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Conservation Strategy for Coho Salmon *(Oncorhynchus kisutch)*, Interior Fraser River Populations

October 2006

Canada

Conservation Strategy for

Coho Salmon (*Oncorhynchus kisutch*), Interior Fraser River Populations

by

Interior Fraser Coho Recovery Team

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Disclaimer:

This Conservation Strategy for coho salmon (*Oncorhynchus kisutch*) in the interior Fraser River watershed was prepared by the Interior Fraser Coho Recovery Team (IFCRT) in consultation with experts and observers

The strategy identifies recovery goals and objectives that are deemed necessary, based on sound biological principles, to protect and recover the coho salmon designated by COSEWIC as the Interior Fraser River populations. The strategy does not necessarily represent either the official positions of all agencies or the views of all individuals involved in the strategy's preparation.

Success in the recovery of these fish depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Fisheries & Oceans Canada or any other jurisdiction alone. Fisheries & Oceans Canada will support implementation of this strategy to the extent possible, given available resources and its overall responsibility for conservation.

This strategy may be complemented by one or more program plans that will provide details on specific recovery measures to be taken to support conservation of this species. Fisheries and Oceans Canada will take steps to ensure that, to the extent possible, Canadians interested in, or affected by, these measures will be consulted.

Acknowledgments:

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) provided the original impetus and some of the background information for this report.

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Sylvia Currie of www.webbedfeat.com was instrumental in establishing a central communication forum for use by all team members. Morley Farwell of Cariboo Fisheries Consulting assembled the efforts of the team and its working groups into this report on behalf of the recovery team.

Executive Summary

Background Information

The endangered status of coho salmon from the interior Fraser River watershed was established by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2002. The Fraser River is the largest salmon producing river in British Columbia (BC) and the interior Fraser River area (*i.e.* that portion of the watershed upstream of Hells Gate in the Fraser Canyon) constitutes most of the drainage basin of the Fraser River. Interior Fraser River coho salmon are genetically unique and can be distinguished from lower Fraser River coho salmon and from non-Fraser River coho salmon.

Summary of COSEWIC Status Report

Coho salmon are an important species, contributing to catches along the Pacific coast of North America and within the Fraser River. However, coho salmon numbers are declining throughout much of their range, particularly in the northwestern United States and southern BC. A COSEWIC species status report focused on coho salmon from the interior Fraser River of British Columbia (Irvine 2002).

Coho salmon from the interior Fraser River (Interior Fraser Coho) constitute a COSEWIC designated unit. The unit is comprised of five known populations (North Thompson, South Thompson, Lower Thompson, Fraser Canyon, and Upper Fraser). COSEWIC was concerned that if Interior Fraser Coho distribution became too fragmented, genetic exchange within the populations may be insufficient to ensure long-term survival.

On average, North and South Thompson coho salmon declined in numbers by approximately 60% during the 10-year period from 1990-2000. There were four years (1991, 1995, 1997, and 1998) when productivity was so low that some of the populations may not have been able to maintain replacement spawner numbers, even with a zero exploitation rate.

Natural spawning is responsible for producing most of the coho salmon escaping to the interior Fraser River, except for the Lower Thompson population where hatchery fish outnumber those produced from fish spawning in natural stream areas. There is no evidence that the overall distribution of coho salmon within the interior Fraser River watershed has changed, although spawners were observed in fewer streams as spawning abundance declined.

Over-fishing, changing marine conditions, and habitat perturbations have all contributed to declines in numbers of Interior Fraser Coho. Excessive fishing resulted when exploitation rates were not reduced in response to climate-driven reductions in marine survival. Exploitation rates have been reduced since 1998 and this combined with an apparent stabilization in marine survivals has resulted in improved returns.

The outlook for Interior Fraser Coho is highly uncertain and depends on the magnitude of negative impacts due to fishing, habitat perturbations, and climate related changes in survival. A return to higher survivals, combined with continued low exploitation rates, conservation of existing habitat, and habitat restoration, could produce increases in escapements and subsequently population recovery. However, if survival rates are at low levels, such as those recorded in 1998, spawner numbers will continue to decrease, possibly resulting in the eventual extinction of Interior Fraser Coho. Since there is no predictor of future survival rates, a cautious approach to harvest and habitat management will be required to ensure the long-term viability of Interior Fraser Coho.

Summary of Conservation Strategy Report

❖ Population Structure and Abundance

Studies of the genetic structure of Interior Fraser Coho indicate that there are five distinct populations within COSEWIC's designated unit; three populations within the Thompson (North Thompson, South Thompson, and Lower Thompson regions) and two populations within the Fraser (the area between the Fraser Canyon and the Thompson-Fraser confluence, and the Fraser River and tributaries above the Thompson-Fraser confluence). Moreover, due to the vast areas of the Fraser River basin, additional demographically independent groups (sub-populations) may also exist. The existence of two to three sub-populations within four of the five genetically defined populations is proposed. The exception is the Fraser Canyon population, where the majority of the spawning and rearing areas are within one river. A total of 11 sub-populations are identified and described in detail in the text (see Section 1.4).

Over the period of record (1975-2003) the 3-year mean escapement for Interior Fraser Coho peaked in the mid-1980's at over 70,000 fish, and declined to a running average of less than 18,000 individuals in the late 1990's. Similar trends are observed in total abundance (*i.e.* catch plus escapement), which declined from over 200,000 in the late 1970's and 1980's to less than 30,000 in recent years.

Trends in escapement for each of the five distinct populations are similar to those shown by aggregate total. The populations differ greatly in abundance; however, the North Thompson has consistently been the largest, and the Upper Fraser and Lower Thompson populations are typically smaller.

❖ Habitat Issues

The definition of habitat for Interior Fraser Coho includes spawning grounds and nursery, rearing, food supply, migration, and any other areas on which the population depends, directly or indirectly, in order to carry out their life processes. This broad definition means that anywhere that Interior Fraser Coho are currently found, or historically existed, is considered to be coho salmon habitat.

Within the geographic range of Interior Fraser Coho, there may be specific areas that, if damaged or destroyed, would jeopardize the survival or recovery of the COSEWIC designated unit or any of its constituents. These specific areas constitute important habitat for Interior Fraser Coho.

Important habitat is the minimum extent and configuration of habitat throughout the life history of each population of Interior Fraser Coho that is necessary to provide an acceptable probability that these fish will survive or recover according to specified recovery objectives. Although it follows that certain quantities of habitat at each life history stage are important, in practice it is difficult to identify these habitats.

Fisheries and Oceans Canada's understanding of important habitat for Interior Fraser Coho will improve as more effort and time is spent studying the interior Fraser River watershed. For the survival and recovery of the designated unit, populations and sub-populations must not become isolated from each other and habitats suitable for coho salmon rearing and reproduction must remain connected.

Given these requirements, three areas were identified by the IFCRT to initially focus on when important habitat is identified in a program planning stage; future work may identify other areas:

- That portion of the Nahatlatch River above Frances Lake to the confluence of the Nahatlatch River and Mehatl Creek,
- The Fraser Canyon in the vicinity of the Hells Gate fishways, and
- The North Thompson River in the vicinity of Little Hells Gate.

The Fraser Canyon population would lose more than 90% of its spawning habitat, and may no longer be viable if the Nahatlatch River above Frances Lake was damaged. Similarly the viability of one or more populations would be threatened if coho were unable to access spawning areas upstream of Hells and Little Hells Gate. Additional studies are needed to determine whether these and other freshwater, estuarine, and marine areas constitute important habitat.

The habitat protection goal is the maintenance of the function of these areas rather than simply maintaining the particular physical attributes of the landscape needed by the individual species. All habitat identified as important is essential to the survival and recovery of a species. Also, the full spectrum of protection and management measures will be required to ensure that there is no negative impact upon important habitat. Important habitat should be further identified during future phases of recovery planning.

In this context, protection has been defined as those measures and mechanisms that can reasonably be expected to protect important habitat from alterations that would reasonably be expected to reduce the capacity of important habitat to provide for the recovery and survival of a species.

It is important to clearly understand the distinction between the definitions of "habitat" and "important habitat" as noted above.

❖ Feasibility of Recovery

It is stated in a draft policy on the feasibility of recovery that recovery feasibility shall be based on specific criteria and must be defensible (Government of Canada 2004). It also states that the recovery of a species is feasible if:

- individuals capable of reproduction are currently available to improve the population growth rate or population abundance;
- sufficient and suitable habitat is available to support the species or such areas can be made available through habitat management or restoration;
- significant threats to the species or its habitat can be avoided or mitigated through recovery actions; and
- necessary recovery techniques exist and are effective.

The feasibility of recovery of the Interior Fraser Coho designated unit is based on the background information presented in the COSEWIC status report (Irvine 2002), further information presented in this report, and the professional opinions of Interior Fraser Coho Recovery Team members.

Following the review of the available data, the recovery team concluded that there are enough coho salmon, capable of reproduction, to increase the abundance of the Interior Fraser Coho populations, and that there is sufficient and suitable habitat available to support Interior Fraser Coho. The IFCRT also concluded that the significant threats to Interior Fraser Coho and its habitat can be avoided or mitigated through recovery actions, and that recovery techniques exist and are effective. Thus, it is feasible to recover Interior Fraser Coho.

❖ Recommended Scope of Recovery

The scope of recovery of Interior Fraser Coho will be determined by the willingness of affected persons, communities, and industrial operations to undertake those measures required for recovery at the population and sub-population levels. If it is possible to maintain the functions of sufficient habitat within the range of each of the 11 sub-populations, then it may be feasible to recover the entire designated unit to a level where all populations and sub-populations are able to maintain themselves through periods of poor ocean survival. Conversely, without ongoing commitments to provide adequate water and functioning habitats, the recovery of some of the sub-populations is unlikely.

❖ Recovery Goal

The recovery goal is to secure the long term viability of naturally spawning coho salmon within the interior Fraser River watershed.

