



The Relationship Between Salmon and the Yurok Tribe on the Klamath River – Native Species Detection, Diagnosis, and Monitoring (December 2020 – Present)

Abstract – Hydroelectric power has always created a challenge for migrating species such as salmon, and the effectiveness of mitigation actions has been hard to quantify. However, using eDNA and eRNA technology it has been possible to cost-effectively and accurately monitor the population density and health of salmon, and take timely corrective action, as required.



Historical Context

The Klamath River basin is home to the Karuk, Yurok, Hoopa, and other tribes. It is a special place, rich in history and culture. Salmon is both a food source and a focal point for their cultural identity. The Klamath was once a highly productive salmon river, with one million fish returning to the river each year.

Sadly, due to the presence of four dams, there are no longer enough fish for the tribes to have Klamath salmon as a primary food source. The loss of this important cultural tradition has been deeply felt by all those who call the Klamath River basin home.

Over the last 100+ years, excessive water diversions, nutrient loading, modified sediment budgets, and dams have created the ideal ecological conditions for fish pathogens to populate the river at elevated rates. In the past two decades, the Klamath River's juvenile and adult salmon populations have experienced numerous disease-driven die-offs, including the largest pre-spawn mortality event in American history.



It's heart breaking to witness how our actions have impacted the natural balance of this ecosystem and caused such devastation to its inhabitants.

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Why is the Salmon Population So Important

On the Yurok Reservation, where the median income is \$11,000, many tribal families rely on the fishery to pay basic bills and make ends meet. The health of the salmon is an integral part of the Yurok community's livelihood and is also extremely important from an ecological perspective. They bring nutrients from the ocean into the boreal forest environment, which supports biodiversity all along the river. So, when a juvenile fish kill happens, it's not just a disaster for the salmon people, but for the entire community and the environment as a whole.



2022 - 2024 Dam Removal: California and Oregon continue prioritizing river restoration and are embarking on the largest dam removal project in history. Over the next three years, three dams are going to be removed, which will hopefully re-populate these areas with salmon.

How Will We Know if the Restoration Projects are Working?

EQO technology will help monitor the DNA and RNA of juvenile fish across geographic and temporal perspectives in the Klamath. Constant monitoring of the salmon DNA and RNA will help determine if there are the proper conditions for salmon life and understand if the salmon are coming back post-dam removal. This testing will help understand the effectiveness of the ecological restoration and refine strategies for ongoing mitigation efforts. At the end of the day, it's all about giving the salmon community a better life while saving the health of the river ecosystem.

Why Was EQO Brought In?

It is very difficult to detect and monitor juvenile salmon. Traditional tracking methods such as tagging and capturing put additional stress on the salmon and are destructive. This is where EQO technology comes in, which is a low-cost, non-destructive, and high-resolution testing solution.

With increasing human demands on water for both drinking and agriculture, the series of pump stations in northern California must be turned on and off to provide

water for the built infrastructure. Currently, these systems operate off historical data that is not correct based on current realities.

Because of climate change and other human-induced factors, the salmon spawning season is rapidly changing. To better understand the migration patterns of salmon, it's important to know how active they are in different parts of the river. This helps understand the migration patterns and protect those areas. Additionally, juvenile salmon produce different genes than adults, and it is possible to track the difference between youth and adult salmon via transcriptomics.

The real goal is to determine when and where the salmon spawns are happening in close to real-time, which can allow the built infrastructure to be operated as efficiently and responsibly as possible. The salmon population is part of the conversation, and we want to ensure that it stays a healthy and thriving ecosystem for all stakeholders in the area. These new insights into the population will help find harmony between humans and the ecosystem.

Short Summary of this case study from ChatGPT

The Yurok Tribe on the Klamath River relies on salmon for food and cultural identity, but the river's ecological conditions have led to disease-driven die-offs, threatening the tribe's livelihood and biodiversity. The largest dam removal project in history is underway to restore the river, but monitoring the success of the project has been challenging. Traditional tracking methods stress salmon and are destructive, but EQO technology offers a low-cost, non-destructive solution to monitor salmon DNA and RNA. This monitoring can help determine if the restoration efforts are working and refine ongoing mitigation strategies. Additionally, the technology can track the differences between juvenile and adult salmon and help operate the built infrastructure more efficiently and responsibly. Ultimately, the goal is to find harmony between humans and the ecosystem to ensure a healthy and thriving environments for all stakeholders in the area.

