Pacific Fisheries Resource Conservation Council

2000–2001
Annual Report

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Pacific Fisheries Resource
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Pacific Fisheries Resource Conservation Council

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Pacific Fisheries Resource Conservation Council
Conseil pour la conservation des ressources halieutiques du pacifique

October, 2001

Hon. Herb Dhaliwal
Minister of Fisheries and Oceans
Government of Canada
Ottawa

The Hon. John van Dongen
Minister of Agriculture, Food and Fisheries
Government of British Columbia
Victoria

Dear Ministers:

As Chair of the Pacific Fisheries Resource Conservation Council, it is my honour to present you with our third Annual Report. I join with my fellow members of the Council in putting forward the information and comments contained here, in line with our mandate to advise your governments and the Canadian public about the conservation of salmon and steelhead and their freshwater and ocean habitat.

This year, our report sets its focus on issues related to ocean survival of salmon.

As you will have already noted, this report is being provided later in the year than our previous reports. With the expiry of members' terms last December and the delay of sixteen weeks until the new appointments in April, the Council was unable to proceed during the period when the Annual Report was normally written. This situation, compounded by the postponement of government decisions due to the federal and provincial elections, also led to the Council's deferment of the public consultations normally held at the beginning of each year. As a result, our Annual Report could not be made available until now.

In this year's report, we make comments on the state of salmon stocks and habitat on a coast-wide basis, including the United States, and provide information on some key fishery stocks related to salmon. In the view of the Council, it is important to recognize the wider context in which Pacific salmon live, in order to understand the crucial conservation challenges.

The comments contained in the report reflect a consensus view of the Council members, and they are intended to provide advice on policy direction in the form of practical suggestions.

The Council has the benefit of continuity of service by Carl Walters, Paul LeBlond, Murray Chatwin, Mary-Sue Atkinson, and Mark Angelo who were re-appointed as members. Frank Brown continues as the appointee of the BC Government. We welcomed the addition of Merrill Fearon, Marcel Shepert and Jeffrey Marliave this year. And, we acknowledge the dedication and contributions of Terry Glavin, Rick Routledge and Don Ryan whose terms as Council members were completed.

The content of this annual report is a departure from the previous years when the species were reviewed separately and considerable emphasis was placed on freshwater habitat and the problems related to in-stream conditions. The environment related to ocean survival and the consequences of climate change, for instance, are given prominence here.

While some bright spots and hopeful trends have become apparent, there are still highly adverse conditions and long-term risks to wild salmon throughout British Columbia. The improvement in some salmon returns is encouraging, but the question remains: Are improved ocean conditions a long-term trend or a temporary, short-term phenomenon?

A precautionary approach and vigilant management of the salmon and steelhead resource must continue to be the foremost objectives for both federal and provincial governments to pursue.

Hon. John A. Fraser
Chairman

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1. INTRODUCTION

The state of British Columbia's salmon stocks has often been characterized in sweeping optimistic and pessimistic statements that generally appeal to emotions, rather than inform a public debate or contribute to public understanding.

The reality is that salmon stocks defy easy overall description, and have to be considered in terms of the many factors that impact upon them. Those factors differ on the basis of geography, species, seasonal runs, responses to water temperatures and levels, predators, spawning locations and weather, to name just a few.

The success of spawning and levels of salmon returns, for instance, can be influenced by many conditions. The depiction of a "good" year or "better" salmon productivity can be a highly subjective opinion and reflect a local or unique situation. It can also relate to a long-term average or to the parent years.

The Pacific Fisheries Resource Conservation Council is mandated to advise the governments of Canada and British Columbia regarding salmon stocks. The Council's mandate specifies that it is to serve as:

> *…an independent body that will provide strategic advice to Ministers and the public on the conservation and long-term sustainable use of Pacific salmon stocks and their freshwater and ocean habitat in British Columbia.*

This report provides a preliminary summary of the state of stocks in 2001. It is preliminary because final spawner counts will not be available for a number of months. The report also summarizes research findings and thinking to date on the subject. Lastly, some related issues are discussed, and some important conservation and management questions are put forward.

Council Initiatives

The Council achieved several key objectives that had been set out in its May 1999 and January 2001 work plans. These included production of the advisory report on the Central Coast and the Council's involvement in several events, including the Okanagan salmon restoration initiatives. The Council encouraged public participation and awareness of salmon issues through its joint sponsorship of workshops and meetings, in cooperation with academic institutions, Aboriginal groups, and environmental non-governmental organizations.

During the past year, Paul LeBlond acted on behalf of the Council to survey the views of several dozen individuals from across the fisheries sector in Canada on the future direction of fisheries education. This led to the production of the Council advisory report entitled "*A Crisis in Fisheries Education*".

The Council initiated a review of habitat-related issues and activities in urban streams, specifically the Fraser River and Georgia Basin. The result of that review has been the preparation of an advisory paper entitled "*The Role of Public Groups in Protecting and Restoring Freshwater Habitats in British Columbia, with a Special Emphasis on Urban Streams*". Its authors were sponsored by the Council, and asked to describe and assess the important role of volunteers and community organizations in salmon conservation.

Last summer, the Council met with the Chair of the BC Government's Aggregate Review Panel. The information and advice on measures to ensure stream protection was reflected in the recommendations contained in the Panel's March 2001 report.

The Council Chair met with Stephen Owen who was then heading the federal government's review of fisheries consultation practices and structure. The May 2001 report was in line with the Council's past suggestions about the need for a more productive and inclusive consensus on policy issues affecting fisheries conservation.

A briefing was provided to the Council on herring management, involving federal government officials who explained the operations and salmon-related effects of the herring fishery.

The presentation on aquaculture last year by BC Government officials enabled the Council to understand key dimensions and directions of that industry sector. The Council Chair participated in a panel discussion at a February 2000 conference where he recognized the aquaculture industry's role while enunciating the Council's position that the industry's activities must be consistent with firm measures to protect wild salmon stocks.

The watershed restoration and nutrient replacement initiatives in the Keogh River on Vancouver Island came to the attention of the Council during the past year. The highly positive results in terms of salmon productivity seemed to bode well for the application of this strategy in other areas of the province. However, it now appears that DFO funding contributions have been cancelled. The Council hopes that DFO can be persuaded to reconsider its decision.

While the BC Government did not provide an official response to the Council's June 2000 Annual Report, it did engage in informal discussions on some of the issues raised in that document. The Council has remained in continuous discussions with the BC Government with respect to habitat and salmon stocks.

The Council received the federal government's detailed response to the Annual Report on April 2, just after the end of the fiscal year. In that federal government response, the Council was asked to undertake an analysis of the concept of over-spawning and carry out discussions of research priorities related to salmon marine survival and climate change. Members were also asked to investigate the impact of low water levels. The Council will carry out these assignments during the current year as priorities in the updated work plan.

Council Membership

The Government of British Columbia named its first appointee to the Pacific Fisheries Resource Conservation Council in June 2000. Frank Brown, a community leader from Bella Bella, has made an exceptional contribution as the BC Government's initial representative, and an ex-officio provincial member is due to be named.

Re-appointed to the Council this year were Carl Walters, Paul LeBlond, Murray Chatwin, Mary-Sue Atkinson and Mark Angelo. Those continuing as ex-officio members are Dick Beamish and Fred Fortier. The new members named by the Government of Canada are Merrill Fearon, Marcel Shepert and Jeffrey Marliave.

Completing their terms as Council members in December 2000 were Terry Glavin, Rick Routledge and Don Ryan. Their valuable contributions of ideas and enthusiasm were particularly appreciated by those who served with them as colleagues.

Organization

The Council continues to perform principally in its designated roles of information source regarding salmon conservation and independent watchdog on activities impacting Pacific salmon. Its purpose has been to alert both levels of government and the public to situations that require action or that give cause for the expectation of problems affecting salmon stocks and habitat.

The Council will continue to engage senior officials in Fisheries and Oceans Canada and their counterparts in the Government of British Columbia in what is hoped will be productive discussion and amendment of the Council’s terms of reference with a view to enhancing the Council’s effectiveness.

At the same time, the fuller participation of the BC Government has proceeded in the form of the appointment of a provincial member, as well as the secondment of a provincial government biologist to prepare the Council’s background paper on public groups and urban streams. This in-kind contribution of resources has demonstrated the considerable goodwill and cooperative approach of the BC Government in building the relationship with the Council that was anticipated under the July 1997 Canada-BC Fisheries Agreement.

2. STATUS OF STOCKS AND HABITAT

In the 1999–2000 Annual Report, the Council expressed the following concerns:

> *The state of salmon spawning populations is an ultimate measure of performance in managing fisheries and habitat. The current status of salmon stocks ranges from those that are productive and apparently sustainable, to those that have low productivity and are at risk of extinction. For example, most Summer Run Fraser sockeye and many chum appear to be productive. In contrast, more than 10% of stocks coast-wide are rated at high risk of extinction.*
>
> *Overall for 1999, salmon catches and many stocks were at their lowest abundance in almost 100 years. For example, the ocean survival of Fraser River sockeye, a mainstay of most commercial and Aboriginal fisheries, was so low overall in 1999 that the fishery had to be closed. The Rivers and Smith Inlet sockeye fisheries have been closed since 1996 and 1997 respectively. These stocks have never been known to be lower.*

The Council's discussions of problem areas this year largely mirrored those already being identified by Fisheries and Oceans Canada officials. The sockeye declines in the Central Coast were of special concern to the Council, as they are to both levels of government. Other severe current problems have become apparent for Thompson River coho in the South Coast and chinook in the west coast of Vancouver Island area.

Also troublesome to the Council is the state of steelhead, particularly in the Strait of Georgia.

It was noted that there were both strong and weak sockeye returns last year. For example, in the Fraser River, the record escapements to the Upper Adams River were in contrast with the high pre-spawning mortality of Late Run Fraser sockeye that undermined those stocks.

Pre-season, Council members were told by various sources that there appeared to be considerable up-side potential for improved salmon returns in 2001 in most regions as increased ocean survival was anticipated. For example, the improved early marine survival and growth that was observed in 2000 for Strait of Georgia juvenile coho could lead to better total returns this year.

The status of stocks in the Central Coast was reviewed in detail in the two advisories sponsored by the Council since last year. Those presented detailed evaluations of stocks across the region, and they provide an information source that is recommended for future reference.

Discussions with community leaders in the Central Coast revealed that the region has been more seriously affected by resource development than was previously believed. Despite its relative isolation, the Central Coast is far from pristine, and the consequences of poor forest practices of the past are still evident in low salmon productivity.

The Council continues to advocate a careful precautionary approach to coho salmon stocks, even where there are signs of greater abundance. The opening of fishing for coho in some specific areas and instances appears to have been justified in the current year, given the evidence that has become available from monitoring since the comprehensive restrictions were introduced four years ago. At the same time, the Council provides a caution about the need for continued fishing restrictions until it can be demonstrated that coho returns have been rebuilt to sustainable levels.

The selective fishing initiatives of the past two years have yielded considerable innovation and demonstrated the willingness of many in the fishing industry to adopt practical methods with positive conservation consequences. It also led to extensive new information being made available for fisheries management purposes. The continuation of such initiatives, in one form or another, would be valuable if they can generate further innovation and information. The selective fishing approach has involved several novel practices, and the pilot projects are serving as best-practice examples in the industry. In developing and implementing selective fishing, there has been increased emphasis on mechanisms to increase individual responsibilities within the fishing industry.

Status of Habitat

The commitment of governments to continue to protect and restore salmon streams and rivers is one that the Council has constantly urged. There is an extensive body of laws and regulations at the federal, provincial and municipal levels that serves as a comprehensive basis for salmon habitat protection. It continues to be important for those requirements to be enforced. This requires a more concerted policing of polluting activities, as well as a stronger effort in education and public awareness concerning the detrimental effects of some industrial, agricultural and other development activity on salmon.

Public involvement in the form of partnerships and local initiatives should be a key part of protecting and restoring salmon habitat. To that end, the Council recently released the adisory paper on public participation mentioned earlier.

After five years of public discussion and unanimous endorsement by the Union of BC Municipalities, the implementation of the BC Government's Streamside Protective Directive is a particularly valuable initiative that is proceeding with the encouragement and support of environmental groups and local governments. The flexibility embedded in the new rules should permit the adaptation that is needed for exceptional conditions and existing developments along the province's salmon rivers. The Council expressed its support for this directive in a letter to BC Government officials last year.

Emerging Issues

There are two mounting concerns about the Streamside Protective Directive and habitat management in BC. One relates to an increasing interest in taking a more "results based" (and less prescriptive) approach in implementing freshwater habitat protection measures. This approach, in the view of many, could undercut the intent and effectiveness of, for instance, the streamside regulations and unintentionally enable development too close to rivers and streams.

The after-the-fact identification of negative consequences of development decisions can run directly counter to the precautionary approach that should prevail in decisions affecting environmentally sensitive areas.

The second concern is reflected in the growing speculation that there will be significant budget cuts to provincial environment ministries and consequent reductions in enforcement capability and capacity to monitor waterways.

The Council recognizes the desire of the BC Government to streamline its regulatory structure, but encourages the adoption of an approach that will not lead to inadvertent losses of salmon habitat or undermine fish stocks. The Council will continue to monitor these issues in the year ahead and intervene where its role as an environmental watchdog is appropriate.

