Pacific Fisheries Resource Conservation Council

State of Salmon Conservation in the Central Coast Area:

Background Paper

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May 2000

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Wood A. 2000. **State of Salmon Conservation in the Central Coast Area: Background Paper**. Vancouver, BC: Prepared for the Pacific Fisheries Resource Conservation Council.

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Printed and bound in Canada

ISBN 1-897110-09-X

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1. EXECUTIVE SUMMARY

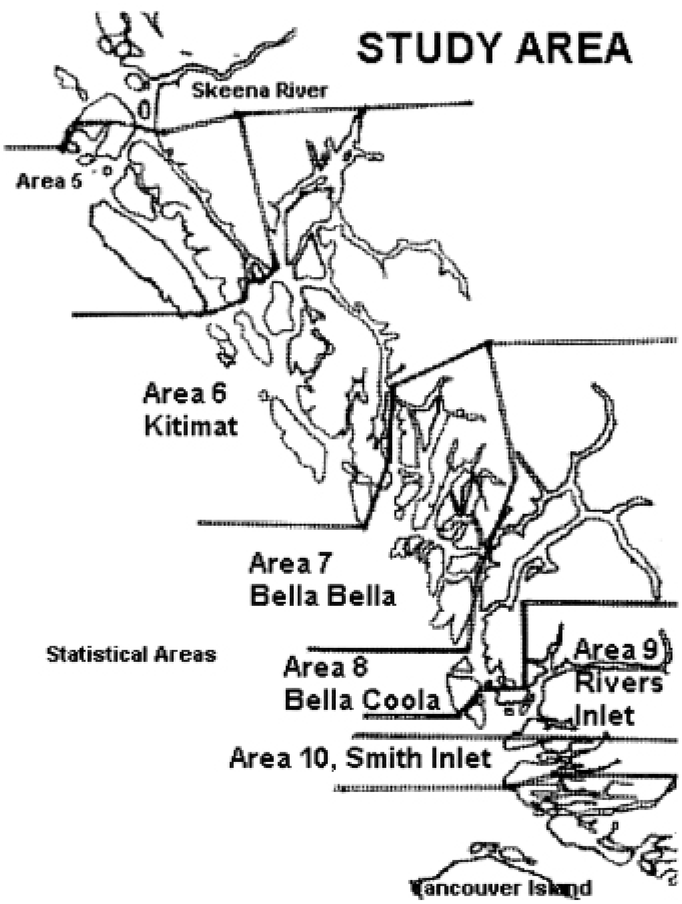
Areas 6–10 of the Central Coast were selected for study because this region provides a good measure of the current state of domestic stocks and their management. Also, this is one of the few relatively undeveloped areas left on the coast.

- Many salmon stocks in the study area are in conservation crisis. In the 1990s, catches of all species except chums declined to or below the catch levels of the early 1900s.
- Fisheries on the two largest sockeye stocks, in Rivers and Smith Inlets, are closed and total returns have continued to decrease. Immediate and comprehensive actions are required to restore these stocks.
- In some areas up to 25% of stocks have been rated at risk of extinction.
- There is not enough basic information about stocks or habitat in the area to be able to say conclusively what caused the collapse of salmon abundance. Catches are pooled by species and by fishery. Spawner information provides the only indication of the state of individual stocks, but counting methods have been inconsistent. Few stocks in the area have been assessed. Little is known about freshwater or ocean habitat productivity.
- The average weight and fecundity of salmon has decreased substantially. While the causes of decline are unknown, the ramifications for the fisheries and habitat management are certain to be important.
- The basis for management of population units is unclear: At what point should the level of spawner abundance be considered a conservation concern as opposed to a production concern?
- There is no consistent, long-term rebuilding plan to protect against loss of genetic diversity or to identify, protect and rebuild depressed stocks.
- The state of habitat information and monitoring impedes accountability, enforcement and compensation for damages.
- Fisheries and habitat management risks are excessive and increasing because of chronic information shortfalls.
- Many of the above-noted problems are a result of cutbacks in financial and human resources, which consequently limit basic monitoring and enforcement, and impose excessive management risks.
- With the limited information about Areas 6–10, there are likely more problems that have not yet been identified.
- Current strategies and programs cannot be effective at conserving stocks.

2. The Central Coast Study Area

The Central Coast study area (Fig. 1) spans 275 kilometres, from Kitimat in the north (Area 6) to Smith Inlet in the south (Area 10). The area is a maze of islands and inlets that reach from the outer coast into the Coast Mountains. Central Coast fisheries do not intercept US stocks of sockeye, pink and chum salmon, and US fisheries are not known to intercept Central Coast stocks. Consequently, this area has been excluded from Canada-US salmon treaty negotiations. As a result, there have been no programs to provide information on these stocks for salmon treaty negotiations. In short, the state of stocks in this area is strictly a result of domestic policy and management. The area is south of fisheries for Skeena River stocks and north of fisheries for Fraser River stocks, so management focuses only on Central Coast stocks. As such, the area is a good indication of the current state of domestic stocks and their management.

Figure 1. Study Area



The Central Coast is one of the few relatively undeveloped portions of the British Columbia coastline. A few watersheds have been logged and more logging is planned. Industrial and urban developments are limited mainly to the Kitimat and Bella Coola valleys. A Land and Coastal Resource Management Planning process is underway to plan for future land and resource use in the area.

There are more than 1,700 separate spawning populations of salmon in the Central Coast area. It is not yet known how many of these populations are closely related or are parts of distinct genetic stocks.

In the Central Coast, the catch of all salmon species except chum (Fig. 4) is down significantly from both long-term and recent levels. Chinook (Fig. 2) and coho (Fig. 3) catches have been in decline since the early 1970s. Pink (Fig. 5) production has tended to cycle, but the decline of the 1990s has taken the catch down below levels of the 1910s, at the start of the fishery. Sockeye catches (Fig. 6) in the 1990s decreased to below levels of the 1890s. Fisheries on the two largest sockeye stocks, in Rivers and Smith Inlets, are closed and total returns have continued to decrease. Long-term steelhead catches (Fig. 7) in the commercial fishery have also decreased to new lows, only in part because of recent conservation actions. Only chums have not exhibited a marked decline to new low levels. They are at the same level of abundance as in previous low periods.

3. HISTORIC CATCH

Until the 1950s, Areas 5–8 and 9–10 were managed as separate units, each with pooled catch statistics. Early in these fisheries, low catches often resulted in low harvest rates rather than low stock abundance. Historic catches by species for each area are as follows.

Fig. 2 illustrates the chinook catch in Areas 5–8 and 9–10. Catch in both areas increased in the 1960s, peaked in the 1970s and declined through the 1980s and 1990s. Local catches are now at the same levels as 100 years ago. Chinook and coho are intercepted in many areas along the coast, so local catches don't necessarily reflect the state of local stocks.

Figure 2. Study Area Chinook Catch

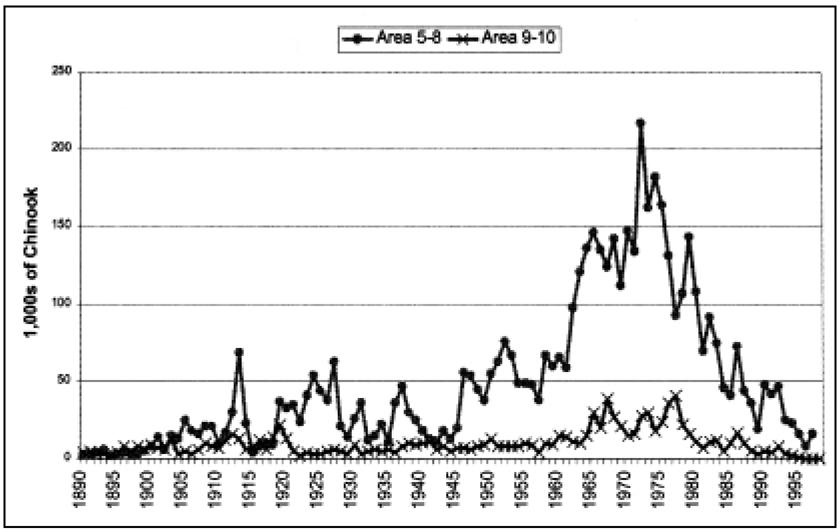


Fig. 3 is the coho catch in Areas 5–8 and 9–10. As is the case for chinook, coho catch in both areas has declined to 1900s levels. The figure shows similar timing of production spikes. Coho and chinook catch increased in the late 1960s and 1970s at similar times, suggesting a common factor, such as increased ocean survival or increased fishing effort.

Figure 3. Study Area Coho Catch

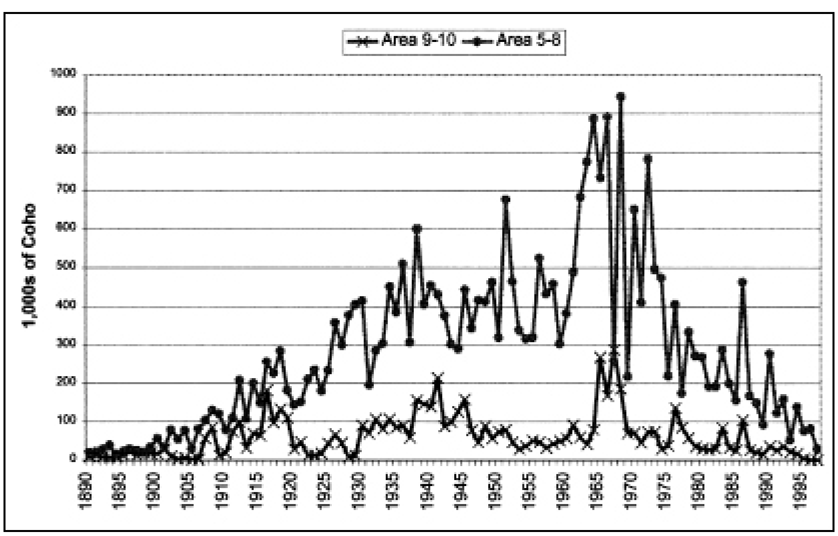


Fig. 4 shows the Central Coast chum catch. Chum stocks in Areas 9–10 are minor compared to those in Areas 5–8. Chums appear to have gone through four productivity cycles, starting in the 1920s. They now seem to be in the low part of a cycle. The Areas 9–10 chum catch has declined significantly from levels in the 1930s to 1970s.

Figure 4. Study Area Chum Catch

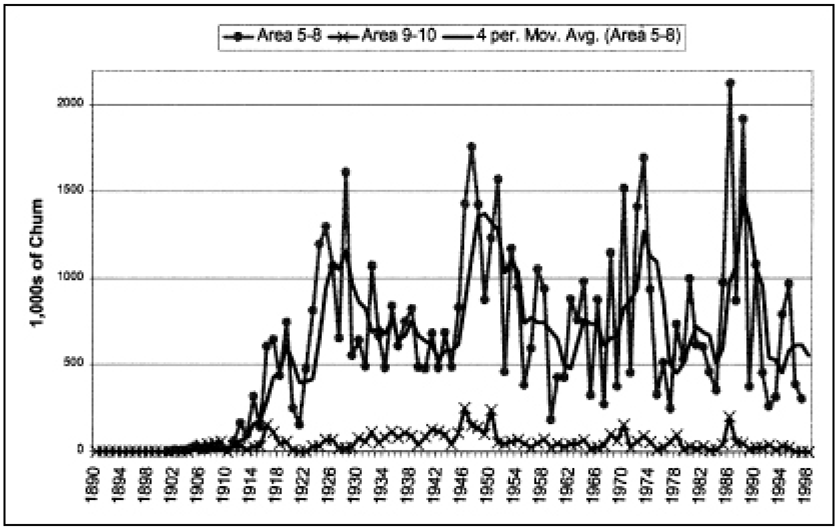


Fig. 5: Since 1993, pink salmon catches in Areas 5–8 have dropped to an average of less than 700,000 and in Areas 9–10 to less than 10,000. In Areas 5–8, from the 1930s to 1950s, there was no clear dominance between even- and odd-year abundance. From the 1960s to 1990s, even-year stocks were dominant, except for a few years in the 1980s when odd-year stocks were dominant. Since the mid-1990s, dominance and associated high productivity have disappeared.

