

Working Together to Monitor the Health of Yukon River Salmon

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Below represents a collaborative approach to better understand the health of Yukon River Chinook salmon and ultimately how to improve that health to the extent possible. This work is generously funded by the following sources. We greatly appreciate and deeply thank the: *Alaska Sustainable Salmon Fund, Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative, U.S. Pacific Salmon Treaty Implementation Funds, Congressionally Directed Stewardship Funds secured by Senator Murkowski, Pollock Conservation Cooperative, North Pacific Research Board, National Institute of Health, University of Alaska Fairbanks Biomedical Learning and Student Training (BLaST) program and Tamamta program (National Science Foundation funded), Natural Sciences and Engineering Research Council of Canada, Mitacs Accelerate Fellowship and Internship with Yukon First Nation Salmon Stewardship Alliance, Wildlife Conservation Society - Weston Family Boreal Research Fellowship, University of Waterloo - Swanson Laboratory, Yukon Fish and Wildlife Enhancement Trust, Kwanlin Dun First Nation, Whitehorse Rapids Fish Hatchery, U.S. Geological Survey, Alaska Department of Fish and Game, and U.S. Fish and Wildlife Service.*

Background

Ichthyophonus is a fish parasite that infects salmon during ocean feeding. This parasite does not harm people, but in salmon the parasite can lead to poor heart health that may lead to death during migration. *Ichthyophonus* infection levels in Yukon River Chinook salmon have fluctuated over time, but a new dramatic rise reported by subsistence fishers in 2020 may be one possible explanation contributing to low numbers of migrating Yukon Chinook salmon in recent years. In response to this trend, a collaborative effort was started to see if poor fish health is related to undocumented death of migrating Chinook salmon, and if so, what can be done about it. For more background on the history of this disease and the ongoing study see the spring 2023 YRDFA article, pages 6-8. (hyperlink: <https://yukonsalmon.org/spring-2023-newsletter/>).

This recent resurgence of *Ichthyophonus* in Yukon Chinook salmon has prompted the collection and testing of their hearts for infection for three years (2022–2024). Unfortunately, because there are currently no non-lethal methods to test for *Ichthyophonus*, lethal sampling is required to evaluate the disease. Alaska Department of Fish and Game (ADF&G) and the U.S. Fish and

Wildlife Service (USFWS) understand that each and every Chinook salmon is very important to people living along the Yukon River. We undertook the decision to initiate a study that required lethally sampling fish very seriously, especially given that Chinook salmon run sizes are at historic lows and fishing has been closed. ADF&G and the USFWS determined the short-term impact of limited lethal sampling will help inform sustainable management, in the face of this disease, for many years to come. In addition to the core study, there have been two silver linings to this sampling. First, all sampled fish are distributed to local Yukon River residents providing a small subsistence connection in another year of empty drying racks and smokehouses. We understand the importance of respecting each fish and making sure none goes to waste. Second, these sampled fish provide an unprecedented opportunity to evaluate their overall health through one of the largest collaborative research endeavors ever to be undertaken for Yukon River Chinook salmon.

Salmon are generally quite resilient when they have just one problem, but when the problems start to pile up, referred to as 'multiple stressors', it is more likely that salmon will not survive to spawn. That is a big concern for management that aims to ensure enough eggs are placed in the gravel for the next generation of Yukon River Chinook salmon for long-term sustainability of populations, ecosystems, and fishing opportunities that maintain the health, culture, and food security of communities along the Yukon River.

Collaborations Around Salmon Health Monitoring

To gain the most information out of each Chinook salmon sampled in the *Ichthyophonus* study, below outlines how a team with many different areas of expertise is using various samples – all from the *same fish* in the core study – to create a more comprehensive understanding of Chinook salmon health within the Yukon River drainage.

