Sustainable Rivers Program

Libby Dam and Koocanusa Reservoir

Nitrate and Temperature Profile and Selective Withdrawal Study

Field Season Report – 2024

May 2025

Libby Dam and the Koocanusa Reservoir (USACE photo)

Prepared by: Seattle District (NWS), Water Quality Program
U.S. Army Corps of Engineers (USACE)

Project Objectives

Libby Dam was constructed with a selective withdrawal structure (SWS) that allows water to be discharged through the dam from different depths in the forebay. This system provides a unique opportunity for the Seattle District (NWS) to inform potential operational changes to improve downstream water quality for nitrate while continuing to meet downstream thermal objectives. Current operational protocol is to optimize downstream temperature using the SWS when the reservoir is thermally stratified. However, increased nitrate loading downstream has been a water quality concern for the states of Montana and Idaho as nitrate loading into the reservoir due to mountain top removal coal mining in British Columbia has increased over the last two decades. Sampling data show that nitrate concentrations in the forebay vary by season and depth in the water column. Understanding this temporal and vertical cycle of nitrate concentrations in the forebay and the relationship to temperature stratification and turnover are key to optimizing future operations of the SWS to maintain the health of aquatic ecosystems connected to Koocanusa Reservoir and the Kootenai River.

NWS began a comprehensive study of the vertical dynamics of nitrate and temperature in the forebay of Libby Dam during the 2024 sampling season and will continue this study through the 2025 season. Using these data, NWS will evaluate if the SWS can be operated to select discharge depths for the optimization of both downstream temperature and nitrate loading, and ultimately improve downstream water quality. The final product will be a report including the raw data, comprehensive study results, with recommendations regarding SWS operations.

Field Methods

Hourly temperature profiles were collected from April through October 2024 via an existing fixed elevation temperature string located on the face of the dam. Additionally, measurements of field parameters (temperature, conductivity, dissolved oxygen, pH) were collected as a profile at 1-meter (m) intervals using a Hydrolab MiniSonde 5 multiprobe coupled with a Surveyor 4 surface display and recording unit.

Bi-weekly nitrate profiles were collected from April through August and monthly in September and October of 2024 at the forebay of the project using a TriOS NICO sensor equipped with a UV photometer for the determination of low-level nitrate concentrations in freshwater. Nitrate profile data was collected at 1 m intervals between the surface and 50 meters of depth and at 2 m intervals from 50 meters to roughly 1 m above the reservoir bottom.

Monthly grab samples for nitrate were collected from April through October 2024 at the forebay station by submerging a cleaned and decontaminated 3.0 liter polycarbonate (Lexan) Van-Dorn style sampler to depth and filling. Up to 15 grab samples were collected as a profile from a depth of 3 m below the surface to approximately 3 m off the bottom. Depths of grab samples were determined in the field based on thermal stratification with samples concentrated in the depth range of more significant temperature gradients. Grab samples were immediately placed on ice and delivered to a contracted water quality laboratory for analysis within 48 hours.

Preliminary Results

The Kootenai River and Koocanusa Reservoir operations for water year (WY) 2024 are depicted in Figure 1 and water temperatures recorded by the temperature string in the dam's forebay are shown in Figure 2. The 2024 sampling season occurred during a low water year, which generated lower-than-expected nitrate concentrations throughout the season. As a result, the study was granted an extension to continue through the 2025 season in hopes of capturing data under more normal hydrologic conditions, which will better inform recommendations for SWS operations.

