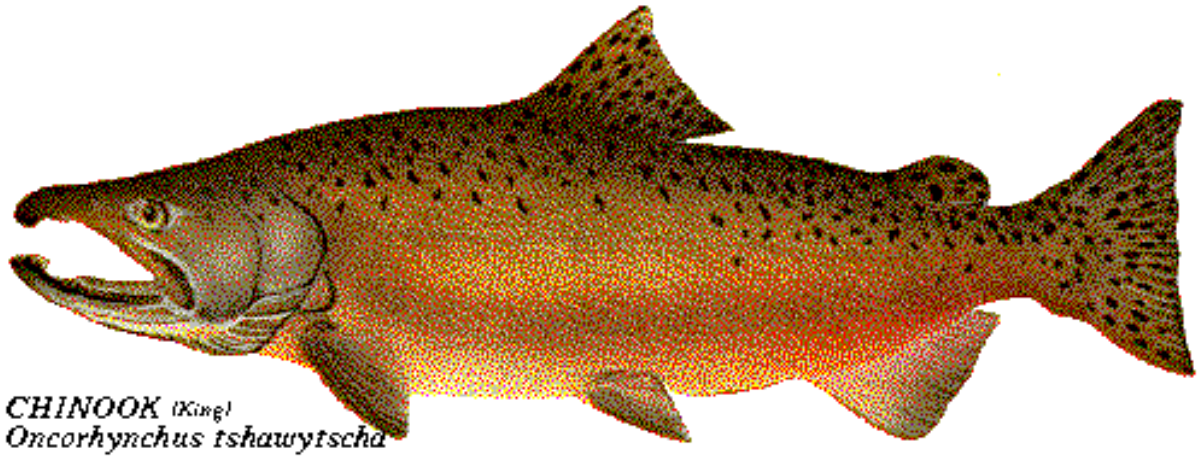
Assessment of Status and Factors for Decline of Southern BC Chinook Salmon: Independent Panel's Report

Riddell, B., M. Bradford, R. Carmichael, D. Hankin,
R. Peterman, and A. Wertheimer. 2013.



Presentation to: First Nations' Visions, July 9, 2014.

Review process managed by: ESSA Technologies Ltd., Vancouver, BC

1.3 Objectives (page 2)

The objectives for both the workshop and this report were:

1) **Review status and trends of southern BC Chinook** salmon Conservation Units and component populations.

2) **Synthesize evidence** regarding:
   a) The impact, relative importance and potential for mitigation of factors hypothesized to limit the productive capacity of Chinook salmon?
   b) The future risks associated with climate change and potential adaptation strategies?

3) Recommend **additional research and monitoring** for future planning.

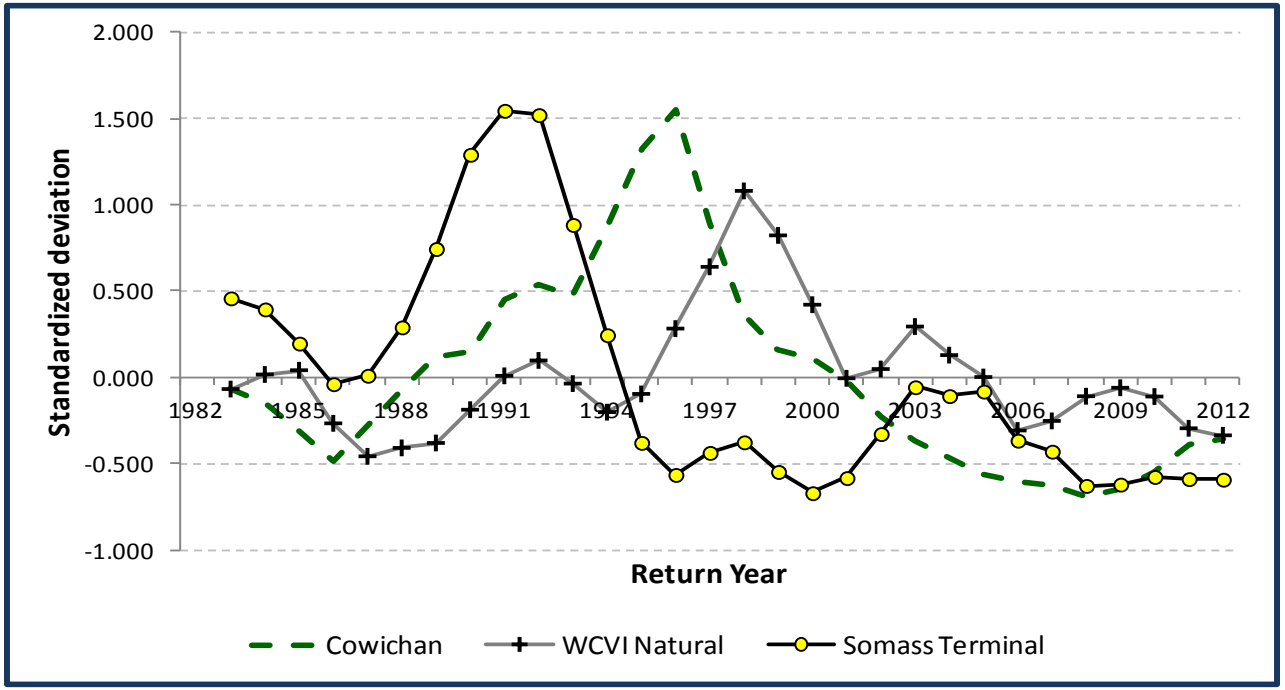
4) Review existing management/assessment tools that could be used to incorporate risks into a management decision making framework and offer suggestions for improvement. ***(This was not addressed by Panel.)***

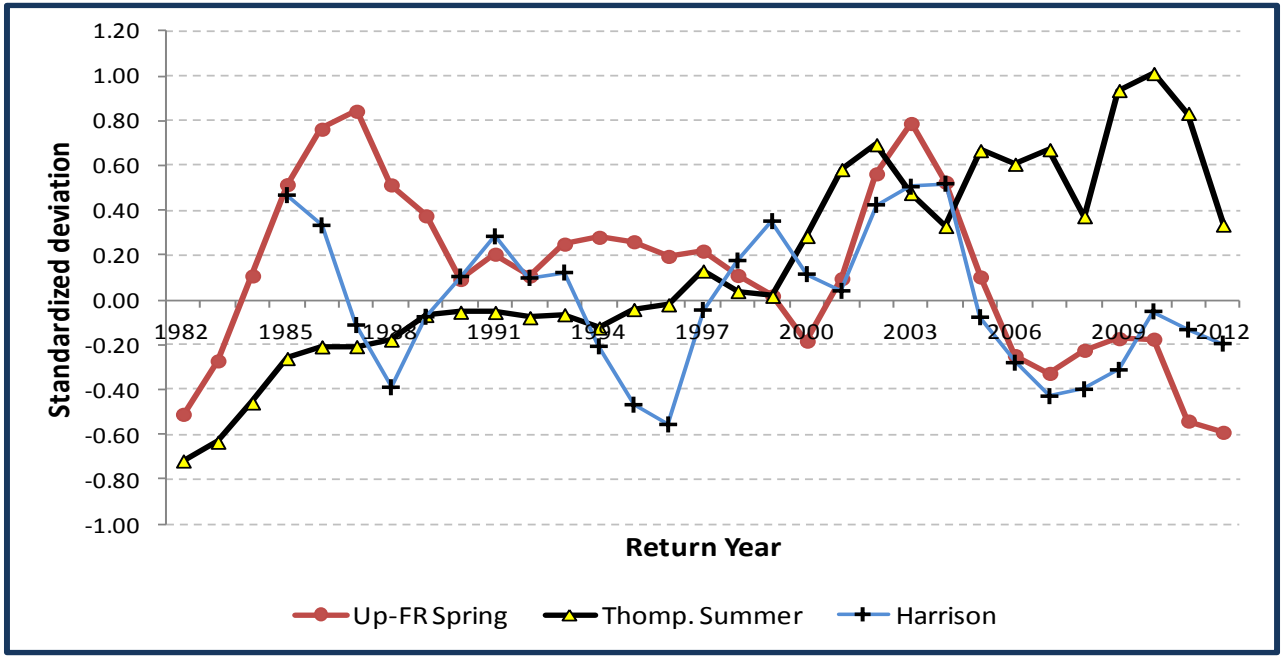
Report Contents:

- Executive summary ... includes overall conclusions
- Introduction, Background & History
- Status and Trends (DFO trend analysis)
- Harvest
- Freshwater Habitat
- Marine Habitat
- Hatcheries
- Pathogens (won't discuss today ... GBC/PSF/DFO project)
- Future Climate Change (minimal consideration today)

Figure B-7
(page 17).

