Disease Interactions of Wild and Cultured Salmon

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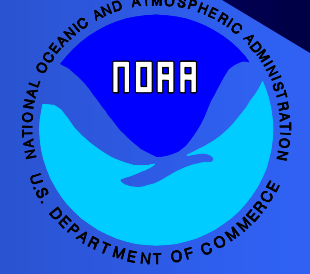


Objectives

1) Understanding of “disease” process
2) Learn about salmon diseases in NW
3) Examine interactions between wild and cultured salmon
4) Consider opportunities to minimize potential impacts of diseases

The Case of the Sickly Salmon

Indictment # 1

"Lo and behold, now we have Atlantic salmon in this state (WA) and now we have viruses (VHSV) we have never seen before."

Rob Zuanich, Commercial fisherman, Seattle P.I., 2/28/89

Indictment #2

"It doesn't take too much gray matter to put two and two together. You have to ask how the thing (VHS virus) leap-frogs from Europe to Puget Sound. The common denominator would be Atlantic salmon."

Jerry Grover, Administrator, USFWS, 2/28/89

Indictment # 3

“ They breed disease and parasites. Like other big animal feedlots there are lots of problems.”

Jeff Reardon, Trout Unlimited, in NY Times article by Marian Burros, 5/28/03

Indictment #4

" And (farmed) fish may transmit diseases such as sea lice to wild stock, or breed with wild fish causing genetic pollution. In the past decade, 1 million non-native Atlantic salmon have escaped…and established themselves in streams in NW America"

The Economist, 8/7/03

Indictment # 5

"In addition to the PCB problem, there are numerous environmental issues associated with farmed salmon: waste, disease, accidental release…"

Carole Baldwin, Smithsonian marine biologist.

Author of "The Smithsonian Sustainable Seafood Cookbook"

Indictment # 6

"At salmon farms, thousands of fish are crowded into net pens with serious health repercussions for both the surrounding waters and the salmon themselves, …diseases spread from the farms to the wild fish that swim past the pens."

Salmon Nation, in pamphlet funded by *Ecotrust*

Guilty as charged?

Or, are we rushing to judgment?

Definitions & Background

- Aquaculture
- Pathogen
- Disease

“Disease” is a complex process!

- Pathogen factors
- Host factors
- Environmental factors

Pathogen Factors

- Virulent?
- Quantity?
- Viability?
- Reservoirs?
- Intermediate life stages or alternate hosts?

Hypothetical bacteria shedding during outbreak

- Pen complex of 500,000 salmon
- Pathogen conc. in pens – 277 “bugs”/ml
- 100 m away from pens - 14 “bugs”/ml
- 200 m away from pens < 3 “bugs”/ml
- Infective dose > 100 “bugs”/ml for 3 weeks

(Rose et al, 1989)

* Assumes a constant depth of 20 m; Pen complex = 90,000 m^3

Conclusions from shedding model

- It takes a lot of “bugs” to cause infection
- Within a pen during a disease outbreak, plenty of “bugs”
- Within a very short distance, not enough “bugs” to cause infection, let alone disease

Host Factors

- Genetics
- General health
- Stage in life history
- Prior exposure, immunization
- Relative density of cohorts

Spawning Sockeye salmon

Environmental Factors – Impacts on host and pathogen

- Season
- Water chemistry
- Tides and currents
- Food supply for host & pathogens
- External “stressors”