❖ Recovery Principles

To guide the development of recovery objectives, three principles apply:

- ***Principle 1****: The recovery of Interior Fraser Coho will require the maintenance of sufficient levels of abundance and spatial diversity to achieve the recovery goal.*
- ***Principle 2****: The spatial structure and distribution of Interior Fraser Coho will be considered at the level of populations and sub-populations.*
- ***Principle 3****: The recovery goal is considered achieved when there are one or more viable sub-populations in each of the five populations.*

The term "viable" in Principle 3 means that the abundance and productivity of the individual sub-populations are sufficient for them to persist over the long term, *i.e.* an average human life time. Viability is achieved by establishing minimum population abundance levels and by ensuring that habitat conditions and fishing mortality are adequate to sustain long-term productivity.

A provisional operational rule for application of Principle 3 is that for each of the five populations, at least half of the sub-populations within each population must be viable.

❖ Recovery Objectives[1]

The following objectives need to be achieved in order for Interior Fraser Coho to be considered to have met the recovery goal.

Objective 1: The 3-year average escapement in at least half of the sub-populations within each of the five populations is to exceed 1,000 wild-origin spawning coho salmon, excluding hatchery fish spawning in the wild. This represents a total Interior Fraser Coho spawning escapement of 20,000 to 25,000 wild-origin coho. This objective is designed to provide the abundance and diversity required to satisfy the recovery goal.

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[1] Bradford and Wood (2004) review the literature and theory involved in establishing minimum viable population sizes and recovery objectives.

Objective 2: Maintain the productivity of Interior Fraser Coho so that recovery can be sustained. This objective is designed to ensure that the threats to recovery are addressed.

This objective may be met by addressing the causes for the decline that were identified by COSEWIC:

- Development of a harvest management plan to ensure that exploitation rates are appropriate to changes in productivity caused, for example, by fluctuations in ocean conditions.
- Identification, protection, and, if necessary, rehabilitation of important habitats.
- Ensure that the use of fish culture methods is consistent with the recovery goal.

Possible Longer Term Objectives: Over the long term it may be desirable to recover Interior Fraser Coho so that other societal objectives can be achieved. Examples of this type of objective have been identified, but determination of the appropriateness of such is beyond the mandate of the Recovery Team (see Section 3.3)

❖ Genetic Issues

There are genetic consequences to small population sizes that might affect the long-term viability of Interior Fraser Coho. Reductions in population size can result in the loss of genetic diversity, and small populations can suffer from the cumulative effects of inbreeding. There is scientific debate over the number of effective breeders required in a population to maintain long-term genetic variation, but the range is approximately 500 to 5,000 individuals. Under ideal conditions, an abundance level of 1,000 spawners in each of the five populations of Interior Fraser Coho would likely be adequate.

However, some Interior Fraser Coho populations encompass a large geographic area and a population of 1,000 spawners could be fragmented into small groups isolated by distance. Because of the fragmentation of Interior Fraser Coho populations into small groups, the 1,000 spawner recommendation may be too small to maintain genetic diversity.

❖ Demographic Issues

Small populations are at risk of becoming extirpated because of chance events, or because of their reduced capacity to survive periods of poor environmental conditions. The analyses conducted to date suggest that if a sub-population has a reasonable expectation for growth, an initial size of 1,000 spawners annually would be adequate for survival and recovery. However, salmon populations are inherently variable and it is unlikely that all 11 sub-populations would have the same status at any one time. The application of Recovery Principle 3 and Objective 1 (see above) suggest that at least half of the sub-populations within each of the five Interior Fraser Coho populations should be viable in order to meet demographic needs.

- **Application of Abundance Recommendations to the Recovery Objectives**

There are additional factors when considering an abundance-based recovery goal for Interior Fraser Coho. These are:

- The 11 sub-populations are different in geographic size, and historically have differed considerably in abundance. Thus, some sub-populations are more likely to recover than others.
- The recovery objective is to be expressed as the number of spawners for the whole designated unit (DU). This number is greater than a minimum value of 7,000 spawners (the minimum number of fish in the minimum number of viable sub-populations).

An evaluation of the performance of Objective 1 was undertaken using historical data. In particular, the relation between the abundance of fish in individual sub-populations and the total DU abundance was examined. An analysis of the geometric mean wild-origin spawner abundance for the 11 Interior Fraser Coho sub-populations for the period 1998 through 2003 indicates that while there has been considerable variation in the average size of each sub-population, nearly all have been near, or above, the 1,000 fish objective. Over that same period, with the exception of the Upper Fraser population, there appears to be at least one relatively dominant sub-population within each population. These data provide evidence that Recovery Objective 1 has, on average, been achieved. The data also indicate that Recovery Objective 1 is realistic and may be achievable if Recovery Objective 2 is implemented.

- **Performance of Recovery Objective 1 using 1975-2003 Data**

The historical data can also be used to find the total abundance level that will lead to the achievement of Recovery Objective 1 of having at least half of the sub-populations in each population with a 3-year mean escapement of at least 1,000 wild-origin spawners. An analysis of these data shows that the number of sub-populations that falls below 1,000 individuals increases significantly when aggregate DU abundance is less than 20,000 to 25,000 individuals. The analysis also suggests that when there were fewer than approximately 20,000 coho salmon spawners (3-year running geometric mean) in the DU, the recovery goal would not be met.

Thus, the historical data suggest that a level of abundance of 20,000 to 25,000 wild-origin spawners in the Interior Fraser coho salmon designated unit is required to achieve Recovery Objective 1.

❖ Approaches to Meeting Recovery Objectives

Approaches to addressing each of the potential threats to recovery are discussed below. The key threats to recovery are harvest, climate change, habitat change, and hatchery production (see section 1.7). Approaches to minimize the impact of each of these threats are:

- *Harvest*. Establish exploitation rates based on survival and abundance forecasts and define conservative escapement goals.
- *Climate change*. Recover all sub-populations so that the probability of remaining viable during periods of climate-related low marine and freshwater productivity is increased.
- *Habitat Change*. Maintain functionality and productivity in as many habitats as is feasible. In addition, investigate the relationship(s) between habitat types and coho salmon throughout their life history in order to assist in the determination of important habitat requirements.
- *Hatchery Production*. Where appropriate, use hatchery production as part of the conservation strategy, as well as for assessment of abundance and survival. Hatchery production should be monitored and minimized to reduce possible genetic and competitive impacts, and, finally, mass marking of selected hatchery releases should be continued to assist in addressing harvest concerns.

❖ Control of exploitation

Southern BC origin coho salmon, particularly those from the interior Fraser River, were at a low level of abundance in 1997 and a series of comprehensive fishery management measures were implemented. In 1998, Fisheries and Oceans Canada (DFO) announced that the objective of their fishery management actions would be to produce no mortality on Thompson River coho salmon, a sub-set of Interior Fraser Coho. The reductions in exploitation initiated in 1997 have been maintained; however, even at the relatively low current exploitation rates (approximately 13%, Canada and U.S. combined) and recent survival rates, the long term probability of wild escapements falling below recent levels is greater than 50%, while, over the short term, the probability of positive growth is 64%. The survival potential for Interior Fraser Coho increases marginally if exploitation is decreased from the current level; however, a decrease in current Canadian exploitation rates would have very little impact upon recovery. The recovery of Interior Fraser Coho to historical levels is highly sensitive to marine survival rates. Specific fisheries management actions to ensure that exploitation rate ceilings are not exceeded (including specific selective fishing practices for Interior Fraser Coho) are currently set out in the Pacific Salmon Integrated Fisheries Management Plan on an annual basis. Restrictions on exploitation rates should continue until there is an increase in survival rates and an increase in the numbers of spawning Interior Fraser Coho.

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1 Background

In 2002, coho salmon from the Fraser River upstream of Hells Gate (Interior Fraser Coho) were categorized by the Committee on the Status of Wildlife in Canada (COSEWIC) as a designatable unit since they are genetically differentiated and substantially reproductively isolated from all other coho salmon. Relying primarily on information provided in a COSEWIC status assessment by Irvine (2002), COSEWIC (2002) assigned the status of endangered to Interior Fraser Coho. COSEWIC concluded that Interior Fraser Coho were a unit of coho salmon biodiversity that had declined by more than 60% in numbers of individuals due to changes in freshwater and marine habitats, over-exploitation, and impacts relating to hatcheries. In addition, COSEWIC was concerned that reductions in fishing mortality, begun by Fisheries and Oceans Canada (DFO) in 1997, were insufficient or would not be maintained long enough to assure recovery. Furthermore, COSEWIC expressed concern that marine survivorship might not improve, that habitat loss or deterioration in the watershed would continue, and that use of hatcheries may threaten recovery.

In 2003, DFO formed an Interior Fraser Coho Recovery Team (IFCRT). The IFCRT prepared this document to provide advice on a recovery goal, recovery objectives, and approaches to reach those objectives. This report describes Interior Fraser Coho and their needs, identifies threats to their survival, identifies important habitat to the extent possible, sets objectives and approaches for recovery, identifies information gaps that should be addressed, and suggests that one or more program plans relating to the conservation strategy should be completed.

1.1 Importance to People

Interior Fraser Coho constitute an important component in the evolutionary legacy of the species and they occupy a significant portion of the species' range within Canada (Irvine 2002). They are harvested in commercial, recreational, and First Nations fisheries in, and adjacent to, the fresh and marine waters of British Columbia. In addition, coho salmon form an important part of the life and culture of First Nations groups within the interior Fraser River watershed. Coho salmon have been harvested and used for food, trade, and ceremonial purposes for centuries by First Nations groups. Finally, many people in the Fraser River watershed place a high value on maintaining healthy fish habitats and viable salmon populations. To that end, many community groups have worked for years to restore or maintain riparian and stream habitat and to promote conservation of species and maintenance of biodiversity. A list of stewardship and other groups working with Interior Fraser Coho is provided in Appendix 1.

1.2 COSEWIC Species Information [2]

Common Name:	Coho salmon (interior Fraser River populations)
Scientific Name:	*Oncorhynchus kisutch*
Assessment Summary – date	May 2002
Status:	Endangered
Reason for designation:	A nationally significant population that has experienced declines in excess of 60% in number of individuals due to changes in freshwater and marine habitats and to overexploitation. COSEWIC was concerned that reductions in fishing pressure may be insufficient or not maintained, that marine survivorship may not improve, that habitat loss or deterioration in the watershed is continuing, and that use of hatcheries threatens recovery. COSEWIC concluded that there is a serious risk of extinction of interior Fraser coho salmon.
Occurrence:	British Columbia
Status history:	Designated endangered in May 2002.