There are substantial differences between regions but there are also common trends. In 5 of 6 regions summarized here, 4 show significant declines in spawners since early 2000's and one has remained depressed since mid-1990s.





Geographic Scope of Study:

- 35 Conservation Units involving 420 spawning sites in Southern BC

- 5 categories of data quality: Persistent, Aggregated, Data deficient, Deleted, and Extirpated

- Analysis based on 157 Persistent sites (verified time series) including 226 sites (**Table ES-1**)

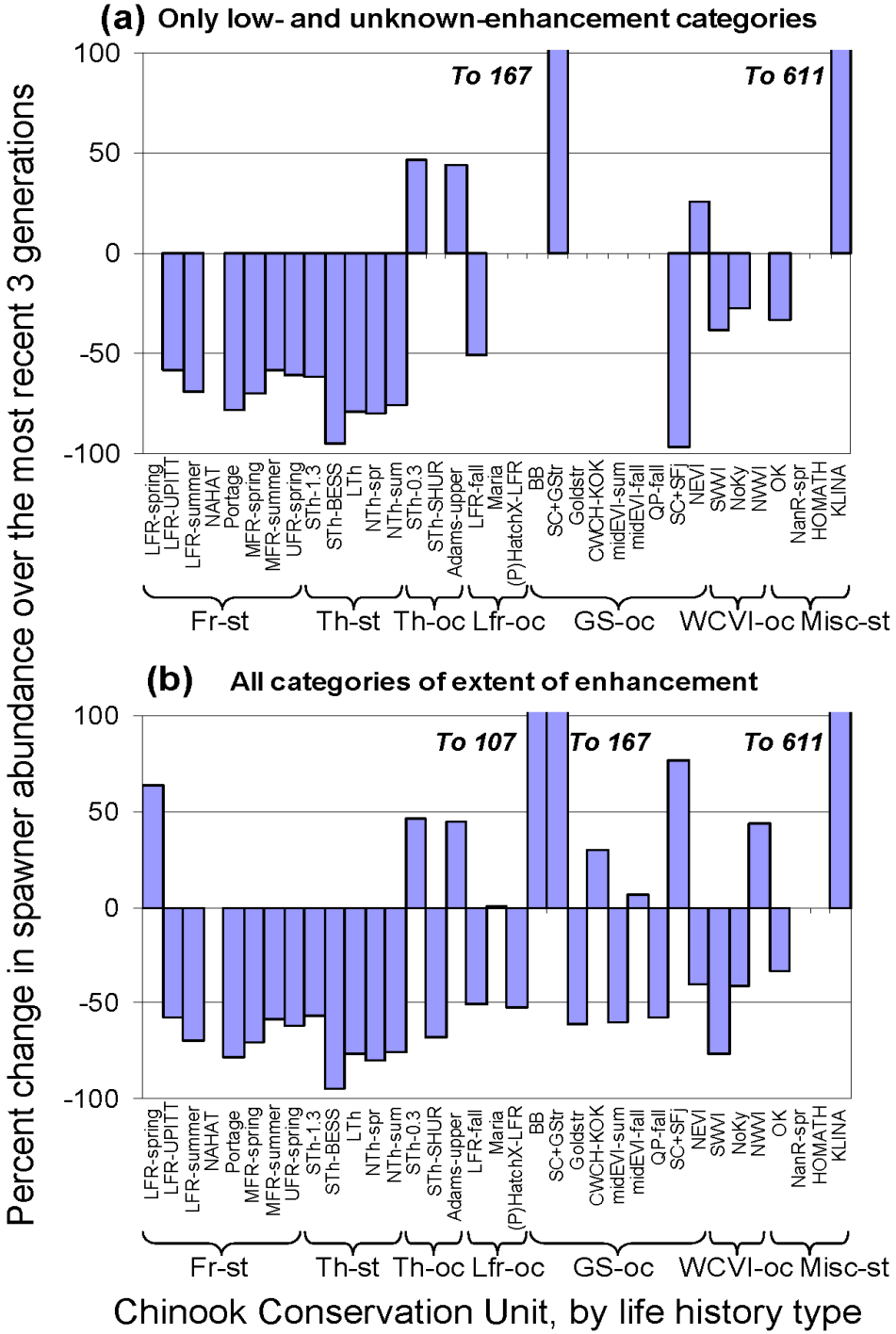
- Persistent sites have variable Hatchery returns

Chapter 3: Status and Trends Analyses

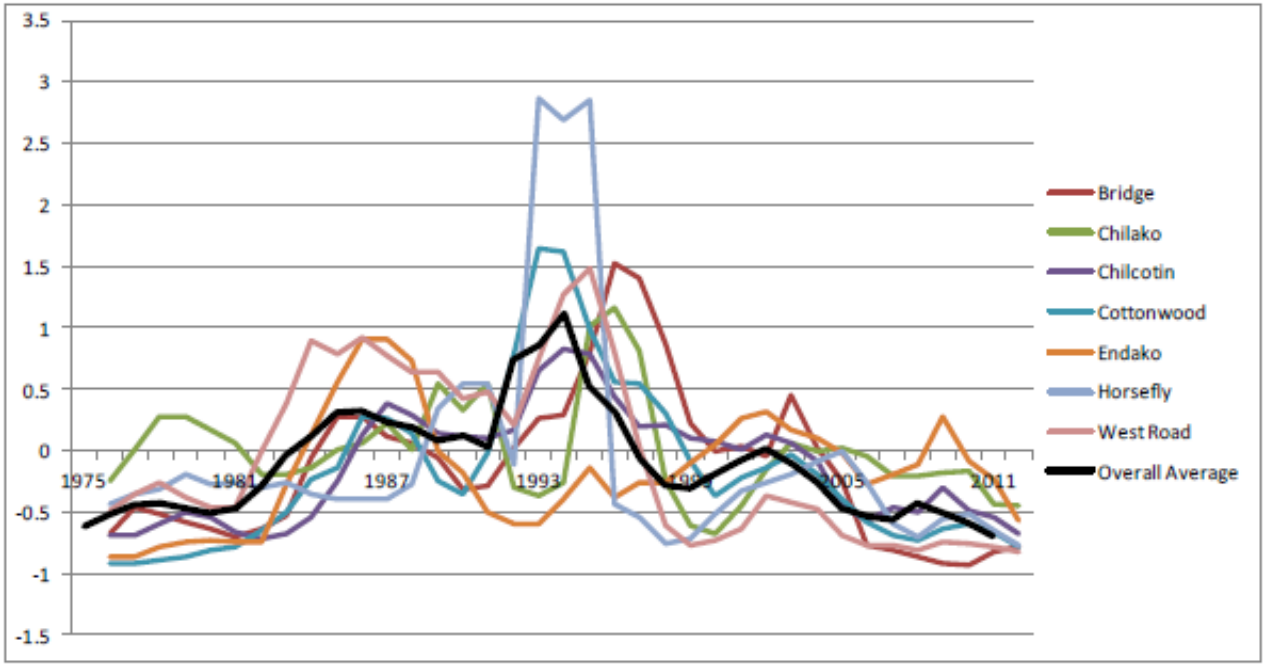
Escapement Trend summary (page ii), for 21 CU with "low or unknown" enhanced activity, based on one time series per CU:
13 showed declines > 50% in last 3 generations
5 showed increases, &
3 showed decreases between zero and 50%.

DFO analysis, Figure ST-1, page 42

Other assessments based on Catches, CWT-derived Marine Survival Rates, Life cycle productivity (including time varying productivity estimates), and multiple stock assessments over larger geographic scales.


