

**Lower Klamath River  
Adult Chinook Salmon Pathology Monitoring, 2009**

Final Technical Memorandum  
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Photo: Healthy gills of an adult Chinook salmon from the Klamath River during 2009.

## INTRODUCTION

Since the fall of 2003, the Yurok Tribal Fisheries Program (YTFFP) has monitored for the prevalence of *Flavobacter columnare* (columnaris) and *Ichthyophthirius multifiliis* (Ich) in fall-run Chinook salmon in the lower Klamath River. Columnaris is a bacterium that affects the skin and gills of many fishes; it is distributed throughout the world and is believed to be native to the Klamath River (Guillen, 2003). In general, healthy fish are resistant to columnaris (Shotts and Starliper, 1999), however infections can develop due to environmental stress, minor injuries to the skin or gills, or the presence of other pathogens. Environmental stress can include overcrowding, handling stress, low dissolved oxygen, high temperatures, toxins, and high organic loads (Thune, 1993). Columnaris is usually secondary to other pathogens, which can include Ich (Plumb, 1999). Ich is a fresh-water ciliated protozoan parasite found throughout the world and is also believed to be native to the Klamath River. Ich infections cause damage to the skin and gills of numerous fish species, including salmonids. Outbreaks of Ich occur when conditions are favorable for rapid reproduction of the parasite, which moves horizontally from fish to fish. These conditions arise in rivers with the combination of a suitable environment and susceptible fish. Suitable environmental conditions occur when flows are relatively low (slow velocities and low turnover rates), which is worsened if water temperatures are relatively elevated, and fish become susceptible when they are stressed and congregating in high densities (Dickerson and Dawe, 1995; Bodensteiner, 2000). High water temperatures are not necessary for an Ich outbreak however, as significant Ich mortality has occurred in British Columbia in low flow spawning channels at 13 to 15°C (Traxler et al., 1998). High water temperatures favor outbreaks but alone do not trigger them. For example, Klamath River water temperatures have been favorable for columnaris and Ich outbreaks in past decades, but the only year an Ich outbreak was observed was in 2002 (Belchik et al., 2004).

The YTFFP began monitoring Ich and columnaris levels in response to the 2002 Klamath River fish kill, which resulted in the death of 33,000 to 67,000 adult fall-run Chinook salmon. The primary cause of the Klamath River fish kill was an epizootic outbreak caused by Ich and columnaris (Foott, 2002; Turek et al., 2004). Factors such as extremely low flows, high fish densities, elevated water temperatures, and long fish residence time are believed to be the main contributing factors to the epizootic outbreak of 2002 (Guillen, 2003; Belchik et al., 2004; Turek et al., 2004). Elevated water temperatures, high fish densities, and long fish residence times occur on an annual basis without producing Ich epizootic outbreaks, thus prudent flow management is of paramount importance in controlling the risk of fish kills such as occurred in 2002 (Strange, 2007).

In 2003 and 2004 the Yurok Tribal Fisheries Program (YTFFP), (with additional samples collected by the USFWS Arcata Fish and Wildlife Office and the Karuk Department of Natural Resources in those years only) quantified the incidence and severity of Ich and columnaris infections in fall-run Chinook salmon during the late summer and early fall. The purpose was to detect any significant increases in the prevalence or severity of Ich or

columnaris infections. If a significant increase was observed, emergency options to prevent or reduce disease mortality would be discussed by river managers and fish biologists (YTFP, 2004; 2005a). In addition to potential emergency options, a pulse flow was released from Trinity Dam during those years coinciding with peak entry timing of fall-run Chinook salmon in the lower Klamath River in order to reduce the risk of a repeat of the 2002 fish kill. No preventative pulse flows were released in subsequent years. The effects of these pulse flows on migrating adult Chinook salmon as determined by biotelemetry is discussed by Strange (2003, 2006, and 2007), including implications for Ich transmission and disease risk. No epizootic fish kills have occurred among fall-run Chinook salmon in the lower Klamath River since 2002, and Ich infections have only rarely been documented and at low severity (YTFP, 2005, 2007; YTFP unpublished data).

