Interactions Between Wild and Farmed Salmonids in Southern British Columbia: Pathogen Transfer

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PICES AGM October 14-23, 2011, Khabarovsk, Russia

What is the impact of salmon farming on wild salmonid populations in British Columbia?

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Declining Wild Salmon Populations in Relation to Parasites from Farm Salmon

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Taylor & Francis

Perspectives on Pink Salmon and Sea Lice: Scientific Evidence Fails to Support the Extinction Hypothesis

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Disease impacts of salmon farming in BC are being debated in scientific publications, as well as in traditional and social media.

Fish farms will make local wild salmon extinct in a decade: study

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CBC News
Accessibility Links

Beginning of Story Content

Parasitic sea lice found in salmon farms are driving nearby populations of wild salmon toward local extinction, according to a scientific paper published Thursday.

Researchers from the University of Alberta, Dalhousie University and the Salmon Coast Field Station in Echo Bay, B.C., said that if outbreaks of sea lice continue at their present rate, the population of wild pink salmon will drop 99 per cent in four salmon generations, or about eight years.

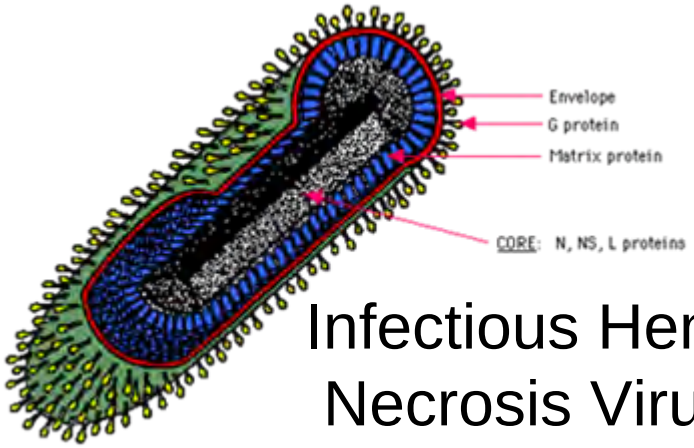
Martin Krkosek, with the centre for mathematical biology at the University of Alberta, said the rate of decline is so steep "it's arresting."

"Something has to happen immediately to turn this situation around," he said in a podcast accompanying the study, which was posted online Thursday in advance of Friday publication in the journal Science.

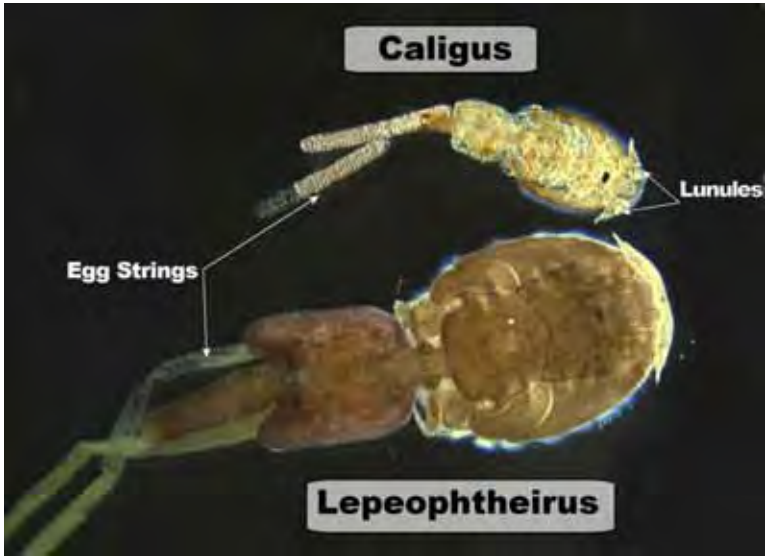
Krkosek said salmon farms are prone to infestations of a parasitic crustacean called *Lepeophtheirus*

A young pink salmon infected with sea lice. (Courtesy of Alexandra Morton/Science)