(a) Only low- and unknown-enhancement categories
To 167
To 611
100
50
0
-50
-100
LFR-spring
LFR-UPITT
LFR-summer
NAHAT
Portage
MFR-spring
MFR-summer
UFR-spring
STh-1.3
STh-BESS
LTh
NTh-spr
NTh-sum
STh-0.3
STh-SHUR
Adams-upper
LFR-fall
Maria
(P)HatchX-LFR
BB
SC+GStr
Goldstr
CWCH-KOK
midEVI-sum
midEVI-fall
QP-fall
SC+SFj
NEVI
SWVI
NoKy
NWVI
OK
NanR-spr
HOMATH
KLINA
Fr-st
Th-st
Th-oc
Lfr-oc
GS-oc
WCVI-oc
Misc-st
(b) All categories of extent of enhancement
To 107
To 167
To 611
Percent change in spawner abundance over the most recent 3 generations
Chinook Conservation Unit, by life history type

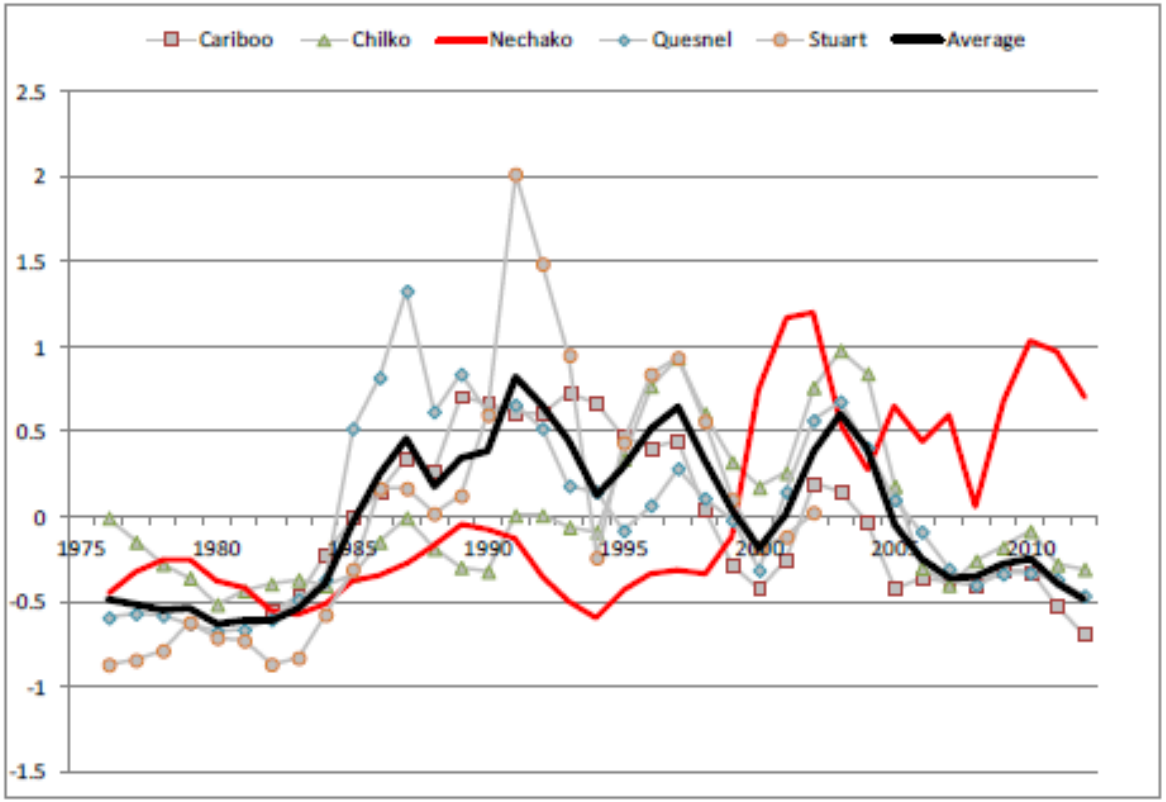
CK-10, Mid-Fraser River Spring Chinook, 7 streams with data, 18 streams in total. The 7 streams presented represent 7 of the 10 'Persistent" data sets provided, 3 were excluded due to extensive in-filling in recent decade. Plots of 3-point moving average of annual deviations calculated within streams. Overall average is the averaged deviations across streams within each year. *Data supports a decline in returns throughout the CU since mid-1990s, however, the Endako shows weaker correlations.*



Simple pair-wise correlations:

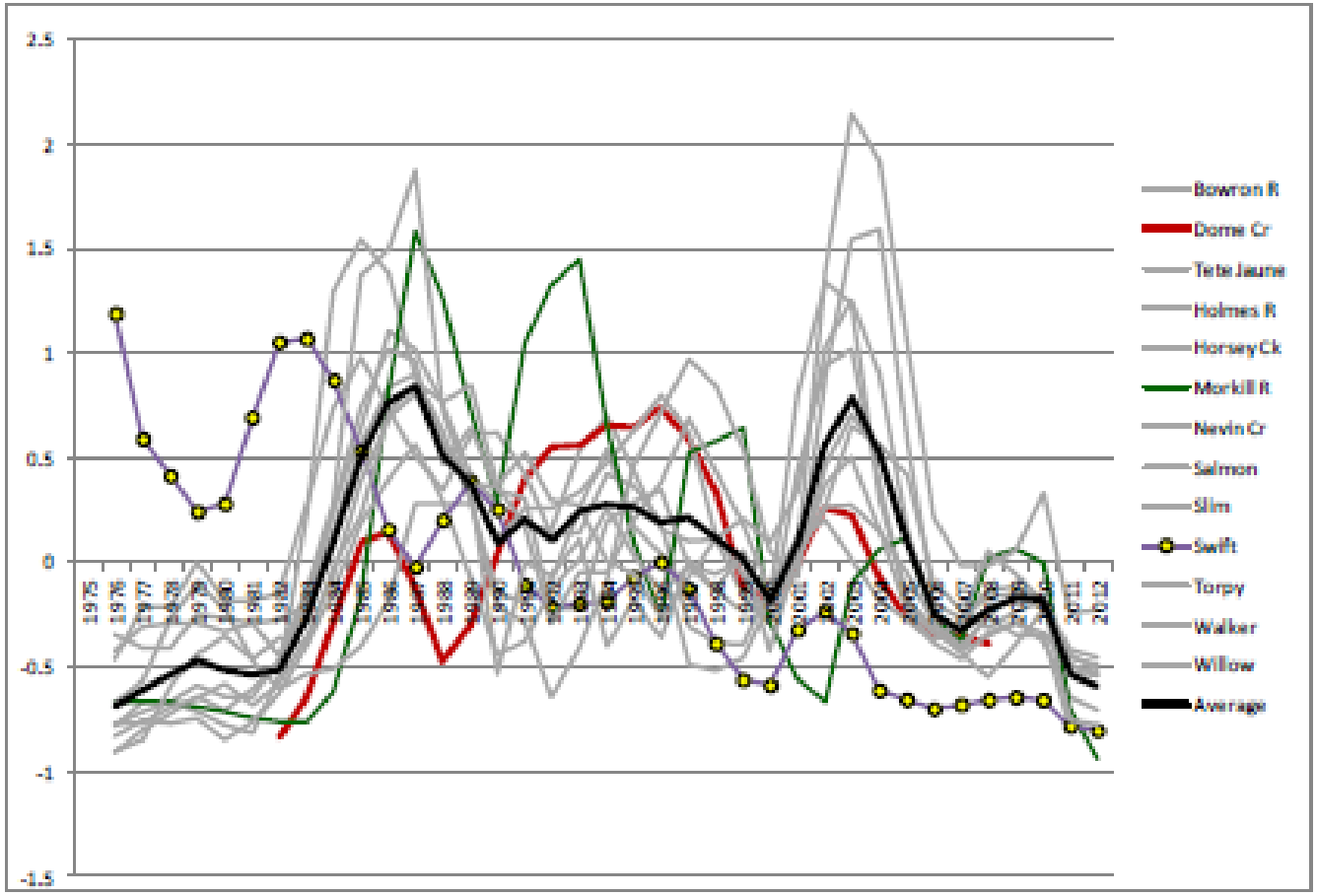
Corr Matrix	Bridge	Chilako	Chilcotin	Cottonwood	Endako	Horsefly	West Road
Bridge		0.3769	0.5074	0.5607	0.1292	0.0221	0.3570
Chilako			0.1527	0.0137	0.0441	0.0830	0.4140
Chilcotin				0.7882	0.3697	0.5657	0.5414
Cottonwood					0.1982	0.5107	0.5837
Endako						0.0580	0.2569
Horsefly							0.4506