Pathogens of salmon

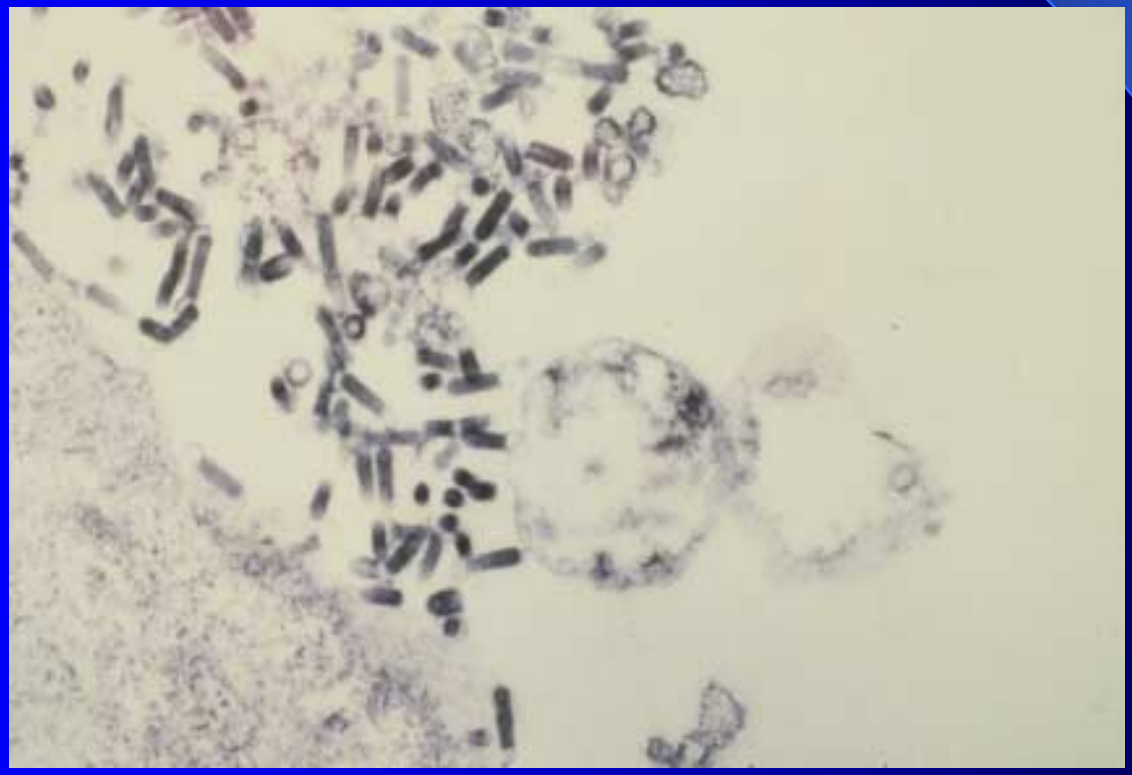
- Virus
- Bacteria
- Parasites
- Fungi

Common viral pathogens in Pacific NW

Infectious hematopoietic necrosis virus - (IHNV)

Viral hemorrhagic septicemia virus - (VHSV)

EM of VHS virus



Common bacterial diseases of wild and cultured salmon

Furunculosis (*Aeromonas salmonicida*)

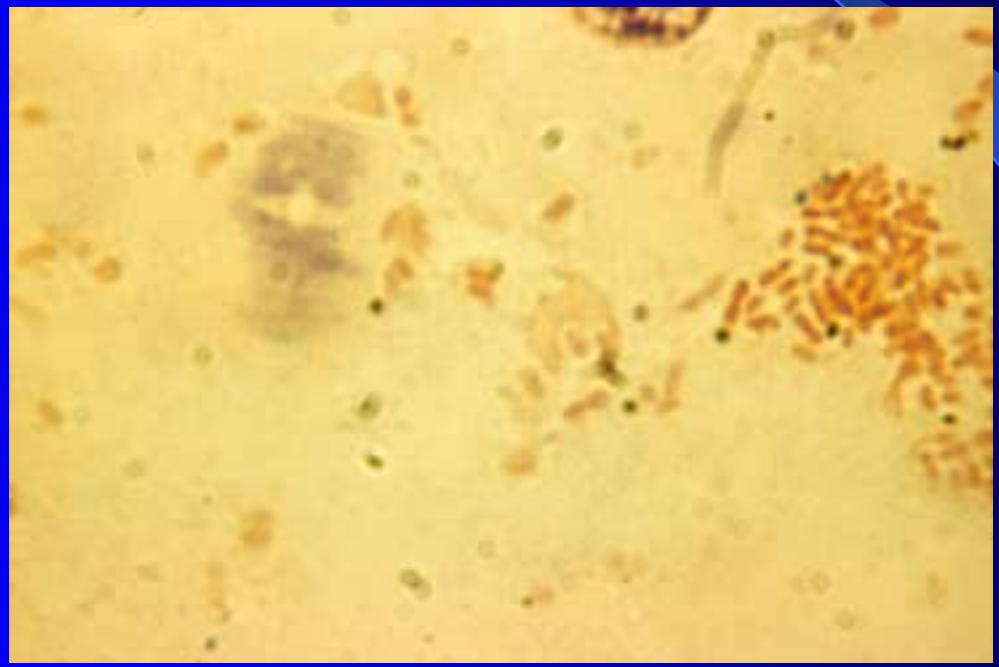
Bacterial kidney disease (*Renibacterium)*

