Hypothesis: Diseases in freshwater and marine systems are an important contributor to the Fraser sockeye situation

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Excerpt from: Report on the Pacific Salmon Commission's Workshop on the Decline of Fraser River Sockeye Salmon (Table E-1).

Hypothesis	Time Period	Strength of evidence	Relative likelihood that each hypothesis caused observed changes in productivity during the indicated time period				
			Very Likely	Likely	Possible	Unlikely	Very Unlikely
1a. Predation by marine mammals is an important contributor to the Fraser sockeye situation (Section 4.1).	overall	Fair					
	2009	Fair					
1b. Unreported catch in the ocean outside of the Pacific Salmon Treaty area is an important contributor to the Fraser sockeye situation (Section 4.1).	overall	Good					
	2009	Good					
2. Marine and freshwater pathogens (bacteria, parasites, and/or viruses), are important contributors to the Fraser sockeye situation (Section 4.2).	overall	Fair					
	2009	Fair					
3a. Ocean conditions (physical and biological) **inside** Georgia Strait are important indicators of contributors to the Fraser sockeye situation (Section 4.3).	overall	Fair					
	2009	Good					
3b. Ocean conditions (physical and biological) **outside** Georgia Strait are important indicators of contributors to the Fraser sockeye situation (Section 4.3).	overall	Fair					
	2009	Fair					
4. Harmful algal blooms in the Strait of Georgia and/or northern Puget Sound/Strait of Juan de Fuca are an important contributor to the Fraser sockeye situation (Sec 4.4).	overall	Fair					
	2009	Fair					
5. Contaminants in the Fraser River and/or Strait of Georgia are an important contributor to the Fraser sockeye situation (Section 4.5).	overall	Poor					
	2009	Poor					
6. Freshwater habitat conditions in the Fraser River watershed are an important contributor to the Fraser sockeye situation (Section 4.6).	overall	Fair					
	2009	Fair					

PSC Workshop Expert Advisory Panel's recommendations

" Create an on-going evaluation of pathogens in Fraser sockeye, and incorporate potential impacts from net-pen salmon farming. Ensure that new Aquaculture Regulations being developed by DFO include full reporting of fish health issues and production levels on farms."

Aquaculture impacts?

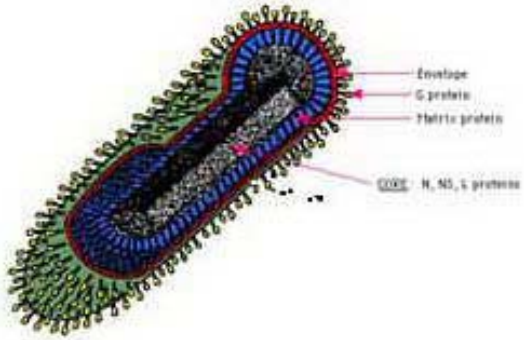
- Aquaculture within sea-cages leads to possible disease risks from the marine environment due to the generality that fish sharing water are likely to share diseases.
- Do salmon farms provide a mechanism for amplifying endemic pathogens?
- A. Morton's presentation, "Pathogens, including sea lice and diseases such as bacteria and viruses, either naturally occurring or passed from fish farms, are an important contributor to the Fraser sockeye situation.
  - Infectious hematopoietic necrosis virus (IHNV)

Infectious Hematopoietic Necrosis Virus (IHNV)

First published description of IHNV in Sockeye salmon appeared over 50 year ago (Rucker et al. 1953)

Naturally occurring in sockeye salmon in BC

- Adults: asymptomatic
- Fry: high mortality



IMPACT:

1. 1973 Chilko - loss of 23.7 million fry (Williams & Amend, 1976)

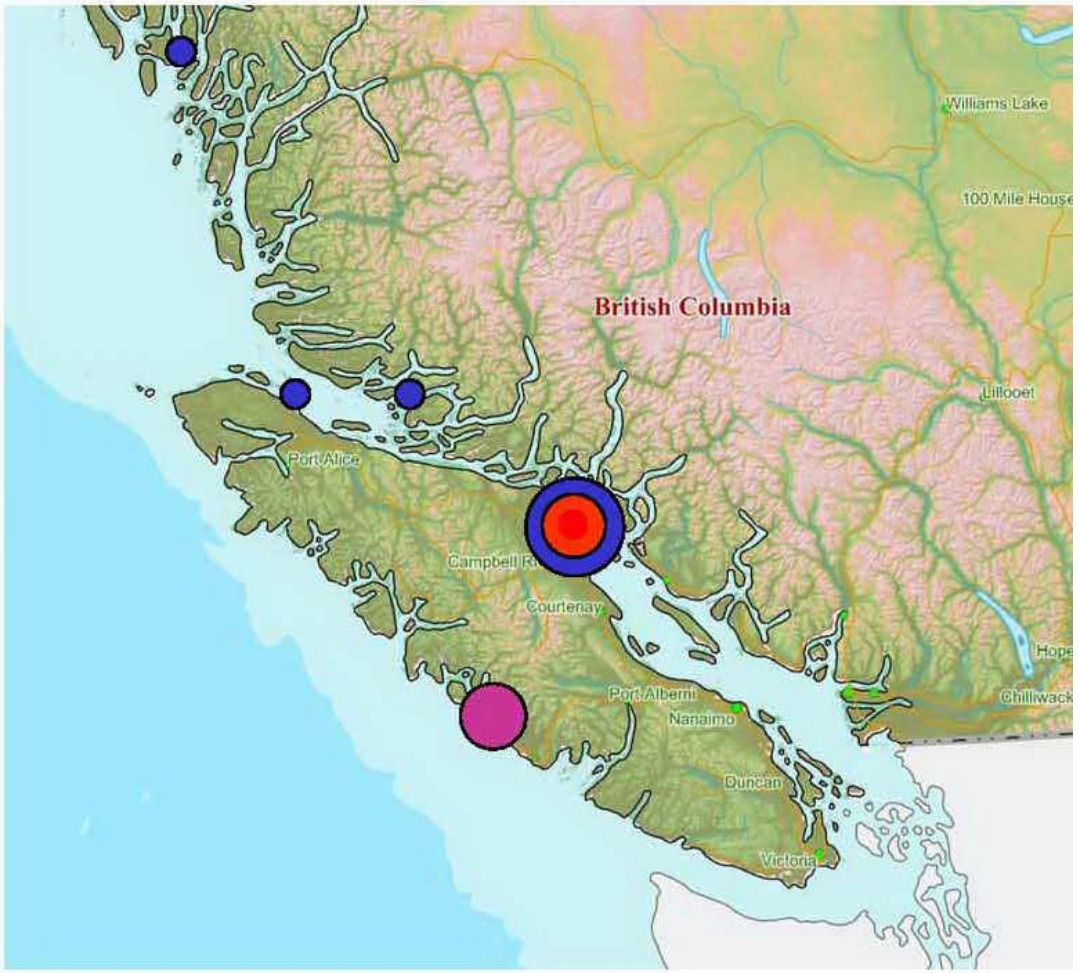
2. 1987 Weaver Creek spawning channel – 50% mortality in fry (Traxler & Rankin, 1989)