CK-11, Mid Fraser River Summers, five streams presented out of 17. Pinchi Creek and Kuzkwa River omitted due to insufficient data. After trying several plots for clarity, this plot presents the 3-point average of the standardized deviations per steam and year (colour points); the Averaged trend for Cariboo, Chilko, Quesnel, and Stuart rivers; and the trend for the Nechako River which is clearly different. *The 'Average' line demonstrates a strong decline but since the mid-2000s but a longer term decline is apparent since the early 1990s, but Nechako has been increasing since mid-1990s (may be confounded with a change in methods used in estimation of annual escapements in the Nechako).*

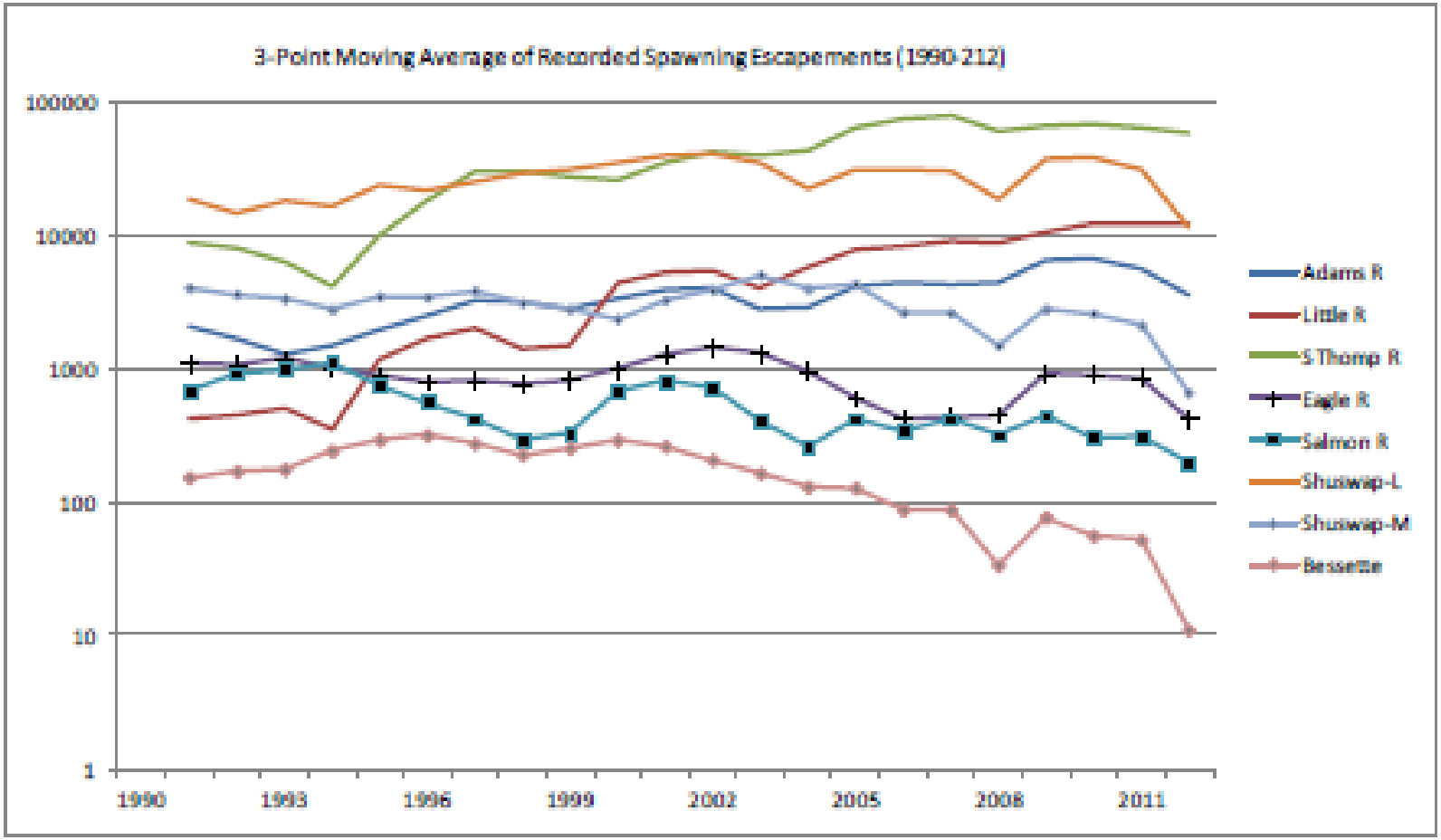


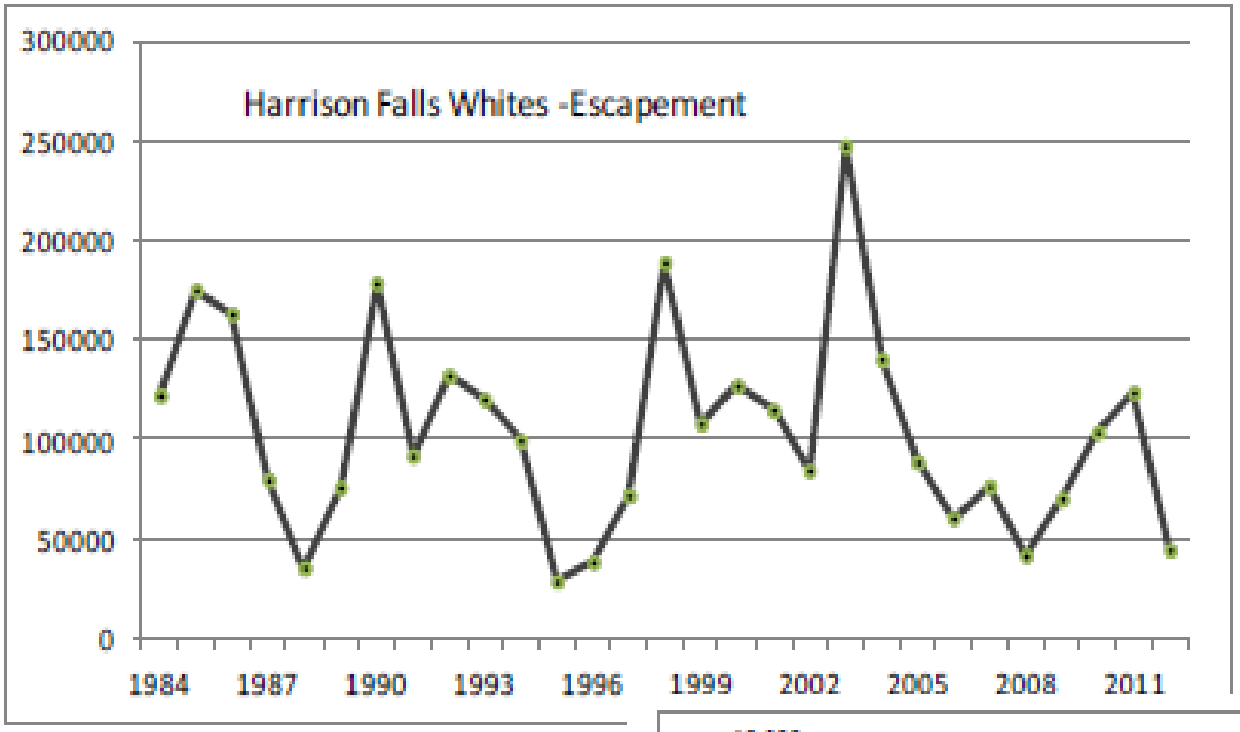
Corr Matrix	Chilko	Nechako	Quesnel	Stuart
Cariboo	0.2927	-0.2414	0.6035	0.2665
Chilko		0.1289	0.3464	0.5391
Nechako			0.0311	0.0985
Quesnel				0.3927

CK-12, Upper Fraser Spring Chinook, 13 streams out of 36; *all Low or UNK enhancement except for Moderate enhancement in Dome Creek*. Swift Creek has a very different trend showing an almost continuous decline over this time period. The other 12 streams are largely coherent in their trends and indicate a decline since a peak in the early 2000s' (similar to CU-11). Excluding Swift Creek, the overall correlation co-efficient of escapement trends amongst these steams was 0.52. Plot of 3-point moving average of the standardize deviations within streams, Average = average annual value over the 12 streams. Streams with differing patterns (Dome and Morkill) have been highlighted.

