Setting the Stage for Canada's Wild Salmon Policy (1980 to March 2000)

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1) A convergence of people and issues ... a chronology for change

A period of accomplishments in science and new agreements, historic highs and lows in Canadian catches of Pacific salmon (Attachment 1), and changes in resource management. But ironically, in the context of Fraser River sockeye salmon, the effect of these changes were less than for other Pacific salmon populations in British Columbia and the Yukon.

The following is my personal perspective on these changes and is provided in a chronology to emphasis the diversity of change and events but is not meant to be comprehensive or to imply that each of the points was equally important.

- Personal perspective determined by PhD research on Environmental and Genetic Sources of Geographic Variation in Atlantic Salmon (McGill University, 1974-1979).
- 1980 International Conference on the Stock Concept, published by Canadian Journal of Fisheries and Aquatic Sciences Vol. 38(12). 1981. (book, not submitted, one article submitted as **Appendix 1**)
- Development of new methods in molecular genetics to study genetic variation (electrophoresis)
- Riddell joined the Department, September 1979, and subsequently established a Salmon Genetics program within Science Branch, 1982.
- **1982 establishment of the International Society for Conservation Biology** ...

Conservation biology is the scientific study of the nature and status of Earth's biodiversity with the aim of protecting species, their habitats, and ecosystems from excessive rates of extinction. It is an interdisciplinary subject drawing on sciences, economics, and the practice of natural resource management. (summarized from Wikipedia, November 5,2010)

The term *conservation biology* was introduced as the title of a conference held at the University of California in La Jolla, California in 1978 organized by biologists Bruce Wilcox and Michael Soulé. The meeting was prompted by the concern among scientists over tropical deforestation, disappearing species, eroding genetic diversity within species. The conference and proceedings that resulted sought to bridge a gap existing at the time between theory in ecology and population biology on the one hand and conservation policy and practice on the other. Conservation biology and the concept of biological diversity (biodiversity) emerged together, helping crystallize the modern era of conservation science and policy. Related issues involved conservation of small populations, value of biodiversity, and risks.

- 1982 El Nino event, poorest survival yet measured for many west coast salmon populations
- 1982 Pearse Commission, "Turning the Tide; a new policy for Canada's Pacific Fisheries"

- 1983-84, DFO Pacific Region internal discussion of a "Stock Write-off Policy" that would allow loss of small salmon populations that were passively managed within salmon fisheries.
- 1985 Pacific Salmon Treaty, first comprehensive coast wide management agreement with the United Sates (1975 U.S. Boldt Decision and management of mixed-stock ocean fisheries).
- 1985 formation of the Pacific Stock Assessment and Review Committee, B. Riddell chair of the Salmon Sub-committee until 1992.
- 1987 United Nations. Report of the World Commission on Environment and Development emphasizes need for sustainable development
- 1988, Riddell and others, first inventory of Pacific streams and enumeration programs.
- 1990 first International Panel on Climate Change report (supplement published in 1992)
- 1991 NATO conference on the Genetic Conservation of Salmonid Fishes (published 1993)
- 1991, Nehlsen et al. "Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries 16: 4-21. (American Fisheries Society, submitted as **Appendix 2**)
- ***1992 United Nations Convention on Biological Diversity (precautionary principle)***
- 1991-1993, extreme El Nino event (lead to closure of Canadian Chinook fisheries in 1996)
- 1992 DFO initiates Coho planning exercise for southern BC coho salmon (actions in 1997)
- 1992, Riddell appointed to U.S. Committee on Protection and Management of Pacific Northwest Anadromous Salmon, supported by the National Research Council. Report in Upstream: Salmon and Society in the Pacific Northwest, National Academy Press, 1996. (reference book, not submitted)
- 1993, Riddell publishes "Spatial Organization of Pacific salmon: What to Conserve? In NATO ASI Series A: Life Sciences Vol. 248. (submitted as **Appendix 3**)
- 1995 UN FAO Code of Conduct for Responsible Fishing (followed by the Canadian Code in 1998)
- 1998, CC Wood and B Holtby, **Defining conservation units for Pacific salmon** using genetic survey data. *In*. Action before Extinction. World Fisheries Trust. (submitted as **Appendix 4**)
- 1999 renewed Pacific Salmon Treaty (introduction of abundance-based management for Chinook coastwide and southern BC coho salmon)
- 1999 first annual report from the Pacific Fisheries Resource Conservation Council (PFRCC) with Background Papers, including Walters and Korman, Salmon Stocks, Background Paper 1999/1b (submitted as **Appendix 5** and available at www.fish.bc.ca)
- March 2000 First draft of Wild Salmon Policy for public consultation (a new framework for the management of Pacific salmon, submitted as **Appendix 6**)