History of IHNV in Atlantic Salmon in BC

1992 : First occurrence of IHN in farmed Atlantic salmon in BC
- From 1992-1997 a total of 14 netpen sites near Campbell River were affected all within 22 km radius

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

2002: Third outbreak occurred on the west coast of Vancouver Island and eventually affected 10 sites



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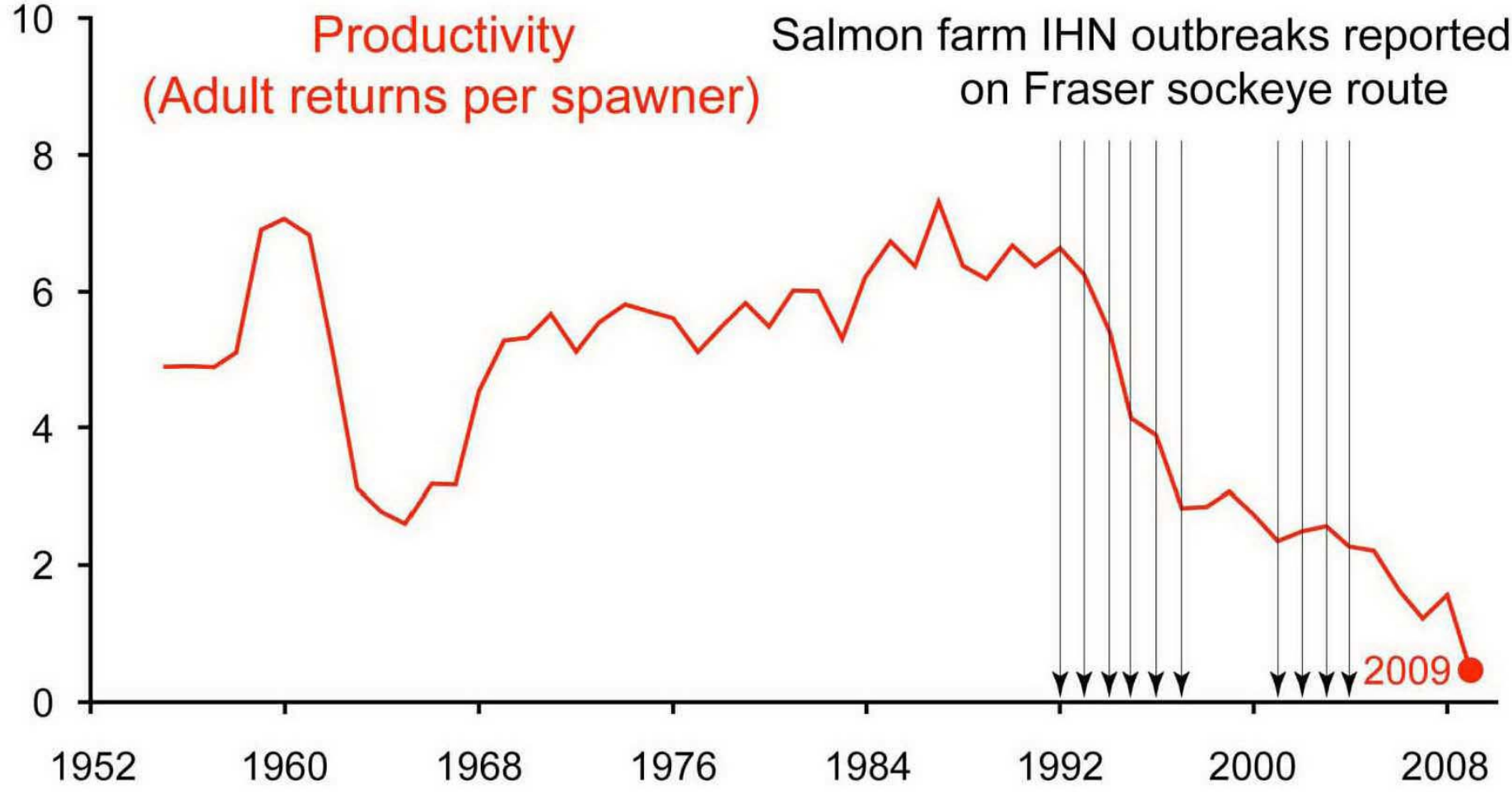
What was learned?

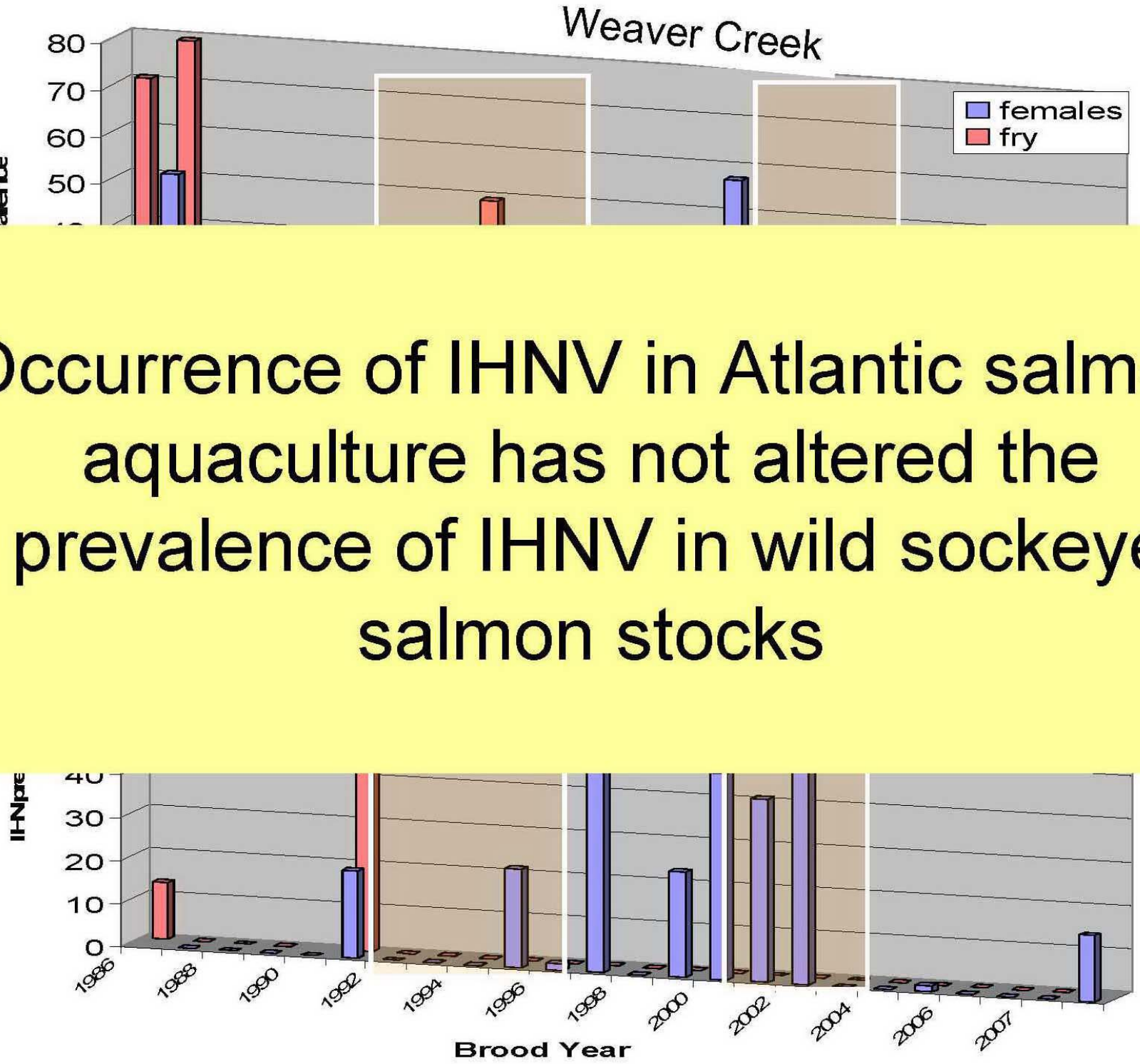
Transmission = rapidly spread (St. Hilare et al. 2002, Saksida et al. 2006)
Farms infected with IHNV during an epidemic had an identical virus type indicating farm to farm spread.