Beginning in 2005, the focus of YTFP adult Chinook salmon pathology monitoring effort has been to collect baseline data on background levels of Ich and columnaris (YTFP, 2005). An important question is whether Ich occurs at low to moderate levels, or if it is largely absent in years with no epizootic outbreak. Ultimately, we intend to develop a long-term data set, inclusive of different water year types, meteorological conditions, and Chinook salmon run sizes, in order to evaluate the relationship between environmental variables, fish variables, and infection levels. Such information would be especially valuable in the unfortunate event of a future epizootic outbreak among adult salmonids in the Klamath River.

This technical report summarizes our findings during the late summer and early fall of 2009 in regards to our ongoing Ich and columnaris monitoring in adult fall-run Chinook salmon.

Objectives:

1. Quantify the prevalence of columnaris and Ich infections among adult fall-run Chinook salmon in the lower Klamath River.
2. Quantify the severity of any Ich infections among adult fall-run Chinook salmon in the lower Klamath River.
3. Develop a long term data set for future analysis of the relationship between infection levels, environmental conditions, and fish variables.
4. Provide the ability for a real-time, early warning of impending epizootic outbreaks.

## **METHODS**

Sampling was conducted in the mainstem Klamath River at rkm 70.5 (Figure 1). We set and drifted monofilament gillnets, which were 50' by 75' in length, 12' deep, and had a 7 ¼" mesh size. Drift sets were conducted by setting a net perpendicular to the thalweg of the river, and allowing it to float downstream with the current. Samplers drifted next to the net in a jet boat to ensure it was positioned correctly or did not get tangled. Nets were

drifted downstream in the current for approximately 450' - 500'. Stationary sets were typically deployed in the upstream terminus of eddies. The float line was secured to the bank and the net was stretched at an angle to the flow of the river. Stationary sets were left for two to seven hours per day. Field crews attended nets for the entire duration of the set, checking them every 30 to 60 minutes, or whenever a salmon appeared to be entangled. All sampling took place between late afternoon and midnight.

Upon capture, live or recently expired adult Chinook salmon were examined externally with the unaided eye for evidence of columnaris infection and general body condition. Samplers then removed the outside gill arch from the left and right sides and placed them in clear ziplock plastic bags for examination. Gill arch samples were examined immediately, typically within five minutes of removal. Each gill arch was examined using a 40X dissecting scope and using a consistent search pattern. Any Ich trophozoites observed on the gill tissue samples were enumerated and recorded. Ich trophozoites are distinguishable from other similar looking benign parasites by their characteristic spinning motion resulting from their cilia. Any gill arches containing Ich trophozoites would be frozen for later examination in the laboratory. Columnaris infections were also noted during the microscope examination. We used a severity index of one through three to document the level of infection. One was considered minor, two moderate, and three severe.

We calculated the mean daily river discharge for the study period based on measurement data records from the U.S. Geological Survey (USGS). Records were obtained from the gauge on the Klamath River near Orleans, CA (USGS 11523000), which is approximately 25 river kilometers upstream of our sample location. These records were provisional for 2009 and subject to minor change; however, they provide a reasonable estimate of Klamath River discharge in a timely manner. Klamath River temperatures were measured a short distance (less than 1 km) upstream from our sampling location (Figure 1). River temperature was measured at this site by the YTFP using an Onset Hobo temperature monitor.

## RESULTS

From August 19<sup>th</sup> to October 7<sup>th</sup>, 2009, YTFP personnel sampled a total of 147 set net hours and 214 drifts. A total of 224 adult Chinook salmon were captured and sampled. Weekly sample sizes ranged from 14 to 40 adult Chinook salmon. During this study there were 52 cases of columnaris observed and not a single incidence of Ich. Columnaris was observed throughout the study period with a low of 0% infected the first week and a high of 38.7% infected the last week of the study (Table 1, Figure 3). The severity of most columnaris infections was mild and did not seem to adversely affect overall fish health. Generally, adult Chinook salmon and their gills appeared very healthy.