All of this development was set within an environment of the Salmonid Enhancement Program (established in 1977) and associated debates, listings of ESU's for salmon in the United States, development of wild salmon policies and recovery programs in Washington State, Oregon, and California; heightened debated between user sectors in Canada; and increased environmentalism.

Attachment 1: Trends in Commercial Salmon Catch and Spawning Escapements (Wild Salmon Policy, December 2004 version) … prepared by B Riddell (fall, 2004).

The figure was created to demonstrate the extent of change in catch and shift to spawning escapements in the 1990s. It is meant simply to show the shift in Departmental actions towards conservation, and does not capture changes in diversity of salmon populations.

2) The value of diversity within Pacific salmon ... the original value

Before the full development of commercial fishing, the diversity of salmon was essential for aboriginal peoples and was widely recognized by early biologists studying salmons. Variation between salmon populations was recognized by the turn of the 19th century in the Pacific (and earlier in Europe) and long before any quantitative basis for their evaluation and management of Pacific salmon was even developed (~ 1950s).

We commonly accept now that Pacific salmon return to their natal stream to reproduce each generation and that differences between populations have a genetic basis ... but evidence to support this was slow to accumulate. The concept of "Stocks" of salmon was first recognized formally in 1939 meeting of the American Association for the Advancement of Science but not fully accepted as having an adaptive (& therefore genetic) basis until the 1972 publication by Canada's W.E. Ricker in his historic publication (cited in my 1993 publication)

The salmon that we observe today reflect their genetic composition and its expression within the environment ... the old Nature vs Nurture debate.

The Stock Concept in Pacific Salmon simply stated says that differences observed between salmon populations result from homing (i.e., returning to specific locations) to their natal streams with the resulting accumulation of genetic differences through time. If environmental conditions are sufficiently stable through time and favour specific genetic differences, then localized ADAPTATIONS develop via natural selection. Salmon adapted to their environments have greater productivity in that specific habitat (i.e., the rate of offspring expected to return per parental spawner). Therefore, the largest production of Pacific salmon will result from the widest and fullest utilization of freshwater habitats ... and maintenance of biodiversity.

The roots of the Stock concept for Pacific salmon has been acknowledge for essentially 100 years now, ***So what happened to the Stock Concept that we now need the WSP?***

1980 Stocks conference: Jack McDonald paper on Stock Concept in BC salmon fisheries (submitted as **Appendix 1**):

"However, the application of the stock concept to management has been fraught with difficulties mainly because of the large number of stocks involved, the increasing catching power of the fishing fleet, and its displacement into fishing areas where stocks are mixed extensively."

Suffice it to say that something was lost in the transition!

In management, the stock concept became more associated with segments of production that could be recognized for management, provided for a basis in evaluation, and these tended to be the larger stronger production units or complexes. **Again, the conflict between production was contrasted with rates of production and sustaining spatial diversity of salmon populations.**

There are three principle messages from the discussion of the Stock Concept:

1. Adaptations that exist today reflect environment/events of the past ... but evolution is a continuous process. The process of ADAPTABILITY in salmon is critical for their future; since we cannot predict the future, to actually "manage" salmon for the future means we need to maximize diversity throughout the range of Pacific salmon.
2. Habitat and ecological diversity (and increasingly climate variation) are the templates for genetic diversity. (Large numerical abundance also helps but less than may be expected.) The tie between conservation units, habitat, and ecosystems within the WSP is simply reflects natural conditions.
3. Maximizing the production of salmon is consistent with maintaining diversity in salmon (not inconsistent) ... in management **the tradeoff that people debate between diversity (i.e., weak stocks) and production is about the rate of use not the total production.** The essential element to maintain in Pacific salmon is their distribution and diversity, and to a lesser extent their abundance since it will vary from year to year with little control.

