Pacific Fisheries Resource Conservation Council

Annual Report
1999–2000

Prepared by
Pacific Fisheries Resource
Conservation Council

May 2000

PFRCC Annual Report 1999–2000

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

May, 2000

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

Hon. Corky Evans
Minister of Agriculture, Food and Fisheries
Government of British Columbia
Victoria

Dear Ministers:

Salmon are an important part of our heritage, and make significant cultural, social and economic contributions to the people of British Columbia and Canada. Salmon are more than just an isolated part of the broad ecosystem. Apart from people, life forms throughout the coastal ecosystems, ranging from bears and eagles to plankton and microorganisms, are linked to salmon and their well-being.

As you know, our purpose in the Pacific Fisheries Resource Conservation Council is to advise governments and the public about conservation of fish, specifically salmon and steelhead, and their freshwater and ocean habitat.

We are pleased that government agencies and many public groups have responded positively to the information and recommendations put forward by the Council last year. We noted that progress on implementing the recommendations has been rapid in some instances, slow in others, but still non-committal in a few cases. Overall, we believe that progress is being made in salmon conservation and moving towards a future in which fish stocks and their habitats can be more effectively sustained.

In this second *Annual Report,* the Council advises on the need to understand and meet the basic needs of the fish throughout their life cycle. Today, fisheries resources are in a period of great change, and not enough is known about the root causes of the major threats to be able to comprehend fully and respond appropriately to them.

The Council has identified the direct and indirect impacts of climate change as some of our most pressing conservation issues that are having dramatic and far-reaching consequences. We have found that climate change may be having the biggest single impact on the deterioration of salmon production, and it is posing the most apparent long-term risk to the future of Pacific salmon.

Another crucial issue addressed in this report is the set of severe problems in the Central Coast region, specifically the declines of salmon abundance in the Rivers and Smith Inlets. This region once comprised the second largest sockeye producing system in the province. By last year, the total population had dropped to less than one percent of its previous average abundance. This desperately low abundance of sockeye, and the depressed state of other Central Coast salmon populations, is a major conservation concern.

Several other basic issues are dealt with in this report, and our findings and recommendations are presented for consideration by governments and the public. The conservation of fish habitat, for instance, presents a complex challenge involving a number of federal and provincial agencies, with the growing participation of volunteer and stakeholder groups. Part of the challenge for everyone involved in the process, but particularly for governments, is to begin working together to achieve the common goals of conserving fish populations and sustaining them in productive habitat conditions.

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The Council has developed effective working relationships with officials in both the Government of Canada and Government of British Columbia. We are looking forward to the next stage that is expected to involve direct participation by the provincial government in the Council's activities.

Council members are particularly grateful for the dedication of the interested public and organizations that contributed their information, ideas and opinions in our extensive consultation sessions and informal discussions.

It has been gratifying to work with such knowledgeable and dedicated Council members as: Mark Angelo; Mary-Sue Atkinson; Murray Chatwin; Terry Glavin; Paul LeBlond; Rick Routledge; Don Ryan; and Carl Walters, as well as ex-officio members Dick Beamish and Fred Fortier. Together, we have been pursuing the Council's mandate of integrating scientific research with practical experience and traditional knowledge to provide a basis for the advice contained in this report.

Hon. John A. Fraser
Chairman

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1.0 INTRODUCTION

The millennium is a time for reflection on where we have been and where we are going. For many Canadians, it has evoked a longer-term perspective of the centuries and decades, by contrast with the minutes and microseconds of the electronic age.

For the Pacific Fisheries Resource Conservation Council, the millennium sets into perspective a sense of time and place in which salmon have evolved and could flourish or languish in the future. The fate of Pacific salmon populations depends on many factors. Some of those, like ocean conditions and predation, are to an extent beyond immediate control. Other factors, such as human-induced climate change, habitat deterioration and unsustainable fishing practices, can and should be mitigated.

This *Annual Report* of the Council reviews the state of salmon stocks and related habitat conditions, and includes particular attention to a set of at-risk areas, salmon populations and habitat situations. It goes on to look at four issues in particular—climate change, *Pacific Salmon Treaty,* salmon in the Central Coast, and strategic management. These were the subjects of particular attention and research during the past year. The Council was assisted in its consideration of several of these issues by background papers produced by researchers and experts. Access to those background papers and other subjects is available through the Council's internet web site (www.fish.bc.ca). The information and analysis contained in the background papers provided a valuable reference for Council members.

Life Cycle Approach

In overall terms, this report advocates a conservation strategy based on understanding and meeting the basic needs of salmon throughout their life cycles. It suggests an approach that builds on the two primary themes of the Council's 1999 report: the importance of maintaining biodiversity; and the acid test of applying the precautionary principle.

Any strategy, to be effective, must deal with all salmon life stages. At present, key aspects of the estuarine, early ocean and high seas life stages of Pacific salmon are largely unknown. Annual variations in survival rates have been recognized but longer-term variations in salmon abundance have only begun to be acknowledged. In the past few years, it has become apparent that survival in all life stages can vary significantly in both the short term and the long term. In these circumstances, it is important to understand all life stages, but particularly the early ocean stage and the interaction of factors in those that produce unexpected results.

The investment to maintain the biodiversity that is inherent in many different salmon stocks is an indispensable form of insurance for long-term survival and sustained salmon production. Stock complexity, climate change, and urban and industrial development impacts on habitat, all interact in broad ecosystem relationships to put salmon at risk.

The life cycle approach involves taking a viewpoint that differs from the fisheries policy perspective, particularly for biodiversity, that has prevailed in the past. The thousands of salmon spawning populations throughout the province present complexity and inherent challenges for any conservation effort. Those populations are genetically adapted to their specific home areas and life characteristics. They are highly dependent on conditions in the various habitats they occupy at each life stage.

In this report, the Council builds on themes it set last year. It presents updated information and proposes a more rigorous application of the standards and principles adopted shortly after the

Council's inception. The report expands on four topics that were interwoven throughout its discussions and public statements, specifically:

- The management of salmon resources is taking place under conditions of such change and uncertainty that past experience is often of little use as a primary guide for conservation decisions.
- The process of coping with conditions now affecting Pacific salmon is beyond the mandate or capabilities of any single government level or agency to address.
- The regulatory and policy decisions of governments that have an impact on salmon and other fish are being taken in a climate of uncertainty created by the increasingly complex and interdependent problems that are beyond current research and information-gathering capabilities.
- Public involvement in salmon conservation is crucial, requiring initiatives to ensure more widespread recognition of the fundamental salmon problems and broader consensus on long-term conservation strategies.

Continuity of Issues

In its report last year, the Council put forward three categories of recommendations, the first of which proposed a coordinated conservation policy with particular focus on governments jointly dealing with biodiversity and habitat protection. The second category set out the case for acquiring better and more relevant information for stock management and rebuilding. The third set of recommendations dealt with habitat protection and restoration.

The responses by officials of the Canadian and British Columbia governments to the Council's 1998–99 recommendations appeared to be both genuine and positive. In some cases, they chose to apply somewhat different priorities, but in an overall sense there was a remarkable degree of consistency between what the Council proposed and what the two governments subsequently said they would do or were doing.

Federal government officials pointed out that they were proceeding with initiatives such as the wild salmon policy paper and cooperative stewardship arrangements that directly addressed the issues raised by the Council. The only instance of notable divergence from what the Council proposed was in the procedure for assessment of stock productivity; the Department of Fisheries and Oceans prefers a more selective process and specialized sampling than the Council recommended.

The Government of British Columbia expressed its determination to close the gaps in those policies and practices that the Council had identified as existing between the levels of government. It also proceeded with several of its own worthwhile initiatives, such as water use licensing, that are consistent with the Council's priorities and advice last year.

Conservation Strategies

In its previous *Annual Report,* the Council directed most of its commentary and advice towards the federal Department of Fisheries and Oceans. The remainder of the suggestions and recommendations were largely about matters of provincial jurisdiction and called for responses by the province's Ministry of Fisheries.

By contrast, the Council found that many of the conservation issues arising this year are under the purview of other federal and provincial government agencies. Although Fisheries and Oceans is the designated federal fisheries agency, a number of others are directly or indirectly involved in many decisions that affect fish and their habitats.

For example, there are extensive roles in monitoring and responding to climate change impacts by federal departments, including Natural Resources, Transport, Industry and Environment. Fisheries and Oceans has an important role to play in describing and interpreting the effects of climate change on Canada's fisheries resources. To do this, it requires the cooperation of the agencies responsible for monitoring climate, ocean environment, water runoff, snow pack and other conditions that inevitably affect salmon survival and health.

A similar situation exists at the provincial level where many activities, such as forestry, transportation, urban development, water use, mining and agriculture, have an impact on watershed habitat. Several provincial agencies and municipal governments must work together to a greater extent to protect fish habitat without unnecessarily impeding other resource use.

Council Activity

During the past year, the Pacific Fisheries Resource Conservation Council considered many of the emerging issues that had been identified in its initial report. It joined with other organizations to sponsor workshops on salmon issues organized through Simon Fraser University. It commissioned background papers that provided an underpinning of the findings and recommendations contained in this report. The Council also carried out extensive public consultations in five regions of the province, enlisting the participation of groups and individuals involved in habitat restoration, agriculture, local government, forestry, First Nations, commercial fishing, sports fishing and volunteer community organizations, among others.

