

# **Evaluating the status of Fraser River sockeye salmon and role of freshwater ecology in their decline**

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## **Overview**

- Importance of freshwater environment
- Report objectives
- Fraser River sockeye salmon
- Salmon life cycle, freshwater habitats, and human activities
- Analyses and key findings of individual stressors
- Weight of evidence regarding role of freshwater stressors
- Core recommendations

## Importance of freshwater habitat

- Humans can harm watershed processes and freshwater habitats for sockeye salmon
- Variability in freshwater habitats is good!  
⇒ diverse life histories, populations, genetics, behaviour
- Biological diversity supports resilience of Pacific salmon & people:
  - stable inputs of water & nutrients for food webs
  - human communities by stabilizing catch



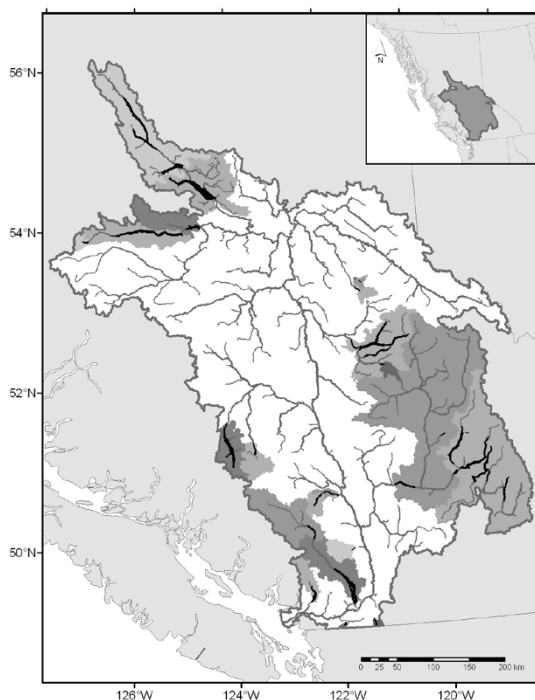
## Report objectives

- Assess current status of Fraser River sockeye salmon
  - delineate populations by Conservation Units (CUs)
  - evaluating DFO's methods for assessing conservation status
  - determine status of Fraser River sockeye salmon CUs
- Evaluate changes in freshwater ecology and its role in recent Fraser sockeye salmon declines
- Have logging, hydroelectricity, urbanization, agriculture, and mining had habitat impacts that could explain recent declines?