- Anthropogenic
- Waterborne

Do salmon farms provide a mechanism for amplifying IHNV?



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



Occurrence of IHNV in Atlantic salmon aquaculture has not altered the prevalence of IHNV in wild sockeye salmon stocks

Risk of IHN virus dispersal from farms?

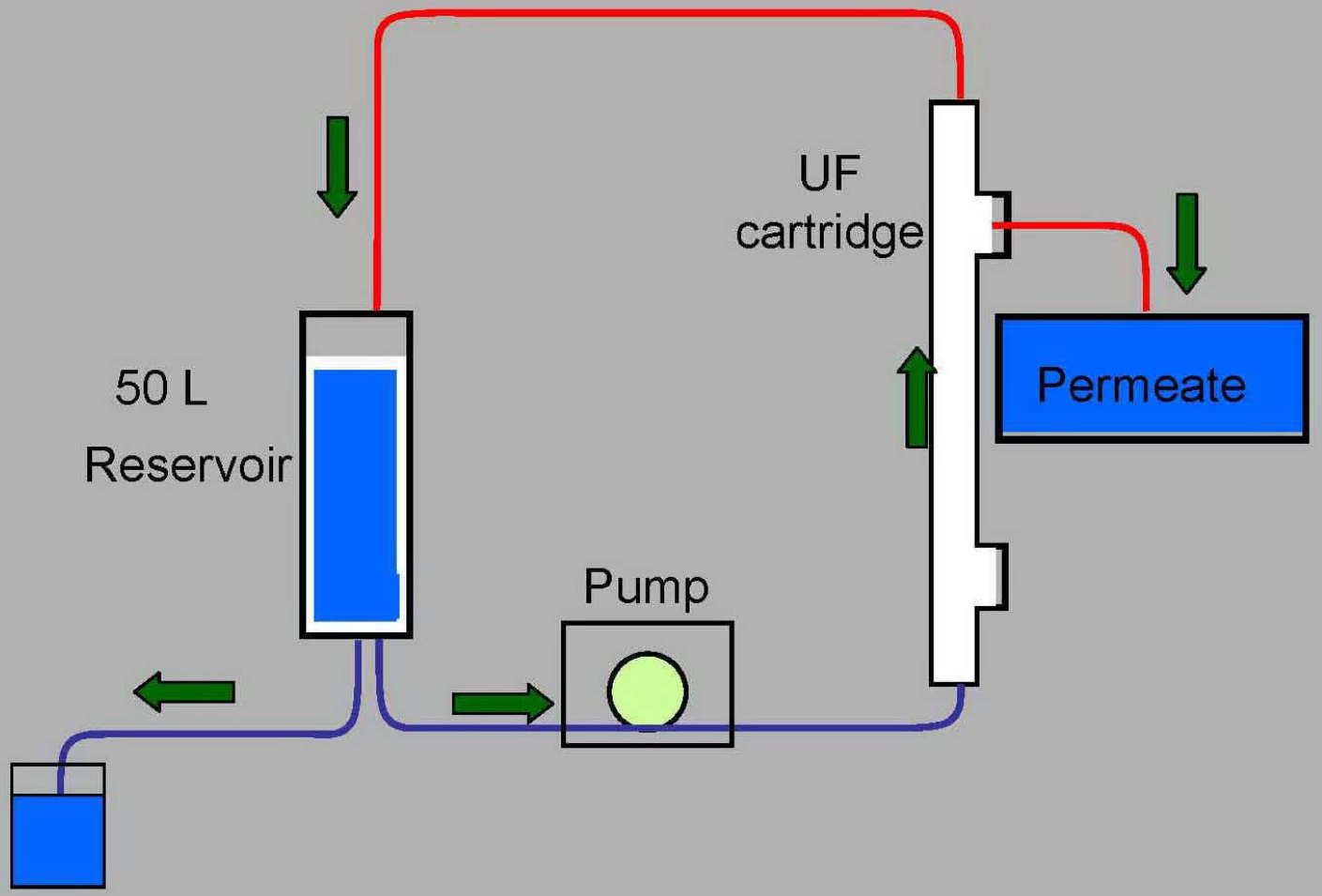
Risk of IHN virus dispersal from farms?

