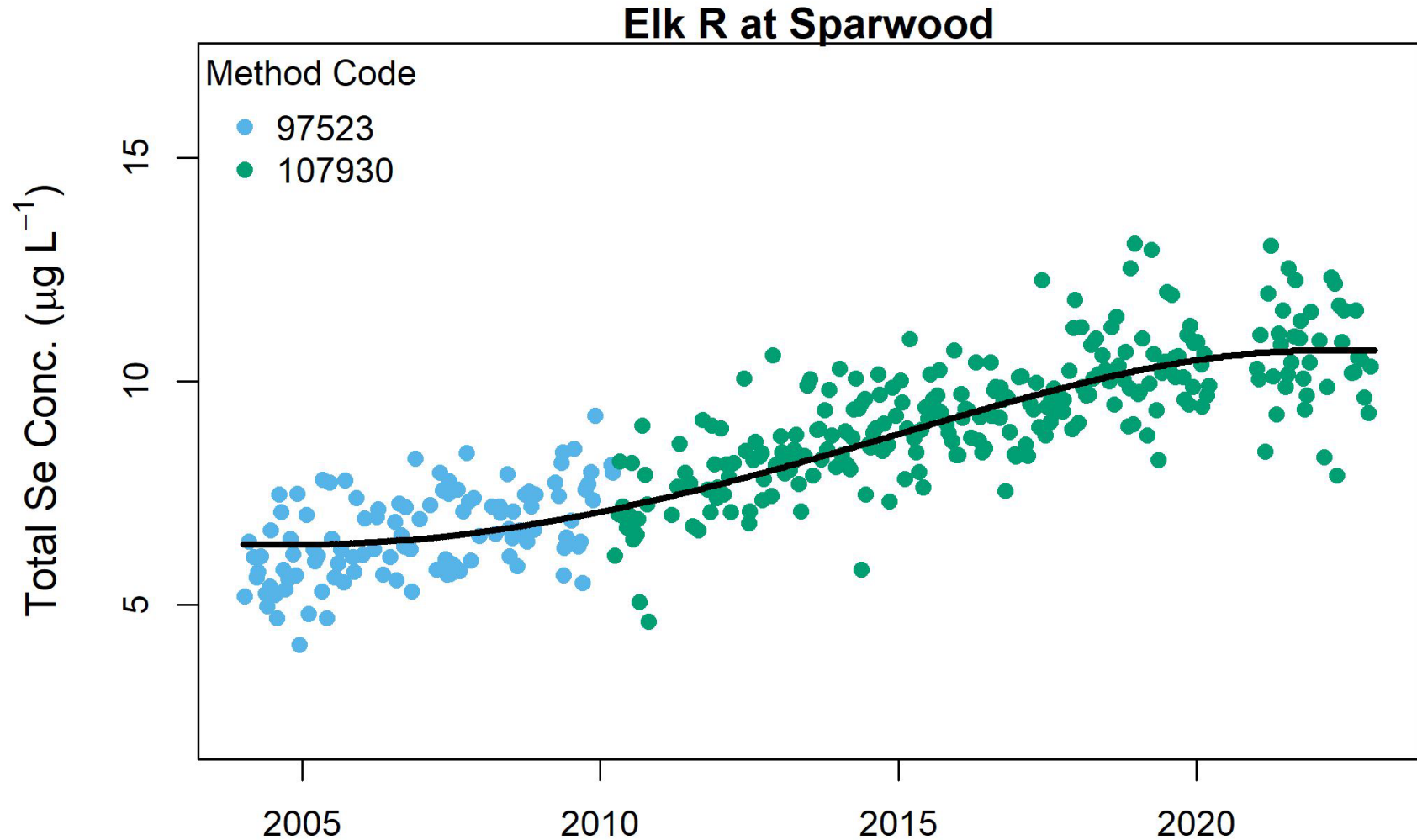
Objectives

1. Assess trends in total Se concentrations
2. Compare Se concentrations
3. Compare Se loads



"This information is preliminary and is subject to revision. It is being provided to meet the need for timely best science. The information is provided on the condition that neither the U.S. Geological Survey nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the information."