Klamath River mean daily discharge for the entire sampling period was 1,741 cubic feet per second (cfs) at Orleans, CA (rkm 94). Mean daily discharge on the Klamath River

increased at the beginning of October due to the first storm event of the season (Figure 2). Klamath River temperatures during this study averaged 18.8°C and ranged from a high of 23.2°C on August 2<sup>nd</sup>, to a low of 13.3°C on October 5<sup>th</sup> (Figure 2).

## SUMMARY

Our findings in 2009 were consistent with data collected in previous studies, where we found no Ich and moderate amounts of columnaris among adult fall-run Chinook in the lower Klamath River (Figure 4). There were no secondary laboratory observations made on gill imprints, so we cannot rule out the possibility that there could have been very minor amounts of Ich present during these years. However, if any Ich were present, the incidence and severity were extremely low or at least some trophozoites would have been observed.

Columnaris infection levels were higher in 2008 and 2009 than in previous study years (Figure 4). We believe this is due to columnaris examinations being conducted using a microscope. In past studies, we identified columnaris using only the naked eye; in 2008 and 2009 we changed our protocol to include a microscope assessment for columnaris. Even the slightest infections are visible through the microscope, these types of infections would not be observable to the naked eye. These extremely low severity infection do not appear to substantially affect fish health.

During the 2002 fish kill, the incidence and severity of Ich were both extremely high based on sampled fish and the amount of mortality. In 2003 we observed the only Ich infections since 2002 among all study years; however, the severity was low and the incidence was moderate. During 2003, we also observed a slight increase in the amount of Ich we encountered as the season progressed. The findings from 2003 are based on our field observations and gill imprints analyzed by the FWS CA/NV Fish Health Center. In 2004 there was only one Ich observation, which was confirmed by the Fish Health Center, although there were also a number of false observations caused by field crews mistaking *Nanophytes* for Ich. Regardless, we can confidently conclude that the incidence and severity of Ich in 2004 was very low. Thus, since 2002 the amount of Ich infections we have observed in adult Chinook salmon in the lower Klamath River has been negligible with the exception of 2003, which had low incidence with moderate severity. The lack of an epizootic outbreak of Ich since 2002 is consistent with the higher flows observed in the lower Klamath River in every year after 2002.

Overall, the 2009 lower Klamath River adult Chinook salmon pathology study was a success. We continue to build a reliable long-term data set for future analysis of the relationship between infection levels, environmental conditions, and fish variables.

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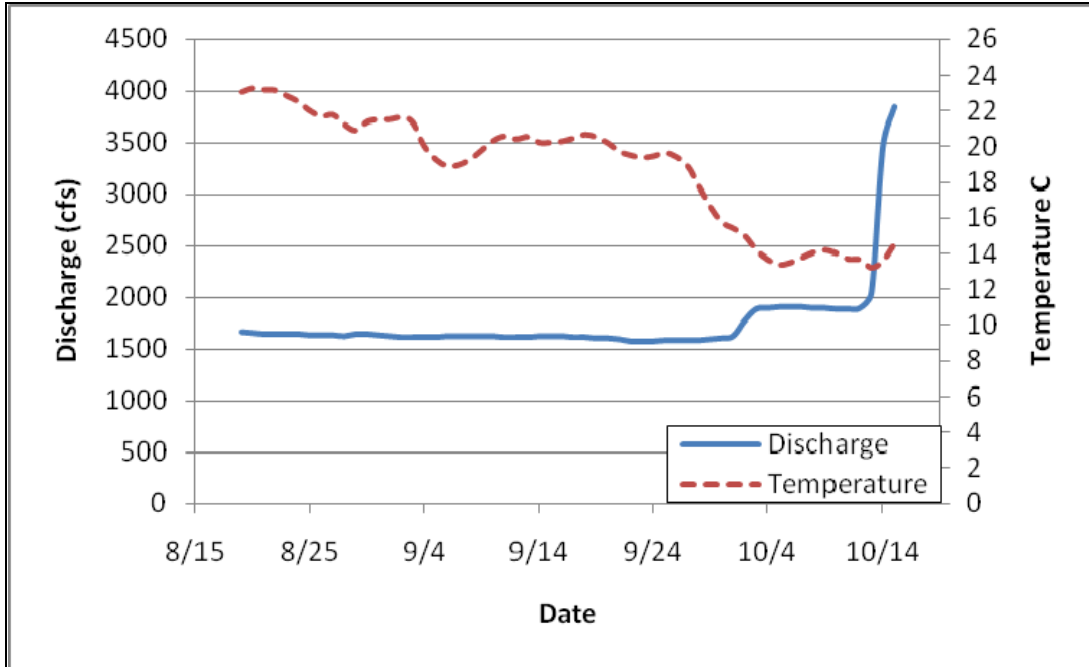