Community Engagement

The USFWS leads sampling at two of the four study sites by engaging with Yukon River Tribal Governments and local fishers to support inclusivity and to gain multiple perspectives (Indigenous, local, and western knowledge) about Yukon River Chinook salmon health and population trends. The USFWS works with very experienced and knowledgeable fishers at Rapids (Stan Zuray, Ruth Althoff, Charlie Campbell, and Joe Zuray) and Fort Yukon (Josh Cadzow) to catch Chinook salmon. Fish are handled with the highest care and respect and we coordinate with Tribal Councils and youth groups to distribute fish to elders, Tribal Governments, and other community members for subsistence use. In 2024 we plan to discuss preliminary results with Tribal Government partners to provide an opportunity for them to co-interpret the data and to help direct future research and management recommendations. Sample efforts by ADF&G and the U.S. Geological Survey also work with YRDFA to engage community members as well. (Contact: keith_ivy@fws.gov, kathrine.howard@alaska.gov, and vvonbiela@usgs.gov)

Ichthyophonus

The core *Ichthyophonus* study is led by ADF&G and the USFWS with local partnerships for field sampling and fish distribution of Yukon River Chinook salmon. The study was designed to collect up to 200 samples per site annually from four sites spanning the Yukon River in Alaska: at the Pilot Station and Eagle sonar test fisheries and at Rapids (in-between Tanana and Rampart)

and Fort Yukon. However, not all sites are sampled every year and sample numbers per site are usually lower. The primary near-term objective is to determine if the *Ichthyophonus* disease is contributing to death during migration that could account for the low numbers of Canadian-origin Chinook salmon that reach the U.S. / Canada border. Heart tissue is collected from sampled Chinook salmon and processed in the lab to measure the prevalence (number of fish with the disease) and density (the level of infection) of *Ichthyophonus*. Other samples are also collected to determine each fish's age, size, weight, sex, and genetic stock of origin to evaluate health patterns across these categories. Long-term, the project intends to establish an annual *Ichthyophonus* monitoring program at the Pilot Station Sonar using fish that have died from handling, build support to increase community-based *Ichthyophonus* monitoring, and to develop methods to estimate yearly disease-associated death to assess the fate of migrating Canadian-origin Chinook salmon. (Contact: jayde.ferguson@alaska.gov and scott_walter@fws.gov)

Egg Condition and Kidney Disease

In another study that uses these sampled fish, ADF&G is evaluating the number and size of eggs of females at Pilot Station and Eagle (2022 only). This information will help understand if the returning fish are producing enough eggs, of high enough quality, to sustain future generations. ADF&G is also studying Proliferative Kidney Disease, an emerging pathogen of concern in Alaska. The disease-causing parasite has not yet been found in Yukon River Chinook salmon but was documented in Yukon River chum salmon in 2011. This disease, while it does not hurt humans who consume the fish, can cause the fish to die before they spawn when the water is too warm. Yearly monitoring of this kidney disease is of interest given global warming and high Yukon River water temperatures in recent years. (Contact: jayde.ferguson@alaska.gov)

Thiamine Vitamin Deficiency

Thiamine is a vitamin that salmon can only get through their food in the ocean and is essential for fish and their eggs to survive. When salmon eggs have too little thiamine it causes lifelong developmental issues impacting their sight, reflexes, immune system, and survival. While low levels of thiamine have been linked to catastrophic reproductive failures in Chinook and Atlantic salmon in some areas, thiamine deficiency has also been found to be treatable in some situations. Given that low thiamine levels have been observed in some Yukon River Chinook salmon stocks, we are sampling the eggs of Chinook salmon in this project to determine how vulnerable Yukon salmon are to thiamine deficiency-related mortality. (Contact: kathrine.howard@alaska.gov)

Paralytic Shellfish Toxins

Paralytic shellfish toxins (PSTs) are a naturally occurring marine biotoxin produced by some algae. When shellfish eat these algae, they retain the toxin that can then be transferred throughout the food web. If humans eat infected seafood, the toxin may affect the nervous system causing temporary paralysis, illness, or even death in severe cases. Past data show that Yukon River Chinook and chum salmon have PST levels below 9 micrograms, which is below the Food and Drug Administration's regulatory and safe limit of 80 micrograms. However, other locations in Alaska have had salmon tissues with higher PST levels. To determine potential human health risks from consuming salmon, we are investigating PST levels in salmon across the state, including on the Yukon River through liver, kidney, digestive track, and muscle

samples collected from fish in this study. So far, we have not seen alarming levels in Yukon fish. (Contact: mbushell@kniktribe.org)