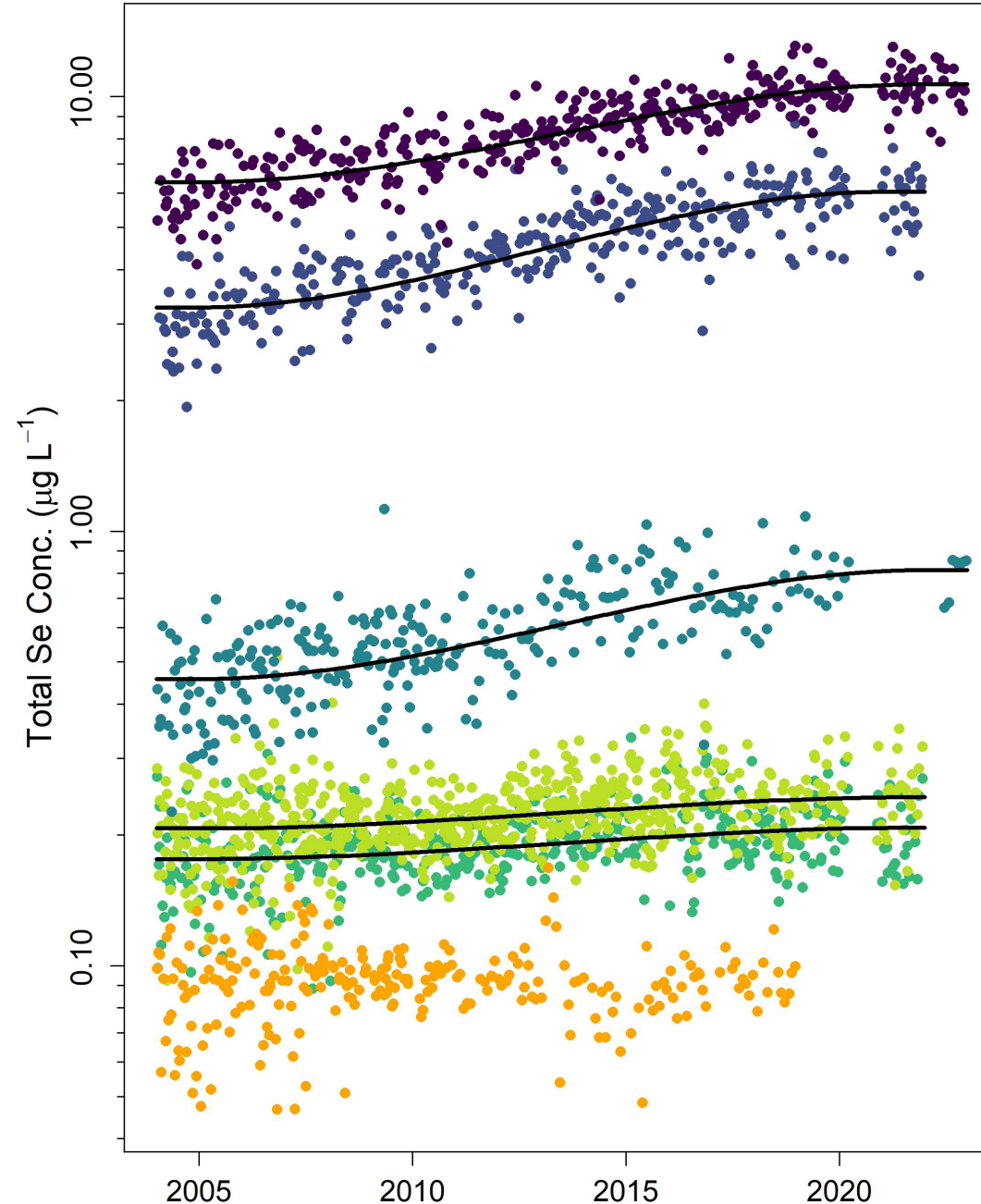
