A Canadian perspective on the recent decline of the New Zealand salmon fishery

Presentation by David Willis

New Zealand Salmon Symposium

Ashburton, Canterbury

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Outline

1. Who I am and what I do
2. Status of Chinook salmon in Canada
3. The role of hatcheries in salmon recovery
   - Maximizing the fishery benefit from hatcheries
   - Hatchery & wild salmon interactions
4. Chinook Salmon management & recovery in Canada
   - Case study of an effective recovery process: Cowichan River Chinook salmon

Who am I?

- I work for the Salmonid Enhancement Program in the Department of Fisheries and Oceans Canada

- DFO is responsible for managing all saltwater fish and fisheries, as well as freshwater salmon.

My job

- Head Biologist for Coastal Hatchery Operations
  - Manage the salmon hatchery programs in Coastal British Columbia
- I oversee 9 government hatcheries (85 staff) that enhance 6 species of salmon on 32 different populations
- Program design, evaluation, research & management

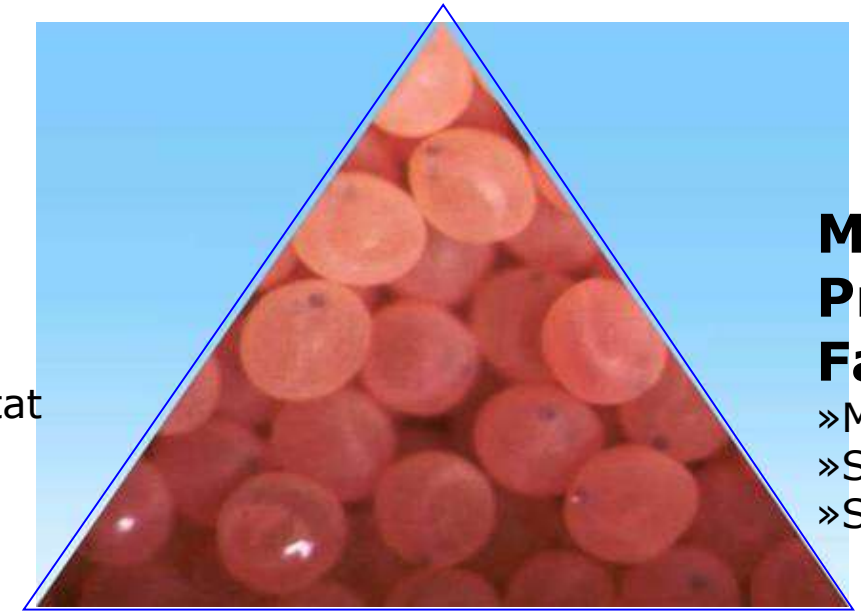
My background

- Wild salmon stock assessment & monitoring
- My recent and current positions have been heavily involved in integrated salmon management, recovery & research from a hatchery perspective





Salmon Enhancement Program (SEP)



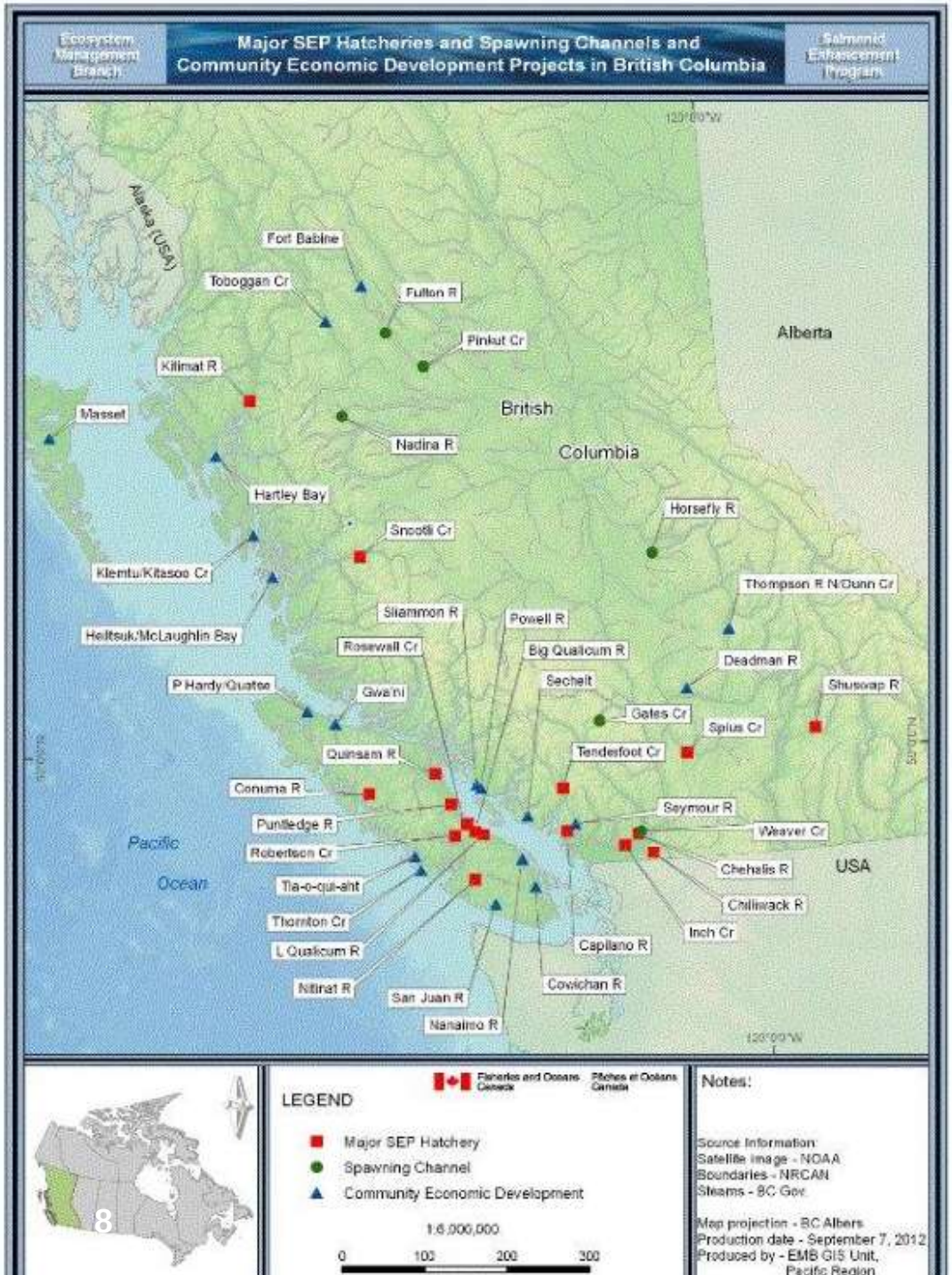
Habitat Restoration
»Net gain of fish habitat
»Watershed health
»Salmon recovery

Major Fish Production Facilities
»Major hatcheries
»Spawning channels
»Sustainable fisheries

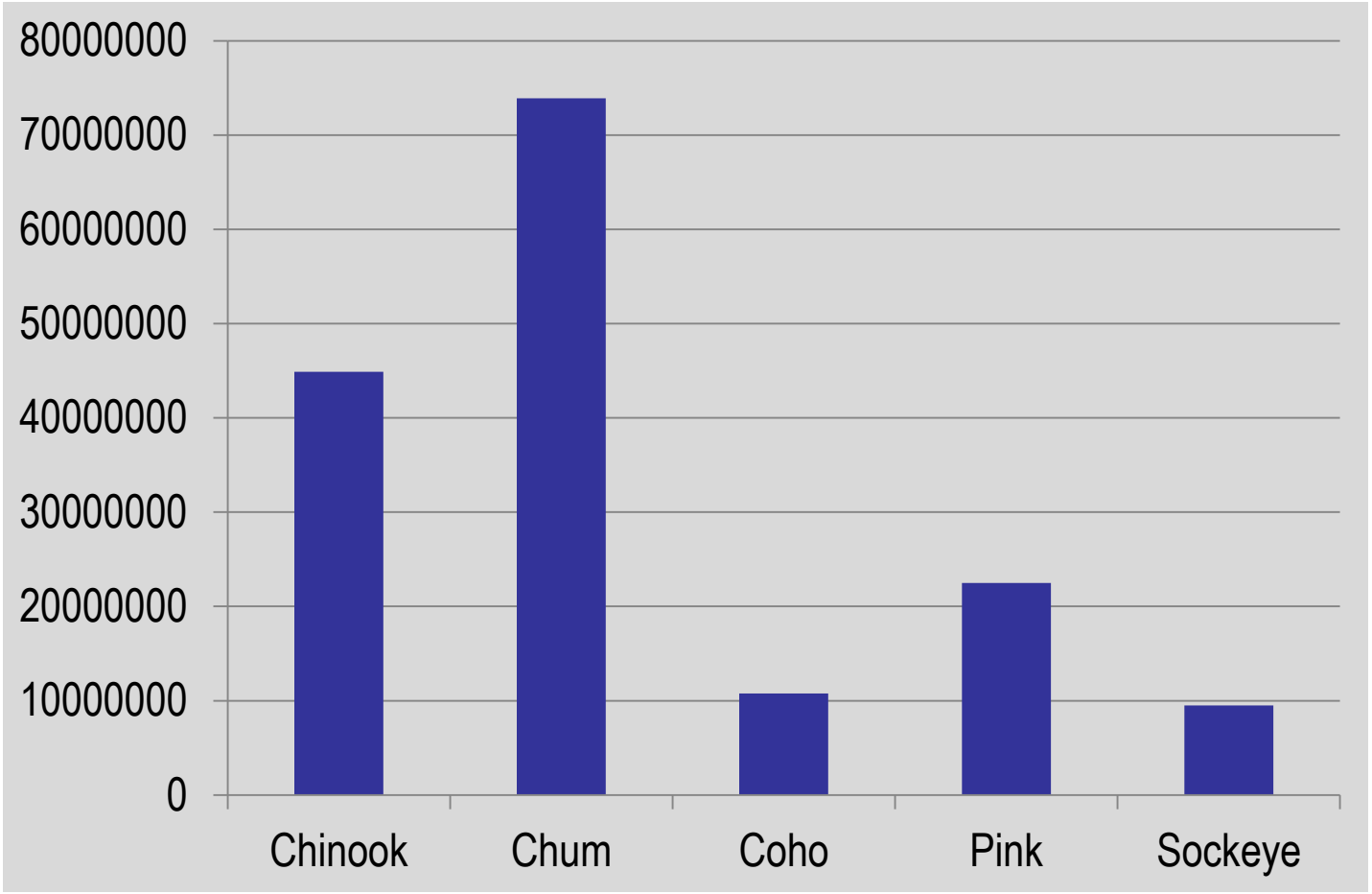
Community Programs
»Volunteer hatcheries
»Stewardship
»Education and Awareness