Endemic Pathogens of Greatest Concern



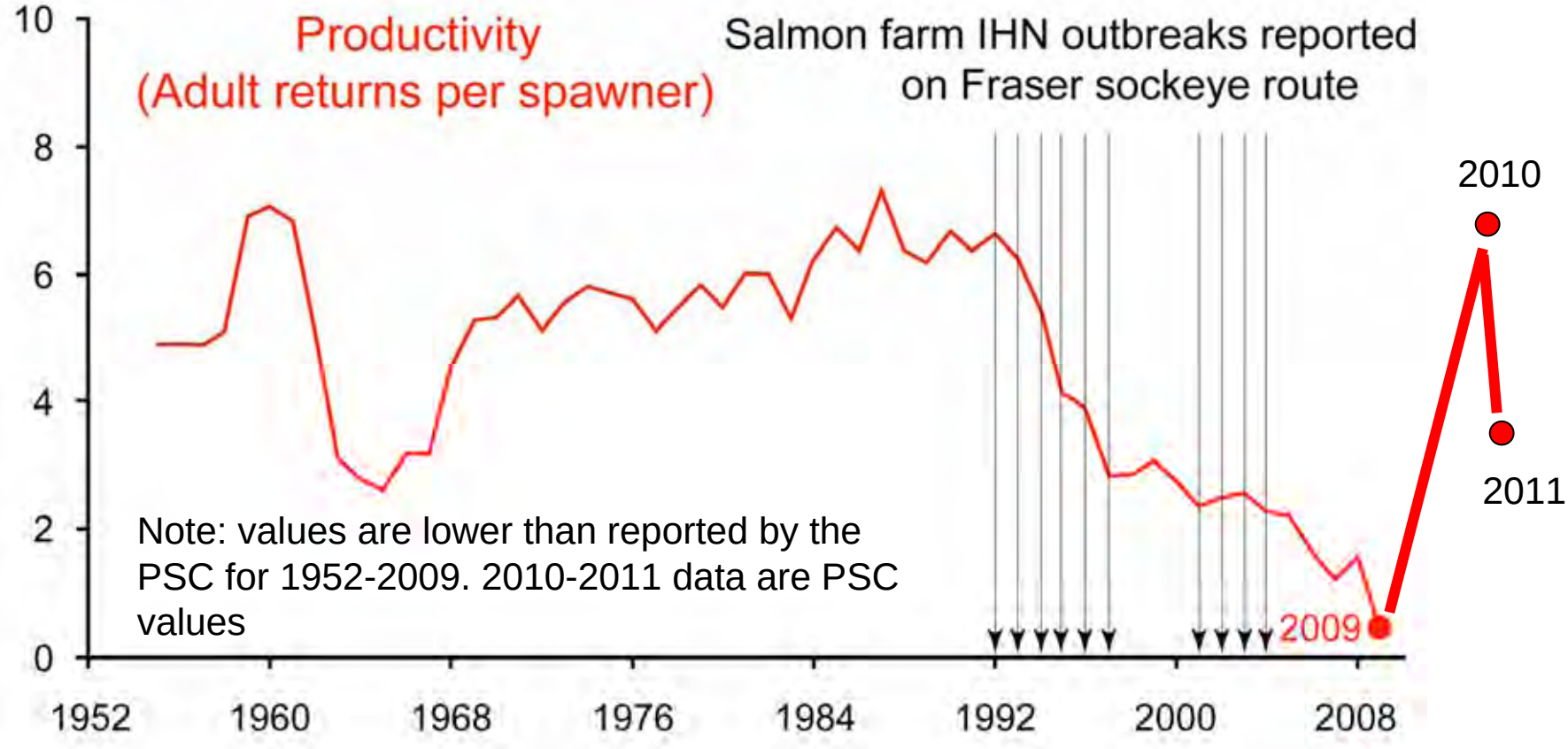
Infectious Hematopoietic Necrosis Virus (IHNV)



Sea Lice

- Only naturally occurring pathogens are present on salmon farms.
- Wild salmon carry these pathogens.
- The types of pathogens carried by wild salmon and their prevalence varies between stocks and years

Various groups and individuals in British Columbia view IHNV and sea lice from salmon farms to seriously impact productivity of wild salmon



Graph taken from A. Morton's presentation at the PSC Workshop on the Decline of Fraser River Sockeye, Nanaimo June 15-17, 2010

The Questions:

Do pathogens arising from salmon farms impact the health of wild salmonids at the individual or population level?

Do salmon farms provide a mechanism for amplifying endemic pathogens?

Do salmon farms effect the natural distribution of pathogens in the marine environment thereby impacting rates of transmission to wild fish?

To assess risk associated with pathogen transfer between farmed and wild populations the following types of information are required:

Farmed populations: species and numbers in culture, age, health status (mortality rates, health management, treatments, vaccinations), pathogens prevalence and abundance

Environment: physical, chemical and biological conditions especially those conditions that impact upon host and pathogen biology/ecology (FW and Marine)

Wild populations: knowledge of production rates and ecology (timing, patterns and rates of migration) of various stocks, distribution and baseline levels of pathogens and infectious disease (environment and stocks), role of disease in the absence of salmon farming, and how these factors naturally change over time.

