

A disease that may limit Yukon River Chinook salmon from successful upriver migration

Written by Keith Herron in collaboration with the ADF&G and the USFWS

Positionality Statement: My name is Keith Herron, I am a Yup'ik biologist and scholar. My family comes from Bethel, Alaska; however, I grew up in the communities of Wrangell, Seward and Kenai, Alaska. I work for the U.S. Fish and Wildlife Service as a Fishery Biologist, Assistant Subsistence Fisheries Manager, and Tribal Liaison for Fisheries on the Yukon River. Part of the information collected by this research will be utilized for my Masters of Fisheries degree at the University of Alaska Fairbanks supported by the Tamamta program (NSF # 2022190). I am honored to live and work on the traditional homelands of the lower Tanana and Dena' peoples in Fairbanks, Alaska.

In 2022, I was one of the fishery biologists out on the river gathering samples to investigate the impacts of the fish parasite *Ichthyophonus* on Yukon River Chinook salmon. I witnessed firsthand the pain and suffering of the people without fish along the Yukon River, and it felt like the entire ecosystem was suffering because of the current fishery collapse. The Yukon River Chinook salmon drainage wide run in 2022 was the worst on record with approximately 45,000 Chinook salmon passing Pilot Station sonar. In the middle Yukon River, the number of Chinook salmon with visual signs of disease caused by *Ichthyophonus* was appalling. While sitting on the bank of the river, the river's unwell state reiterated a deep feeling of empathy for the wellbeing of the people, the land, and the salmon. I felt compelled to write this article to help introduce this important fish health issue, provide a brief history of *Ichthyophonus* within the Yukon River, and explain some of the approaches that are being taken to learn more about overall Yukon River Chinook salmon health. On behalf of the large research and management team that is supporting this work, we look forward to sharing more information and research findings in the coming months.

What has caused such low numbers of spawning Chinook salmon in the Yukon River in recent years? While many factors likely contribute to the salmon declines, we suspect that the resurgence of the parasitic pathogen *Ichthyophonus* may be a significant factor adding stress on Yukon River Chinook salmon and might prevent them from successfully reaching their spawning grounds. Understanding the impacts of *Ichthyophonus* on migrating Chinook salmon and whether it causes mortality before they spawn is essential for effective fisheries management.

Some of the factors contributing to the Chinook salmon decline are outside of our control as stewards and managers. However, we can influence the information that is collected to enable effective management actions designed to protect Yukon River Chinook salmon. That is why starting in the spring of 2021, the Alaska Department of Fish and Game (ADF&G) and the U.S. Fish and Wildlife Service (USFWS) brought together many experts, Alaska Native Tribes, and communities to work collaboratively to address growing concerns about *Ichthyophonus* and other fish health related issues. Through this fish health research, we aim to develop an annual *Ichthyophonus* monitoring program, build support to increase community-based (or Tribal-led) *Ichthyophonus* monitoring, improve tools to estimate annual disease-associated mortality, and provide a more complete assessment for the fate of Chinook salmon migrating up the Yukon River mainstem. Our anticipated results will allow fishery management agencies to better account for potential disease-associated mortality during future runs while still allowing for sustainable harvest levels assuming, and hoping, the run rebounds.

Ichthyophonus infects Chinook salmon while at sea rather than in freshwater. The infection is not believed to kill many ocean-phase salmon, but infection can cause disease within spawning-phase freshwater salmon that may progress to lethal levels resulting in en route mortality. Current information suggests en route mortality may be associated with high levels of *Ichthyophonus* and may have limited many Yukon River Chinook salmon from successful upriver migration in 2020, 2021, and 2022.

Fishers on the Yukon River have been able to observe *Ichthyophonus* in diseased Chinook salmon and recognize trends over time in the Yukon River. This knowledge led fishers to suggest *Ichthyophonus* could be a significant source of en route mortality. Not all Chinook salmon are infected with *Ichthyophonus*, but those infected may show visual signs of disease such as white spots on the heart (Picture 1) and elsewhere in the body. The filets from infected fish can have an unusual “sweet” or “tangy” smell and do not dry well, which can impact common fish preservation practices. By measuring these visual signs of disease, one can determine prevalence of disease based on the proportion of diseased salmon present within their harvest. Also, by counting the number of white spots within the heart muscle, one can determine density of disease based on the relative level of infection. Once infected, fish do not recover from the infection and the disease continues to progress within the fish during their freshwater migration. Fishers in the middle Yukon River in Alaska have reported that visible signs of disease in Chinook salmon are at higher levels now than they remember in previous years. And fewer severely diseased fish are observed by fishers further upstream in the river around Fort Yukon and Eagle. This strongly suggests that heavily infected fish in the middle river perish before reaching the upper river.