The new federal government Pacific Salmon Endowment Fund will soon begin to furnish some of the resources needed for crucial habitat projects across the province. The structure and administration of the endowment is well founded in its assurance of involvement by all of the stakeholders and interested parties. It enables the funding allocation decisions to be based on valid criteria and in line with scientific priorities and measurement of expected returns. The Salmon Endowment Fund represents a highly positive step towards better investment decisions in salmon habitat restoration and the health of future salmon stocks.

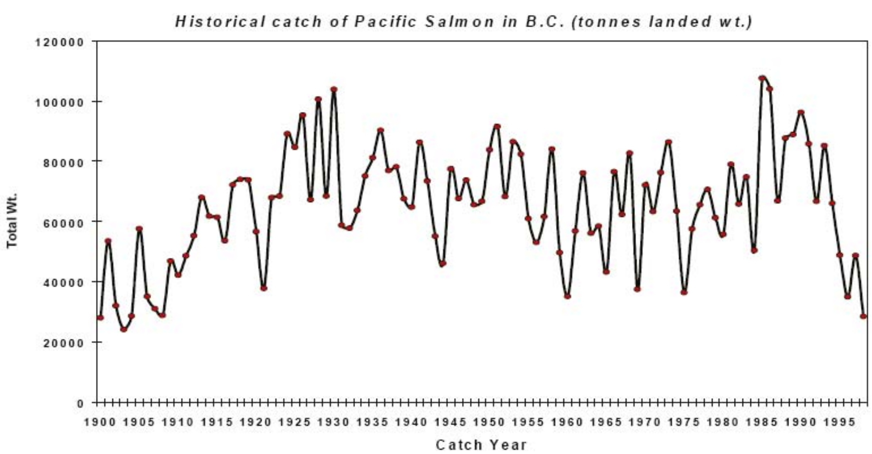
3. Salmon and Ocean Climate

During the past decade, the abundance of an increasing number of stocks coast-wide decreased to unprecedented low levels. Many chinook and coho stocks have been especially affected, but also sockeye and some pink and chum stocks. The problem has been not just a few high profile stocks in trouble; many fisheries have been either closed or severely restricted to try to sustain spawning populations.

The Council has taken the view that a better understanding of ocean processes and salmon survival is essential to conserve our salmon resource. Habitat restoration and regulatory control of fishing continue to be primary management tools, but the focus of research and knowledge development in the next few years would be most productively directed towards the ocean and the period of the salmon lifecycle in the ocean environment. While at-sea conditions may be largely beyond direct control, they appear to be crucial to take into account in pursuing any long-term Pacific salmon management strategy.

The impacts of marine and other conditions are chronicled in Figure 1, showing the Canadian historical commercial catch of all Pacific salmon for over nearly a century to 1998. Catches in the most recent three years have continued to decline, although this result is due, in part, to the conservation measures and fishing restrictions to protect depressed populations of several major stocks. From 1900 to the 1920s, the commercial fishery was still developing and many stocks were not fully exploited, hence the low catches. The peak catch occurred in 1985 and 1986, but dropped substantially after that period.

Figure 1: Historical Catch of Pacific Salmon in BC (tonnes landed wt.)



Also shown in figure 1 are the previous peak catches that occurred during the late 1920s and early 1930s. The catch in the period that followed seemed to be fairly stable, but much of the variation in productivity and stock levels was probably masked since fisheries were intensive at that time.

But in the 1990s, BC got a rude awakening. It was discovered that the North Pacific Ocean was highly unpredictable, not the static ecosystem that had been generally presumed. In a seminal paper by Beamish, McFarlane and King (1999b) on this topic, it was noted that:

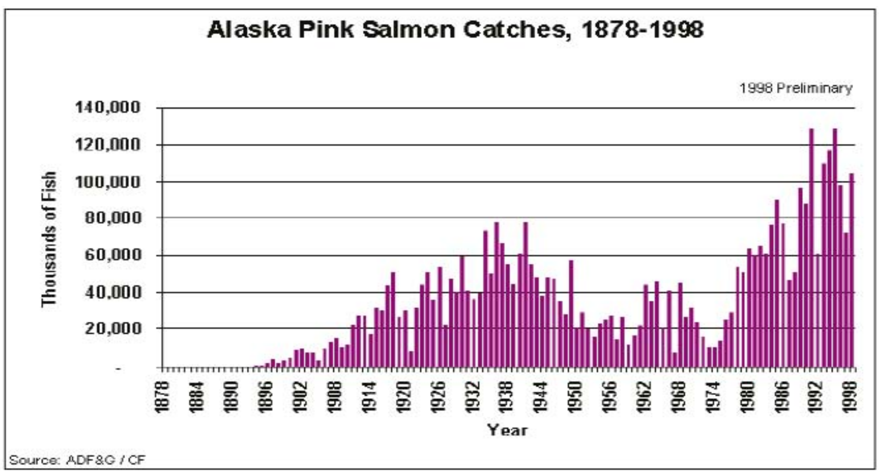
> *…the climate and ocean systems of the North Pacific are dynamic and, in addition to interannual variability, there are decadal-scale states evident in several climate-ocean parameters. The climate-ocean systems experience these steady states, or*

regimes, that last for decades and also abrupt shifts from one state to another that occur within one year. Regime shifts have occurred in 1925, 1947, 1977 and 1989. The productivity of British Columbia fisheries appear to respond to these abrupt changes in climate-ocean states. The evidence is not clear and unequivocal, but the production of Pacific salmon, halibut and some groundfish species can be grouped into similar regimes.

Regime shifts are large-scale events when the ocean climate switches from one prevailing set of environmental conditions to another. In 1989, there was a regime shift that first impacted southern waters and then moved progressively north. This was accompanied by decreases in salmon production off California, then Oregon and the Columbia River, then Washington, the BC South Coast, Central Coast and finally North Coast of BC.

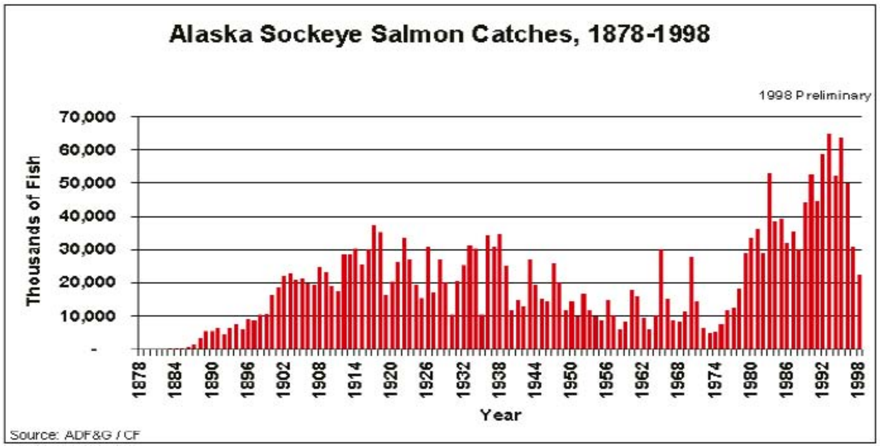
There were previous changes in salmon production also. From the 1950s to late 1970s, salmon production from California to BC was good, while in Alaska it was relatively low (Figures 2 and 3). The southern production had been assumed to be normal and the result of hatchery and other enhancement projects. The low Alaskan production, compared to the 1920s and 1930s, was attributed to various causes ranging from poor freshwater survival and cold winters to inadequate numbers of spawners and federal government mismanagement of territorial fisheries.

Figure 2: Alaska Pink Salmon Catches, 1878–1998



Then, in the 1980s, something changed, and Alaskan salmon production increased rapidly from an average of fewer than 10 million sockeye and 20 million pinks, to 40 million sockeye and 60 million pinks. About the same time, salmon production in the south Pacific coast of the United States decreased rapidly. It was as if the territorial boundaries of salmon had abruptly moved northward. This shift in productivity continued through the 1990s, first affecting Washington, then Southern BC, and finally the Central and North Coast of BC. At the same time, Alaskan production continued to increase with record annual catches of over 50 million sockeye and 100 million pinks in the 1990s.

Figure 3: Alaska Sockeye Salmon Catches, 1878–1998



The extent of decline in BC catches after 1989 was especially evident in key stocks. By the mid-1990s, coho abundance was so low that stringent closures were implemented to protect the at-risk populations, and production of sockeye, pink, and chum salmon was severely depressed. This constituted a widespread collapse of salmon stocks along the BC coast. The general conclusion that emerged was that there was very poor ocean survival, probably in the early ocean life when juvenile salmon are inshore and highly subject to predation and adverse habitat conditions.

4. SCIENTIFIC FINDINGS RELATED TO PRODUCTIVITY IN THE OCEAN

In the past few years, there has been some expansion in the scientific study of ocean climate and measurement of its effect on salmon production. For many years, the potential for salmon production in the ocean was considered to be unlimited. The massive output from hatcheries and other artificial programs throughout the north Pacific was premised on this belief. However, observations through the past two decades have clearly demonstrated that the ocean can constrain salmon production and that the capacity of the ocean to produce salmon is not constant over time or locations.

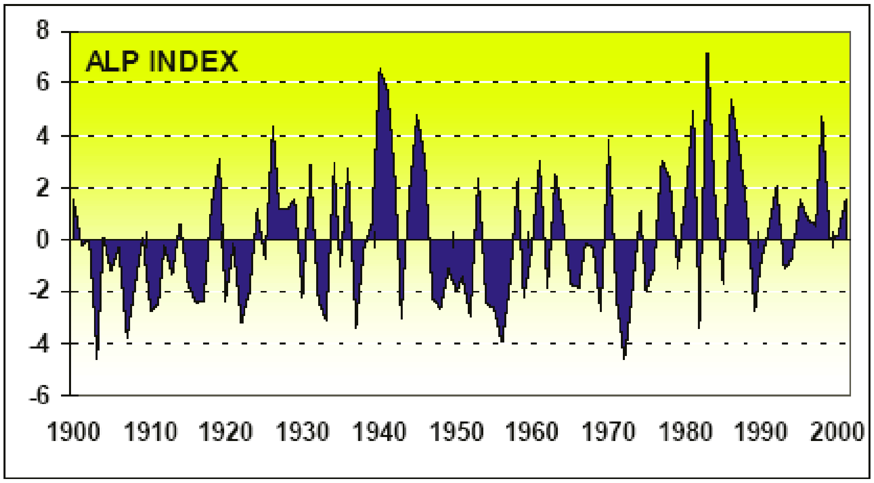
There are important questions for salmon conservation that have consequently emerged. Why does the ocean climate for salmon change? How predictable are these changes? And, what are the appropriate management responses?

Many Canadians are conscious of global climate change and impacts on weather patterns, but fewer are aware of changes in ocean climate and the linkage between ocean productivity and atmospheric climate patterns. Variations in salmon production have commonly been attributed to alterations in fishing pressures or freshwater habitats, or to ocean events such as El Niños along the west coast of North America. However, a much more complex picture of ocean climate change and its impact on salmon production is becoming evident.

A study by Beamish and Bouillon (1993) was one of the initial and important papers concerning salmon production and ocean climate. These authors identified a strong similarity in the pattern of sockeye, pink, and chum salmon catches over time suggesting that common events over a vast area in the north Pacific Ocean affect salmon stocks. This research identified relationships between salmon production and the size, strength and location of the Aleutian Low pressure weather system in the ocean. Changes in the Aleutian low pressure system between years corresponded to weather-related indices, copepod (a plankton in the salmon food chain) production, and changes in salmon catch. Together, these suggest that climate and the marine environment may play a much more important role in salmon production than previously thought.

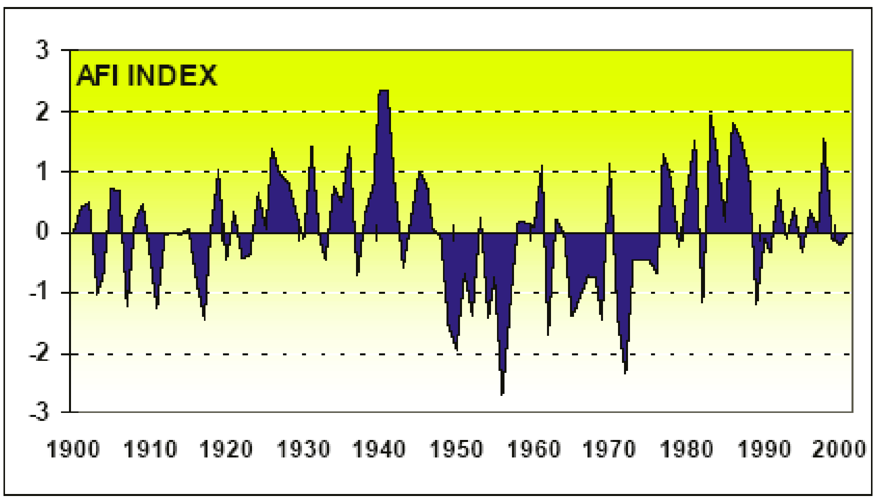
To demonstrate changes in ocean climate, two examples of measures or indices are provided below in figures 4 & 5. The first is the Aleutian Low Pressure (ALP) index (Beamish and Bouillon 1993, Beamish et al. 1997) through 2001. This index measures the relative intensity of the Aleutian low pressure system in the period from December through March. A positive index reflects a relatively strong or intense Aleutian Low. The second was recently developed, and it integrates three climate indices into the Atmospheric Forcing Index (AFI) proposed by McFarlane et al. (2000). The derivation of the AFI is complicated, but a positive value indicates: an intense Aleutian Low; above average frequency of westerly and southwesterly winds; cooling of sea surface temperatures in the central Pacific; and warming within North American coastal waters.