Columnaris (*Flexibacter sp.*)

Vibriosis (*Vibrio ordali, V. anguillarum*)

BKD in wild female Chinook

Bacteria – *Aeromonas salmonicida*



Common parasites of salmon

Sea lice

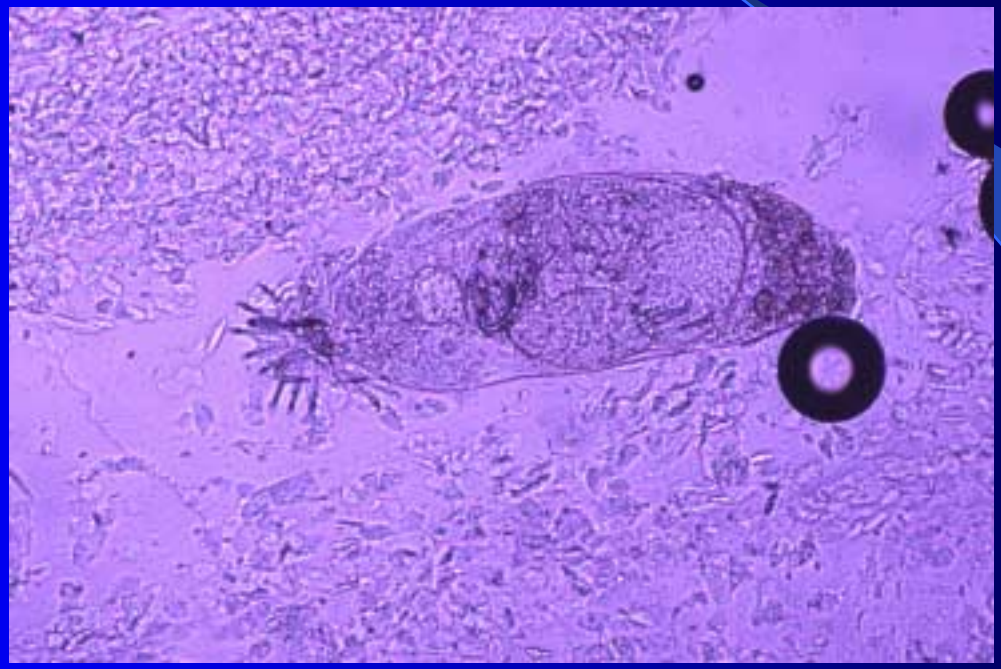
Gyrodactylus

Myxosporeans – Kudoa, Henneguya,

“White spot” or “Ich”

Gill amoeba

“Gyro”



Sea lice

What do all the salmon “bugs” have in common?

1) Occur naturally in wild fish.
2) Not introduced by Atlantic salmon.
3) None are exotic to the region
4) All are capable of causing disease in wild and cultured salmon

Essentials to cause a disease outbreak: “Perfect Storm”

1) Adequate number of susceptible hosts
2) Adequate number of virulent “bugs”
3) Environmental conditions which favor the pathogen and compromise the host