Pathogens: pathogens that are present, lethal and sub-lethal impacts on hosts, shedding rates (carrier and diseased hosts), infectious dose, survival in the environment, effects of co-current infections, and triggers for disease.

Predicting IHNV Spread from Point Sources

Endemic in sockeye salmon, single genotype
Sporadic outbreaks of IHN in sockeye populations
Asymptomatic sockeye carriers present (smolts and adults)

Atlantic salmon highly susceptible to infection

1992 : First occurrence 1992-1997 at 14 netpen sites near Campbell River (all within 22 km radius)

2001: Second outbreak occurred in same area in 2001-03 Spread north to 3 other areas eventually involving 26 sites

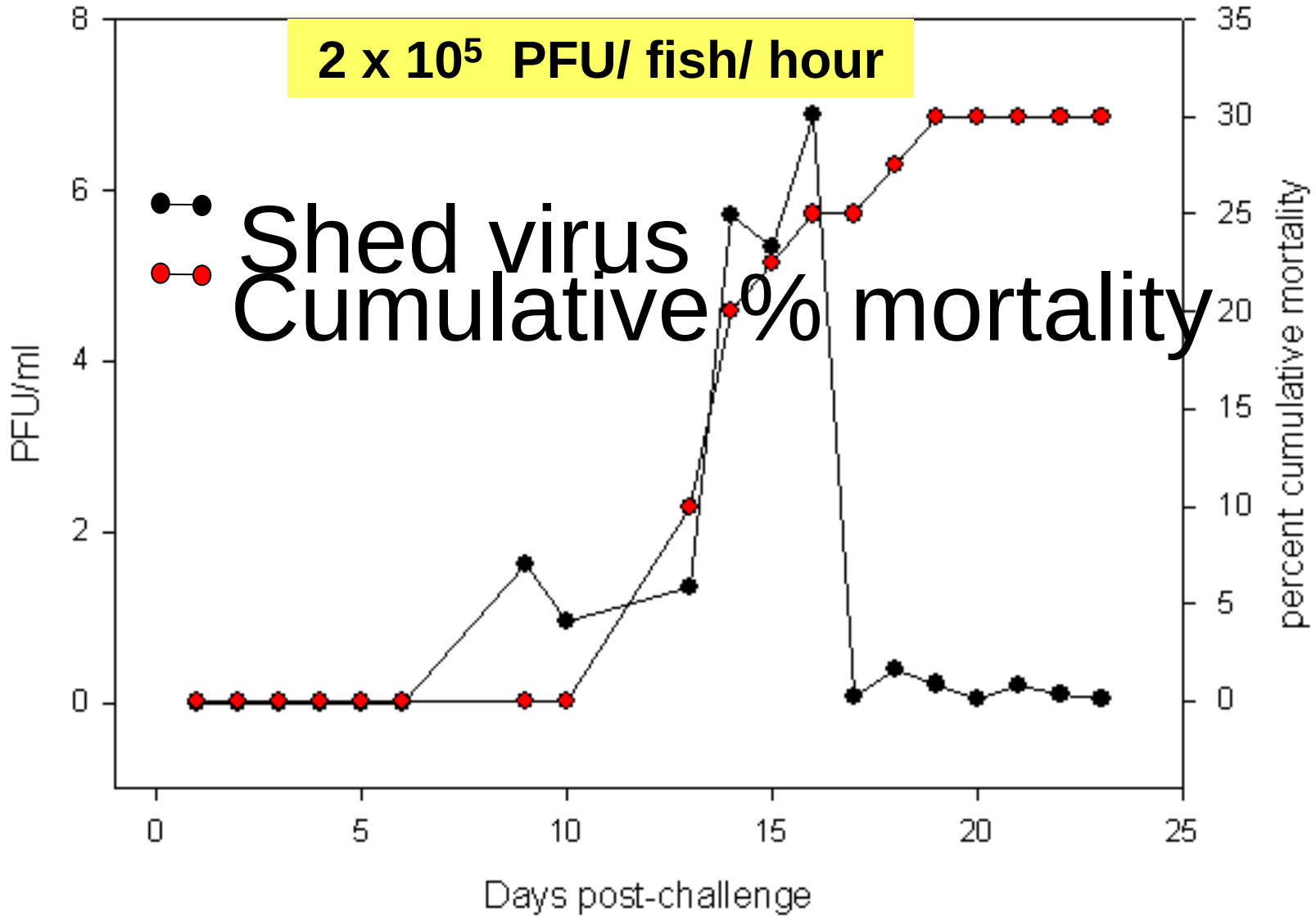
2002: Third outbreak west coast of Vancouver Island (10 sites)