Scientifically, there is no question that diversity in Pacific salmon is an essential value for their continuance and our sustainable benefits, but the rates of use today and what are acceptable risks to the resource base for tomorrow are more social and cultural issues that require a strong process in order to find agreements (science can still advise) ... therefore Strategy 4 in the WSP.

More recent considerations of the importance of between population diversity (recently referred to as the Portfolio effect) are also important but were not really explicit in the genesis of the Wild Salmon Policy (other than the general acknowledgement of the importance of spatial distributions of spawning populations). This topic may certainly be relevant to the Commission's consideration of sustainability of Fraser sockeye salmon but is not considered further in this submission.

3) Managing Diversity in BC's Pacific salmon

If **each combination of a salmon species and a stream** is equated to a "**stock**", then managing our Pacific salmon becomes an impossible task. Slaney et al. (1996) documented these combinations and the report has been provided to the Commission. In summary:

From Slaney et al. 1996. Fisheries 21(10), page 24. Summary of "Stocks" (individual combinations of species and streams) (submitted as **Appendix 7)** in BC and the Yukon, the proportion of Stocks that could be evaluated with existing data, and the number of stock extinctions documented.

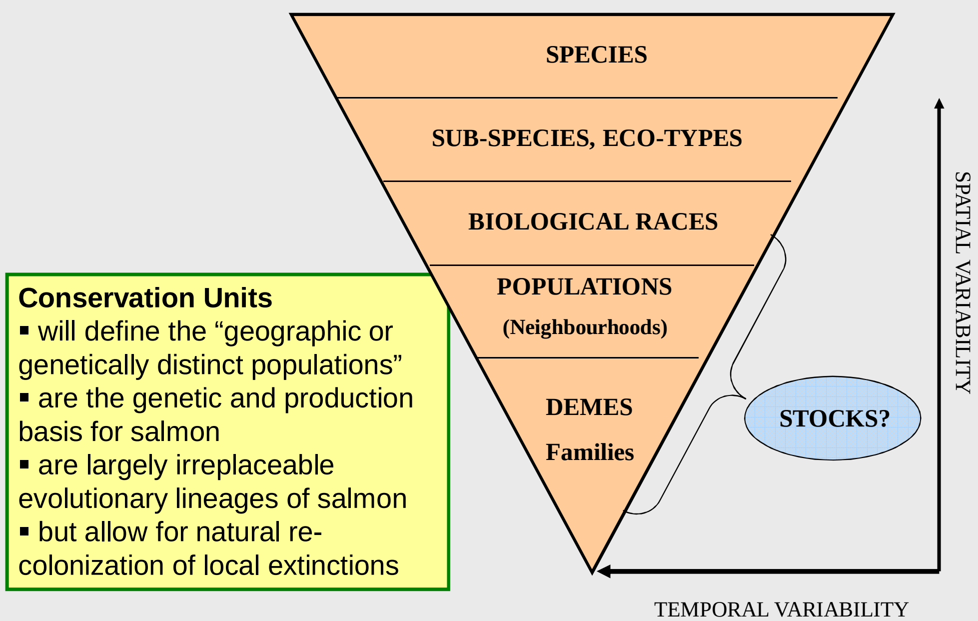
Species	# of "Stocks"	Status could be determined for % of "Stocks"	% Extinctions of Known "Stocks" (number of Stocks)
Chinook	866	47%	4.2% (17)
Chum	1,625	70%	1.9% (22)
Coho	2,594	50%	2.2% (22)
Pink	2,169	69%	1.1% (17)
Sockeye	917	60%	3.7% (20)
Total	8,171*	60%	2.1% (105)

Footnote: * this summary does not include steelhead or cutthroat trouts (add 1,479 stocks), nor does it include "stocks" that may have been lost before the early 1950s.

For Fraser sockeye alone, DFO recognizes 229 spawning locations within 151 "stocks" of Fraser sockeye. These "stocks" are aggregated into four run timing groups for fishery management and are summarized in 21 "production units" for quantitative assessments (with varying numbers of streams included within production units). We will see later that these "stocks" of Fraser sockeye have been organized into 32 Lake-rearing sockeye Conservation Units (CU) and 5 river-rearing CU's under the Wild Salmon Policy.