Figure 5. Study Area Pink Catch

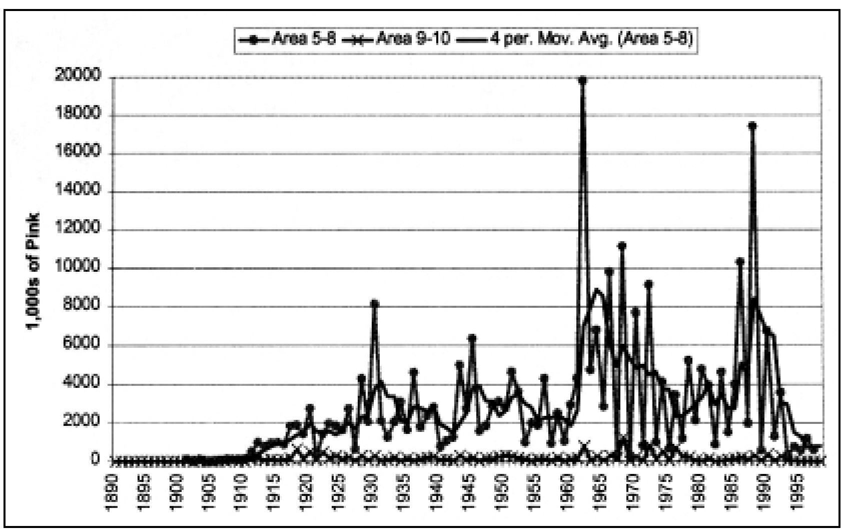


Fig. 6: The Areas 9–10 average catch was 1.2-million sockeye from 1900 to 1974. Since 1975, catches declined until, in 1996, Area 9 was closed and, in 1997, Area 10 closed. Areas 9–10 sockeye catch is more than twice that of Areas 5–8. The Areas 5–8 catch shows a long, slow decline. The catch in 1990–99 is 60% of the 1900–1909 catch and less than 50% of the 1920s catch.

Figure 6. Study Area Sockeye Catch

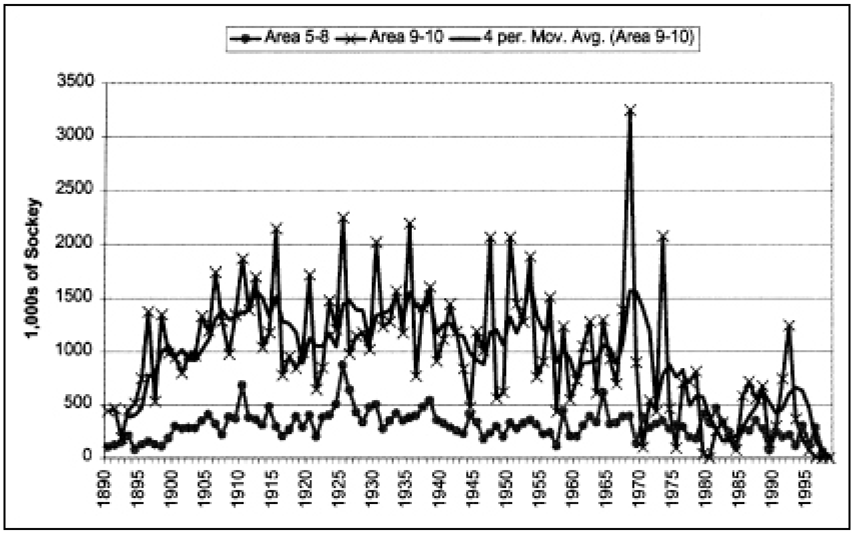
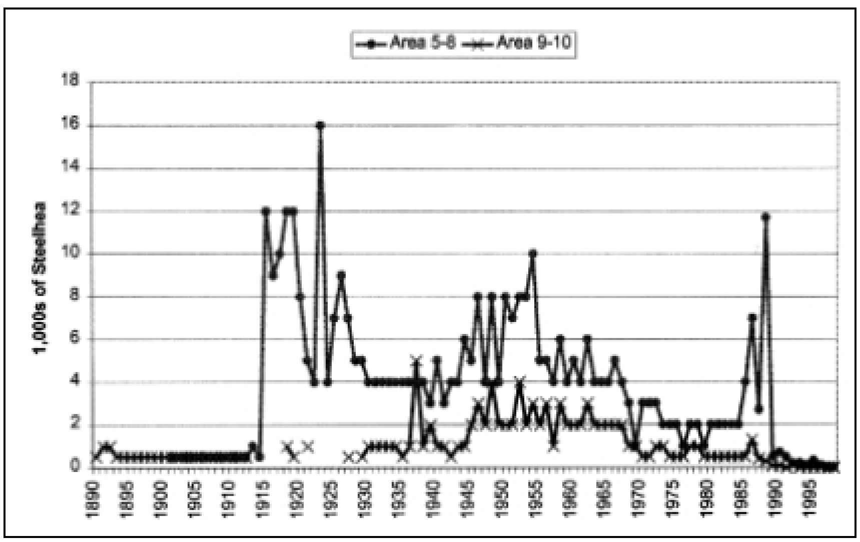


Fig. 7 shows steelhead catch in the commercial fishery. Catches in both Areas 5–8 and 9–10 have fallen off since the 1950s. The harvesting of steelhead in the commercial net fishery was de-emphasized in the 1990s, contributing to at least part of the decreased catch in the 1990s.

Figure 7. Study Area Steelhead Catch

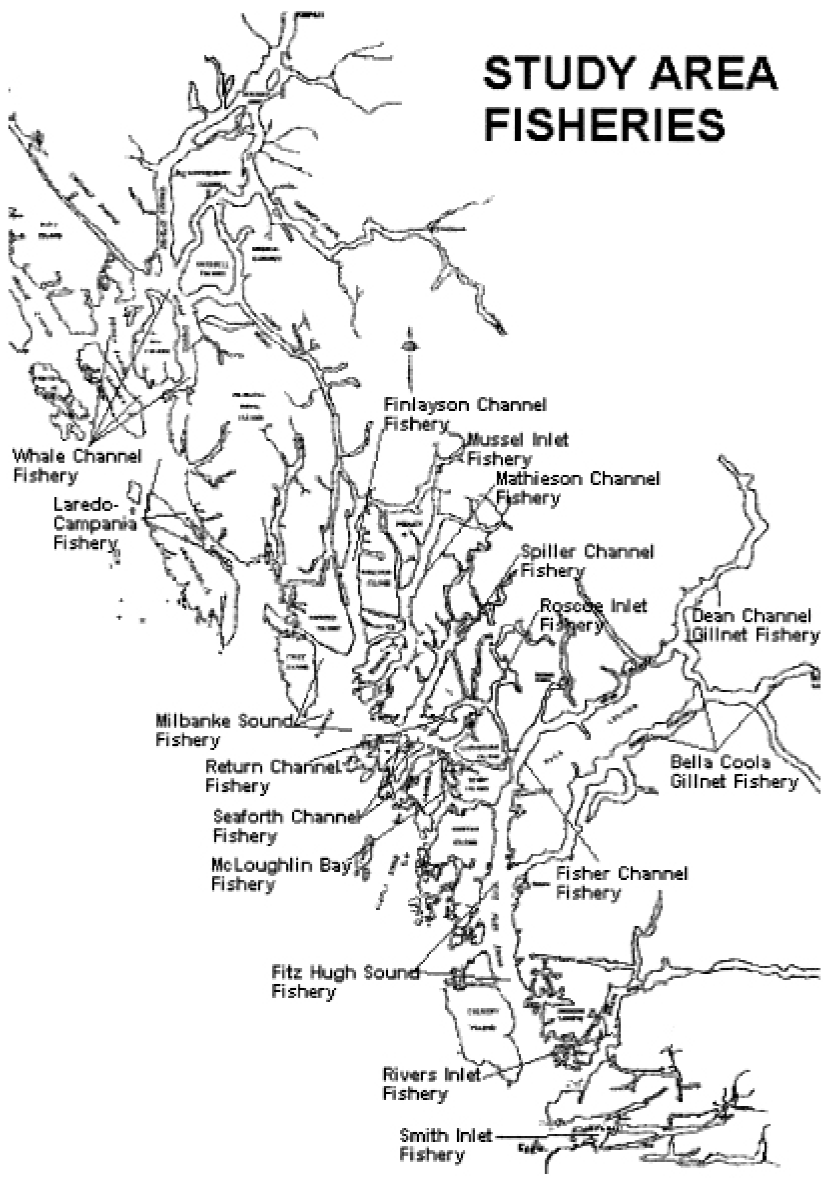


The bottom line is that, in the 1990s, catches of all species except chum have declined to or below, the levels of catches in the 1900s.

4. Study Area Commercial Net Fisheries

The following fisheries have been active in the last 20 years (see Fig. 8).

Figure 8. Study Area Fisheries



Whale Channel Fishery: A major interception/mixed stock fishery; once fished intensively for all species over four to six months a year during the 1960s; now for only a few days over one month. Seines target pinks and chums, gillnets target chums.

Laredo-Campania Fishery: A major interception/mixed stock area—not fished since the early 1980s.

Milbanke Sound Fishery: A major gillnet interception and mixed stock fishery primarily targeting chums—not fished intensively since the early 1980s.

Finlayson Channel Fishery, Mussel Inlet Fishery, Mathieson Channel Fishery, Spiller Channel Fishery, Roscoe Inlet Fishery and Return Channel Fishery: All harvest mainly local stocks.

McLoughlin Bay Fishery: Harvests local hatchery stocks.

Seaforth Channel Fishery: A major interception and mixed stock fishery; once fished intensively, now fished only a few weeks per season, mainly to harvest local stocks.

Dean Channel and Bella Coola Gillnet Fisheries: Harvest local stocks.

Fisher Channel Fitz Hugh Sound Fishery: Major interception and mixed stock fishery of local and passing stocks can still be an intensive, nonselective fishery. Seines target pinks and chums; gillnets primarily target chums.

Rivers Inlet Gillnet Fishery: Primarily targets local sockeye stocks.

Smith Inlet Gillnet Fishery: Once a major interception and mixed stock fishery outside the inlet; fishery is now restricted to inside the inlet where it primarily targets local sockeye stocks.

There have also been troll fisheries, mainly in outer coastal areas on highly mixed stocks. Also, there are a number of Aboriginal and sport fisheries in the area. Some are on local stocks and some are on highly mixed stocks.

For the few salmon stocks that have been assessed, the recent decrease in overall survival has been attributed primarily to decreased ocean survival. Indications are that the reduced survival occurred mainly in the early ocean life stage, probably in the estuary or inner coastal area. This mortality could be a result of factors such as smaller smolts, reduced ocean productivity and food supply, slower juvenile salmon growth rates and increased predation. If the decrease in production was the result of natural causes, Fisheries and Oceans couldn't have prevented it. Although the decline in production has been apparent for at least the last four years, there has not been enough basic monitoring or directed studies to do anything more than speculate about the specific causes of the decreased survival. With appropriate monitoring, Fisheries and Oceans could have known the causes sooner and might have been able to react to prevent fishing-down stocks such as Rivers Inlet sockeye.

It is difficult to evaluate the state of each single stock because catch is pooled by species and by fishery. Consequently, spawner information provides the only indication of the state of individual stocks. Also, without information about catch by stock, it can't be determined whether over-fishing or habitat changes are causing conservation problems. In a few cases, there is enough specific information about a local group of spawning populations to better understand some of the basic conservation issues. The stock groups presented here are Smith and Rivers Inlet sockeye, and pink and chum of Areas 6, 7 and 8.

5. Smith and Rivers Inlet Sockeye

Fig. 6 shows the long-term catch trends of Rivers and Smith Inlet sockeye. The catches of these stocks averaged 1.2-million sockeye per year, from 1900 to 1974.