To address these challenges, the Council has drawn from the findings of the workshops, studies and public consultations to describe and characterize the issues, their consequences and some possible solutions. In a few cases, the conclusions call for investment in new knowledge. In other cases, they involve innovative ways of working that require more precautionary responses to conditions of uncertainty.

Now is the time, while millennium insights are in people's minds, to develop the required long-term plan that commits governments, agencies and the public to move more resolutely towards a sustainable future for Pacific salmon.

2.0 STATE OF STOCKS

Overview

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.

With so many salmon stocks now at risk, strong measures are required to realize the most basic conservation needs. For example, the closure of fisheries and widespread non-retention of coho were essential to prevent extinction of the Upper Skeena and Thompson coho stocks. A number of other coho and steelhead stocks are also at very low abundance.

The Council has deep concerns about the state of steelhead, particularly in the Georgia Strait and Fraser areas. The continuation of low marine survival and inadequate returns illustrate the severe conservation problem, with many spawning populations at only remnant abundance. The causes of this depressed production seem to be related to climate conditions and habitat deterioration in fresh water and estuaries. They are also related to mixed stock fishing and other practices.

In the Fraser watershed, the timing of the run-off has changed and the volume of the spring period has been at the extremes of experience. High spring flows were a problem in 1999, and summer water temperatures in some areas during 1998 had been near-lethal for salmon. There were very high pre-spawning mortalities and a number of major disease outbreaks. The combination of such factors undermined salmon survival in that watershed and coast-wide.

Public concern was expressed to the Council about catch-and-release stress and about summer fisheries on steelhead smolts by children. These problems in 1999 were exacerbated by the lack of education, monitoring and enforcement on Vancouver Island, specifically the supervision of closures. In lieu of complete closure, a “living gene bank” program of raising brood stock was instituted. This approach led to further questions about the related domestication and genetic selection issues.

Fraser River Sockeye

The extraordinary decision of the federal government to close the Fraser River sockeye fishery in 1999 was a conservation measure that gained widespread public attention and led Council members to review the state of these significant sockeye populations.

In 1999, only about three million of the forecasted eight million Fraser River sockeye returned from the ocean. Survival in the ocean was much lower than was normal. Index fisheries along the coast provided an in-season warning of this shortfall and the expected fisheries were not held. Each of the runs was successfully protected from harvesting through all coastal areas and into the Fraser River as far upstream as Mission. From there, however, nature took over again.

Record-setting snowfalls of the previous winter led to melt-waters from the vast upper watershed that poured through the Fraser Canyon and presented early-returning sockeye with virtually impassable conditions. The Early Stuart sockeye, having the longest migration route of any substantial sockeye stock grouping, were those most affected. For the third year in succession, adverse river conditions caused the estimated number of spawners to this early sockeye run to fall far short of expected levels.

There was a seven-fold decrease in the number of successful spawners, compared to the parent generation, due to the decreased survival in the ocean and stresses of upstream migration.

The estimated total for the numerous spawning populations that comprise the Summer Run was the highest on record for this cycle year. However, the spawning populations of the Early Summer Run were also hit hard. By August, the freshet had receded, and mid-summer migrating runs found easier passage up the river. Then more problems struck. For the last group of the Summer Run sockeye to head up the river, including those headed for the Adams River, the en-route mortality appears to have been very high. There was also a lack of spawning success. Of those females that arrived on the spawning grounds, just over two thirds spawned successfully. Most of the mortality was the result of a parasite infestation. Further up the watershed, in the Shuswap Lake area, survey crews found evidence suggesting that at least 150,000 sockeye died there before spawning.

The Late Run spawning populations to the lower Fraser River were also affected. The Pacific Salmon Commission's echo sounding estimated that approximately 1.4 million late-run fish passed Mission. This was well above the spawning target of 880,000. But shortly after the run passed Mission, a dramatic increase in the numbers of carcasses floating back downstream was observed. There is uncertainty about the count at Mission and the number of carcasses, but the resulting low number of spawners is certain. Those sockeye were headed for Lower Fraser spawning grounds. Recently, the late runs have been entering the river sooner than normal, which may account for the apparent increase in susceptibility to parasites. Overall, the result was a setback to spawning goals for all but the mid-summer runs. Were this year's experience an isolated event, it might not be so troublesome, but setbacks have been occurring with alarming frequency in recent years.

The Council agrees with the 1999 closure of fisheries on Fraser sockeye as a necessary conservation measure. The Council also concurs with the view expressed by many that these conditions are not likely to go away soon. There is evidence that temperatures in some of the headwaters of the Fraser River system are now routinely reaching near-lethal levels. Facing such risks, the future health of Canada's most valuable sockeye runs cannot be taken for granted.

Coho Conservation

In 1999, the federal government announced a continuation of the zero fishing mortality policy, with modified restrictions that included new special zones on the West Coast of Vancouver Island. These restrictions were primarily to address the dangerously low abundances of coho expected to return to the Thompson and Upper Skeena rivers. They also helped to address other problems, including the continuing declines in the Georgia Basin and Johnstone Strait, and chronically low abundances in the southern Queen Charlotte Islands and the Kitimat area.

The Council emphatically agrees that the tough fishing restrictions are appropriate. Coho throughout both the Thompson and Upper Skeena regions were chronically depressed. The conservation measures also benefited the coho populations in much of the Inner South Coast. They had barely held their ground in 1998, and the parent generation for 1999 was generally the

worst on record. There was an overwhelming risk that spawning abundances would have declined further had exploitation rates not been severely restricted.

The real target of the coho restrictions was clearly to keep fishing-induced mortality down at least to the 1998 level. Any target above zero mortality would have represented a compromise between short-term economic and social gains versus risks of irreparable losses. Under present conditions, any target above the existing level would risk rapidly driving many individual Thompson River coho spawning populations to extinction. The 1999 returns and those expected in 2000 are even lower than in 1998, when the adult progeny barely outnumbered their parents. The restrictions were essential in 1999 and will be equally important in 2000.

The Council proposes that these stocks should be monitored for changes in their overall abundance, marine and freshwater survival rates, geographic distribution, and genetic integrity. Any signs of further weakness will call for further decisive management action.

Canadian exploitation rates on Thompson River coho were estimated at 1.5% in 1999. This compares favorably to the estimated 2% in 1998. In addition, American exploitation was down substantially from an estimated 5–6% in 1998 to 2–3%. This reduction appears largely due to tougher regulations imposed on sport fishing in the American side of Juan de Fuca Strait. It is aimed, in part, at protecting depressed stocks in that country.

Fishing regulations were similarly successful in controlling mortality on Upper Skeena coho in Canadian waters. Alaskan-induced mortality remained at around 40%. In the Upper Skeena, there was a remarkable increase in the number of coho spawners. The fishing restrictions and resurgence in marine survival in 1999 began to allow the stocks to rebuild, and at least three more years are required. The improved cooperation between Canadian and Alaskan management agencies is leading to better in-season assessment of run-sizes to monitor the rebuilding.

In the Thompson River, the estimated numbers of coho spawners were up substantially over those for the 1996 parent generation. Nonetheless, they were still slightly below the estimates for 1998. The fishing restrictions seem to have fostered a modest recovery, but this represents a first, small step in what is proving so far to be a slow recovery process. As long as marine survival remains low, Thompson River coho will not be able to recover quickly. Any substantial increase in fishing mortality would impose unacceptable risks to their long-term survival. On the brighter side, the rejuvenated spawning surveys of Fisheries and Oceans are leading to discoveries of spawning populations elsewhere in the Upper Fraser watershed, including the Nechako River.

There is reason for anxiety about the health of the salmon populations in the Inner South Coast, including the Lower Fraser. Spawning estimates were generally down from last year, but up from the all-time low numbers of spawners in the 1996 parent generation. Some populations, such as the Pitt River coho, increased significantly, but many remain depressed. The 1999 coho returns to two wild indicator streams (Black Creek on Vancouver Island and Salmon River near Fort Langley) were both the second lowest on record. Marine survival estimates for wild and hatchery stocks remain low, in the 1–2% range. Estimated marine survival of Black Creek wild coho dipped below 2% from the 12% average for the late 1980s. South Coast stocks are chronically depressed, and any further decline in natural survival or increase in fishing mortality would undermine them even further. The Council is also concerned about the apparent high proportion of hatchery fish in this region, and their potential impacts on wild stocks through competition, genetic alteration, and over-harvesting in mixed-stock fisheries.

The coho appear to be faring better on the West Coast of Vancouver Island than on the Inner South Coast. Still, marine survival at Robertson Creek was 0.6%, the second lowest level on

record. This occurred at the same time as disturbing signs of weakness were evident in many chinook stocks in the region.