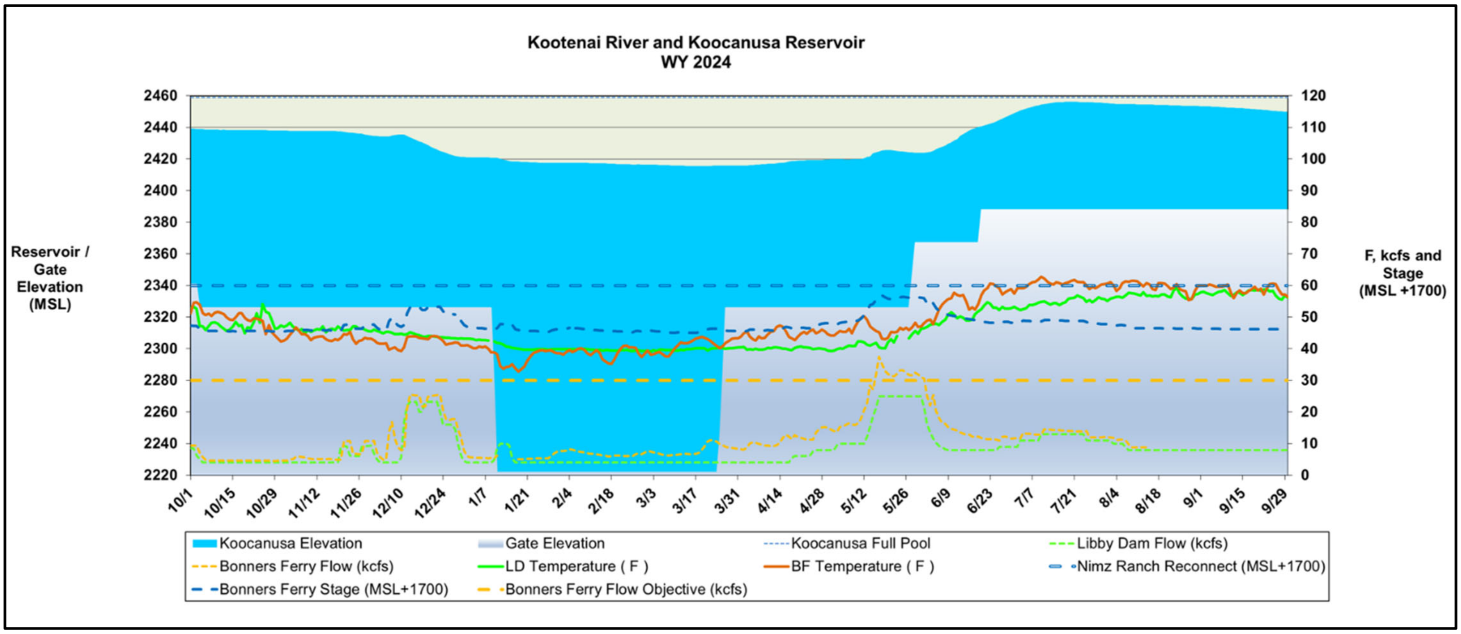

Figure 1. Kootenai river and Koocanusa reservoir data from water year 2024.

Grab samples collected by NWS were analyzed by a contracted water quality laboratory (IEH Laboratories) and the results were compared to the data captured by the TriOS NICO sensor and grab samples from U.S. Geological Survey (USGS) collaborators conducting similar monitoring above and below Libby Dam. The contracted water quality lab consistently reported lower nitrate concentrations in comparison to those recorded by the TriOS NICO sensor and USGS grab samples results. Therefore, a correction factor will be applied to the laboratory data for the final report using a linear relationship model between the USGS grab sample data and contracted lab results.