Do disease outbreaks occur-

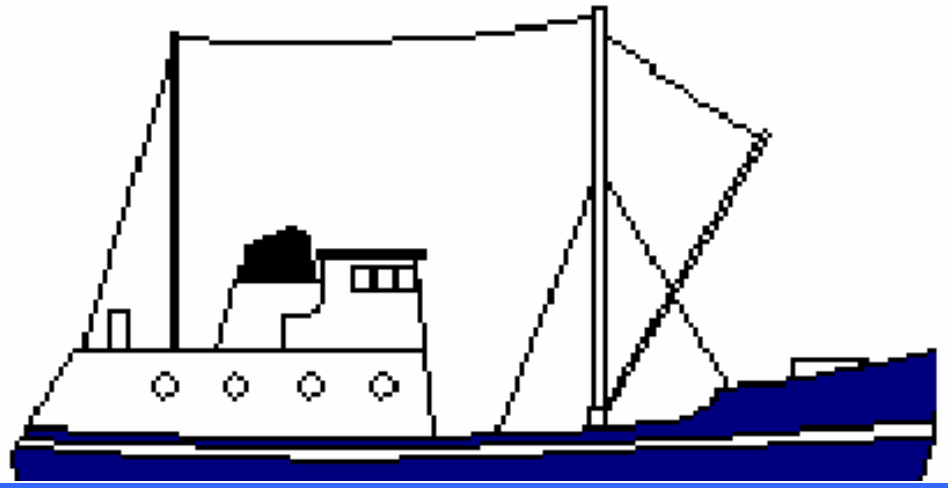
In marine pens and hatcheries? Yes!

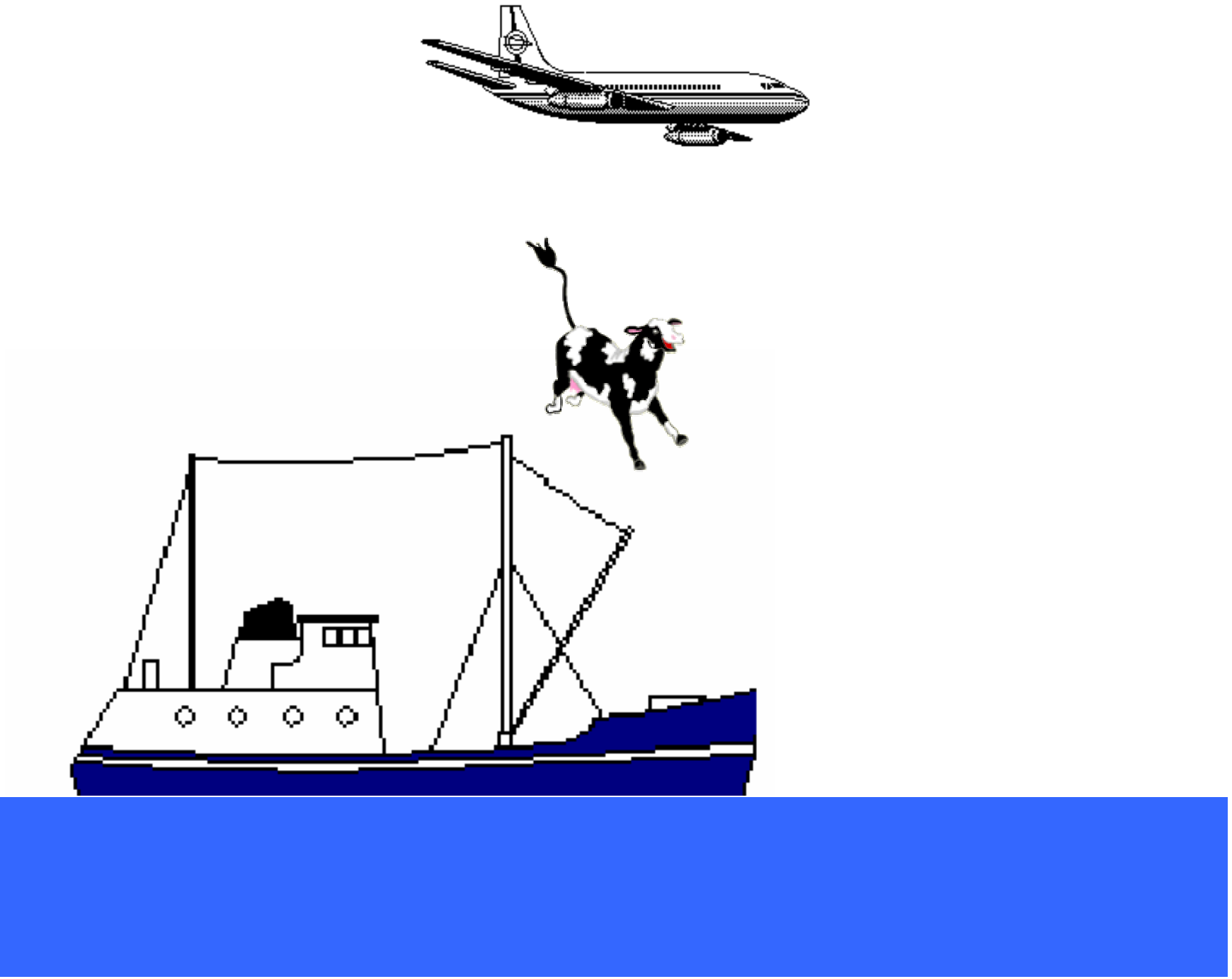
In wild salmon stocks? Absolutely!