1. How much virus is produced from an infected farm? (Viral shedding rates of Atlantic salmon)

2. How long can the virus last outside of its host? (Virus stability in seawater)

3. What is the minimum infectious dose of IHNV in salmon?

Ultrafiltration method



Retentate (100X) → 50,000 to 500 mL

>80% retention of virus

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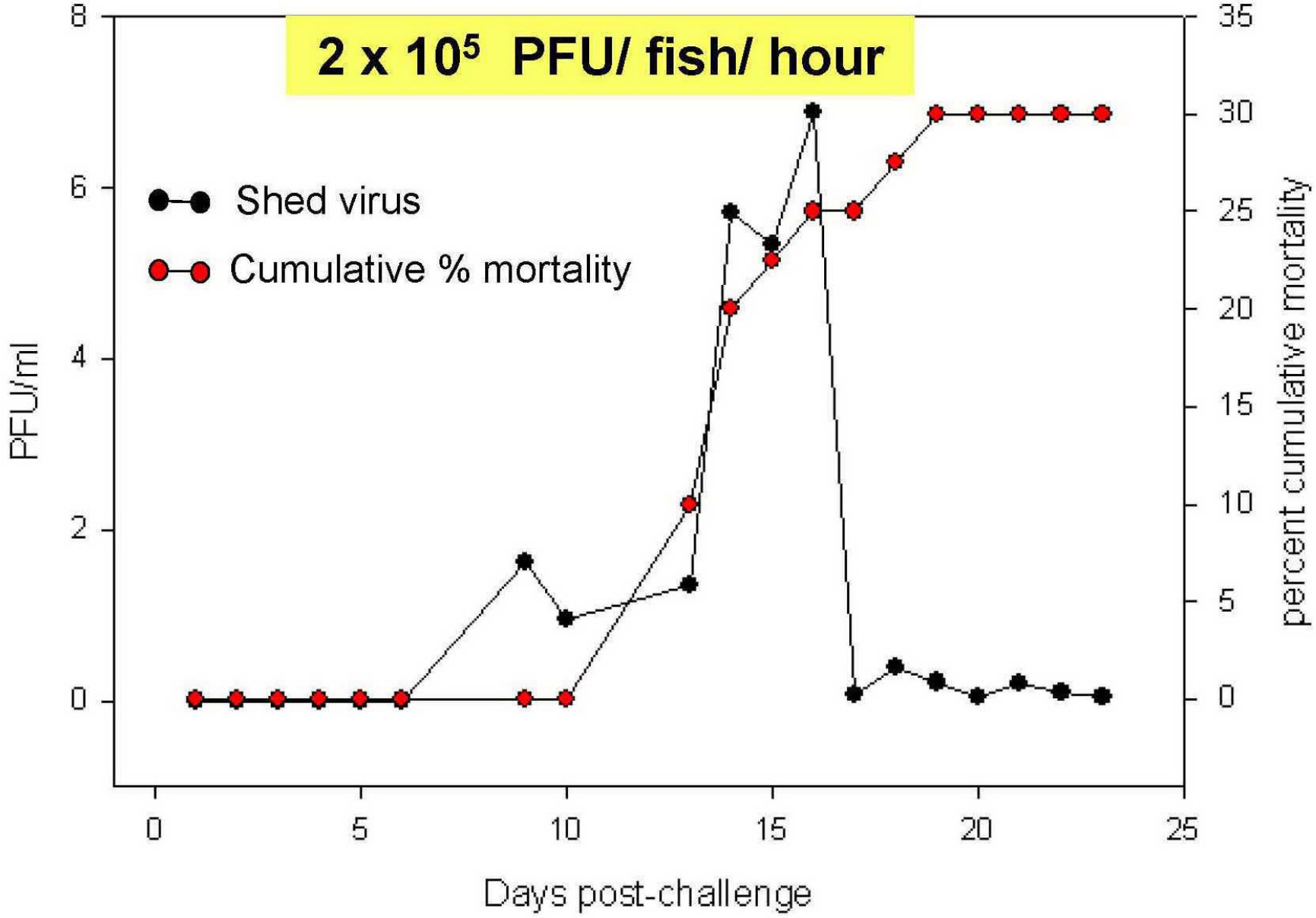
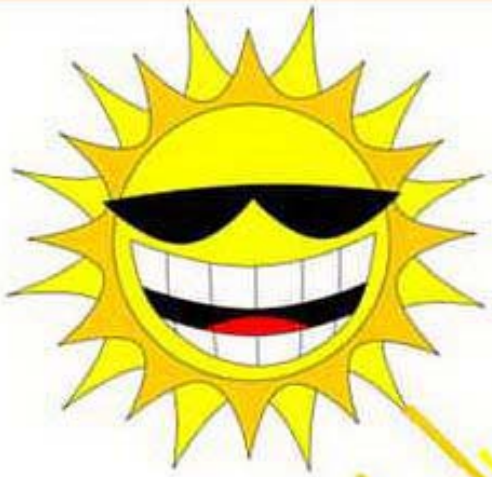
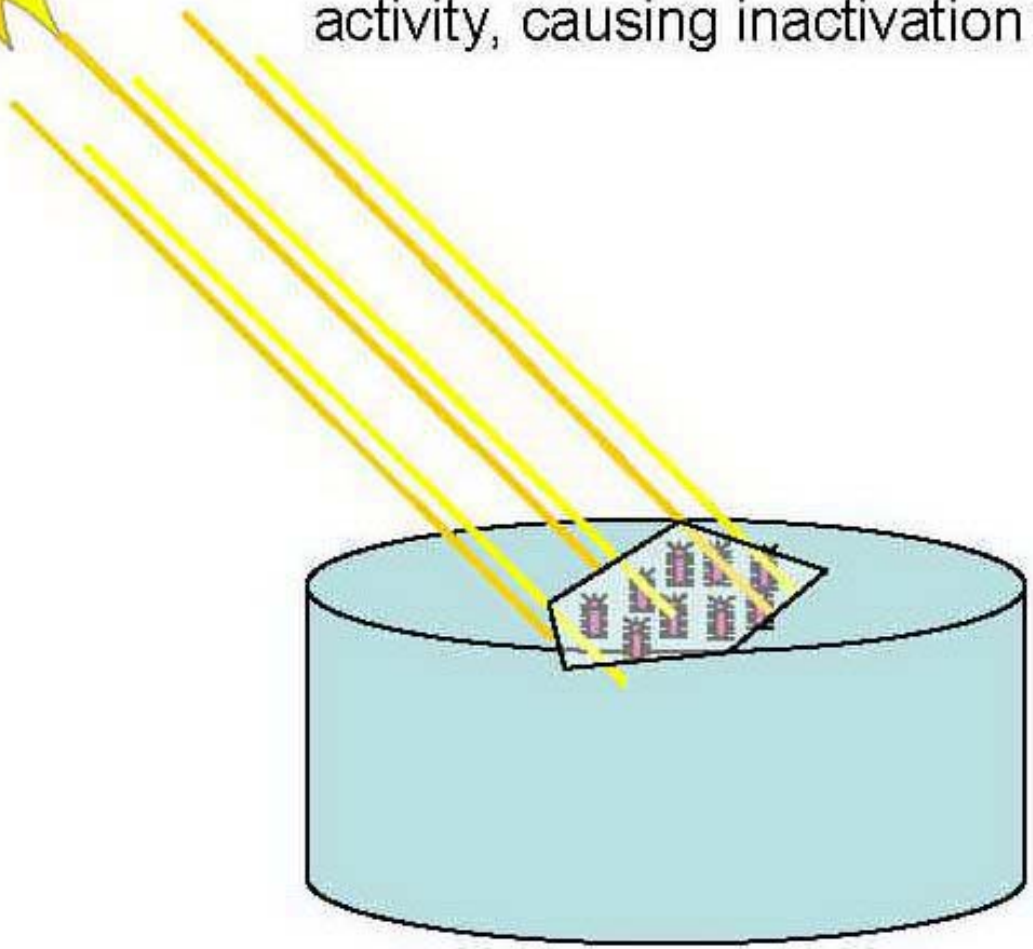
IHNV shedding in Atlantic salmon



