

Chinook salmon *Ichthyophonus* Investigations

Final Report to the Yukon River Panel

For project titled: "*Ichthyophonus* in Chinook salmon – Continuation of a baseline in Emmonak and Eagle, Alaska and potential links to fecundity and blood chemistry." URE 13-10

by

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Abstract

Ichthyophonus hoferi is a protozoan parasite of various fish species, including salmonids, and infection has led to mass mortalities in species of economic significance. Prior evidence suggests that infection with *Ichthyophonus* leads to reduced endurance, increased pre-spawning mortality, and potentially low fecundity. Poor returns of Chinook salmon (*Oncorhynchus tshawytscha*) from adequate spawning escapements in 2007 to 2010 raise questions about involvement of disease in these declines. This study continued to establish baseline prevalence (1999-2009) of *Ichthyophonus* in Emmonak (river mouth) and Eagle (U.S.-Canadian border). In addition, potential effects of the parasite on female fecundity and egg quality were investigated. Further, blood plasma was analyzed for a variety of blood chemistry parameters including cortisol (as an indicator of stress) to aid in the development of potentially non-lethal biomarkers for *Ichthyophonus* infection. Prevalence of *Ichthyophonus* in Yukon Chinook salmon at the river mouth shows a cyclic variation over time. *Ichthyophonus* prevalence in 2010 was 8.7% in Emmonak and 7.0% in Eagle. Total egg counts did not differ between “healthy” and infected females ($P=0.45$). Egg quality (as determined by proximate composition analyses) showed some differences, mainly lipid contents was higher ($P=0.003$) in eggs from *Ichthyophonus*-positive females, while crude protein contents was significantly lower in eggs from infected compared to “healthy” females ($P=0.02$). However, only 6 of 63 females sampled were infected with *Ichthyophonus* and stock-specific differences in lipid contents in particular may confound any potential differences in egg quality. Analyses of blood chemistry parameters revealed some differences between *Ichthyophonus*-infected and “healthy” fish. In Emmonak, blood chemistry parameters identified as indicators of inflammation and heart or liver disease were different between “healthy” and infected fish (i.e., CK, UA, ALP, ALT, and BUN). Cortisol was also significantly elevated in *Ichthyophonus*-positive fish from Emmonak ($P=0.03$). In Eagle, a different set of blood chemistry parameters showed significant differences between “healthy” and infected fish (i.e., AST, TBIL, and Na). Cortisol did not differ by health status of fish sampled in Eagle ($P=0.24$). However, cortisol levels were significantly lower in salmon sampled in Eagle compared to fish sampled in Emmonak ($P<0.0001$), either related to capture method (set gillnet versus fish wheel) or adrenal fatigue in fish from Eagle. Nonetheless, blood chemistry profiles were distinguishable between “healthy” and infected Chinook salmon, making this a promising tool in the development of non-lethal methods to detect *Ichthyophonus* infection.

Introduction

Ichthyophonus hoferi (*Ichthyophonus* here after) is a marine-derived protozoan parasite infecting a variety of marine and anadromous fish species including salmonids (Kocan et al. 2004; Tierney and Farrell 2004; Gavryuseava 2007). While the parasite is not harmful to humans, the effects on the fish host can be devastating and mass mortalities of herring have been attributed to infection with *Ichthyophonus* (Sindermann 1965; Mellergaard and Spanggaard 1997; Kocan et al. 1999). Continued poor returns of Chinook salmon from adequate spawning escapements raise questions about the potential contribution of *Ichthyophonus* to these declines either due to pathogen-induced mortality, reduced fecundity, or the inability of fish to successfully migrate and spawn in tributaries. Prior