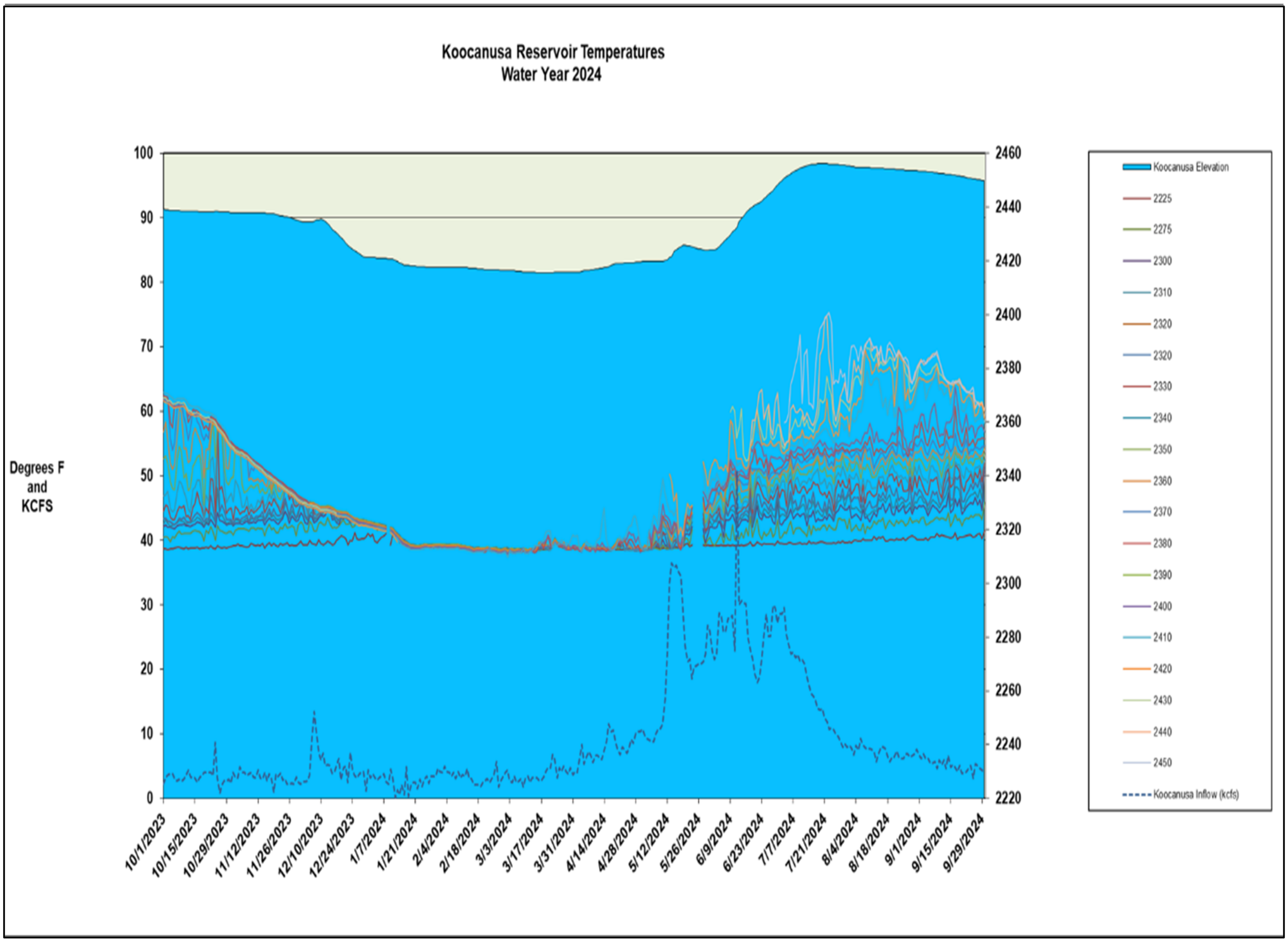

Figure 2. Koocanusa reservoir forebay water temperature, elevation, and inflow data.

Graphs for each sampling event depicting the concentrations from the three data sources (IEH Laboratory, TriOS, and USGS) for the 2024 field season are found in Appendix A. In general, patterns in the forebay nitrate concentration profiles are seen from June through October, with marked fluctuations appearing in the 20 to 40 m zone of the water column. This corresponds to the formational zone of temperature stratification in the Libby Dam forebay. USGS partners have confirmed a similar pattern in their data collection. Further analysis will be executed in the final report to ascertain how nitrate concentrations associate with positioning of the dam withdrawal gates, which will ultimately drive the ability to possibly influence downstream loading of nitrate. Nitrate concentrations measured and expressed in milligrams per liter (mg/L).