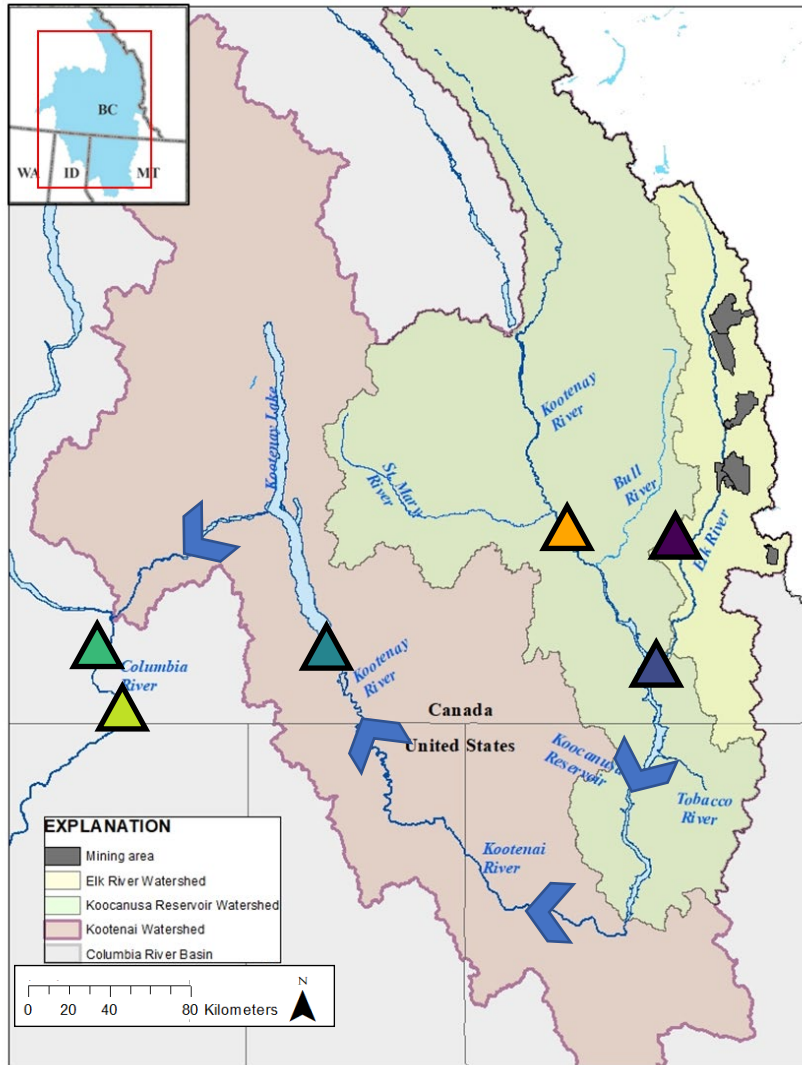
Trend analysis using R-QWTREND