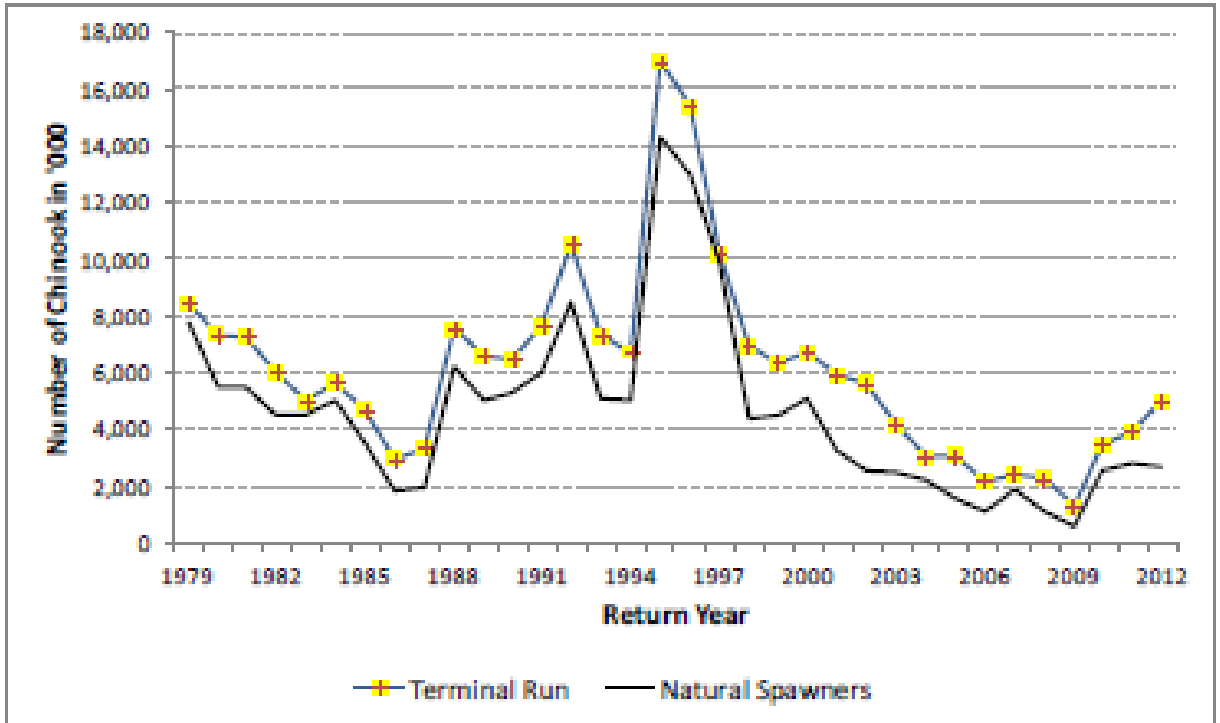


Summary of CK-13, 14, 15, 16, Thompson River Summers (both 0.3 and 1.3), involving 8 of 15 streams and the vast majority of the annual spawning escapements and data. However, this plot differs from previous as it is a simple 3-point average of the reported spawners plotted on a $\log_{10}$ scale due to the large differences in magnitude of the escapements between rivers. *Trends amongst these Conservation Units differ with four streams increasing and four declining but at differing rates. A significant drop in numbers of spawners was recorded for the Shuswap and Bessette populations in 2012.*





Cowichan River fall Chinook (Hatchery + Natural spawners)