Figure 4: Aleutian Low Pressure (ALP) Index



data: www.pac.dfo-mpo.gc.ca/sci/sa-mfpd/english/clm_indx_alpi.htm

Figure 5: Atmospheric Forcing Index (AFI)



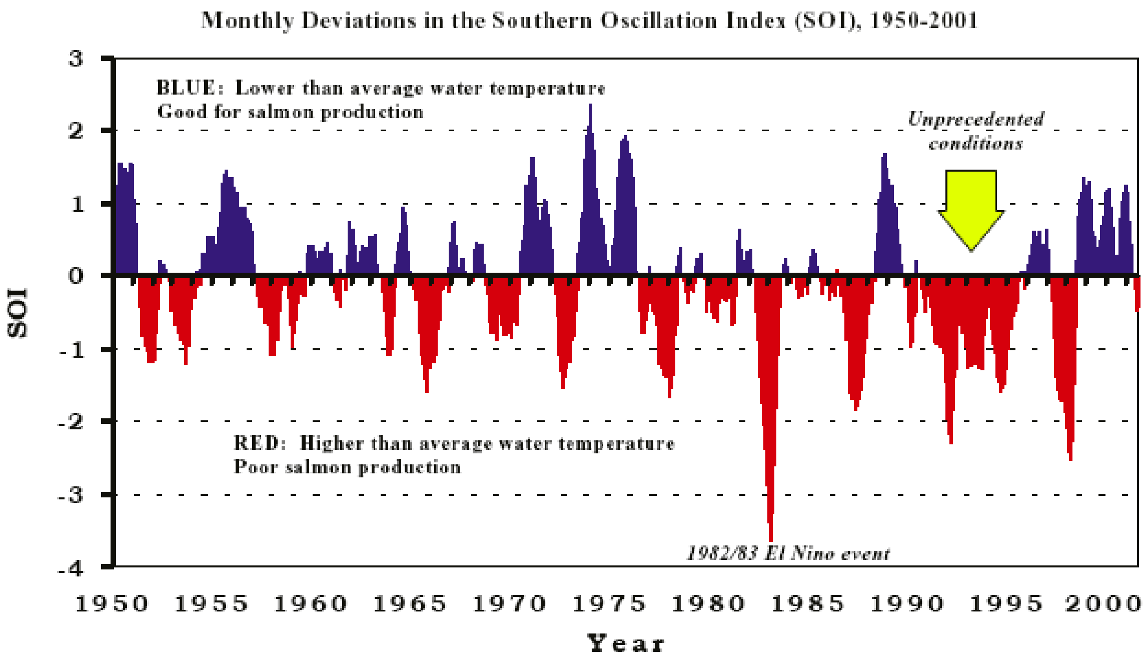
data: www.pac.dfo-mpo.gc.ca/sci/sa-mfpd/english/clm_indx_afi.htm

These indices show runs (i.e., sequences of years with mostly positive versus negatives, or vice versa) of similar deviations and sudden changes in sign of the deviations. Notable examples are the positive values in the 1920s through the late 1940s, the subsequent negative values until 1977, and the largely positive values since then. In the most recent period, there are initial indications of another shift that occurred in the late 1990s, suggested by recent high returns of many salmon populations along the Pacific coast. At the same time, it is notable that there is interannual variability of these indices within the longer cycles.

The duration of these cycles is more long-term than the high-profile but brief El Niño and La Niña events. These shorter-term events have their own frequency of occurrence and are superimposed on the longer-term cycles noted above. Ware (1995) identified a number of different climate cycles that affect BC, ranging between two to three years and fifty to seventy-five years, and interacting to cause variable conditions.

An El Niño event is usually of short duration but can have significant effects on coastal production of salmon. The El Niño is also an example of a change in ocean climate associated with an atmospheric event; in this case, it is atmospheric pressure across the equatorial Pacific. Variation in this pressure is referred to as the Southern Oscillation Index (Figure 6). Large negative deviations in this index are generally associated with strong El Niños and transport of warmer waters northward along the Pacific coast of North America.

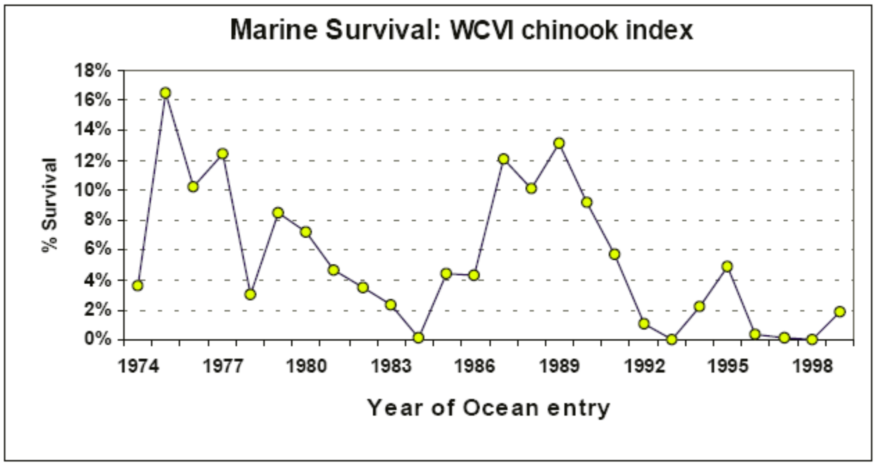
Figure 6: Monthly Deviations in the Southern Oscillation Index (SOI), 1950–2001



data: www-sci.pac.dfo-mpo.gc.ca/osap/projects/elnino/s osc.txt

The warm water floats on top of the ocean, preventing nutrients from reaching the surface where they can nurture plankton. This dramatically decreases ocean productivity in affected areas. The warm water also brings with it fish species from the south, such as hake and mackerel, that prey on and compete with juvenile salmon. On average, El Niño events occurred about every seven to eleven years, and most were not strong enough to have a significant effect in BC waters. In the past 20 years, however, several major El Niño events have had an influence on salmon along the west coast of Vancouver Island. For example, the figure 7 below shows the survival of Robertson Creek Hatchery chinook (since tagging of the releases began in 1974) released into Barkley Sound on the west coast of Vancouver Island. Depending on the year that these fish enter the coastal marine environment, survival has varied from 0.03% to over 10%, and is strongly associated with El Niño events. While this is only one example, strong associations are also known for other chinook populations, sockeye salmon in Barkley Sound, and coho salmon populations along that coast.

Figure 7: Marine Survival: West Coast of Vancouver Island Chinook Index



data: Riddell, B. (pers. Comm.) Pacific Biological Station, Nanaimo, BC.

The La Niña, with its cooler-than-normal conditions, follows an El Niño. In early March of 1999, a very strong La Niña occurred, and water temperatures along the outer coast of BC fell below normal and have stayed cool.

While scientists are gaining better insight into the potential impact of change in ocean climate on salmon production, their understanding of the mechanisms remains poor. The impact of ocean climate changes on salmon production will be a complex interaction of large spatial and temporal scale climate cycles, impacts of the shorter-term weather events, and the joint effect on freshwater productivity of these species. The general understanding at this time, however, is that the longer cycles tend to have more long-term impact on ocean survival for BC stocks and more effect on weather than El Niños and La Niñas. Ware (1995) found that:

> *…forty-four percent of the low-frequency variability in British Columbia air temperatures is associated with the strength of the Aleutian Low pressure system in winter. Only 42% of the 'strong' and 25% of the 'moderate' ENSO [El Niño ~ Southern Oscillation] events in this century have produced large warm anomalies off BC.*

Interactions between these different cycles produce alternating warm and cool conditions. There have been seven warm and six cool periods since 1850. Sharp transitions from cool to warm climate states occur when cycles coincide. The severity of change in ocean climate is related to how the cycles interact. Sometimes, the cycles cancel out each other, and at other times they combine for a larger impact in the form of the regime shift. As Beamish et al (1999) reported:

> *The concept of regimes and regime shifts is important in fisheries management as changes in carrying capacities may change natural mortalities which will have impacts on the acceptable level of fishing mortality.*

The past decade has been notable for changes in climate and salmon production. The 1990s was the warmest decade and 1998 was the warmest year in recorded history, but the abundance of many Pacific Coast stocks decreased significantly. Reductions in plankton were first noted first off California, and later off BC. The mid-ocean warming was beyond previously recorded levels. In coastal southern BC waters, El Niño-like events persisted for years and were extreme.

A positive sign, however, was evident in the winter of 1998–99. The water cooled and coincidentally mixed layers were deeper, nutrient supply was higher, and primary and secondary production began to return to typical levels (DFO report, *2000 Pacific Region State of the Ocean, July 2001*). Fish production improved in 2000, and more salmon stocks in 2001 have been showing indications of improved survival and growing conditions.

Ocean Production and the Aleutian Low Pressure System

In the ocean, water near the surface gets enough light to grow microscopic marine plants [phytoplankton]. Animal plankton [zooplankton] feed on the plants and, are in turn, eaten by fish, and so on. But once the nutrients are utilized by the phytoplankton, plant growth slows down and may stop. This condition subsequently limits zooplankton and eventually fish growth and survival. Nutrients in the ocean are similar to those in lawn fertilizer—nitrogen, phosphorus and potassium compounds and some other chemicals such as silicates. Although the nutrients in the surface layer are tied up, there are plenty of nutrients in deeper water. If surface waters are moved away, then the deeper nutrient-rich water can raise or upwell to replace them. Nutrients in surface waters are replaced and the growth cycle can resume.

How does surface water get moved to cause the nutrient rich water to upwell? In the North Pacific, there is a weather pattern called the Aleutian low pressure system. Winds circulate counterclockwise around the Aleutian Low and spin surface waters out from its center, thereby causing an upwelling of the nutrient-rich water. Strong Aleutian Lows displace more surface water providing more upwelling of nutrients in a larger nutrified area. When the Aleutian Low is strong, the winters are stormier. There is more mid-ocean upwelling that provides more nutrients to the surface, as well as a cooling of the surface. The resulting increased plankton production increases the amount of food available for salmon in both the open ocean and the coastal areas.

When the Aleutian Low is weak, the opposite occurs, and the capacity to produce salmon is reduced. It is important to recognize that there are associated alterations in the coastal ecosystems in which winds and currents adjust, resulting in oscillations of good and poor ocean conditions for salmon in the north and south. For example, the 1989 to 1998 regime was generally a period of poor ocean conditions for coho and chinook in the south.

This cycle also affects weather patterns in Alaska, BC, Washington and further south. This weather may also impact salmon survival in freshwater through reduced snow-pack and rainfall, as well as increased temperatures.

Recent studies have indicated that the intensity of the Aleutian low pressure system follows a cycle of alternating weak and strong lows each with about a 20 to 30 year period. Also, abundance of sockeye, pink and chum salmon, the species that rear in the area of the Aleutian Low, follows the same basic cycle with strong production during periods with strong Aleutian Lows (Beamish and Bouillon, 1993). Changes in salmon abundance, however, lag those in the Aleutian Low. This is because the changes first affect phytoplankton, then zooplankton, and then juvenile salmon, but there is a half-year or longer before the adult salmon return to coastal areas.

5. 2001 PRELIMINARY REPORT ON STOCKS

Over the past few years there have been dramatic changes in the survival and abundance of many salmon populations and other fish species. These changes appear to have been related to an ocean regime shift that likely occurred in 1998.

Much of the following data and many of the observations are still preliminary, and will only be available in final form next year. However, information on select stocks is presented here, in preliminary form, because of the importance of the general message it conveys. A lot remains uncertain, but the recent dramatic consequences of poor ocean conditions seem to be easing in many areas. This report comments on salmon stocks along the entire Pacific coast, including the United States, in order to portray the scope and geographic context of this change.

Fraser River

The Fraser is the largest salmon-producing river in BC. It is also the southernmost major sockeye and pink salmon system, and is highly subject to environmental influence, whether from climate, weather or habitat changes. The watershed is also vulnerable to intensive urban and industrial development, deforestation, agriculture, water use, global warming, and other impacts. Greater Vancouver straddles its mouth and estuary. Both American and Canadian fishermen are heavily dependent on the Fraser salmon stocks, some of which are being especially undermined. There are also continuing conservation concerns about the Thompson and Upper Fraser coho. More recently, there have been serious concerns about late-run sockeye, including the Adams River sockeye stock.

Major Conservation Concern

Since 1996, early river entry of Late-run Fraser River sockeye has been associated with high pre-spawning mortality en route and near the spawning grounds. The Late-run stocks include those sockeye returning to Adams River, Lower Shuswap River, Portage Creek, Harrison River, Weaver Creek, and Cultus Lake. The normal behaviour of these stocks has been to arrive off the Fraser River in August and early September and hold in the Strait of Georgia for three to six weeks before entering the river in September or early October.

Since 1996, the Late-run stocks have entered the Fraser River earlier, with no delay in the Strait of Georgia in 2000 and 2001. Most of the mortality associated with this early entry has been attributed to a parasite that results in kidney failure. The parasite is likely acquired as the fish migrate through the lower Fraser River or estuary. It is thought that the longer period in freshwater, resulting from early entry and more gradual migration, gives the parasite more time to weaken and kill the sockeye before they can spawn. From 1996 to 1999 the freshwater losses ranged from 45% to 63%. In 2000, the pre-spawning mortality was 90%, and the spawning population was the lowest of any cycle year. The stocks in 2001 have had a migration pattern similar to the other affected years.