Point Source IHNV Dispersal in the Environment

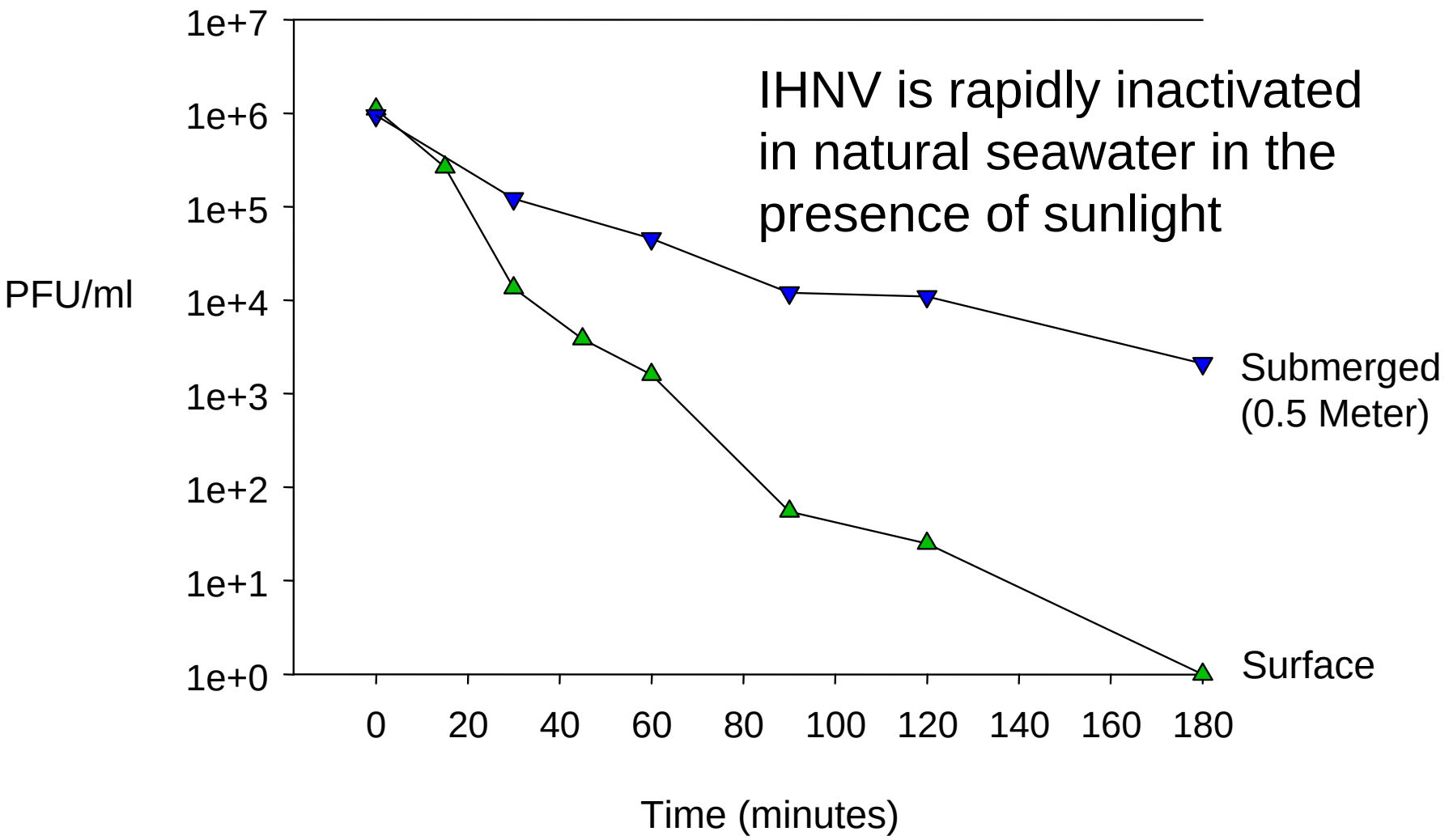
Kyle Garver, Michael Foreman et al. (ongoing research)

1. IHNV shedding rates from carrier and diseased fish (shedding rates of Atlantic salmon complete, shedding rates of sockeye salmon to be determined)
2. IHNV survival outside of its host (stability in seawater, effects of UV radiation etc.)
3. Minimum infectious dose of IHNV needed to infect and/or cause disease in Atlantic and sockeye salmon
4. Application of finite volume ocean circulation models to predict IHNV spread from point sources