Accounts for:

- **Flow-related variability**
- **Method biases**
- **Temporal autocorrelation**

Trends in Total Selenium Concentrations



**Elk R at Sparwood
(2005-2022)**
p-value = <0.001

**Elk R at Highway 93
(2005-2021)**
p-value = <0.001

**Kootenay R at Creston
(2005-2022)**
p-value = <0.001

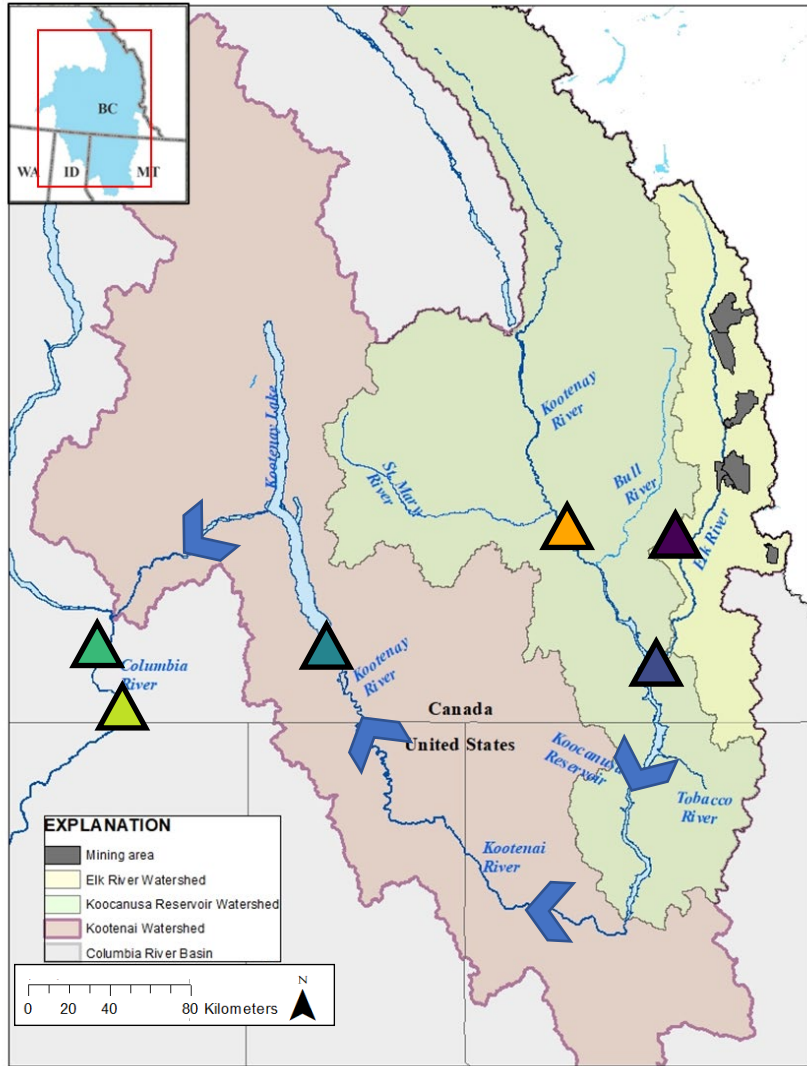
**Columbia R at Waneta
(2005-2022)**
p-value = 0.02

**Columbia R at Birchbank
(2005-2022)**
p-value = 0.02

**Kootenay R near Fenwick
(2005-2018) (Reference)**
p-value = 0.94

"This information is preliminary and is subject to revision. It is being provided to meet the need for timely best science. The information is provided on the condition that neither the U.S. Geological Survey nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the information."