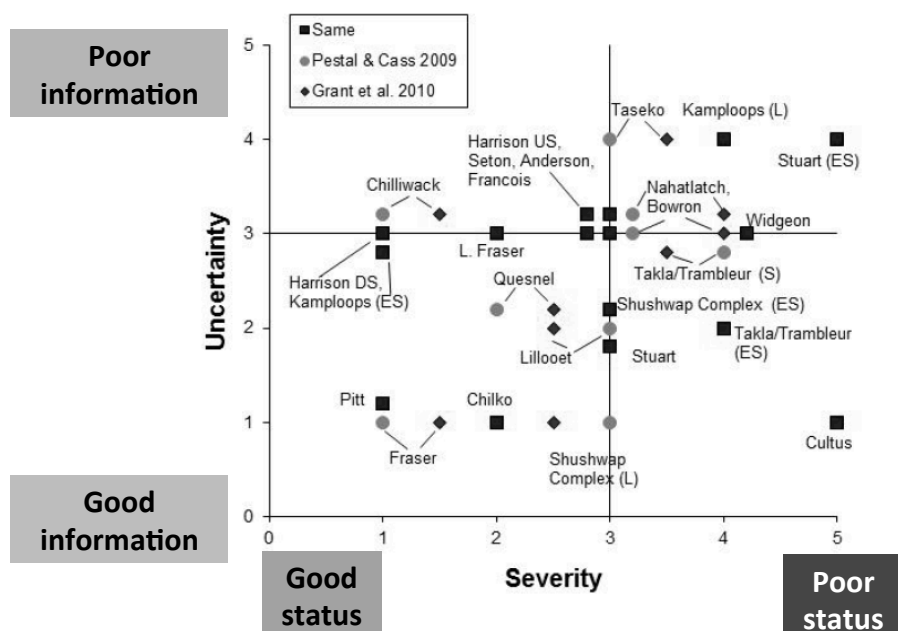


## Fraser River sockeye salmon

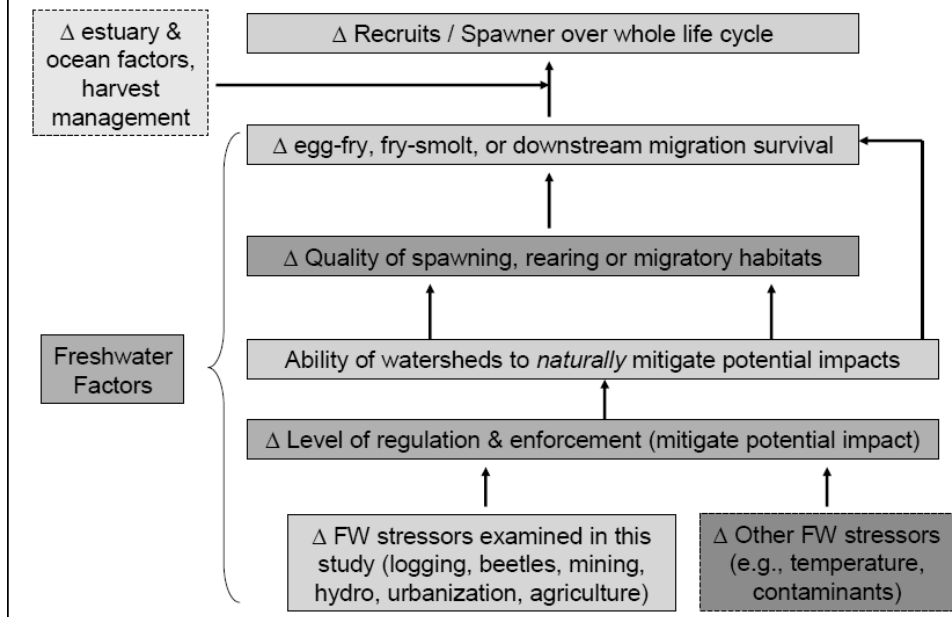
- 36 Conservation Units (30 lake, 6 river)
- Four timing groups; strong and weak stocks
- Freshwater habitats:
  - migration corridors
  - tributary and mainstem spawning
  - nursery lakes
- Human activities and land development interact through “zones of influence”



## Population status



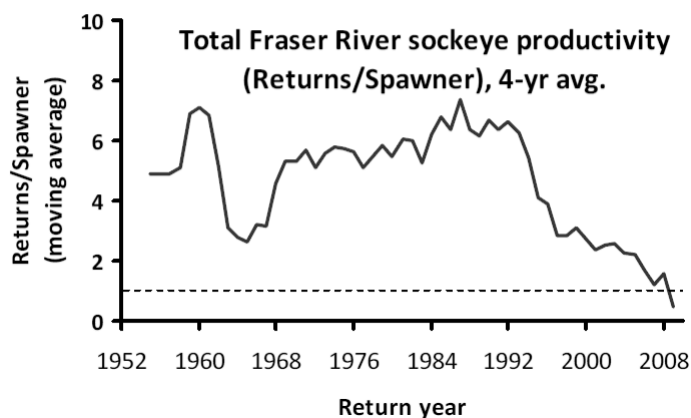
## Conceptual model of FW habitat impacts



## Data analyses

### Dependent variables:

- Trend in total life cycle productivity (residuals from Ricker curve of Recruits/Spawner, based on Selbie et al. 2010)
- Trend in Juvenile productivity (residuals of Fry/Spawner)