IHNV Shedding from Atlantic Salmon



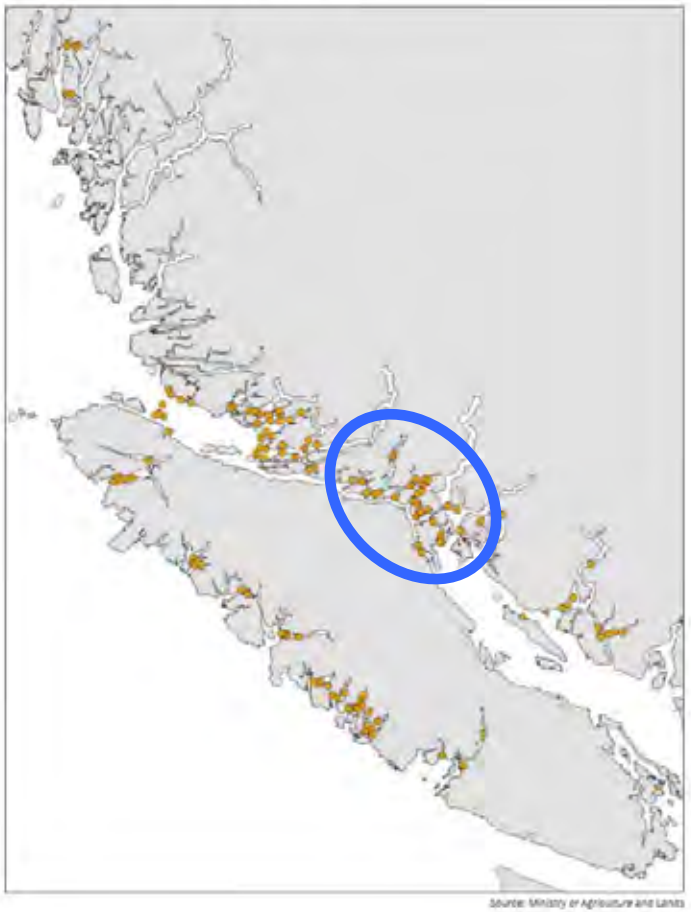
IHNV Decay (sunlight exposure)



Water Circulation Model for the Discovery Islands

- Temperature
- Salinity
- Tidal influence
- Current Speed
- River discharge
- Solar/UV
- Winds
- Bathymetry