1.3 Description of the Species

Coho salmon occur naturally only within the North Pacific Ocean and its tributary drainages (Scott and Crossman 1973). Within North America, naturally spawning coho salmon occur in streams from California north through British Columbia to Alaska (Figure 1). Their distribution extends across the Bering Sea through the Kamchatka area to the Sea of Okhotsk (Sandercock 1991). In addition, coho salmon have been introduced to many other global locations, including several New England states, the Great Lakes of North America, Alberta, New Zealand, and South America.

[2] Additional details on the causes of the decline in the interior Fraser River coho salmon population, including information gathered subsequent to the COSEWIC Status Report (Irvine 2002) may be found later in this document (see section 1.7, Potential Threats).

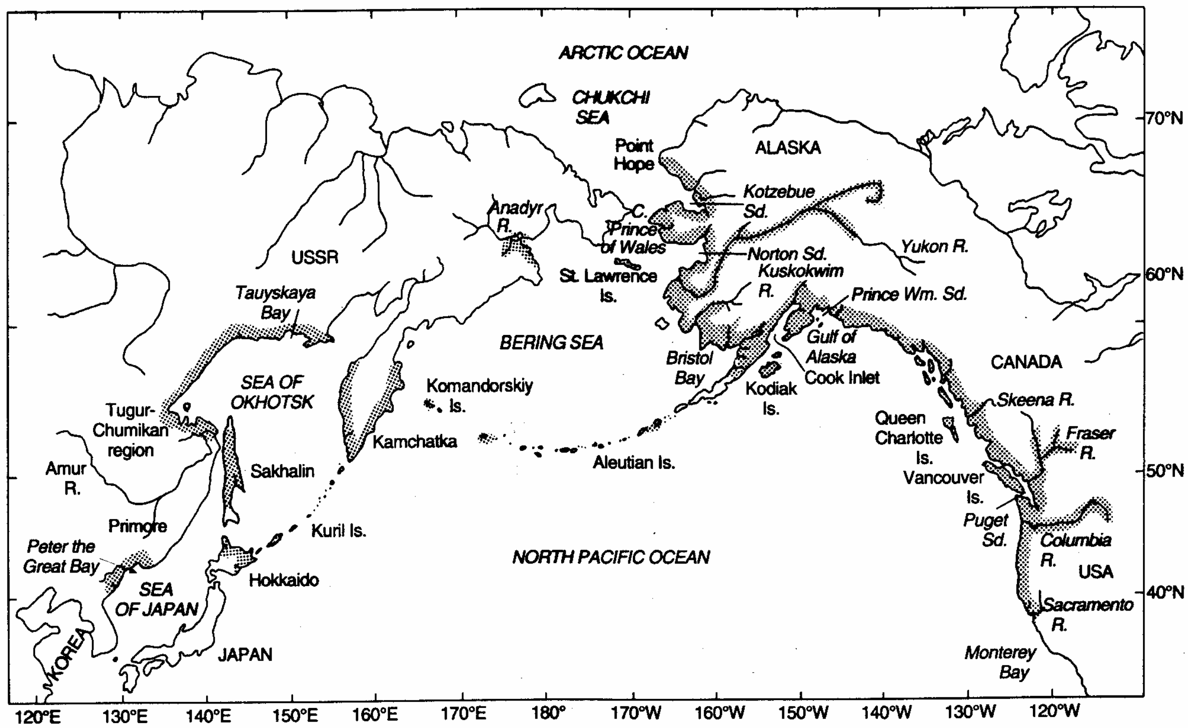

Figure 1. Approximate global distribution of naturally spawning coho salmon (Source: Sandercock 1991).

1.3.1 Freshwater Distribution

Coho salmon spawn and rear in most coastal streams of BC including the Fraser River, the largest salmon producing river in BC. Upstream of Hells Gate in the Fraser Canyon, coho salmon are widespread throughout the Thompson River system (Figure 2). Their distribution in non-Thompson River tributaries to the Fraser River, *i.e.* in the Upper Fraser and Fraser Canyon areas, is less well known. Coho salmon are known to occur as far upstream as the Nechako River in the Upper Fraser area, but there are several major Upper Fraser watersheds where coho salmon presence is probable but has not been confirmed. More details are provided in the discussion of the populations and sub-populations of coho salmon within the interior Fraser River watershed (see section 1.4).

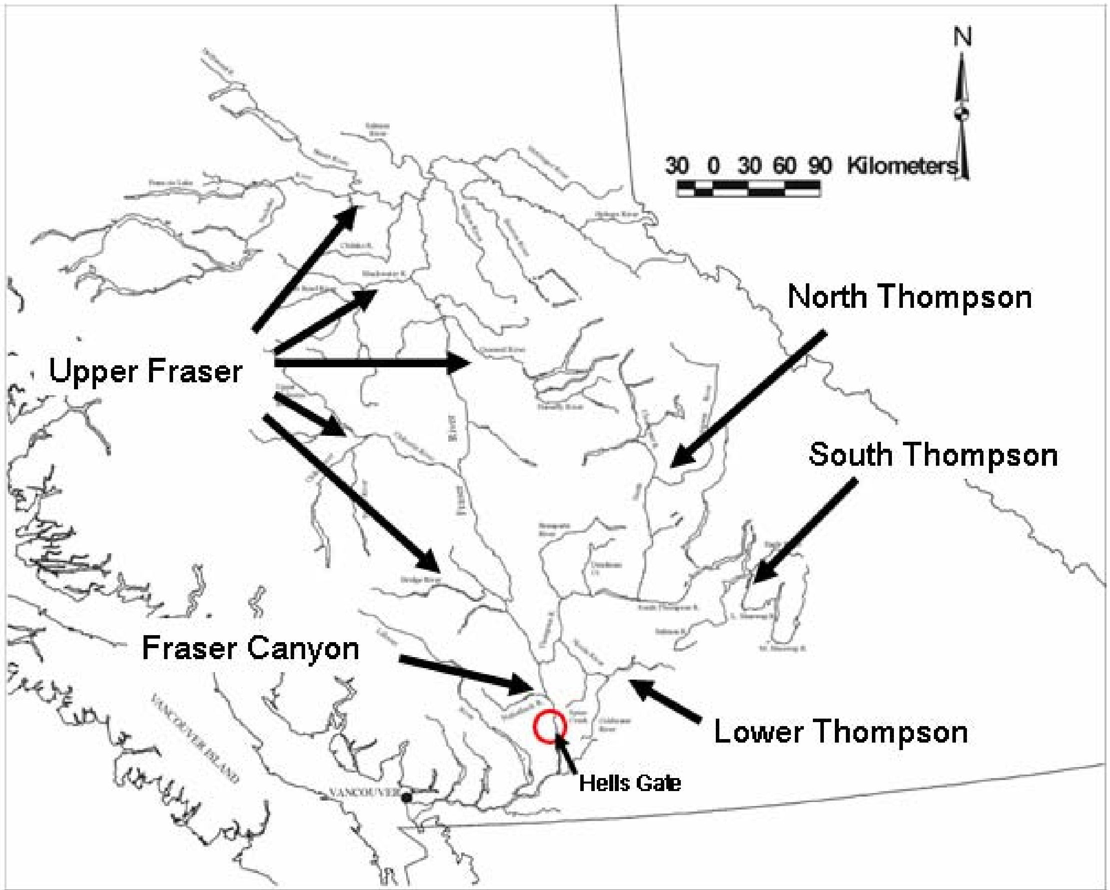

Figure 2. Approximate freshwater distribution of known populations (North, South, and Lower Thompson, Fraser Canyon, and Upper Fraser) of interior Fraser River coho salmon.

The distribution of coho salmon within the interior Fraser River watershed is dependent upon the overall distribution of accessible rearing and spawning areas. There are more than 11,775 km of stream habitat within the known range of Interior Fraser Coho and of this total approximately 7,019 km are accessible to migrating coho salmon (Table 1). These are minimum estimates as, for the most part, they only represent mainstem distances along the major tributaries of the Fraser River and the mainstem distances along the main tributaries to those streams. While the amount of coho salmon utilization of the Upper Fraser area is poorly understood it is important to note that over two-thirds (67%) of the stream area accessible to coho salmon lies in the upper portions of the Fraser River. The populations for which most data exists, *i.e.* those in the Thompson River drainage, occupy less than one-third (31.9%) of the area accessible to coho salmon. The lack of records on the presence of coho salmon in many parts of the Upper Fraser area is a major knowledge gap (see section 1.8).

Table 1. Total mainstem stream lengths and currently accessible coho salmon habitat in the interior Fraser River watershed (Source: Appendix 2).

Population region	Total stream length (km)	Percent of total	Stream length accessible to coho salmon (km)	Percent of total	Stream length suitable for coho salmon spawning (km)	Percent of total
Fraser Canyon	104.4	0.9	78.3	1.1	78.3	2.1
Upper Fraser	7,504.1	63.7	4,702.3	67.0	1,754.4	47.7
North Thompson	1,536.4	13.0	844.0	12.0	576.3	15.7
Lower Thompson	1,013.2	8.6	613.3	8.7	585.7	15.9
South Thompson	1,620.6	13.8	781.4	11.1	686.9	18.7
Total	11,778.6	—	7,019.3	—	3,681.5	—

Within the 7,019 km accessible to coho salmon there are nearly 3,682 km that are suitable for coho salmon spawning (Table 1). It should be noted that these are minimum amounts of spawning areas as they only represent mainstem distances along major interior Fraser River streams and their tributaries. Of the total spawning area to which Interior Fraser Coho have access, one-half (50.3%) is located within the Thompson River drainage; however, an almost equal amount (47.7%) of spawning area is accessible within the Upper Fraser area. Although there are over 1,754 km of spawning area within the Upper Fraser area there are relatively few streams within that area where coho salmon are regularly observed. The high abundance of spawning area in a region where there are few reports of spawners further exacerbates the knowledge gap around the distribution of Interior Fraser Coho.