The status of coho in the Central and North Coast, from the northern end of Vancouver Island to just south of Prince Rupert, is very uncertain because of an information void. For the second consecutive year, the Council stresses the importance of rectifying this information shortfall, and of managing with exceptional caution until this void is filled. Fisheries and Oceans has begun to develop plans for improved abundance monitoring in the region. The new *Pacific Salmon Treaty,* with its requirements for abundance-based management, appears to have provided the impetus. While this is a very favorable development, the Council remains apprehensive about the lack of immediate abundance measures in response to continuing signs of stock weakness. Of particular concern is the lack of reliable information on coho in the outer coastal areas from Bella Bella northward, and especially in the southern Queen Charlotte Islands.

The Council has noted some flaws in the application of the coho conservation restrictions, specifically related to the Gwaii Haanas National Park Reserve. In that instance, Fisheries and Oceans officials assigned only minimal fishing restrictions, in spite of the apparent severe declines in spawning observed during the preceding ten years. Adherence to the precautionary principle in this case would have called for more serious protective measures.

Complicating the situation even further in the Gwaii Haanas National Park Reserve was the failure to survey the spawning populations during the 1999 season. The status of the 1999 returns is therefore completely unknown. The inadequacy of fishing restrictions and abandonment of monitoring in the area are inexplicable given the circumstances.

An important position of the Council deserves to be reiterated in relation to coho conservation. It is that biodiversity is the key for this and other species to survive the long-term stresses of climate change and other habitat factors. To that end, it is imperative that firm fishing restrictions remain in place. Specifically, the measures to protect Thompson River coho are crucial because they also shelter many other southern coho stocks that cannot withstand any significant fishing pressure.

The coho conservation program is a clear example of what can be done when decisive action is required. It also illustrates the inevitable costs and risks in letting stocks slide to such low levels that stringent measures are required. Better information is needed to detect early signs of such conservation problems, and better management tools are prerequisites to enable timely and effective intervention.

Central Coast Conditions

The background paper entitled *State of Salmon Conservation in the Central Coast Area,* prepared by Allen Wood, provides an illuminating look at the state of salmon populations in an area of the province that has received little attention in recent years. The Central Coast area includes the inlets and tributary watersheds lying between Kitimat and Smith Inlet, just northeast of the top of Vancouver Island.

The area is geographically isolated from the other salmon-producing locations. For sockeye, pink and chum salmon, Central Coast fisheries do not intercept US stocks and US fisheries are not known to intercept Central Coast stocks. The area is south of fisheries on Skeena stocks and north of fisheries on Fraser stocks. Consequently, the Central Coast is a valuable indicator of the current state of many domestic salmon stocks and their management.

From 1900 to 1974, an average of 1.2 million sockeye was caught annually in the Rivers and Smith Inlet area. The average number of spawners was probably about 0.7 to 1.0 million, making the average total stock about 2 million. Since then, the number of sockeye has decreased rapidly. Until the mid-1990s, the average annual catch was 281,000 and the average total returns were 613,000. The fisheries have been closed since 1996 in Rivers Inlet and 1997 in Smith Inlet. In spite of the closure, the total sockeye returns in 1999 dropped to 3,600 in Rivers Inlet and 5,900 in Smith Inlet. This is less than ¼% of the Rivers Inlet average and about 1% of the Smith Inlet average.

From 1913 to 1992, there was an average catch of 3.6 million pinks in the Central Coast area. The 1993–99 average catch was restricted and reduced to 680,000 pinks in an effort to sustain the number of spawners. Catches have never been that low for that long since the fishery was fully operational, over 80 years ago. One or another of the even or odd year stocks has usually been highly productive and abundant. However, the productivity of both even and odd year stocks has decreased to replacement levels. The causes of these changes are not known, and there has been no research to identify the nature of the problem.

Chum salmon appear to have gone through four productivity cycles starting in the 1920s. They are now in a trough of relatively low abundance, but not as low as other salmon species. Chinook, coho and steelhead commercial catches in the area have dropped to a fraction of the previous levels.

For the few salmon stocks that are monitored, the major decrease in salmon production in the region has been attributed to increased mortality in the early ocean life stage. The causes of the declines are not known. Why chum salmon have not also declined to the same extent remains a mystery.

Spawner estimates up to 1993 indicate that at least 25% of spawning salmon populations in the Kitimat area were rated at high risk of extinction. There was not enough information available to classify about one third of the spawning populations. Alarmingly, most of the known at-risk stocks are in outer coastal areas where habitat is undisturbed. These problems could be largely due to past mixed stock fishing or a history of poaching. They could also be a result of failing to monitor the stocks adequately. Regrettably, there has been no special activity initiated to assess or protect them.

3.0 STATE OF HABITAT

Overview

Salmon habitat is where salmon live. Habitat conditions determine the survival and abundance of salmon available for spawning and harvesting. Salmon are especially vulnerable because they live and migrate through so many different habitats—first freshwater streams and rivers, then estuaries, inner coastal and open ocean, and finally freshwater rivers and streams again.

In each life stage and habitat, salmon have high mortality. Even a moderate change in habitat may make a big difference in overall survival. All habitats, for instance, have been subject to the impacts of climate change. Many freshwater and estuary areas have seen an array of activities including forest harvesting, water extraction, siltation, sewage disposal, diking, dredging and more intensive use. With so many government agencies and diverse interests involved, habitat management is complex and challenging.

The Central Coast provides a particularly interesting and representative example of habitat conditions. In much of the area, the freshwater habitat is undisturbed. There has been extensive logging, as well as industrial and urban development, in the Kitimat and Bella Coola valleys. A number of other medium-sized watersheds have also been logged. The freshwater sockeye habitat is essentially natural in Smith Inlet with only relatively minor development that occurred in the distant past. In Rivers Inlet, the main spawning rivers have been extensively logged. The vast expanse of land and the variations in both physical conditions and development patterns illustrate the difficulty in habitat evaluation.

Many habitat impacts take place in watersheds at a distance from streams. They affect the water runoff rates, temperature, erosion, and vegetation in the watershed and ultimately in the streams and rivers. Some habitat impacts are from activities conducted in the water supply or directly affecting it. With economic growth and changing climate conditions, the rising demand for water could compromise its availability for fish. This presents a conflict among interests that could best be resolved by cooperative water management arrangements.

Salmon spawn in the gravel in streambeds. If the gravel is removed or fouled with silt or other materials, the fish have nowhere to spawn. A result is that the survival of their offspring decreases, often to unsustainable levels. Similarly, juvenile salmon rearing in their freshwater life stage need a habitat with natural hiding areas, abundant food supply and good growing conditions. This involves streams with resting and hiding places, streamside vegetation, and stable bed and banks. The naturally moderating effects of forests and streamside vegetation have been lost from broad areas of the province. Forest harvesting, agriculture, and industrial and urban development have been among the factors that, for many years, removed, transformed or destabilized fish habitat.

Water Use Planning

Water is essential for life. It is vital for living organisms—fish, plants and humans—and required for commercial and industrials applications. The use of water and its requirements for salmon conservation were identified by the Council as matters that needed more detailed information than was currently available. As a consequence, the Council asked Mark Angelo and Marvin Rosenau to expand on some of the ideas they presented last year. The result is their background paper

entitled *Water Use Planning: A Tool to Restore Salmon and Steelhead Habitat in British Columbia Streams*.

That background paper emphasizes that, with all of the conflicting demands for water, priorities must be set for its use. Clearly, providing water to maintain and conserve living natural resources should take priority over most other uses. Salmon are especially impacted by water use practices because they require water that is cool and clean. It appears that many salmon populations have become extinct and others are at risk of extinction due to careless water use.

In British Columbia, the current *Water Act* does not recognize fish as legitimate users of water. That is, it does not specifically protect salmon from over-extraction of water from streams by humans. The *Canada Fisheries Act* and the new *BC Fish Protection Act* deal with the protection of flows for salmon in streams, but have limited effectiveness in ensuring water or productive capability needed for survival.

In November 1996, the Government of British Columbia announced the creation of its new water use planning process. This initiative was, in part, a response to a public insistence that the government give greater consideration to the array of interests and stakeholders and involve them in water use decisions.

During the 1996 announcement, the government also announced a review of water licences at all BC Hydro facilities. BC Hydro holds 88 licenses, many of which were granted before 1962. Most of these do not have clauses or conditions relating to the protection of fish or fish habitat.

The goal was to develop Water Use Plans (WUPs) for all of its licences around the province with the southern interior, coastal and Vancouver Island areas to be addressed first. The process gives all interested parties the opportunity to explore the costs and benefits of changes to existing system operations and make informed choices about the balance between power and non-power (e.g., fisheries) values. Currently, draft WUPs have been submitted for the Alouette and Stave River watersheds, and there are WUPs consultations underway for the Campbell River, Coquitlam River, Cheakamus River and Bridge-Seton watersheds, with others to follow shortly. WUPs could be expanded to other non-BC Hydro water licences around the province and may prove to be effective tools in rationalizing licensed water use and protecting fish and aquatic resources.

The Council agrees with the crucial observations made by the authors of the background paper that it is important to define and enforce water requirements that conserve and sustain salmon. In some areas, this will encroach on existing water users. To minimize the effect, it is important for governments to help in the transition to more efficient and effective water use. The development of WUPs will help all stakeholders make this transition, especially in high water demand areas.