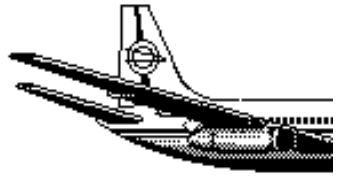
In species other than salmon? For sure!

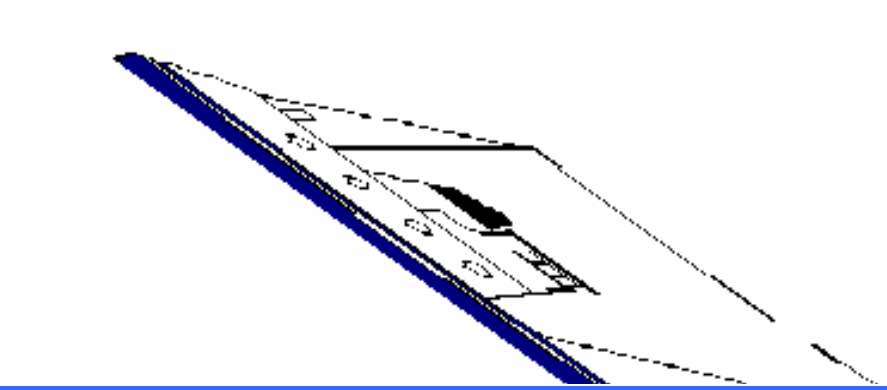
Due to transmission of “bugs” from wild to cultured fish? Unquestionably!

In wild fish due to shedding of “bugs” from net pens? Possibly…….









The Evidence

- Evidence will be science-based!
- The sciences of epidemiology & pathology will form the cornerstones of our case.
- The “Court” will avoid philosophy, religion, sociology, and politics.

Summary of salmon releases/escapes

- In 2002, **2.3 billion+** salmon released from government & tribal aquaculture facilities
- Assume > number of wild smolts emigrated
- In 2002, **20-23 million** "SPF" Atlantic salmon smolts brought to pens
- From 1992-2002, estimated 1 million Atlantic salmon escaped from pens

Salmon Aquaculture in 2002

(Numbers of fish stocked/released in millions)

States/Province	Atlantic salmon	Pacific salmon
Alaska	-0-	1,485
British Columbia	18-20	492
OR & CA	-0-	80
Washington	2-3	248
Total	23	2,305

Case histories

- IHN
- Furunculosis
- Sea lice
- Gyros in Norway/Baltic
- VHS in the Pacific NW

Facts on IHN

- Many wild salmon stocks (all sockeye) are infected with IHN virus.
- IHN outbreaks occur regularly in cultured and wild salmon populations.
- Most severe outbreaks occur in years of largest returns of stocks to spawning grounds. Example – Chilko River

(Williams&Amend,1976)

VHS virus

- VHS virus first isolated in U.S. in “wild” Pacific salmon
- Non-scientists blamed Atlantic salmon
- VHS virus determined to be native bug
- Major outbreaks occur in the wild in sardines, herring and mackerel

Furunculosis and Vibriosis

- Both are native bacterial diseases
- Outbreaks in wild populations are well documented
- Outbreaks linked to high fish populations and adverse environmental conditions
- Vaccines effectively prevent diseases in pens

