The possible role of salmon aquaculture in the decline of Fraser River sockeye productivity

Fraser River Aboriginal Fisheries Secretariat
Science Workshop, March 27/13

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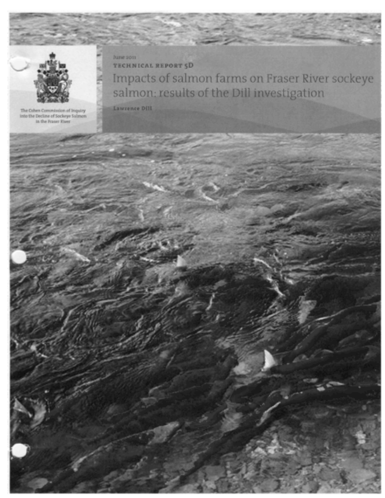
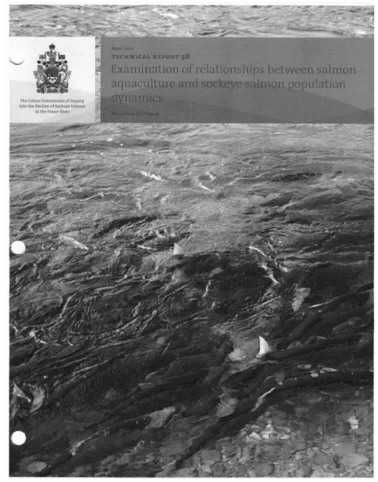
Technical Report 5D

"Impacts of salmon farms on Fraser River sockeye salmon: results of the Dill investigation"



Technical Report 5B

"Examination of relationships Between salmon aquaculture and sockeye salmon population dynamics"



Brendan Connors

Published as: *Connors et al. 2012. Migration links ocean basin-scale competition, local climate, and exposure to farmed fish to shape Fraser sockeye dynamics . Conservation Letters 5:304-312*

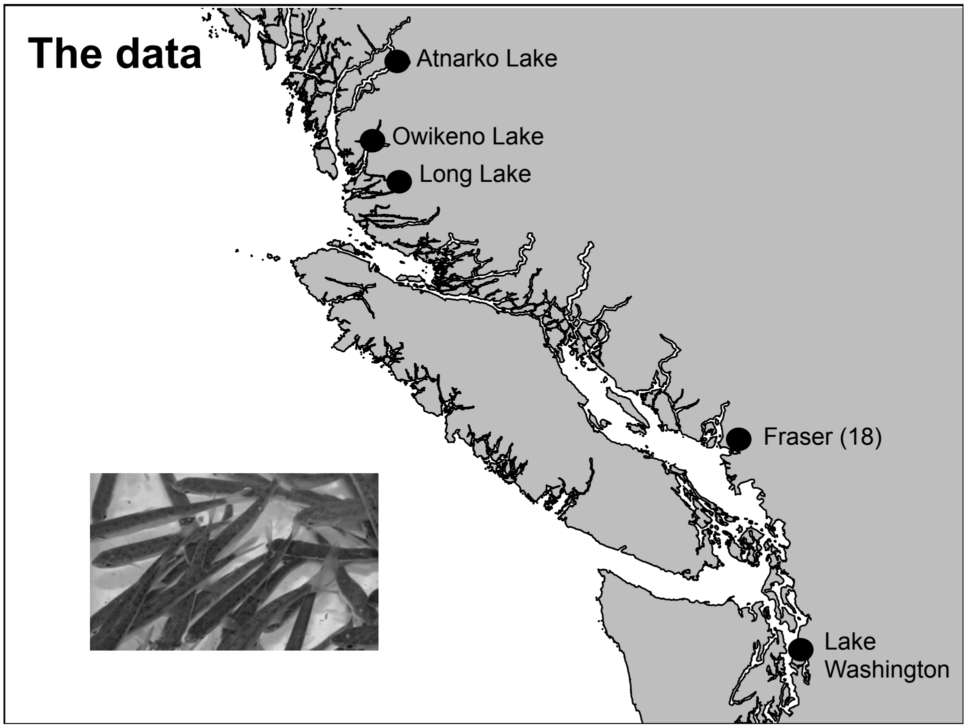
Synthesis of evidence from a workshop on the decline of Fraser River sockeye