Smith Inlet (Area 10) Sockeye

There are three sockeye-spawning populations in Smith Inlet that are probably of a single stock. (See Chapter 8, Salmon Genetic Concerns.) Fig. 10 shows the changes in total returns and spawner abundance of Smith Inlet sockeye since 1951. The recent decline in production can't be attributed to overharvesting because escapement targets were met until total returns dropped below target escapement levels. There is no evidence of spawner die-off from disease, flooding or other natural events. The limited logging in the watershed ended in the 1970s and there has been no industrial or urban development. Juvenile sockeye abundance has been monitored and shows no dramatic decline in the rearing lake. Other sockeye stocks that occupy the same area of the Gulf of Alaska as this stock haven't had similar declines in production. The increased mortality therefore, seems to have occurred between freshwater and open ocean habitats, probably soon after the sockeye entered the ocean. Factors that could affect the early ocean life stage include river discharge (the amount of water coming down the river), ocean temperature and salinity, and predators and competitors. The river discharge pattern has changed in Central Coast rivers that are monitored. Also, ocean conditions at Egg Island (Fig. 9), at the mouth of Smith Inlet, changed significantly over the 1951–99 period. In the 1990s, mackerel, pilchards and possibly hake have moved into the Smith Inlet area. Mackerel and hake are known predators of juvenile salmon.

Figure 9a. Egg Is. Average Sea Surface Temperature (SST)

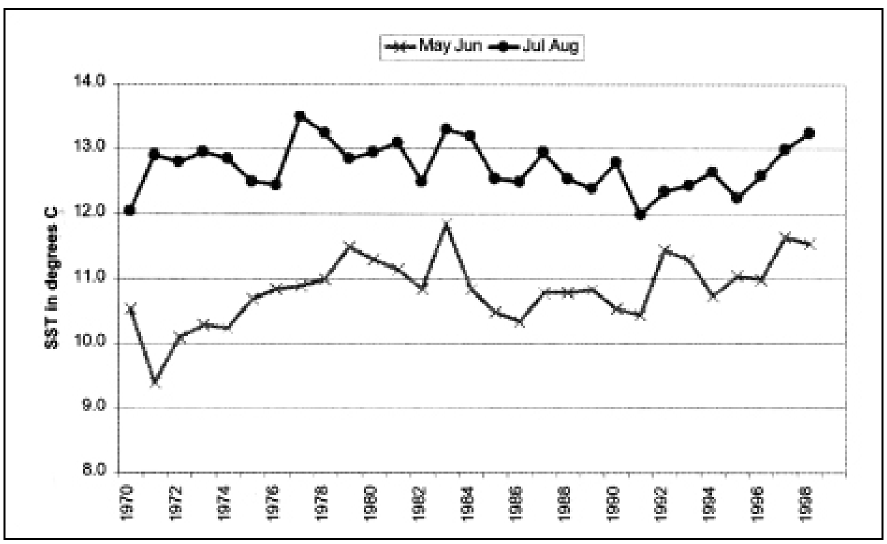


Figure 9b. Egg Is. Average Sea Surface Salinity (SSS)

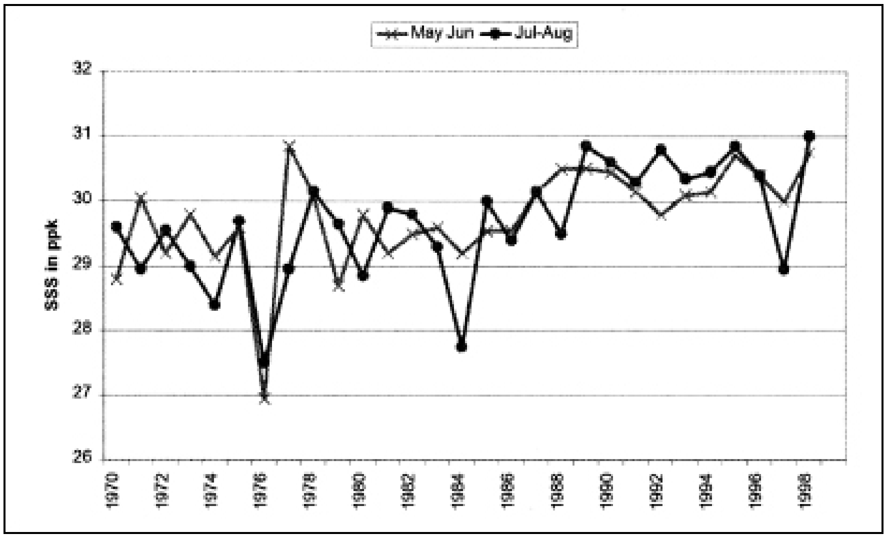
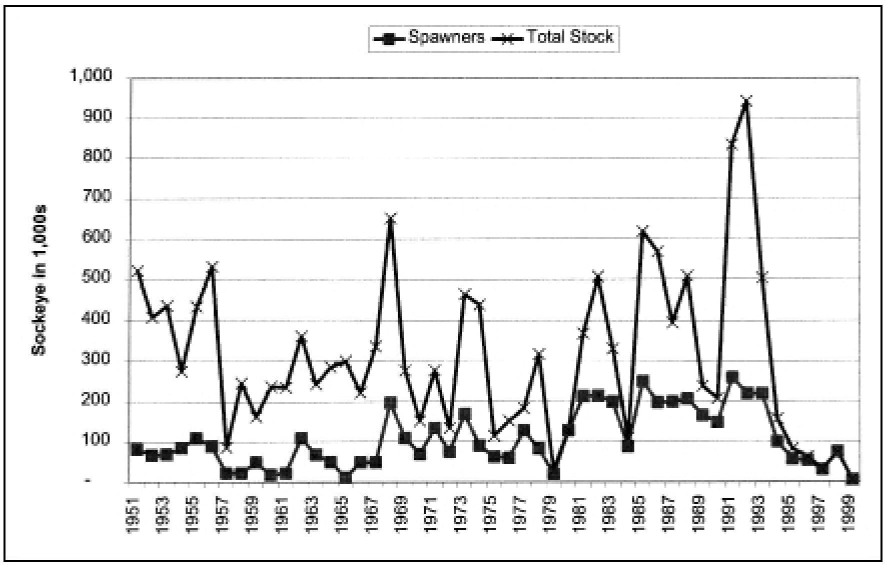
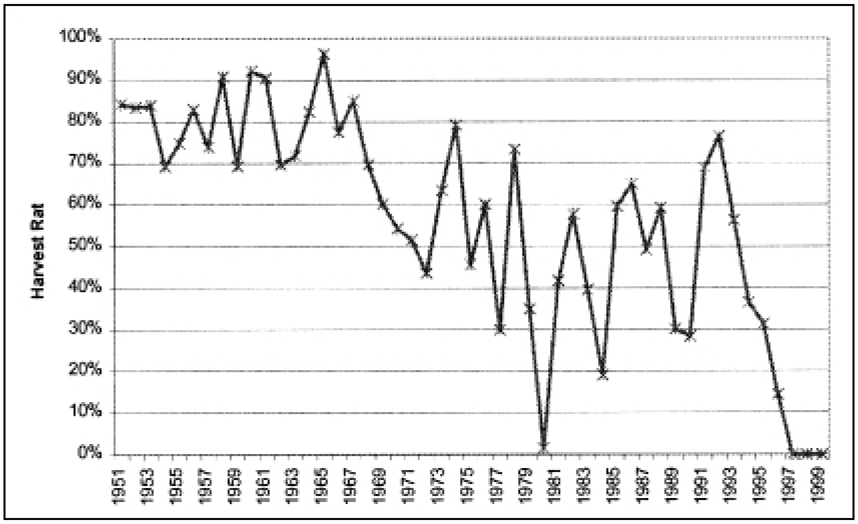


Figure 10. Smith Inlet (Area 10) Sockeye



Around 1970, there was another apparent change in the productivity of the stock that is reflected in the change in harvest rate (Fig. 11). This may have been a result of a change in either the biological productivity or in enumeration methods. Figs. 2, 3, 6 and 7 also show an apparent change in production around 1970. These changes appear to have affected stocks over much of the Central Coast area. This may suggest a common climate or ocean effect. Chinook and coho outside the area were also affected at that time. Sockeye stocks outside the Central Coast were not affected. Average sea surface temperature decreased about 1970 in some coastal locations and has since increased. The available information is not adequate to determine if there was a change in productivity that affected Smith Inlet sockeye or what that change might have been.

Figure 11. Area 10 Sockeye Harvest Rate



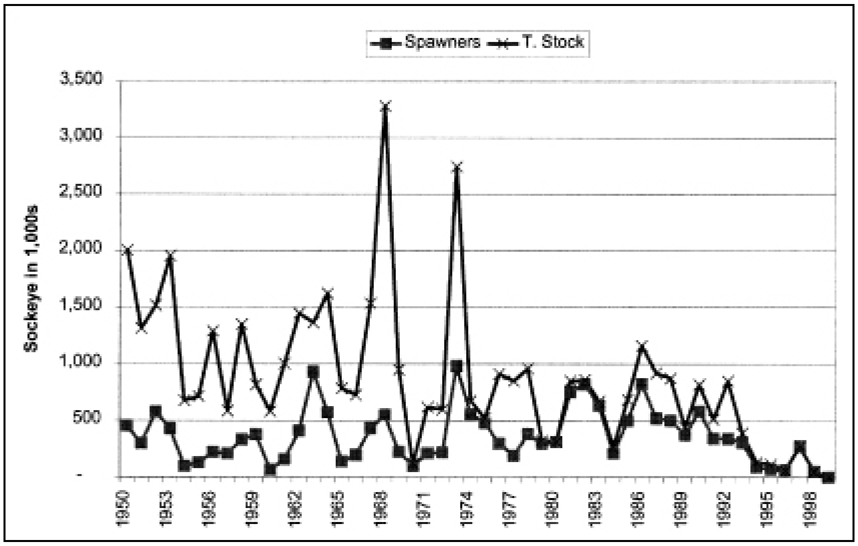
The portion of the fishery outside Smith Sound, where significant numbers of Rivers Inlet sockeye were intercepted, has been closed to sockeye fishing since 1971. These interceptions inflated the early Smith Inlet catch and the apparent stock productivity. (See Chapter 10, Fisheries Issues, Mixed Stock Fisheries.) Before 1970, the number of spawners was estimated by standardized stream index counts that tend to underestimate actual abundance. Since 1971, escapement has been counted as the sockeye migrate through the Docee River counting fence. This provides a more reliable and consistent count. Comparing the counts by the two methods suggests that the stream index counts were about one-half of the fence counts. (See Chapter 10, Fisheries Issues, Fisheries Management Information.) Underestimated escapement before 1970 would overestimate stock productivity. Adjusting for likely interceptions and spawner underestimates would bring the production in the two periods to about the same level.

A change in biological productivity and/or in enumeration methods might explain the changes in Area 10 sockeye production. Given the available information, there is no definitive answer.

Rivers Inlet (Area 9) Sockeye

Rivers Inlet sockeye comprise 13 spawning populations, possibly of two genetic stocks. (See Chapter 8, Salmon Genetic Concerns.) Fig. 12 shows the changes in total stock and spawner abundance of Rivers Inlet sockeye since 1950. As for Smith Inlet, the recent decline in abundance can most likely be attributed to increased mortality in the early ocean life stage. Although important spawning rivers have been extensively logged, no direct link between logging and abundance of salmon stocks has been demonstrated. Juvenile sockeye abundance was higher in the 1960s and 1970s before logging, but spawner abundance was also higher then. Also, no juvenile sampling was conducted in the late 1970s and early 1980s, so it is difficult to track the decline. Open ocean survival rates of most other sockeye stocks don't show a comparable decline. Like Smith Inlet, the total average, annual returns of Rivers Inlet sockeye were lower after 1970 than they were before. This may have been a result of a change in biological productivity or basic spawner enumeration.