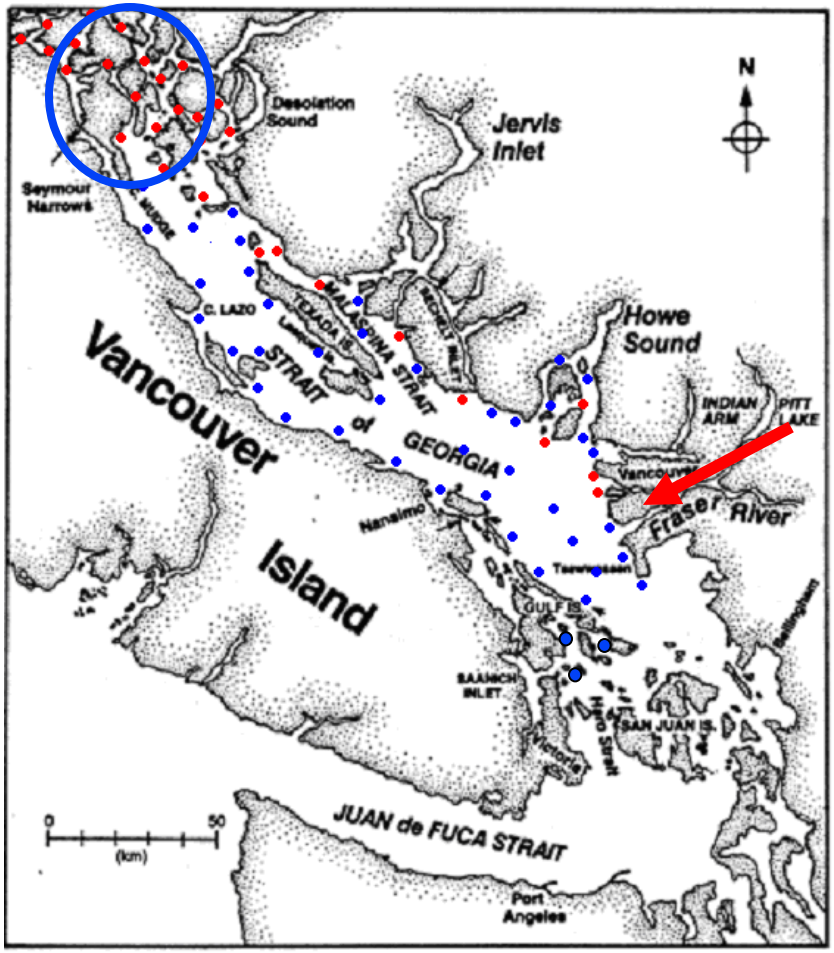
Fish farm locations



Michael Foreman, et al. Uncertainties in modeling water-borne disease transmission among salmon farms in the Discovery Islands, British Columbia **October 20, 11:35 (S9-7733)**

Health Assessment of Juvenile Salmon in the Strait of Georgia

- Freshwater and marine-surveys completed during smolt out migration period: 2010 – 3 cruises, 2011 – 2 cruises. Samples collected throughout the Strait of Georgia and Johnstone Strait
- Focus on sockeye (full health assessment), pink and chum salmon (sea lice), and non-salmonids (sea lice)



Distribution of Sampling Sites

Smolt Sampling 2010/2011

Stock ID (Chinook, Coho, Sockeye), Sea Lice (Pink, Chum, Sockeye, Non-salmonids), Histology (Chinook, Coho, Sockeye), Pathogen Screening (Sockeye)

2010 Sockeye Diagnostic Results Virus and Bacteria

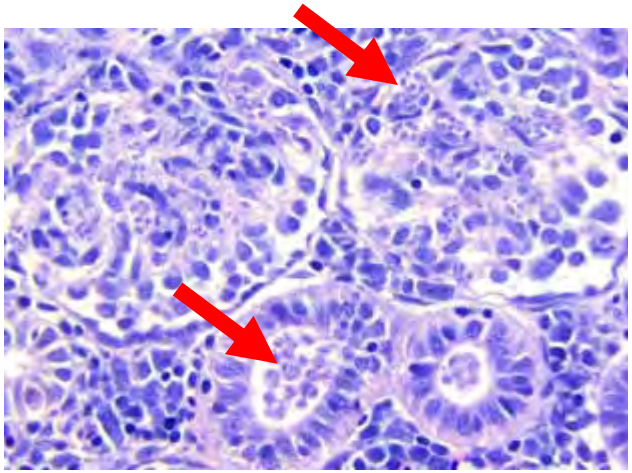
- Samples of kidney and spleen were pooled from each individual
- Virus isolation was conducted following NAAHP protocols using EPC, CHSE, and SHK cell lines which are suitable for the culture of all salmonid viruses known to be present in Canada.
- Bacteriology samples were plated on TSA and TSA+salt. An ELISA for BKD was also conducted (FHPR methods).
- All samples collected during our survey (river and marine samples) tested negative for the presence of virus and bacteria by culture. The BKD-ELISA did not identify any positive individuals.
- 580 fish had multiple tissues sampled for molecular diagnostics using validated diagnsotic tests (IHNV, VHSV, ISA, BKD)
- 2/475 tested to date were positive for IHNV in the kidney, none of the other pathogens have been identified.

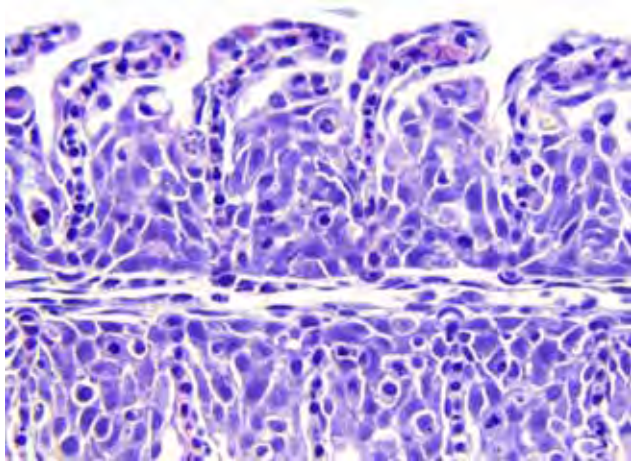
2010 Histology General Summary (ca. 330 fish examined)

- May and June: Fish were in good morphological condition. No evidence of significant infectious disease problems or inflammation.
- There was a low prevalence of intestinal trematode and intraperitoneal cestode infestations and a moderately high prevalence of intracerebral myxosporidian infections noted. None of these agents were causing significant pathologic changes.
- Samples obtained at Chilko lake in May also showed a high prevalence of sessile protozoan infestations of the gills and intracerebral myxosporidian infections.
- Although not visible by histology 3% of the May and 26% of the June fish tested positive for *Parvicapsula* by PCR.