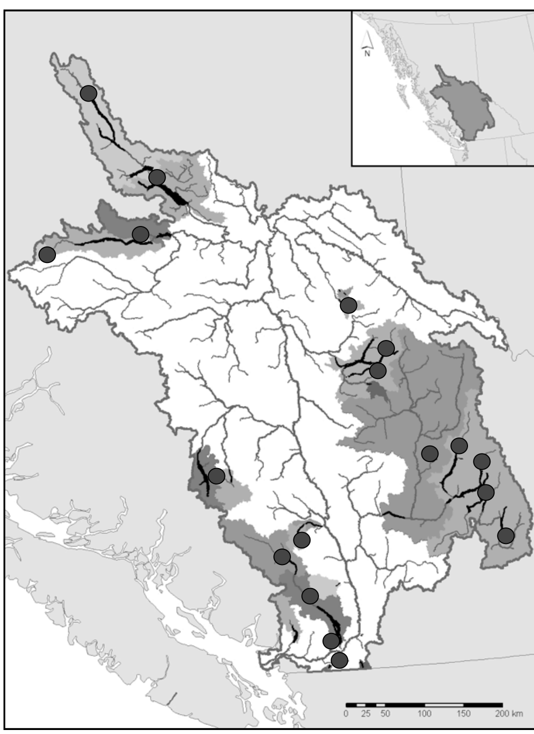
"likely" to "very likely" contributing factors:

- Ocean conditions
- Pathogens (incl. aquaculture)
- Competition

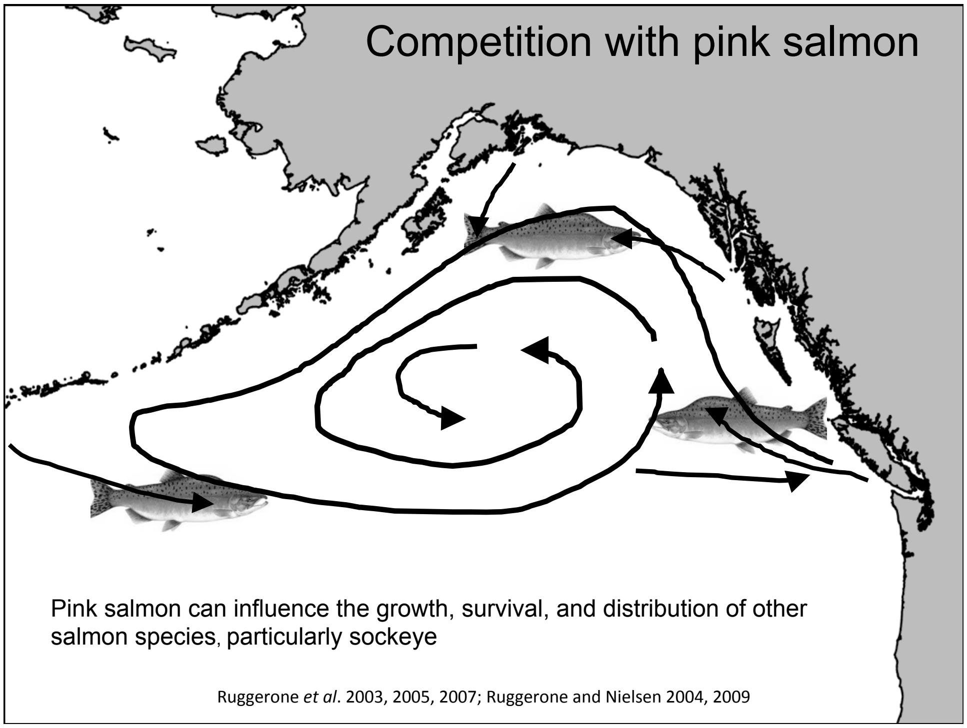
"… multiple hypothesized causal mechanisms are very likely to be operating simultaneously and their effects may be additive, multiplicative (i.e., synergistic), or may tend to offset one another's."