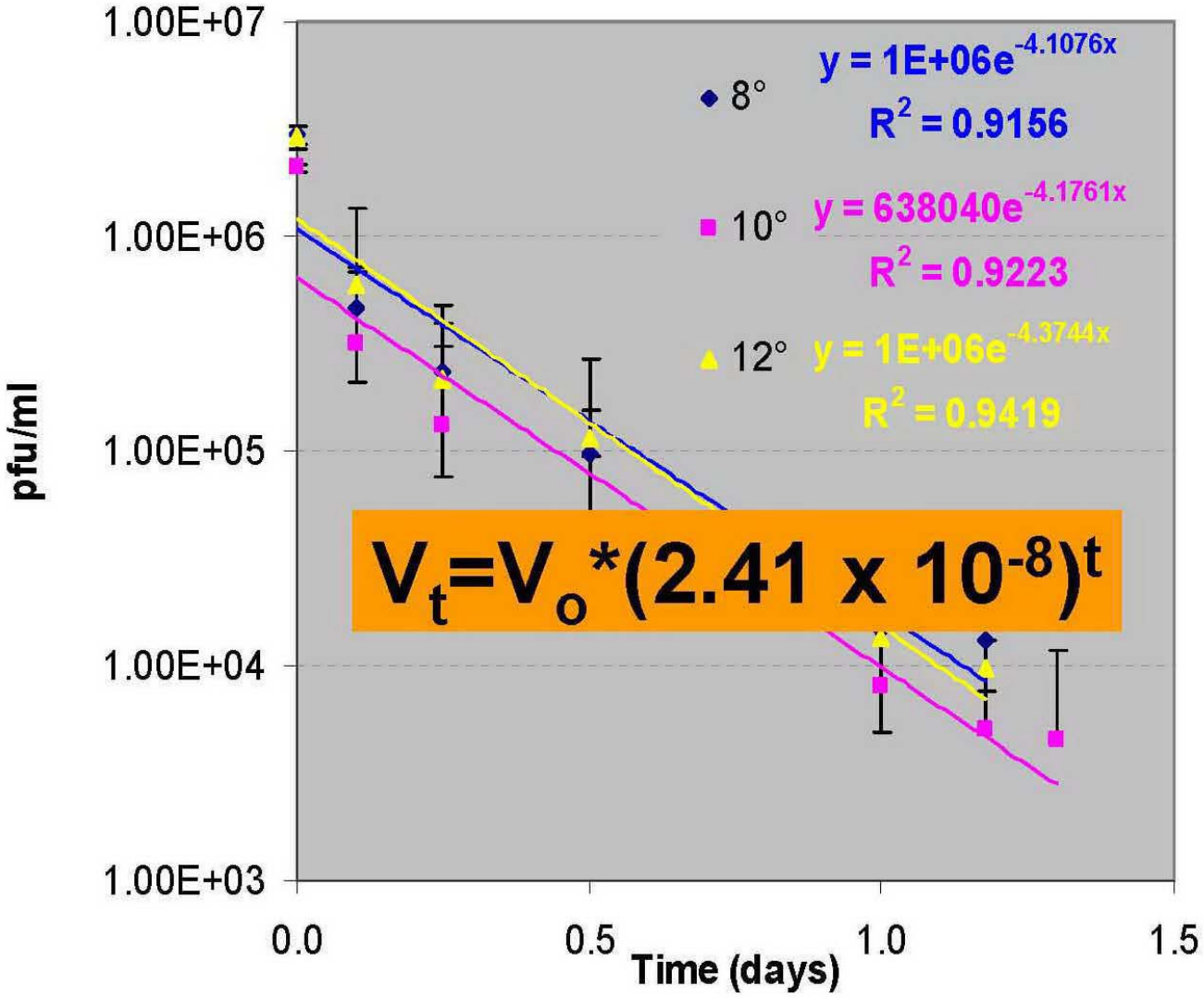
Virus inactivation



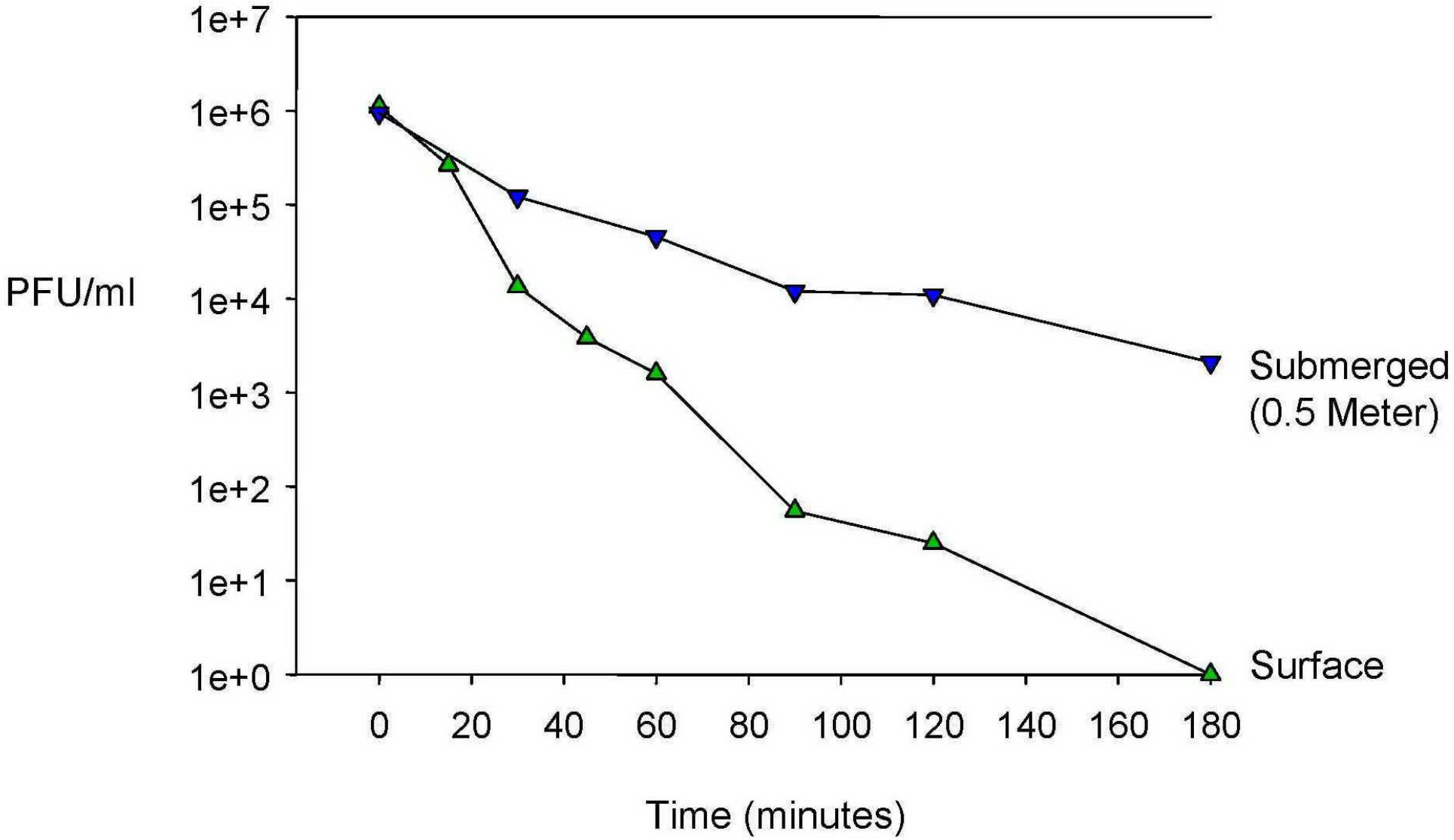
- UV radiation from the sun is the primary germicide in the environment
- Naturally occurring microbes also have antiviral activity, causing inactivation of viruses



IHNV decay over time in Saltwater (Night)