## Data analyses *across* 17 stocks

### Independent variables:

- Intrinsic habitat vulnerability (**migration distance**, area of nursery lakes, ratio of lake influence to total spawning extent)
- Forestry (harvested area, **MPB area**, **road density**, number of road crossings)
- Mining (#, type of mines)
- Hydroelectricity (# of run of river, effects of large scale operations)
- Urbanization (area, human population size)
- Agriculture (area)
- Water use (allocations, number of licenses, number of restrictions)
- Cumulative effects (aggregation of all human activities)

**Migration distance** and **MPB area** showed strongest negative correlations with total productivity trends across stocks, but are also correlated with each other.

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## Key findings

### Forestry

- Level of forest harvesting within the last 15 years has been less than 10% of sockeye watersheds
- Riparian zones in upslope areas tend to be more heavily disturbed than riparian areas
- Road activity is highly variable; highest interaction in areas adjacent to mainstem spawning and along migration corridors

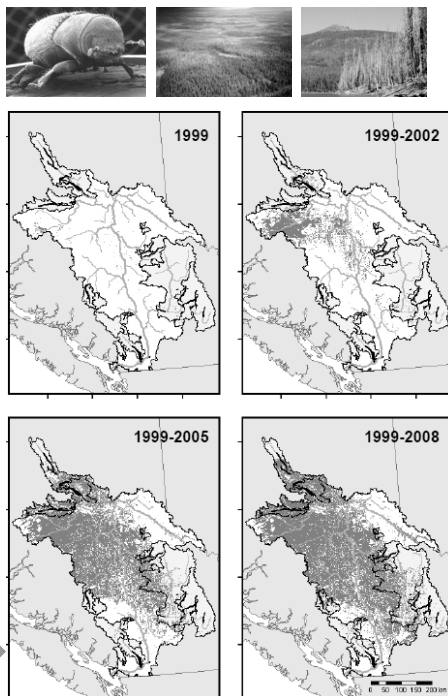


## Key findings

### Forestry

- MPB disturbance increased dramatically since 2003; up to 90% in some interior watersheds
- Intensity of log storage in lower Fraser varies more across reaches than across seasons / years; past studies show no significant impacts on juvenile salmon

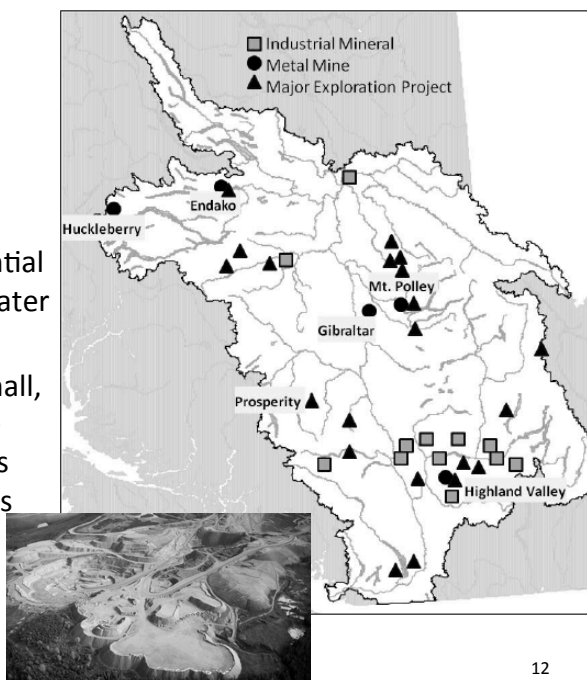
Cumulative Area Affected by Mountain Pine Beetle



