WATER & ECOLOGY CASE STUDY

Advancing Aquatic Science: Minnow Environmental's Data-Driven Approach to Regulatory Monitoring

CHALLENGE

A Canadian mining company needed a comprehensive aquatic monitoring program to track selenium bioaccumulation, assess ecosystem health, and meet strict regulatory requirements under the oversight of an independent environmental committee.

SOLUTION

Minnow Environmental developed a multi-layered monitoring approach, integrating broad-scale and site-specific studies with advanced machine learning and predictive modeling to analyze mining impacts and ecosystem variability.

RESULT

The mining company gained defensible, data-driven insights to support regulatory compliance, improve environmental decision-making, refine mitigation strategies, and strengthen its relationship with regulators and First Nations communities.

A major Canadian mining operation operating in British Columbia is subject to complex regulatory requirements for monitoring the aquatic environment surrounding its mines. With concerns such as selenium bioaccumulation, elevated metal and nitrate concentrations in mine-contact water, and changes in aquatic habitat, the company needs a robust, defensible and ongoing monitoring program to track water quality, sediment conditions, and biological impacts across multiple mine sites. For over 20 years, Minnow Environmental, a Trinity Consultants team, has played a critical role in the mine's regulatory compliance efforts. Through comprehensive monitoring, predictive modeling, and advanced statistical analysis, Minnow provides the mine with the insights needed to inform decision-making and support ongoing mitigation efforts..

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CHALLENGE

Under the company's existing permit, it must conduct a broad-scale regional monitoring program to examine water quality, sediment conditions, and biological health across multiple sites. In addition, more focused, mine-specific aquatic effects monitoring programs are required to assess local impacts. This work is reviewed not only by the Ministry of Environment and Parks but also by an independent oversight committee made up of government agencies, First Nations representatives, and other regulatory stakeholders.

The client needed clear, defensible data to understand mining effects, identify environmental changes, and demonstrate regulatory compliance. Traditional monitoring approaches alone were not enough—the mine required highly detailed analysis that could begin to tackle the challenge of differentiating between natural environmental variability and mining-related changes in benthic invertebrate communities and support strategic decision-making.

SOLUTION

To support regulatory requirements, Minnow designed a multi-layered monitoring and analysis approach that combined field data collection with advanced predictive modeling and statistical interpretation. The work spanned both broad-scale regional monitoring and focused site-specific programs, ensuring a comprehensive understanding of mining impacts and overall ecosystem health.

The team conducted regular assessments of key constituents of concern (e.g., selenium, nitrate, sulphate, cadmium, nickel) in water, sediment, and/or biological tissues, tracking how these constituents moved through the environment, where possible. Alongside these efforts, Minnow also closely monitored the benthic invertebrate communities, which serve as key indicators of aquatic ecosystem health. These organisms, which spend their lives in and around aquatic substrates, are valued ecosystem components that provide insight into habitat function and food availability for fish and other wildlife.

To address the complex relationships among benthic invertebrate communities, habitat conditions, and mine-related inputs, the team decided to develop its own predictive benthic invertebrate community model based on an advanced machine learning artificial intelligence (AI) platform. The model integrated vast datasets, including GIS-based habitat data, mine-related water and habitat stressor data, and reference site comparisons, to generate predictions about what a healthy benthic invertebrate community should look like without mining on the landscape. By comparing these predictions to real-world field data, Minnow could begin to better understand whether observed changes were due to water quality stressors, habitat modifications, or natural seasonal variability.

The shift to machine learning provided greater predictive accuracy and a more nuanced understanding of environmental changes. To support this effort, Trinity Consultants invested in high-performance computational infrastructure that allowed Minnow to process the large datasets more efficiently and maximize the value of the information collected.

RESULT

Minnow's data-driven approach transformed how the mine tracks mine-related ecosystem changes, providing a higher level of insight than ever before. The predictive benthic invertebrate community model has proven to be an invaluable tool, helping to distinguish between natural environmental variability and mining-related impacts. This clarity will support precise and targeted mitigation efforts, ensuring that the client's responses are based on scientifically defensible conclusions.

Minnow's transparent, science-based approach has facilitated productive discussions with the mine's leadership, regulators, and the independent oversight community and strengthened trust among all parties involved. By ensuring that environmental decisions are backed by rigorous data and defensible scientific methodologies, Minnow continues to provide the client with the insights necessary to meet regulatory expectations and advance environmental stewardship throughout the region.

ABOUT TRINITY CONSULTANTS

Trinity Consultants, a leading global environmental consulting firm, provides services and solutions in the EHS Regulatory Compliance, Built Environment, Life Sciences, and Water & Ecology markets. Founded in 1974, Trinity has the technical expertise, industry depth, and capabilities to help clients achieve their goals across the natural and built environments.