SEP facilities

- 17 major hatcheries
- 6 spawning channels
- 19 contract hatcheries
- ~100 volunteer sites



Canadian Hatchery Production Targets



- 78 Chinook populations with hatchery releases (up to 7M down to a few hundred)
- All hatchery work falls directly under one of four categories
  - Harvest
  - Rebuilding & conservation
  - Stock assessment/research
  - Stewardship & education

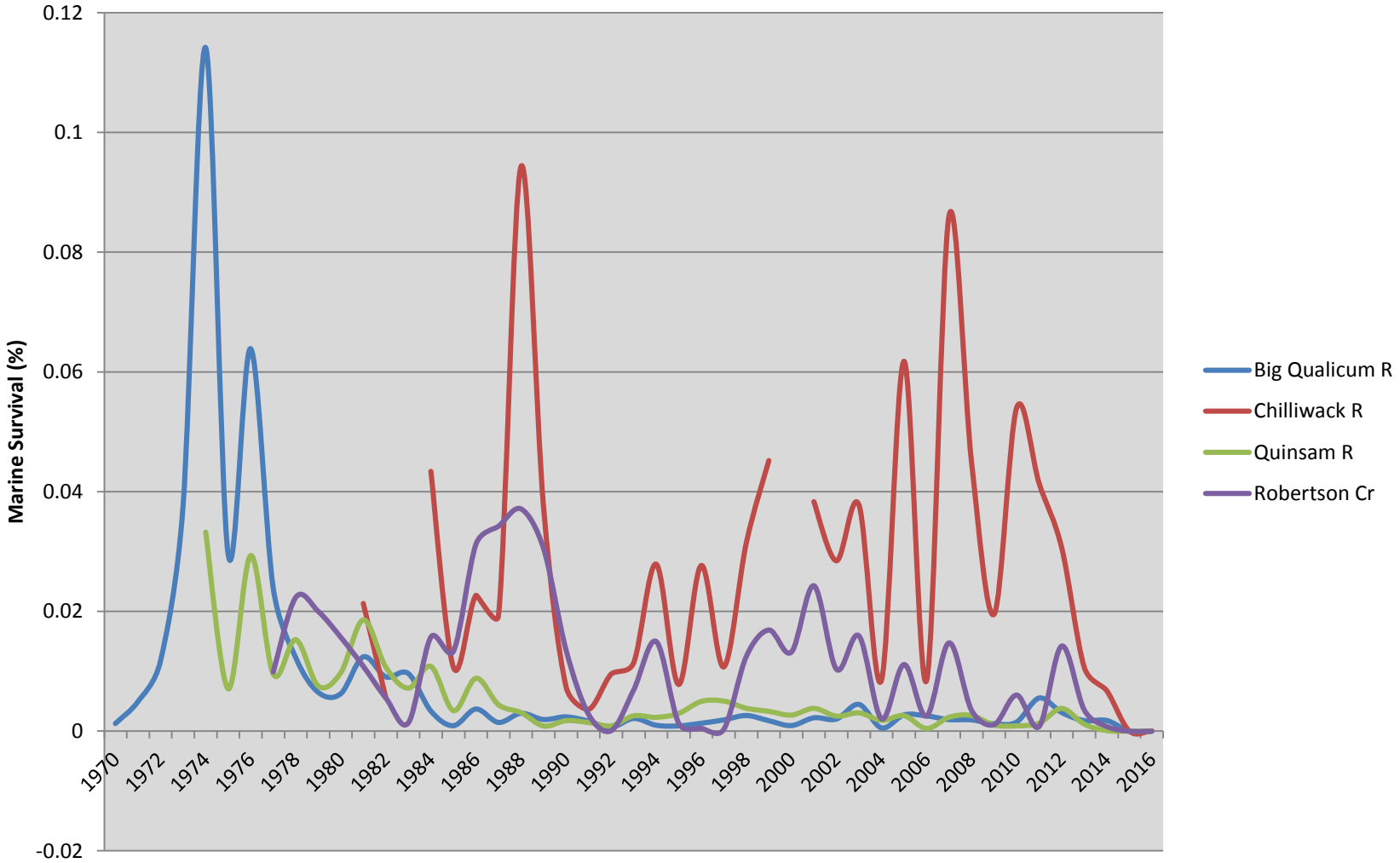
Part 2: Status of Chinook Salmon in Canada

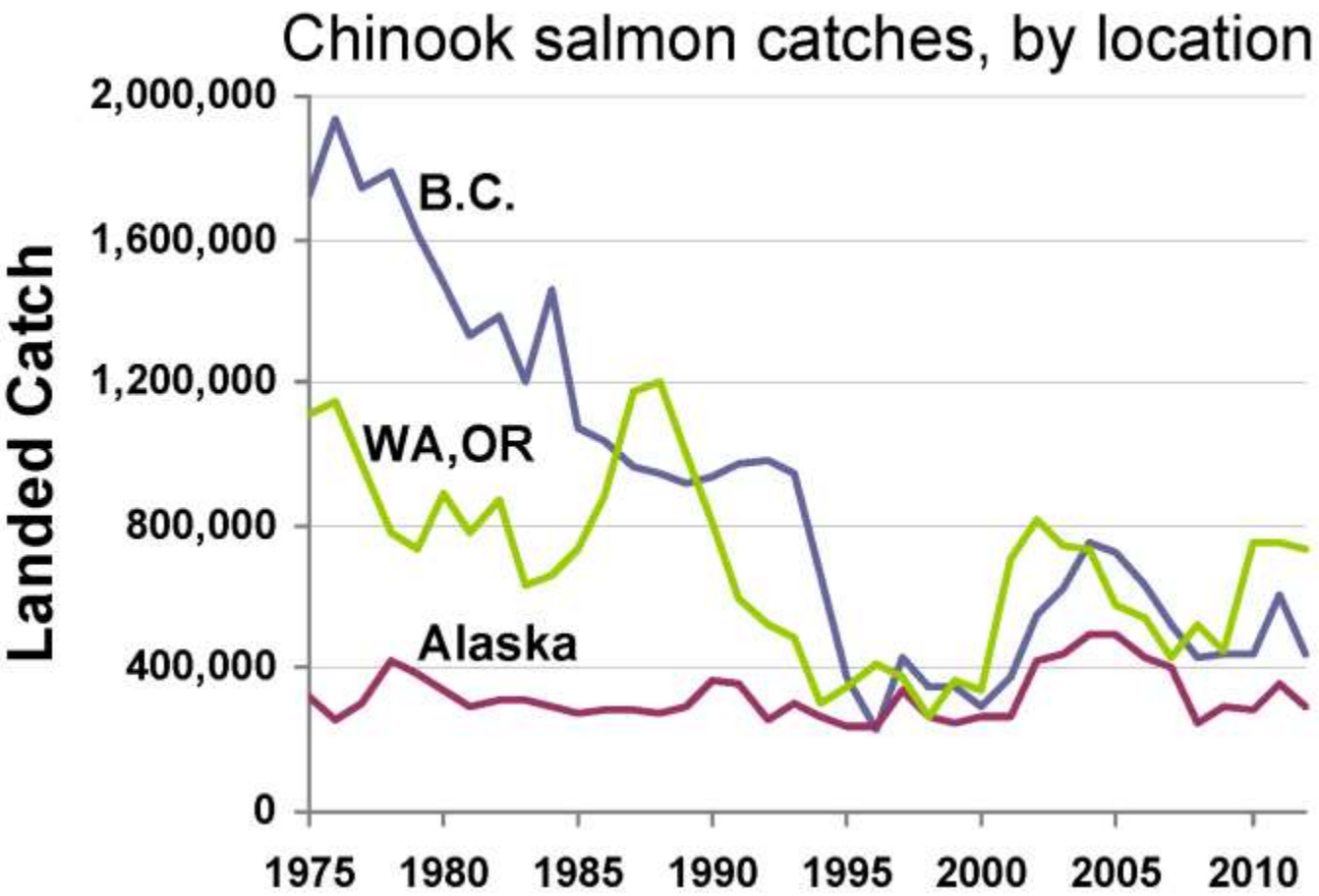
- 850 Chinook populations in British Columbia, dozens more in the Yukon territory