IHNV decay rate due to sunlight exposure

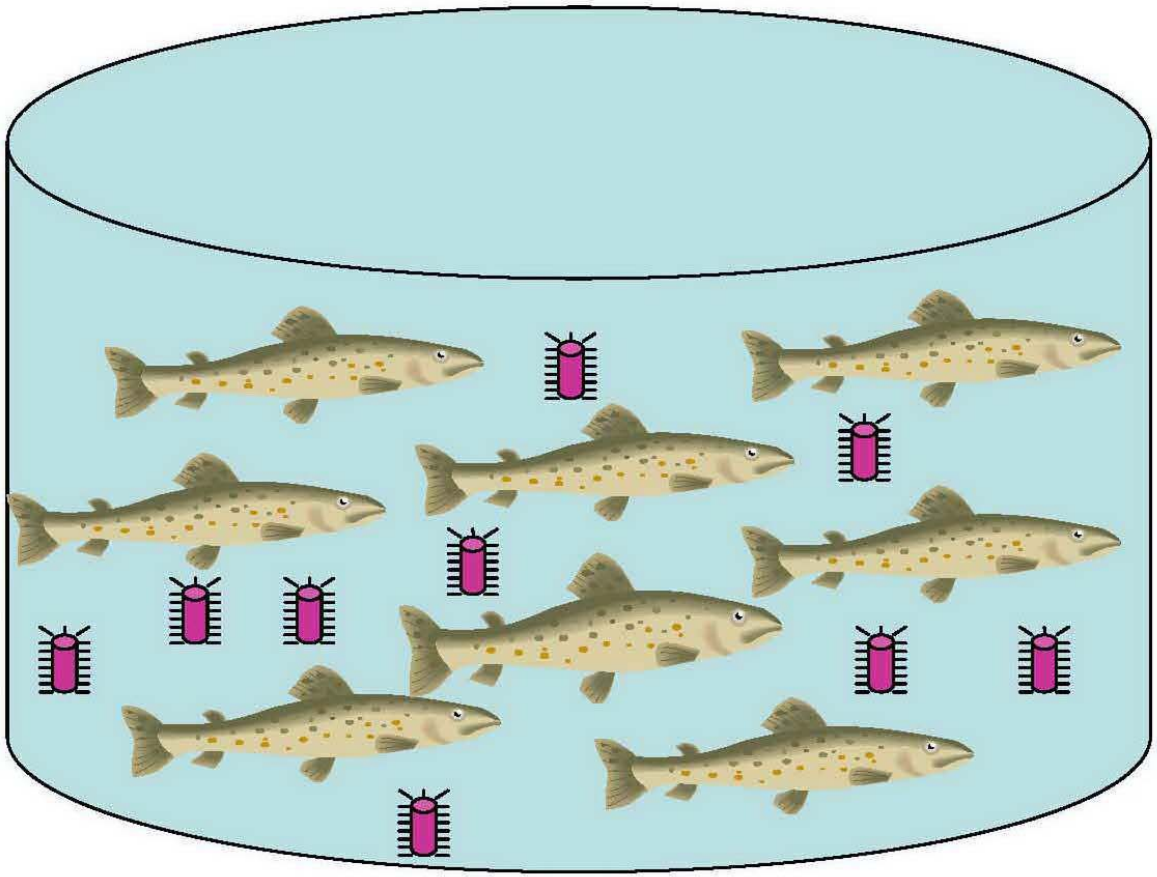


Minimum Infectious Dose (MID)

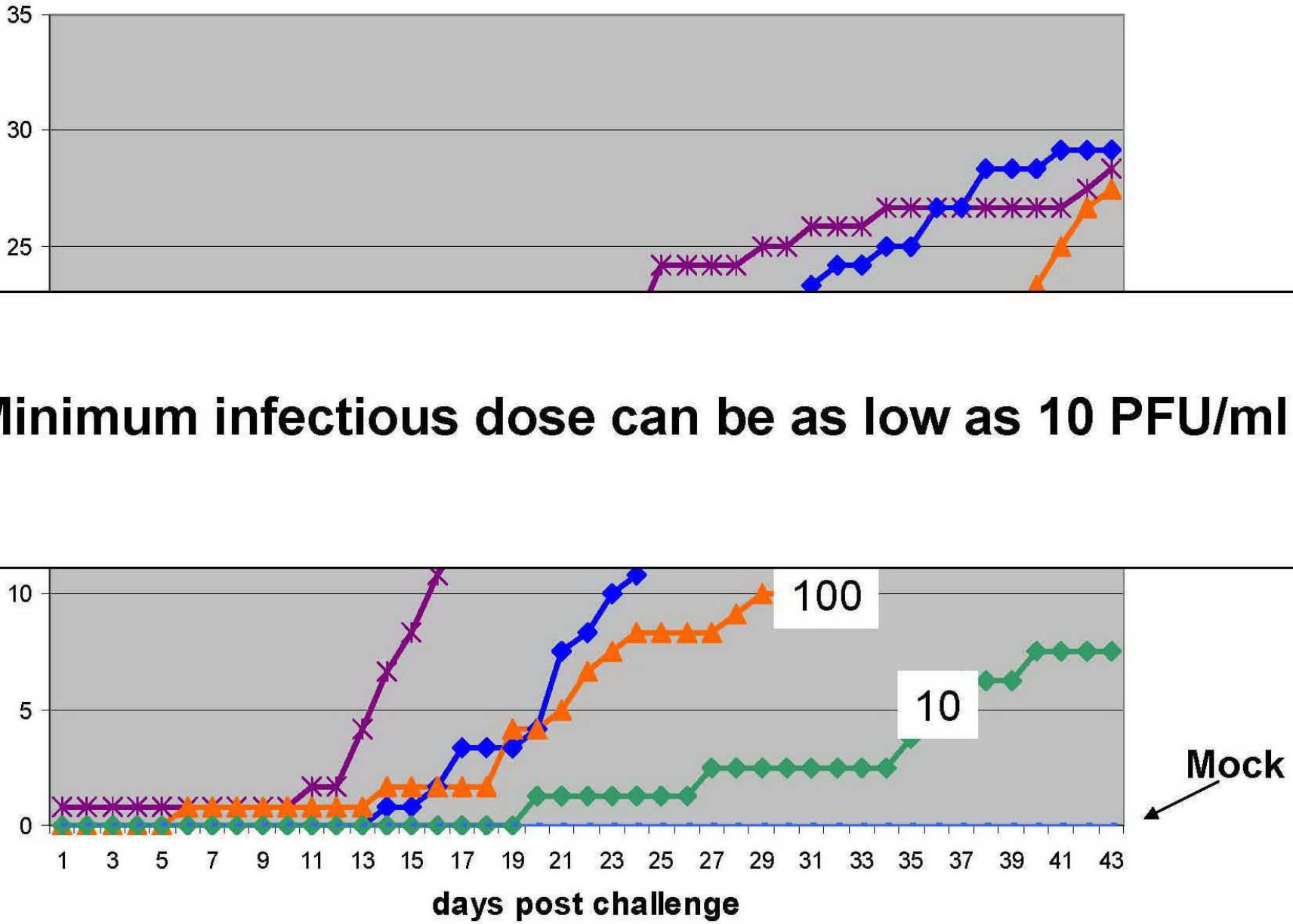
- Waterborne exposure of Atlantic Salmon to IHNV
  - 1 hour static immersion challenge
  - IHNV strain isolated from Atlantic Salmon
  - 10 degrees Celsius