1.3.2 Ocean Distribution

Juvenile coho salmon emigrate from their natal areas to the ocean via the Fraser River and its estuary, likely between April and June. Juveniles rapidly disperse in the marine environment, but are thought to remain largely in coastal waters (Sandercock 1991).

Coho salmon become vulnerable to marine fisheries in the spring, summer, and fall of their second year of ocean residence, and captures of Interior Fraser Coho in various fisheries provides insight into their probable marine distribution and migration patterns. However, it is important to realize that fish samples are only available from areas and times in which fisheries occur, and thus may be providing an incomplete assessment of their true ocean distribution.

Since 1984, the marine distribution of marked coho salmon populations has been estimated using data obtained through the Mark Recovery Program (MRP) operated by Fisheries and Oceans Canada (DFO). Magnetic coded-wire tags (CWTs) are inserted into large numbers of juvenile coho salmon during their freshwater period of residence. Recoveries of CWT marked coho salmon from various fisheries provide information on fishery exploitation rates and apparent marine distributions. More recently, DNA analysis has been used to identify the origin of coho salmon captured in fisheries (Irvine et al. 2001).

Coho salmon that originated in the interior Fraser River area have been recovered in fisheries from Alaska to Oregon (Irvine et al. 1999a). In general, most were recovered from commercial troll and sport fisheries operating during the summer months off the west coast of Vancouver Island and in the Strait of Georgia. Maturing coho salmon begin to migrate towards the Fraser River in their second summer at sea, with upstream migration occurring in September and October (Irvine et al. 2001).

The proportion of the catch of coho salmon from fisheries within the Strait of Georgia (inside) compared to fisheries operating off the west coast of Vancouver Island (outside) has varied considerably among years. These variations have been correlated with changes in ocean salinity (Kadowaki 1997). During the 1970's and 1980's, large numbers of coho salmon remained inside the Strait of Georgia each year and supported large sport and troll fisheries (Simpson et al. 1997). In 1991, 1995, 1996, and 1997, most coho salmon appeared to leave the Strait of Georgia in the fall of their first year, and were vulnerable to fisheries operating in outside areas (Irvine et al. 1999b). There are relatively few catch distribution data available for Interior Fraser Coho. However, those that are available support the hypothesis that Interior Fraser Coho have a similar distribution to many other southern BC coho salmon populations. In 1993, most Interior Fraser Coho were caught in the Strait of Georgia, while in 1996 most were taken off the West coast of Vancouver Island. Beamish et al. (1999) suggest that these distribution variations were caused by changing ocean conditions driven by climate. Major fishery closures commencing in 1998 have made it more difficult to infer inside-outside distribution changes.

1.4 Population Structure and Abundance

1.4.1 Population Structure

The viability of Pacific salmon populations depends not only on the number of individuals that comprise them, but also on the maintenance of genetic, life history, and geographic diversity (McElhaney et al. 2000). Diversity protects the evolutionary capacity of the population to change and persist in the face of future environmental change, such as climate variation and habitat change. Therefore, conserving biodiversity is an insurance policy for the future evolution and survival of coho salmon. With regard to Interior Fraser Coho, such conservation forms the basis for the continuation of cultural and socio-economic benefits and for maintaining ecological processes.

The coho salmon that re-colonized the interior Fraser River and tributaries above Hells Gate in the Fraser Canyon (Figure 2) at the end of the last period of glaciation came from glacial refugia in the Columbia River basin (Northcote and Larkin 1989). Coho salmon in the middle and upper Columbia River watershed areas that may have been genetically similar to Interior Fraser Coho are now extinct, thus Interior Fraser Coho represent the last remaining populations of this genetic group. Interior Fraser coho are readily distinguished from coho salmon of the lower Fraser River using neutral genetic markers (Beacham et al. 2001). Hells Gate in the Fraser Canyon appears to be a natural boundary that separates many fish populations into interior and lower Fraser River genetic units.

The genetic structure of Interior Fraser Coho has been investigated extensively (Beacham et al. 2001; Irvine et al. 2000). Sampling has been widespread across the interior Fraser River spawning areas; however, there are still significant gaps in the baseline samples, particularly from spawning areas in the upper Fraser and in some of the more remote Thompson River tributaries.

Studies of the genetic structure of Interior Fraser Coho indicate that there are five distinct populations within COSEWIC's designated unit (Table 2). These populations correspond to the five major coho salmon bearing regions within the interior Fraser River; three within the Thompson (North Thompson, South Thompson, and Lower Thompson regions) and two within the Fraser (the area between the Fraser Canyon and the Thompson-Fraser confluence and the Fraser River and tributaries above the Thompson-Fraser confluence) (Figure 2).

Migration among different Thompson River basins and between Thompson and non-Thompson drainages is sufficiently restricted to permit local adaptations to occur (Irvine et al. 2000). Coho salmon of the Fraser Canyon population are quite distinct from other Interior Fraser Coho populations, and appear to be closely related to those of the lower Fraser River, implying that some genetic exchange may occur between those areas. Irvine et al. (2000) noted that, based on genetic information, subdivision of the designated unit beyond these five populations was not warranted.

Table 2. Populations within the interior Fraser River coho salmon designated unit.

Population	Description
Fraser Canyon	Coho salmon originating from the Fraser River and tributaries upstream of Hells Gate and downstream of the Fraser-Thompson confluence
Upper Fraser	Coho salmon originating from the Fraser River and tributaries upstream of the Fraser-Thompson confluence
North Thompson	Coho salmon originating from the North Thompson River watershed including the mainstem, lakes, and tributaries upstream of the confluence of the North and South Thompson rivers.
South Thompson	Coho salmon originating from the South Thompson River including the mainstem, lakes, and tributaries upstream of the confluence with the North Thompson River
Lower Thompson	Coho salmon originating in the Lower Thompson River including mainstem, lakes, and tributaries downstream of the confluence of the North and South Thompson rivers.

While the genetic data does not suggest the presence of additional populations, many of the five populations occupy vast areas of the Fraser River basin, within which demographically independent groups may exist. Such groups have been defined as sub-populations. Sub-populations within a population may not be isolated enough from each other to be differentiated based on neutral allele composition; however, they may have different life history traits, productivities, and population dynamics.

Within each sub-population there are varying numbers of spawning aggregations or demes (Table 2). Information on the recovery of tagged hatchery fish from non-natal streams suggests that Interior Fraser Coho have a lower level of fidelity (*i.e.* more straying) to individual spawning streams than occurs in most coastal coho salmon. Observations of annual variations in spawning escapements support this contention. Spawners appear to choose spawning sites opportunistically from within broad geographic areas, based on flows, access, and temperatures, rather than homing with high fidelity to individual streams. This behaviour may have evolved in response to widely fluctuating surface flow and groundwater conditions, and beaver activity that can compromise access to individual tributaries.

Procedures for defining sub-populations are inexact; however, a suite of characteristics based on similarities in productivity, run timing, and other life history traits, geography, and manageability have been used. Earlier analyses failed to detect appreciable differences in the marine mark recovery patterns among South Thompson, North Thompson, Lower Thompson, and Upper Fraser populations (Irvine et al. 1999b). Nevertheless, since their spawning and rearing distributions are geographically discrete, it is likely that coho salmon populations from each interior Fraser River region have been, and continue to be, subjected to differing selective pressures within the freshwater environment. Similarly, among or within the five populations, spawning and rearing conditions may be influenced by the presence of barriers, thermal and flow variations, or other selective factors.

The existence of two to three sub-populations within four of the five genetically defined populations is proposed. This is based on the following factors: the presence of natural barriers, the influence of large lakes on downstream discharge and thermal regimes, observations of spawner aggregations under differing discharge conditions, and limited genetic evidence. The Fraser Canyon population, where the majority of the spawning sites are within one river, is the exception where only a single demographic sub-population is proposed. The 11 sub-populations are described in detail below (Figures 3 through 7), and are summarized in Table 3.

1.4.1.1 Sub-populations of coho salmon of the North Thompson

Within the North Thompson basin, three sub-populations or aggregations of coho salmon spawners have been defined (Figure 3); however, it is likely that there is substantial overlap of habitats used by rearing juveniles from those sub-populations.