Figure 12. Rivers Inlet (Area 9) Sockeye



From 1979 to 1984, a strategy to improve Rivers Inlet sockeye production was implemented. It involved increasing the number of spawners to the levels of 1963 and 1968 that produced the very large returns of 1968 and 1973. Closing the fishery significantly increased the number of spawners, but production didn't increase to levels hoped for. This suggests the possibility of a significant decrease in habitat productivity at the time of the optimization strategy. A related observation is that there have only been large returns of Rivers Inlet sockeye when the combined North American sockeye production was relatively low. Since the late 1970s, the North American sockeye production has been high. This may be a coincidence or it may be related to competition[1] on the high seas. During the same period, the percentage of Rivers Inlet sockeye that stay an extra year in the ocean has also increased, suggesting increased competition at sea and/or a poor start as small smolts.

The enumeration situation in Rivers Inlet is much more complicated and challenging than in Smith Inlet. Rivers Inlet is a bigger watershed with more and larger spawning streams. The two largest streams are very silty and difficult to access, making spawner abundance more difficult to estimate. The abundance of spawners is estimated by visual spawner index counts, as used in Smith Inlet before 1970. Because of these factors, there has never been a complete and credible measure of the number of spawners in the system. Without such a measure, there can be no estimates of freshwater or total survival, stock productivity, optimum harvest rates or conservation concern levels. Furthermore, without spawner abundance counts, there is a strong tendency to fish into required escapement.

From the late 1960s and into the 1970s, acoustic indexing was conducted in Rivers Inlet. It didn't provide a reliable measure and so was stopped. More recently, mid-season Docee fence counts of sockeye were used to trigger fisheries in Rivers Inlet. To address the need for a reliable estimate of escapement, in 1999 the Rivers Inlet Restoration Society and the Owikeeno Nation, funded by Fisheries Renewal BC, initiated a fishwheel sockeye-abundance index and tagging program. If continued, the fishwheel program could provide a future reference measure for in-season management and stock assessment, as the Smith Inlet counting fence now does. **This fishwheel program should be one of the highest fisheries priorities in British Columbia.**

For at least the next five to ten years, both fishwheel information and standardized spawner index counts should be collected to determine how they relate to each other. In addition, the data collected would provide spawner abundance information to help assess the current problem. It would also aid the development and monitoring of a strategy to stop the decline and begin to rebuild the stock to safe levels. The fishwheel estimates might also be used to calibrate past spawner index measures.

If Smith Inlet spawner index counts were 50% of actual numbers from fence counts, it seems likely that the Rivers Inlet spawner index counts in the 1950s were less than that. In Rivers Inlet, two large spawning rivers are difficult to access and are very silty, making visual counts of spawners virtually impossible. If past spawner index counts were 50% of actual abundance, then the productivity of the stocks was lower than is currently thought. Also, more than the current target of 200,000 spawners would be required to achieve past levels of production. Recently, accessibility to spawning areas has increased and spawner estimates are probably closer to actual numbers. (See Chapter 10, Fisheries Issues, Fisheries Management Information.)

Past tagging programs have demonstrated that in some years significant numbers of Rivers Inlet sockeye have been intercepted in fisheries in Areas 7, 8 and 10. Since then, interception fisheries have been reduced. The amount intercepted in each area depends on the sockeye migration route and stock abundance. In some years, the interceptions have been a few thousand. In 1968, interceptions were over one million. At the recent very low total stock levels, even a small interception can make a relatively big difference in the number of spawners. For example, 1999 catches in the Fisher-Fitz Hugh area could have accounted for between 500 and 1,500 Rivers Inlet sockeye[2]. This would be a significant conservation loss in a year when only 3,600 sockeye spawners escaped to the Owikeeno watershed. (See Chapter 10, Fisheries Issues, Fisheries Management Information.)

Making allowances for both interceptions and escapement estimates could change the estimated Rivers Inlet productivity rate to less than that of Smith Inlet. This would be reasonable, considering that the Smith Inlet freshwater habitat is undisturbed. Also, the spawning streams and rearing lake are clear and more productive than those of Rivers Inlet. In addition, the Smith Inlet rearing lake was fertilized from the mid-1970s to the mid-1990s.

Rivers Inlet area conservation concerns go beyond the sockeye. With only 3,600 spawners in 1999, the ecosystem that is dependent on the sockeye collapsed. Bears, eagles, seals and other animals starved, and either migrated or died. The people dependent on this stock had to do without. The concern now must be not to lose the remnants of the sockeye stock before action can be taken to rebuild it to safe, sustainable and productive levels of abundance.

It is important to understand the history of these stocks because stock assessment and fisheries management are based on historic experience. If that experience is misinterpreted, it can lead to setting the wrong production goals and harvest rates. Also, if there was a major change in productivity around 1970 as well as in the mid-1990s, then such changes might be expected at regular intervals and fisheries should be managed accordingly. If, however, the apparent change in productivity is a result of past enumeration methods, then the mid-1990s change may be the exception rather than the rule.

To better understand the Rivers and Smith Inlet sockeye stocks:

The juvenile sockeye and their freshwater, estuarine and early ocean environments should be monitored to determine the possible causes of the 1990s decline in production. Fishers might be able to provide their recorded 1990s observations of mackerel, hake, pilchards and other species not normally encountered in the study area.

All information on Smith and Rivers Inlet sockeye should be assembled, reviewed and made available. This should include information from past tagging programs, past scale sampling for stock identification, observations by fishers and any other relevant activities. Based on this information, stocks should be reassessed. **A plan for rebuilding these stocks should be developed and implemented as soon as possible.** The plan and progress should be open to public scrutiny.

A major part of the current problem is that the population was allowed to drop to dangerously low levels without even basic actions to determine the causes or develop remedial strategies. In the future, **spawner abundance levels at which conservation actions are required should be clearly specified.** These conservation levels should be risk-averse, be based on rationalized stock information and involve easily understood measurements. (See Chapter 8, Salmon Genetic Concerns, Conservation Guidelines.)

Recent major reductions of Fisheries and Oceans operational budgets and core programming, while committing more than $400 million to adjusting the commercial fishing fleet and doing habitat restoration, suggest a lack of clear conservation priorities. Much of the current expenditure in the Rivers and Smith Inlet areas is for temporary funding of public groups. This funding has often been allocated too late in a season to do important activities. In addition, both of the main funding sources are temporary—with Fisheries Renewal BC and the Habitat Renewal and Salmon Enhancement Program only funded until 2001. **The federal and British Columbia governments should implement a coordinated long-term program to properly address Rivers Inlet sockeye and related ecosystem problems, and to develop a plan to manage the ecosystem for long-term sustained use.**

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1. Rivers and Smith Inlet sockeye smolts are very much smaller than most other sockeye smolts. This may put Rivers and Smith smolts at a competitive disadvantage.
2. Fraser River sockeye are also sometimes intercepted in this fishery.

6. Areas 6, 7, 8—Pink and Chum Salmon

This is a large area with pink and chum populations throughout. Catch statistics are from sales slips and are assumed reliable. Visual stream-walk and aerial counts of spawners provide an index of abundance. These spawner index counts have served as an important management tool for a number of years. However, there is a concern about the consistency of individual indices over the last 50 years because of changing access to the spawning areas, changing survey intensity and methods, and changing personnel making the estimates. The recent estimates might be better than those in the 1950s because of improved access and methods. **These spawner index counts should be reviewed to account for changes in access and coverage to make them consistent**.

Of the many pink and chum populations in the area, it is not known how many are genetically distinct stocks that must be conserved and managed as separate entities. It is possible that pink and chum spawning populations in a large watershed, or even in an inlet, are related and can be managed as a group. (See Chapter 8, Salmon Genetic Concerns.)

Pink Salmon

In all three areas, pink salmon production decreased sharply in the early 1990s. In response, harvest rates were reduced but production hasn't yet recovered. In Areas 6–8, usually either the even- or the odd-year pinks are dominant and very productive. Since the production decreased, the even-/odd-year cyclic dominance has disappeared. Fig. 5 shows that the abundance of pinks in these areas has gone through a number of long-term cycles. It also shows that the catch has never been so low for so long.

No measurements of freshwater or early ocean survival of pink salmon help to identify when or where the increased mortality happened. Pink salmon production in Southeast Alaska has not shown similar decreases, so it is unlikely that the mortality occurred in the open ocean. River discharge in the area has changed somewhat, but not dramatically. The sea surface temperature and salinity have changed, but not consistently between areas, nor suddenly during the current period of reduced abundance. Mackerel and pilchards have been observed in this period.

Allowing for the two-year life cycle of pinks, the timing of the decreased production is the same as for the four- or five-year old Rivers and Smith Inlet sockeye. This suggests a possible common cause. However, the cause can't be demonstrated given the available information.

Chum Salmon

Chum salmon in these areas have not shown the same decreased abundance in the 1990s that sockeye and pinks have. Fig. 4 shows that chum production in the area has undergone four production cycles since the 1920s. The 1990s average annual production is at the same level as the lows in previous cycles. The cause of these production cycles is not known.

Why didn't chum production decrease in the 1990s the way sockeye and pink production did? All three species occupy overlapping areas in the open ocean. They migrate downstream to the ocean about the same time. The only obvious difference is that juvenile chum tend to stay in estuaries and shallow coastal waters longer than either pink or sockeye. Without field observations, it isn't known whether such behaviour is a significant factor in the differences in chum survival in the 1990s. **Research should be conducted to find out why pink production is down while chum production has been maintained.**

The differences between total stock abundance of chum in Areas 6–8 may be, in large part, a result of changing interception rates, particularly in Area 7.

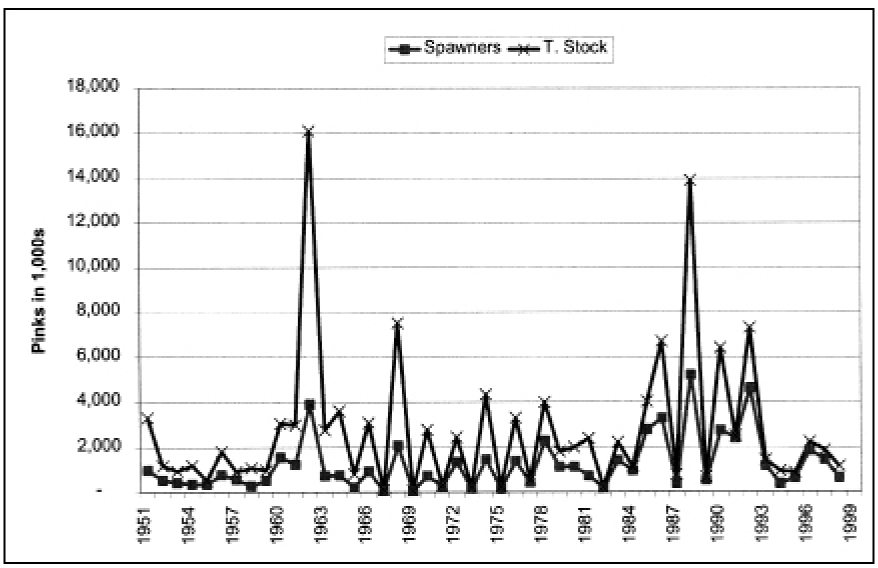
Area 8

This is a large area, with pink and chum populations throughout it. There are three fisheries in Area 8: the Bella Coola and Dean Channel gillnet fisheries, which are on local stocks, and Fisher-Fitz Hugh seine and gillnet fishery, which intercept passing stocks. More formal monitoring and accounting of the stocks being harvested in the Fisher-Fitz Hugh fishery could improve both conservation and sustained use. **As long as Rivers Inlet sockeye stocks are at low abundance, interceptions should be eliminated in the Fisher-Fitz Hugh fishery. The fishery could be relocated to make it more stock-specific. Close monitoring will be required so that fishing in interception areas can be closed as and when interceptions are observed.**