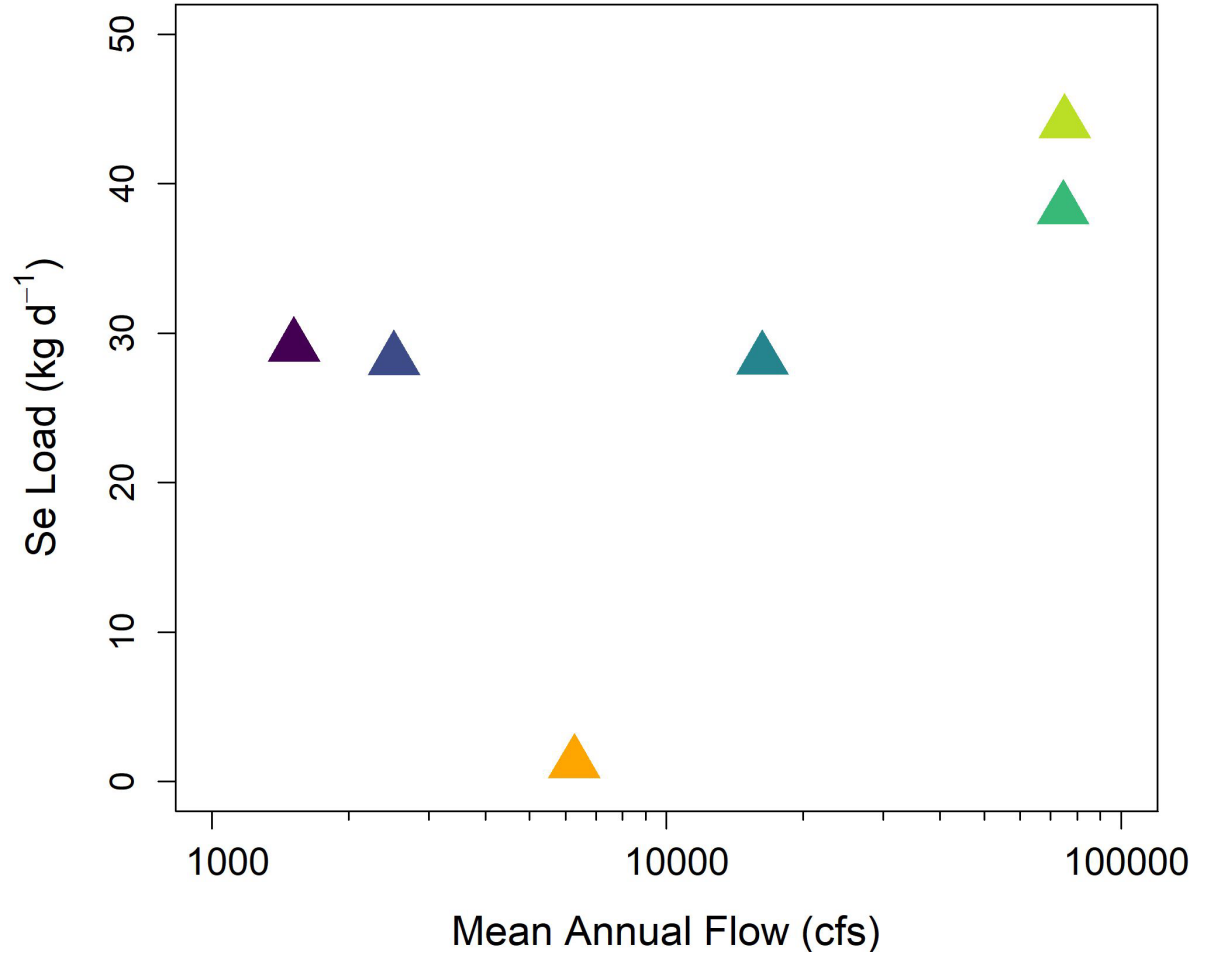
Total Selenium Loads



USGS
science for a changing world

"This information is preliminary and is subject to revision. It is being provided to meet the need for timely best science. The information is provided on the condition that neither the U.S. Geological Survey nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the information."