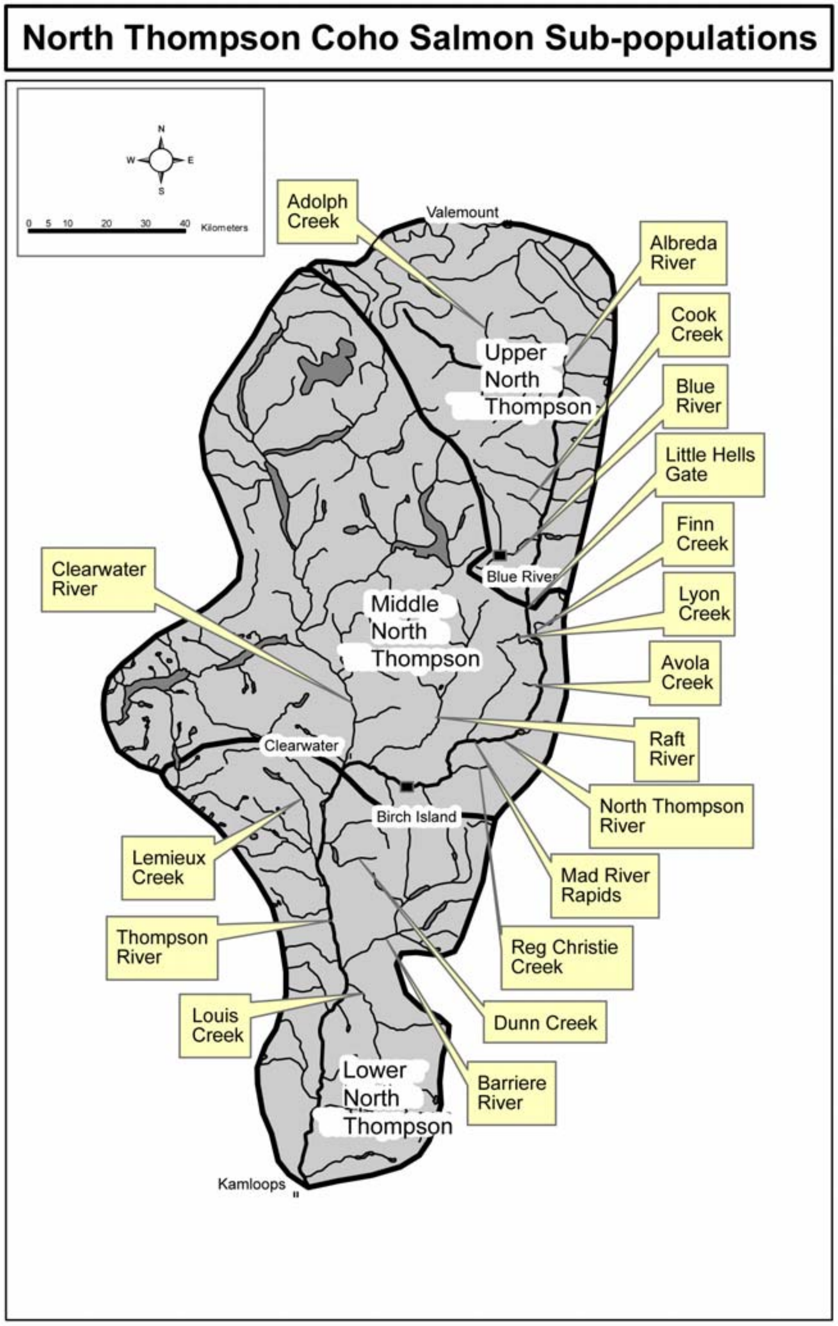

Figure 3. Sub-populations of coho salmon within the North Thompson River

1.4.1.1.1 Upper North Thompson coho salmon sub-population

The Upper North Thompson coho salmon sub-population is located within the North Thompson and tributaries in the vicinity of, and upstream of, Little Hells Gate on the North Thompson. During high water years, coho salmon have access to the upper river tributary streams, and spawners are found in the Blue River and its tributaries, Albreda River and tributaries, Mud River, Thunder River, Milledge Creek, Cook Creek, and other tributaries to the North Thompson mainstem upstream to at least Adolph Creek. In years where access to smaller tributaries and upstream areas of larger creeks is poor due to low water or beaver activity, coho salmon spawning tends to occur in the lowermost reaches of the larger rivers (*e.g.* Blue and Albreda rivers) and in aggregations in the mainstem North Thompson from Blue River upstream; particularly in the area upstream of the Albreda confluence. It is possible that fish from Lion and Finn creeks, located in the Middle North Thompson sub-population, may actually belong to this sub-population, as there have been several years when passage above Little Hells Gate was not possible. In those years large numbers of spawners have been observed in Lion and Finn creeks and in the mainstem Thompson at the mouth of Finn Creek.

Arrival on the spawning grounds may be hampered at low flows producing difficult passage through the North Thompson mainstem constriction at the Mad River rapids. Issues with restricted passage through a second rapid (known as Little Hells Gate) have been addressed on several occasions by blasting, and unobstructed fish passage has occurred annually since 2000. Peaks of spawning activity usually occur 1-2 weeks earlier than for the middle and lower North Thompson sub-populations.

1.4.1.1.2 Middle North Thompson coho salmon sub-population

The Middle North Thompson coho salmon sub-population is located within the North Thompson mainstem and its tributaries between the confluence of the Clearwater and North Thompson rivers upstream to Little Hells Gate on the North Thompson. In this section, there are several productive tributaries and at least five groundwater fed side channels that, when accessible, are heavily colonized by spawners. The main spawning tributaries include Reg Christie and Wire Cache creeks and the Raft River. Side channels are located in the area between just upstream of Vavenby downstream to Birch Island, and include the Pig, Slate, and Birch Island channels. In higher flow years, spawners have access to both tributary and side channel habitats; however, in low water years, spawning is restricted to large areas of the North Thompson mainstem alongside instream islands from Vavenby downstream to Birch Island. Spawners also utilize a rolling gravel dune habitat off the mouth of Finn Creek. Spawning has been reported in the Clearwater River; however, they have only been observed in the vicinity of the Clearwater hatchery and near the Whitehorse Bluffs. No coho salmon have been observed upstream of the confluence of the Clearwater and Mahood rivers.

1.4.1.1.3 Lower North Thompson coho salmon sub-population

The Lower North Thompson coho salmon sub-population occupies the North Thompson and its tributaries downstream of the confluence of the Clearwater River and is centered in the area between the communities of Barriere and Blackpool. Both wild and hatchery origin coho salmon spawn in Dunn, Louis, and Lemieux creeks, while significant numbers of wild coho salmon return to the Barriere River system including Fennel Creek and its tributaries. During wetter periods, spawning occurs throughout the tributary streams listed above as well as in Mann, Fish Trap, and Jamieson creeks. However, in low flow years, access to tributaries can be difficult and spawning frequently occurs in the North Thompson mainstem between Blackpool and Lemieux Creek, in areas also used by pink, sockeye, and chinook salmon spawners.

The coho salmon in three streams in the Lower North Thompson sub-population have been enhanced. From 1983 to the present, the North Thompson Indian Band has operated an enhancement facility adjacent to Dunn Lake. The goal of this facility is to increase the returns of coho salmon to Dunn, Lemieux, and Louis creeks. Louis Creek coho salmon were considered by DFO to be of conservation concern, but, following changes in fisheries management practices in the late 1990's, their numbers are increasing.

The abundance of spawning coho salmon in Lemieux and Louis creeks is used as indicators of status of these demes (a group of fish in which the genetic mix is similar throughout the group; for coho salmon, a deme is often a group of fish found reproducing within a single stream or portion of a stream). To assist in assessment of these Lower North Thompson demes, juvenile coho salmon are marked prior to release and the returning escapement is monitored. Straying of returning marked coho salmon among streams in this sub-population has been commonly observed.

1.4.1.2 Sub-populations of coho salmon of the South Thompson

As with the North Thompson drainage, three demographically based sub-populations of coho salmon spawners are defined within the South Thompson River (Figure 4). Unlike the North Thompson, it is less likely that there is substantial overlap of habitats used by the juveniles from the three sub-populations, with the possible exception of coho salmon juveniles, which rear in Shuswap Lake.

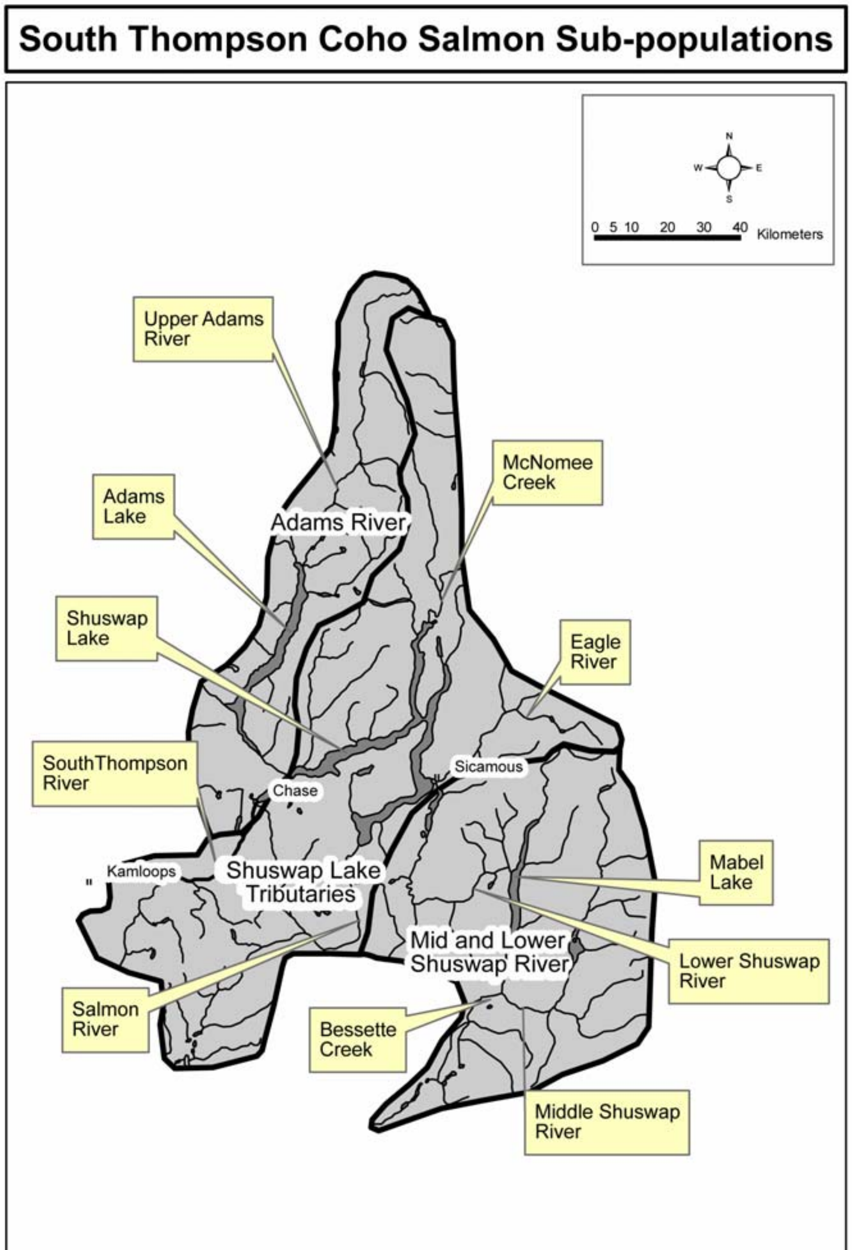

Figure 4. Sub-populations of coho salmon within the South Thompson River

1.4.1.2.1 Adams River coho salmon sub-population

The Adams River coho salmon sub-population is located within the tributary streams of Adams Lake, including Sinmax, Momich, and Cayenne creeks, and the Upper Adams River and its tributaries. The coho salmon in the Upper Adams River spawn in the mainstem below and above Tum Tum Lake at low water levels. However, during high water periods, they are most abundant in tributary spawning areas such as Harbour Creek and in the Upper Adams River upstream of Tum Tum Lake.