2002 is the dominant-line run of Adams River sockeye. Reduced returns of this run are expected because of the pre-spawning mortality in the 1998 parent year. Another year of high mortality could decrease the spawning population to exceptionally low levels.

A number of studies are underway to try to determine why the sockeye are entering the river early and what can be done about it. These are investigating changes in oceanography, water quality and possible contamination in the holding area, as well as biological analysis of the parasite and the fish. There are no conclusive results to date.

This high mortality year-after-year constitutes a new and potentially severe conservation risk. continues into the next generation, the abundance of the Late-run sockeye stocks could be at dangerously low levels. The consequences include immediate and future economic losses, and a diminished ability to sustain the stocks and prevent their extinction.

In 1999, there were a number of significant problems. The return abundance of all four sockeye run timing groups and of Fraser River pink salmon were less than forecast. The estimated total return of Fraser River sockeye in 1999 was 3,643,000, less than half of the preseason forecast and the lowest on the cycle since 1955. The Fraser River pink salmon return of 3,616,000 was also less than half of the forecast and the lowest odd-year return since 1965.

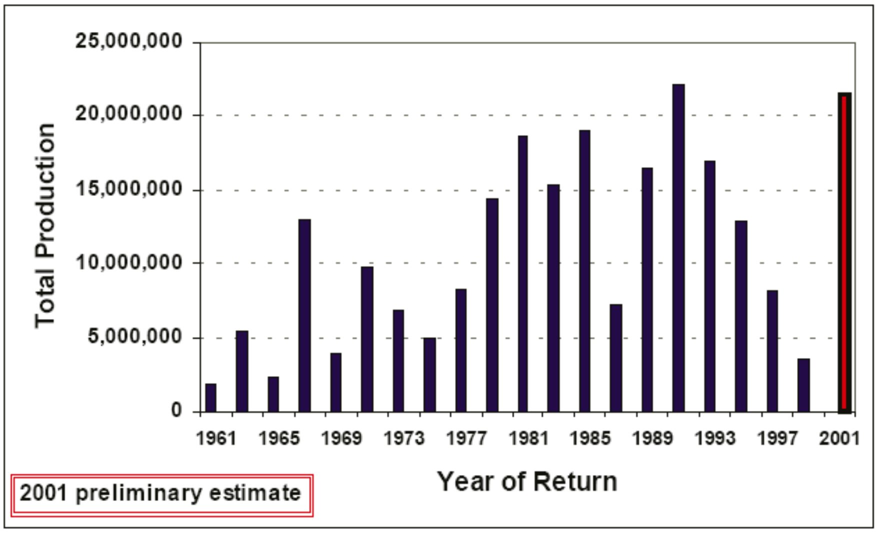
Also in 1999, the sockeye were relatively small and in poor condition as they approached the coast, and were late in arriving. This suggests unfavorable at-sea conditions. There were substantial en-route mortalities of sockeye salmon in the Fraser River, along tributaries and in terminal areas. The abundance of Early Stuart, Summer and Late-run stocks were considerably below forecasts. Also, those stocks met abnormally high water flows in the Fraser River that caused difficult passage conditions in the Fraser Canyon and upstream. These environmental conditions generally resulted in large en-route and pre-spawning mortalities of those stocks. Additionally, there were difficulties in assessing the Late-run sockeye because they did not pause during the normal period in the Strait of Georgia.

The year 2000 is the lowest of four cycles of Fraser sockeye, but it showed returns that were better than expected. Run timing in Juan de Fuca Strait was earlier than recent returns and fish were better quality. However, high river flow conditions made migration through the Fraser Canyon difficult. En-route and pre-spawning mortalities resulted and fewer-than-predicted sockeye spawning. The Early Summer run was above the predicted level, and escapements to the Upper Adams and Nadina Rivers were the largest recorded on any cycle and should contribute to rebuilding production of those stocks. The Summer run returned fourteen percent more than predicted. Twenty-three percent more Late-run sockeye than predicted returned – a total of 709,000. However, the early migration parasite-related mortalities resulted in ninety percent mortality of these sockeye. Particularly hard-hit were Weaver and Cultus Lake spawners.

In 2001, Fraser sockeye stocks were generally near forecasted returns. The fish were in good condition in the ocean and more fish migrated through Juan de Fuca Strait, again showing signs that at-sea conditions had improved. The Early Stuart run estimated at 226,000 is about half of the forecast level. The Early Summer run returns were 313,000, compared to the predicted 202,000. Fraser Mid-Summer-run sockeye abundance was near the low end of preseason forecasts of between 6,159,000 and 11,715,000 fish. Early Stuart, Early-summer, and Mid-summers sockeye have spawned successfully but the Late-run stocks again migrated upstream early and there are indications of pre-spawning mortality. Mortality in the Shuswap sockeye is expected to be much less than last year but Weaver Creek sockeye have suffered high morality rates again in 2001. A notable observation in 2001 is the weak presence of four-year-old sockeye in some of the major stocks. This would indicate a poor production of the 1997 brood year (1999 ocean entry) but, at this time, is thought to be more related to freshwater than marine conditions.

Fraser River pink salmon production (Figure 8) was being rebuilt from 1961 to 1991, increasing by a factor of almost ten. Then, the production decreased from 22.2 million pink salmon returning in 1991 to only 3.6 million in 1999. This decrease was related to poor ocean survival. In 2001, the preliminary estimate of production is about 21.5 million. This would be almost six times the level of the 1999 parent year, and would be a strong indication of the improved ocean productivity.

Figure 8: Pink Salmon Production Returning to the Fraser River, 1961–2001



Fraser River interior coho salmon production (above Hope on the Fraser mainstem) has also been severely depressed and resulted in severe fishing restrictions. However, these restrictions appear to have stopped the decline in spawning escapement, and productivity has improved sufficiently that the populations might now sustain themselves, under these limited fishing scenarios. There are insufficient data available so far to assess this year's returns, but initial reports on spawning escapements indicate a substantial improvement in 2001.

A Fishing and Conservation Success Story

The Juan de Fuca Strait (Area 20) seine fishery for Fraser sockeye and pinks was closed in 1997 as part of protection measures for south coast (particularly Thompson River) coho. This fishery was among the most valuable on the coast, although in the 1990s high migration of sockeye through Johnstone Strait lessened the impact of the closure. In 2000 this migration shifted back to this area and was expected to do so in 2001, making a fishery there more important.

In order to access this fishery, the industry organized itself this year into an association and achieved consensus on a plan that met DFO's requirement to protect coho, chinook and steelhead. These requirements were to meet conservation objectives for stocks of concern, stay within allowable catch on target species, strictly control catch and reporting during the fishery, require fleet training and education, implement on-board monitoring, utilize selective fishing gear and techniques, and institute a post-release mortality study.

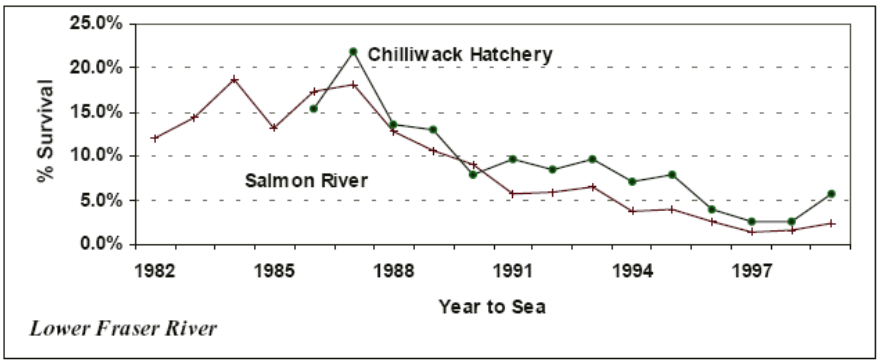
The plan developed to achieve this had nearly unanimous support of the seine sector, including vessel owner organizations, the Union, Native Brotherhood, processors and individual vessel owners. It was also remarkable in that it had the support of the other commercial gear sectors. A key mechanism was the formation of a single pool to share the catch equally among all participants. This eliminated fishing competition and allowed DFO to control individual sets. The other important mechanism was that the association developed the list of eligible vessels, providing unprecedented discipline. Eligible participants were required to pay for crew training and observers as well as post a $5,000 performance deposit.

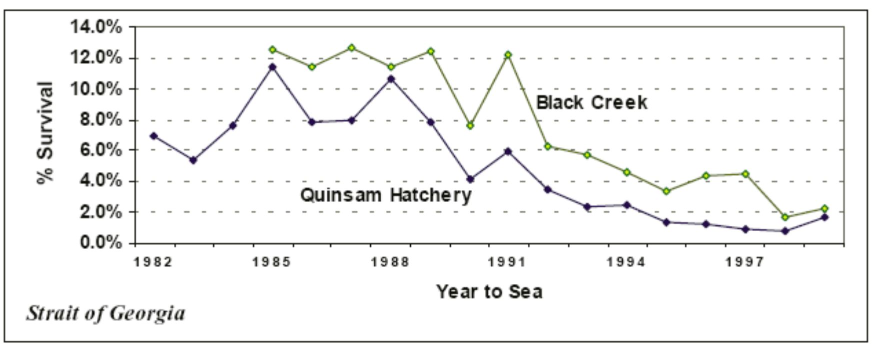
The fishery took place on August 5 and 6of this year. It started slowly and developed as the DFO manager was able to ascertain selective compliance and low coho encounters. The first day was closed early, as sockeye catches were low, making even low coho encounters inappropriate. The small overall catch (46,000 sockeye, 11,000 pink) was due to a lull in the migration. However, it was generally felt by participants that this demonstration fishery achieved its objectives. Final analysis of the bycatch post-release mortality has not yet been completed.

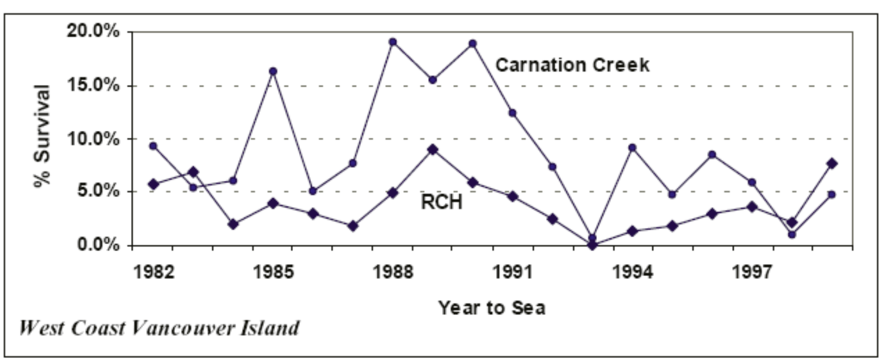
Southern BC Chinook and Coho Salmon

The catch of Strait of Georgia and Fraser River coho declined by over fifty percent between the late 1970s and the late 1980s. This led to widespread concerns that triggered the establishment of a regulatory regime to reverse this trend. Although the plan was completed in 1992, the first consequence was what DFO terms "active management" of the west coast of Vancouver Island troll fishery in 1995. This response was too tentative to halt the rapid declines in survival. It was followed by closure of the troll fishery in the Strait of Georgia, but the 1996 returns were still dismal. In 1997, coho catches were limited to 221,000, and escapement improved. Until 1997, a broad range of fisheries was consistently over-harvesting many BC wild coho stocks, particularly those that spawn in Georgia Basin tributaries. It was not until 1998 that stringent measures were implemented to protect coho in southern BC, and coho returning to the upper Skeena River. A key part of this coho problem was clearly a widespread decline in marine survival (Figures 9, 10 & 11).

Figures 9, 10 & 11: Time Trends in Marine Survival in Several Southern BC Stocks







The extent of the decline in coho survival was stunning. Survivals that were frequently between eight to twelve percent from smolts to adults, and annually supported large fisheries, declined to less than a few percent. And, on the west coast of Vancouver Island (Figure 11), survival was almost zero for smolts that entered the ocean in 1993.

However, by the years 2000 and 2001, there were large numbers of juvenile coho observed in the Georgia Strait, and marine survivals began to increase slightly (Figure 10). This indicates that productivity increased, and is consistent with the improved marine conditions following 1998.

The other major conservation concern in southern BC was for chinook salmon along the west coast of Vancouver Island. This stock of wild and hatchery chinook is an important contributor to ocean troll and recreational fisheries from South East Alaska to Vancouver Island. But in recent years, the ocean survival has been extremely variable and related to the unprecedented El Niño-like conditions during the mid and late 1990s.

In 2000, however, signs of improved survival of the offspring from the 1998 spawning year provided some hope for changing conditions. While it remains too early to comment conclusively on the 2001 returns, some populations have shown the levels of three-year-old returns that were hoped for. But others, particularly the smaller natural populations, continue to be depressed in the number of spawners.

Central Coast BC

The spawner target for sockeye for the Nimpkish River, near Port Hardy, is 100,000. In 1999, a total of 21,000 sockeye returned, and in 2000 the returns dropped to only 5,800 sockeye. The estimated sockeye returns in 2001 are 25,000. There has been little fishing impact for several cycles, so the depressed returns cannot be a result of excessive catches. Poor ocean survival is assumed to be the primary cause of weak returns. Other stocks in the Nimpkish also had very low returns in 2000. There were only 260 chinook spawners, a disaster compared to the usual 3,000 to 4,000. Chum escapement that year was only 1,000 when the return expected was 38,000. The official reports on this year's chum returns are expected to be available by year-end.

