

## **EXECUTIVE SUMMARY:**

### **Project 5A: Summary of Information for Evaluating Impacts of Salmon Farms on Survival of Fraser River Sockeye Salmon**

The main objective of this report is to summarize spatial and temporal trends in salmon farm data the commission compiled for its evaluation of effects of salmon farms. This includes information on sea lice abundance and the frequency of bacterial and viral diseases. This report provides details on the provincial- and industry-based salmon farm monitoring program, and comments on the utility of these data for meeting the objectives of the commission's salmon farm investigation.

The majority of information on pathogens on salmon farms in BC comes from a fish health database maintained by BC Ministry of Agriculture and Lands (BCMAL), and an industry fish health and production database maintained by the BC Salmon Farmers Association (BCSFA). As part of salmon farm license requirements in BC, all farms must monitor their fish and report the status of health at their farms on a monthly basis. These reports are standardized and include monthly information on the number of fish on each farm, total mortality, causes for the mortality, and data from sea lice monitoring. In addition, industry veterinarians and technicians must report all fish health events (FHEs), which are defined as an active disease occurrence or a suspected infectious event on a farm that triggers veterinary involvement and an action such as a request for a laboratory diagnosis or use of prescription medication. BCMAL conducts approximately 100 audits of randomly selected salmon farms each year. These audits are used to inspect records maintained by salmon farmers, obtain samples of fish that may have died of disease from bacterial and viral infections, and to ensure that lice counts are accurate. The monitoring program was initiated in 2002 and was fully operational by the last quarter of 2003.

Approximately 70% of salmon farm production in BC originates from sites located between the mainland and the east coast of Vancouver Island along the main migratory corridor for Fraser River sockeye. An average of about 75,000 tonnes of salmon is produced annually. Over the last five years, an average of 32 million fish per year were

held in net pens in BC waters, and 91% of these fish were Atlantic salmon. Approximately 3 million fish died each year on BC salmon farms (12% mortality rate) over this period, with 20% of that mortality comprised of fish classified as 'fresh silvers', which potentially died of disease. Thus, an annual average of approximately 600,000 farmed salmon potentially died due to disease.

Across all farms between 2003 and 2010, an annual average of 30 fish health events that indicated the presence of high risk diseases to sockeye salmon (Furunculosis, infectious hematopoietic necrosis virus, bacterial kidney disease, and Vibrio), were reported by industry. All these diseases are endemic in wild fish populations in BC. There was a statistically significant declining trend in the number of high risk diseases reported by salmon farms between 2003 and 2010 (slope = -5.81 events/yr,  $r^2=0.62$ ,  $n=8$ ,  $p=0.02$ ). The BCMAL audit program recorded an annual average of 12 farm-level high risk disease diagnoses between 2003 and 2009, and there was a declining but non-significant trend in this frequency over time. In the vast majority of audit cases where 'fresh silver' dead fish from salmon farms were tested, bacterial and viral infections were not found and no sign of disease was observed. For example, between 2002 and 2007, BCMAL tested 496 groups of 5-8 'fresh silver' dead fish from randomly selected farms for the presence of six types of viruses or bacteria that are pathogenic to wild salmon, but only two cases of the Infectious Hematopoietic Necrosis Virus (IHN) and two cases of Viral Haemorrhagic Septicaemia (VHS) were found.

An average of 30,000 farmed Atlantic salmon has been examined per year between 2004 and 2010 to quantify lice abundance. Averaged over all seasons and years, 1.7 motile salmon lice were found per fish examined. There has been a modest but significant decline in the number of lice found per fish examined between 2004 and 2010 in spring (slope=-0.32 lice/fish/yr,  $r^2=0.65$ ,  $n=7$ ,  $p=0.03$ ) and throughout the year (slope=-0.25 lice/fish/yr,  $r^2=0.78$ ,  $n=7$ ,  $p=0.008$ ). An average of 30,000 Atlantic salmon have escaped from salmon farms or juvenile production facilities annually between 1991 and 2008. Only 33 Atlantic salmon escapes have been caught or sighted in the Fraser River drainage, and there is no documented evidence of reproduction in this system.

Inferences from statistical analyses that correlate trends in abundance or survival of Fraser River sockeye with trends in pathogens found in salmon farms will be extremely limited by the number of years of available data. There are only 3-5 years of overlapping Fraser River sockeye survival and salmon farm data available for statistical evaluation. A simulation analysis was used to demonstrate that as sample size declines, there is an increasing probability of obtaining a negative correlation between a trend in salmon farm pathogens and survival of Fraser River sockeye due to chance alone, and not because a true relationship exists. However, the estimated statistical reliability of such false positive relationships are low when sample size is small, often leading to the correct conclusion that there is very little evidence for a relationship between variables if one does not exist. Conversely, the simulation showed that tests based on short-time series have very limited power to detect a negative relationship should one exist.

Our ability to make informed statements about the effects of salmon farms on wild salmon in BC will improve over the next decade as the number of years of monitoring data increases. However, correlation alone cannot be used to establish causation. Research on pathogen transmission from farmed to wild salmon, along with meaningful evaluations of the fraction of wild fish infected and the additional mortality associated with infection, are required to determine if cause-and-effect relationships between Fraser River sockeye returns and pathogens on fish farms exist. Financial resources are always limiting, and there are number of other factors that could have caused the decline in Fraser River sockeye productivity, some of which can be improved by management actions. Investment in research on effects of salmon farms and other factors on Fraser River sockeye should be consistent with the scientific consensus on the most likely causes of the decline in productivity and the feasibility of obtaining useful information.