- Many populations unmonitored. “Indicator” populations used to represent marine survival, abundance & trend for larger aggregates of populations

- Trends have been variable, generally more declining than not in past ~15-20 years. Some populations at all time lows, some very high

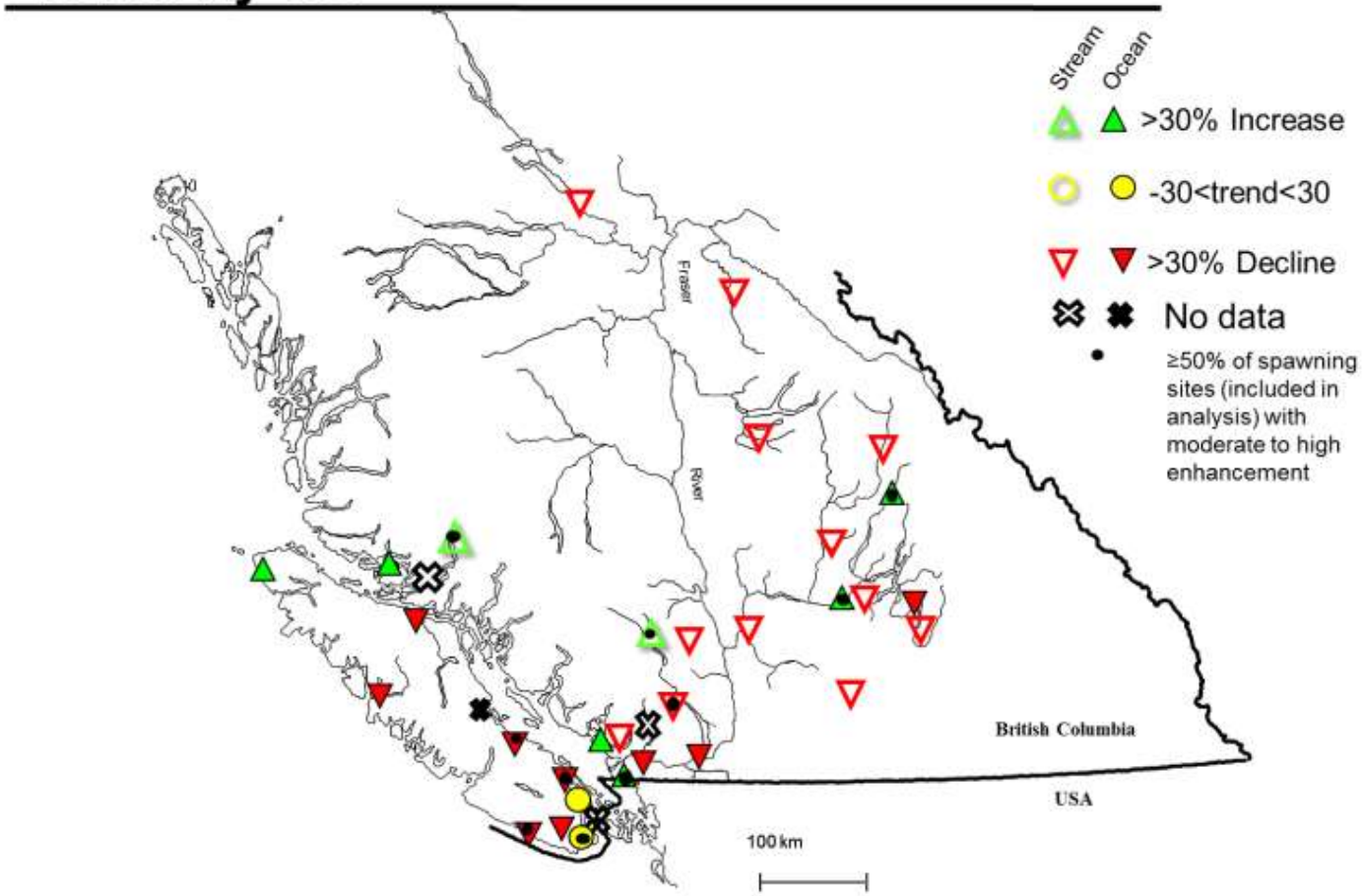
Marine Survival Southern BC Chinook




Chinook salmon catches, by location
Landed Catch
2,000,000
1,600,000
1,200,000
800,000
400,000
0
B.C.
WA,OR
Alaska
1975
1980
1985
1990
1995
2000
2005
2010

Patterns in B.C. Chinook abundance

Short term trends in abundance and enhancement levels by CU



Chinook salmon status: summary

- Overall trends ⬇, but with differences
- Main factor thought to be climate (ocean and freshwater)
- There is enough variability between populations within and across Alaska, B.C. and lower US states to indicate that local causes also exist

Part 3: The Role of Hatcheries in Recovery

Part 3A: Maximizing the fishery benefits of hatcheries

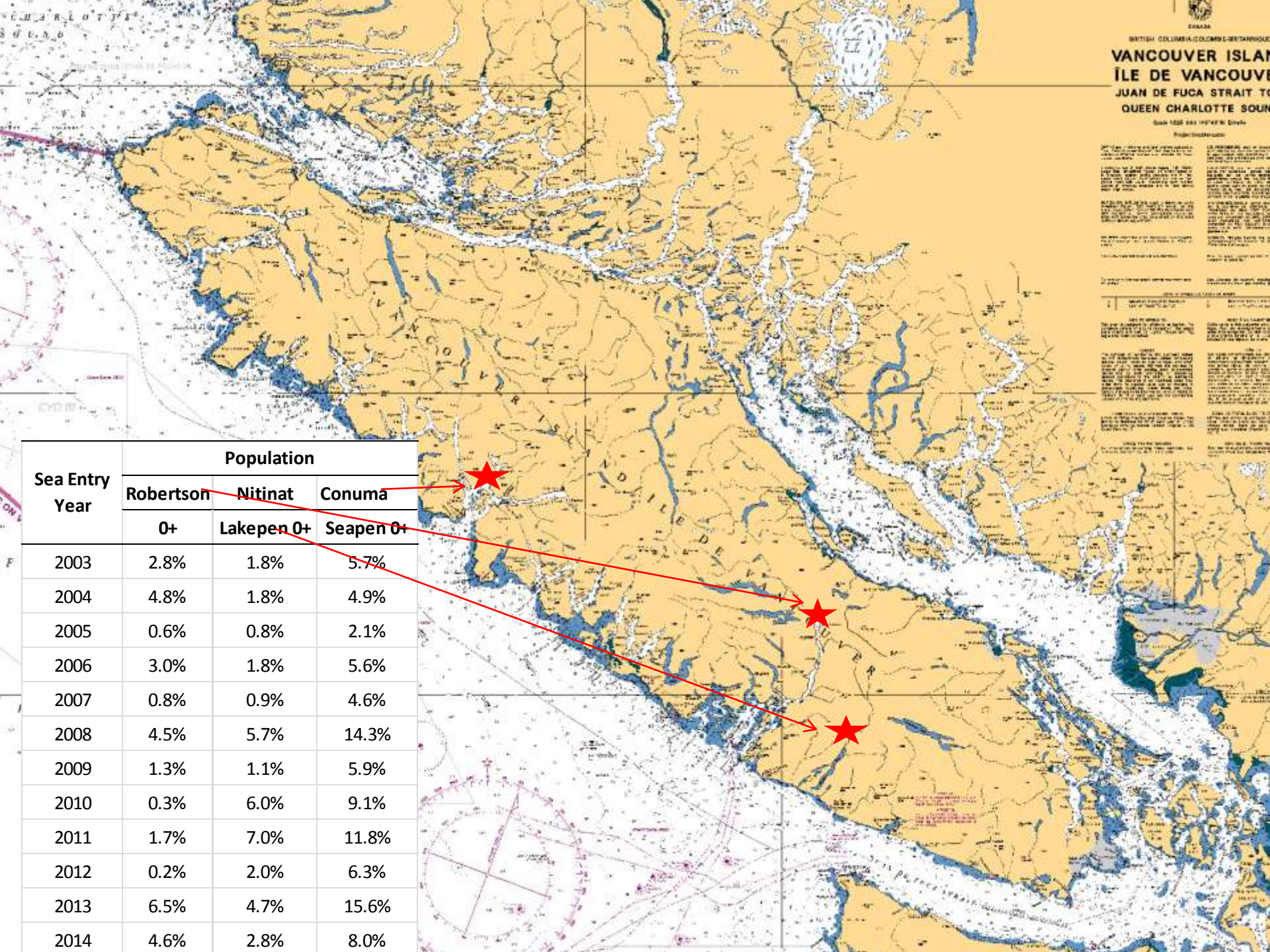
Part 3B: Hatchery & wild salmon interactions