2010 Histology General Summary (ca. 330 fish examined)

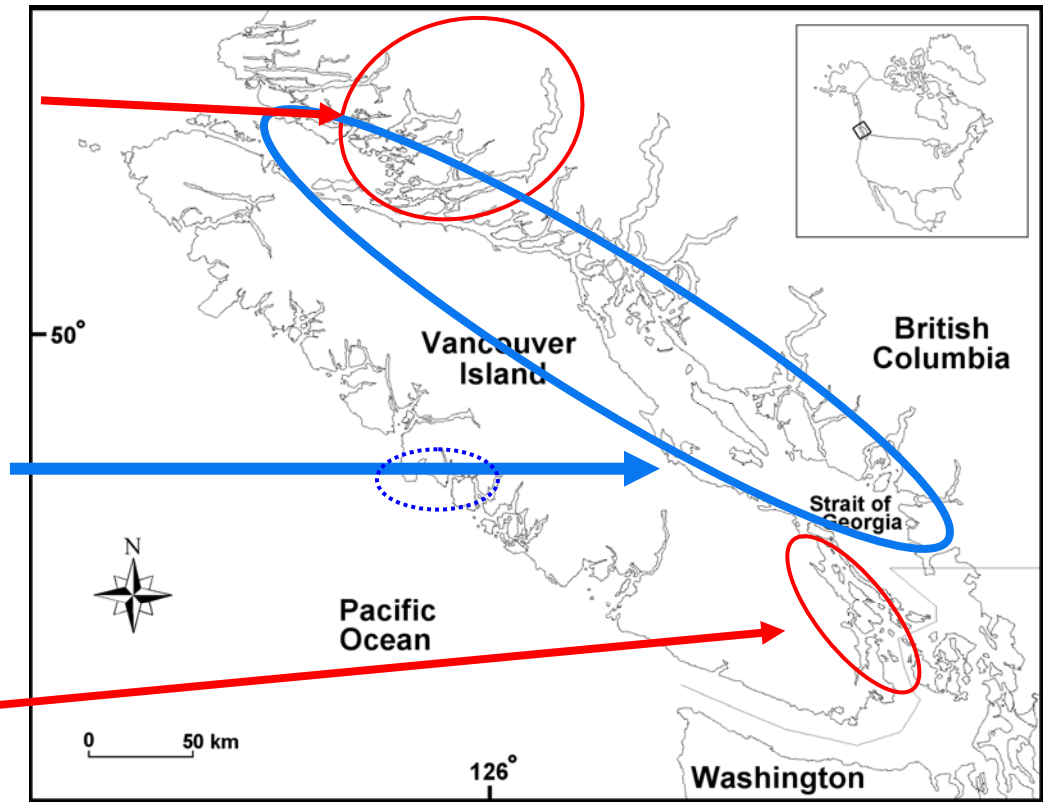
- Harrison River sockeye were the only stock captured in August sampling.
- Fish were located near the mouth of the Fraser River in areas of relatively low salinity.
- August: No evidence viral, bacterial or fungal disease.
- 78% of the fish examined had *Parivcapsula minibicornis* infection of the kidney (red arrow) (44% positive by PCR)
- 44% of gills were infected with a mixed infection of protists effecting gill structure