Area 8 Pinks

There are 34 rivers with even- and odd-year pink spawning populations that have been regularly monitored in Area 8. Fig. 13 shows the changes in the number of spawners and total stock of pink salmon in the Bella Coola area (Area 8). The low number of spawners and total stock in the 1950s may be similar to current levels in the 1990s. However, as for Rivers and Smith Inlet sockeye, it seems likely that early pink salmon spawner abundance was underestimated. Current pink spawner abundance is probably lower than in the 1950s. Reduced harvesting has helped to maintain spawner abundance levels in the 1990s. **There is concern that fishing to provide a measure of stock abundance is reducing spawner abundance and, in years of very low returns, taking an unnecessary conservation risk.**

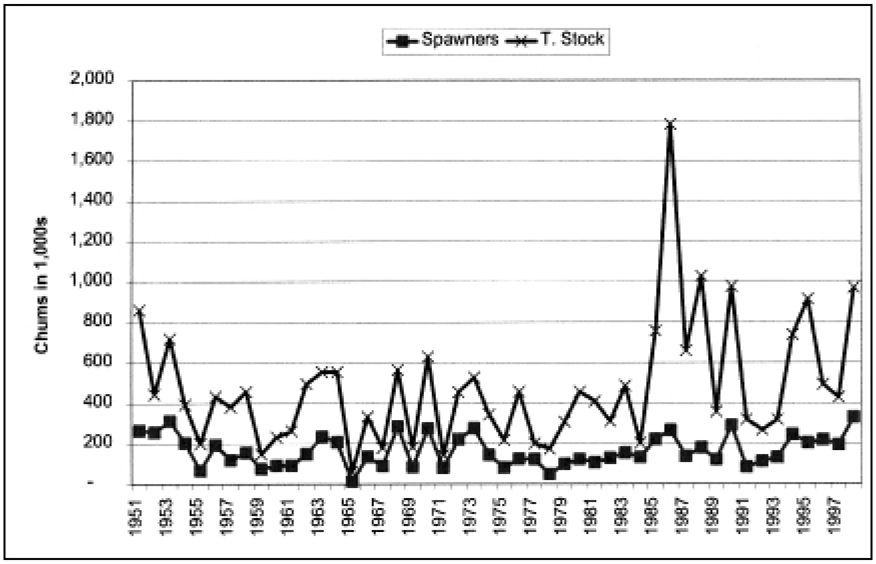
Figure 13. Bella Coola (Area 8) Pinks



Area 8 Chums

Fig. 14 presents information on Area 8 chum spawners and total stock. There are 34 chum spawning rivers in the area. Since the mid-1990s, there has been no drop in total stock, as there was for Area 9 and 10 sockeye and Area 6, 7 and 8 pinks. The harvest rate averaged about 50–70% from 1951 to the mid-1980s when it increased to over 80%. Since that time, the harvest rate has decreased to about 60%. As is the case for other species, chums have been significantly intercepted by fisheries in other areas, mainly Area 7.

Figure 14. Bella Coola (Area 8) Chums



Area 7

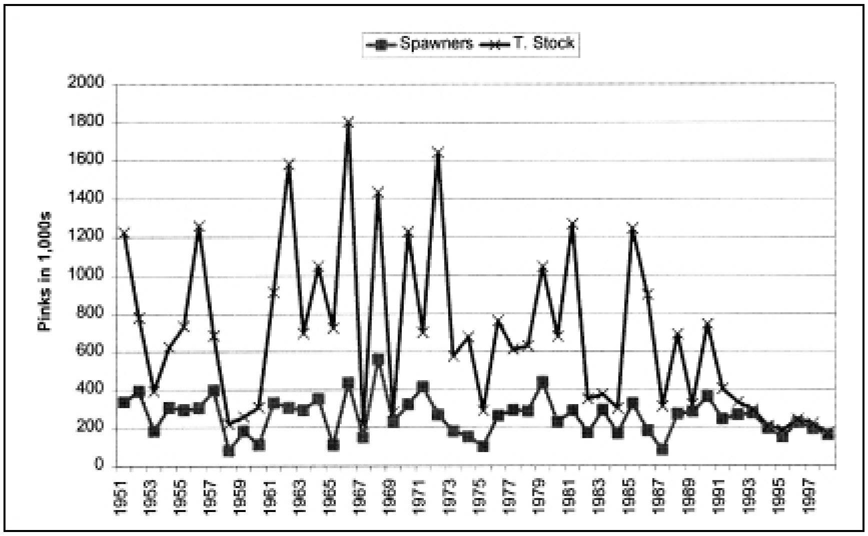
Area 7 is a major transit route for stocks going to Areas 6, 7, 8 and 9. The percentage of stocks from other areas passing through Area 7 varies between years, areas and time of year. In the 1960s and 1970s, the interception fisheries accounted for a significant portion of catch in Area 7. In the early 1980s, interceptions were reduced and fisheries were moved more into inlets, where they are more stock-specific. Fisheries have been conducted in eight separate areas, only one (Seaforth Channel) of which is a high-potential interception area. Such local fisheries provide good potential for stock-specific harvest to optimize local production and serve as examples that could be applied in other areas. The Seaforth fishery catch should be monitored for stock composition so that in-season decisions can be made to protect at-risk stocks.

Six of 58 chum spawning populations and eight of 114 pink spawning populations in the area were rated at high-risk of extinction[3]. The populations were evenly divided between coastal and outer-coast areas. Also, 19 of 51 coho and seven of 18 sockeye spawning populations were at risk, most in the outer-coast area. At-risk stocks should be reviewed and an interim protection strategy implemented until conservation units are formally designated.

Area 7 Pinks

Fig. 15 presents the abundance of pink salmon spawners and total stock in the Bella Bella area (Area 7). Total stock has decreased from an average of about one million per year in the 1960s and early 1970s, to about 200,000 since 1994. Before 1982, significant numbers of both Areas 6 and 8 pink stocks were intercepted in Area 7. With changes in fishing times and areas since then, interceptions have been significantly reduced, but not eliminated.

Figure 15. Bella Bella (Area 7) Pinks



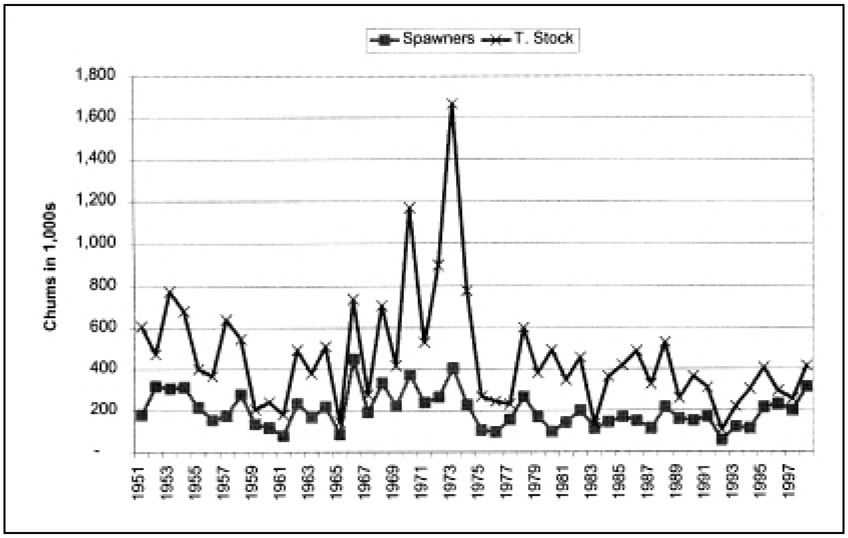
The current pink abundance is as low as the lowest off-cycle production levels at the same time for both even- and odd-year stocks. Reduced harvesting in the 1990s has helped to maintain spawner abundance so that, when conditions are more favourable, the populations may rebuild quickly.

Area 7 Chums

In Fig. 16, the total chum stock and escapement have been relatively stable except for a period of high production from 1965 to 1974. It is not known whether this high production was a result of increased biological productivity or of interception of passing stocks. Comparing chum total stocks in Area 7 (Fig. 14) and Area 8 (Fig. 16), the higher abundance of Area 7 in the 1960s and early 1970s may have been the result of a significant interception of Area 8 chums in Area 7. There was no tagging for that specific period, but later tagging confirmed that there were significant interceptions of Area 8 chums in Area 7. In the 1980s, after the interception fisheries had been closed or reduced, the Area 8 chum catch was much higher than that of Area 7.

From 1996 onwards, the harvest rate has been reduced and the number of chum spawners has been increased to safe, risk-averse management levels.

Figure 16. Bella Bella (Area 7) Chums



Area 6

This area drains more than 25,000 square kilometres. It extends east from the outer coast for 120 kilometres. There are more than 500 spawning populations in the area. Based on spawner counts until 1993, 96 spawning populations were rated at high risk of extinction. This underestimates the number of at-risk populations because there wasn't enough spawner information to classify one-third of the populations. In total, about 25% of salmon spawning populations in Area 6 were rated at-risk (25 of 107 chum, 29 of 224 pink, 10 of 37 sockeye, 28 of 110 coho and four of 16 chinook). Most at-risk populations are small and located in outer coastal areas.

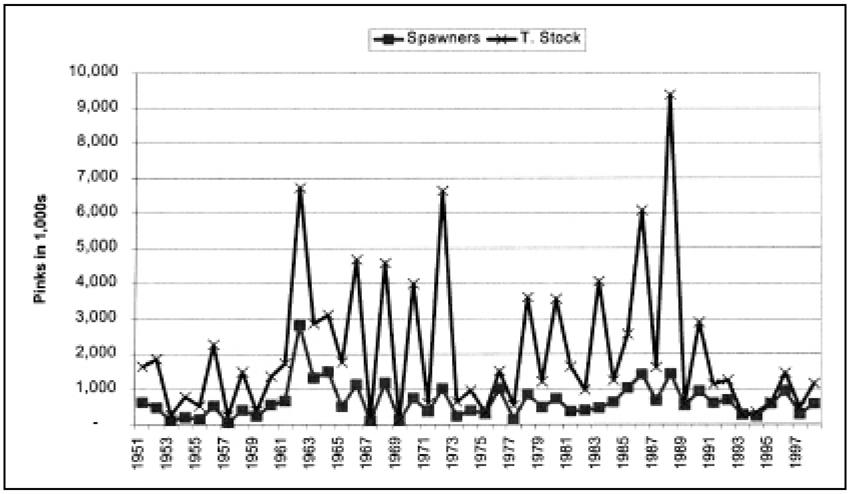
The outer parts of this area are major transit routes for stocks from Areas 4–8. Many of the inlets are also transit routes for many local stocks. There is a single fishery[4] in the area, at the junction of six major transit routes for local and distant stocks. This fishery harvests an extreme mix of stocks. The intensity and duration of fishing in this area has been significantly reduced since the 1980s. The outer part of the area has not been fished commercially for over 20 years. Even so, the incidence of at-risk stocks is highest in that area.

There should be an immediate review as to why so many populations in this area were rated at high risk of extinction.

Area 6 Pinks

Fig. 17 follows the abundance of total pink salmon returns and spawners in the Kitimat area (Area 6). The abundance patterns in Areas 6 and 8 are similar, with a low production period in both the 1950s and 1990s. Although spawner abundance in the 1990s has apparently been maintained at higher levels than in the 1950s, the early estimates probably underestimated actual spawner abundance more than current estimates. Catch has been controlled, but **there is concern that commercial catch is still the primary measure of in-season abundance used in the management process.** With the diversity of stocks fished together, this cheap, but ineffective, **measure often involves unnecessary risks when total returns are low**.