Part 3A: Maximizing the Benefits of Hatcheries

- For hatcheries that intend to provide fish for angler harvest, factors I consider are:
  - Location of releases
  - Release strategy
  - Nature of fisheries

EXAMPLE: CONUMA RIVER HATCHERY

Conuma Hatchery Seapens



Sea Entry Year	Population		
	Robertson	Nitinat	Conuma
	0+	Lakepen 0+	Seapen 0+
2003	2.8%	1.8%	5.7%
2004	4.8%	1.8%	4.9%
2005	0.6%	0.8%	2.1%
2006	3.0%	1.8%	5.6%
2007	0.8%	0.9%	4.6%
2008	4.5%	5.7%	14.3%
2009	1.3%	1.1%	5.9%
2010	0.3%	6.0%	9.1%
2011	1.7%	7.0%	11.8%
2012	0.2%	2.0%	6.3%
2013	6.5%	4.7%	15.6%
2014	4.6%	2.8%	8.0%

Part 3A: Considerations for New Zealand

- Hatchery fish staying close to fishery is good!
  - Consider shifting releases to lower hatcheries and into lower rivers (McKinnon's, Silverstream, Isaac's)
  - Avoid downstream mortality where it is suspected
  - More hatchery fish in lower river vulnerable to fishery
- Stick to higher efficiency release techniques
  - Consider releasing more fish at smaller size (same biomass)
  - Egg/ova plants not a preferred strategy in Canada

Part 3B: Hatchery & Wild Salmon Interactions

- Three (3) types of risk to wild salmon from hatcheries
  - Genetic
  - Disease
  - Ecological

Genetic Interaction of Wild & Hatchery Salmon

- Hatchery salmon spawn less effectively than wild salmon in the natural environment (~50%-80%)
- **Non-native broodstock hatchery salmon (e.g. transfer from other river, farms) likely to be even less effective**
- Reductions in fitness result from:

➢ **Environmental influence** of Hatchery spawning and rearing

➢ **Genetic Selection** in Hatchery Environment (domestication)