HOWEVER, these individual combinations of species and streams are NOT stocks in the sense of irreplaceable lineages of salmon that have evolved through time. In isolation, most individual combination of species and steam has a very limited opportunity to evolve or survive. Actually, the species/stream combinations are only one step in a hierarchical continuum linking spawning groups of salmon within a stream (a deme) to other such groups within a geographic area and forming a population (or neighbourhood) of salmon demes. Due to habitat differences and/or distance, populations are sufficiently genetically isolated that localized adaptations persist over time and form the basis of biological or geographic variation in Pacific salmon. This geographic variation based on irreplaceable genetic lineages are the Conservation Units within the Wild Salmon Policy. (from Figure 2 in Riddell 1993)

Hierarchy of biological diversity within Pacific Salmonids (from Riddell 1993)

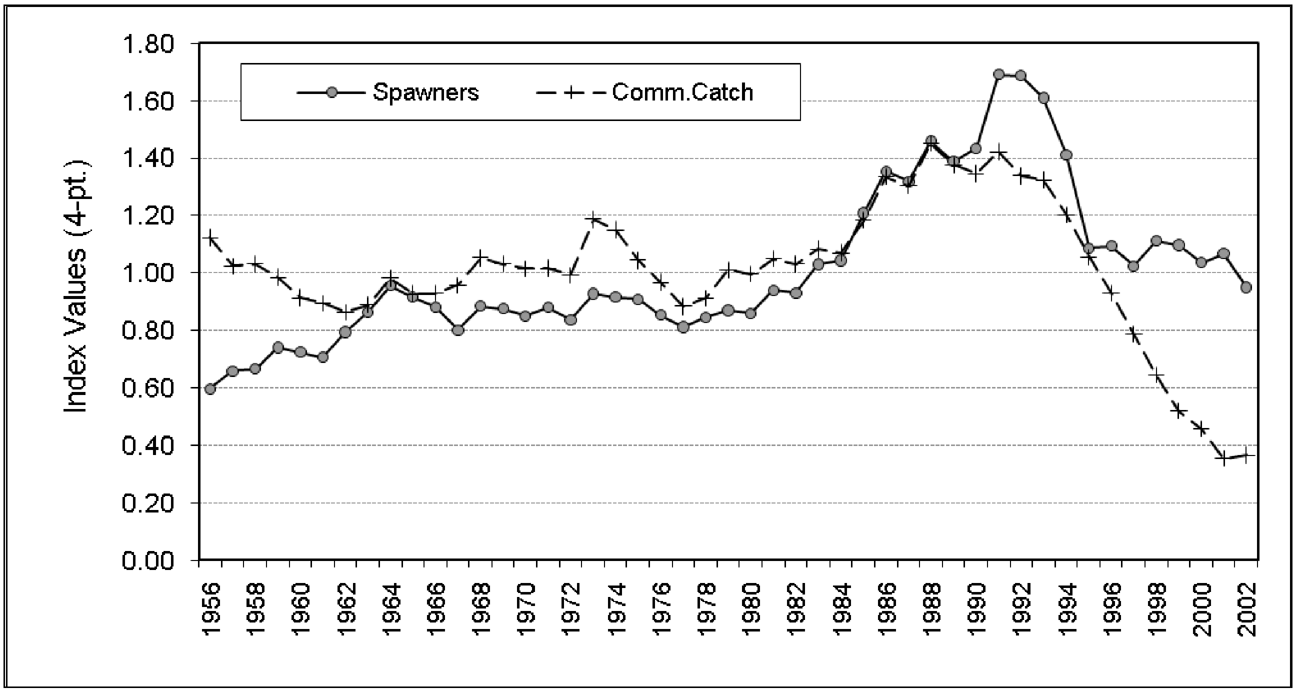


While the theory of conservation units is the same between each species of Pacific salmon, in practice the size of these units will differ between species due to differences in their genetic history and life histories. For example, pink salmon show little genetic variation (based on neutral genetic markers) over large geographic areas but essentially all sockeye rearing in different lakes are also genetically different. Consequently, the number of conservation units for sockeye salmon will remain fairly large but conservation units for pink salmon will be much larger and fewer. For sockeye salmon, sustaining diversity in BC requires careful management of each conservation unit. The loss of a sockeye conservation unit will be the loss of an irreplaceable genetic legacy that cannot be replaced. The latter is re-enforced by a history of transplanting sockeye salmon between lake systems ... they are essentially never successful. In other words, if a sockeye CU is lost we may not even be able to replace the production via transplanting other sockeye into that system.

