BACKGROUNDER
September 7, 2011

Technical Report 6 – Cumulative Impacts

Project description: The researchers synthesized information contained in the other Cohen Commission contractors' technical reports, to address cumulative effects and to evaluate possible causes for the decline of Fraser River sockeye fishery.

As this report was completed before finalization of Technical Reports 1A and 5A, 5B, 5C and 5D, an Addendum was also written to update the conclusions and recommendations of Technical Report 6 based on the findings of these technical reports on hatchery diseases and salmon farms.

Researchers:

ESSA Technologies Ltd. is an independent Canadian environmental consulting company headquartered in Vancouver, with a branch office in Ottawa and staff in Toronto, Victoria and Kelowna. Established in 1979, ESSA has grown to become a world leader in the field of environmental consulting and decision support. The team at ESSA have expertise in aquatic and terrestrial ecosystem sciences, ecological modelling, adaptive management, decision analysis, and environmental information systems.

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Based on other Cohen Commission technical reports, this report sought to explain the following five patterns of change in Fraser and non-Fraser sockeye populations:

1) Within the Fraser watershed, 17 of 19 sockeye stocks have shown declines in productivity over the last two decades (with the exception of Harrison and Late Shuswap sockeye). Productivity is the number of mature adults per spawner.
2) Most of 45 non-Fraser stocks examined show a similar recent decrease in productivity.
3) Of the nine Fraser sockeye stocks that are regularly monitored, only Gates sockeye have showed declines in juvenile productivity during the time when the sockeye are resident in freshwater.
4) Productivity decreases extend between the fry and adult phase, suggesting either a productivity reduction in the marine environment or during the period when smolts outmigrate to the ocean.
5) There have been three separate phases of decline since 1950, with the timing of declines varying among stocks. The first occurred in the 1970's, the second in the mid-1980's and the third in late-1990's or early 2000's.
6) Over the last two decades, en-route mortality (adult salmon mortality during migration) of returning Fraser sockeye spawners has increased.

The report presented conclusions for each life history stage and determined whether a factor was *unlikely, possible, likely*, or *very likely* to have been a primary driving factor behind the overall pattern of declining productivity in Fraser sockeye. For one factor where no data were available (pathogens), the report was not able to draw a conclusion on its contribution to observed declines.

Stage 1: Incubation, Emergence and Freshwater Rearing

Factors considered for this stage were forestry, mining, large hydro, urbanization, agriculture, water use, contaminants, density dependent mortality, predators, pathogens and Lower Fraser land use on spawning and rearing habitats. Researchers concluded that with the exception of climate change, it is *unlikely* that the other factors considered for this stage were the primary drivers behind long-term declines. However, given the absence of data for pathogens, it was not possible to make conclusions on their likelihood of causing the decline.
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Stage 2: Smolt Outmigration

The same conclusions were reached for stage 2 as for stage 1.

Stage 3: Coastal Migration and Migration to Rearing Areas

Factors that were considered in this stage were human activities and development, predators, marine conditions and climate change. The evidence presented suggests that sockeye salmon in the Strait of Georgia have little direct exposure to human activities and development, leading to the conclusion that it is *unlikely* that this factor contributed to the decline of Fraser River sockeye. However, because some important predators appear to be increasing in numbers and some prey are decreasing, it remains *possible* that predators have contributed to the observed declines in sockeye salmon. It is also *very likely* that poor marine conditions during the coastal migration life stage in 2007 contributed to the poor returns observed in 2009. Climate change was deemed a *likely* contributor as well.

Stage 4: Growth in North Pacific and Return to Fraser

The same conclusions were reached for stage 4 as for stage 3.

Stage 5: Migration Back to Spawn

Researchers concluded that it is *unlikely* that en-route mortality is a primary factor in declining productivity in Fraser sockeye. However, en-route mortality has definitely had a significant impact on the sockeye fishery and the numbers of adult fish reaching spawning grounds. Pre-spawn mortality (premature mortality on spawning grounds), habitat changes and contaminants are *unlikely* to be responsible for the overall pattern of declining sockeye stocks.

Recommendations:

The report has highlighted the need for:

- Improved information on potential stressors affecting sockeye along their migratory path from the mouth of the Fraser through Queen Charlotte Sound.
- A coordinated, multi-agency collection of data on sockeye stock abundance, survival and stressors for each life history stage.
- The development of an integrated database and cumulative assessments both within and across multiple life history stages.
- Transparent dissemination of information annually to scientists and non-scientists.

Addendum:

The Addendum to this report reviewed the implications of Technical Reports 1A (Hatchery Disease Impact Assessment) and 5 (Impacts of salmon farms on Fraser River sockeye salmon) on the cumulative impacts analysis. Note that because the issue of interactions between salmon farms and sockeye salmon is highly polarized, the Cohen Commission contracted two reports to evaluate the potential impacts of salmon farms. The two authors (Noakes {Technical Report 5C} and Dill {Technical Report 5D}) were provided with a report synthesizing the data complied specifically for this project (Korman, Technical Report 5A) and a report performing statistical analyses of these data (Connors, Technical Report 5B).

An evaluation of these reports did not add any further factors to the cumulative impact analysis that were *likely* to have been primary factors in Fraser sockeye declines. The researchers did note that diseases of salmon farm origin are a *possible* factor (based on the report by Dill) or *unlikely* (based on the report by Noakes). However both reports judged them to have been *unlikely* as primary causes of long term productivity declines, though they may still have been contributory factors. Waste, escapees and sea lice from the operations of salmon farms are *unlikely* to have been primary factors in the observed declines. Diseases of hatchery origin were judged as *no conclusion possible* due to insufficient data on how these affect salmon sockeye populations.