Adaptation in Wild Populations

Hatchery Environment

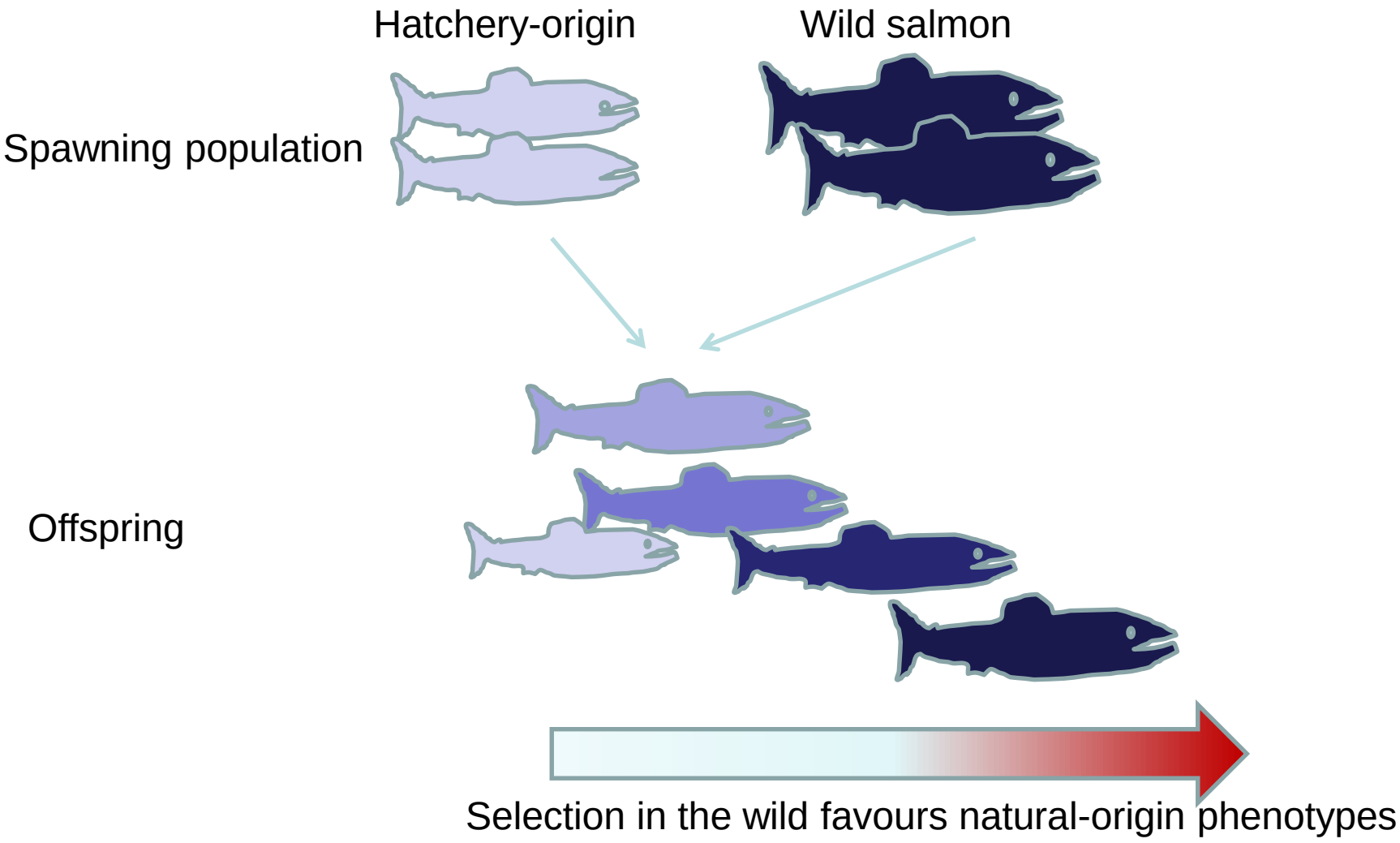
Gene exchange

OR

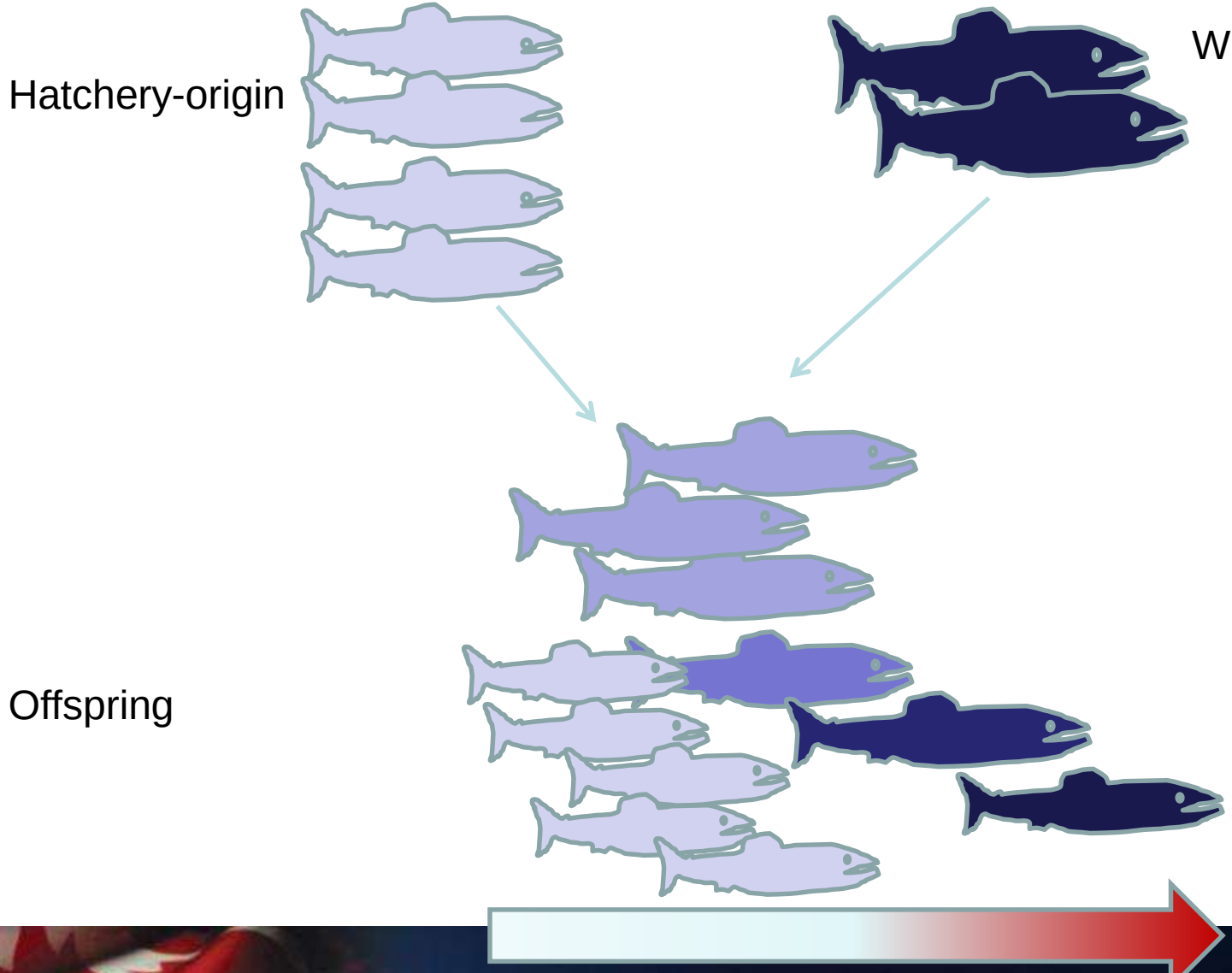
Natural Environment

- **Wild salmon are well adapted to their specific environments**
- **Hatchery salmon are well adapted to their environment**
- **"Too many" hatchery salmon spawning with wild populations can decrease the overall productivity of the wild population**

Balance between gene flow and selection in the wild



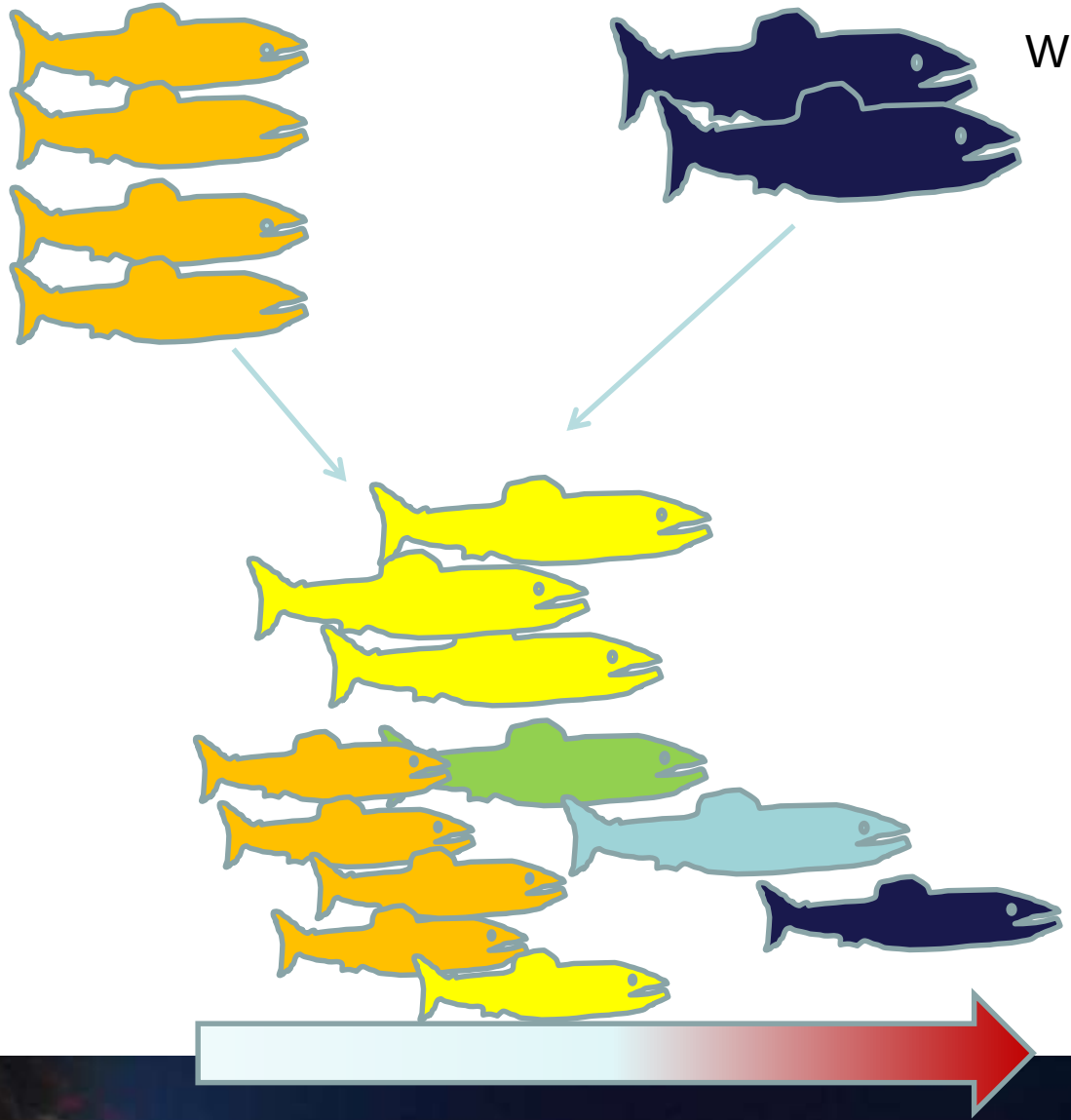
Relative productivity is important



Commercial farm salmon releases

Commercial-origin

Wild salmon



Offspring

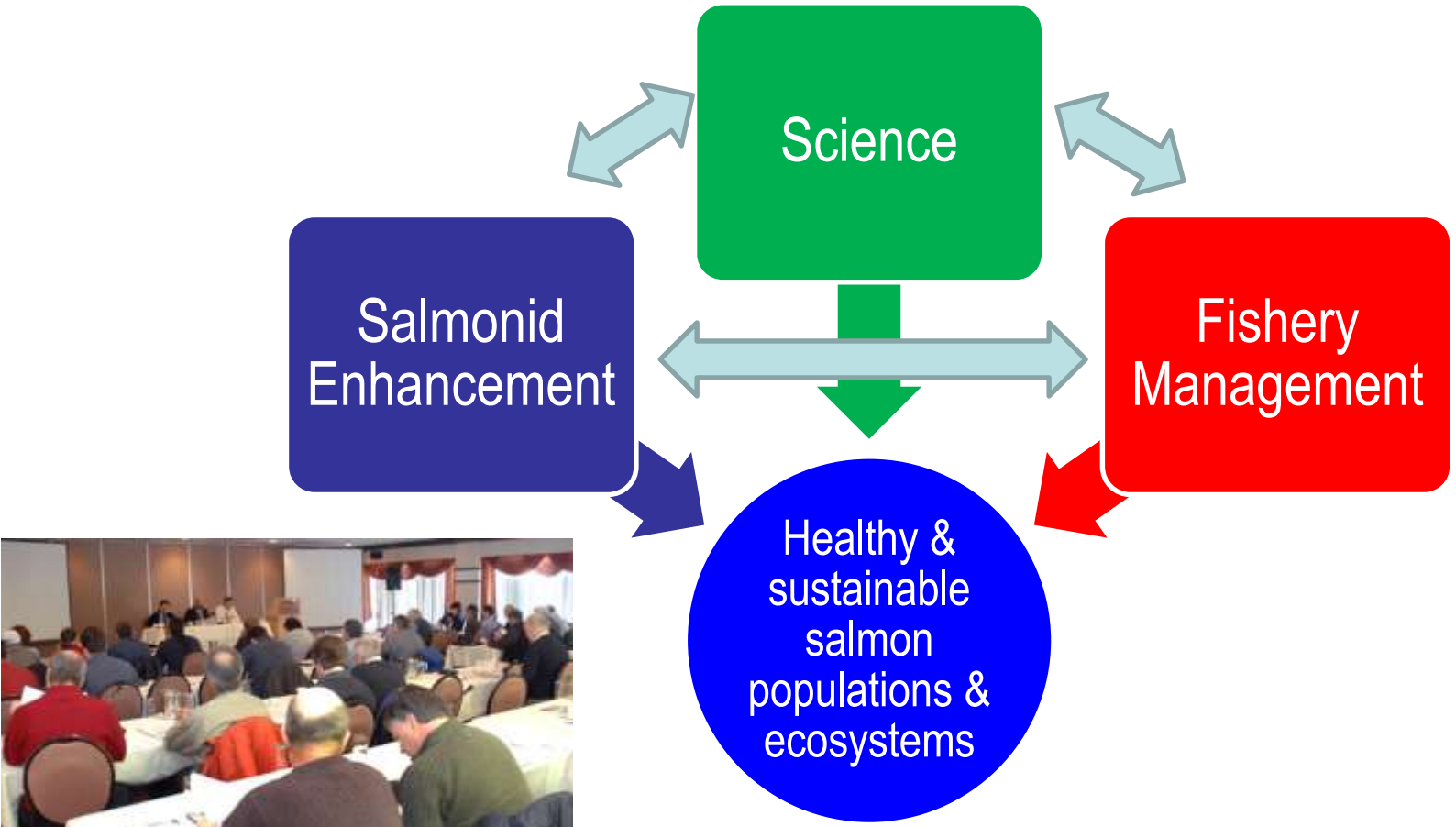
How many hatchery salmon is "too many"?

