Comment on "Fish Remain High in Selenium Long after Mountaintop Coal Mines Close" (Environ. Sci. Technol., 2026, DOI: 10.1021/acs.est.5c10900)

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Abstract

This Comment evaluates the interpretation and conclusions presented in "Fish Remain High in Selenium Long after Mountaintop Coal Mines Close" by Cooke et al. (2026). While the study provides valuable data on selenium concentrations in fish tissue from Crowsnest Lake, several limitations may affect the strength of the conclusions. These include a lack of sufficient temporal and site-specific context to interpret bioaccumulation, limited evidence to support attribution to legacy mining, and the extrapolation of ecological and population-level effects in the absence of supporting biological data. Additional uncertainties arise from cross-system comparisons and mechanistic linkages that remain speculative. Overall, the conclusions regarding persistence, source attribution, and ecological risk may not be fully supported and would benefit from a more comprehensive, hypothesis-driven framework.

Keywords: selenium; bioaccumulation; coal mining; fish tissue; ecological risk; source attribution

The recent article by Cooke *et al.* (2026) presents new selenium (Se) concentrations in fish muscle tissue from Crowsnest Lake, AB and concludes that these concentrations represent an environmental concern based on exceedances of fish tissue guidelines. While the dataset contributes useful information, the interpretation, contextual framing, and supporting evidence – or lack thereof - raise several scientific and methodological concerns that warrant clarification.

A central theme of the article is the apparent discrepancy between relatively low aqueous Se concentrations and elevated fish tissue concentrations, which is framed as an ecological concern indicative of on-going or legacy bioaccumulation. However, this interpretation is not supported by sufficient spatial or temporal contexts. Selenium is known to bioaccumulate in aquatic food webs, particularly in lentic systems with longer residence times, and tissue concentrations can remain elevated long after reductions in aqueous Se exposure. In the absence of time-resolved water or biota data, comparison of present-day water concentrations to current tissue burdens represents a potential "apples to oranges" scenario. While the inclusion of sediment core data provides some historical perspective on Se inputs, it does not resolve whether aqueous concentrations were previously higher, nor does it establish the temporal relationship between exposure and bioaccumulation. Furthermore, selenium can be subject to post-depositional mobility within lake sediments under changing geochemical conditions. As such, interpretation of this condition as inherently anomalous or ecologically significant remains purely speculative.

Moreover, the lack of historical (temporal) fish tissue data from Crowsnest Lake or nearby systems (spatial) further limits interpretation. Comparisons to reference lakes in other parts of Alberta are limited at a regional scale, as they do not provide insight into temporal trends within the study's specific geological setting and alpine ecosystem. Demonstrating whether tissue concentrations are increasing, stable, or declining is necessary to support any conclusions regarding persistence, bioaccumulation, or risk. Without such context, it is not possible to conclude that the observed concentrations reflect a sustained condition required for long-term bioaccumulation.

The attribution of Se sources being solely due to legacy coal mining operations, particularly the Tent Mountain Mine, is also not directly demonstrated. While elevated Se concentrations in inflowing waters and sediment records are consistent with a mining-related source, neither chemical fingerprinting, isotopic analyses, nor hydrological mass balance are presented, and other plausible selenium sources are not evaluated, to substantiate this linkage. In addition, the potential influence of fish mobility is not addressed. Species such as brown trout and mountain whitefish may utilize tributaries and connected river systems for spawning or feeding, potentially exposing them to Se outside of the lake. Without evaluation of fish population movement patterns (e.g., via radiotelemetry, tagging, or isotopic approaches), attribution of Se exposure to Crowsnest Lake remains uncertain.

The discussion of potential ecological effects, including reproductive failure and population collapse, is not supported by empirical data from the study system. The authors themselves note that fish populations in Crowsnest Lake are self-sustaining, while at the same time suggesting that current Se concentrations may lead to population-level impacts. This apparent contradiction is not reconciled. Specifically, no data are presented on recruitment, deformities, reproductive success, or population trends. While exceedance of tissue guidelines may warrant further investigation, extrapolation to population-level consequences without supporting biological data is premature.

The suggestion that Se toxicity and Whirling Disease may produce overlapping clinical symptoms is also highly speculative. There is currently no established mechanistic linkage between Se exposure and infection by the cnidarian parasite, *Myxobolus cerebralis*, and no direct evidence is presented to support this assertion within the study. As such, the implication of potential diagnostic confounding is not substantiated.

Comparisons of Se concentrations across species and regions in Alberta (e.g., Figure 2 in Cooke *et al.* (2026)) are presented without sufficient consideration of underlying geology and climate, species-specific bioaccumulation potential, trophic position, life stage, or habitat use. Cross-system comparisons that do not account for these factors—particularly differences between lentic and lotic environments—may be misleading. A more rigorous approach would involve normalization for these variables or restriction of comparisons to ecologically-comparable species and systems.

The published[1] version of the article provides improved transparency regarding analytical methods and quality assurance/quality control procedures, which strengthens confidence in the reported concentrations. However, interpretations made relative to regulatory benchmarks would benefit from clearer articulation of guideline applicability. In particular, distinctions between fish muscle tissue screening values and egg/ovary-based thresholds intended to protect reproduction should be explicitly acknowledged to avoid any mischaracterizations of ecological risk.

Finally, the discussion references declines in fish populations in other systems and associated regulatory actions in a manner that imply causal relationships that have not been definitively established (see Gilron *et al.* (2021)). Attribution of such declines to Se exposure remains complex and context-dependent, and care should be taken to avoid conflating correlation with causation.

In summary, while the Cooke *et al.* (2026) study provides useful new data on Se concentrations in fish tissue, the conclusions regarding source attribution, ecological significance, and potential population-level effects are not supported by the evidence presented. Addressing these uncertainties would require a more comprehensive, hypothesis-driven approach, including time-series monitoring of water and biota, evaluation of food web dynamics, assessment of fish movement and habitat use, and direct measurement of reproductive and population health endpoints. Such an approach would provide a more robust basis for interpreting Se dynamics and associated ecological risk in this ecosystem.

References

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[1]NOTE: a non-peer-reviewed, pre-publication version of the article was posted on bioRxiv on May 27, 2025.