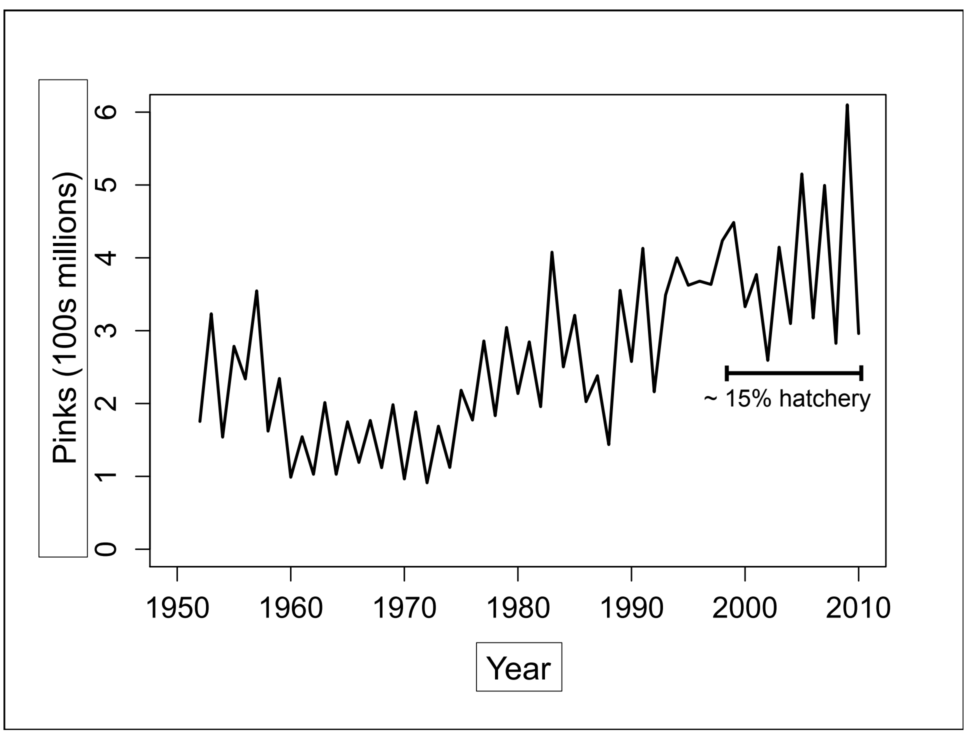
Peterman *et al.* 2010

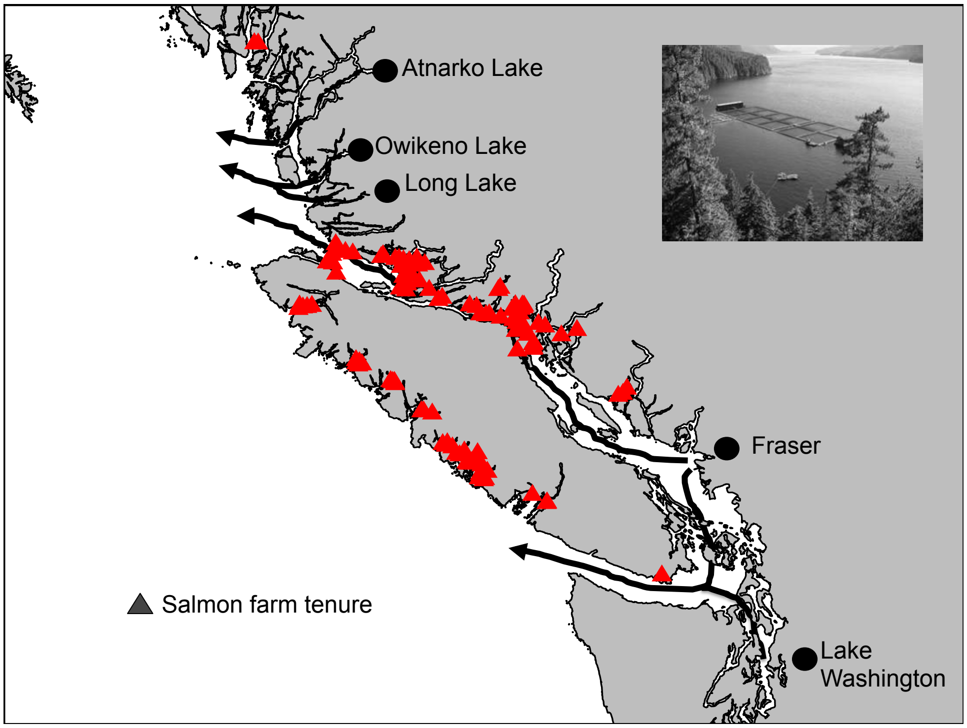




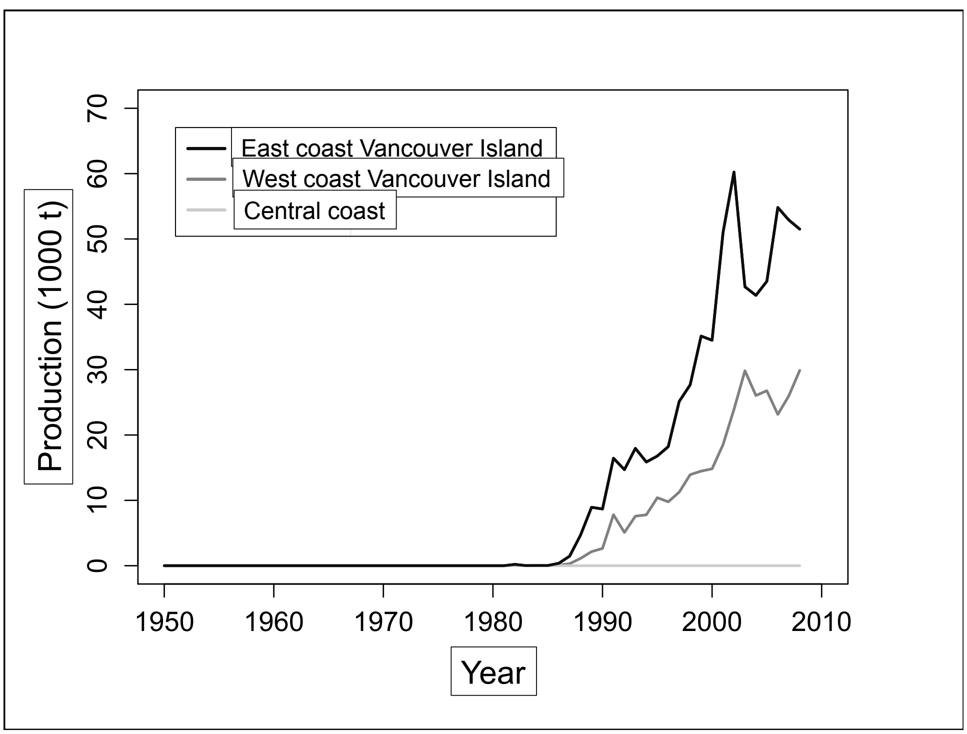
Fraser sockeye stocks used in the Connors analysis


Competition with pink salmon
Pink salmon can influence the growth, survival, and distribution of other salmon species, particularly sockeye
Ruggerone et al. 2003, 2005, 2007; Ruggerone and Nielsen 2004, 2009