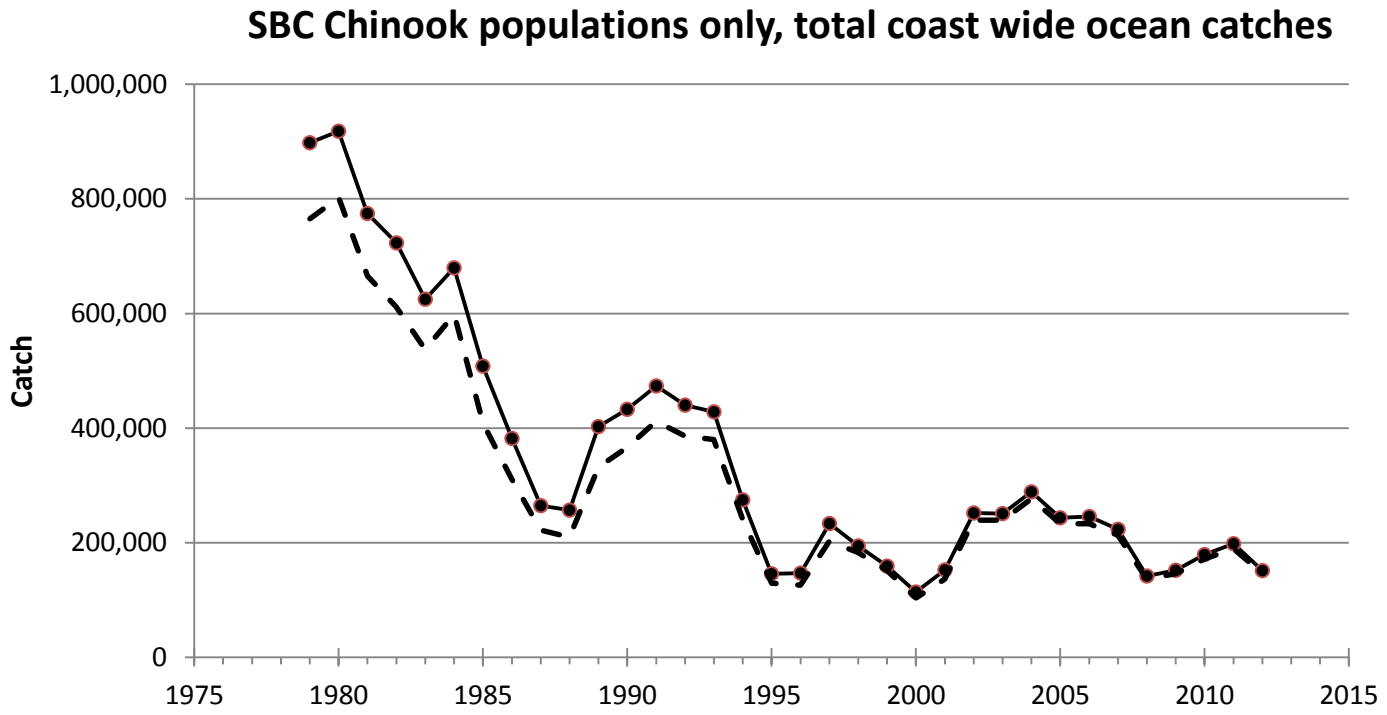


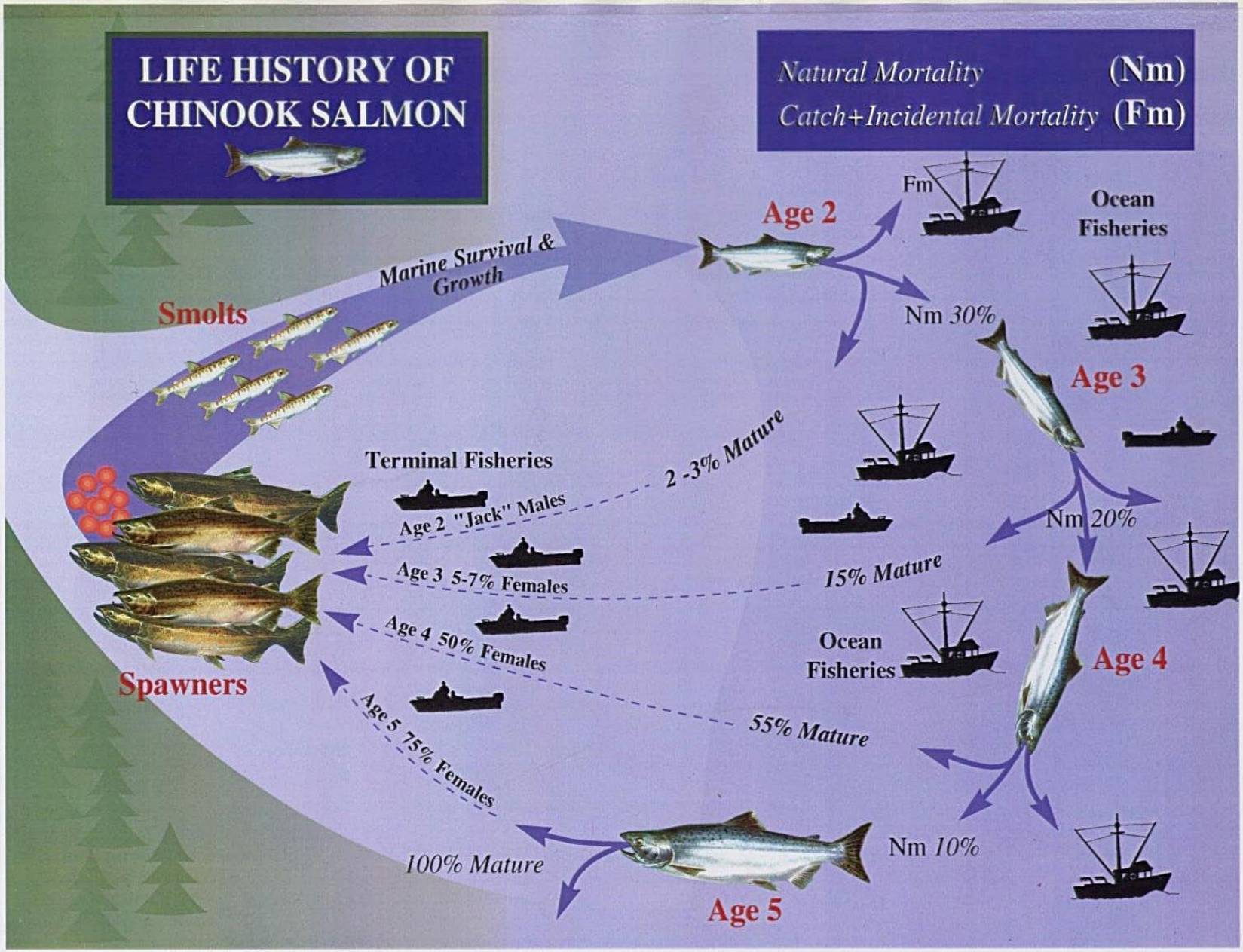
Chapter 4. Is HARVEST a significant stressor on Southern BC Chinooks?

Introduced 3 Regional clusters of Chinook CU's: Offshore, Far-North Migrating, and Local

Largely dependent on workshop presentation and discussions with Chuck Parken.

Examined distribution of CWT stocks, Catch trends in ocean and terminal fisheries, and CWT estimated Total Exploitation Rates.




LIFE HISTORY OF CHINOOK SALMON
Natural Mortality (Nm)
Catch+Incidental Mortality (Fm)
Marine Survival & Growth
Smolts
Age 2
Fm
Ocean Fisheries
Nm 30%
Age 3
Terminal Fisheries
2 -3% Mature
Age 2 "Jack" Males
Age 3 5-7% Females
15% Mature
Nm 20%
Age 4 50% Females
Ocean Fisheries
Age 4
Spawners
55% Mature
Age 5 75% Females
100% Mature
Nm 10%
Age 5

Harvest, page 84:

" …. The relative stability of recent low CWT-based marine survival rates … indicates that there has been a substantial and persistent reduction in survival from smolt to age 2 for some Chinook stocks "

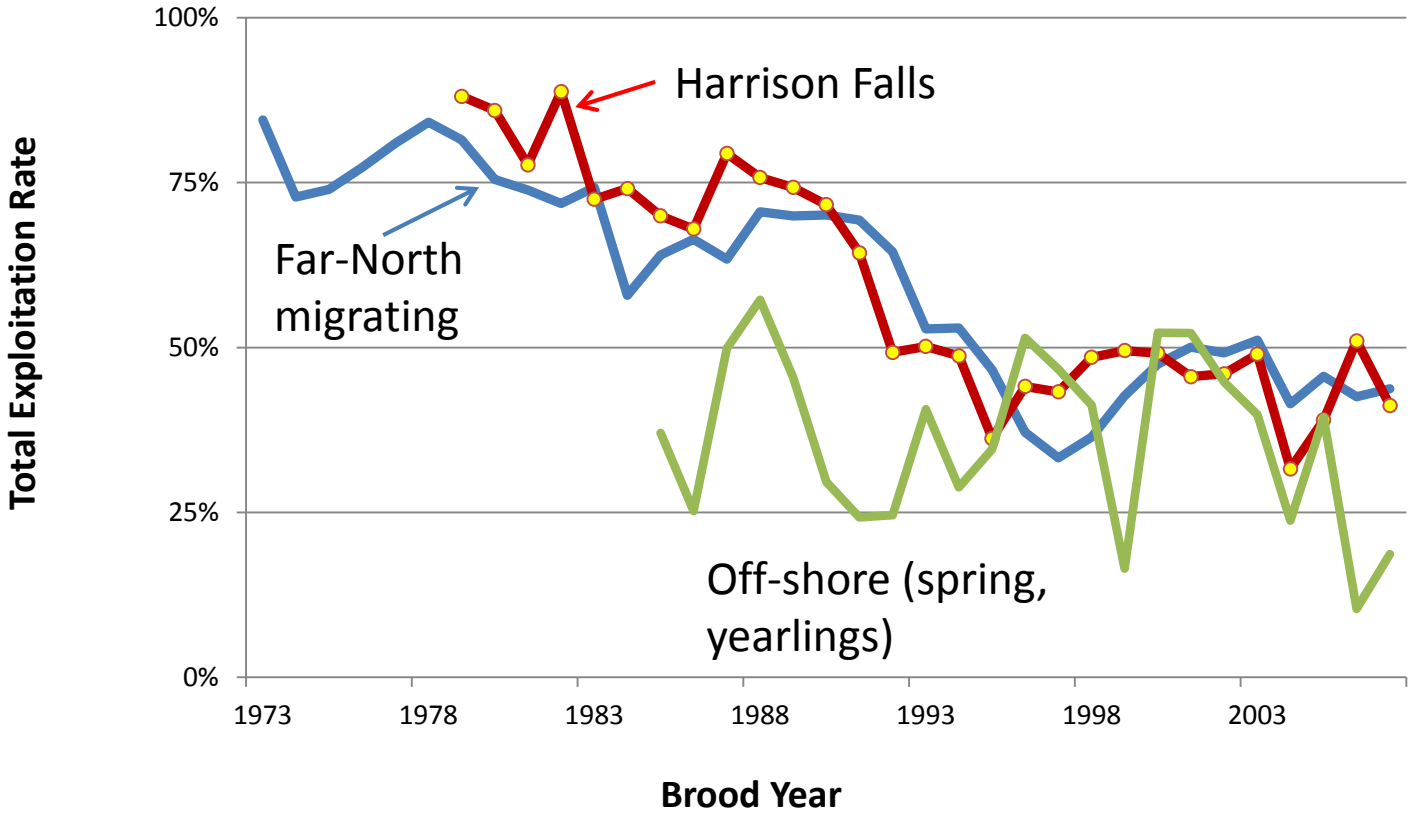


Figure H-13 ... Estimated total exploitation rates by stock groups (page 110)

Harvest (continued) …

“ … the question is, were they reduced by enough and early enough on particular stocks to avoid contributing substantially to the observed decrease in spawner abundances?”