1.4.1.2.2 Shuswap Lake Tributaries coho salmon sub-population

The Shuswap Lake Tributaries coho salmon sub-population is located within the tributary streams of Shuswap Lake, excluding the Shuswap River drainage. This sub-population is numerically dominated by the coho salmon spawning in the Eagle River drainage, but there is also a significant spawner aggregation in McNomee Creek. There are lesser abundances scattered throughout the remaining Shuswap Lake tributaries. Coho salmon also spawn in the Salmon River at Salmon Arm; however, most of these are of hatchery origin.

The coho salmon within the Salmon River were considered by DFO to be of conservation concern and have been enhanced since 1984, first at the Eagle River Hatchery and since 1994 at the Spius Creek Hatchery. In some years, the coho salmon escapement to the Salmon River is so low that this deme may disappear if enhancement ceases. Hatchery juvenile releases are marked when numbers permit and adult returns are assessed annually.

At low water, adult coho salmon access into many tributary streams, other than the Eagle River, can be difficult, and access into some streams may be blocked entirely. Conversely, during periods of high water flows, coho salmon spawn in many of the smaller streams that flow into Shuswap Lake, and they will colonize the upper reaches of the Eagle River above Three Valley Gap.

1.4.1.2.3 Middle and Lower Shuswap coho salmon sub-population

The Middle and Lower Shuswap coho salmon sub-population is located within the Middle and Lower Shuswap rivers and their tributary streams, including Wap Creek, a tributary to Mabel Lake. As is the case in other sub-populations, in periods of higher water, spawners utilize the upper reaches of tributary streams such as Duteau and Danforth creeks, whereas at lower water levels, significant spawner aggregations are observed in the mainstems of the Middle and Lower Shuswap rivers. In contrast, Wap Creek appears to be used by coho salmon spawners at all water levels.

Bessette Creek, in the Middle Shuswap, was deemed by DFO to be of special conservation concern and has been enhanced since 1998. Fish culture activities take place at the Shuswap River Hatchery and when numbers of juveniles permit, the releases are marked. Adult returns are assessed annually.

1.4.1.3 Sub-populations of coho salmon of the Lower Thompson

In the Lower Thompson, there are two demographically based sub-populations (Figure 5); one in the Nicola River basin and the other encompassing the Lower Thompson mainstem and the Deadman and Bonaparte rivers.

1.4.1.3.1 Nicola coho salmon sub-population

The Nicola sub-population of coho salmon occupies Spius Creek, Coldwater River, Clapperton Creek, the Upper Nicola drainage and Guichon Creek, plus other tributary streams of the Nicola River downstream of the Spius Creek confluence. Unlike most other Thompson River tributaries, the Nicola River basin has some coastal climatic influences, often experiencing fall, winter, and spring freshets, due to the origins of the Coldwater River and Spius Creek in the mountains between Hope and Merritt. The Upper Nicola area, conversely, arises on the Douglas Plateau, a relatively arid zone between Nicola Lake and the Okanagan Valley. This latter region relies heavily on the amount of winter snow to provide its summer water supply. Much of the lower elevation areas of the watershed are in an arid grassland area.

Spawning in the Coldwater River drainage occurs throughout the mainstem with many coho salmon spawners utilizing the area upstream of Juliet Creek. In Spius Creek, most spawning occurs in a low gradient, high elevation tributary, Maka Creek. Spawners also use Guichon, Clapperton, and other tributary streams when flow conditions are suitable. Coho salmon access to the Upper Nicola River drainage area is water level dependant and fish may not be able to access that area in dry autumns. Spawning also occurs downstream of the Nicola Lake dam, and sporadically throughout the Nicola River mainstem.

DFO determined that the coho salmon from the Coldwater River and Spius Creek, while not of specific conservation concern, were in need of rebuilding. Thus, these demes have been enhanced since 1985 with all fish culture activities being carried out at the Spius Creek Hatchery. In 2004, a decision was made to stop enhancing Spius Creek and to reduce the number of fry released into the Coldwater River. Adult returns to Spius Creek will be monitored for several years. The Coldwater River, where hatchery juveniles are marked and adults are surveyed, is an indicator stream for assessing coho salmon abundance.

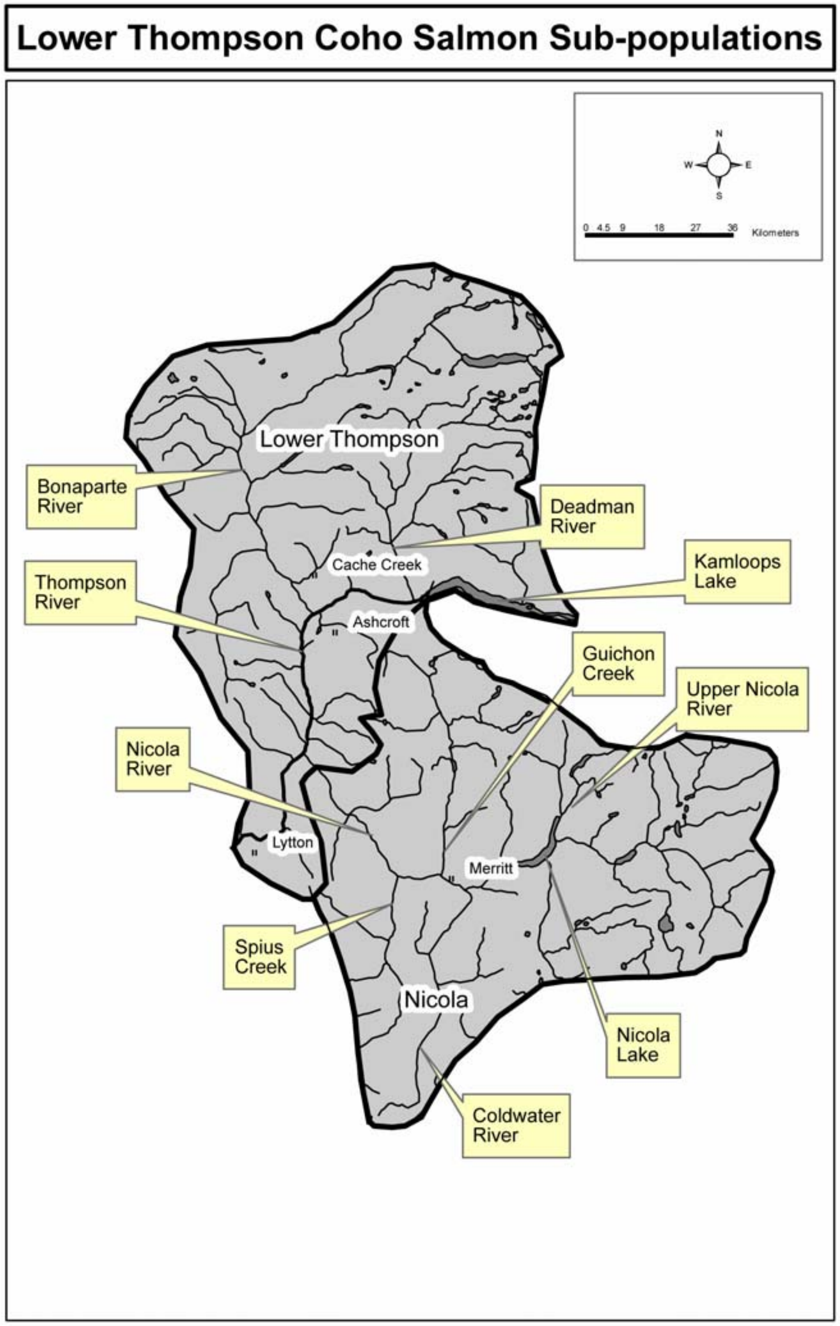

Figure 5. Sub-populations of coho salmon within the Lower Thompson River.

1.4.1.3.2 Lower Thompson coho salmon sub-population

The two significant tributaries within the Lower Thompson River coho salmon sub-population are the Deadman and Bonaparte rivers. Prior to construction of a fishway in the mid 1980's, anadromous salmonids were unable to access the Bonaparte River above a canyon located approximately 4 km upstream of the confluence with the Lower Thompson River. Since the fishway was completed, anadromous fish have been able to access the entire Bonaparte River watershed, and coho salmon have been colonizing that area. The Deadman River is the other significant tributary of the Lower Thompson sub-population. Due to conservation concerns, Deadman River coho salmon have been enhanced since 1990, first at the Skeetchestn Indian Band facility and more recently at the Spius Creek Hatchery. The releases are not marked; however, there are annual assessments of adult spawners. There is evidence that enhanced returns stray from the Deadman River to the Bonaparte River system.

1.4.1.4 Fraser Canyon coho salmon sub-population

There are very few streams contributing to the population in the Fraser Canyon, and the population is numerically dominated by the coho salmon spawning in the Nahatlatch River (Figure 6). Coho salmon may also use accessible sections of Kwoeik Creek and the Anderson River. We have no evidence to support the creation of demographically based sub-populations within this population. As previously mentioned, Fraser Canyon coho salmon are genetically different from other Interior Fraser Coho populations, and exhibit some evidence of gene exchange with Lower Fraser coho salmon populations.