**Figure 1:** Satellite photo of 2009 YTFP adult Chinook salmon pathology study area. This photo shows the confluence of the Klamath and Trinity Rivers in Northern California (photo from Google Earth 2007).

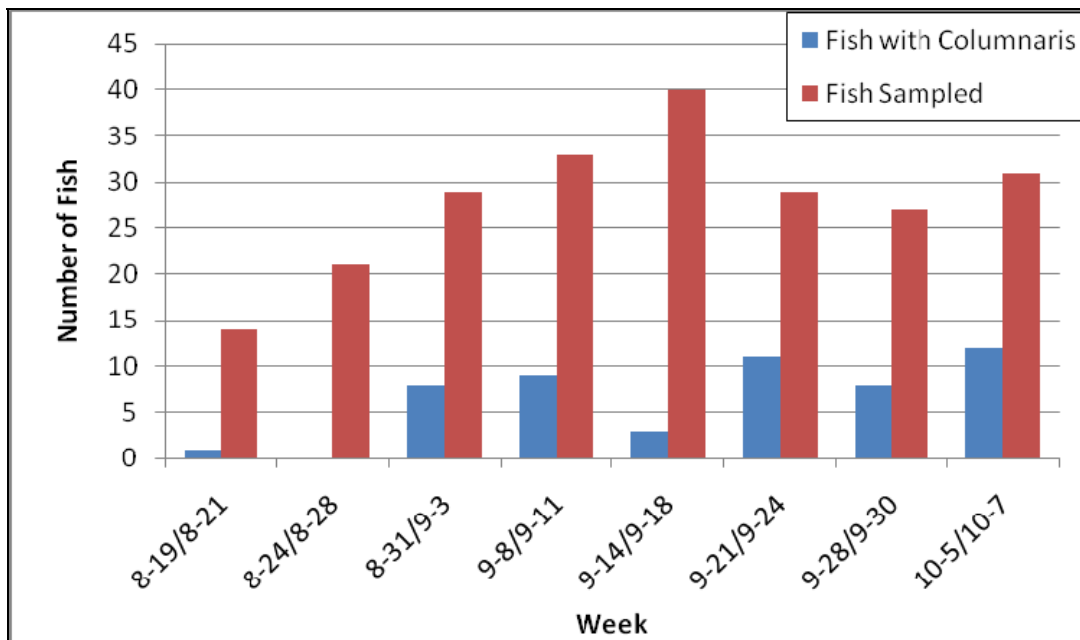
**Table 1:** Results of the adult fall-run adult Chinook salmon pathology monitoring study on the lower Klamath River, California, in 2009.