Heart Stress

Ichthyophonus infection of heart tissue may change the level of different molecules and proteins in the bloodstream. We collected blood samples from the *Ichthyophonus* study fish for laboratory testing to measure levels of different blood components that could suggest heart infection and damage. This testing included looking at a group of proteins known as troponins that are released into the bloodstream from heart tissue when it becomes damaged. By comparing blood troponin levels against varying levels of *Ichthyophonus* infection, this project aims to identify indicators of heart infection. While blood samples were collected from dead fish in the *Ichthyophonus* sampling, blood samples can also be taken from live fish. Therefore, although still being explored and requiring further ground-truthing, if levels of troponin or other markers in the blood correspond to levels of *Ichthyophonus* infection, this may be a step towards developing a non-lethal tool to test Chinook salmon for *Ichthyophonus*. (Contact: mclinton2@alaska.edu)

Heat Stress

Previous research in the Yukon River found that water temperatures higher than 64.4°F cause heat stress in Yukon Chinook salmon and adults that experience warmer freshwater migrations produce fewer juveniles in the next generation. Therefore, we are estimating the proportion of fish from the *Ichthyophonus* study that also have heat stress that could be another source of mortality or reduce reproduction. We collected a small muscle tissue sample to measure the heat shock protein 70 because cells make a lot more of this when they are too hot. The combination of heat stress and *Ichthyophonus* disease may be particularly deadly because heat stress is associated with high demand on the heart to provide extra oxygen that may not be possible if *Ichthyophonus* disease weakens the heart tissue. Other stressors mentioned in this article could even further put migrating Chinook salmon at risk to death before spawning. (Contact: vvonbiela@usgs.gov)

Juvenile Locations

To understand where juvenile Yukon River juvenile Chinook salmon spend their time during the first two years of their life while in freshwater, ear bones, known as otoliths, were collected from fish in the *Ichthyophonus* study. These tiny bones contain chemicals that are absorbed over time at different locations and when analyzed they can tell us where fish have been and when. Laboratory analyses compare the chemical strontium absorbed in the ear bones' growth rings to strontium levels measured in water samples collected at different locations throughout the Yukon River drainage. This research is important for fishery managers and stewards to identify and protect critical juvenile salmon habitat. (Contact: nsayoub@uwaterloo.ca)

Ichthyophonus Laboratory Trials

To expand the broader goal of understanding effects of *Ichthyophonus*, ADF&G, the U.S. Geological Survey, and Alaska Pacific University have started a new line of research using samples of the Yukon River-specific 'strain' of *Ichthyophonus* collected from Chinook salmon. Feasibility trials are being conducted with laboratory fish to support a multi-year experiment to determine how *Ichthyophonus* infection is associated with mortality. No laboratory fish will be released to the wild and results will be used long-term to understand how Yukon River Chinook

salmon respond to different levels of infection, estimate yearly *Ichthyophonus*-associated death, and inform sustainable management of Yukon River salmon fisheries. (Contact: jayde.ferguson@alaska.gov)

Future Plans

The continued success of these diverse collaborative projects is groundbreaking and is establishing a strong trajectory to develop a new and long-term Chinook salmon health monitoring program in the Yukon River. The foundation of this initiative is to build capacity and support at the community-level of subsistence users, empower Tribal Governments and Yukon River fishers to collect data from harvest, and to develop improved methods to monitor the effects of multiple stressors on Chinook salmon throughout the Yukon River drainage. By working together as stewards, researchers, and managers, we will better understand how to maintain a healthy Yukon River Chinook salmon population and ecosystem.



Keith Herron and Jaden Andrew, graduate and undergraduate students at the University of Alaska Fairbanks and USFWS employees, at a fishwheel operated by a local fisher to catch Yukon River Chinook salmon to support a variety of fish health projects. Photo credit: Allison Heaslet with the Alaska Native Science and Engineering Program (ANSEP).