Pinks (100s millions)
0
1
2
3
4
5
6
1950
1960
1970
1980
1990
2000
2010
Year
~ 15% hatchery

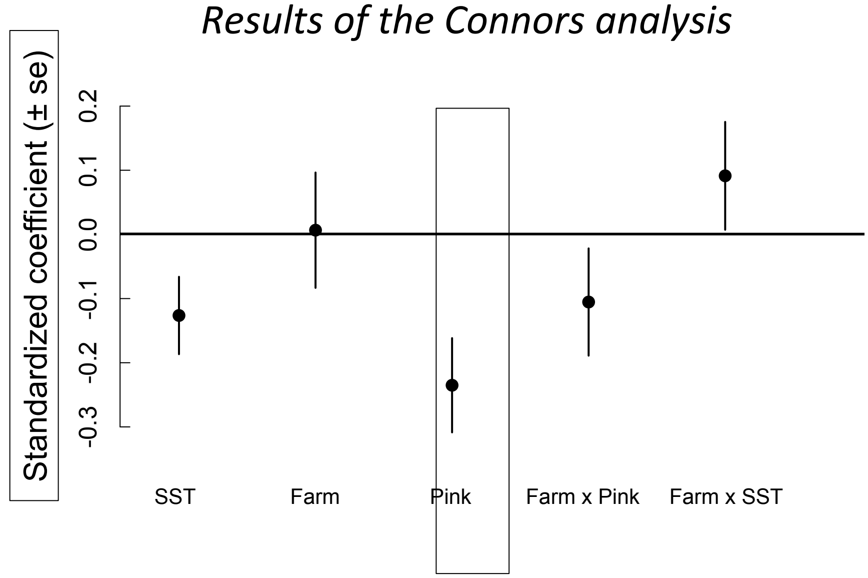


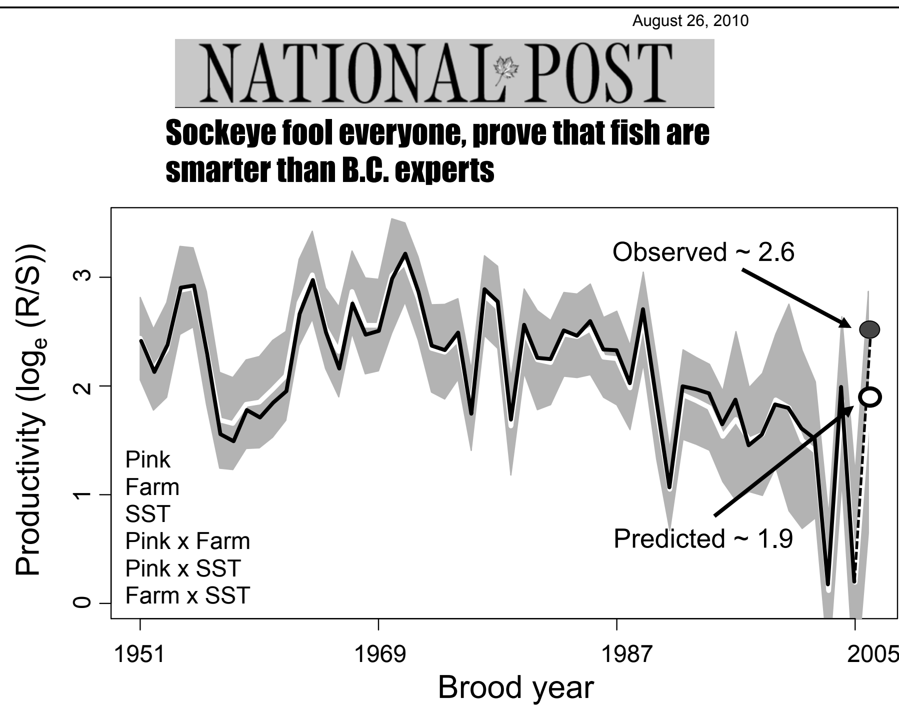
Atnarko Lake
Owikeno Lake
Long Lake
Fraser
Lake Washington
Salmon farm tenure