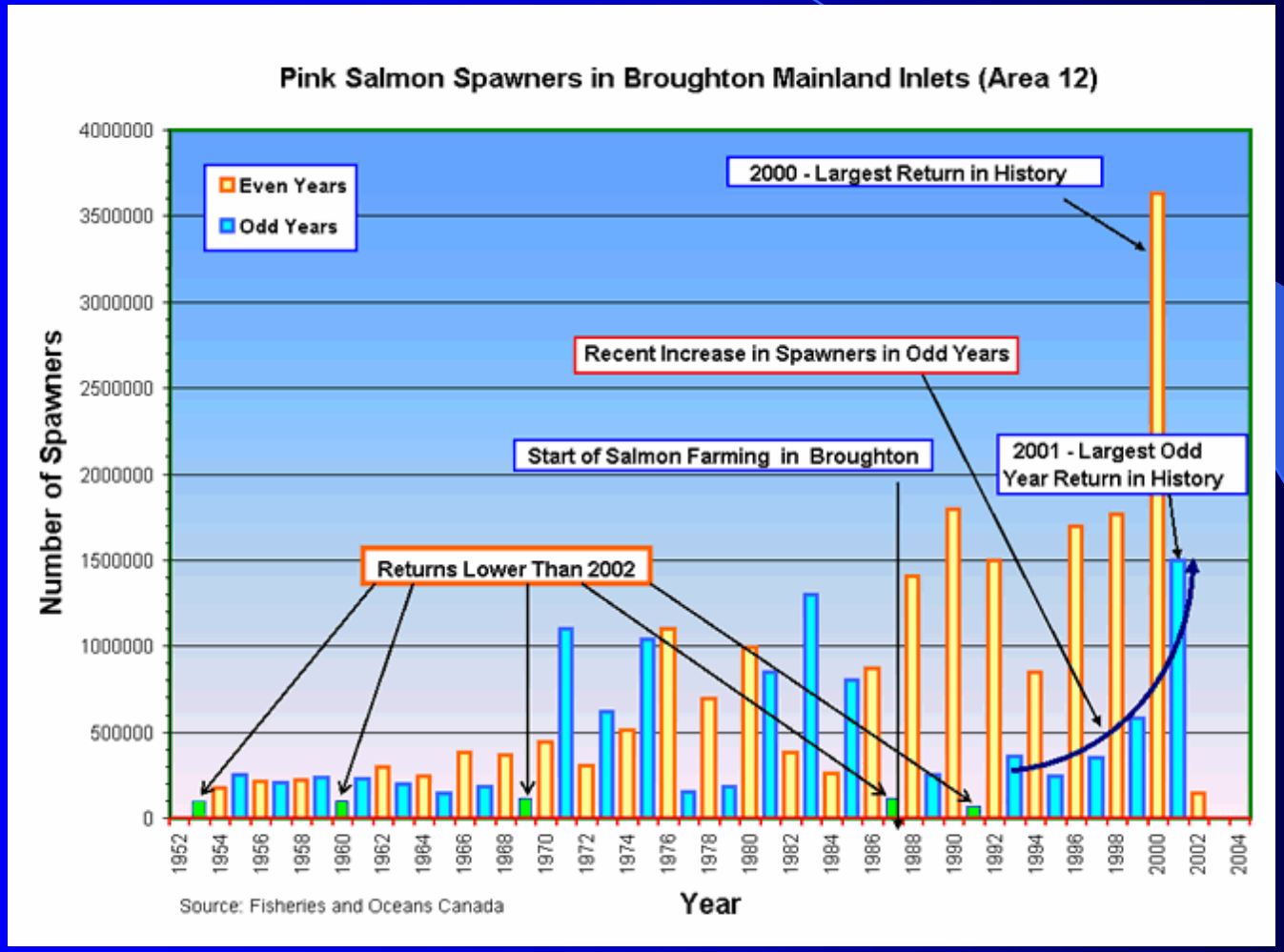
Sea lice

- High prevalence in Pacific salmon stocks.
- Natural outbreaks recorded – many prior to marine aquaculture – 1906, 1918, 1971.
- Linked to high numbers of salmon in close proximity
- Unusual environmental conditions
- Secondary invaders contribute to mortality

Broughton Archipelago

- Lice observed on pink salmon fry in 2001
- Record returns of pink salmon in 2000
  (> 3.5 million pink salmon adults)
- Near-record low returns in 2002 (200,000)
- Lice known to exist on Atlantic salmon
- Conclusion by some – Low return of adult pinks in 2002 due to lice from farms.