## Key findings

### Mining

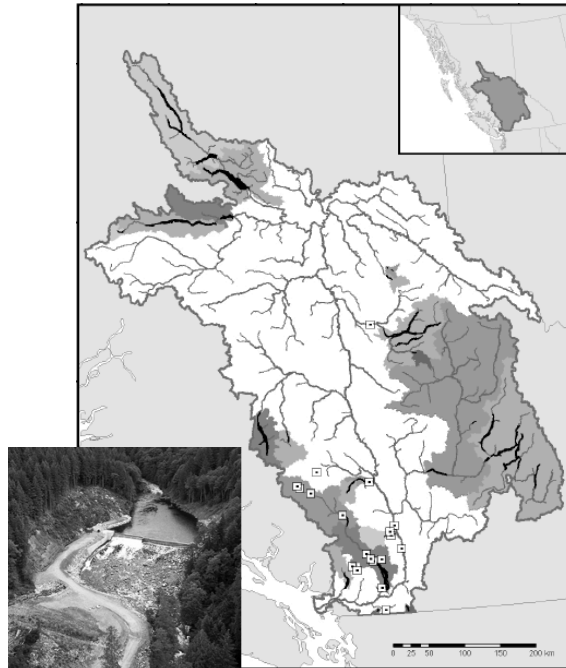
- Mining activity varies substantially; placer mining most dominant and has greatest potential to reduce early freshwater survival
- Impacts on sockeye small, difficult to detect since contrasts among stocks and strength of effect is low relative to other factors



## Key findings

### Hydroelectricity

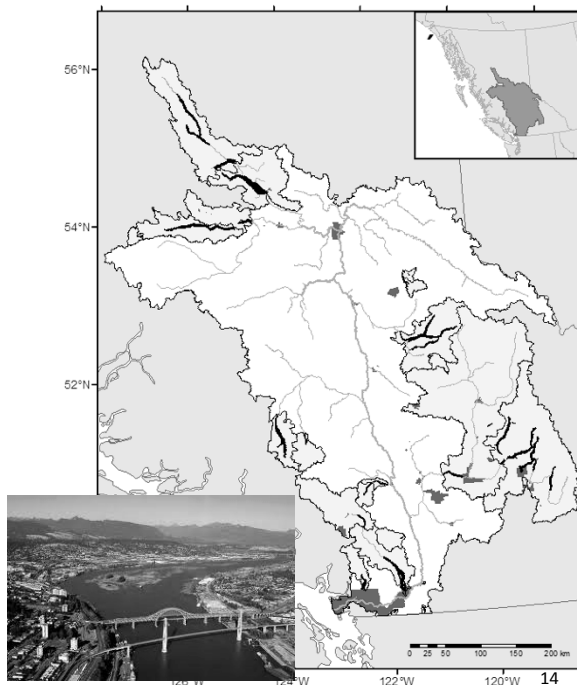
- Large scale hydro (e.g., Bridge-Seton, Kemano) affect smolts and adults, but adverse effects have been largely mitigated on Seton and Nechako Rivers
- History of interaction between IPPs and sockeye salmon is very short and limited in number and spatial extent



## Key findings

### Urbanization

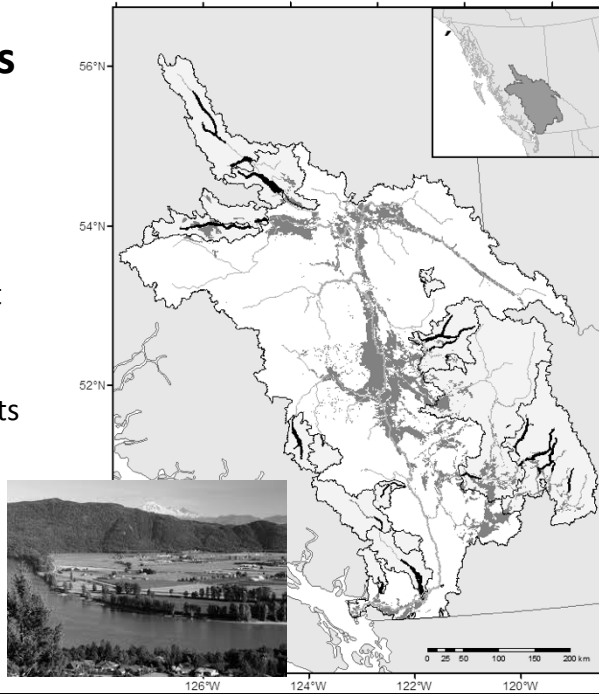
- relatively small footprint within watersheds and riparian zones that influence sockeye salmon
- intense interaction along migration corridors
- humans also concentrated along migration corridors