Figure 17. Kitimat (Area 6) Pinks

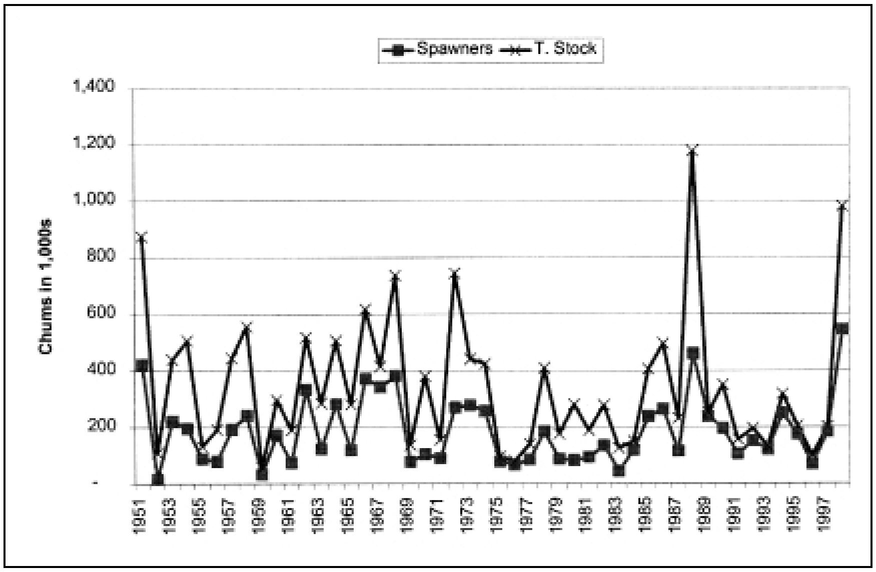


Another concern in Area 6 is the 29 pink stocks that were rated at risk of extinction. These are not just small, possibly ephemeral, stocks: four of them have spawner targets of 15,000 or higher. Since pinks generally have a high average productivity, it is no surprise that 67 spawning populations of other species in the area were also identified as being at-risk. For some populations, this suggests an overharvesting problem that could exist because all commercial harvest in this large area is taken in one large mixed stock fishery in the Whale Channel. (See Chapter 10, Fisheries Issues, Mixed Stock Fisheries.) Such a fishery inadvertently overharvests stocks with below-average productivity. Also, there is great potential for poaching in this area, which may account for some overfishing. (See Chapter 12, Enforcement Issues.) In Area 6, there should be increased monitoring for illegal fishing, pilot testing of more stock-specific fisheries and more in-season stock identification.

Area 6 Chums

Fig. 18 shows that the total chum stock was higher in the 1950s and 1960s, but no trend has been apparent since the 1970s. Recently, escapement has increased by more conservation-oriented management, which has reduced the harvest rate. In the 1950s and 1960s, there was significant harvest from outside areas, such as Laredo Inlet and Sound. This may in part account for the high total stock and escapement of that period. Production decreased in these areas and populations haven't been harvested for many years. The cause of this decreased abundance is unknown and, apparently, has never been studied. Understanding why stocks in this outer area have remained locked at low abundance would provide valuable insight into improving management strategies.

Figure 18. Kitimat (Area 6) Chums



3. Rated at-risk by an American Fisheries society study.
4. Fishery is around Gil Island and is known as the Whale Channel fishery.

7. Conservation Issues

A number of factors make in-depth evaluation of the status of Central Coast salmon resources impossible at this time. As well as a shortage of basic stock and habitat information, there are very basic management uncertainties. The population units that should be managed for are not yet defined, nor are the minimum safe conservation levels for each population unit. There is no consistent, long-term rebuilding plan to protect against loss of genetic diversity or to identify, protect and rebuild depressed stocks. There are fundamental problems with fisheries and fisheries management. The state of habitat information and monitoring impedes accountability, compensating for damages and enforcement.

The rest of this report describes these factors in more detail and provides general recommendations on how to address them. It starts with the issues of fish stocks as basic genetic and biological entities. Then it addresses fisheries and habitat management issues.

8. Salmon Genetic Concerns

People are generally aware that there is more than one kind of salmon. Some are aware that there are six species of salmon native to British Columbia: chinook, chum, coho, pink, sockeye and steelhead. Atlantic salmon have been introduced for salmon farming.

Few people know that each of the six wild species is comprised of many separate genetic groups, each adapted to different spawning and rearing conditions. These different genetic capabilities allow the salmon to survive in, and take best advantage, of a broad array of habitats. At one time, they occupied almost every accessible stream in British Columbia. Salmon range from coastal muskeg streams to glacier-fed rivers. They are present from Osoyoos Lake, in the dry belt of the southern interior, to coastal rain forests on Vancouver Island and northern rivers flowing from British Columbia through the Alaska Panhandle.

Each genetic group is called a stock. It is not known whether each separate spawning population is a stock, or whether the spawning populations in a general area, such as a single river system or all the streams flowing into an inlet, comprise a stock.

To date, studies indicate that most coho and pink stocks tend to include spawning populations over a broad area, while a sockeye stock often may be a single spawning population. Other species tend to be in between these extremes.

Until the extent of each stock is defined, prudence suggests that each spawning population should be assumed to be a genetically different stock, and that fisheries and habitat must be managed to protect each stock.

More than 1,700 individual spawning populations have been identified in the Central Coast study area. Protection and management of so many populations poses a major challenge.

In order to realize the full potential of salmon resources, we must protect the genetic, or biological, diversity of each of the stocks. Today, the ocean environment and climate are changing rapidly, and there is industrial and urban development in some salmon watersheds. Protecting biodiversity is crucial if the salmon populations are to be allowed time to adapt to these changes. Protecting biodiversity is vital to sustaining stocks and salmon production.

The few salmon that can survive and breed at increased temperatures, or can adjust their migration timing to optimize migration temperatures and flows, may be key to long-term survival. Maintaining biodiversity is key to conserving and sustaining salmon.

Further, biodiversity is adaptation to local habitats. Fish that are adapted to their home stream have the highest genetic fitness and, therefore, productivity for that stream. Destroying biodiversity is the same as destroying productivity.

Factors That Affect Biodiversity

Biological, physical and chemical changes in habitat, changes in harvest rate and pressures of natural selection can all affect biodiversity. These factors interact so that a small change can have a big impact. For example, climate change can make previously tolerable conditions intolerable. It can also make previously acceptable habitat impacts, harvest rates and predator-prey relationships unacceptable.

A stock adapts to change only through survival of those fish with viable genetic capabilities. In each generation, this natural selection for genetic traits goes on. When change is rapid, selective pressures are extreme: population abundance decreases and only those fish viable under the new conditions survive. In the Central Coast area, most of the stocks have shown major decreases in abundance since 1995. This raises questions: How low can a stock go before we should be concerned about extinction? How might we help the fish to survive, recover or adapt?

Geneticists have said that a minimum of 300 spawners is necessary to ensure the genetic viability of a stock under certain conditions. Three hundred spawners are believed to have enough genetic diversity to enable a stock to cope with the challenges it faces. This might be a reasonable assumption in a low-change situation; however, in the face of the current and foreseeable habitat changes, it seems more likely that larger numbers of spawners offer a better chance of having required survival traits. It also means that artificial selection pressures, such as size-selective harvest, should be carefully avoided for their impact on future viability.

The selective nature of some enhancement[5] practices should also be scrupulously avoided. For example, brood stock selection can narrow the genetic composition of the fish produced, and high production rates can overwhelm natural production. Incubation and rearing practices can result in domestication of hatchery stocks, creating fish that are less viable in the natural environment. On the positive side, some types of enhancement can increase productivity of a stock to help ensure its continued existence. In some cases, a short-term boost of production may be all that is required to get a stock to a self-sustaining level. Also, some forms of enhancement may be the only way to address some types of habitat damage. In short, enhancement can be a valuable tool, but it should be used carefully to avoid long-term genetic and other problems.

Biodiversity within stocks is increased by fish that stray from other areas, interbreed and introduce new genetic traits. If these new genes are beneficial, the fish carrying them survive. If not, they eventually die. The amount of straying appears to be related to the abundance of stocks: large, successful populations probably produce more strays. Maintaining spawning populations at a higher than minimal level helps to maintain biodiversity. Overharvesting stocks not only reduces the diversity within each stock, but probably also reduces the number of strays.

Habitat changes can also be selective for specific traits. For example, the high temperatures recently experienced in the Fraser River system select for temperature tolerance. Pulp mill effluent selects for tolerance of its various chemicals. The influxes of mackerel that prey on salmon select for predator avoidance by fast growth rate and different behaviour of salmon. Fisheries are also selective for size, age, run timing and other behavioural traits.

Because of such selective pressures, abundance and biodiversity within many stocks in the Central Coast area are decreasing. Fourteen per cent of the stocks have been classified as at high risk of genetic extinction. Many more stocks are in need of conservation actions to rebuild base production to an abundance level at which the stocks are not at conservation risk. There is too little information to classify at least one-third of the stocks. Many other streams are far below spawner and rearing capacity. How do we decide which stocks need protection or help and in what order they should be addressed?

Conservation Guidelines

Guidelines could be helpful in trying to decide which salmon stocks should get priority for different sorts of conservation actions.

Conservation guidelines are needed to:

- **define stocks;**

- **indicate when a stock is at conservation risk and needs special protection and restoration;**
- **identify acceptable types of restoration; and**
- **help set priorities for addressing stock needs and providing remedial actions, including when increased monitoring is required.**

Possible conservation criteria include:

- primary conservation considerations of urgency, uniqueness of the stock and probability of success; and
- secondary sustainable-use considerations of the original stock size, potential production at risk and stock uses.

Conservation Considerations

Urgency would differentiate between a stock that has been at low abundance for a number of generations and one that is in rapid decline. For example, Rivers Inlet sockeye have declined from an average population of over 1.5 million to 3,600 in 1999—most of the decline occurring in the 1990s. The urgency criteria would recognize stocks that are under different amounts of pressure, and should prescribe a number of basic levels of response. For example, the percentage that current abundance is of original, target or optimum stock abundance could be used to trigger conservation actions. For steelhead, a stock abundance below 25% of its habitat capacity has been set as a conservation concern. Ideally, before such a level is reached, fisheries would be reduced and monitoring would be increased. At lower abundance, other conservation actions would be triggered, including closure of all fisheries on the stocks and prescriptive enhancement to address specific needs.

Probability of success relates to whether the causes of the stock's problems are known and if there are proven remedies to stop the decline and rebuild abundance to safe levels. For example, the decline in production of many Central Coast stocks is a result of as-yet-unknown factors. Consequently, the probability of success could be lower than addressing a stock devastated by a known event, such as a landslide. The landslide should trigger remedial actions. The decreased Central Coast stocks should trigger a study to understand the problems.

Uniqueness of stock is related to stock genetics. It includes such factors as migration timing, physical characteristics and habitats used. For example, since most sockeye populations rear in lakes, the few that rear in streams or estuaries are unique.

Sustainable Use Considerations

Stock abundance criteria are related to the amount of production, or harvest, that is being forgone as a result of decreased stock abundance. For example, an annual catch of about one million Rivers Inlet sockeye and 400,000 Smith Inlet sockeye is currently forgone. From a sustainable-use perspective, restoring production of these stocks should be a high priority.

Stock uses could also be considered to account for fiduciary obligations, uniqueness of use, ease of management and other characteristics. For example, which stock would we least like to lose?

Other concerns might include the number of at-risk stocks in an area, especially if they all seem to have the same or related problems.

Possible Conservation Actions

A number of conservation actions might be taken in response to conservation priorities. First are the obvious, immediate actions to stop the losses and prevent further decline of a stock to higher risk levels. These actions include:

1. **Reducing or eliminating harvest** of affected stocks in both directed and interception fisheries. The extreme case has been the coho conservation actions of the last few years such as closures, gear restrictions and mandatory live release of coho. When conservation levels are defined, stocks shouldn't be allowed to get so low that a complete closure would be necessary.
2. **Addressing obvious habitat problems** or limitations. Extreme examples of such problems include: an obstruction that is preventing upstream migration to spawning areas; a landslide that has covered spawning areas with silt; and extreme predation by seals, as on adult and juvenile Puntledge chinook.
3. **Determining less obvious causes of the decline** in stock abundance. This would likely be part of the medium-term strategy, as it involves study, time and resources.
4. **Addressing specific causes of decline**, at least to the extent required to move stock abundance out of the conservation risk zone.
5. **Implementing monitoring programs** to understand stock needs and to provide an early warning of future stock declines.