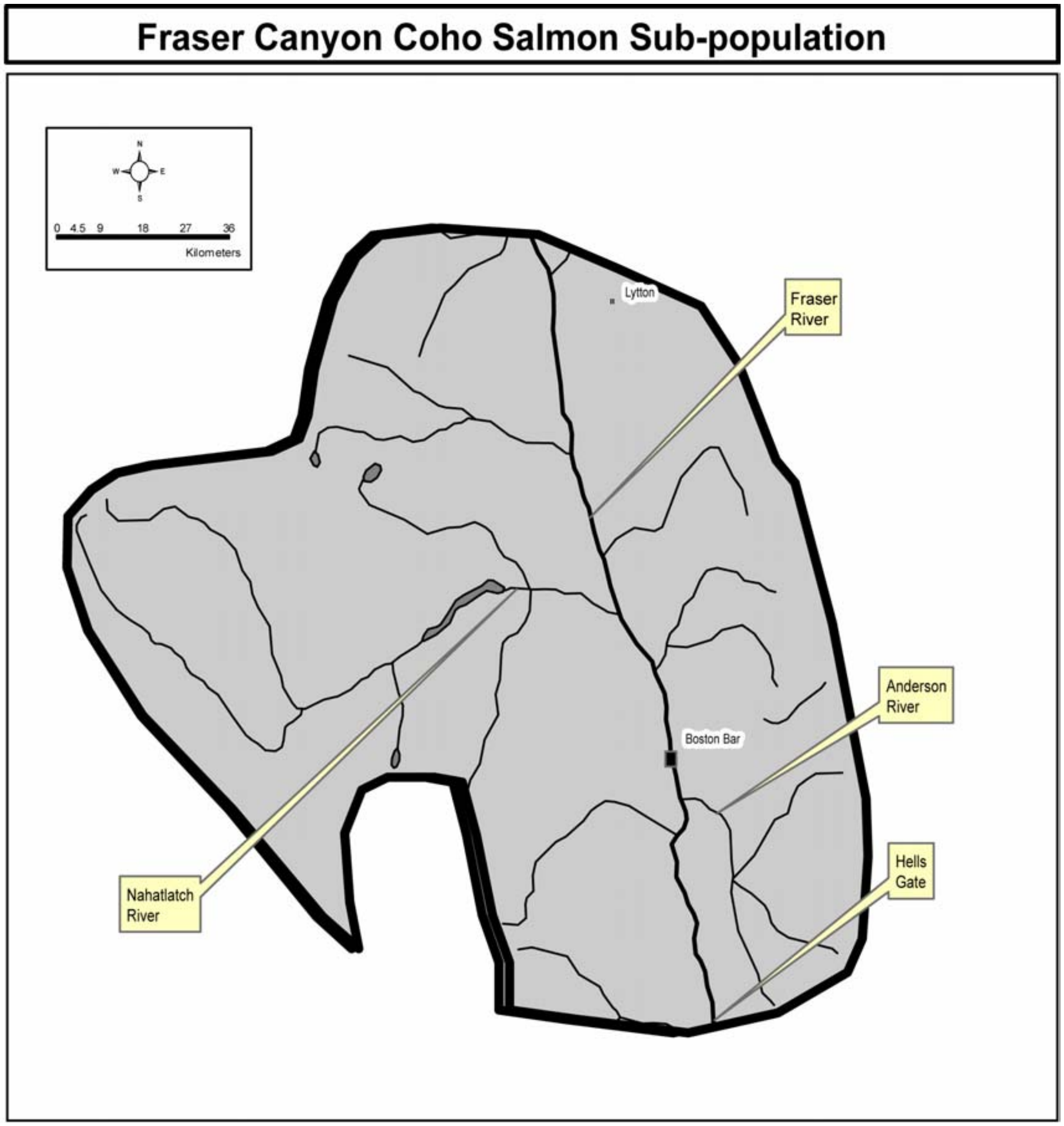

Figure 6. Location of the Fraser Canyon coho salmon sub-population

1.4.1.5 Sub-populations of coho salmon in the Middle and Upper Fraser

The distribution of coho salmon in the Upper Fraser and its tributaries is not well known. Additional stream observations and further baseline genetic sampling is required to expand our knowledge of the location and extent of coho salmon spawning in this area. Due to the limited number of verified records of coho salmon spawning in this region, and the small number of genetic samples collected, the Upper Fraser has only been partitioned into two demographically based sub-populations: the Middle Fraser and the Upper Fraser (Figure 7). The Bridge River rapids in the Fraser River mainstem have been designated as the boundary between these two sub-populations. Based on the large geographic area within the Upper Fraser region, there may be a need to further subdivide this sub-population when additional data are gathered and assessed.

1.4.1.5.1 Middle Fraser coho salmon sub-population

The Middle Fraser sub-population comprises coho salmon spawning aggregations in streams upstream of the Fraser-Thompson confluence and downstream of the Bridge River rapids. The principal drainages in this region include the Bridge and Yalakom rivers, and the Seton River drainage. Within the Seton drainage, coho salmon spawning aggregations occur in Gates Creek, Portage Creek, and in the lower Seton River mainstem. Coho salmon also have access to the Stein River system, although the extent to which this system is used is unknown.

1.4.1.5.2 Upper Fraser coho salmon sub-populations

There is limited knowledge, outside of that for the Quesnel River system, of coho salmon distribution within the Upper Fraser River. Coho salmon are widely distributed within the Quesnel system, although to date, they have not been observed upstream of a fishway on the Cariboo River. Within the Chilcotin River drainage, coho salmon spawn in the Chilko River; including the area just below Chilko Lake, and spawners have also been observed in the mainstem Chilcotin River downstream of Chilcotin Lake. Coho salmon have also been observed in the Nechako River, the lower reaches of the Cottonwood River, and in the West Road (Blackwater) River system. Anecdotal information suggests the occasional presence of coho salmon in the Stuart River and coho salmon are known to be present in the Bowron River drainage.

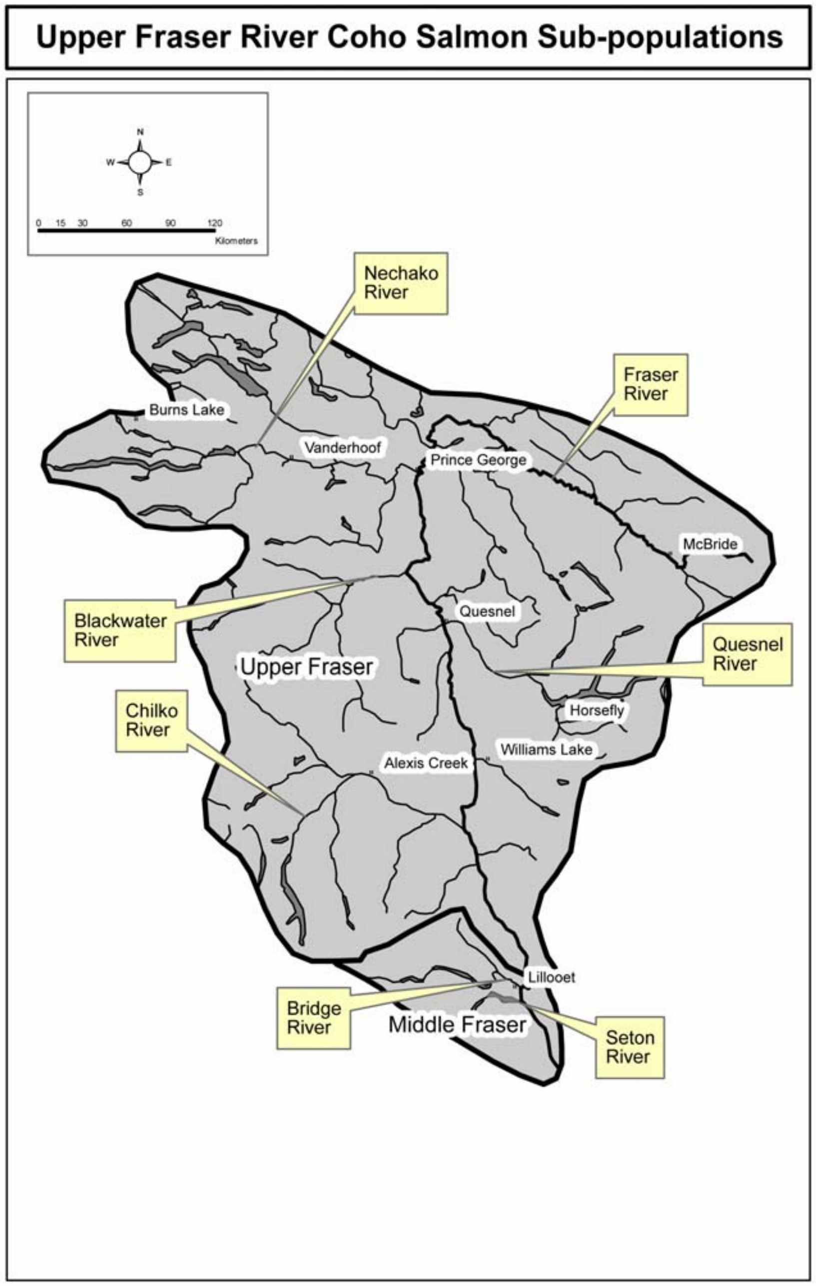

Figure 7. Coho salmon sub-populations within the upper Fraser River area.

Table 3. Locations of coho salmon sub-populations within the interior Fraser River watershed.

Population	Sub-population	Description
Fraser Canyon	Fraser Canyon	Coho salmon originating from the Fraser River and tributaries upstream of Hells Gate and downstream of the Fraser-Thompson confluence
Upper Fraser	Middle Upper Fraser	Coho salmon originating from the Fraser River and tributaries upstream of the Fraser-Thompson confluence and downstream of Bridge River Rapids
	Upper Upper Fraser	Coho salmon originating from the Fraser River and tributaries upstream of Bridge River Rapids
North Thompson	Upper North Thompson	Coho salmon originating from the North Thompson including the mainstem and tributaries at, and upstream of, Little Hells Gate
	Middle North Thompson	Coho salmon originating from the North Thompson including the mainstem and tributaries, upstream of the confluence with the Clearwater River and downstream of Little Hells Gate
	Lower North Thompson	Coho salmon originating from the North Thompson including the mainstem and tributaries, upstream of the confluence with the South Thompson and downstream of the confluence with the Clearwater River
South Thompson	Adams River	Coho salmon originating from the Adams River, Adams Lake, and tributaries
	Shuswap Lake and Tributaries	Coho salmon originating from Shuswap Lake and tributaries, excluding the Adams and Lower Shuswap river drainages.
	Middle and Lower Shuswap	Coho salmon originating from the Lower and Middle Shuswap rivers and their associated tributaries
Lower Thompson	Nicola	Coho salmon originating from the Coldwater and Nicola rivers, Spius Creek, and their associated tributaries
	Lower Thompson	Coho salmon originating from non-Nicola tributaries to the Lower Thompson River.