Water is a renewable resource, if managed as such. The water from annual precipitation is renewable but variable. Water from glacial melting is not renewable. Similarly, most ground water is not renewable unless it is recharged annually. For many watersheds, the amount of licensed water was set in an era when there was considerably more meltwater and groundwater than today. This means that as meltwater and groundwater decrease, the amount of over-subscription of water will increase, even without any new water use. However, water demand will increase with global warming, as it has with increased population and economic growth.

This situation illustrates why there has to be more cooperation to meet fish needs, and how there could be mutual benefit from developing a proactive water strategy to meet immediate and future needs. Fisheries and Oceans has demonstrated that it can get fish into the Fraser River, for

instance, but it needs help from other agencies, companies and the public to make sure the freshwater habitat has the quantity and quality of water for the fish to thrive there.

Sand and Gravel Management

The abundance and quality of gravel and other sediments within and adjacent to the spawning and rearing streambed is a prerequisite for the productivity of salmon.

The high levels of productivity formerly seen in many of British Columbia's chum, pink and sockeye populations were, in part, the result of the conditions of the spawning sediments, primarily gravel. Furthermore, coho, chinook and steelhead are normally not limited by the amount of spawning area, but by the amount and quality of the freshwater rearing habitat. Gravel, cobbles and boulders comprise their instream rearing habitats.

The foregoing information was presented to the Council in the background paper entitled *Sand and Gravel Management and Fish Habitat Protection in British Columbia Salmon and Steelhead Streams.* It was prepared at the Council's request by Mark Angelo and Marvin Rosenau to provide a basis of facts and analysis on a set of crucial and controversial issues.

The background paper made the point that, unfortunately, human activities have degraded many spawning and rearing streams over the last century by disrupting the stream processes that regulate the recruitment and revitalization of gravel and sediments. These activities include: mining for aggregate or minerals; damming of rivers; dredging for navigation and flood protection; and diking, armoring and straightening of rivers for the protection of property. The character and composition of the gravel and other sediments in streams are changed as a result of these activities, usually reducing or eliminating the characteristics that enable salmon to become productive.

Historically, the mining of sand, gravel and cobbles from streams by the aggregate industry, or placer mining, was conducted with little regard for fish. Sediment extraction from streams was a method used to provide flood protection by increasing the flow-carrying capacity of the stream. Usually, this occurred in areas adjacent to floodplains where normal water run-off would otherwise inundate properties. Over time, the line between flood proofing and extraction for industrial purposes became blurred.

There have been a number of collapses of salmon stocks in British Columbia subsequent to extensive instream extractions of gravel. These in-stream mining activities have caused losses in available spawning area. They have increased the levels of fine sediments that smother the river bottom, and decreased the quality and productivity of salmon rearing habitat.

It is recognized that sand and gravel are vital to economic and infrastructure development in the form of roads, buildings and other structures. However, the removal of sand and gravel from salmon streams has typically been having far-reaching biological, economic and social implications in lost fish productivity.

In many instances, sand and gravel are still mined from sensitive locations adjacent to or within rivers. Consequently, it is important that any new mines be located where they will not degrade fish habitat by interrupting stream processes or causing fine sediments to be entrained into a fish stream. For example, there is concern that the Pitt River sand and gravel mining operation, as it has been proposed, will not meet these requirements.

Human impacts on sediments, streambed structure, and fish habitat also occur as a result of dredging for navigational purposes. In British Columbia, this activity occurs in some of the more

important salmon streams, most notably, the lower Fraser River downstream from New Westminster. This dredging has degraded the streambed of the river in the shipping channels, but the full biological impacts are still not well understood. These activities affect fish habitats by changing the shape of the streambed. And, as many fish and aquatic insects are adapted to streambed shape, dredging likely affects their habitat productivity.

The construction of dams also affects the quality and abundance of spawning and rearing substrate in downstream areas. Damming of rivers normally stops the natural recruitment of larger gravel and sediments and causes the riverbed to become coarser and less desirable habitat. Furthermore, dams can reduce peak downstream flows so that the very fine sediments are no longer flushed out. Dams that are obsolete, insofar as their social costs outweigh their benefits, should be considered for decommissioning. For other dams, changes in their operations might resolve some of the gravel and sediment problems, as well as provide significant benefits to society, the environment, and even the owners of the dams.

The agreement to decommission the Theodosia dam near Powell River is a heartening step towards allowing a return of salmon to the river. The work of the participants, including Pacifica Papers, Sliammon First Nation, the Government of British Columbia, Fisheries and Oceans, Outdoor Recreation Council and others, shows what positive results can be achieved.

The Council has noted that people in British Columbia have encroached, as they have elsewhere, on floodplains where streams historically meandered and naturally flooded. Many of the waterways have been dramatically altered to prevent flooding, or to allow further development to occur. The spawning and rearing habitats are, without exception, affected by these projects. The detrimental effects must be reduced, and adequate salmon-rearing conditions must be restored through measures undertaken by federal, provincial and local governments.

Water planning should be conducted with reference to climate change conditions, specifically increasing average temperatures, varying water supply levels, and rising demand for water. With these added pressures, it is important to define and enforce salmon habitat quantity and quality conservation requirements, and take a precautionary management approach. In some areas, this could result in increased development costs, hopefully with the beneficiaries of the development paying for them. This prospect would also encourage shifts of projects to other, lower-impact areas. It is not the intent of the Council or of fisheries resource interests to increase the cost of sand and gravel or other services. At the same time, subsidizing these developments and users at the cost of fish production, fish habitat and other environmental values is not acceptable.

4.0 CLIMATE CHANGE ISSUES

A review of the October 27, 1999 workshop on climate change provided a valuable baseline for the Pacific Fisheries Resource Conservation Council to comment on the issues that arose at that event. Council members emerged from the workshop with a sense of apprehension and concern. Much of the available evidence about climate change illustrates disconcerting trends and influences that affect the viability of Canada's wildlife, traditional industries, and ways of life.

The risks associated with climate change are becoming more evident as Canadians observe, but do not clearly understand, the impact it appears to be having. Scientific knowledge is often unable to give immediate guidance to governments on the ways to mitigate the negative aspects of climate change that is associated with human activities. But, science provides a necessary set of rational boundaries within which climate change issues should be debated. The evaluation of evidence and cause-and-effect relationships can ensure that the issues are given full and fair consideration.

At the same time, the lack of absolute scientific certainty or the inability to identify every causal factor in climate change cannot be an excuse for government inaction where effects and evidence can clearly be inferred, even if not immediately proven.

The examples of the asbestos and tobacco industries and their claims of insufficient proof linking their products to health conditions have provided vivid illustrations of how scientific proof from research can lag behind the ability to make inferences from convincing, though not irrefutable, evidence. Government action in such conditions is justified by its adherence to the precautionary principle.

No one should underestimate the seriousness of climate change issues for salmon or other species. A great deal can already be inferred from what we know about matters such as the growth of greenhouse gases and their effects. Recognition of this issue in the Kyoto Accord, for instance, illustrates the stated intent and official commitment of governments to act more decisively.

What we are doing now in terms of polluting activities with direct environmental effects is speeding up the process and risking the creation of uncontrollable conditions in the near future. The prospects for survival of Canada's Pacific salmon may be determined largely by what can be done to counter the effects of human activities that are impacting climate change.

Fisheries scientists are still exploring the links between changes in ocean properties and the survival rate of salmon at sea where they spend much of their life. It appears that broad ecosystem variations associated with temperature changes are probably more important for salmon survival than the direct influence of physical variables like temperature on individual fish.

There is too much that we do not know about what happens in the ocean to project with any confidence the future conditions of individual fish stocks. Natural fluctuations in the presence and abundance of most marine species are the rule rather than the exception. Reasonable hypotheses for these fluctuations are not lacking, but few of even the worst fisheries collapses have been fully explained or their causes identified. Persistent changes appear to be particularly strong in a few coastal areas (Georgia Strait, Rivers and Smith Inlets), with some hints that north coast areas may soon be affected. Thus, much may be happening to fish as they disperse in the ocean and interact with their environment, but science does not now possess the powers of observation capacity and information storage to follow their fate.

From the Council's perspective, the most immediate and relevant issues of climate change are those that have an impact on salmon and conservation in the Pacific fisheries. Salmon serve as a bellwether of the more wide-reaching effects of climate change. It is crucial to maintain the perspective of this larger context and the impact on salmon and other species.

The impact on salmon serves as an indicator of the prospects for other species. Their sensitivity to temperature is widely recognized, and climate change seems likely to take a particular toll on their survival prospects ahead of others. Like the canary taken into a mine, salmon may be the precursor of problems that all of us will face as the consequences of climate change become more evident.

It is important that action on climate change should not be predicated only on mitigating the effects on salmon. Salmon is just one example, however important to this Council, of a species impacted by climate change. The effect on salmon should be recognized in terms of the entire ecosystem that is being influenced. This greater economic and social context should be a prevailing element in any research or government action that may be considered to assess climate change impacts on salmon.

Canadians need to know more about the impact of climate change and its effects on salmon and other species. That said, the reaction of calling for more research is not necessarily the priority. The members of the Council working in universities and research institutions have, to their credit, been the first to point out that merely spending more on research is not automatically going to generate solutions to mitigate climate change problems. More research can and will have considerable value, but this should not be the only response to the uncertainty and lack of knowledge about climate change.