## Key findings

### Agriculture

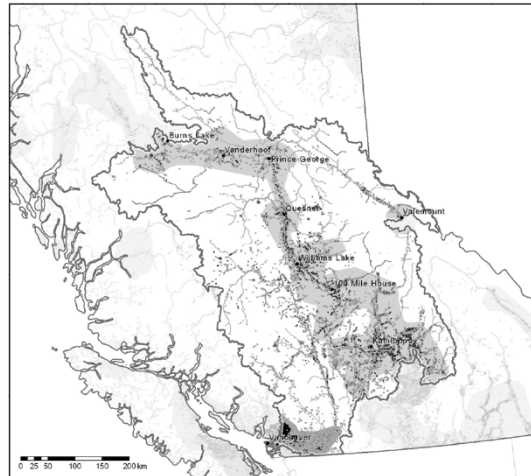
- relatively small footprint within watersheds and riparian zones that influence sockeye salmon spawning and rearing habitats
- larger interaction along migration corridors



## Key findings

### Water use

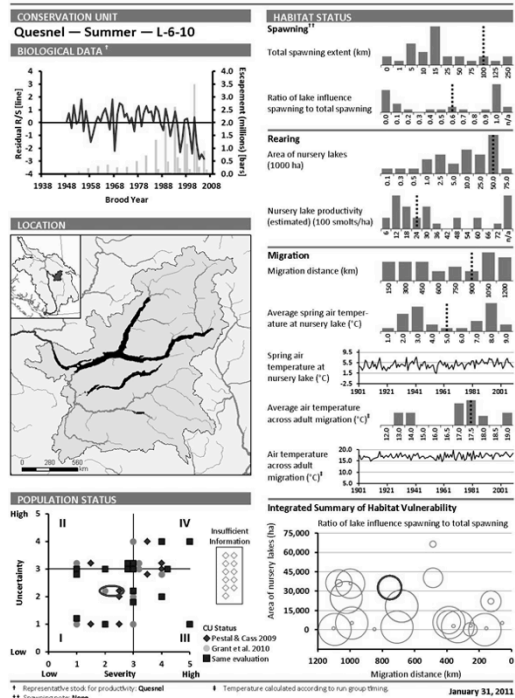
- High water demand associated with the highest concentrations of people across Fraser basin
- Migration corridors have greatest allocation of water and greatest density of water allocation restrictions, mostly agriculture
- CUs of the Lower Mainland have the highest water allocations



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## Indicator dashboards



## Weight of evidence: 7 questions

1. How **plausible** is the hypothesized causal mechanism?
2. What is the **strength** of the estimated effect?
3. Does the **consistency** of direction, magnitude, and duration of observed effects lend credibility to a particular mechanism?
4. Are **life stages** affected by the proposed mechanism affected whereas others are not?
5. Did the **timing** of observed changes coincide with a change in the state variable of the proposed causal mechanism?
6. Is there a similarity or **coherence of responses** across space, time, populations, etc that strengthens the case for a mechanism?
7. Are there natural gradients or **contrasting conditions** that result in outcomes consistent with the proposed mechanism?