In recent years, two Central Coast sockeye stocks have been dangerously close to extinction, and a remedial program has been underway since 1999 to rebuild them in Rivers and Smith Inlet. The Recovery Plan Working Group and its three technical committees enlisted scientific and community resources to address the problems and pursue the priority conservation objectives on a timely basis.

Smith Inlet sockeye have been in desperate trouble since the late 1990s. The average yearly return was about 500,000 from 1985 to 1994, but then declined so rapidly that fisheries on this stock have been closed since 1997. The total return dropped to 5,900 in 1999 and only 1,400 in 2000. In 2001, the total return has increased to 8,400, an improvement but still a long way from the spawner target of 200,000 sockeye.

Rivers Inlet sockeye returns were in a slow decline from the mid 1980s until 1996 when they crashed. There was no fishery that year, nor since then. The total stock and spawning population in 1999 was down to 3,600 sockeye. In 2000, the estimated total number of spawners was 21,000. In 2001, the total is 24,500. For comparison purposes, it should be noted that this river had annual catches of over one million from the 1900s to the 1970s, with long-term average annual production of 1.5 to 2.0 million sockeye.

A significant decline in marine survival of Smith Inlet sockeye was found with increasing sea surface salinity in the month of June at McInnes Island. According to a recent study by Dan Ware, the:

> *…observed sea surface salinities in June 1997, 1998 and 1999 suggest that the brood years that went to sea in 1997 and 1999 could have average survival rates, while survival for the 1996 brood year could be well below average…The upwelling-favourable winds were at a record high level in June 1998. This was such an anomalous year that it is unclear what effect, if any, these extreme wind conditions may have on the marine survival of the 1996 brood year.*

Starting in 1998, the Docee River counting fence in Smith Inlet has operated for one month longer to improve estimates of coho escapements. A total of 6,252 coho were counted in 1998 and 4,413 in 1999. The escapement increased to 9,697 coho in 2000, and 10,650 in 2001. These recent escapements are considered to be strong returns for this population.

Escapements of chinook stocks in Rivers Inlet have been improving in recent years. Those in the Kilbella and Chuckwalla rivers have been increasing since 1996, but many of the spawners are of hatchery origin, rather than wild salmon. Returns of most small Owikeno Lake populations have improved significantly in 2000 and 2001. While the number of Wannock River spawners was estimated to be only 500 chinook in 1999 (although this value was contested by some local observers), escapement rebounded to 4,500 in 2000. Escapement estimates for 2001 are still pending for this late-run fall chinook stock.

The pink and chum stocks in the Rivers Inlet area had also collapsed about the same time as the sockeye. The returns of both pinks and chums have been up in 2001 in the Chuckwalla and Kilbella rivers, with pinks well above targets. Also, all indications are that coho returns are strong. Coho catches in the sport fishery have been high, while chinook catches appear to be similar to those of last year.

In the Bella Coola area in 2001, the pink returns have been unexpectedly strong, but were about ten days late entering the Bella Coola River. Average size of the fish was also larger than in the past few years. Atnarko River sockeye are about the same abundance as those of the past few years. The chum populations are coming back with more than 80,000 in the river. Chinook returns continued to be strong in the Atnarko and Dean Rivers.

Selective Fishing for Conservation

Significant progress has been made on developing, testing and demonstrating selective gear and methods for salmon fishing. There has been advancement in identifying times, areas and approaches to avoid intercepting coho and other at-risk species. Careful handling and effective revival boxes allow for live-release of those fish that are caught.

An example of the progress made in selective fishing in 2001 was the pilot testing of seine grids. These grids provide special areas in the net that allowuvenile salmon to escape unharmed. This technique is especially useful in areas such as Juan de Fuca Strait where significant numbers of juveniles can be encountered. Different sized grids can also be used to allow automatic selective release of adult fish. For example, it is possible to allow release of small pinks while retaining larger chums. The big advantage of these grids is that the fish to be released do not have to be handled and, therefore, have less chance of being damaged.

Pinks throughout most of the Central Coast are coming back, and the Central Coast chums have been near the predicted numbers. Early indications are that coho returns are going to be strong. The relatively fast recovery of Central Coast stocks is due, in part, to previous fishing restrictions.

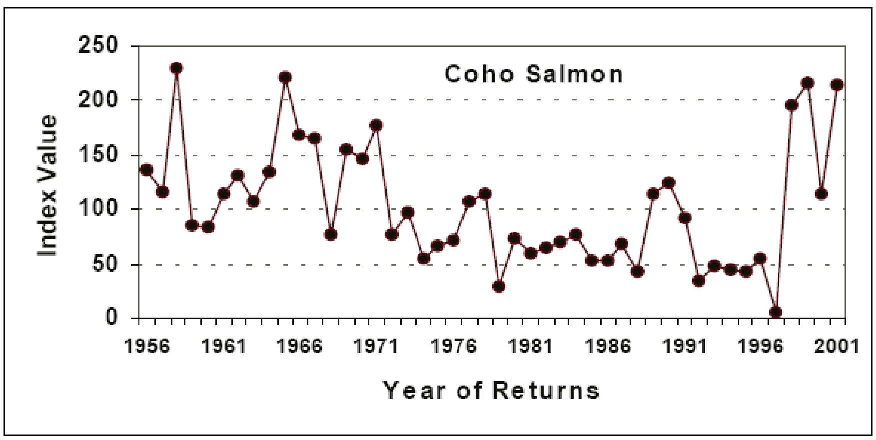
In response to the adverse conditions and poor returns in the late 1990s, there was an increased focus on conservation and precautionary management in this area. The catches were reduced in order to maintain stronger spawning populations. In 2001, this precautionary approach appears to be paying off.

North Coast BC

Salmon stocks, other than coho, in the North Coast have generally been spared the dramatic reductions in ocean survival so evident in many Central and South Coast stocks in recent years. North Coast coho had long-term over-harvesting problems, resulting from the combined impacts of harvest in Alaskan and Canadian commercial, recreational and Native fisheries. The long-term decline in North Coast coho, coupled with an exceptionally low ocean survival in the 1997 returns, triggered the major conservation initiative that began in 1998.

The long-term decline of coho from the 1950s to 1997, attributed primarily to over-fishing, is apparent in figure 12. The subsequent fishing restrictions for conservation purposes, particularly those beginning in 1998, have enabled coho returns to maintain the rebuilding process. Skeena River test fishery results are based on a standardized assessment sampling (gillnet catches per day) used since 1956. The Index Value in these figures is the sum of each daily index within a year.

Figure 12: Skeena Test Fishery: Cumulative Index of Coho Returns, 1956 to 2001



There has generally been a strong rebuilding of North Coast coho in response to the Canadian management restrictions, with the added benefit of better-than-average ocean survivals. Babine coho, an Upper Skeena stock, is a good example of this turnaround. Babine coho escapements bottomed out in 1997 when the count through the Babine Weir declined to only 453 coho. The escapements since then have been: 4,291 (1998); 14,907 (1999); 2,230 (2000); and, a projection of 8,000 for 2001. This rapid rebuilding towards the target of 12,000 is expected to continue and should lead to limited fishing opportunities.

Selective Fishing Success

A major conservation achievement on the Skeena River this year was selective fishing for sockeye with measures that protected Upper Skeena coho. Commercial fishermen have been developing and testing different ways to harvest target species (Babine sockeye) selectively without harming non-target coho, steelhead and minor sockeye stocks. While progress had been made in selective seine fisheries, which actually began in 1989, there were only modest results in selective gillnet fisheries. This year, however, gillnetters made changes in their gear and fishing operations that significantly reduced the mortality rate on coho. In return, fishermen were given the opportunity to catch more Babine sockeye. Without those changes, the sockeye would not have been available to catch because their migration timing is the same as for endangered coho.

Gillnetters were able to reduce their induced mortality of intercepted coho from about sixty percent to well below forty percent. The whole fleet co-operated and, as a result, was rewarded with increased catches. A total of 600,000 more sockeye were harvested because of these new arrangements, effectively doubling the gillnet catch on the Skeena to 1.2 million sockeye. success was achieved through findings from research conducted by individual fishermen, under the auspices of the DFO selective fishing policy. These changes were a major conservation win for the coho. They illustrate how both sustainable management and harvesting are possible and can be profitable. They also give a clear indication of the strength of co-management with fishermen and managers working together to meet common goals. This success, moreover, helps to validate selective fishing techniques in the minds of fishermen.

It is notable that there are still low returns and declines of some non-Babine sockeye even after a period of strong rebuilding over the last ten years. In the year 2000, Nanika River sockeye declined to about 4,000 spawners from parental abundance of 30,000 to 40,000. Severe fishing restrictions were implemented in 2001 to address the situation of Nanika and some other wild sockeye stocks.

Co-Operative Venture Improves Sockeye Escapements

Before the 2001 season, DFO warned that Nanika River sockeye escapements were so low as to be a conservation concern. This river originates in the Coast Mountains east of Kitimat and flows into the Morice River that in turn flows into the Bulkley River. Harvest rates on Skeena sockeye were greatly reduced to protect the Nanika sockeye and other wild sockeye stocks. This meant foregoing significant catch of other strong stocks that migrate at the same time. Even with cutbacks in the commercial fishery, the Wet'suwet'en, the local First Nation that relies on Nanika sockeye, did not expect to be able to harvest enough to meet their food fish needs.

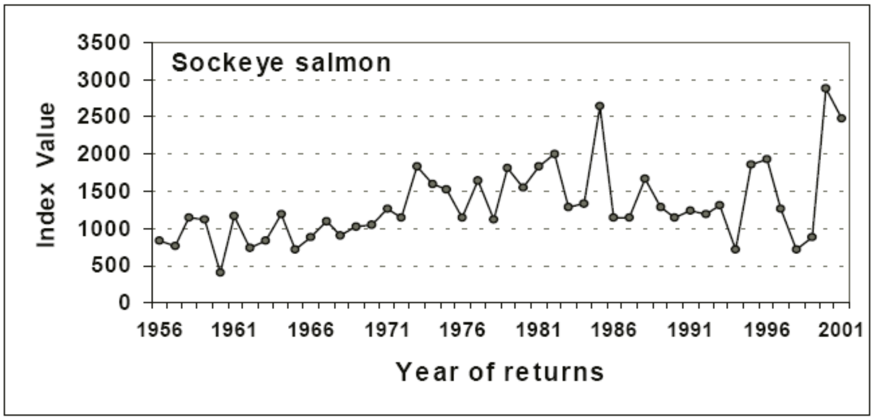
The Native Brotherhood of BC, in association with the United Fishermen and Allied Workers Union, north coast gillnet groups and fish processing companies, organized a unique agreement between the Wet'suwet'en and the commercial fishermen. The Wet'suwet'en agreed to forgo their in-river fishery on Nanika stocks in return for 8,000 sockeye from the commercial fishery. having the directed Wet'suwet'en fishery on Nanika stocks, one extra day of commercial fishing on all Skeena sockeye was possible without exceeding target harvest rates. To get this extra day, each commercial fisherman agreed to give 18 sockeye to the Wet'suwet'en. The processing companies arranged the collection of the fish. The Wet'suwet'en picked up the 8,000 sockeye in Prince Rupert and distributed them to Band members. The harvest rate on Nanika sockeye was reduced, the Wet'suwet'en met their fish food needs, and the commercial fishery got increased catch.

This was a major win for conservation of the Nanika sockeye. The Wet'suwet'en, commercial fishermen and processors all benefited from this innovative local arrangement. The two parties with a veto to this agreement, DFO and the Wet'suwet'en, took a risk, supported the agreement and made it a success. With more of these approaches to work out conservation and management arrangements, there is greater hope for the salmon resources in the future.

It is still too early to know how many sockeye made it to Nanika River to spawn this year. Early indications are that abundance has improved, but considerably more spawners are still needed. The strength of the returns of other wild sockeye stocks are mixed, with very strong escapements to wild Babine Lake tributaries, much improved returns to Sustut Lake, while Kitwanga sockeye remain poor.

The increased returns of sockeye in the Skeena River from spawning channels have been apparent since the early 1970s, and are shown in figure 13. The decreased returns noted in 1998 and 1999 are thought to be due to an infectious disease. During the mid to late 1990s, there was no marked decrease in returns because of reduced ocean survival, as was seen in many other BC salmon stocks.

Figure 13: Skeena Test Fishery: Cumulative Index of Sockeye Returns, 1956–2001



Ocean survival of Skeena sockeye from the 1996 spawning year was exceptionally high. In contrast, the returns from the 1997 brood appear to be extremely low. It appears that, in 2001, ninety-five percent of sockeye returns have been five-year-olds. This implies that there will be very few five-year-olds next year and any success will depend on the strength of the four-year-old returns.

The Skeena chinook returns in 2001 are the highest on record. Also, there have been reports of very large fish, over 90 pounds, in the sport fishery. This indicates good ocean growing conditions. Chinook returns were also strong in the Nass and Yakoun rivers.

In the north in general, including the Queen Charlottes, coho salmon were strong this year. Fall chum in the Queen Charlotte Islands appear weak. Pinks were strong in the Nass and moderate in the Skeena for 2001.