- Challenge dose (PFU/ML)
  - 10^4 ,10^3, 10^2, 10^1

- Monitor for mortality and assay for virus

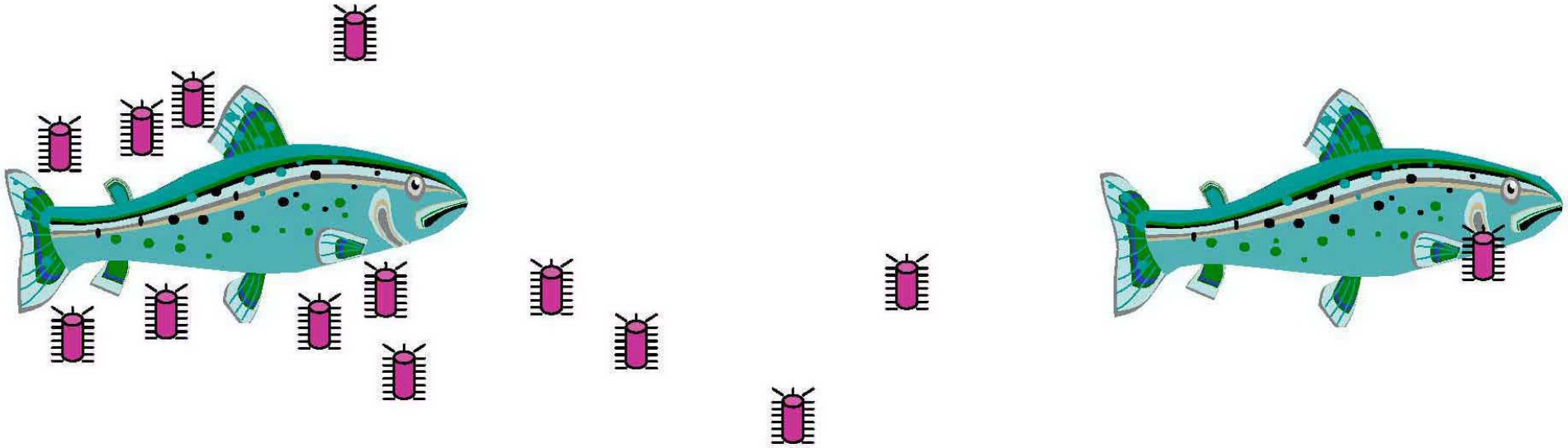


Minimum infectious Dose



Minimum infectious dose can be as low as 10 PFU/ml

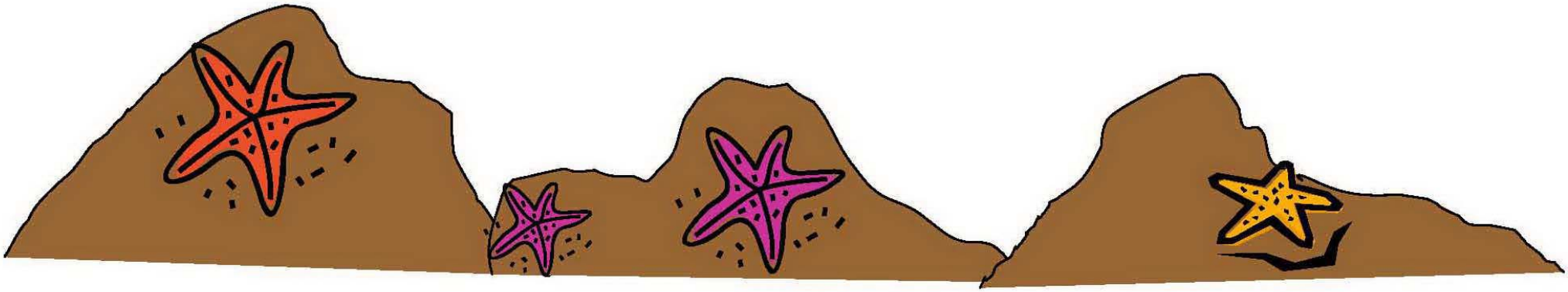
Summary



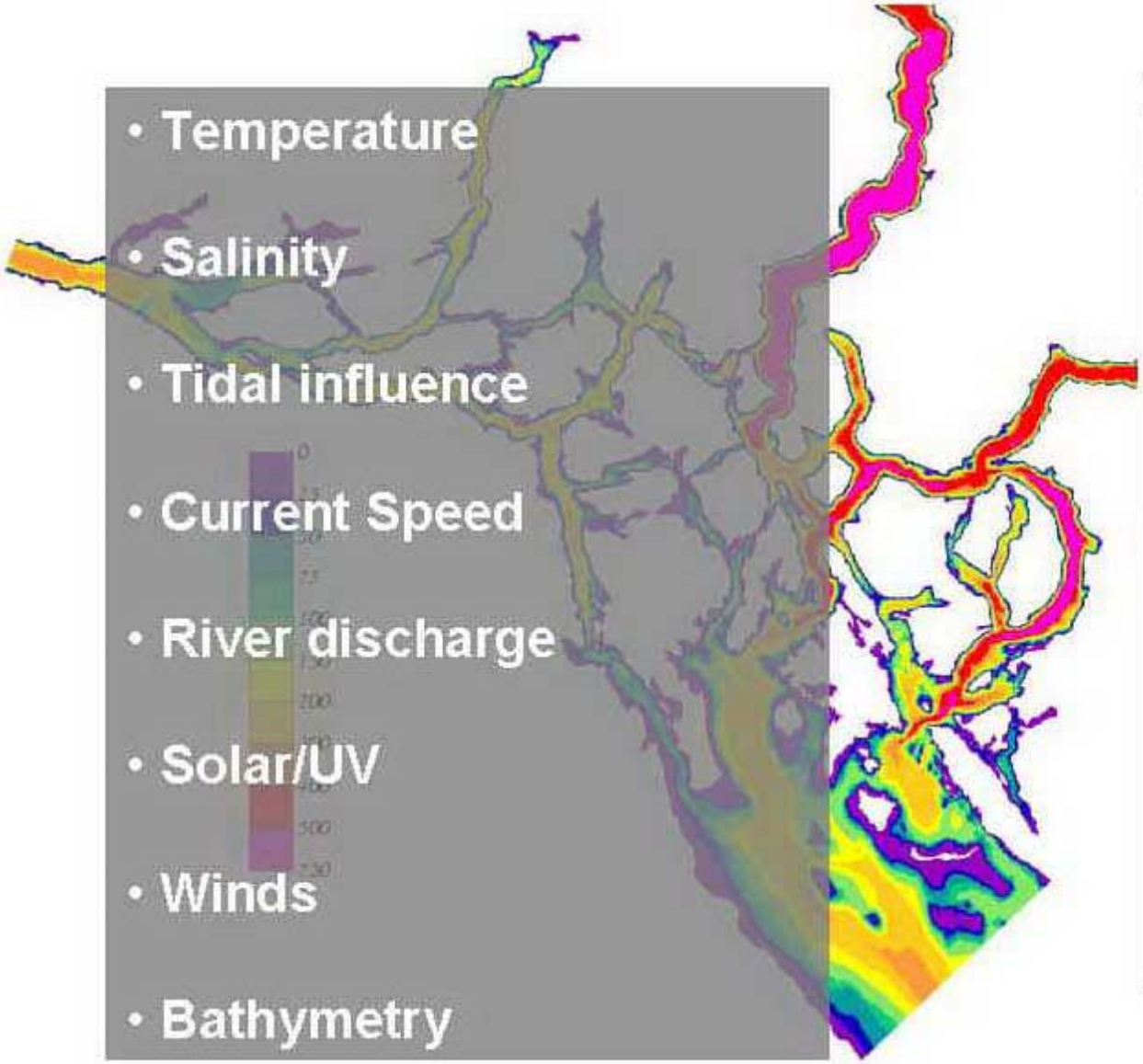
1) Large number of viruses are shed

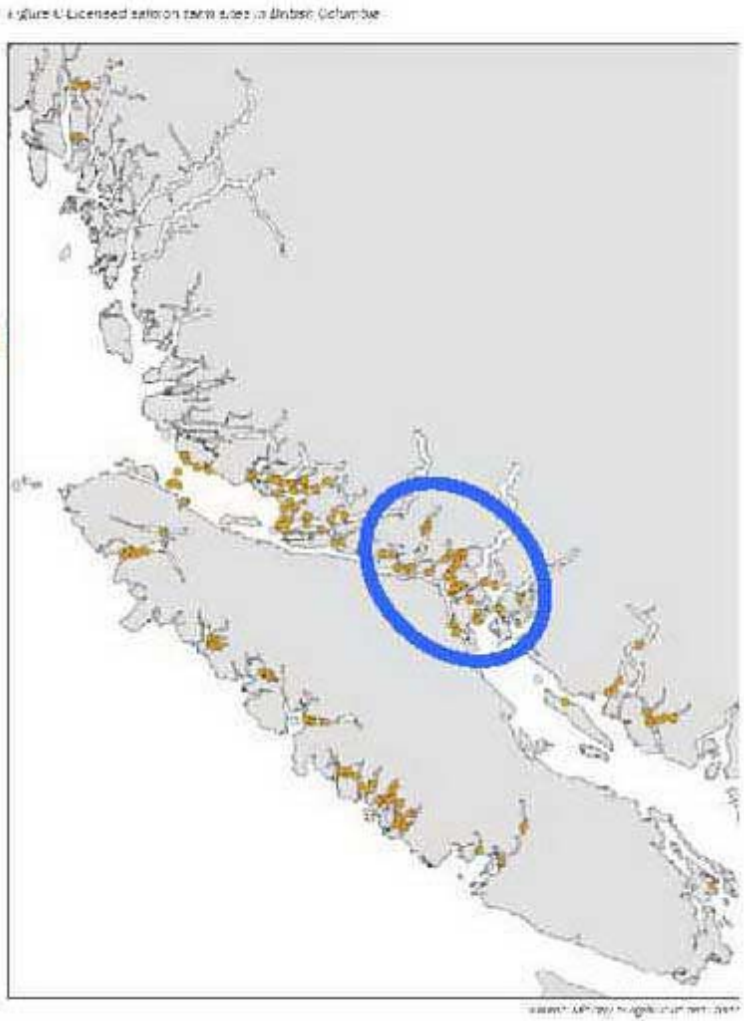