Sample Week	Samp Size	Number of Ich	samples with Columnaris	Effort			
				net hours	drifts	% w/ Ich	% w/ Col.
Aug 19-21	14	0	1	15	20	0.0%	7.1%
Aug 24-28	21	0	0	23	35	0.0%	0.0%
Aug 31-Sept 3	29	0	8	19	28	0.0%	27.6%
Sept 8-11	33	0	9	21	27	0.0%	27.3%
Sept 14-18	40	0	3	23	36	0.0%	7.5%
Sept 21-24	29	0	11	20	28	0.0%	37.9%
Sept 28-30	27	0	8	12	19	0.0%	29.6%
Oct 5-7	31	0	12	14	21	0.0%	38.7%
	224	0	52	147	214	0.0%	22.0%

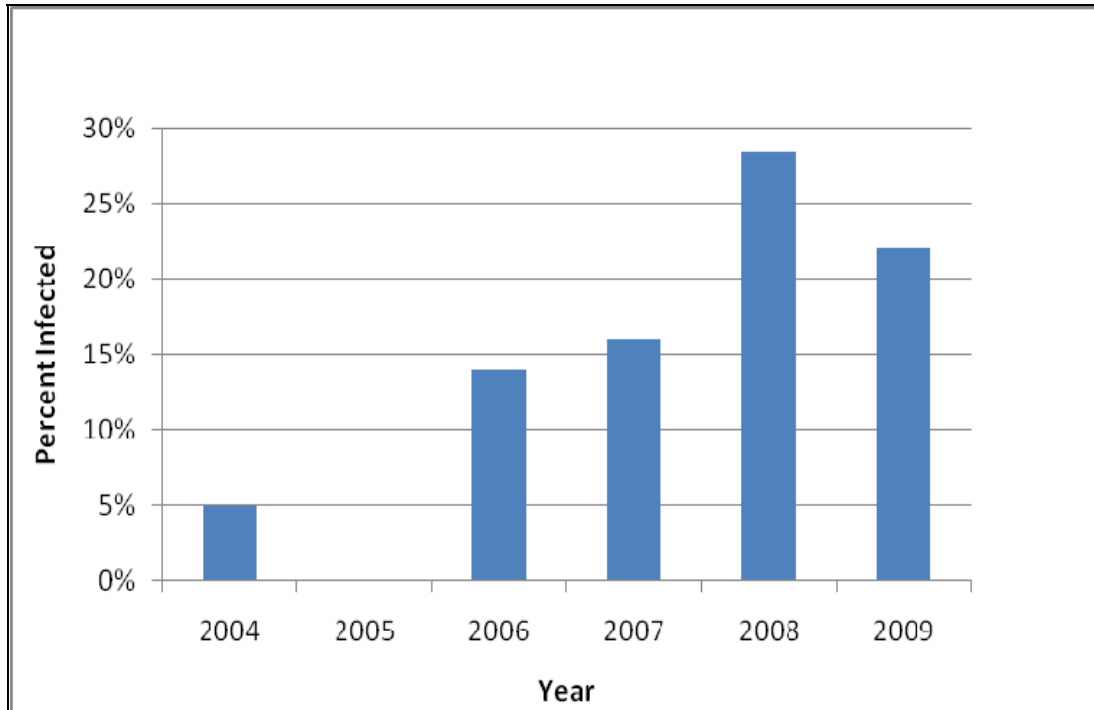
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**Figure 2:** Mean daily discharge, measured in cubic feet per second (cfs), of the Klamath River during the adult Chinook salmon pathology monitoring sampling period, August 19<sup>th</sup>, to October 8<sup>th</sup>, 2009. Discharge was estimated on the Klamath River near Orleans, CA. Also shown is mean daily Klamath River temperature which was also measured at Orleans.



**Figure 3:** Data from 2009 adult Chinook salmon pathology monitoring project showing the number of fish captured and sampled per week, along with the number of sampled fish that were infected with columnaris.



**Figure 4:** Year to year comparison of the percentage of fish sampled that were infected with columnaris from the ongoing adult Chinook salmon pathology monitoring project. Study years 2008 and 2009 show substantially higher numbers. We believe this is due to a change in sampling protocol that required a dissecting scope to be used when looking for columnaris infections.

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