Transboundary and Yukon Rivers

Salmon returns in the transboundary rivers (Alsek, Taku, and Stikine) in northern BC improved in 2001 relative to recent years. Production in many of the sockeye, chinook, and coho salmon runs had peaked in the mid-1990s but declined in abundance since then. Managers indicate, however, that the improved in-river abundance of these stocks in 2001 also reflected substantial reductions in fishing in order to achieve spawning escapement goals. Most escapement goals for these species were met or exceeded in 2001, the exception being Talhtan Lake sockeye in the Stikine River. The assessment of pink and chum salmon is limited in these rivers but their production is considered to be poor, particularly illustrated by the recent declines in Taku River pink salmon.

In Canada's most northerly Pacific salmon river, the Yukon River, run sizes of chinook and chum salmon continued to be below average in 2001. This occurred despite excellent brood year escapements, and it suggests continued poor marine survival for these broods. An abrupt decrease in production was noted in 1998 with a significant decline in chinook salmon returns to the Yukon River that has persisted since then. For chum salmon, a declining trend has been noted over the same period but it is not as obvious due to problems distinguishing U.S. and Canadian production. The biggest decline has been in summer chum which do not generally migrate into the Canadian section of the Yukon.

To conserve these Yukon River populations, extensive reductions in fishing effort have been implemented in the form of closures in commercial fisheries and significant reductions in subsistence fisheries in Alaska and First Nation fisheries in Canada. Consequently, in 2001, a near record chinook spawning escapement was achieved in Canada.

6. CHANGES IN U.S. SALMON CONDITIONS

The ocean conditions and salmon trends that are apparent to Canadians are also occurring within the broad Pacific coastal region. The four coastal states of California, Oregon, Washington and Alaska have been experiencing similar phenomena, and their responses to the impact on salmon provide a valuable context for measuring and comparing Canada's policies and conservation efforts.

California

California has the largest wild chinook population among the west coast states, and its annual catch is larger than Alaska's. In 2000, the chinook catch was even higher than the record level of 679,000 that occurred in 1995. At the same time, it is notable that there are severe commercial fishing restrictions on chinook, including prohibitions on nets.

California experienced drought in 1994, and subsequently developed water supply sharing arrangements that have enabled fish populations to obtain generally adequate levels. The more recent drought conditions in the other Pacific Northwest states have created similar pressures for the consideration of salmon in water sharing.

California biologists noted that more coho and pink salmon had been recently migrating south. In the case of coho, these were thought to be from hatcheries in the Columbia River Basin. Their presence was unanticipated, given their traditional locations in the colder areas further north in the Pacific.

Angling for coho salmon has been prohibited in all California ocean fisheries. In a June 2001 news release by state officials, the situation of preceding years was portrayed in the following way:

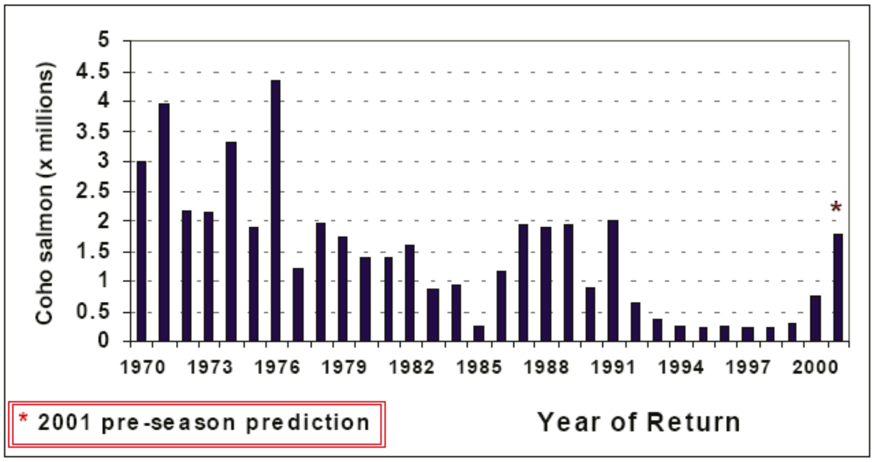
> *Since the mid-1990s, coho (also known as silver) salmon has been recognized as a vitally important ecological and economic resource in California. In 1994, the Fish and Game Commission and the California Board of Forestry found that coho salmon population in the state had declined significantly. Timber operations, hydro-power dams, habitat destruction, predation, commercial and sport fishing, and unfavorable oceanic conditions have all contributed to the decline of salmon stocks coastwide.*

Chinook returns in California had been very low through most of the 1990s. Then, in 1998, chinook catches increased markedly and have remained strong since then. Maybe this should not be a surprise, considering the cold ocean temperatures off the California and Oregon coasts decreased sharply in this period. These cold temperatures mean upwelling of nutrients and, therefore, high productivity. After the spring of 1999, these cold ocean temperatures spread north off the Washington and BC coasts.

Oregon

The long-term decline in coho production was attributed to changing ocean conditions. As shown in figure 14, coho production was exceedingly low in the 1990s when ocean conditions were unfavorable, but in 2000 coho production doubled and, in 2001, it doubled again. These increases took place in response to better ocean conditions following the shift in ocean conditions in 1998, as noted above.

Figure 14: Oregon Coho Production Index (OPI) of Oregon and Northern California Combined Hatchery and Natural Coho Production, 1970–2001



(Pacific Marine States Fisheries Commission 2001)

The 2001 value in figure 14 is a pre-season forecast of the OPI but in-season catch observations support the continued improvement in Oregon chinook and coho salmon production, as illustrated in Table 1. Both commercial and recreational catch of chinook has increased by a factor of four between 1999 and 2001. Coho catch has increased by a factor of eight over the same period. The scale of recreational fishing clearly reflects the increased availability of salmon catch.

Table 1: Preliminary Oregon Ocean Catch Estimates through Week 34

Fishery	Chinook				Coho			Effort	
	1999	2000	2001	1999	2000	2001	1999	2000	2001
Recreational	5,030	19,733	21,164	11,447	33,146	87,747	27,618	60,228	101,709
Commercial	51,354	60,135	207,096	169	6,425	6,067	3,561	3,948	7,915

Columbia River

The states of Oregon and Washington share the Columbia River as a border, and have a common interest in the watersheds that form the river and basin. In the 1990s, Columbia River salmon returns were poor and spawning populations depressed.

BC's Okanagan River is a tributary of the Columbia River. From 1989 to 1998, the annual returns to the Okanagan River averaged 18,000 sockeye, the lowest of any decade in the forty-five years of records for the stock. Stock sizes of less than 5,000 fish occurred in 1994, 1995, 1998 and 1999. Then, in 2000, there were unexpectedly large returns.

It is important to note that there are two measures of Okanagan escapement, one at Wells Dam and the other on the spawning grounds. They involve different bases for their calculations, so the estimates are not the same. Also, some of the differences could result from natural mortality and poaching in areas between the two sites. However, both sets of estimates show the same pattern of recent increases in returns, as illustrated in Table 2.

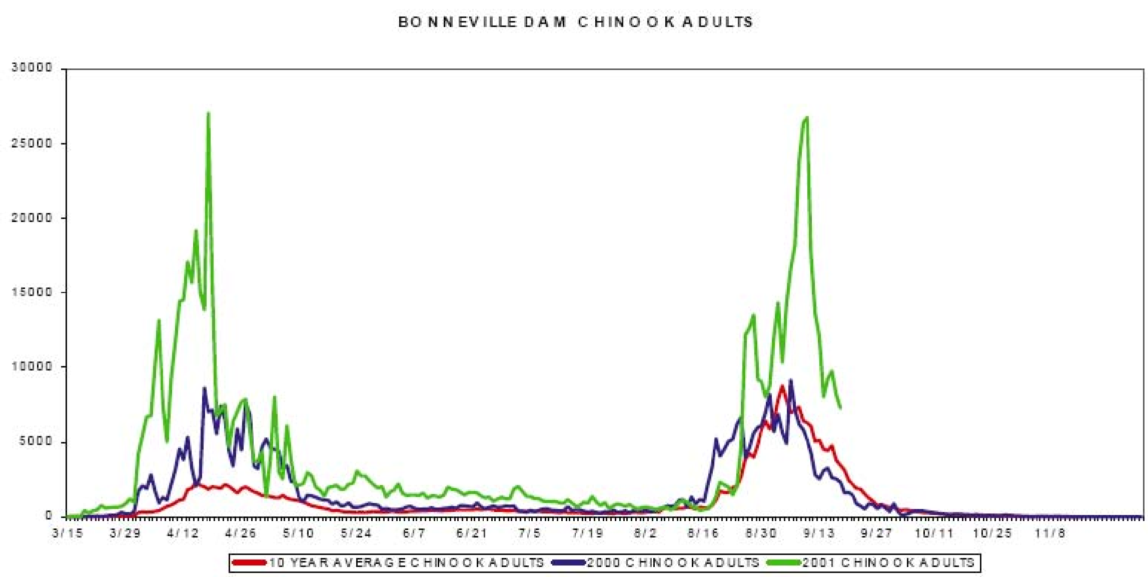
Table 2: Counts of Okanagan Sockeye, 1999–2001

Count Site	1999	2000	2001
Wells Dam	12,228	59,994	72,186
Spawning Grounds	3,234	15,157	not complete

These increased returns resulted in the largest sockeye spawning population in the Okanagan River since 1984. In 2000, commercial fishermen had their first chance since 1988 to fish sockeye in the Columbia River. The catch was limited to 1,500 fish, just a fraction of a harvest that at times exceeded 150,000 in the 1940s and 1950s. The original forecast of 31,000 was upgraded to 150,000 – the greatest run in fifteen years. The high sockeye return is significant because it indicates that ocean conditions are becoming more favourable for salmon. In 2000, sport fishermen had their first chance in nine years to fish the sockeye in the region. In 2001, both Okanagan and Lake Wenatchee sockeye returns are up well above recent levels and are supporting fisheries. This year, many anglers were reported to have gotten their two fish limits on Lake Wenatchee sockeye. The age structure of the 2001 returns was mainly four-year-old fish with no jacks. This suggests that returns next year could again decrease, but it is thought to be due to the small number of smolts produced in freshwater, rather than ocean conditions.

In 2000, Columbia River chinook returns exhibited a surprising increase, and the number of chinook migrating up the Columbia River during 2001 was extraordinary (Figure 15).

Figure 15: Counts of Chinook Salmon Passing Bonneville Dam in the Columbia River



Data: http://www.fpc.org/adultqueries/Adult Table Submit.asp

The 2001 run was the largest in 50 years and was observed in spring, summer, and fall run-timing chinooks, and in both hatchery and naturally-spawning populations. Abundance of adult chinook salmon returning to the Columbia River Basin during the year 2000 and 2001 exceeded the recent ten year average. High run-off during the years for smolt emigration and improved ocean conditions are believed to be responsible for this sudden change in returns. As well, the returns to the Columbia River during these years also benefited from substantially reduced ocean fisheries. Some very large chinooks were being caught at the mouth of the Columbia River, also suggesting good ocean conditions.

In 2001, there was also a record Upper Columbia River steelhead run of more than 400,000 up to late August. It has been estimated that the number of steelhead in the Columbia River passing the Bonneville site is about twice the level of that species produced in all of British Columbia.

Washington

In the State of Washington, the late 1990s were bad times for salmon and fishermen. Many fisheries were terminated because of weak returns. Some stocks were declared endangered. Then, in 2000, the situation started to turn around. That year saw the first Lake Washington sockeye season since 1996 with an estimated 2000 run size of 475,000. In 2001, there was again a large return of sockeye and big sport fishery.

For the past few years, the average size of salmon had been decreasing. Then, in 2001 the average size increased, and there were many record sizes, such as the pink salmon that weighed more than ten pounds that was caught in Puget Sound. A twenty-five pound chum was landed in Westport, a possible saltwater record. Also, a number of fifty or more pound chinooks have been recorded at Westport and Neah Bay. One landing in Neah Bay was a twenty-two pound coho, well over the previous state record. The increased dimensions of the salmon and their run sizes indicate a favorable change in ocean conditions relative to recent years.

The May 26th edition of the Economist magazine summarized the state's and Columbia River's situation in the following pithy comment:

> *The dramatic numbers of chinook that returned this year have less to do with a wise investment of taxpayers' money than with unusually favorable sea conditions. Changes in Pacific wind patterns and temperatures have caused an upwelling of nutrients from the bottom of the ocean off the coasts of Washington and Oregon. Things have not been this good for 20 years. Unfortunately, nobody knows when it might happen again, nor how to predict such conditions. Even if they did, no amount of intervention by the Department of Fisheries and Wildlife could bring them about.*

Alaska

Alaskan salmon production in many cases has slid recently, but not generally beyond the normal range of variation. Pink catch was down from the parent year, but above the five-year average and still in the range of recent returns. Sockeye catch has decreased since 1996, particularly in Bristol Bay (Table 3). Chum catch has been generally increasing until this year when it was below forecast but larger than in the parent years. Coho catch has decreased since the mid-1990s. Chinook catch has decreased since 1998, particularly in the Yukon and northern areas.