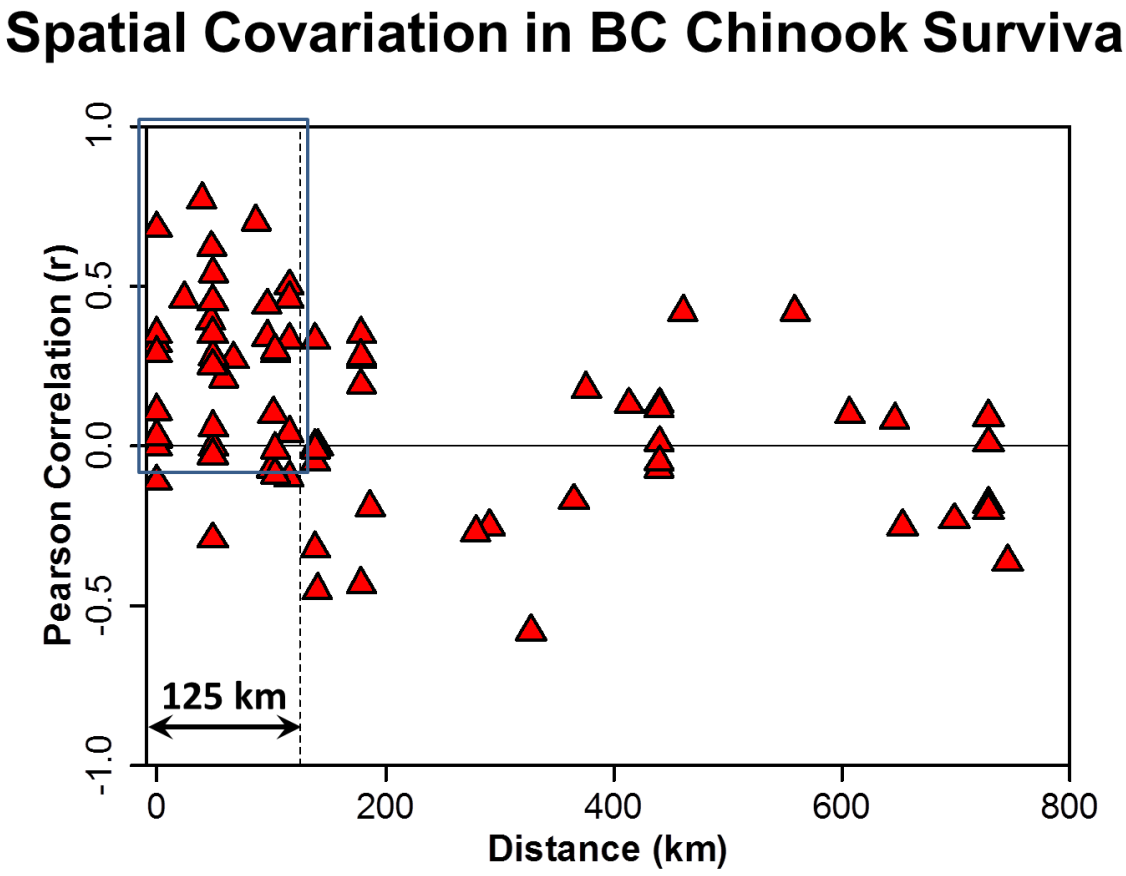
A fundamental issue is the sustainable harvest impact on a stock is determined by the population unit’s productivity (i.e., the returns per spawner) … But these are poor known by Conservation Units and Chinook life history types.

Chapter 6. Marine Habitat

"The general decline in spawner abundances across CU's suggest that mortality causing the decline occurred in habitat shared by SBC stocks." page 95

Figure MH-4. Bivariate correlation coefficients of marine survival rates and distance between entry points for BC Chinook stocks. (page 107)

Marc Trudel, DFO, presentation slide 23

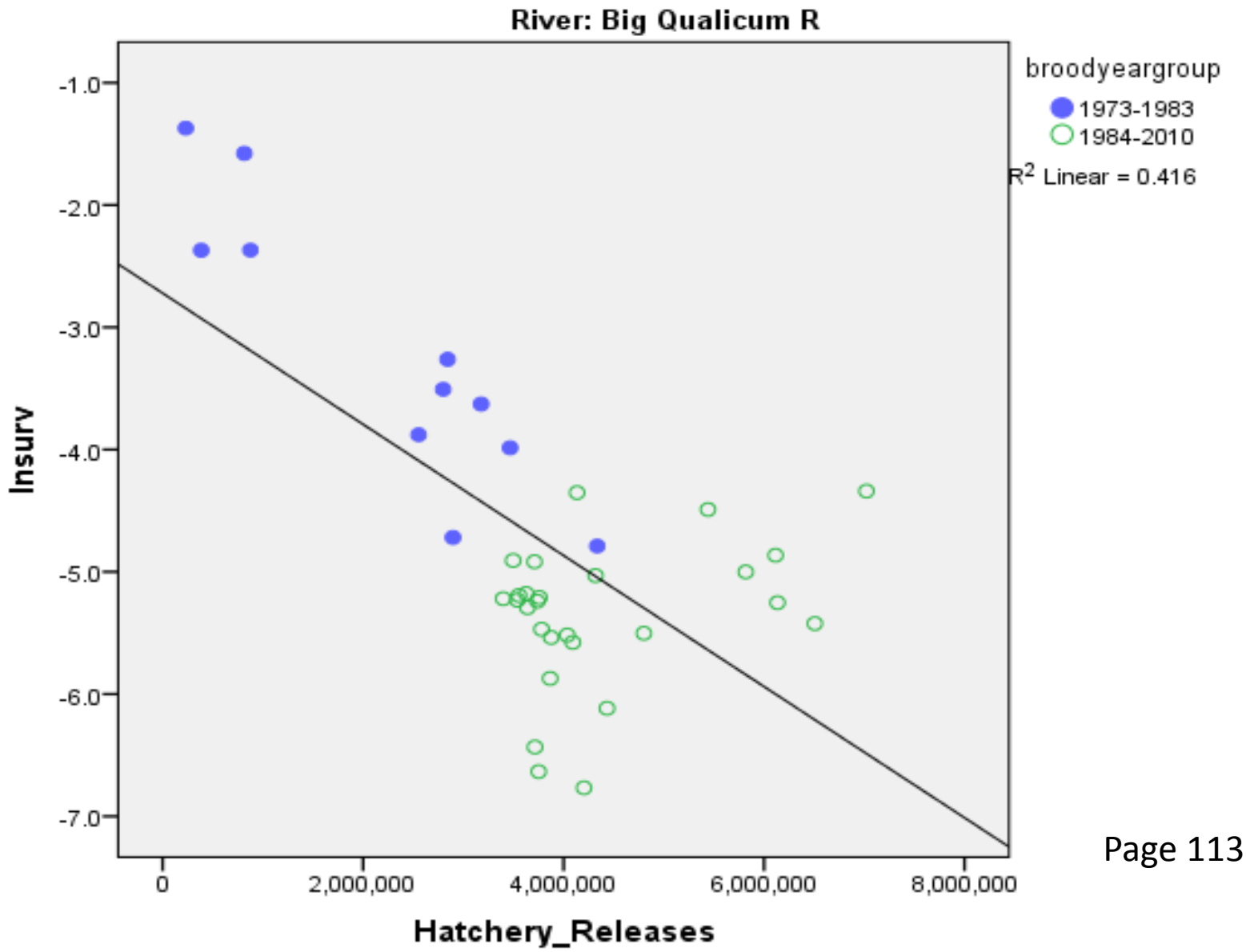


6.3 Has Marine Habitat Likely Been a Factor Responsible for Recent Trends in Abundance of Southern BC Chinook? (pg 98)

The Panel concluded that conditions in the marine environment during the first year of marine residency of SBC Chinook salmon was *very likely a key driver* in recent trends in survival and productivity. Both local and basin-scale oceanographic conditions are affecting marine survival. There is strong evidence of direct effects of local marine conditions on the survival of Chinook salmon, *especially in the Strait of Georgia.*

Based on CWT marine survival rates, climate indices and effects on biological production, top-down controls (predation) and models of Killer whale impacts, hatchery Chinook competition

Figure MH-13 ... Marine survival rates vs. Numbers of Hatchery Chinook released.