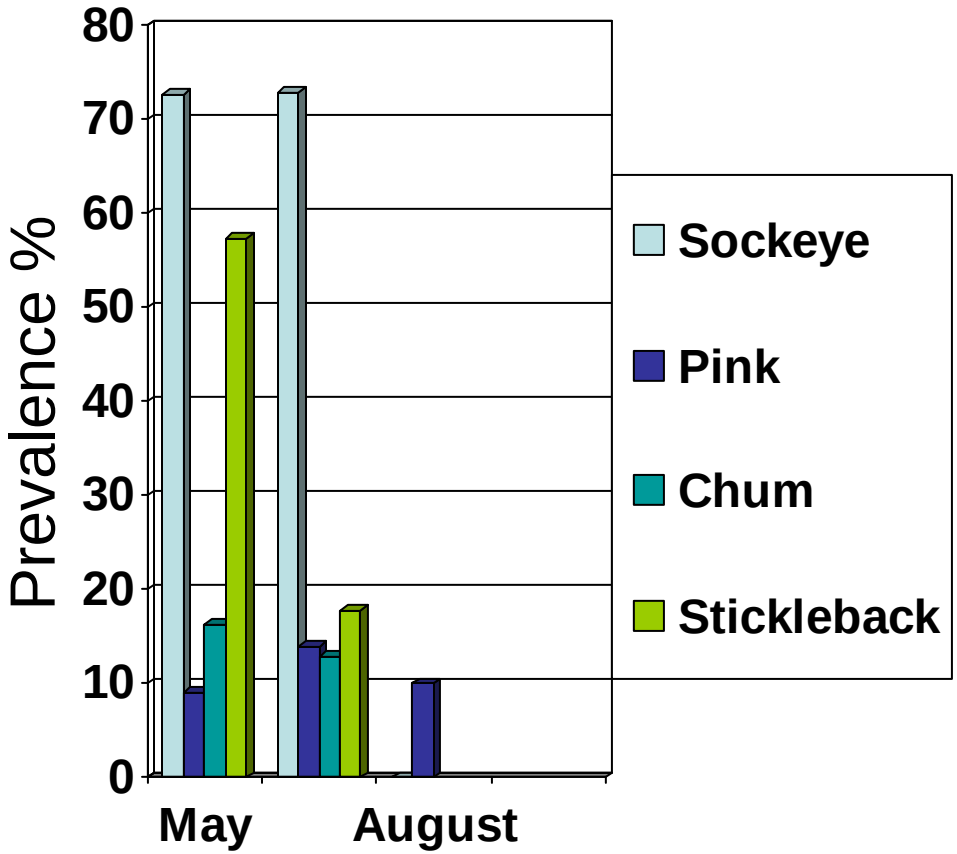
DFO Sea Lice Surveillance in BC

- Broughton Archipelago (DFO Pink Salmon Action Plan – 2003 to 2009)
  - Juvenile pink and chum salmon and non-salmonids
  - Continued as BAMP since 2010
- Strait of Georgia (PARR project 2010 to 2012)
  - Juvenile sockeye, pink, chum and non-salmonids
- Strait of Georgia Gulf Islands (Beamish surveys 2008-2010)
  - Juvenile salmon and non-salmonids



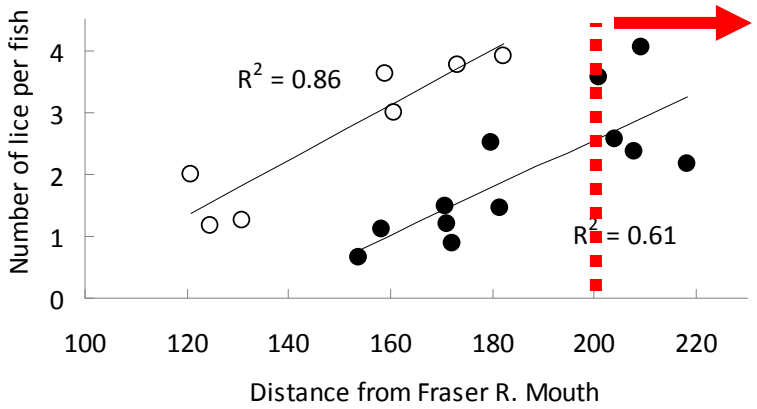
In BC salmon farms are required to treat for sea lice to reduce possible risk of transfer to wild fish. High cost and risk of parasite resistance developing. Are these treatments necessary and/or effective?

2010 Sea Lice General Summary



Wild salmon begin to acquire sea lice before contacting salmon farms.

Fish collected at sites downstream of salmon farming do not always have more sea lice.



Mean number of sea lice on sockeye salmon vs. distance from mouth of Fraser River

Large % of sockeye with very low numbers of sea lice. *Caligus clemensi* most common species on salmon and non-salmonids in our surveys.

Summary

- No pathogens on farms that do not naturally occur in wild salmon stocks. In the case of virus no genotypic differences.
- General agreement that pathogens transfer between wild and farmed fish. IHN outbreaks in Atlantic salmon due to exposure to IHNV in sea water.
- Based on available data there is no evidence that pathogen transfer from farmed salmon has negatively impacted wild sockeye salmon populations (sea lice, IHNV).
- However, quantification of sub-lethal effects is extremely difficult.
- Differences between stocks of salmon (life history, behaviour, history of pathogen exposure, susceptibility to infection etc.) and our lack of knowledge in these areas complicates studying these interactions.
- Risk posed by pathogen transfer will vary between stocks and between years (biological and environmental factors).