In 2001, the Governor of Alaska declared an economic disaster in Western Alaska because of dwindling numbers of salmon and low prices. Federal funding is being sought to help coastal and inland communities from Bristol Bay to Norton Sound that rely heavily on commercial fishing. The salmon harvest in Bristol Bay, a major sockeye producing area, has fallen to half of the recent ten-year average, coming in at 14 million so far this year. The situation has been getting increasingly serious for a number of years, to the point that fishermen are calling for a buyback of fishing permits to reduce the fleet. The governor also announced that the State would pursue research into changing ocean conditions and the ocean survival of Alaska salmon.

The catch of 14 million sockeye may be much lower than recent catches, but it is higher than most years in the 1970s.

Table 3: Bristol Bay Sockeye Catch, 1988–2001

Year	Catch	Year	Catch	Year	Catch	Year	Catch	Year	Catch
1988	13.7M	1991	25.3M	1994	33.9M	1997	12.0M	2000	20.5M
1989	28.5M	1992	31.3M	1995	43.6M	1998	10.0M	2001	14.0M
1990	33.0M	1993	40.2M	1996	29.2M	1999	25.3M		

Further north in the Yukon River area, chinook returns in 2000 were less than half of the twenty-year average. In 2001, the returns were even lower and no commercial fishing was allowed.

7. Other Pacific Coast Species

The changing ocean conditions have affected more than just salmon. It is important to recognize how different species react to these changing conditions and events, as an indication of the changes as well as for possible interactions with salmon.

Recent conditions favoured the spread of hake, mackerel and sardines as far northward as Southeast Alaska. After the regime shift in 1998/9, most hake and mackerel have moved south of Juan de Fuca Strait again, but sardine populations are still in BC.

An extensive presentation of the impact of ocean changes on an array of Pacific species is contained in the DFO report entitled *2000 Pacific Region State of the Ocean*. The following species and trends are cited as examples of recently observed conditions.

Sardines

The sardine population is centered off the southern California coast, the primary spawning area. When the population was very large, in the 1920s and 1930s, it extended northward into waters off the Oregon, Washington and BC coasts. In British Columbia, the highest catch was 86,300 tonnes in 1929. The peak catch in California (791,320) occurred in 1936–7. The sardine fishery was very intensive and, for a long time, was blamed for the collapse of the stocks. In hindsight, it appears that the collapse may have been a combination of over-fishing and ocean conditions. In any case, the sardine population is rebuilding along the coast. By 1999, the biomass of sardines in U.S. waters had increased to an estimated 1,581,346 tonnes. In that year, the catch had increased to 115,051 tonnes off California and Baja California. The U.S. harvest guidelines for 2001 are 134,740 tonnes.

In 1992, sardines appeared off BC for the first time since the 1940s. The abundance increased, and an experimental fishery was conducted in 1995. By 1997, the abundance had risen to an estimated 60,000 tonnes distributed along the province's entire coast. The sardines remained off the BC coast year-round in 1997 and 1998 and even spawned there. The regime shift in 1998 has not resulted in the entire population moving south out of Canadian waters, although it might have resulted in reduced spawning there.

Mackerel

Pacific mackerel are increasing in abundance. For 1999, the mackerel biomass in U.S. waters was estimated to be 239,286 tonnes. In 1998, 70,799 tonnes of Pacific mackerel were landed, representing near-records for the combined fisheries off California and Baja California. The U.S. harvest guideline is 20,740 tonnes for the July 2000 to June 2001 period.

At times, the mackerel have been very abundant off the west coast of Vancouver Island where many tonnes are sometimes obtained in purse seines. In the past, small numbers entered the Strait of Georgia and small schools have been observed in the vicinity of Prince Rupert. In the 1990s, mackerel showed up in numbers on the BC coast and into Alaska. With the changes in water temperatures induced by the ocean regime shift in 1999, most mackerel have now moved south out of Canadian waters.

Hake

There is a large migratory population of Pacific hake that spawn off Baja California and migrate north to summer feeding grounds. From the 1960s to the early 1990s, about twenty-five to thirty percent of the population moved into Canadian waters. In the early 1990s, as many as forty percent of the hake population migrated further north and remained year-round. With the recent retreat of hake, there has been a bloom of juvenile pollock off the west coast of Vancouver Island.

Herring

The west coast of Vancouver Island herring stock tends to have poor recruitment in warm El Niño years, but is stronger in cold La Niña years. Based on this trend, the 1999 year-class could be average to strong, and the 2000 and 2001 year classes should be average or better. The link between climate and recruitment in other herring stocks is not as clear as for the west coast of Vancouver Island stock.

Summary

There have also been major changes in relative species composition and distribution over the 1990s, with marked increases of sardines, mackerel and hake in the south.

The observations of these other species support the view that there appears to have been a broad and major variation in recent ocean survival for salmon associated with an ocean regime shift. The impacts were felt first in the south and then moved northwards with evidence of increased salmon returns and changes in the productivity of other species in California, then Oregon and Washington and now BC. At the same time, there may have been a reduction of salmon production in Alaska.

The productivity trends affecting several Pacific fish species reinforce the view that ocean conditions have a significant, and possibly definitive, role in salmon yield and population health.

8. Conservation Perspectives

Why would pink and coho returns have increased in many areas of BC this year, but not other salmon species? One answer lies in the important differences between species in age characteristics and time spent rearing in the ocean. Pink and most coho go from freshwater to the ocean to rear in the late spring until the fall of the following year. Sockeye, chum and chinook spend one or two years longer in the ocean. This means that the strong returns of pinks and coho in 2001 are showing that ocean growing conditions have been good in 2000 and 2001.

On this basis, it would be expected that sockeye, chum and chinook survivals should improve in 2002 and 2003. Clearly, salmon production will not return to what would be considered customary levels for at least a few years at the earliest because the already low spawning populations will continue to limit the potential for growth. However, increased survivals could enable the populations to rebuild.

The rebuilding scenario for salmon relies on progress being made on several fronts. Ocean survival is not the only problem. For example, Late-run Fraser sockeye are at dangerously low abundance because of factors described earlier. Some chinook populations on the west coast of Vancouver Island seem likely to remain at low levels of production, although the specific causes remain uncertain.

Global warming and intensive uses of land are also causing impacts on water related to shortages, inadequate snowpack, and high demand. A notable example is in Oregon where a severe water problem in the Klamath River basin resulted in ranchers, farmers, conservationists and Indian tribes fighting over scarce water. The salmon stocks in that system have been declared at-risk under the US Endangered Species Act. Water has been held in reserve for release to protect the fish. In turn, this has forced the shutting off of water that sustained 200,000 acres of irrigated farmland and several wildlife refuges in the basin. To cope with this problem, governments are restoring fish habitat in tributaries and estuaries and considering the possibility of breaching up to four dams on the Lower Snake River. The Oregon Governor warned that similar, but much larger scale, water-related environmental, economic and community crises are building in the Columbia River basin.

The BC Government, in cooperation with DFO, recently acted to increase water flows in the Nanaimo River to enable chinook and other fish to migrate and spawn. The low water levels and high temperatures threatened to inhibit the return of the salmon to spawning areas. In this instance, the reservoir storage and release decisions satisfied the needs of the salmon at the same time as they recognized the interests of First Nations and local recreational users.

Other issues related to global warming include increased water temperatures that have been observed to reach lethal levels. For example, Okanagan sockeye rear in Osoyoos Lake, but only in one arm because of high water temperatures that make the rest of the lake inhospitable. A number of other areas in the southern interior are now experiencing water temperatures regularly approaching levels that are unfavorable to salmon.

The increasing temperature is causing other salmon health problems. Many diseases are more dangerous and spread rapidly in warm water conditions. Under such circumstances, fish are subject to temperature and oxygen stress, and they become susceptible to disease and parasite problems. As temperature increases, the amount of oxygen fish use and the energy they consume increases rapidly. This makes fish more vulnerable to toxic substances. High temperature also speeds the decomposition of organic material, such as bark, leaves, soil, pulp, and sewage, and this process consumes oxygen from the water. These and related problems are developing rapidly and becoming more apparent across southern BC.

Challenges

The changes in ocean productivity raise a number of questions that should be addressed in future research and management decision-making. Looking back on the 1990s, what can we learn? What should we have done differently if we knew then what we know now?

If there are definite cycles of ocean productivity that affect the abundance, size and fecundity of fish produced, then it is important (and should be a priority) to monitor ocean parameters and become aware of changes in those cycles. Also, as the various ocean changes begin to occur, the management strategy should be adjusted to compensate for the projected effects. For example, if a decrease in productivity is anticipated, harvest rates must be reduced to sustain spawning populations. Should hatchery or enhanced production be maintained or increased to help maintain fisheries during down periods or decreased to reduce mixed stock fisheries and genetic impacts on natural stocks? Should selective harvest of enhanced fish be a part of the strategy?

If regime shifts are part of the overall global cycle, then a management strategy should be designed for the shifts and the different climate phases. This strategy could be for the overall salmon ecosystem, not just for salmon stocks and fisheries.

If freshwater conditions are also affected by the same cycles in the North Pacific Ocean, then freshwater survival and growth conditions in lakes and rivers may also be subject to climate cycles that need to be understood. Knowing that there can be long periods of high and low productivity should result in different habitat protection requirements. It would be wise and precautionary to provide much more protection to key spawning and rearing areas within watersheds and to install more semi-natural spawning and rearing channels to buffer the effects of floods, droughts and high temperature. Without such protection, the low ocean survivals could interact with low freshwater survivals and spiral populations down to lock them into unsustainable levels, to permanently alter the ecosystem, or to permit their extinction.

There are a lot of "ifs" because these are new ideas in climate and salmon research that are just now being considered and debated. It is essential to invest in the testing and development of these concepts. They could provide some much-needed structure to fisheries and habitat management to cope with the uncertainty of returns and habitat conditions. This is also important in assessing the impacts of habitat development. The variance of population returns is now so high it takes many years or dramatic impacts to demonstrate a detectable habitat impact. If survivals follow a basic cycle, this variance and time to demonstrate impacts could be modeled or, at least theoretically, be reduced.

Some stocks will not appear to be as affected by ocean conditions as others, in part because of other problems. For example, ocean changes may be obscured in stocks subject to major habitat or fish health problems, such as the parasite-related mortality in Late-run Fraser sockeye.

Outlook and Uncertainty

If salmon productivity is cyclical over long periods, an analysis of the data and information on production, stocks and conditions of the 1920s, 1930s and 1940s might foretell the next fifteen to twenty years.

Even if the 1920s and 1930s cycle is being repeated, it should still not be expected to be exactly the same. A big difference now is that the freshwater habitat productive capacity has been significantly reduced by water consumption, pollution, and deforestation. As a result, there is less production from many freshwater areas than there was sixty or eighty years ago. There have also been significant modifications in the estuarine and coastal habitat since then.

The consideration of trends in ocean conditions and their consequences for salmon requires an intensified effort that involves new learning and rethinking of conservation strategies.

9. RECOMMENDATIONS

The Pacific Fisheries Resource Conservation Council provides the following synopsis of recommendations on issues dealt with in this report.

1. More information, in the form of scientific data and evidence-based research on ocean survival, is crucial to the understanding of the key factors affecting Pacific salmon productivity.

Recent impacts of changing ocean productivity on salmon production have changed fundamental assumptions underlying salmon conservation and management. Further research in this field deserves a higher priority since the current lack of understanding of how ocean climate affects salmon survival and growth processes limits assessment and management of salmon and other fish stocks. The linkages between ocean climate, freshwater habitat and global climate change appear to be crucial, and may be the key to sustaining and rehabilitating salmon stocks in far more cost-effective ways than now exist.

2. Long-term salmon management strategies and monitoring should be adjusted to account for ocean productivity cycles and climate change.

As government agencies proceed with policy changes during coming years, they must begin to build assumptions on climate changes and ocean conditions into their decision models and management decisions. The emerging Wild Salmon Policy, for instance, could fail if the impact of the ocean environment and at-sea phase of salmon life cycles are not assessed and factored into decisions.

3. The focus on high-risk stocks should be maintained. Improved salmon production may continue, but government resource managers should proceed cautiously in the next years to ensure that these increased levels of production are sustained and production restored.

The Council is in accord with the pressing conservation challenges that Fisheries and Oceans Canada has identified as being at-risk and requiring continued attention and protection. Those vulnerable stocks include:

- Late-run Fraser sockeye.
- West coast of Vancouver Island chinook stocks
- Rivers and Smith Inlet sockeye stocks
- Upper Fraser/Thompson river coho stocks.

While measures are being taken to prevent further damage to these stocks, it is important for DFO to begin taking preventive action on other emerging stock, fishery and habitat problems to avoid reaching the point of similar major conservation crises. The Council is concerned that current levels of budget and human resources in the federal and provincial governments are insufficient. The costs of poor planning and crisis management could be avoided in many instances by effective enforcement measures and the adoption of the precautionary approach that the Council endorses.

4. Fishing stakeholders and government agencies should continue to devote resources and energy to selective harvesting initiatives and pilot projects.

Much progress has been made on selective harvesting during the past few years, but especially in 2001. Commercial fishermen are taking the initiative with the support of local DFO staff and demonstrating what is possible. They should continue to strive to get fishermen to participate in selective harvesting projects and to improve techniques and procedures that meet both conservation and economic goals. Effective selective harvesting by commercial, recreational and Aboriginal fisheries can help to address many of the outstanding fisheries management problems and achieve stock-specific harvesting.