Appendix A – Field Season 2024 Sampling Event Nitrate Data (Figures 3 to 13)

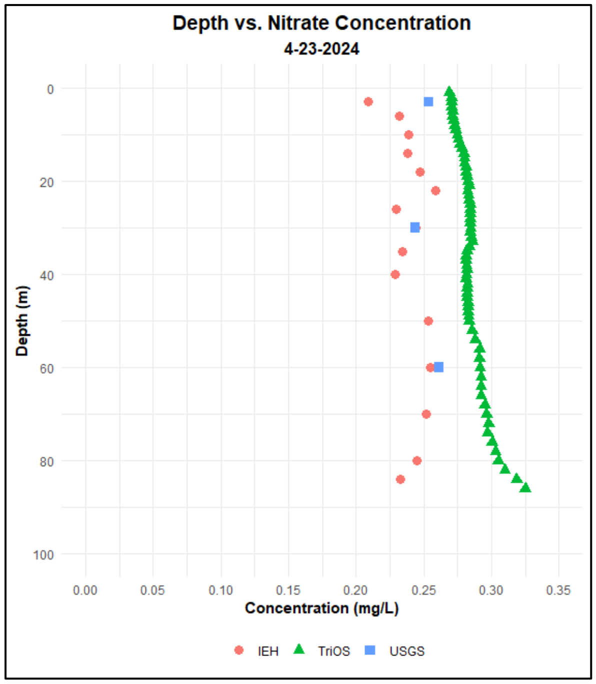

Figure 3. Water column nitrate (NO_3) concentrations (mg/L), April 23, 2024.

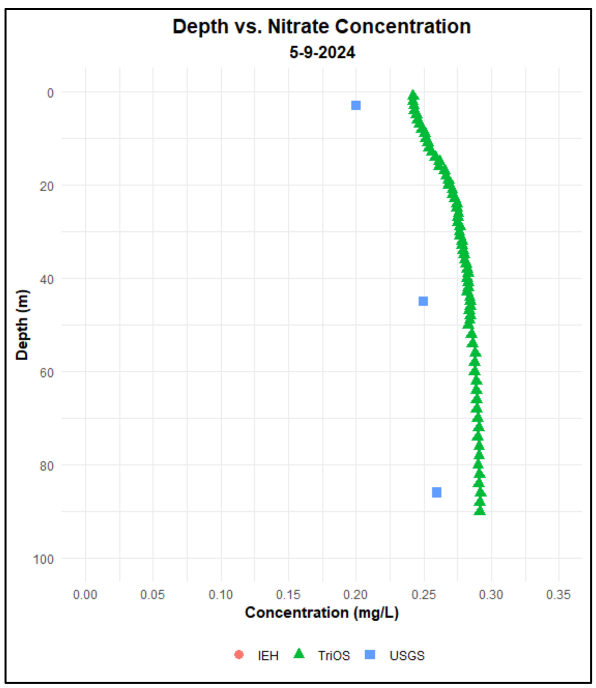

Figure 4. Water column nitrate (NO_3) concentrations (mg/L), May 9, 2024.

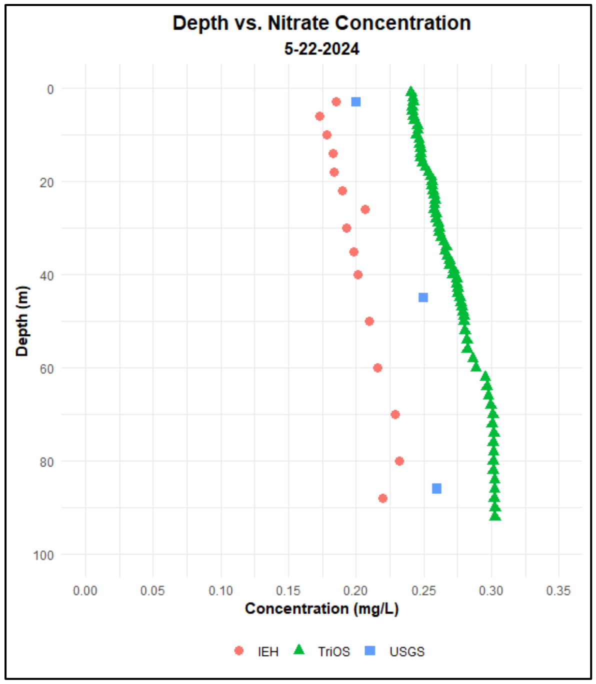

Figure 5. Water column nitrate (NO_3) concentrations (mg/L), May 22, 2024.