Now, there is a backlog of unaddressed problems created or aggravated by long-term over-fishing, habitat development impacts and climate change. In the future, clearly defined stock abundance levels should trigger remedial fisheries and habitat management actions to prevent most conservation problems becoming entrenched. Then, fewer conservation decisions would have to be made as to which at-risk stocks to address. In the interim, with the currently available information, only larger spawning populations would be addressed and most small spawning populations would be left to fend for themselves. This might still result in loss of biodiversity, but less than if conservation priorities are not set.

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5. Enhancement is used here to mean all forms of improving habitat or increasing survival of salmon. This ranges from obstruction removal, fishways and habitat restoration to large spawning channels and hatcheries.

9. Salmon Production Issues

To sustain salmon production, the productive capacity of the habitat and the fish that use it must be maintained. Habitat capacity issues are dealt with in Chapter 11, Habitat Issues. The number of salmon spawning in many of the streams in the study area is less than 25% of the spawner capacity of the stream. This is a concern because it limits both the production of that stock and the work that the spawners do to maintain the cleanliness of spawning gravel. It forgoes the production potential of unused habitat. The spawner shortfall is often a result of inherent weaknesses in fisheries management. This is discussed in Chapter 10, Fisheries Issues, Mixed Stock Fisheries.

The spawner abundance measures referred to under Conservation Considerations, are based on the assumption of an average spawner. However, spawners have been changing in the Central Coast. The average weight of some salmon species in the study area has decreased more than 25% in the last 40 years. For example, in 1951–54, the average weight of pink salmon was 2.07 kilograms and by 1991–94, the average weight had decreased to 1.4 kilograms. The decline in size is not just recent; a study by the fisheries scientist, Bill Ricker, showed that the size of chinook in the catch has declined since at least the 1920s.

George Brajcich seined in the study area in the 1940s. His catch log shows average pink weights of over 4.7 pounds (2.13 kilograms) in the late 1940s on the Central Coast. This doesn't account for the 3–6% shrinkage in weight from dry handling of catch then, or for gillnet selection for large fish, both of which would increase the average size of the catch compared to today. Allowing for these factors, the average weight could have been five pounds (2.27 kilograms) as compared to three pounds (1.4 kilograms) recently.

This is a concern to fishers because of the decrease in their weight of catch. More importantly, it is a conservation and sustainability issue because the number of eggs decreases with the size of the fish. The decline in the number of eggs per female may have been 20–30% or more since the early days of the fishery in the 1900s.

Another fish-size related concern is that the large fish can plant their eggs deeper in the gravel, thereby providing them more protection from predators, flooding and other disturbances. This means that small spawners produce fewer eggs and the resulting progeny are at higher risk of a number of mortality factors.

Small spawners also produce small eggs. Small eggs develop into small fry. Small fry are more susceptible to predation and for a longer time. In short, fry from small eggs have a lower survival rate than fry from large eggs.

The number of spawners has decreased. The number of eggs per spawner has decreased. The survival of the eggs has decreased and the survival of the resulting fry has decreased. This combination means that the overall production inputs have decreased much more than the spawner abundance trends indicate. Also, susceptibility to habitat variation has increased the production risks.

The possible causes of the decline in average size include:

- long-term size-selective harvesting, which reduced the average size of spawners and, for multi-age species, reduced the average age of spawners;

- medium-term reduced number of spawners that reduced competition for spawning area so that small fish are not displaced from viable spawning areas;
- medium-term increased competition in the ocean. (The size of Alaskan pinks has decreased as the abundance has increased; sockeye size also has been shown to decrease with abundance.); and
- the recent downturn in ocean survival, which may have aggravated the longer-term situation. However, salmon size was decreasing long before the recent changes in ocean conditions.

The potential impacts on stock biodiversity of these selective pressures are unknown.

The decrease in size and fecundity of spawners should be reviewed. Research should be conducted to determine the causes and consequences of size decreases and to identify possible remedial actions. In the meantime, increased numbers of spawners are required to compensate for lost productivity.

10. Fisheries Issues

Mixed Stock Fisheries

When a number of stocks with different productivities are fished together, there are **mixed stock fishery** problems. It is likely that stocks with below average productivity will be overharvested and those with above average productivity will be underharvested. Stocks with productivity reduced by the impacts of habitat development are particularly vulnerable to overharvesting. Those stocks that are harvested sequentially in a number of fisheries usually have a high probability of being overharvested. Because stocks are fished together, managers usually have no harvest information on specific stocks. This results in 'loose' management because it is difficult to attribute production to specific stocks. Without information on specific stocks, the only way to make a mixed stock fishery safe is to manage it very conservatively and, where justified, to have a subsequent, more stock-specific harvest. The key problems with mixed stock fisheries relate to the number of stocks fished together, differences in productivity and the capacity to harvest stock selectively.

All fisheries in the study area involve a mix of spawning populations. Over the last 30 years, fisheries have become considerably more stock-specific. Mixed stock fisheries on the outer coast have been closed or limited to reduce interceptions. Fishing has become more stock-specific. There still are potential interception problems in three commercial net fisheries that are on major migration routes and involve many local and passing stocks. These fisheries are:

- in Whale Channel (around Gil Island) in Area 6, with about 160 local and over 200 passing spawning populations;
- in Seaforth Channel in Area 7, with about 73 local and more than 150 passing spawning populations; and
- in Fisher-Fitz Hugh Sound in Area 8, with about 65 local and more than 120 passing spawning populations.

Other commercial net fisheries in the Central Coast area involve few passing spawning populations. Most also involve fewer local spawning populations. Most troll and sport fisheries in the area take place on major migration routes and involve many stocks.

There are significant differences in productivity of the stocks involved in fisheries in the Central Coast study area. These differences are related to the stocks' habitat, species and genetic characteristics. The productivity of stocks varies from year to year. Estimated productivity in the past ten years has ranged from 4.36:1[6] to 0.9:1 for pinks, 2.29:1 to 0.7:1 for chums, 1.7:1 to 0.24:1 for sockeye. It is clear that, on average, pinks can sustain a higher harvest rate than chums, which can sustain a higher harvest rate than sockeye. Most hatchery stocks are much more productive than wild stocks. With the differences in productivity between species and stocks, the less productive stocks tend to be overharvested in mixed stock fisheries unless special actions are taken for stock-selective harvesting. As a consequence, most small sockeye stocks in the area now get less that 25% of their target number of spawners. Clearly, more stock-selective harvesting and mandatory release of sockeye may be required to rebuild those sockeye stocks.

Chinook and coho are caught in a series of mixed stock fisheries, primarily outside their home area, so productivity rates are difficult to estimate. Such sequential harvesting is also a problem for the Rivers Inlet sockeye that, in the past, have had significant harvest in the Seaforth Channel, Fisher-Fitz Hugh Channel and outer Smith Sound fisheries. Unless harvests in other areas are carefully accounted, they can lead to overharvesting and can aggravate mixed stock fishery problems. Not identifying and accounting for harvesting in other areas (interceptions) is a problem in the study area. In the 1970s and 1980s, this problem was partially addressed when locations and management of a number of fisheries were changed in response to tagging program results. However, the available tagging information is very limited. Also, there have been no further tagging programs and stock-identification work in the area has been limited since then. Consequently, available information about stock migration routes, rates and timing doesn't adequately cover most of the current fishing areas.

The stock composition of catch in all major mixed stock fishing areas should be monitored and interceptions accounted for appropriately. All tagging information should be reviewed and summarized for stock migration route, rate and timing; programs should be conducted to fill in key missing information. Fisheries should be managed to minimize interception of stocks at conservation risk.

Actively and Passively Managed Stocks

Managing many different spawning groups together in a fishery is a major challenge. Instead of trying to manage for all of the stocks, the current practice is to manage fisheries for a few spawning populations that are representative of others in the area. These few spawning populations are "actively managed." This means that fisheries are managed to meet the escapement targets of these few spawning populations. All other spawning populations are "passively managed"—that is, they get no special protection in the fisheries. Essentially, they are incidental catch. If the actively managed spawning populations are representative of the other spawning populations, this is a relatively low-risk management approach. However, the current actively managed spawning populations are larger than other spawning populations. There are indications that actively managed spawning populations are also more productive. This means that managing for the actively managed spawning populations will tend to result in overharvest of passively managed spawning populations. For example, in the 1990s, passively managed spawning populations received a lower percentage of their spawner targets than actively managed spawning populations, as illustrated in the table below.

Most salmon species spawning populations are managed passively in the study area. Also, all but one of the spawning populations at risk of extinction are passively managed. The exception is the Green River odd-year pink spawning population that is actively managed and appears to have been wrongly classified as at-risk.

Percent of Spawner Targets Achieved

	Area 6 South		Area 7	
Species	**Active**	**Passive**	**Active**	**Passive**
Pink	34%	32%	67%	36%
Chum	55%	32%	62%	46%

When stocks have been genetically defined, it is likely that many passively managed spawning populations will be found to be closely related to actively managed spawning populations in the area. Where this is the case, allowing minor spawning populations to be run down might be considered a production issue, rather than a conservation issue. For spawning groups that are found to be stocks, as many sockeye will probably be, overharvesting will still be a conservation issue. Such stocks could be managed passively, as long as their abundance is not a conservation concern. If the abundance of such stocks decreases to levels of conservation concern, fisheries and habitat would have to be actively managed to protect the stock. Clearly, if stocks are to be conserved, they can't be passively managed unless they are at least as productive as the actively managed stocks they are fished with.

When stocks have been defined, actively and passively managed designations should be reviewed to ensure that basic conservation and sustained use requirements are met.

Pre-Season Management

The effectiveness of management tends to be conditioned by pre-season estimates of the number of salmon expected to return. Large estimated returns tend to result in optimistic management and high expectations of fishers. Overestimated forecast returns tend to result in overharvest and in delay making in-season conservation changes to fishing plans. Most pre-season estimates are based on the long-term average abundance and return rates. Consequently, when the returns are on a decreasing trend, as they have been recently, they are overestimated. When the conservation priority was emphasized recently, the pre-season estimates became more conservative. On average, 1990s pre-season predictions have improved over those of the 1970s, with more predictions within 50% of actual returns. There is a tendency to overestimate Central Coast returns and, in more than half of the last 12 years, the pre-season estimates were not within 50% of actual returns. This is not surprising because of the many variables affecting salmon returns. Most of these variables are poorly understood and monitored, and not easily predicted. These variables include ocean survival, age of return, migration rate, route and timing. It is for these reasons that there is a heavy reliance on in-season management.

The pre-season process for predicting returns should be reviewed to make predictions more risk-averse and to incorporate more factors in predictions.

Percent of Years Predictions within 50 per cent of Actual

Area	Chum	Pink	Sockeye	Chinook
6	45%	36%	—	—
7	73%	64%	—	—
8	64%	36%	64%	91%
9	27%	36%	45%	—
10	27%	45%	18%	—

In-Season Management

In-season management is decision-making based on actual measures and observations of the fish and fisheries made during the fishing season. By far the most effective in-season management in the Central Coast area has been for Smith Inlet sockeye. The reason is that this stock is managed by using an in-season fence count of salmon escapement and a terminal fishery. This has resulted in more consistently met spawner targets than for other stocks.

A key problem in managing other stocks is related to the reliance on catch in regular fisheries as an indicator of in-season abundance. On the positive side, this approach has low costs. On the negative side, the catch is from a mix of stocks so, at best, it indicates average returns and it is an unreliable predictor of abundance. Another concern with reliance on catch as an indicator of stock abundance is the great variability of stock migration route, rate and timing, and of fishing effort and catching power. Consequently, there is difficulty in controlling catch and harvest rate and in interpreting catch levels. For example, early in the season it is difficult to tell the difference between an early small return and a large return with regular timing. If the early small return is harvested as a large return, it could be severely overharvested. When stock returns are near to conservation concern levels, the manager is faced with either doing without any in-season indication of abundance or fishing into required escapement. For some spawning populations, counts of fish near or in their home streams provide a stock-specific indication of return early enough to be used to adjust the fishery.