The Council is concerned that, in a cumulative sense, the current research agendas of universities and government agencies may not be leading to the kind of information needed to cope with fisheries challenges that seem to be related to climate change. Some of the studies and on-going research appear to yield limited useful information about the correlation between climate change and fisheries. Clearer and more regionally specific projections of climate change are needed. Regional modeling and an assessment of the sensitivity of marine coastal areas will be necessary to get a firm grip on projected variability. Computer simulations may help, but they must be well based on observation if they are to be trusted.

Council members believe that new approaches to research will be required to begin measuring the impacts of climate change in ways that will enable governments and the Canadian public to understand and respond to the challenges.

Canadians will be fully supportive of government decisions based on the premise of the precautionary principle. Too many fundamental environmental changes related to human activities can never be undone, no matter how much money is spent after the fact. It would be unwise and a tragedy for generations to come if governments were to allow climate change to be accelerated merely because of the absence of absolute or irrefutable specific evidence in every instance. The validity of empirical evidence and the legitimate inference of facts should also be guiding standards for governments in such circumstances. Delaying action where reasonable evidence is available is not an acceptable or responsible alternative.

Fisheries and Oceans should begin to adopt management strategies that anticipate the climate change impacts from global warming. The department should initiate a dedicated task team on climate change to ensure that information is included to a sufficient extent in the management decisions that affect salmon.

In terms of immediate action, governments and individual Canadians have to become more seriously committed to reducing greenhouse gas emissions. There is no reason for confidence, given the level of effort and limited funding provided so far, that Canada will meet its Kyoto Accord commitments. This country may not even maintain its current greenhouse gas emission levels, never mind reduce them. Without more recognition of this issue and a combination of stronger sanctions and incentives, greenhouse gas emissions will take a serious toll in accelerating climate change and threatening fish populations.

5.0 PACIFIC SALMON TREATY ISSUES

In June 1999, Canada and the United States signed a new *Pacific Salmon Treaty.* The Council decided not to participate at that point in the highly charged public debate. Later in the year and in a more subdued atmosphere, however, the Council asked Dr. Randall Peterman of Simon Fraser University to review the key components of the *Pacific Salmon Treaty.* His background paper entitled *Review of the Coho and Chinook Salmon Sections of the "Agreement Under the Pacific Salmon Treaty" between Canada and the United States, dated 30 June 1999,* contained the evaluation of the Agreement's objectives and the new rules intended to achieve those objectives.

The Council specified a rigorous basis for the review's assessment of chinook and coho from a conservation perspective, requiring it to deal with four questions:

- Do the Aggregate Abundance Based Management rules as presented provide for an adequately risk averse, precautionary approach to management of chinook and coho salmon, keeping in mind Canada's commitment to biodiversity and maintenance of productive salmon populations?
- Do the rules create risks for maintenance of biodiversity? In particular, are there reasonable or probable abundance/survival scenarios (differential patterns of survival among stocks or stock aggregates) under which the rules would permit continued overfishing of any "evolutionarily significant" stock units?
- Under what survival patterns and/or enhancement regimes would the rules permit localized or regional overfishing?
- Will the rules permit recovery/restoration of historical biodiversity, or even maintain the status quo in terms of relative stock contributions to overall productivity?

Treaty Provisions

Both countries agreed to develop and implement an innovative management approach. For chinooks, this includes Aggregate Abundance Based Management (AABM), with total adult equivalent fishing mortality specified as a target catch index. This means that at low chinook abundance the fishing mortality would be reduced in highly mixed stock fisheries: Southeast Alaska troll, net, and sport fisheries; Northern British Columbia troll; Queen Charlotte Islands sport fisheries; and West Coast of Vancouver Island troll and outside sport fisheries. The parties also agreed to develop and implement a standardized regime for annual management.

For all other chinook fisheries, Individual Stock Based Management (ISBM) would be used. This involves a non-ceiling index computed pre-season and based on forecasted abundance and fishing plans. This will be evaluated post-season each year. There will be limits on fishing to sustain long-term production. A management framework based on total fishing mortality will be adopted in all fisheries by 2002.

The two parties agreed to implement assessment programs and to assemble and refine information on stocks and stock behaviour. Based on this information, the countries will establish cooperative management plans. It was also agreed to account for all induced mortalities and to halt declines in spawning escapements in depressed stocks, as well as review enhancement-related opportunities and issues. The joint technical committees of the Pacific Salmon Commission are crucial in the implementation process. The key to realizing the conservation potential of the Treaty will be goodwill between the parties.

Review Findings

The background paper prepared for the Council suggested that the Treaty is a positive step forward in many respects, particularly by creating procedures for adaptation of target catches based on pre-season and in-season estimates and by setting a framework for future conservation measures. It suggested that the Treaty was a substantial improvement over previous years when there was no agreement.

However, the paper pointed out that the new rules concerning the magnitude of reduction in catch do not seem sufficient to maintain some Canadian chinook stocks, let alone rebuild them in reasonable time when abundances are low or survival rates are poor. Based on the analysis, the Agreement's provisions for additional catch reductions when spawner abundance is low are not likely to be triggered frequently enough, or be sufficiently restrictive when needed.

The background paper commented on the Treaty by comparing it to five assumed elements of an ideal management system. Those elements and the evaluation of the Treaty's provisions in terms of fulfilling them are summarized as follows:

- **Well-defined objectives for harvest, conservation and biodiversity**
  The Treaty's goals are general, rather than precisely defined, and some aspects are still to be developed.
- **Effective indicators of abundance and productivity**
  Indicators of these are limited by the current state of knowledge and capacity to monitor stocks, so they are difficult to apply in practice.
- **Pre-specified adjustments to harvest in response to those indicators, so as to prevent conservation problems from developing, and to ensure prompt response when they do occur**
  The Agreement creates a formal procedure for revising target catches and a framework for implementing future changes. It also establishes mechanisms of uncertain effectiveness for reducing chinook catches by adequate amounts.
- **Effective monitoring and control of exploitation rates**
  This is limited by the capacity to monitor and the current state of knowledge.
- **Harvest rules that take uncertainty and variability into account**
  It is unclear whether or not catch reductions will be enough to maintain all Canadian stocks, and indicator stocks may not be representative of most populations in an area.

The Treaty fails to meet the test of several standards and commitments previously made by both countries in the United Nations Agreement on Straddling Fish Stocks and Highly Migratory Stocks. Specifically, there is no assurance that individual stocks can or will be conserved by the Treaty's provisions. On the positive side, the two countries have agreed to cooperate more closely and to strengthen regional fisheries institutions and arrangements in line with international requirements.

Council Perspectives

The Council reviewed the background paper and discussed it in detail with its authors and others who were knowledgeable about the Treaty and its implications. In terms of the four primary questions posed for the study, the Council was informed of the conclusions drawn by the author.

- The Aggregate Abundance Based Management rules provide increased protection, but not to sufficient levels under low abundance and survival conditions. Also, there are no provisions for climate change impacts.
- With the stated provisions and the limited number of indicator stocks that may not even be adequately representative, there are significant risks for maintaining biodiversity.
- The Treaty's provisions could, in some circumstances, result in local overfishing.
- The full recovery of historical biodiversity is not promoted by the Treaty.

Based on its review of the report, the Council found that progress towards basic conservation of stocks was not certain for all species. The rules for chinook and coho management include controls intended to apply when the total return is severely depressed.

The changes that seem to offer the most conservation improvement are the agreed operating processes, cooperative programs, and substantial new funding for research and conservation projects. The consequent improved knowledge and understanding could also aid conservation and management in geographic areas not covered by the Treaty.

The Council's consensus opinion is that the new Treaty is a significant improvement for conservation over the previous situation. The increased funding and cooperative arrangements in the Treaty should improve the conservation of all salmon species. However, the agreed arrangements alone will not ensure that the stocks are conserved or sustained. It is essential for the implementation process to address the following basic conservation needs:

- Clearer definition of conservation goals, including specification of spatial units, measurable targets, and specific time frames for reaching the goals.
- Data collected at an appropriate spatial scale and intensity to estimate directly how well those goals are being met.
- Precautionary management that adjusts catch targets to account for in-season abundance indices.
- Indicator stocks that reflect conditions of those that are most at risk and will trigger reductions in target catches to protect them.
- Appropriate limit reference points at which information on low abundance levels will trigger conservation measures.
- Indicators of variations and trends in survival induced by climate change.
- Rules that are proactive, as well as reactive, to reduce the likelihood that stocks could reach low-spawner thresholds.

6.0 CENTRAL COAST ISSUES

Mentioned earlier in this report was the decision of the Council to ask Allen Wood to prepare a background paper. The resulting report entitled *State of Salmon Conservation in the Central Coast Area* established a baseline of worthwhile, if somewhat disturbing, information and ideas.

The Council took the view that the Central Coast provides a good measure of the current state of domestic salmon populations and their management, and it is one of the few relatively undeveloped areas left on the coast that should be a more important contributor to salmon production. The background paper revealed several unique aspects of conditions and management practices in the area. It also provided a clear understanding of how the region serves as a microcosm of the circumstances facing salmon conservation initiatives across the entire province.