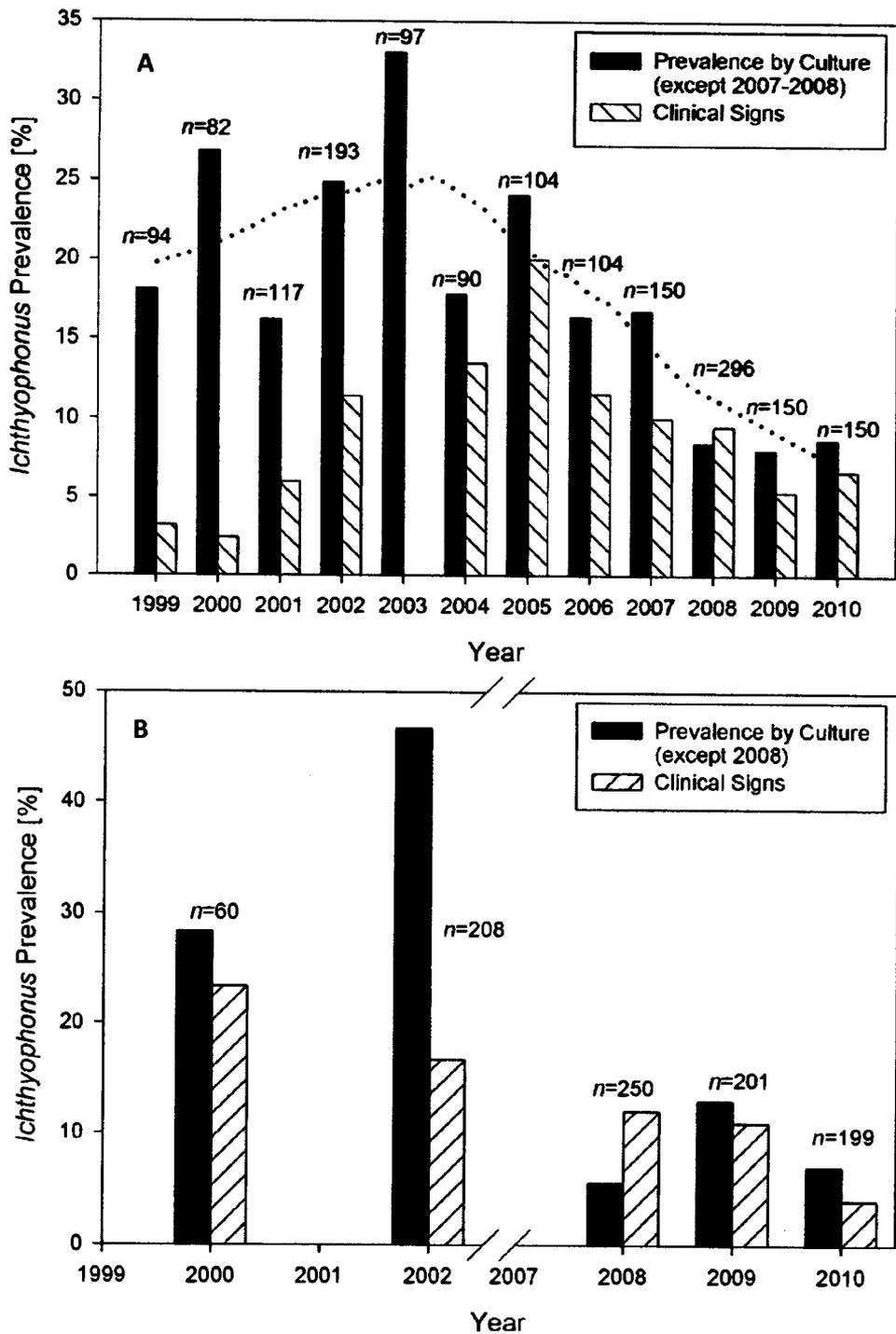


Figure 1: Time-series of *Ichthyophonus* prevalence at Emmonak (A) and Eagle (B) based on heart culture and PCR in Chinook salmon (n = sample size). LOESS non-parametric smoothing (dashed gray line) was applied to visualize temporal trends of parasite prevalence. Data from 1999 to 2003 is based on studies by Kocan et al. (2004), Kocan and Hershberger (2006) in Eagle and Emmonak, data from 2004-2006 in Emmonak after Kahler et al. (2007), and 2007-2010, this study.