Performance at in-season management in the Central Coast has been mixed, with some areas performing well and others poorly. Relying on catch as the primary in-season indicator of stock abundance may cost little but it **entails considerable conservation risk**, especially when stocks are low.

A network of index fisheries and key streams, with appropriate sampling, could provide information for both in-season and longer-term management of fisheries and habitat. Such a network could provide sequential measures of stock abundance and mix, timing, harvest rates and other assessment measures. It would have to be a long-term investment, but could be funded by catch.

In-season stock-abundance indicators other than catch in regular fisheries should be sought, at least for low abundance returns. A network of index fisheries and key streams should be considered. Also, population abundance should be specified below which no harvest will be allowed.

Fisheries Management Information

The state of fisheries management knowledge in the study area is mixed. Catch is accounted and sampled, but there has been little continuing effort to identify or account the stocks being caught. In the case of escapement, the visual index of salmon spawner abundance could serve as an adequate estimate of actual abundance, if there was consistency between years. However, the access to spawning areas has improved. Early estimates were all made by stream walks. Recent estimates are also made by aerial counts, which tend to see more of the spawners in a river. With recent budget cutbacks in federal and provincial government agencies, the number of stocks monitored and the number of visits per year have decreased on many streams. Also, the people making the estimates have changed irregularly, usually without any continuity between them. The expansion factors used to adjust for areas and times not observed were not formalized or consistent. The result is that these measures have changed through time but haven't been adjusted to account for these changes. Therefore, the amount of decline of many stocks is probably hidden.

Few stocks in the study area have reliable enough spawner estimates to do formal stock assessments. Clearly, there is more information on large sockeye stocks and on enhanced chinook and coho than on most wild pink, chum, coho or steelhead. The only stocks that have adequate input measures for assessment are Area 10 sockeye, hatchery stocks and, possibly, Bella Coola steelhead.

There is a desperate need for more in-depth monitoring and stock assessment, specifically for Rivers and Smith Inlet sockeye stocks, to understand and address the current dramatic declines in abundance.

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6. 4.36:1 means that on average 4.36 progeny return per parent spawner. 0.9:1 means that fewer (0.9) progeny return per parent.

11. HABITAT ISSUES

To conserve stocks and maintain their use, the productive capacity of salmon habitat must be sustained. Development in a salmon watershed involves important trade-offs in the public interest. It is in the public interest to have a diverse and developing economy. This means that each sector must compromise somewhat to allow other sectors to operate. The hope is that trade-offs between sectors and their related costs will be minimal and that the costs will be acknowledged and accepted. For the salmon resource, the trade-offs include reduced production in watersheds that are developed by other sectors such as forestry, agriculture, and urban and industrial users. These salmon production trade-offs are to increase the economic viability of these other sectors. If the salmon trade-off is limited to economic benefits, it is a political decision that may be acceptable. However, **if it is a salmon conservation trade-off that puts a stock at risk, there should be a public process to approve the trade-off**.

There are relatively few habitat management problems in the Central Coast area, compared to the Fraser River basin. However, all development in the Central Coast area is taking place in salmon watersheds, often immediately adjacent to salmon habitat. Logging has been underway in the large watersheds for many years and is moving to medium-sized watersheds. There is industrial and urban development in the Kitimat and Bella Coola watersheds. There are a number of small communities and developments on a few other salmon streams.

The major habitat management problem is related to the cost and difficulty of accessing this area. In other areas of British Columbia, habitat staff can drive to most development sites for pre-development inventory and planning, monitoring, implementation and operations, and evaluating any impacts. In most of this area, access is by sea or air, both of which are expensive. With the withdrawal of both federal and provincial fisheries staff and resources from the area, many development sites are not regularly monitored. Many streams are only visited by people enumerating spawners. Some salmon streams are not visited.

Because of limited management resources, high operating costs and the difficulty of accessing the area, the current habitat planning and management processes are less effective in the Central Coast than in other areas. Most habitats have not been inventoried, so development plans are often based on limited stream-specific information. Also, most habitats are not regularly monitored or documented. Therefore, there is no basis to demonstrate cause and effect of development impacts or as a basis for enforcement actions.

At the local level, loss of habitat productive capacity can be demonstrated. However, the impacts on fish production can’t be demonstrated in the short term, primarily because catch of pooled stocks and natural survival, fish behaviour and fisheries are highly variable. Another contributing factor is inconsistent measures of stock-specific abundance. In the Central Coast, developed areas have fewer at-risk spawning populations than undeveloped areas. However, developed areas are in the inner coast on large watersheds, with a reliable water supply that often is ice-fed. Most at-risk spawning populations are small, in the outer coast areas, often in small muskeg streams with seasonal water supply.

Although there has been loss of productive capacity, there is considerable underutilized habitat. Many areas are receiving only a fraction of their target number of spawners. The 17% of stocks in the study area that are rated at high-risk of extinction are underutilizing their habitat. For chinook, coho and steelhead, juvenile rearing and over-winter habitat is often the limiting factor. In the few streams that have been surveyed for rearing juveniles, unutilized habitat has been demonstrated.

Although the Fisheries and Oceans habitat protection policy direction is to seek "no net loss" and "net gain" of habitat capacity, neither is achieved. The current approach and tools are primarily defensive. At best, a defensive strategy can only slow the losses. With current management resources, agencies are forced to make conservation decisions on habitat with limited information and few effective tools. Without monitoring and follow-up, with plans based on limited information, and with enforcement based on voluntary compliance, a defensive strategy can't be expected to be effective.

It has become apparent that trying to restore habitat and stocks after damage has become detectable is ineffective. With high natural salmon variability, demonstrating damage can take a long time. The cost of restoring after-the-fact is much more than the cost of prevention. Even immediate mitigation is cheaper and more effective than waiting until problems have become firmly established.

Working with the developer to minimize impacts on fish and their habitat usually provides more protection per dollar than an adversarial approach. However, both approaches assume that minimizing impacts is enough to sustain salmon production and to conserve stocks. Any cost of foregone fish production is considered a necessary cost of realizing the benefits of development. In many of the watersheds in the area, forest harvesting is, at best, marginally economic. Any significant loss of fish production is enough to make the overall result an economic cost instead of a net benefit. Such development just reallocates jobs and income from one sector to another. Instead of narrowly evaluating the benefit/cost of the development, all impacts, including those on fish and other natural resource sectors, should be considered over the life of the impacts. If the potential impacts include a risk of reducing stocks to levels of conservation concern, the development as proposed should be rejected.

A more proactive approach could ensure that key production areas are better protected before development, by physical structures if necessary. Anticipated losses could also be compensated for before or during development. This would help to prevent losses, instead of only reacting to them after the fact. To date there has been limited pre-development mitigation. Some British Columbia municipalities have adopted the developer-pays principle as a means of ensuring that they can fund proper planning, preparation for and enforcement of development. This includes the developer posting a bond and making up-front payments. This puts the cost of development on the developer instead of on the public. A similar system would help to address salmon habitat protection in the Central Coast area. It would also tend to inhibit uneconomic development in salmon watersheds in the area.

For this area, adoption of a proactive habitat protection strategy is recommended, including: defining separate conservation and sustained habitat production levels; providing protection of salmon production areas before, during and after development; and requiring the developer to pay salmon conservation and protection costs.

A major shortfall in the area is the lack of area-specific habitat information. **There is an urgent need to get information on the early ocean salmon habitat to understand and address the causes of the widespread decreased survival in the last few years.** These impacts appear to have occurred in the estuarine or early ocean life habitats. Over the last 30 years, annual river discharge has decreased with the spring flow increasing and summer flow decreasing. Sea surface salinity and temperature have changed with different patterns in different areas. These factors may have affected salmon growth, transition to salt water and survival. There have also been influxes of species, such as mackerel and hake, which prey on juvenile salmon. It is not known what habitat factors have caused the recent dramatic decline in production in most stocks. A study of juvenile sockeye in the inner coastal area was conducted in Rivers Inlet in 1998, but the results have not yet been released. There has been no other recent work on this life stage for these stocks or anywhere else in the area.

12. Enforcement Issues

In both fisheries and habitat management, there is a heavy reliance on voluntary compliance. Often fisheries enforcement staff doesn't see habitat development or fisheries management problems until they receive a request from operational staff. In the case of a habitat issue, this is often when a development is substantially completed. As the development has been approved, technical staff often doesn't collect the information necessary to lay charges. **Without complete and conclusive information, enforcement and charges are often ineffective**.

It is becoming less reasonable to rely on voluntary compliance in the light of the desperate economic situation of many commercial fishers and ex-fishers. Furthermore, legal deterrents are weak, given the low probability of being detected and, if caught, of getting to court, being convicted and receiving a significant penalty. Current levels of enforcement are inadequate to provide a deterrent to inhibit illegal fishing.

The most stocks at high-risk of extinction are in areas that are difficult to monitor and enforce and that offer good poaching potential. It is difficult to determine whether the risk of being caught poaching has now become just another business risk and cost.

In outer Areas 6 and 7, many spawning populations have been declared at high risk of extinction. There has been little freshwater habitat alteration in the area and there have been no commercial fishery openings there in over 20 years. However, it is an isolated area that is difficult to enforce. There is no direct evidence that poaching is the problem in the area, but there are means, motive and opportunity.

There have been major cutbacks in financial and human resources assigned to the Central Coast area. Fisheries and Oceans staff, budgets, vessels and contracted patrolmen and guardians have all been significantly decreased as part of government downsizing. For example, in the Rivers and Smith Inlet area, the permanent staff has been moved out of the area. Departmental patrol vessels and seasonal patrolmen and guardians were also moved out of the area. Biological staff lacked the funds needed to conduct proper field investigations. Stock monitoring has been cut back and is now heavily reliant on community groups using temporary funding from British Columbia and Fisheries and Oceans Canada. If there were a fishery in these areas, the current resources wouldn't be enough to manage it and do any monitoring. **The resources dedicated to protecting these stocks in the 1990s clearly have not been adequate to detect, assess and address basic conservation and management problems.** A consequence of government budget reductions has been that there is now no knowledge of the causes of the precipitous decline in Rivers and Smith Inlet sockeye. Without such knowledge, effective remedial actions are delayed and may be impossible. In Rivers Inlet, this has been a very expensive loss in terms of how long it is likely to take the sockeye ecosystem to rebuild. The foregone annual average catch is worth between $10 million and $16 million and 500 or more jobs.

13. Effectiveness of Current Strategies

At an overview level, it appears that fisheries management has become more risk-averse and precautionary in response to recent policy direction that conservation is the first management priority. However, **without the above-described changes, current strategies will not be effective at conserving stocks**.

To ensure that conservation and sustained use of salmon stocks are achieved, many things should be done. To ensure continued improvement, a set of standard stock, habitat and management performance indicators should be developed and reported on annually.

Conservation and resource management responsibilities are divided among various agencies and levels of government. The federal government is responsible for the fisheries resources. The British Columbia government is responsible for all land and freshwater-based resource use and development. The industry sectors, which actually use the resources, are licensed to do so by various government agencies. The sectoral resource users and agencies all compete with each other to maximize their net benefits. In this competitive sectoral process, the lack of basic fish stock and habitat information has tended to compromise the sustained use of fisheries resources and, in some cases, their conservation. The inter-sectoral process has not been able to respond to changes in fisheries resource needs, such as the recent downturn in productivity.

The federal-provincial Land and Coastal Resource Management Plan (LCRMP) process is an opportunity for the various agencies and resource-use groups to work together. It is also an opportunity to address the increased salmon resource management risks resulting from the decreased salmon productivity in the Central Coast. The precautionary principle should be applied in developing the LCRMP. **In response, the federal and provincial governments, through the LCRMP process, should either defer all development potentially impacting salmon streams, or apply more stringent, proactive protection, until the current low productivity conditions end. This protection would avoid loss of salmon stocks that are under severe natural stress**.

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