- These values are for % hatchery spawners in wild populations
- Significant work in the US on this topic → **33%**
- Ongoing Canadian work (Wither et al, in pub.) has developed guidelines based on models of gene flow
  - Hatchery fish from same population→ **28%**
  - Hatchery fish from commercial farms → **3%-5%**

Part 3B: Considerations for New Zealand

- Protect the diversity in your wild populations! Consider using commercial releases only when and where they are highly unlikely to stray to spawning streams
- Site hatchery releases away from wild populations, where practical
- Focus harvest on hatchery fish to remove them at a higher rate

Part 4: Salmon Management & Recovery in Canada



- There are many formal and informal salmon management planning & recovery processes in Canada
  - Southern BC Chinook Planning & recovery
  - Wild Salmon Policy Integrated Planning
  - Yukon River Chinook restoration
  - Cohen Enquiry into the Decline of Fraser River salmon
  - Salish Sea Marine Survival Project

Many lessons learned (sometimes the hard way)!

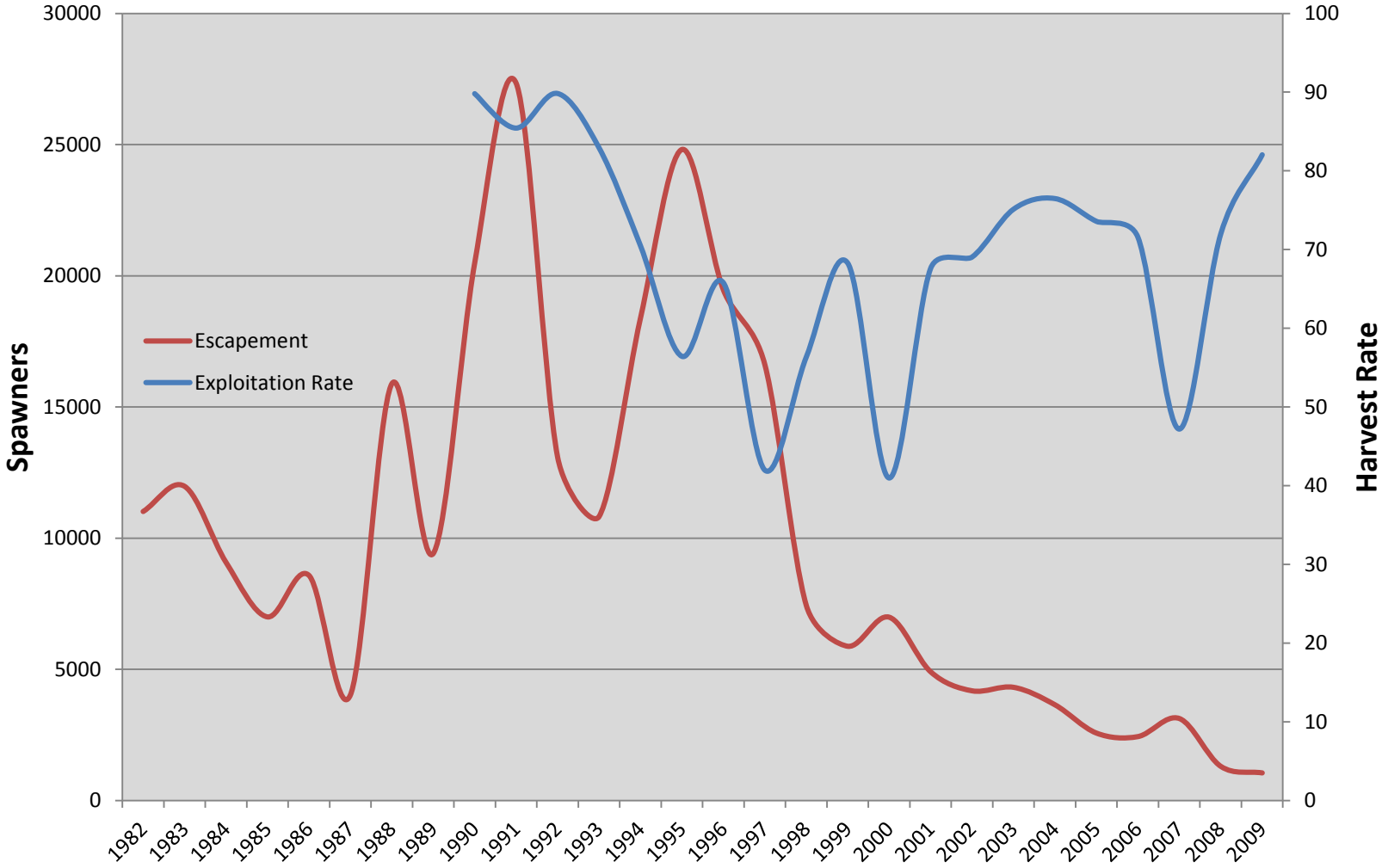
Salmon Recovery Action Planning

- Key points
  - Some local issues in nature, some large scale
    - Global issues, local solutions
  - Integrated plans. Look at all potential factors, address limiting factors as possible (4-H approach)
  - Engagement. Has to be a bottom-up approach, with top-down support

Integrated Planning & Action Case Study

The Cowichan River Chinook Salmon

Cowichan Chinook Escapement, 1982-2009



Cowichan River Recovery Planning

- Multiple sectors worked together
- Scientific data combined with expert & traditional knowledge to identify and understand likely factors for decline
- 4-H approach used to ID problems and solutions
  - Harvest
  - Habitat
  - Hatcheries
  - Hydro (water management)

Life History of Cowichan Chinook salmon

Time Frame	Life Stage
August - September	Terminal return
September – November, peaks in October	In-river migrants
Mid October – Mid December, peaks in first half of November	Natural spawners
Late October – February/March	Egg in the gravel
February	Emergence and alevin stage
March - June	Fry migrating downstream
April – July	Fry/smolts in lower river
May – August	Smolts in estuary
August - January	Nearshore juveniles
Year 2-4	Maturing adults in marine habitat

High & Very High Risk Factors

- Adults: Very high harvest rates (over 80% some years)
- Adults: Low water at the mouth delayed adult entrance into river in fall. Seals known to prey on adult salmon.
- Egg-smolt: High suspended sediment loads pose a significant threat to egg incubation and emergence of alevin out of the spawning gravels.
- Fry-smolt: The juvenile chinook migrating downstream do not have sufficient refuge area and habitat in which to feed, due to channelization by the dykes.
- Fry –smolt: Predation on juvenile hatchery & wild salmon as they migrate downstream