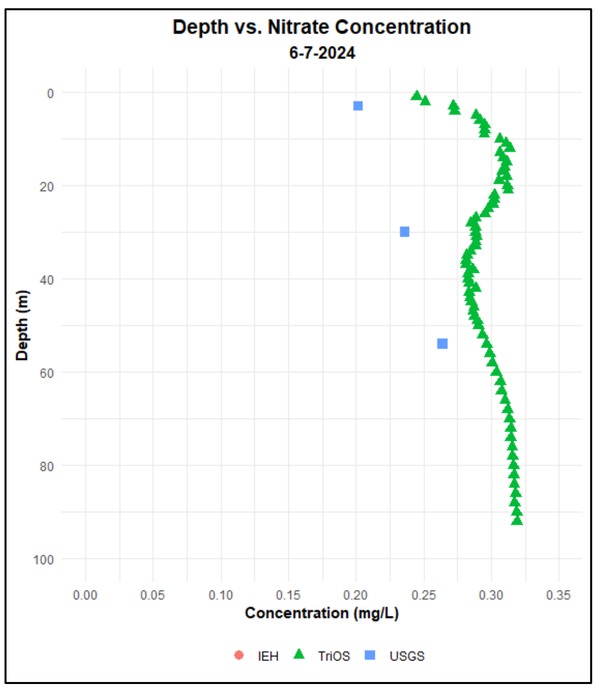

Figure 6. Water column nitrate (NO_3) concentrations (mg/L), June 7, 2024.

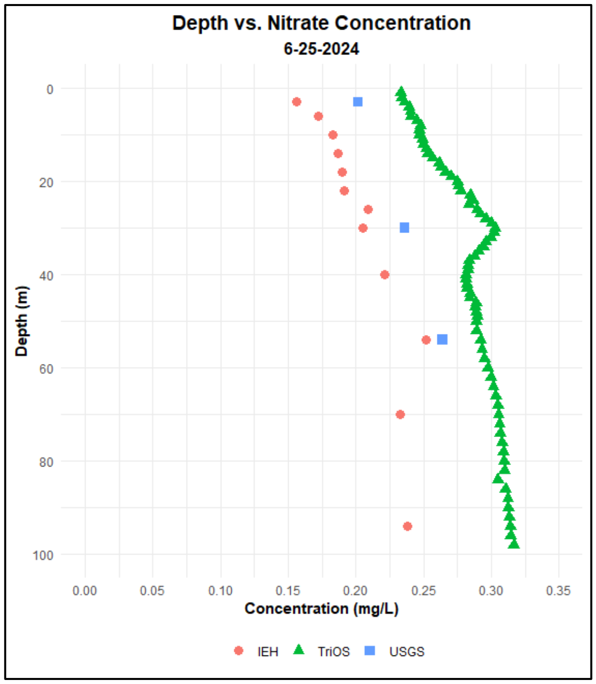

Figure 7. Water column nitrate (NO_3) concentrations (mg/L), June 25, 2024.