Learn more Resources:

[Five Key Lessons as World's Biggest Dam Removal Project Will Soon Begin on the Klamath River](#)

[In Klamath River Drought, a Massive Juvenile Salmon Die-Off](#)

Who is EQO?

We are an Austin-based biotechnology company tackling challenges in aquatic ecosystems including: lakes, reservoirs, rivers, wetlands, estuaries, and intercoastal waterways.



Our Tech

Field and lab innovations in eRNA and eDNA to diagnose, detect, and monitor invasive species, native and endangered species, and biosecurity risks.



Our Vision

Forge partnerships with synergistic technologies, engineering firms, and conservation groups.





Providing Safe Drinking Water to Residents of New York City from the Catskills & Croton Water Shed (March 2021 – Present)

Abstract – The New York Department of Environmental Protection (DEP) faced a challenging taste and odor problem that was difficult to detect. The use of eDNA and eRNA technology proved to be effective in identifying the precise strain and source of the issue. Furthermore, these technologies provided valuable insights into the dynamics of both invasive and native populations.



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Problem

New York City quenches its water thirst from the pristine Catskill watershed, the largest unfiltered watershed in the world due largely to the pristine water and rigid watershed protection program. When demand rises, New York taps into the Croton watershed, which is in a more developed area and has less water flow. This means there is more human activity in the Croton area, which can increase the risk of disruptions and contamination of the water supply. It's no wonder that the New York City Department of Environmental Protection was alarmed when there was a foul smell and taste in the water – something was not right.

There were additional concerns that included source tracing of microbial contamination and harmful algae blooms, along with the desire to gain insights into the invasive and native species population dynamics.

Why Was EQO Brought In?

EQO leverages biotechnology via eRNA and eDNA sample processing and metagenomic and bioinformatic tools to gain new insights. The dedicated and passionate team in NYC was interested in finding a quantitative method to look at the microbiome responsible for the taste and odor issues in the water. After ongoing discussions, this testing expanded to include the monitoring of invasive species and harmful algae bloom detection.



Water Quality Tests and Lab Insights

In one day, EQO collected 10 different water quality samples around the watershed via the Osprey field water testing kit. Back in the lab, the team worked to isolate the RNA and DNA from these samples and went on to investigate the presence of two of the most concerning aquatic invasive species – Hydrilla and Quagga mussels.

Quagga Mussels

- There were positive DNA tests that came from upstream, but the RNA proved they were not alive and active in this area. Thus showing no evidence of Quagga Mussels being alive.



Hydrilla

- RNA and DNA concentrations were both detected. EQO balanced the concentration values to geolocate the exact locations of the highest concerns in order to direct the best mitigation efforts.



Taste & Odor

- Using the PhyloChip to do the microbiome analysis, EQO identified the taste- and odor-producing bacteria at different levels. In the lab analysis, EQO identified the trends of DNA and RNA to figure out where the DNA and RNA matched. Through trend analysis, there was a mismatch of data of DNA and RNA detected, which helped determine where the taste and odor bacteria were highly active. This provided precise insights into the source point of the stinky water.
- To understand what type of feces was going into the Croton watershed, EQO analyses microbiome fingerprints to identify sources of fecal contamination. This identified a direct correlation between Harmful Algae species concentration and cattle feces-specific microbe concentration at a nearby cattle ranch. The insights from the DNA and RNA testing helped determine the exact source and location of the problem.

Conclusions

New York gained precise insights into the specific locations of concerns, which allowed them to save time by reducing labor hours in the field, helped direct the limited amount of mitigation resources, and provided actionable insights into where to implement ongoing testing efforts. Additionally, these insights will continue to help them ensure the continued health and safety of the environment for years to come.

Next Steps

EQO and New York City will expand testing to more locations and at a higher frequency. This will begin to look at additional native and endangered species to understand the population dynamics, while also looking at point source pollution identification for risk assessment and mitigation.

Short Summary of this case study from ChatGPT

EQO helped New York City solve the issue of taste and odor concerns in their water supply from the Catskills and Croton Water Shed. EQO identified the microbiome responsible for the issue and conducted water quality tests to identify the presence of invasive species and Harmful Algae Blooms. EQO isolated RNA and DNA to locate the areas of highest concern and direct mitigation efforts.

EQO also analyzed microbiome fingerprints to identify sources of fecal contamination. This provided precise insights into the specific locations of concerns, allowing for more efficient use of mitigation resources and ongoing testing efforts. EQO and New York City plan to expand testing to more locations and look at additional species for population dynamics and point source pollution identification.

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