LIMITING FACTORS → ACTIONS

Actions & likely outcomes

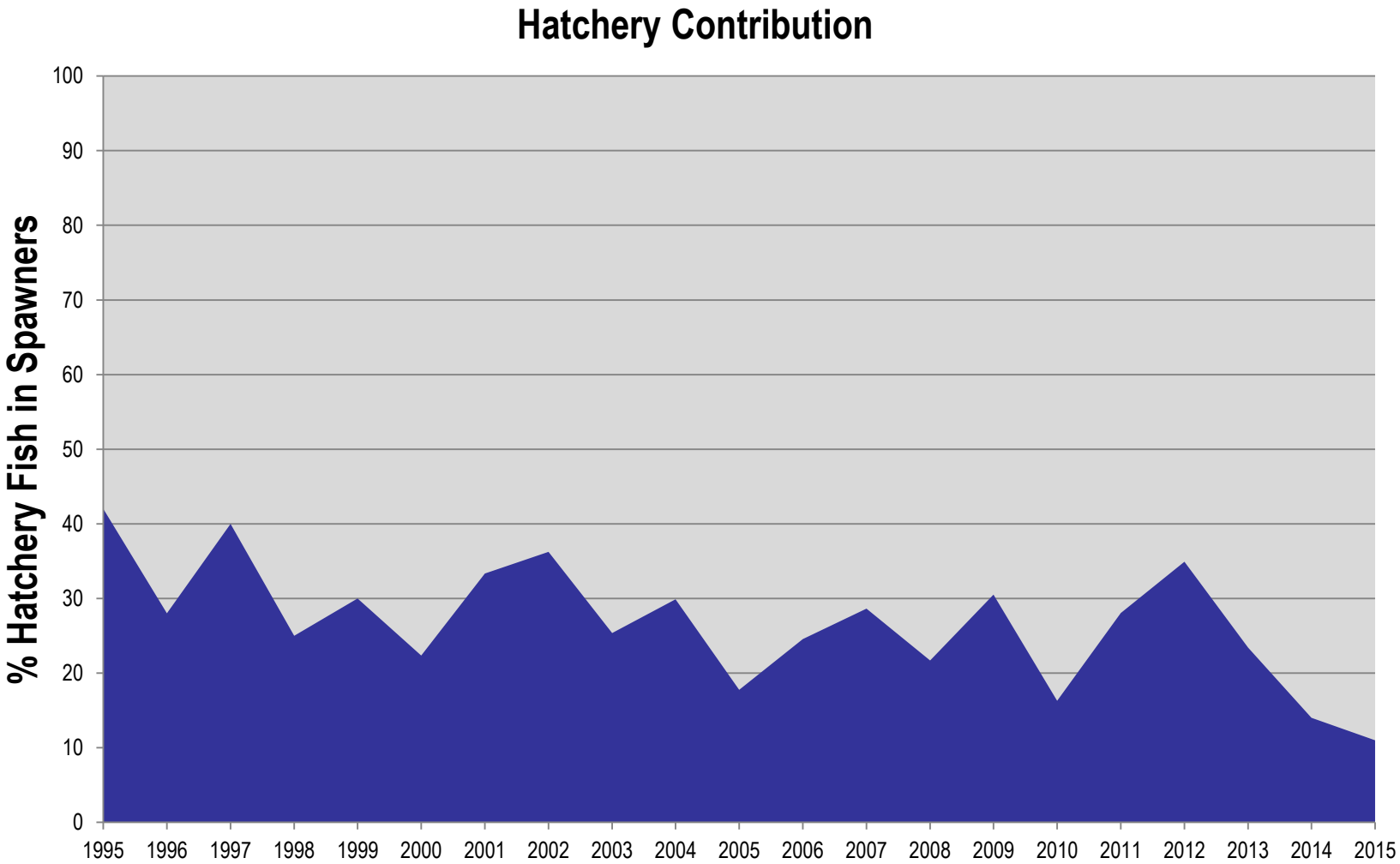
Life Stage	Ecosystem Unit		Mortality	Abundance		Mortality (90% FW)	Abundance
Migrating adults	Estuary to upper river		20%	3,000		20%	3,000
Spawners	Upper river - uplands			2,400			2,400
Eggs laid	Upper river - uplands		90%	4,440,000		**80%**	4,440,000
Smolts out	Lower river to near shore			444,000			888,000
Adults produced	Estuary to ocean		98%	8,880		98%	17,760
Caught in ocean	Ocean		60%	5,328		60%	10,656
Terminal return	Estuary to river			3,552			**7,104**

- Effectiveness of actions evaluated using a very simple life stage model
- Relative effectiveness of actions at different stages is highly variable.

Actions: Juvenile Chinook Predation

Fishingwithrod.com

Actions: Hatchery Management



Actions: Water Management

Actions: Fishery Management

- Reduced harvest rate ~5%-10%
  - Area and time closures
  - Gear
  - Catch Limits
  - Hatchery selective fishery at certain times and places