From Stewart-Oaten 1996

## Conclusions

- Pattern of decline in total salmon productivity did not coincide with level of variation of individual or cumulative stressors **across CUs**
- Pattern of decline in juvenile survival has remained relatively stable across CUs (compared to life cycle survival), even though there is substantial variation in stressor intensity across CUs
- These and other observations contributed to the conclusion that **recent declines in Fraser River sockeye salmon are unlikely the result of changes in the freshwater environment**
- However, **protection of freshwater habitats remains important** to the conservation of Fraser River sockeye salmon because they contribute to their overall diversity and resilience

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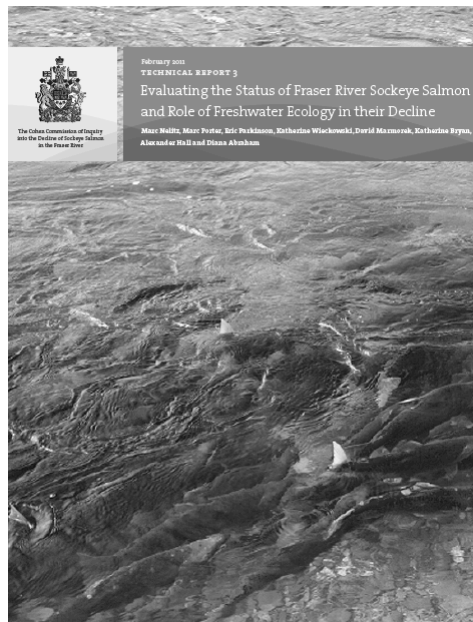
## Core recommendations

1. **Survival:** better estimates of juvenile abundance, overwinter survival, and mortality during smolt outmigration.
2. **Population status across CUs:** data on abundance and distribution of small lake CUs and all river CUs.
3. **Habitat status across CUs:** monitor habitats consistently on a regular basis across a larger number of rivers and nursery lakes.
4. **Population level effects of stressors:** better estimates of biological consequences of disturbance as stress increases.
5. **Improve transparency in science and decision making:** make information more accessible, with collection and organization integrated across federal and provincial agencies.

All of these recommendations were included in Justice Cohen's report, though in a slightly different form.

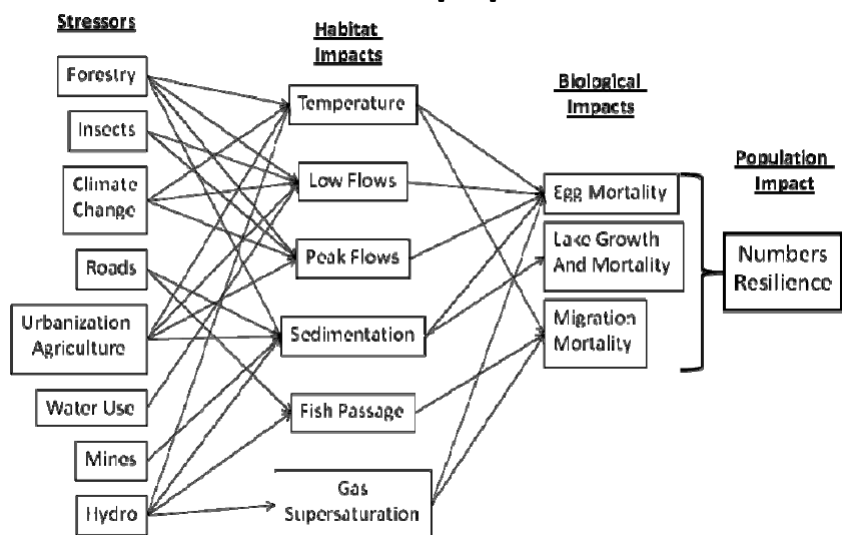
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Thanks! Questions?



Nelitz, M., M. Porter, E. Parkinson, K. Wieckowski, D. Marmorek, K. Bryan, A. Hall and D. Abraham. 2011. Evaluating the status of Fraser River sockeye salmon and role of freshwater ecology in their decline. ESSA Technologies Ltd. Cohen Commission Tech. Rept. 3: 222p. Vancouver, B.C.  
[www.cohencommission.ca](http://www.cohencommission.ca)

## Human impacts on habitats and populations



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