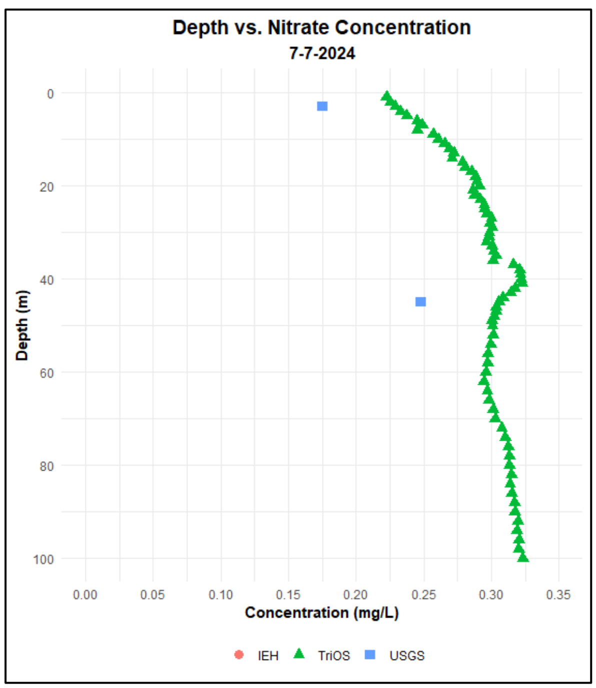

Figure 8. Water column nitrate (NO_3) concentrations (mg/L), July 7, 2024.

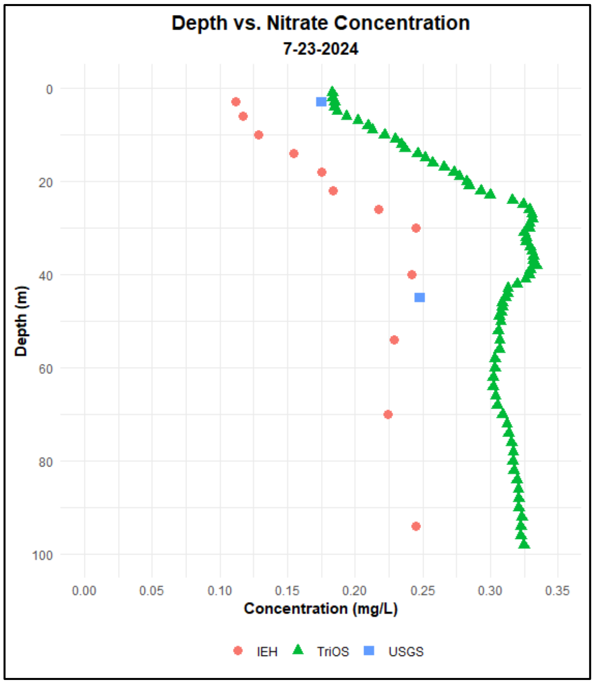

Figure 9. Water column nitrate (NO_3) concentrations (mg/L), July 23, 2024.

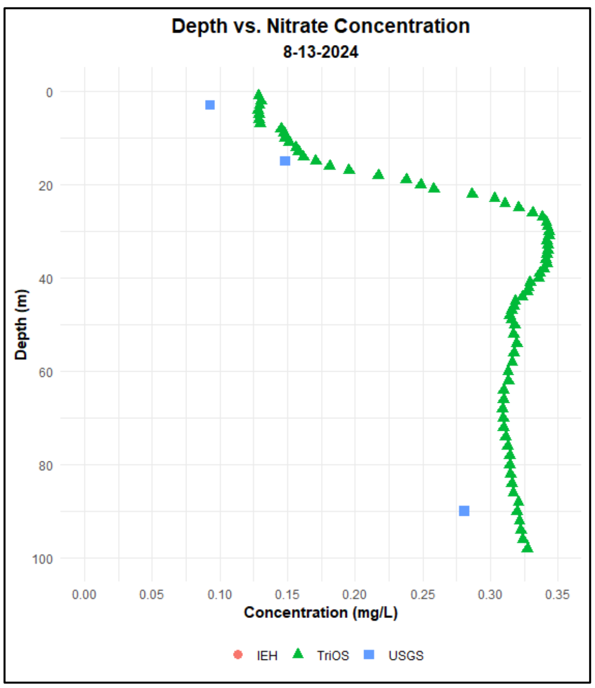

Figure 10. Water column nitrate (NO_3) concentrations (mg/L), August 13, 2024.