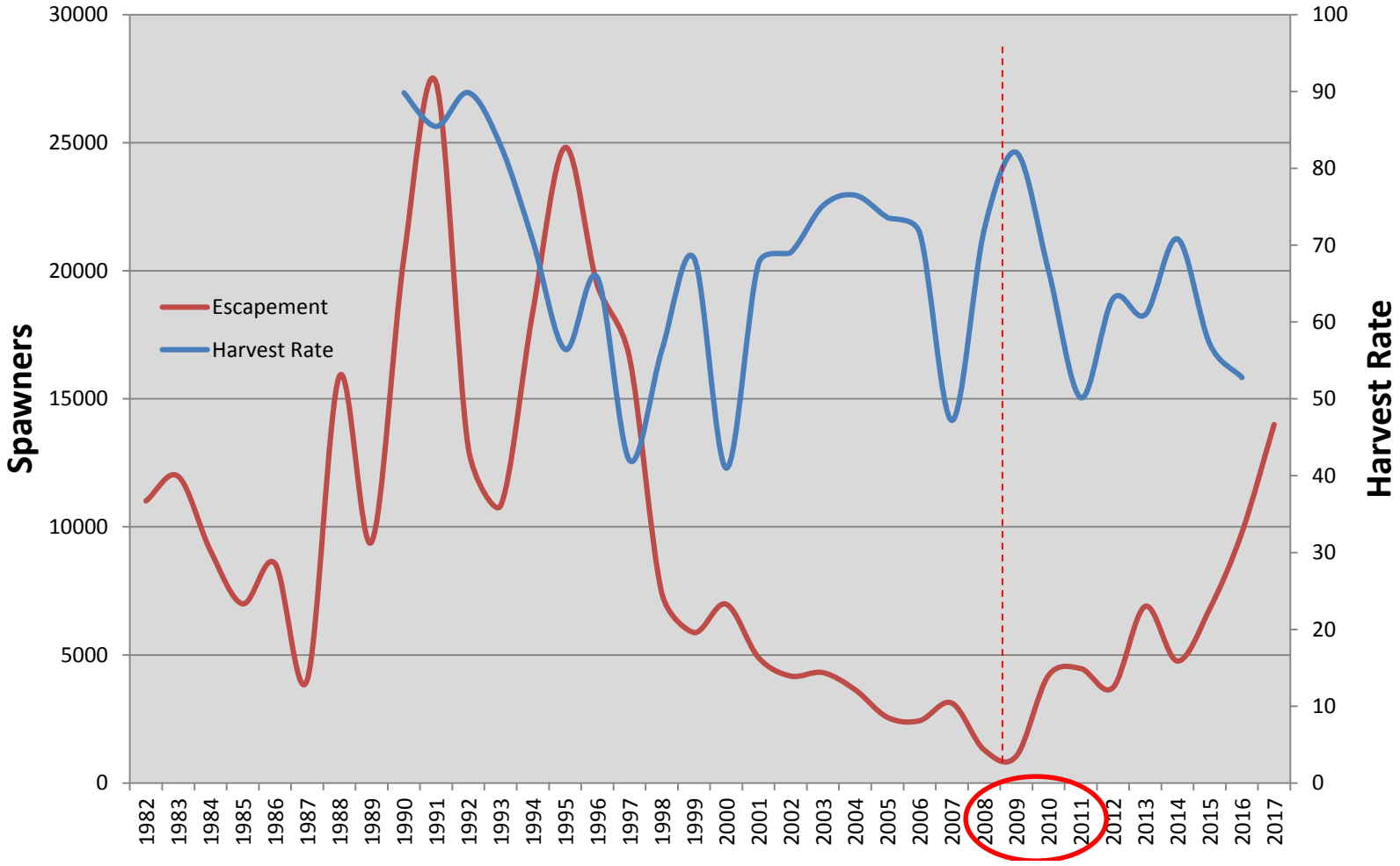
Actions: Predation on Adult Chinook

Actions: Habitat

Sediment Management: Before

Sediment Management: After

Cowichan Chinook, 1982-2017



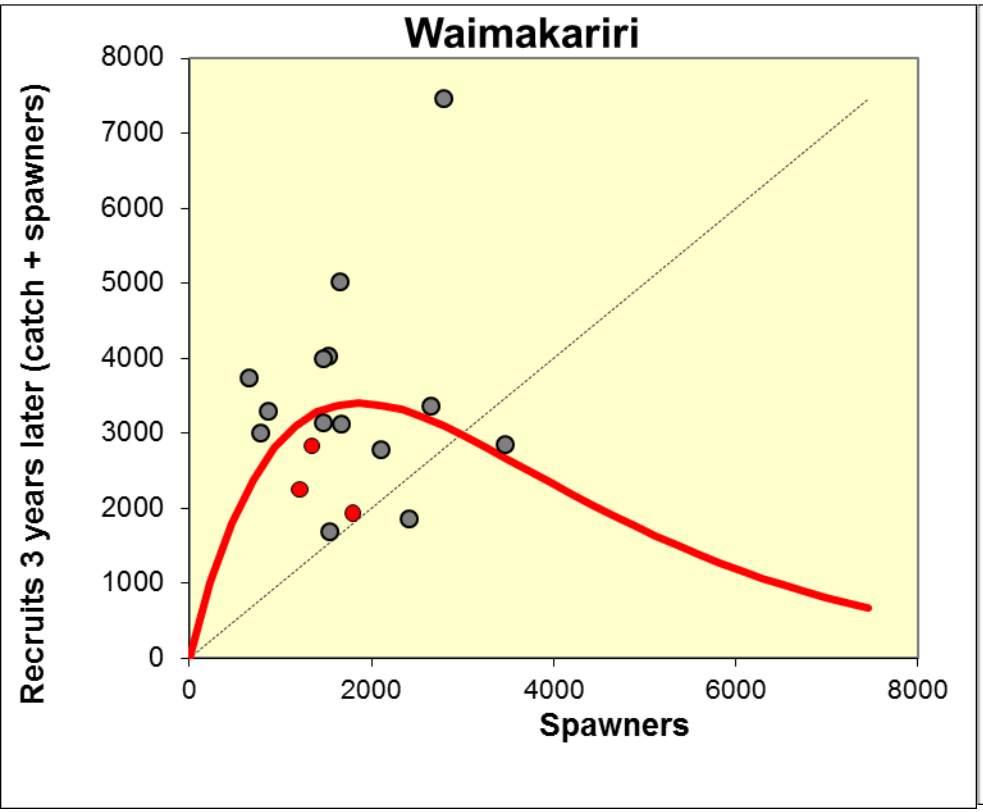
Cowichan summary

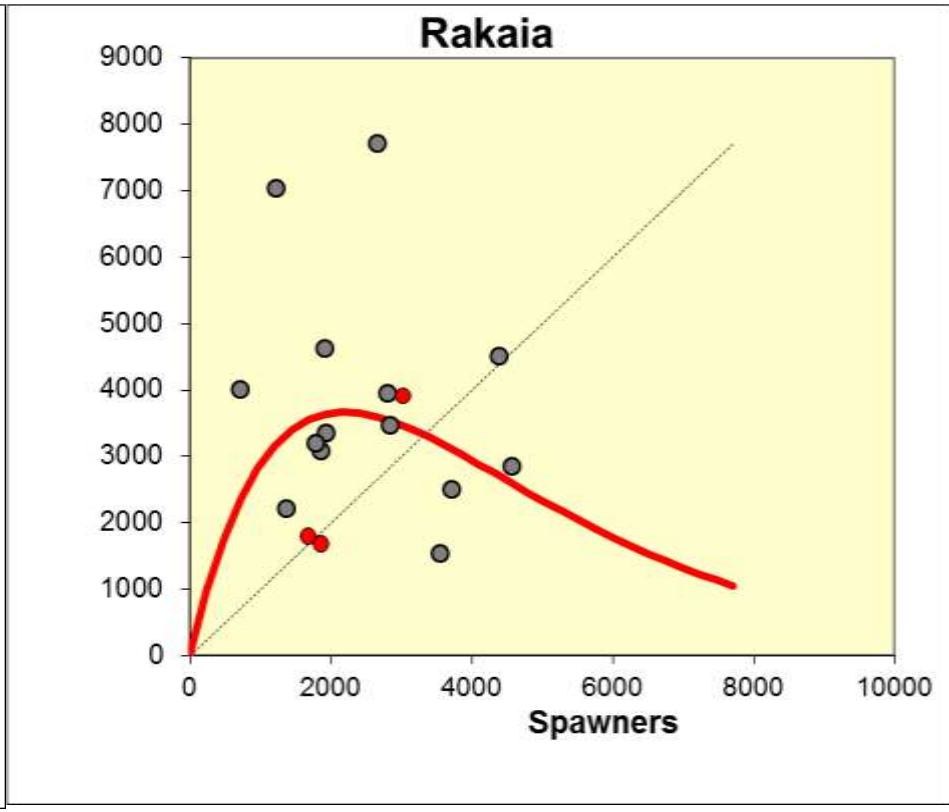
- Multiple sectors working together
- Problems identified, local solutions found
- Balanced approach, several causes addressed
- Despite marine productivity remaining low, population has rebounded significantly
- Focus on wild salmon recovery, habitat & juvenile survival; hatchery measures used cautiously

Part 4: Considerations for New Zealand

- Work together & build strong partnerships!
- Maintain or protect spawning habitat
- Downstream juvenile mortality
- Fishery management measures
  - Catch limits
  - Gear types

New Zealand Salmon Productivity





Closing Thoughts

- Climate change has caused declines in salmon productivity across Pacific
- Despite likely large scale causes, there are solutions at hand!
- Be conservative with fishery during downturn, look at habitat & juvenile survival solutions
- A sustainable fishery for generations to come!

Thank you!

- Thank you for this opportunity to come to your beautiful country, for your hospitality and
- Special thanks to Steve Terry, Richard Cosgrove, Hamish Stevens, Dirk Barr and Mark Webb for taking the time to show me around ,for sharing your knowledge, and for many interesting and creative discussions over the last week about the unique salmon and trout populations and fisheries in New Zealand

Questions??

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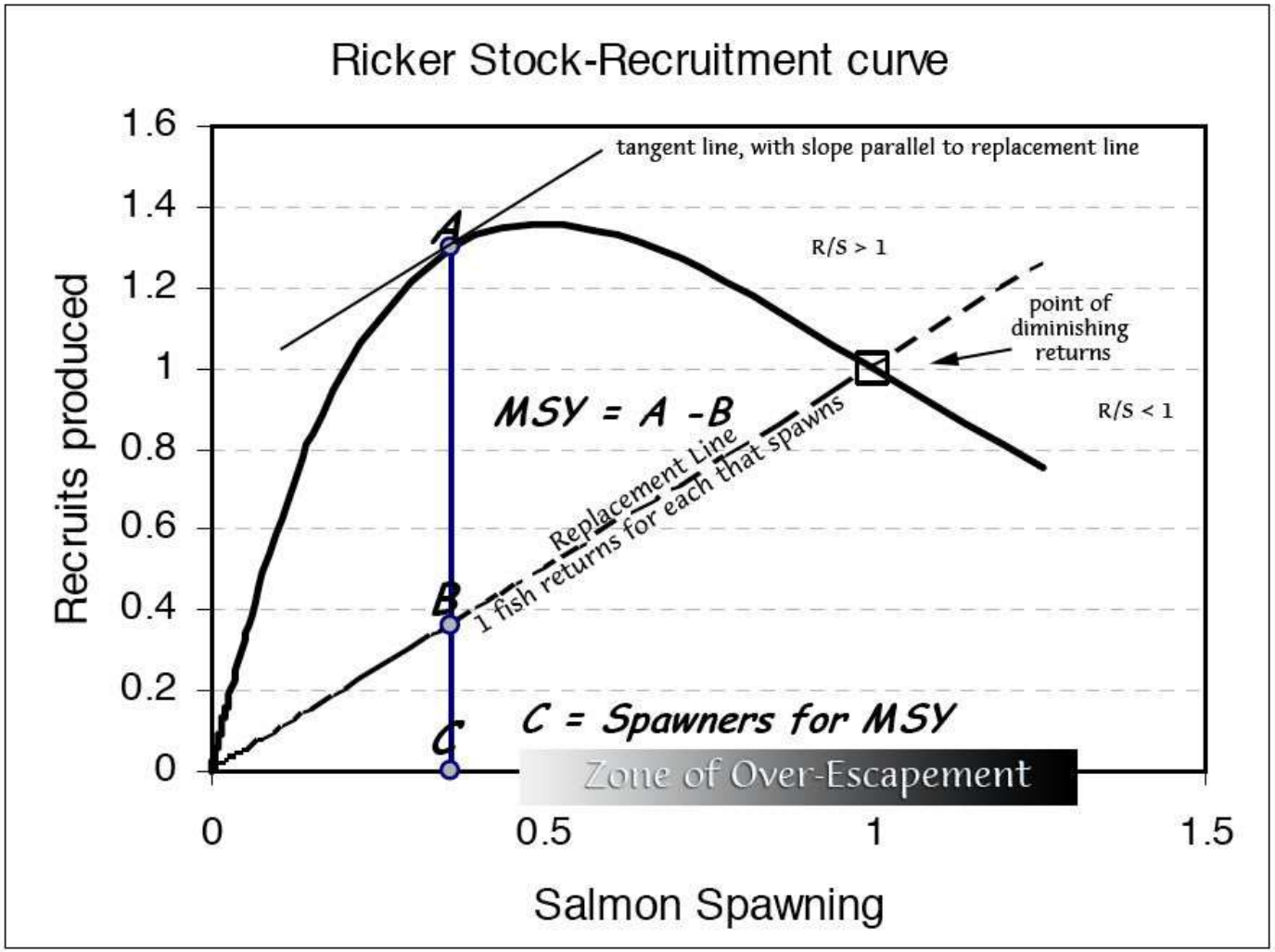
Ricker Stock-Recruitment curve
Recruits produced
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
tangent line, with slope parallel to replacement line
A
R/S > 1
point of diminishing returns
MSY = A -B
R/S < 1
Replacement Line
1 fish returns for each that spawns
B
C
C = Spawners for MSY
Zone of Over-Escapement
0
0.5
1
1.5
Salmon Spawning