Ichthyophonus has been detected on the Yukon River off and on for over 30 years. In 1986, Bill Fliris, a fisherman from Tanana, recalled one of his harvested Chinook salmon did not dry properly, and at the time did not recognize the incident to be related to *Ichthyophonus*. The following year in 1987, he reported several more harvested Chinook salmon had visual signs of disease and his report aligns with other confirmed *Ichthyophonus* cases. In 1988, an ADF&G pathologist confirmed the first case of *Ichthyophonus* infection in Alaska from a Yukon River Chinook salmon harvested near Galena. After 1988 and throughout the 1990s, fishers continued to report high levels of *Ichthyophonus* within their harvest, which led to a 5-year study led by Drs. Richard Kocan and Paul Hershberger in the late 1990s and early 2000s, followed by additional studies by Dr. Kocan and colleagues, the ADF&G, and others. Since 2001, Stan Zuray, a fisherman, biologist, and Yukon River Drainage Fisherman Association (YRDFA) board member from Tanana, has monitored his Chinook subsistence harvest for salmon size and visible signs of *Ichthyophonus* disease during most seasons over the last two decades. Mr. Zuray’s monitoring in the middle river (at his Rapids Research Center) showed low *Ichthyophonus* prevalence from 2005 to 2019, which corresponded to a reduction in *Ichthyophonus* research around 2010. In 2011, the Yukon River Panel Joint Technical Committee recommended that *Ichthyophonus* monitoring, and research be implemented when more than 25% of the adult Chinook salmon return are diseased. In 2020, Mr. Zuray reported that the disease had reemerged at a historically high level, which prompted immediate action by the ADF&G and the USFWS.

Better understanding the factors that influence *Ichthyophonus*, and thus salmon en route mortality, is critical to understanding and preserving salmon runs. Previously, Dr. Kocan and

collaborators predicted that high levels of *Ichthyophonus* within Yukon River Chinook salmon may result in en route mortality. What is not yet known, is what density of disease is associated with mortality, how many fish die annually due to disease, and how different environmental stressors, such as high-water levels and high-water temperatures may affect the disease progression. Therefore, annual *Ichthyophonus* and environmental monitoring is essential to understand the disease and its impact on the Yukon River Chinook salmon population. After Mr. Zuray noted high levels of *Ichthyophonus* in 2020, he advocated for fishery management agencies to take the reemergence of disease seriously. As a result, in 2021 the USFWS partnered with Mr. Zuray to collect a small number of samples at the Rapids, which again showed high levels of the disease. Also in 2021, the ADF&G evaluated the prevalence and density of disease in Chinook salmon near the mouth of the Yukon River and initiated partnerships to establish an annual *Ichthyophonus* monitoring program.

Beginning in 2019, the estimated number of Canadian-origin Chinook salmon that passed the Eagle sonar, located near the U.S.-Canada border, was far smaller than what was anticipated based on counts passing the Pilot Station sonar in the lower river. ADF&G explored possible factors to explain the discrepancy between sonar estimates, and all collaborating agencies agreed the discrepancy could not be explained by sonar uncertainty, genetic uncertainty, or unreported harvest. After experiencing two years (2020 and 2021) of high *Ichthyophonus* levels, as well as continued differences in fish passage estimates between Pilot Station and Eagle sonar, both the ADF&G and the USFWS decided to implement a study to investigate the impacts of *Ichthyophonus* on Yukon River Chinook salmon at various sites within the U.S. portion of the Yukon River starting in 2022.