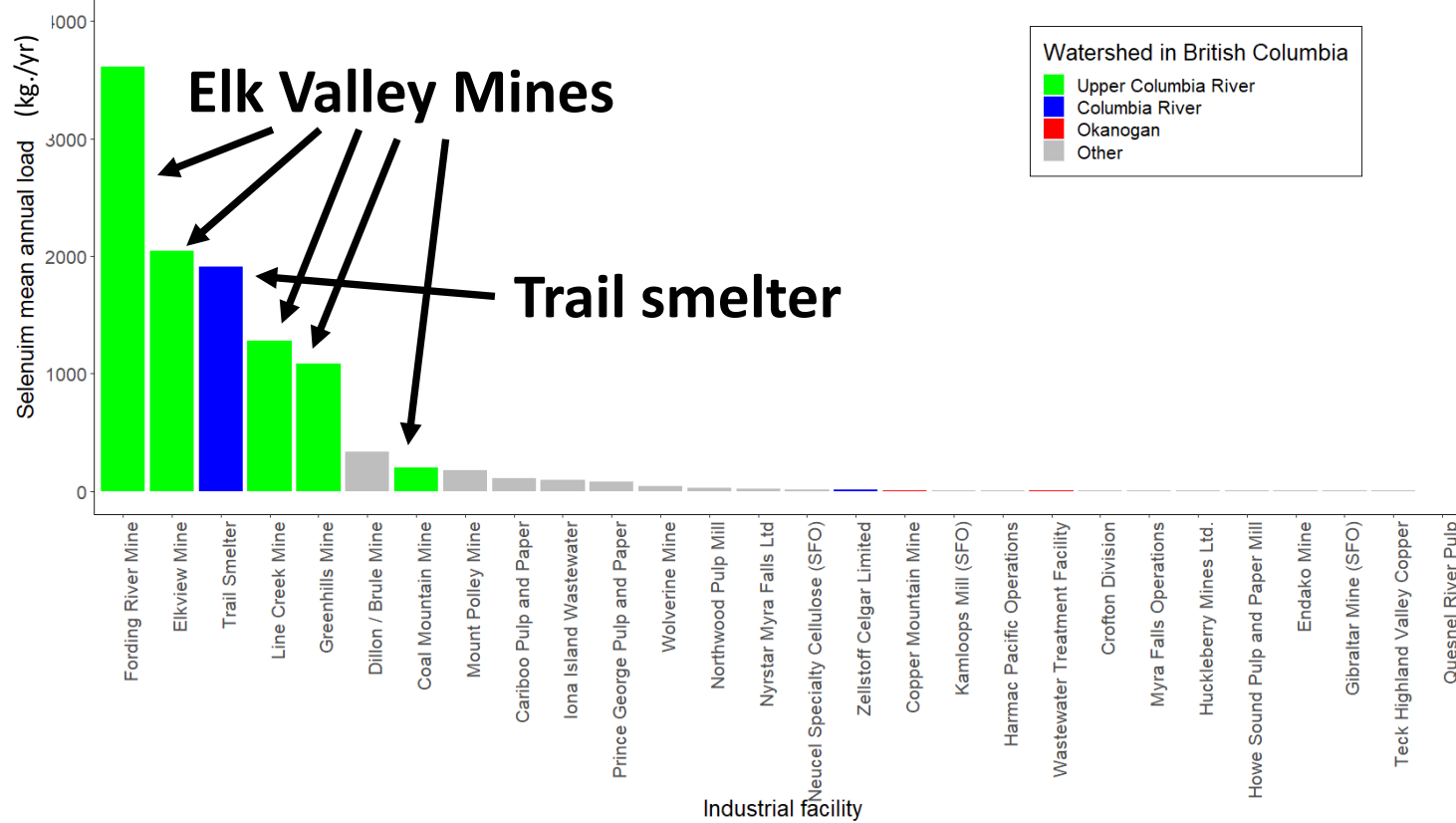
Mean Annual Se Loads 2014-2019



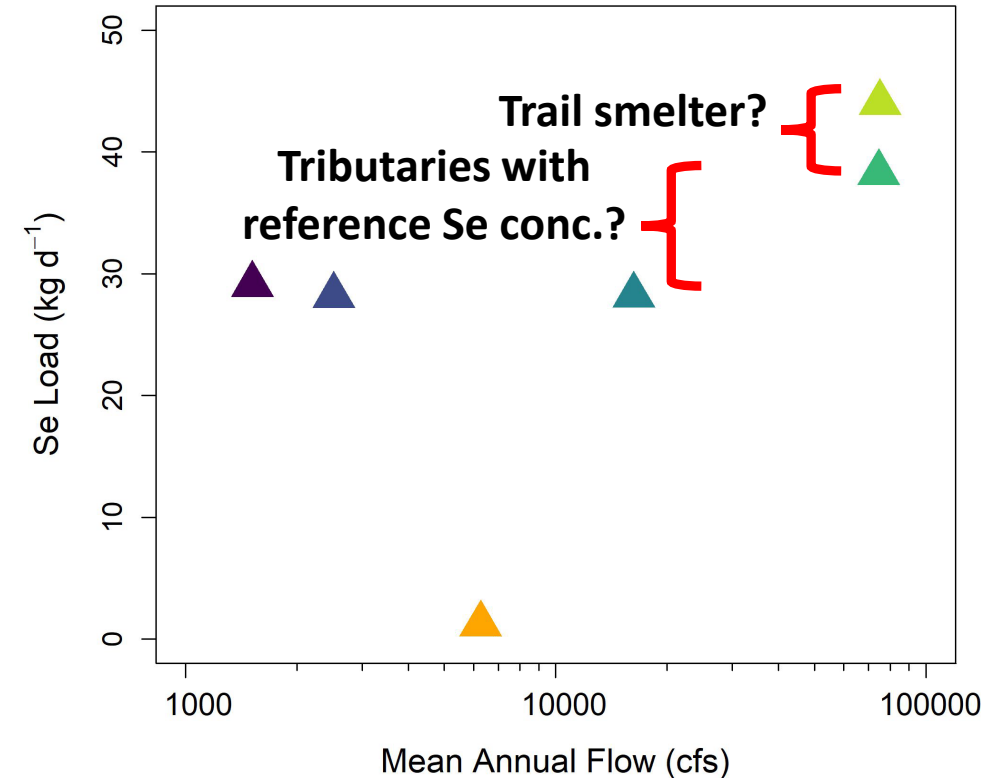
- Elevated loads at mine-affected sites
- Loads increase downstream
- What are major sources of Se downstream?