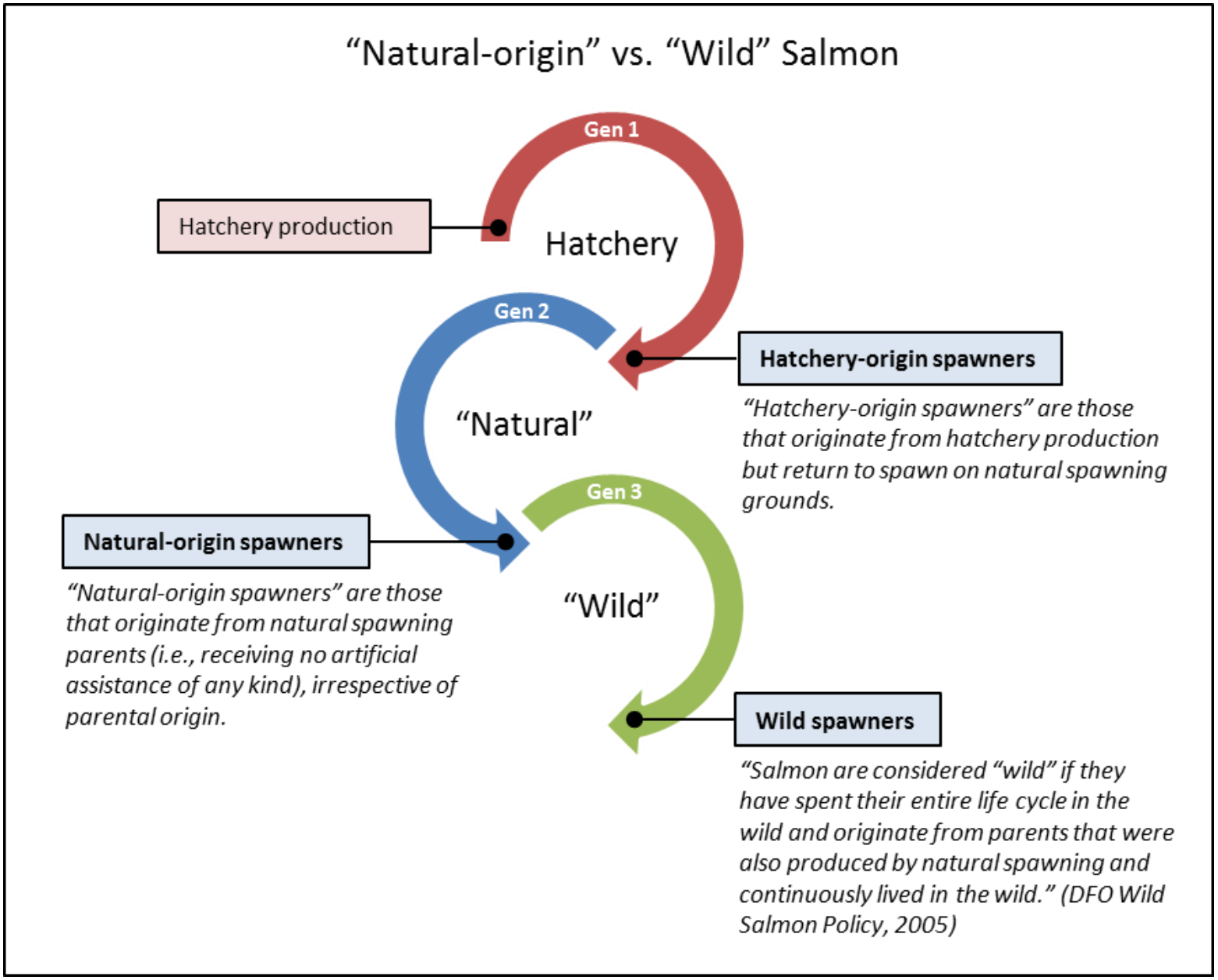


Chapter 7. Hatcheries ... *Likely the most extensively discussed section of the report, compared to extensive US reviews.*

Panel concerned with the impact of hatchery Chinook production on natural populations for 3 reasons:

1. Information provided was largely numbers of fish released, no metrics on adult production and contribution to local natural spawning populations was provided.
2. U.S. Members were concerned with definition of wild salmon under Canada's Wild Salmon Policy and questioned how we would evaluate the numbers of wild salmon in the presence of hatchery strays.
3. R. Withler's presentation on WCVI Chinook genetics indicates strong evidence of genetic introgression.

However, hatchery effects can not account for broad geographic pattern of decline in Chinook spawning abundances as the greatest declines occurred where there is the least likely hatchery effects (interior Fraser Chinook).


"Natural-origin" vs. "Wild" Salmon
Gen 1
Hatchery production
Hatchery
Gen 2
"Natural"
Hatchery-origin spawners
"Hatchery-origin spawners" are those that originate from hatchery production but return to spawn on natural spawning grounds.
Gen 3
Natural-origin spawners
"Natural-origin spawners" are those that originate from natural spawning parents (i.e., receiving no artificial assistance of any kind), irrespective of parental origin.
"Wild"
Wild spawners
"Salmon are considered "wild" if they have spent their entire life cycle in the wild and originate from parents that were also produced by natural spawning and continuously lived in the wild." (DFO Wild Salmon Policy, 2005)

Chapter 8. Pathogens

"There is no doubt that pathogens and disease cause mortality in Chinook salmon individuals, but evidence of population level impacts in southern BC Chinook salmon is very limited and largely inferred from experience in cultured populations (both in federal hatcheries and the salmon farming industry, also see Hershberger et al. 2013)." (page 144)

Chapter 9. Future Climate Change

"While climate likely has an impact on southern BC Chinook through a number of these pathways, no evidence was presented to the workshop that could attribute some portion of the decrease for the period 1995 to 2012 to this mechanism." (pg. 150) **… but future impacts likely to increase.**

OVERALL CONCLUSIONS OF PANEL ... Page xviii to xxii

The abundances of Chinook salmon spawning in many Conservation Units (CUs) in southern BC have declined substantially over the past 3 generations, but the clearest indication of this decline is within the Fraser River and not as apparent in other regions.

Limitations of Information ... ***Encountered in every topic reviewed.***

… it was not possible for the Science Panel, to *quantitatively assess the relative likelihood of different factors* contributing to trends in the abundance and productivity of southern BC Chinook salmon stocks.

Trends in SBC Chinook Abundance and Productivity

Southern B.C. Chinook stocks exhibit temporal patterns in life-cycle productivity, and to a lesser extent age-2 marine survival rate, that are *shared to some extent across a large spatial area* from Oregon up through western Alaska. Thus, it seems likely that there are large-scale marine processes influencing Chinook productivity. However, *stock-specific deviations in survival rates and productivity from the shared trends indicate that there are other key factors affecting productivity that are not shared across a wider group of stocks*. That is, local processes causing variation in productivity are also prominent. Any consideration of mechanisms causing changes in survival rate and life-cycle productivity ***must recognize variation on both local and large scales*****.**

Research Priorities ... Pages xxi to xxii

"Throughout our review the panel was frequently confronted with limited information over time and space. The highest priority follow up from this review would likely be for DFO and collaborating entities to undertake a critical review of assessment data available and needs, and related research."

Fundamental issue is one of monitoring and assessment versus explaining causation. Requires much more strategic plan with much better data.

"Finally, because the need for more quantitative evaluations of complex systems will likely increase, the Panel strongly recommends the department consider new more collaborative and inclusive processes to meet these needs."

Support slides ... Other conclusions.

Harvest: … If the latter possibility is true, then even the reduced exploitation rates may remain too high to sustain Chinook production for some CUs. (section 4.4)

A fundamental issue is the sustainable harvest impact on a stock is determined by the population unit's productivity (i.e., the returns per spawner).

Freshwater Habitats:

… there was no evidence presented to suggest that the variation in patterns of decline or increase observed in recent years among CUs is related to land-use activities including forestry, urban development, and linear developments (roads, pipelines) and water uses.

BR: Conclusion is weaker than it sounds due to data.

Marine Habitat: ... Major conclusion shown earlier

There is strong evidence of direct effects of local marine conditions on the survival of Chinook salmon, especially in the Strait of Georgia.

On general principle, however, smaller fish have higher natural mortality rates, which helps to support our primary research recommendation is to focus on early marine periods.

Hatcheries:

… there are a number of factors that indicate that hatchery programs have likely had a negative effect on the productivity and viability of natural populations in some CUs. The effect appears to be highly variable between CU groups, ranging from little or no impact (in most Fraser River CUs) to substantial risks (Vancouver Island).

… the Panel recommended an independent programmatic assessment including evaluation of the role hatcheries serve, the consistency with which hatchery programs meet Wild Salmon Policy (WSP) goals, and more quantitative accounting of the contributions of hatchery-produced Chinook to fisheries and natural spawning streams.