Pink adult returns to Broughton - BCSFA



Cause and effect

“When you hear the clattering of hooves, don’t assume it’s a zebra – more likely it is a horse!”

Lice shedding model for Broughton in 2001

Assume:

- 10 mil. Atlantics each with 3 gravid lice
- Estimate 5×10^9 total copepodid production
- Egg to smolt survival 10% = 5×10^8 pink fry

Outcome:

Only 10 lice for each pink salmon fry in whole archipelago!!!

Other considerations

- Many factors affect survival of pink fry as illustrated by graph
- Loads of lice > 100 lice/adult wild salmon regularly observed
- Loads of gravid lice on 3 kg+ Atlantic salmon Jan – Mar < 3 lice/fish
- Instantaneous standing crop of carrier wild salmon in Broughton exceeds # Atlantics

Conclusions on sea lice

- Wild salmon are a major reservoir
- Fish-to-fish transmission occurs within pens due to proximity of fish
- Lice #'s in pens low relative to wild salmon
- Given the history of lice and the dynamics of the salmon population in Broughton Archipelago, the evidence is weak that Atlantic salmon are responsible for population decline in 2002

New study from Scotland

- Laxford Bay data for 1999-2001
- Demonstrates lack of correlation between sea lice abundance on wild and farmed fish
- Other factors more important on the level of lice on wild fish than shedding from farmed fish.

(Marshall, 2003)

Alternative scenarios for Pink salmon crash

- “Feast begets famine” – redd superimposition, disease transmission on redds, poor nutrition due to competition.
- Significant environmental events in the rivers? Floods or de-watering of redds
- Higher than usual number of fry resulted exacerbated lice situation
- High # of adults in 2000 contributed to lice reservoir

Gyros

- Norway imported infected smolt from the Baltic to govt. hatchery.
- Norwegian stocks naïve to *G. salaris*
- Baltic stocks resistant to *G. Salaris*
- Lack of bio-security allowed Gyros to spread within Norway.
- Huge impacts due to disease mortality and decision by govt. to attempt eradication

High Risk – the “Exotics”

- “Exotics” have been major contributors to disease catastrophes world-wide in aquaculture.
- Yet to find an “exotic” salmon pathogen in Pacific NW

Summary of Evidence

- **“Bugs” don’t equal disease!**
- **“Bugs” are in all wild salmon stocks**
- **The # of wild salmon far exceed cultured salmon in pens.**
- **Atlantic salmon smolt are “SPF” when moved to pens.**
- **“Disease” is a complex process which occurs in both wild and cultured stocks.**

Judgment

- Salmon in pens are not causing disease outbreaks in wild salmon.
- Wild and cultured salmon shed “bugs”
- Disease outbreaks can occur in any population of wild or cultured salmon when we have the “Perfect Storm.”
- Impact of disease on wild salmon negligible compared to over-fishing or habitat degradation.

The Sentence

- Bio-security
- National health regulatory programs
- Public education
- Responsible reporting

Bio-security – role of the culturists

- “Protect” the farm from outside “bugs”
- Manage the spread of bugs within the site
- Keep staff informed and trained
- Use the services of fish health professionals

Regulatory programs – role of government

- Institute science-based national aquatic animal health programs – NAAHP
- Prevent the introduction of exotics!
- Focus on disease-prevention – license enough sites to allow fallowing and single-year class rearing
- Provide necessary resources for program
- Be good stewards of both wild and cultured resources.

Public education – roles of govt. and citizens

Government:

Make public aware of scientific facts regarding disease and aquaculture: Workshops, public forums for input, quick response to inquiries, work with the media (Kudos to PSMFC!)

Citizens:

Become educated! Be discerning on media outputs; Ask questions! Alert officials on disease events.

Responsible reporting – by public agencies and media

- Get your facts straight!
- Obtain the best scientific information from scientific experts!
- Give the public an opportunity to develop an opinion based on accurate reporting and science, rather than spin.

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