The current *Ichthyophonus* research is a collaboration between the ADF&G and the USFWS in coordination with fish disease experts, including Dr. Kocan, affected communities, Indigenous and/or local fishers, including Mr. Zuray (Picture 2). In 2022, sampling occurred at three locations: The lower river at Pilot Station sonar; middle river at the Rapids; and the upper river at Eagle sonar near the U.S.-Canada border. The information collected allows us to make reliable estimates of disease prevalence and density at multiple locations within the Yukon River drainage. Our preliminary findings indicate that the proportion of Chinook salmon infected with *Ichthyophonus* was high in the lower river, but overall, the disease was not very advanced. In the middle river, the proportion of infected Chinook salmon was still high, and the disease had progressed to a highly advanced stage within a substantial number of fish. And finally, in the upper river at Eagle sonar the proportion of Chinook salmon carrying the disease was still high, but only minimally or moderately diseased fish were encountered. The pattern we observed across all three sites was consistent with the upriver progression of disease between Pilot Station sonar and the Rapids and the loss of heavily diseased fish between the Rapids and Eagle sonar, which indicates disease-associated en route mortality may be occurring.

Additionally in 2022, only about half of the expected number of Canadian-origin Chinook salmon were counted at the upper river Eagle sonar. This is now the fourth year in a row that expected numbers of Canadian-origin Chinook salmon failed to pass the U.S.-Canada border. We also express concern for those that do reach the border with minimal or moderate disease levels, since these fish still have a long journey ahead to reach their spawning grounds and the disease may progress to lethal levels during this final unmonitored segment of the migration. The

biological samples taken in 2022 provide support for *Ichthyophonus* to be considered one of the most likely explanations for the in-river loss of Yukon River Chinook salmon in recent years. We believe this research deserves our full attention to develop actionable solutions, which requires more sampling in 2023 and 2024.

Each sampling location provides a critical piece of the puzzle. Pilot Station sonar is a vital baseline for assessing the initial prevalence of infection and density of disease within Chinook salmon entering the Yukon River. The Rapids sampling location is essential to monitor disease prevalence and how it progresses in fish as they migrate upriver. Based on the fisher reports about not seeing this disease near Fort Yukon, USFWS planned to sample there in 2022. However, after gaining initial support, USFWS experienced a staffing shortage and could not conduct the sampling. In 2023, USFWS plans to add Fort Yukon as a sampling location after gaining Tribal and community support for the project and have the staffing capacity to conduct the project successfully. Fort Yukon will be a key sampling location because it is far enough upriver and far enough from the Rapids site to more precisely see where Chinook salmon disease mortality may occur, and what level of disease density is associated with mortality. It is essential to continue monitoring at a lower, middle, and up-river sampling location as the Chinook salmon run passes into Canada in order to make conclusions about potential disease-associated en route mortality in the Yukon River mainstem.

This research requires lethal sampling of fish, which we know is often controversial, and especially so in these times with subsistence salmon fishery closures and poor escapements. The decision to sample fish this year was made thoughtfully and intentionally by the ADF&G and the USFWS, who consulted and received research support from the Tribal Governments near each sampling location before sampling began. Each fish is precious, and this research seeks to maximize the benefit of each sampled Chinook salmon by collecting multiple tissues for various Chinook salmon health and life history studies. Whole Chinook salmon are donated to elders, Tribes, and individuals for subsistence needs after the required samples are collected. These sampled fish are handled with the highest care and respect, and none of the fish are wasted. In this time of crisis, we believe this research is vital to quantify the impacts of the *Ichthyophonus* disease on homeward migrating Yukon River Chinook salmon, improve tools to consistently monitor this disease over time and, to develop management strategies to support healthy salmon populations.

As a lifelong Alaskan, I acknowledge this information is heartbreaking given the current state of Yukon River fisheries. I hope to assure readers that the research investigators are sensitive and empathetic for the fish and the people without fish living along the Yukon River. The last two years with no directed subsistence salmon fishery has resulted in tremendous hardship, immense strain on cultural practices, and unprecedented sacrifice within Yukon River households and communities. I personally have reflected on the ethics and importance of this research, and strongly believe it is of utmost importance that the ADF&G and the USFWS continue the current *Ichthyophonus* research to proactively understand this issue for the benefit of future Yukon River Chinook salmon and the people who rely on them.



Picture 1. *Ichthyophonus*-infected Chinook salmon heart muscle. “White spots” are common visual signs of disease associated with *Ichthyophonus* infection. This heart was sampled from a Chinook salmon harvested at the Rapids in the middle Yukon River in 2022.



Picture 2. Local Yukon River fishers (left to right, Charlie Campbell, Stan Zuray, Ruth Althoff) and Keith Herron (front center) at a fishwheel placed in the Rapids in the middle Yukon River in 2022.