Emerging Issues

The Pacific Fisheries Resource Conservation Council has identified the following important conservation issues that it will address on a priority basis:

The **Okanagan sockeye** spawn and rear in Canada, then migrate down the Columbia River to the ocean. On their return they are harvested in U.S. fisheries and face a remarkable challenge over tremendous distances and migrating up past a gauntlet of dams. This watershed is shared by the two countries and there is an increasing need for coordination of the conservation efforts across the border. The Council is working with Aboriginal groups and government agencies to draw together the resources and plans that can help restore the integrity of this vital salmon watershed.

Changes in forest, municipal, mining and other sector habitat policies are anticipated as the new BC Government begins to implement its environmental and economic development promises. The anticipated changes in **habitat protection policies** will be expected to involve streamlining without increasing the risk of losses in fish populations or habitat required to produce fish. The Council will review proposed regulatory changes with a view to assess their likely impacts and ensure that no measures are taken that would put BC salmon at risk.

The Council will consider the issues of **salmon over-spawning** and **impact of low water levels**, in upcoming reports in response to the request by DFO Minister Herb Dhaliwal.

The topic of **salmon interaction with mammals** will be reviewed by the Council, and possibly be presented as an advisory report in the coming year.

The Council will participate in the next phase of consideration of the **Wild Salmon Policy**, and put forward its views on this crucial subject.

The Council will continue to encourage dialogue and the resolution of aspects of **aquaculture policies** that have persisted in the highly-charged public debate on this matter. A determination of the role of aquaculture within broader resource and conservation policies, particularly the Wild salmon Policy, is an essential step that the Council will continue to promote energetically.

APPENDIX 1

Council Members

The Honourable John A. Fraser, Chairman

John Fraser was born in Yokohama, Japan and raised in Vancouver. He graduated from the University of British Columbia in 1954 and practised law until his election to the House of Commons in 1972. During his 21years in Parliament, John Fraser served in key positions, including Minister for the Environment and Minister of Fisheries. He was the first person to have been elected Speaker of the House of Commons by his peers, a practice instituted in 1986. In 1994, John Fraser was selected to head the Fraser River Sockeye Public Review Board investigating the salmon fishery. He was subsequently Canada's Ambassador for the Environment, responsible for Canadian follow-up to commitments made at the United Nations Rio Conference on Environment and Development. In September 1998, John Fraser was appointed Chair of the Pacific Fisheries Resource Conservation Council. He also currently chairs the Minister's Monitoring Committee on Change in the Department of National Defence and the Canadian Forces, as well as the Parliamentary Buildings Advisory Council.

John Fraser is a Queen's Counsel, an officer of the Order of Canada and a member of the Order of British Columbia and he holds the Canadian Forces Decoration. In 1999, Simon Fraser University and St. Lawrence University awarded him honorary Doctor of Laws degrees for his contributions to environmental causes.

Mark Angelo

Mark Angelo is a noted river conservationist, outdoor leader, teacher and writer. He is Program Head and Instructor of the Fish, Wildlife and Recreation Department of the British Columbia Institute of Technology. He is a recipient of the Order of Canada and the Order of British Columbia, in recognition of outstanding achievement in preserving Canada's waterways. Mark Angelo was also the first recipient of the National River Conservation Award as Canada's most outstanding river conservationist in the past decade. His involvement with river conservation in British Columbia spans three decades, and he has published more than 200 articles and editorials on the issue. He speaks regularly at conferences throughout Canada and in other parts of the world.

Mary-Sue Atkinson

Mary-Sue Atkinson is a noted volunteer who devotes countless hours to the preservation and well-being of the salmon resource. She is a Director of the Fraser River Sturgeon Conservation Society, a member the Nechako River White Sturgeon Action Planning Group and is actively involved in public education. She is also a North Shore Streamkeeper. Mary-Sue Atkinson has worked tirelessly to raise public awareness about the value of riparian habitat to a healthy watershed and to ensure the survival of wild salmon. She helped to establish the "Gently Down the Seymour" program to teach school children about watershed stewardship. She has also contributed to public education about the current state of coho stocks in British Columbia.

Frank Brown

Frank Brown of the Heiltsuk First Nation is an ecotourism operator from the village of Bella Bella in the Central Coast region. He has a philosophy of holistic community development with an emphasis on social, spiritual, and cultural needs. His entrepreneurship involves innovative economic development that marries conservation and development, supporting and stabilizing his community through greater economic diversity that extracts less and produces more with natural resources from within the Central Coast. He has spearheaded the Renaissance of traditional ocean going canoe carving and expeditions, and successfully initiated the first major ocean going canoe expedition by a North West Coast tribe in the 20th century. Frank Brown served as the President of the Rediscovery International Foundation and was Founder and Camp Director for Heiltsuk Rediscovery, a program for Native and non-Native youth and elders in a wilderness camp setting. He has overcome major personal challenges (including living alone in the wilderness for 8 months at age 14) to become one of the most creative and successful community development facilitators in British Columbia. Frank Brown was selected by the BC Government in 2000 to serve as its first appointee to the Council.

Murray Chatwin

Murray Chatwin is Vice President Fisheries Management for Ocean Fisheries Ltd., which he joined in 1970 as a student working on fishing vessels. He earned a Bachelor of Commerce in economics from the University of British Columbia in 1972, and began working for the company full-time. He is a licensed Ship's Master and, in his present position, is responsible for the company's fishing fleet, overseeing all of its salmon, herring and groundfish operations in British Columbia. Murray Chatwin is active in several industry groups, including the Central Coast Advisory Board, the Fraser Panel of the Pacific Salmon Commission, the Groundfish Trawl Advisory Committee, the Groundfish Special Industry Committee, Director of the Groundfish Research and Conservation Society and the South Coast Advisory Board. He is Vice President and Chairman of the Planning and Operations Committee for the Hake Consortium of British Columbia and a member of the BC Salmon Industry Marine Stewardship Certification Steering Committee.

Merrill Fearon

Merrill Fearon is the Executive Director of the Federation of BC Writers and an educational media producer with a special interest in fish and fisheries. Her company, Merrill Fearon Communications, has produced a number of environmental-education resources for children. At the Sturgeon General's web site sponsored by Environment Canada, www.sturgeongeneral.org, a 135-year-old grandmother sturgeon teaches children about climate change, nonpoint-source pollution, and other ways in which humans are affecting fishes' lives. A Social Studies-based program called FishSMART: Responsible Angling and Stewardship for Grades 4–6, sponsored by BC's sport fishing community, encourages children to learn about fish and fisheries in their local community. Merrill Fearon has worked with a number community stewardship groups to help get the message out to the public that our fish need our protection. She is a Director of the Save Our Fish Foundation and developer of the Foundation's web site.

Dr. Paul H. LeBlond

Paul LeBlond holds a PhD in physics and oceanography from the University of British Columbia, a BSc in mathematics and physics from McGill University, and a BA in humanities from Laval University. Following a post-doctoral fellowship in Germany, Dr. LeBlond served as Professor of Oceanography and Physics at the University of British Columbia until his retirement in 1996. He is now active in a variety of local, national and international ocean science and conservation forums. Before joining the Pacific Fisheries Resource Conservation Council, Dr. LeBlond was one of the original members of the Fisheries Resource Conservation Council for Atlantic Canada. He chairs the Science Advisory Council of Fisheries and Oceans Canada as well as the Science and Industry Advisory Board of the Institute for Pacific Ocean Science and Technology. He is a Fellow of the Royal Society of Canada.

Dr. Jeff Marliave

Jeff Marliave is a marine biologist specialising in early life history studies. His degrees are from the University of Washington (BSc Fisheries, 1970) and the University of British Columbia (PhD Zoology, 1975). Dr. Marliave's career has been at the Vancouver Aquarium, initially as Resident Scientist, and progressing to become Senior Scientist, Director of Conservation and Research, Director of Operations and Vice President Marine Science. He has produced over 70 scientific and technical publications, and has reared 55 marine fish and 15 crustacean species from hatching to juvenile stages.

Marcel Shepert

Marcel Shepert has been a fisheries program manager and co-ordinator for the Carrier Sekani Tribal Council since 1996. With over ten years prior experience in sales and marketing, he brings a diverse background ranging from horticulture to international art sales. Having lived in Europe and travelled extensively throughout the continent for three years, Marcel Shepert is passionate about preserving our natural resources. Academically trained in Ontario at Mohawk College of Applied Arts and Technology, British Columbia Institute of Technology, and the Justice Institute of British Columbia, he focused on communications, negotiations and conflict resolution. Within the First Nations context, Marcel Shepert has been instrumental in building a strong First Nations management team capable of establishing itself as a solid management force within the interior of British Columbia's resource management sector. He sits on a number of boards including the Upper Fraser and Nechako Fisheries Council.

Dr. Carl Walters

Carl Walters is a Professor in the Fisheries Centre and of Zoology at the University of British Columbia. He holds a PhD and MSc from Colorado State University, and BSc from Humboldt State College in California, and he is a Fellow of the Royal Society of Canada. Dr. Walters' main research work is on the theory of harvesting in natural resource management, and on methods for incorporating ecosystem change in fisheries policy design. His chief interest is in the basic problem of how fisheries management should behave adaptively in the face of extreme uncertainty. Dr. Walters was recently awarded a Pew Marine Conservation Fellowship, which is considered the world's preeminent award for marine conservation. He also maintains an active field research program on recreational fisheries in the British Columbia interior.

Ex-Officio Members

Dr. Richard Beamish

Richard Beamish is Senior Scientist at Fisheries and Oceans Canada's Pacific Biological Station where he was Director from 1980 to 1993. Early in his career, Dr. Beamish studied freshwater fish and was the first to recognize the impact of acid rain on freshwater fisheries in North America. He has made significant contributions to the biology of groundfish in British Columbia waters, discovering that some rockfish live to be 100 years old. Dr. Beamish has been active in international fisheries in the North Pacific and has collaborated widely with foreign scientists on a variety of fisheries issues, more recently on identification of the impacts of climate change on fish stocks. He is a graduate of the University of Toronto, and is an Affiliate-Professor at Malaspina University College. In 1998, Dr. Beamish was named a Member of the Order of Canada for his contributions to fisheries science. He was recently elected a Fellow of the Royal Society of Canada.

Fred Fortier

Fred Fortier is a Senior Councillor for the North Thompson Indian Band, one of the 17 Shuswap, or Secwepemc, First Nations from the south-central interior of British Columbia. He is Chairman of the Shuswap Nation Fisheries Commission and the Columbia River Intertribal Fisheries Commission in his territory. Until recently, he chaired the British Columbia Aboriginal Fisheries Commission, where he was responsible for the regional co-ordination of information and policy associated with aboriginal fisheries in BC. Fred Fortier is known for his work to recover wild fish populations and as an advocate of aboriginal rights and responsibilities in fisheries. A key component of his work in the last 10 years has been the development of an international working group of indigenous peoples on aquatic biological diversity, and he has played a leadership role in related work with the Convention on Biological Diversity. Fred Fortier sits on the Board of the Global Indigenous Knowledge Program, the World Fisheries Trust and the Pacific Coast Sustainable Fisheries Strategy.

APPENDIX 2: TERMS OF REFERENCE

The following are key excerpts from the Council's Terms of Reference:

The Pacific Fisheries Resource Conservation Council is an independent body that will provide advice to the Minister of Fisheries and Oceans, the British Columbia Minister of Fisheries and the public on matters dealing with the conservation of Pacific fish populations and the status of their freshwater and ocean habitat in British Columbia.

Specifically, the Council will:

- provide strategic advice regarding stock conservation and enhancement, habitat restoration, protection and improvement, and fisheries conservation objectives. This will include identifying stocks in need of conservation actions and stocks where there is insufficient information to assess their conservation status;
- describe the effects of conditions in freshwater and marine ecosystems on the conservation of Pacific salmon;
- review and make recommendations pertaining to research programs, stock and habitat assessments, enhancement initiatives, and government policies and practices related to conservation of Pacific salmon and their freshwater and ocean habitat;
- integrate scientific information with knowledge and experience of First Nations, stakeholders and other parties;
- alert the Minister of Fisheries and Oceans and the public on issues which threaten the achievement of departmentally-defined conservation objectives for Pacific fish populations or their freshwater or ocean habitats;
- provide information to governments and the public on the status of Pacific salmon stocks and their freshwater and ocean habitat in order to enhance understanding and support for fish conservation and habitat protection.

The Council will provide its recommendations to Ministers and the public simultaneously.

- The recommendations will provide an overview perspective on long-term strategic priorities for the conservation of Pacific salmon stocks and their freshwater and ocean habitat in British Columbia.
- The Council will convene and host public meetings each year at several locations in the Province of British Columbia to receive, review and discuss information pertaining to the status of salmon stocks and their habitat.
- The Council will provide recommendations to the Minister of Fisheries and Oceans, British Columbia Minister of Fisheries, and the public, in its annual report due March 15 of each year, and from time to time as the Council deems appropriate.
- The Council will work with Federal and Provincial government agencies to ensure comprehensive data and information sources related to pacific salmon stocks and their habitat are available to First Nations, stakeholders and the general public.
- The Council may review progress on implementation and the degree of success achieved by their previous recommendations.

- From time to time, the Minister of Fisheries and Oceans will refer specific requests for advice to the Council. This advice may be incorporated into the annual report of the Council or provided at other times as an extraordinary report.
- The Council will set its own agenda on an annual basis within the context of its terms of reference and taking into account requests from the Minister of Fisheries and Oceans.

APPENDIX 3: REFERENCE MATERIALS

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