The paper cited the situation in the 1990s in which catches of all salmon species, except chums, had declined to the lowest levels since the commercial fisheries became fully operational. The scientific evidence, as well as information provided to the Council in its consultations, demonstrated that there is a conservation crisis in many salmon stocks in the Central Coast area.

Fisheries on the two largest sockeye stocks, in Rivers and Smith Inlets, are closed and total returns have continued to decrease. Fisheries and Oceans has attributed the reduction primarily to poor ocean survival. However, few stocks in the area have been adequately assessed. Spawner information provides the only indication of individual stocks, and spawner counts have changed through time. Catches are pooled by species and by fishery. There is not enough basic information on stocks or habitat in the area to be able to draw definitive conclusions about what caused the collapse of abundance.

The background paper explained that a number of factors make an in-depth evaluation of the Central Coast stocks impossible at this time. As well as a shortage of stock and habitat information, there are basic management uncertainties. It is unclear what constitutes the management units. Also unclear is when, where and how management action is triggered to address the region's conservation problems. Moreover, there is no consistent, long-term rebuilding plan to protect against loss of genetic diversity, or to identify, protect and renew depressed stocks.

The state of habitat information and monitoring impedes accountability and enforcement. Information shortfalls result in too much risk being taken on the basis of available knowledge. Many of these problems are a result of cutbacks in the financial and human resources assigned to the area by government agencies. The previously inadequate levels of monitoring and enforcement were reduced even further during the past decade.

Fisheries and Oceans staff, budgets, vessels and contracted patrolmen and guardians have all been substantially decreased as part of government downsizing. For example, the permanent staff located in the Rivers and Smith Inlet area was moved out, along with departmental patrol vessels and seasonal patrol and guardian staff. Biological staff has lacked the funds needed to conduct field investigations. Stock monitoring has been cut back and is now heavily reliant on community groups using temporary funding from various federal and provincial government agencies. By cutting budgets too far, both federal and provincial governments have been taking an excessively high risk.

The Central Coast review revealed more than a broad decrease in spawner abundance. In addition to this worrisome quantitative aspect, there were serious qualitative declines illustrated by the reduced average weight per salmon and average number of eggs being produced. The decreased

size also results in reduced survival of young fish. This problem appears to have been created over a long period, and it has been suggested that it is a result of size-selective harvesting and changes in competition between fish. The number of spawners would have to increase substantially to compensate for this decreased survival and maintain production levels. This problem applies across all salmon species.

The background paper presented a set of important findings with which Council members concur:

- Many salmon stocks in the Central Coast area are in conservation crisis, with some of those rated at risk of extinction.
- Decreased size of spawners is likely resulting in fewer eggs being spawned and lower survivals than in the past.
- Governments have taken excessive conservation risks by cutting fisheries program budgets in the area too far.
- There is insufficient knowledge of the causes of the precipitous decline in Rivers and Smith Inlet sockeye and other Central Coast stocks. Only with an effort to attain such knowledge can effective remedial action be taken.
- Without a long-term integrated management plan and a program to implement the plan in the Central Coast area, the severe problems cannot be addressed effectively.
- The fishing closures on the Rivers and Smith Inlet stocks must be continued and interceptions of these stocks in other areas should be prevented until a rebuilding has been achieved.
- Programs that are essential to provide crucial information include the fishwheel and tagging program to enumerate the escapement, measurement of the relative survival in clear and silted rivers, and ecosystem monitoring.
- The deferral of forest harvesting and other development in the area is an essential measure that will enable natural salmon productivity to be restored.

A compelling theme of the Central Coast background paper was that the government agencies with a conservation mandate have not been adequately monitoring stocks, habitats, fisheries and development projects. Their enforcement effort has also been insufficient to provide protection.

If governments are unwilling or unable to provide the resources necessary to meet their basic conservation mandate in the region, then the alternatives must include either implementation of other funding and delivery arrangements, or reduction of fishing pressure on the salmon stocks. Whatever course is selected, it should be driven by the precautionary principle and involve the mitigation of conservation risks associated with fishing and development that affects salmon habitat.

The information shortfall identified in the Central Coast applies to most coastal areas in British Columbia. New approaches are obviously required to address this shortfall. Implementation of a comprehensive and coordinated network of index fisheries, combined with key-stream monitoring and associated sampling, could provide much of the required information for both in-season and post-season assessment. Such a network should be implemented in the context of an integrated management plan.

7.0 STRATEGIC MANAGEMENT ISSUES

The Council noted a set of conditions and trends that are having particularly significant effects on the capability of governments to manage salmon stocks and the conditions that affect them.

Increased Change and Uncertainty

The 1990s has been a decade of persistent and unpredictable shifts affecting salmon and their habitats. There are indications that many of these changes are climate-related and will not only continue, but will accelerate. At the same time, conditions will be variable because of the interaction between long-term changes and shorter-term cycles. In the foreseeable future, temperatures are projected to reach new highs. There has been further variation in local weather conditions and in ocean temperature and productivity.

The impacts of these climate-related changes are being compounded in freshwater areas, by extensive deforestation, loss of riparian vegetation and increasing water consumption. These are evident in increased summer water temperatures, faster and earlier run-off of water, low water levels in the fall, decreased water quality, and less cover and food for stream-rearing fish.

The climate changes in the ocean are also amplified by influxes of warm-water predators and by lower levels of productivity in many instances. The stocks most affected are often battered further by harvest in mixed stock fisheries. This incidental harvest lowers the abundance of spawners and reduces the overall resilience of stocks to cope with habitat and climate stresses. It is uncertain how many of the salmon stocks in southern interior streams can survive these combined pressures. Stocks in other coastal and interior areas are under many of the same stresses.

There has been a considerable alteration of the fishing industry. In the past five years, the number of commercial licences has been reduced to half of those in 1995, and now each licence can be used only to fish a single area and gear. Because of licence stacking, the number of vessels allowed to fish salmon has been reduced to about 37% of the 1995 level (from about 4,365 to 1,644 vessels). Many fisheries have been drastically reduced in response to reduced salmon availability that resulted from decreased ocean survivals.

Many fisheries now must be stock-selective to protect those at highest risk. With some stocks more affected than others, the need for more stock-selective harvest has increased. This has necessitated new fishing gear and fishing restrictions, as well as the collection of additional information on stocks and their behaviour and survival.

Climate changes appear to be making previously sustainable habitat conditions unsustainable. For instance, alterations in the timing of water run-off patterns have begun to threaten the survival of some salmon stocks. It may also be increasing the demand for water for irrigation and the potential for forest fires.

There is a pressing need for more basic information on the salmon and their habitat in the early ocean, freshwater, and open ocean life stages. As well, better information on survival patterns, abundance, behaviour, and harvest is essential for stock-specific management. A better understanding of the biological implications of various methods to increase salmon survival is required to enable the management tools, such as fishing limits and habitat restoration, to be used to address current and emerging problems.

Multi-Agency Involvement

Broad ecosystem issues extend beyond the mandates of individual government agencies. Problems must be addressed in the context of ecosystems in order to sustain living resources and a livable environment for salmon. Moreover, climate change and its impacts can only be understood in this larger context.

The current patchwork of mandates, shared between levels of government and among agencies that are competing for resources, is a formula for continued failure. No current accountability process effectively addresses this problem that permeates intergovernmental and interdepartmental issues. There are few, if any, incentives for agencies to cooperate rather than compete.

There should be a common plan for each major watershed and area involving prioritized projects and schedules, as well as clear accountabilities and expectations of results. Agencies working together with common objectives for the benefit of salmon would be more likely to achieve their results than if they continue to work primarily in isolation.

Knowledge Gaps

Experience and historical data has traditionally provided the basis for managing habitat and fisheries. However, many new, unexpected conditions in this decade have emerged, and events have occurred that are inconsistent with experience and previous observations. This means there is less relevant experience on which to base management decisions about possible intervention to help salmon stocks. For example, it had been assumed that survival in the freshwater habitat was the primary determinant of overall salmon survival and production. Consequently, most research was focused on the freshwater life stages.

Now more than ever, information on the ocean life stage is required to understand what is happening. While there has been considerable research on oceans and climate, there has been very little on the impacts of climate change on fish. Little is known about the inner coastal ecosystems where juvenile salmon mortality appears to have increased significantly in the 1990s. Critical knowledge gaps that reach across the mandates and interests of a number of agencies are becoming more apparent and worrisome.

There are also important knowledge gaps on: salmon stock constituents; genetic selection impacts of harvesting and culturing; species interactions and interdependencies within ecosystems; capabilities to cope with climatic extremes; and reactions under stress conditions, such as disease. Other knowledge gaps relate to long-term effects of development activities on salmon ecosystems.

The narrow scope and limited scale of current scientific work is not adequate to address many of these knowledge gaps that have great significance for salmon conservation. Over the years, the trends in salmon productivity have not been tracked well enough to provide the essential understanding of the most fundamental cause-and-effect relationships in all of the various life stages. Consequently, small problems have become big problems.