2) Viruses decay rapidly in saltwater environments

3) Low doses of virus are infectious

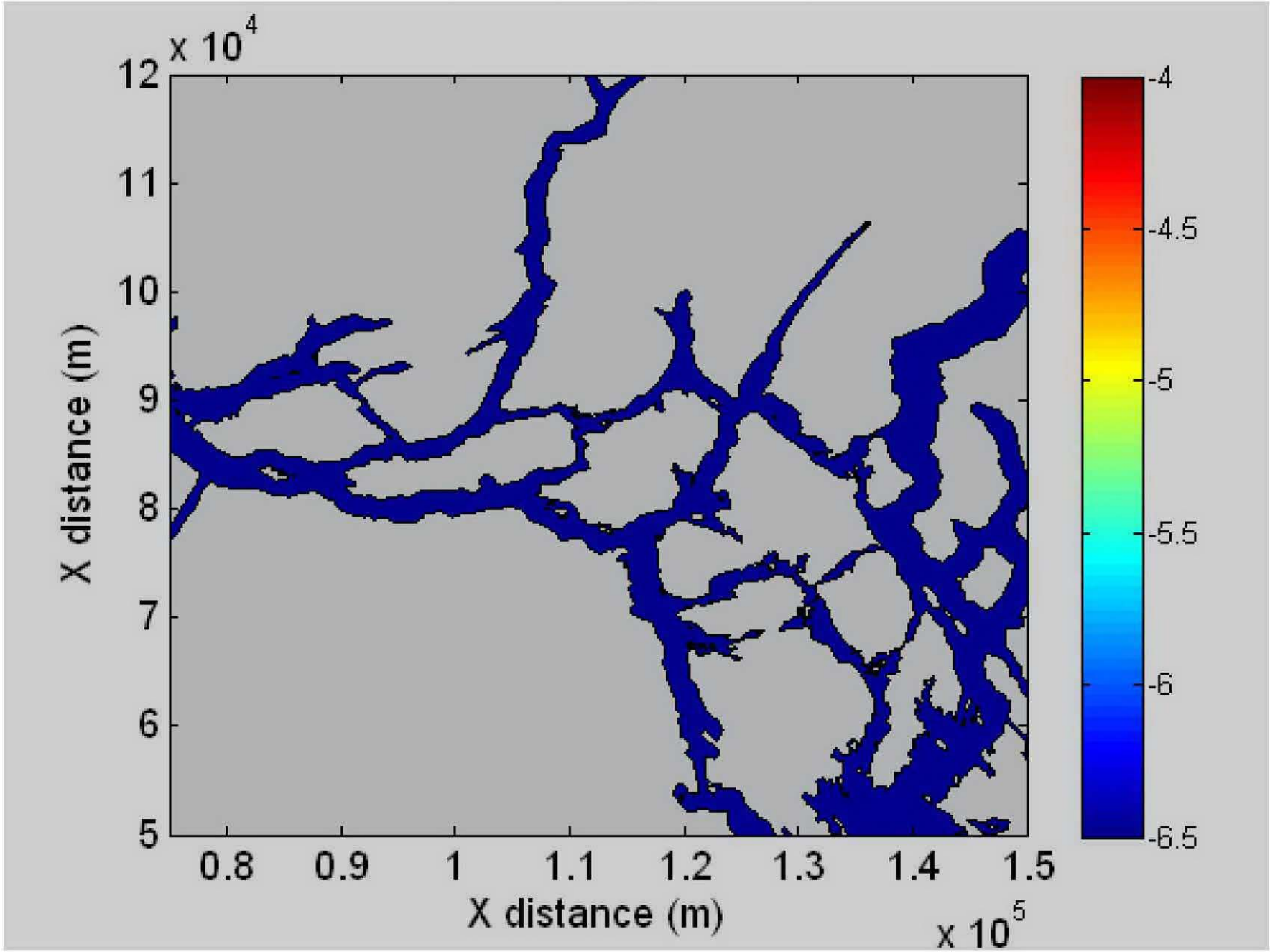


Water circulation model for the Discovery Islands





Viral Dispersion



Future work

- Refinement, completion and extension of virus dispersion model to West Coast Vancouver Island
  - Shedding rates and minimum infectious dose of IHNV in Sockeye salmon