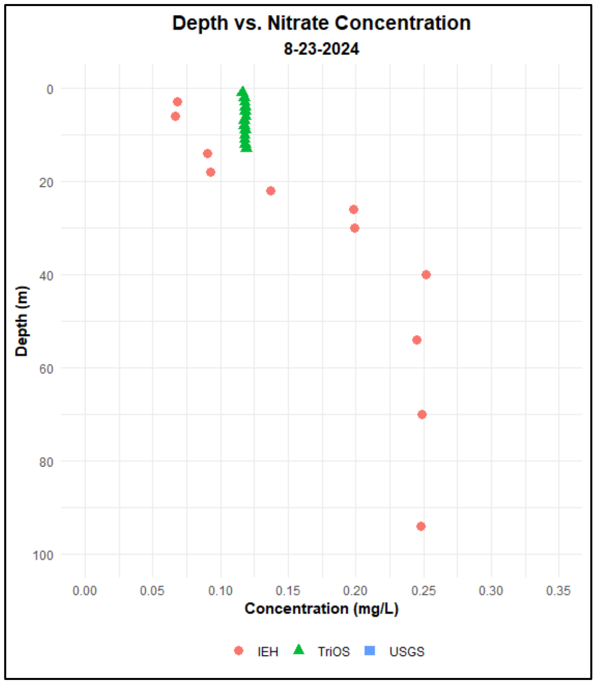

Figure 11. Water column nitrate (NO_3) concentrations (mg/L), August 23, 2024.

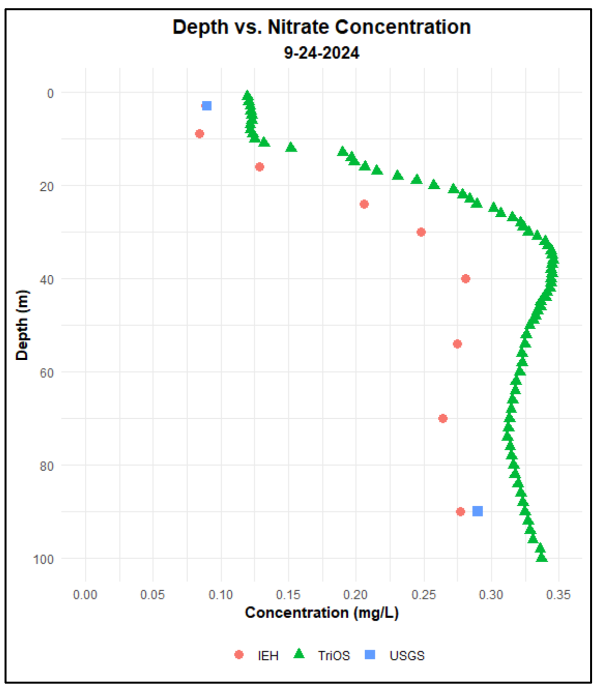

Figure 12. Water column nitrate (NO_3) concentrations (mg/L), September 24, 2024.

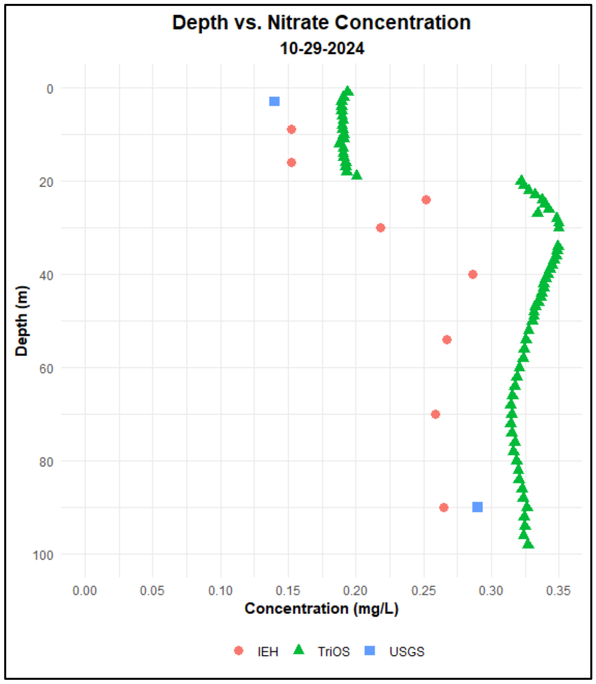

Figure 13. Water column nitrate (NO_3) concentrations (mg/L), October 29, 2024.