Attachment 1: Trends in Commercial Salmon Catch and Spawning Escapements (Wild Salmon Policy, December 2004 version) … prepared by B Riddell (fall, 2004)

*This figure summarizes **trends** in commercial catch and total spawning and is **NOT** intended to reflect the change in diversity of salmon populations over time.*

This figure shows the trends in commercial catch of all Pacific salmon (five species combined) and the total number of Pacific salmon spawning in B.C. streams. Annual values have been averaged over four years to reduce year-to-year variation and illustrate the overall trend. For example, the catch and spawner data plotted for 1956 are averages of values for 1953 through 1956. It is meant simply to show the shift in Departmental actions towards conservation.



The reduction in catch to provide more spawning salmon is evident in the figure. The numbers of salmon spawning in B.C. streams (based mostly on visual estimates of spawners) have increased since the early 1950s while catch declined dramatically in the 1990s. The extreme reduction in commercial catch, from record high values in the early 1990s to record low levels recently, reflects declines in marine production of salmon during the mid-1990s, changes in markets for salmon (value for pink salmon), and significant conservation actions since 1996. The figure does not include First Nation or recreational catches, but their addition would not significantly alter the trend. Nor are the contributions of enhanced and wild salmon distinguished.

Methodology (Appendix in WSP 2004)

The index of commercial catch is based on the total annual catch, in weight landed, of all salmon species from 1953 through 2002. It was calculated by: (1) summing all landed commercial catches within a given year; (2) dividing each year's value by the average landed weight over the entire period; and (3) averaging every four years to account for the annual variation in returns of Fraser sockeye salmon and the two-year cycles of pink salmon in British Columbia (four-point moving average).

The value used for each year is the deviation of the landed weight from the long-term average landed weight. This calculation will not change the trend pattern, but does standardize for different units of measure when comparing with other trends, such as total spawning escapements. Escapements are largely based on visual surveys and extrapolations to total numbers of salmon spawning in a stream. While these estimates are of unknown accuracy in terms of the true number of fish spawning, they are considered to be a consistent index of annual changes in spawning numbers.

The index value for spawners is calculated by summing the numbers recorded for all salmon species in all BC streams for each year (data based on DFO BC16 spawning escapement records). These annual values are then treated in the same way as steps (2) and (3) above for commercial catch.

Certain data have not been included in the figure, as they were not available for the full time period and/or their inclusion would not change the trends shown, these included:

- BC recreational catches and First Nations catches in British Columbia and the Yukon were not available for every year, and would not have changed the catch trend as presented;
- Catches in BC transboundary rivers and the Yukon River were not included, since they would not change the trend due to their relatively small magnitude compared to the total BC commercial catch; and
- Spawning escapements in BC transboundary rivers and the Yukon River were similarly excluded.

Appendix of References:

1. 1980, International Conference on the Stock Concept, published by *Canadian Journal of Fisheries and Aquatic Sciences Vol*. 38(12). 1981
2. 1991, Nehlsen et al. “Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. *Fisheries 16: 4-21.* (American Fisheries Society
3. 1993, Riddell publishes “Spatial Organization of Pacific salmon: What to Conserve? *NATO ASI Series A: Life Sciences Vol. 248.*
4. 1998, CC Wood and B Holtby, Defining conservation units for Pacific salmon using genetic survey data. *Action before Extinction*. World Fisheries Trust.
5. 1999, first annual report from the Pacific Fisheries Resource Conservation Council (PFRCC) with Background Papers, including Walters and Korman, *Salmon Stocks, Background Paper 1999/1b*
6. March 2000, First draft of *Wild Salmon Policy for public consultation* (a new framework for the management of Pacific salmon
7. Slaney et al. 1996, Summary of “Stocks” (individual combinations of species and streams) *Fisheries 21(10), page 24.*