Public Involvement

The Council has been heartened by the extensive work being done in salmon conservation by volunteer groups and dedicated individuals across the province. The expansion of that activity and public involvement should be a vital component of future conservation policy.

A number of federal, provincial and municipal agencies each have a part in the broad sustainability mandate. The many stakeholders, including fishermen, developers, First Nations and salmon advocacy groups, all have a vital role to play in salmon conservation. Creating a common vision of the salmon resource and establishing workable partnerships among all the groups involved in its future are crucial tasks. Working together is the only way to begin rebuilding and implementing an effective salmon conservation strategy and plan.

The barriers to cooperation and coordination between levels of government and between agencies can be overcome. However, their many programs, planning, attitudes, and funding mechanisms must be adapted to get the required levels of cooperation and coordination with public groups.

It will be important to deal with one controversy in particular that has recently become evident. Although prevention of habitat damage is cheaper and more effective than restoration, most expenditures seem to be going into restoration projects. The Council was told in its consultations that both restoration and preventative work could be done more effectively. Lack of enforcement and monitoring resources to prevent damage is leading to an ever-growing series of habitat problems and expanding need for habitat restoration. Governments naturally tend to favour restoration projects, instead of prevention, because they provide more direct jobs and have a higher public profile.

Summary

A crucial challenge in salmon conservation will be to retain as many stocks as possible in the face of the high risks to biodiversity. Even with international actions to reduce greenhouse gases, conditions are unlikely to return to levels and patterns more favorable to salmon production. The number of salmon spawning populations that can be sustained is highly dependent on crucial factors, such as riparian vegetation, reforesting watersheds, water management arrangements, and stock-specific harvesting. It is also dependent on whether or not the public considers the salmon resource important enough to be worth the effort and restraint necessary to nurture it.

Despite the uncertainties generated by larger issues such as accelerated climate change, much can be done, including:

- taking a long view rather than short-term fixes;
- applying the precautionary principle;
- managing stocks to preserve biodiversity;
- promoting public understanding of the critical issues that affect fish survival;
- researching at least the most critical issues and geographic areas; and
- taking special measures to address at-risk stocks.

Protecting and managing salmon resources is a complex task. The thousands of spawning populations, for instance, respond differently to harvesting and habitat impact. However, it is not possible to manage each spawning population separately because many are fished together and because there is not enough basic information to assess the productivity of each of them and its habitat.

Highly variable salmon returns, changing environmental conditions, and lack of information all contribute to generally poor preseason predictions and difficulties in management responses.

This, in turn, requires a reliance on in-season measurement of abundance, stock mix and catch as a basis for management decisions. But in many cases, such measurements are neither reliable nor is essential information available. In such circumstances, the precautionary principle should prevail.

The catch allocation process has often compromised conservation to achieve positions of equity among the various fishing groups. These include international fisheries, Aboriginal fisheries in-river and in the ocean, sport fisheries in the ocean and in fresh water, commercial fisheries with three competing gear groups, and fishers in different areas all competing for catch. An added complexity has been the use of technology to increase the catching power of all types of competitive fisheries. In other fisheries, there has been a trend to reduced competition.

In order to address such complexity all the various interests must begin to buy into a common plan that includes a pre-eminent conservation component. Without such a coordinated approach, there will be deeper erosion of salmon stocks and further fisheries closures.

8.0 FINDINGS AND RECOMMENDATIONS

No one has failed to notice the persistent problems and series of crisis conditions that have been plaguing salmon in British Columbia. The risks and uncertainties they face have increased, and more effective work needs to be done by everyone concerned about the future viability of Pacific salmon and their habitat. The solutions, however, will not be easily achieved.

Contained throughout this report are suggested measures that could be taken by governments and stakeholders involved with salmon stocks and their habitat. In presenting its advice and recommendations, Council members emphasize that, in many instances, it will take strong and visible public support for these measures to convince government officials that they should accept and implement them. The Council continues to take the approach described in last year's *Annual Report:* "...the Council will be effective only if it maintains its work with the broad cross-section of fish conservation advocates who continue to be vocal, active and passionate on behalf of fish and their habitat."

The Council provides the following synopsis of recommendations taking into account the natural, policy and program environments for salmon conservation in British Columbia.

1. Coping with Declining Populations

A more effective process is required to identify and respond to stocks in decline and at risk. This requires meeting basic assessment needs with consistent information about the stocks and their habitats at all life stages. The Council recommends: (a) continuing the firm fishing restrictions on Thompson coho and Rivers and Smith Inlet sockeye; (b) firm fishing restrictions on Upper Skeena coho in the absence of solid evidence of continuing improved marine survival; (c) comprehensive monitoring of potentially depressed stocks; (d) research on causes of declines in marine survival; (e) attention to issues surrounding declines in adult body size; and (f) where required, addressing habitat issues that pose a risk to the survival of stocks.

2. Improving Habitat Conditions

The provincial government should evaluate the potential of a developer-pays approach to fund necessary conservation activities associated with each development project. This should include identifying the baseline habitat conditions in relation to fish requirements that are essential for protecting habitat and evaluating development effects. Allowance should also be made for public involvement and stewardship to help address existing problems and prevent further habitat deterioration.

3. Coming to Terms with Climate Change

Greenhouse gas emissions pose a substantial risk of irreversible losses to Pacific salmon. Immediate actions are required to reduce these emissions at least to levels agreed in the Kyoto Accord. A multi-agency approach is vital to understand and act upon climate change effects on fish and fish habitats, as well as shared use of habitats.

A task team should be used by Fisheries and Oceans to ensure that key aspects of climate change are given full weight in fisheries management decisions. Research should focus increasingly on unravelling the ecosystem dynamics and ocean conditions that have resulted in decreased production. An interdisciplinary workshop could be used to re-focus research priorities.

4. Utilizing the Pacific Salmon Treaty

Canada should act to increase the effectiveness and responsiveness of the Treaty in protecting stocks. This should include monitoring more indicator stocks and negotiating more sensitive

conservation triggers. The key is to maintain a cooperative working relationship and goodwill in the Treaty process to make as much joint progress as possible while working towards meeting clear Canadian conservation requirements.

5. Addressing Central Coast Challenges

The relatively undeveloped Central Coast area should be managed with the purpose of rebuilding its salmon production capacity. A network of index fisheries and index streams would provide a starting point to meet basic information needs. It should be designed to provide measures of stock-specific abundance in fishing and spawning areas. This network should be supplemented by monitoring conditions that affect juvenile salmon rearing in freshwater and coastal habitats. A task force, with specific accountabilities, schedule and public involvement to address the region's issues, is recommended.

6. Levering Management Resources

In this period of change, uncertainty and risk, management on a precautionary and more stock-specific basis is essential. This will require more information on individual stocks, and better in-season measures of total stock and spawner abundance, stock identification and interception. It will require information about development and climate change impacts on habitat. Public awareness and involvement are essential to reinforce environmental stewardship. To address broad ecosystem issues, agencies and public groups will have to have the resources to work together in common plans. Governments should make more effective use of existing resources and provide the necessary additional resources and/or implement other funding and delivery arrangements.

9.0 EMERGING ISSUES

The Council has identified the following important conservation issues that it will address on a priority basis.

- Consideration of the specific elements of a comprehensive and coordinated **conservation strategy** will be part of the Council's agenda. This will include advising on the new Fisheries and Oceans **Wild Salmon Policy** that is the subject of public consultation. The Council intends to provide its views particularly on ensuring the protection of salmon biodiversity.
- The severely depressed **state of steelhead** in the Georgia Basin and the lack of basic information on the stock's status in many areas are matters that the Council intends to consider in specific terms.
- A number of concerns about **hatcheries and salmon farming** have come to the Council's attention. These will be reviewed particularly in conjunction with the issues related to wild salmon.
- **Climate change** will continue to be a subject for the Council's consideration, and will constitute an element of the work plan during the coming year.
- **Water use** will be given particular attention. This will involve building on the research that was recently prepared but not yet reviewed in detail.
- **Research strategies** have been discussed by the Council on several occasions, and will be the subject of further consideration in terms of how the information needs for analysis and management purposes can be satisfied.

During the coming year, the Council will continue to fulfill its mandate by sponsoring research, providing public information, supporting conservation-related events, and conducting extensive consultations across the province.

APPENDIX 1. COUNCIL MEMBERS AND PARTICIPANTS

Chairman

The Honourable John A. Fraser, PC, OC, OBC, CD, QC, LLB
Chairman, Pacific Fisheries Resource Conservation Council

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 21 years in the House (1972–93), Mr. Fraser served in a number of positions, including Minister for the Environment and Minister of Fisheries. He is the first person to have been elected Speaker of the House of Commons by his peers, a practice instituted in 1986. In 1988, the honour was confirmed with his re-election to a second term. Among his accomplishments as Speaker were the establishment of the Central and Eastern European Parliamentary Cooperation Program; the creation of the House of Commons Public Information Office; the establishment of the House of Commons Environmental Program, Greening the Hill; and the establishment of the Task Force on the Disabled and Handicapped, to ensure access and employment opportunities on Parliament Hill. He also commissioned the publication *The House of Commons at Work.*

In 1994, Mr. Fraser was appointed Canada's Ambassador for the Environment. In this role, he was responsible for Canadian follow-up to commitments made at the United Nations Conference on Environment and Development, held in Rio in 1992, and other related events, such as liaison with international bodies, federal departments, provincial governments, the private sector, academic institutions, community groups and interested individuals. In September 1998, Mr. Fraser was appointed Chair of the Pacific Fisheries Resource Conservation Council. The Council is an independent body that reports annually on the status of British Columbia's salmon stocks, their habitat and related ecosystems.