East coast Vancouver Island
West coast Vancouver Island
Central coast
Production (1000 t)
0
10
20
30
40
50
60
70
1950
1960
1970
1980
1990
2000
2010
Year

Results of the Connors analysis





Possible Drivers of Farm Effects

- Benthic impacts (i.e., changes to the sea floor)

Possible Drivers of Farm Effects

- Benthic impacts
- Pelagic impacts (plankton)

Possible Drivers of Farm Effects

- Benthic impacts
- Pelagic impacts (plankton)
- Chemical inputs

Possible Drivers of Farm Effects

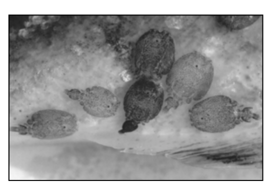
- Benthic impacts
- Pelagic impacts (plankton)
- Chemical inputs
- Structural and operational impacts (e.g. lights)

Possible Drivers of Farm Effects

- Benthic impacts
- Pelagic impacts (plankton)
- Chemical inputs
- Structural and operational impacts
- Escapes

Possible Drivers of Farm Effects

- Benthic impacts
- Pelagic impacts (plankton)
- Chemical inputs
- Structural and operational impacts
- Escapes
- Sea lice



Possible Drivers of Farm Effects

- Benthic impacts
- Pelagic impacts (plankton)
- Chemical inputs
- Structural and operational impacts
- Escapes
- Sea Lice
- **Disease**

Failure to detect disease effect in short-term analyses

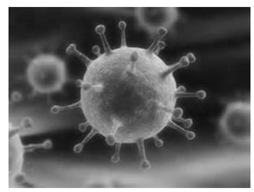
- Data set too small (too few years)
- Not looking for the right diseases
  – e.g. new and emerging ones
- Not sampling the right fish
  – only fresh silvers, not the "dead fish swimming "

NB: No cause of death found for approx. 80% of the fresh silver morts

Viruses

4 types are of current concern

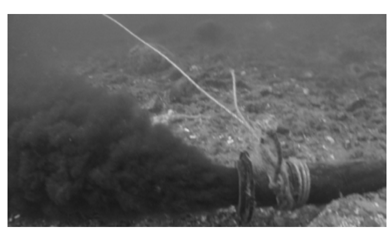
1. ISA virus
2. Salmon leukemia virus
   - parvo virus (aka “Miller virus”)
3. Piscine reovirus
4. IHN virus



Human influenza virus

Routes of transmission

- direct horizontal transfer through the water
- benthos (some parasites)
- escapees
- carried by sea lice (vectors)
- bloodwater from processing plants



Management options

- More frequent fish health audits and broader suite of diagnostic procedures
- Lower densities of fish on farms
- Regional planning and scheduling of adult harvest
- Relocation of farms (off migration routes)
- Continued use of chemotherapeutants (lice)
- Closed containment

State of the science: knowledge gaps

- Cumulative impact of disease and other stressors
- Possible presence of Miller-virus on farms and its relationship (if any) to marine anemia
- Infective state of apparently healthy farm fish
- Potential for lice to act as pathogen vectors
- Potential for bloodwater (from processing plants) to be a source of infection
- Disease incidence and levels in wild sockeye (and other Pacific salmon)

Disease interactions in the complex real world of wild salmon

- Food supply affects fish growth, disease susceptibility and impact
- Pathogen challenge can affect competitive ability and thus survival when food is in short supply (high SST) or competitors are abundant
- Other stressors (e.g. pollution) can affect the ability to resist pathogens
- Weaker or smaller fish (due to pathogens) are more susceptible to predators (escape ability, risky feeding)

Note interactions found in the Connors analysis