Elk Valley Mines and Trail Smelter contribute most reported industrial Se load in British Columbia

National Pollutant Release (Industrial) Inventory, British Columbia 2014-2019

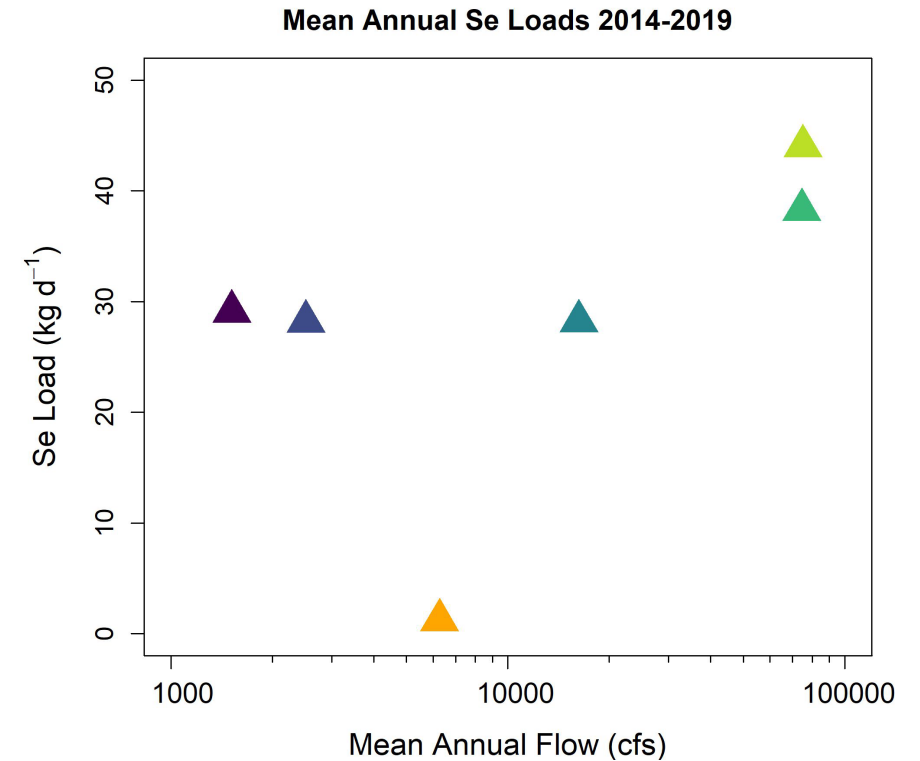
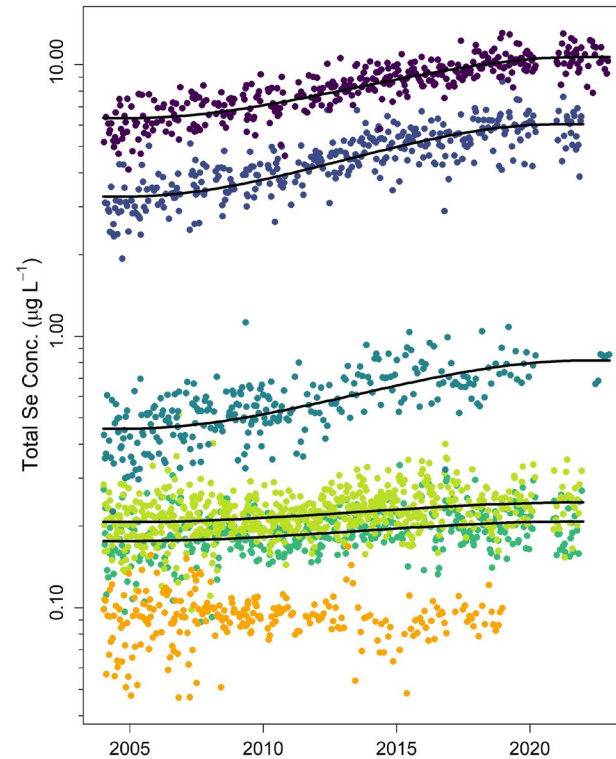
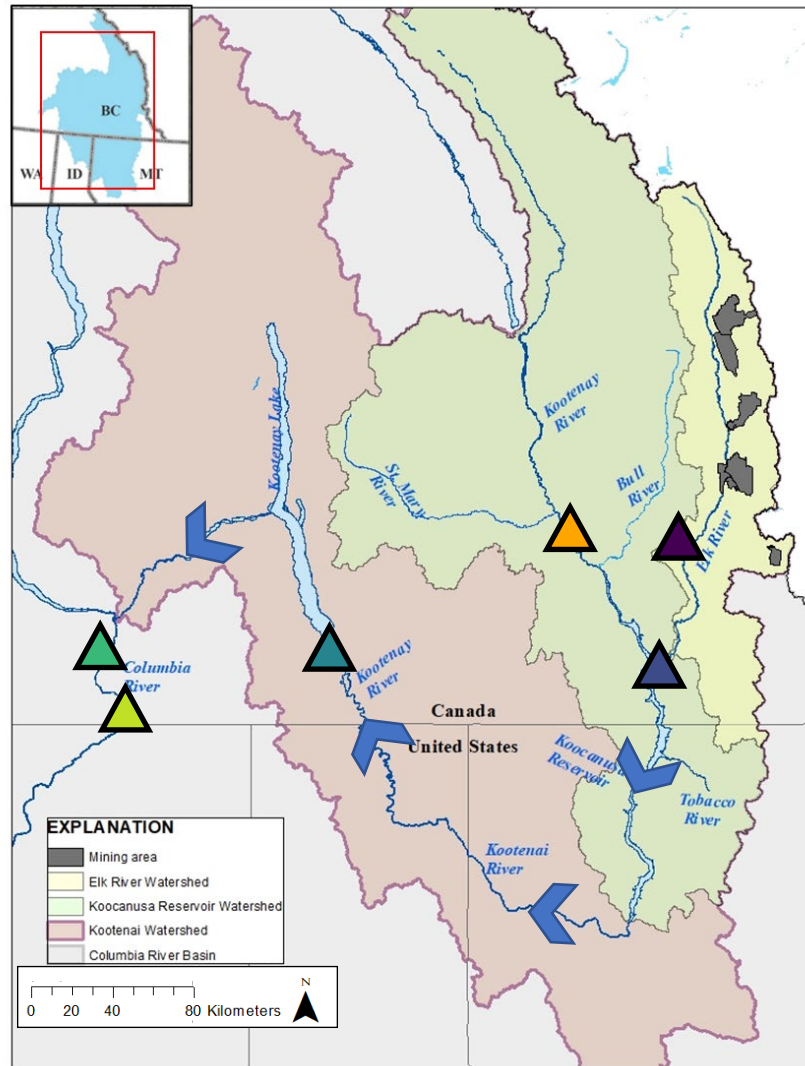


Mean Annual Se Loads 2014-2019



"This information is preliminary and is subject to revision. It is being provided to meet the need for timely best science. The information is provided on the condition that neither the U.S. Geological Survey nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the information."

Take home: evidence of long-range transport of Se in Upper Columbia River Basin



Mine-affected sites have...

- Increasing trends in Se concentrations
- Elevated concentrations
- Elevated loads

"This information is preliminary and is subject to revision. It is being provided to meet the need for timely best science. The information is provided on the condition that neither the U.S. Geological Survey nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the information."

USGS Lake Koocanusa talks:

Melissa Schaar on project
overview — 8:50 AM
Thursday

Kathy Chase on
Flow/Temperature
Modeling — 10:50 AM
Thursday



Thank you to:

Ashley Bussell
Travis Schmidt
Meryl Storb
David Lange
Johanna Blake
Rochelle Nustad

Environment and
Climate Change Canada

Contact: mfoster@usgs.gov