Mr. Fraser serves on many domestic and international bodies. In Canada, he is Chair of the Minister's Monitoring Committee on Change in the Department of National Defence and the Canadian Forces, and of the Parliamentary Buildings Advisory Council. He is a member of the International Institute for Sustainable Development, the Advisory Committee for Protection of the Seas and the Kitlope Management Committee.

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

Members

Mr. Mark Angelo, OBC—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. Mr. Angelo is a recipient of the Order of British Columbia, in recognition of outstanding achievement in river conservation. He was also the first recipient of the Ten-Year National River Conservation Award as Canada's most outstanding river conservationist in the past decade. Mr. Angelo's involvement with river conservation in British Columbia spans two decades, and he has published articles and editorials on the issue. He speaks regularly at conferences throughout Canada and in other parts of the world.

Ms. 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 Seymour

Salmonid Society and actively involved in public education. She is also a North Shore Streamkeeper. Ms. 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.

Mr. 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. In 1972, when he earned a Bachelor of Commerce in economics from the University of British Columbia, he began working for Ocean Fisheries full-time. He is a licensed Ship's Master and, in his present position, is responsible for the company's fishing fleet. Mr. Chatwin oversees all salmon, herring and groundfish operations in British Columbia. He 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, 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.

Mr. Terry Glavin—Terry Glavin is a writer and conservationist from Mayne Island, British Columbia. He is the recipient of several prestigious literary awards for works including *Dead Reckoning—Confronting the Crisis in Pacific Fisheries* (Greystone Books/David Suzuki Foundation, 1996); *A Ghost in the Water* (New Star-Transmontanus, 1994); *Nemiah—The Unconquered Country* (New Star, 1993); and *A Death Feast in Dimlahamid* (New Star, 1991). Mr. Glavin writes a regular column for the *Globe and Mail* and is a frequent contributor to *Canadian Geographic, Canadian Forum,* the *Georgia Strait,* and other publications. He has also served on a number of fisheries-related foundations.

Dr. Paul H. LeBlond, FRSC—Paul LeBlond holds a Ph.D. in physics and oceanography from the University of British Columbia, a B.Sc. in maths 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. Dr. LeBlond is a Fellow of the Royal Society of Canada.

Dr. Richard Routledge—Richard Routledge is Professor of Math and Statistics at Simon Fraser University. He holds a Ph.D. in statistical ecology from Dalhousie University, an M.Sc. in statistics from the University of Alberta, and a B.Sc. (Honours) in math and physics from Queen's University. Dr. Routledge is currently involved in the development and use of random models and statistical inference techniques with emphasis on applications to populations ecology and renewable resource management. He is the recipient of numerous academic grants, including a research grant from Natural Sciences and Engineering Research Council. He is a member of the Institute for Fisheries Analysis at Simon Fraser University.

Mr. B. Donald Ryan—Donald Ryan has been Director of Significant Progress for the Gitxsan First Nation, based in Victoria, since 1999. From Hazelton, BC, Mr. Ryan was the Chief Negotiator of the Gitxsan Treaty Office from 1994. He also served as Co-ordinator for Watershed Authorities from 1992 to 1994, as the Speaker for the Office of Gitxsan Hereditary Chiefs from

1987 to 1992, and as Executive Director for the Tribal Council from 1981 to 1987. Mr. Ryan also serves as the President of the Company of Gitxsan Houses Trading, a subsidiary of the Gitxsan Resources Trust. The Gitxsan is a First Nation whose territory is located in northwestern British Columbia.

Dr. Carl Walters, FRSC—Carl Walters is a Professor in the Fisheries Centre and of Zoology at the University of British Columbia. He holds a Ph.D. and MS from Colorado State University in Fort Collins, CO., a B.Sc. from Humboldt State College in Arcata, CA, and 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 to behave adaptively in the face of extreme uncertainty. Dr. Walters also maintains an active field research program on recreational fisheries in the British Columbia interior.

Ex-Officio Members

Dr. Richard Beamish, C.M.—Richard Beamish is Senior Scientist at the Pacific Biological Station of Fisheries and Oceans Canada in Nanaimo, BC; 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 very 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. Dr. Beamish is a graduate of the University of Toronto. He is an Affiliate-Professor at Malaspina University College, Nanaimo. In 1998, he was named a Member of the Order of Canada for his contributions to fisheries science.

Mr. 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. The Secwepemc know his Peoples as the Simpc, or "the people up-river." He is Chairman of the Shuswap Nation Fisheries Commission, the Columbia River Inter-tribal Fisheries Commission in his territory and the British Columbia Aboriginal Fisheries Commission, where he is responsible for the regional co-ordination of information and policy associated with aboriginal fisheries in BC. Mr. 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. He has played a leadership role in related work with the Convention on Biological Diversity. Mr. Fortier sits on the Board of the Global Indigenous Knowledge Program, the World Fisheries Trust and the Pacific Coast Sustainable Fisheries Strategy.

Council members wish to express their special thanks to Sheila-Marie Cook for her valuable contributions of expertise and advice. They also wish to acknowledge the contributions of: Kenneth Beeson, Austin Cabral (PWGSC), Malcolm Metcalfe, Glenda Thomson and Allen Wood.

APPENDIX 2. OBJECTIVES AND MANDATE

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

Reports produced by the Pacific Fisheries Resource Conservation Council since its inception are available on its web site at www.fish.bc.ca.

Background Papers

Angelo, Mark and Marvin Rosenau. *Water Use Planning: A Tool to Restore Salmon and Steelhead Habitat in British Columbia Streams.* Pacific Fisheries Resource Conservation Council, Vancouver. Background Paper No. 2000/1

Peterman, Randall and Brian Pyper. *Review of the Coho and Chinook Salmon Sections of the "Agreement Under the Pacific Salmon Treaty" between Canada and the United States, dated 30 June 1999.* Pacific Fisheries Resource Conservation Council, Vancouver. Background Paper No. 2000/2

Rosenau, Marvin and Mark Angelo. *Sand and Gravel Management and Fish-Habitat Protection in British Columbia Salmon and Steelhead Streams.* Pacific Fisheries Resource Conservation Council, Vancouver. Background Paper No. 2000/3

Wood, Allen. *State of Salmon Conservation in the Central Coast Area.* Pacific Fisheries Resource Conservation Council, Vancouver. Background Paper No. 2000/4

APPENDIX 4. GLOSSARY

Alluvial processes:	in-stream processes by which flowing water deposits sediments
By-catch:	unintended catch of a species; interception of a species or stock that a fishery is not intended to catch
Catch-and-release stress:	trauma to fish from being caught, handled and released
Climate change:	changing average temperature, precipitation, and weather patterns
Depressed stock:	a stock with an abundance or production rate that is significantly below its expected average capability
Enhancement:	man-made improvements to natural habitats or the application of artificial fish culture technology intended to lead to the increase of abundance of salmon stocks
Escapement:	the number of fish escaping from a fishery; the escapement from all fisheries is the spawning population
Freshet:	the increased stream flow resulting from the spring thaw or heavy rain
Habitat:	the area in which an organism would normally be found
Index fishery:	a standardized fishery with controlled effort to provide a consistent measure of fish abundance
Index stream:	a stream that is monitored as being representative of other streams in an area
Index stock:	a spawning population of fish that is monitored as representative of other populations of the same species in an area
Interception:	catching fish from an area or stock on which that the fishery is not targeted
Limit reference points:	specified conditions, such as low abundance of spawners, that are at unacceptable levels to the extent that they trigger conservation measures as they are being approached
Living gene bank:	a captive brood stock program designed to protect the genetic composition of a spawning population in living fish by reducing natural mortality
Over fishing:	harvesting more fish than a population can sustain, with a consequence that the future production decreases
Precautionary principle:	erring on the side of caution and conservation: the greater the uncertainties are, the more that harvests and other impacts should be reduced to diminish conservation risks
Remnant abundance:	a spawning population that has decreased to such a low abundance that it may not be genetically viable
Risk averse management:	a management system weighted in favor of conservation of stocks.

Salmonid:	a category of fish that includes salmon and steelhead
Scale analysis:	assessment of the pattern of rings on salmon scales to determine age, growth rates at different life stages, and possibly home watershed
Spatial scale:	the area over which sampling data are pooled; ideally scale would be representative of individual stocks
Spawning:	the act of fertilizing and planting fish eggs
Stock:	a genetically similar group of fish, usually returning to a specific geographic area.
Stock assessment:	determining the population dynamics of a stock as a basis for deciding conservation, management and restoration strategies
Total stock:	spawners plus catch; all of the returning adult fish
Watershed:	an area or region drained by a river and its tributaries; also known as a drainage area
WUPs:	Water Use Plans

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