1.4.2 Population Abundance

There are no estimates of the abundance of coho salmon in the interior Fraser River watershed prior to the arrival of Europeans. Northcote and Burwash (1991) estimated the average annual total abundance (catch plus spawners) of

Fraser River coho salmon in the 1920's and early 1930's at approximately 1.2 million. Irvine (2002) estimated that approximately one third of those coho salmon were from the interior Fraser River watershed area indicating a total abundance of Interior Fraser Coho during this period of approximately 400,000. Northcote and Burwash (1991) estimated that exploitation rates were approximately 50% during this period, indicating an annual escapement (*i.e.* number of salmon escaping all fisheries and returning to freshwater to spawn) of approximately 200,000 Interior Fraser Coho. They further estimated that coho salmon in the Fraser River underwent a 7.7 fold decrease between the 1920's and the era between the 1950's and the 1980's. Fish passage through Hells Gate in the Fraser Canyon after the 1913 rock slide, but before the completion of the fishways in 1966, was limited. This slide may have limited coho salmon access to upstream spawning areas.

Interior Fraser Coho return to spawn within the traditional territories of several groups of First Nations' people. Aboriginal Traditional Knowledge (ATK) pertaining to some of the natural resources in the interior Fraser River watershed has been assembled (Turner et al. 2000); however, no thorough review of ATK of salmon abundance has been undertaken to date. Further assembly and analysis of ATK may assist in determining the distribution and relative abundance of coho salmon prior to the arrival of Europeans.

Spawning coho salmon are notoriously difficult to count. Although escapement estimates were recorded for some streams in the interior Fraser River as far back as 1951, many of these older estimates are of unknown accuracy and precision. Consequently, they are of little use for analyses of changes in abundance over time. More recent data are thought to provide relatively reliable estimates of spawner abundance (Irvine et al. 1999a). Since the 1970's, many North and South Thompson River tributaries accessible to coho salmon have been surveyed in most years. In 1984, escapement survey effort expanded to include the majority of coho salmon bearing streams in the Lower Thompson River region. Overall, however, enumeration of Interior Fraser Coho spawners was sporadic prior to 1998.

Most escapement data are collected by one of two methods: visual observations of coho salmon on the spawning grounds and direct enumeration at counting facilities. Prior to 1998, most visual surveys were conducted by DFO Fishery Officers. These data varied in precision and accuracy. Irvine et al. (1999a and 1999b) describe salmon escapement methodologies in more detail. In recent years, methodologies have generally improved and the spatial extent of spawner surveys has increased. Recent data for some streams has produced a time series of estimates with associated approximations of their precision. The historical data (1975 onward) have been re-assessed using these recent data, thereby allowing DFO to fill in missing data and adjust older, less reliable data (see Appendix 3 for details).

In addition to estimating spawner abundance, total abundance has also been calculated. Total abundance refers to the annual number of adults arriving in marine areas prior to interception by fisheries. Total abundance is calculated based on the escapement estimate for that year and the total exploitation rate as estimated from either the recovery of coded wire tags or the analysis of the genetic composition of the catches in various fisheries.

In some populations there are returning fish whose parents were spawned in a hatchery, but those progeny have returned to a stream area to naturally spawn in the wild. When numbers of these fish were known they, and other hatchery fish, were subtracted from the escapement estimate to derive an estimate for wild-origin spawners. Thus, hatchery fish were not used in the assessments of population status relative to recovery objectives.

In preparing this recovery document the time series of escapement data that were presented in the COSEWIC assessment (Irvine 2002) and other recent assessments and forecasts (*e.g.* Irvine et al. 2001, Simpson et al. 2001) were updated. The data presented in Table 4 reflect the best available estimates derived using the methods detailed in Appendix 3.

Table 4. Annual escapements of naturally spawned coho salmon (excludes hatchery fish) to the five populations within the interior Fraser River coho salmon designated unit, 1975 to 2003.

	Population					
Year	Fr. Canyon	Upr. Fr.	N. Thom.	Lwr. Thom.	S. Thom.	Total
1975	9,504	5,995	27,618	4,630	10,613	58,359
1976	8,130	5,128	26,198	3,961	6,506	49,922
1977	12,260	7,733	35,220	5,972	14,096	75,281
1978	11,372	7,173	33,021	5,540	12,725	69,832
1979	9,498	5,991	22,247	4,627	15,958	58,320
1980	5,462	3,445	10,943	2,661	11,028	33,538
1981	6,836	4,312	21,265	3,330	6,235	41,979
1982	8,063	5,086	23,639	3,928	8,795	49,511
1983	7,597	4,792	21,759	3,701	8,802	46,651
1984	14,925	9,414	40,419	6,556	19,617	90,931
1985	10,084	6,360	18,546	4,475	22,016	61,481
1986	11,026	6,955	26,874	3,879	17,479	66,212
1987	11,470	7,234	27,416	5,889	18,722	70,730
1988	14,449	9,114	32,914	3,193	25,209	84,878
1989	9,918	6,256	23,701	3,207	16,196	59,277
1990	6,420	4,049	16,042	4,599	9,783	40,894
1991	4,113	2,594	11,703	5,413	4,842	28,665
1992	6,510	4,106	13,193	3,838	12,995	40,643
1993	2,193	1,383	6,192	11,034	2,631	23,434
1994	4,000	2,523	9,878	4,759	6,210	27,370
1995	3,119	1,967	8,477	2,692	4,070	20,326
1996	1,403	885	3,846	617	1,799	8,550
1997	1,846	1,165	5,457	4,214	1,970	14,652
1998	5,460	4,404	8,755	889	5,875	25,382
1999	4,096	1,776	8,801	2,068	3,342	20,083
2000	2,719	1,241	4,508	2,451	3,787	14,706
2001	5,971	5,962	22,731	5,379	13,696	53,738
2002	3,817	4,923	17,107	6,633	11,082	43,563
2003	4,552	3,331	5,537	1,700	3,364	18,484

1.4.3 Trends in Abundance

Spawning coho salmon are typically three years of age; therefore, for the purposes of this report, the status of a generation of coho salmon has been based on three consecutive years of adult coho salmon data. To assess the abundance trend for Interior Fraser Coho, their escapement and total abundance data have been plotted as 3-year running geometric means (referred to as the 3-year mean). This method of averaging places an increased emphasis on low numbers and produces a smoothed trend line.

Over the period of record (1975-2003), the 3-year mean escapement for Interior Fraser Coho peaked in the mid-1980s at over 70,000 fish, and declined to a running average of less than 18,000 individuals in the late 1990's. Similar trends are observed in total abundance, which declined from over 200,000 in the late 1970's and late 1980's to less than 30,000 in recent years (Figure 8).

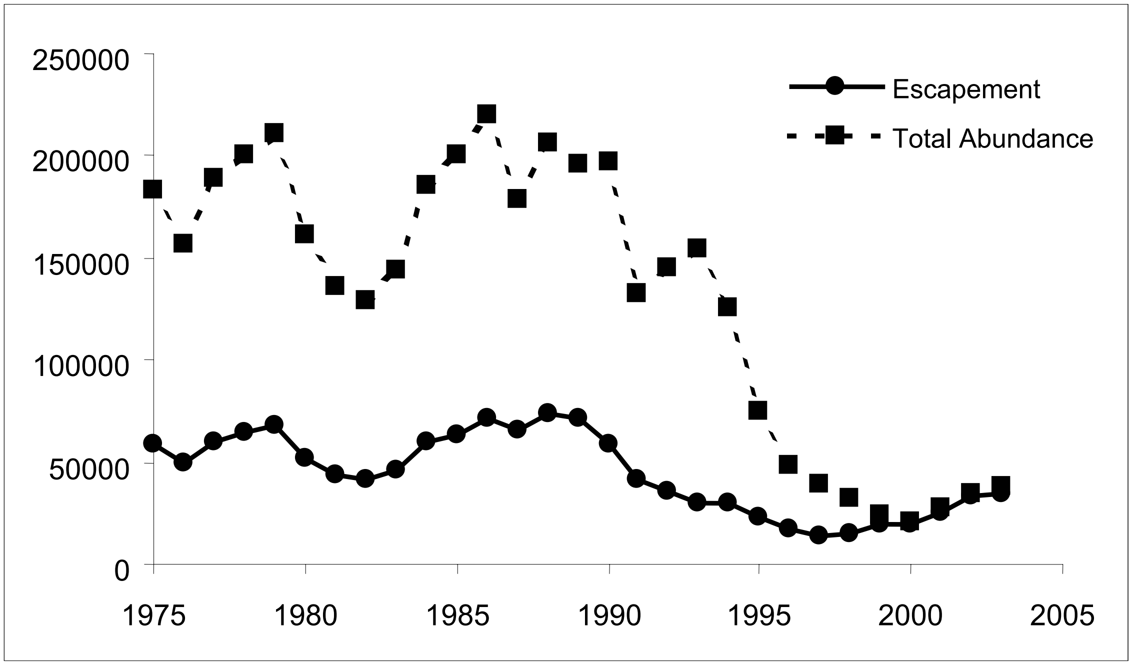

Figure 8. Trends in escapement and total abundance (catch plus escapement) of naturally spawned Interior Fraser Coho (excludes hatchery fish). Data are plotted as 3-year running geometric means.

Trends in escapement for each of the five Interior Fraser Coho populations (Figure 9) are similar to those shown by the aggregate total (Figure 8). The populations differ greatly in abundance; however, the North Thompson population has consistently been the largest, and the Upper Fraser and Lower Thompson populations typically being much smaller. It should be noted that the escapement estimates to the Upper Fraser have high uncertainty, and the Lower Thompson population has had significant numbers of hatchery fish removed from its spawning escapement estimates.

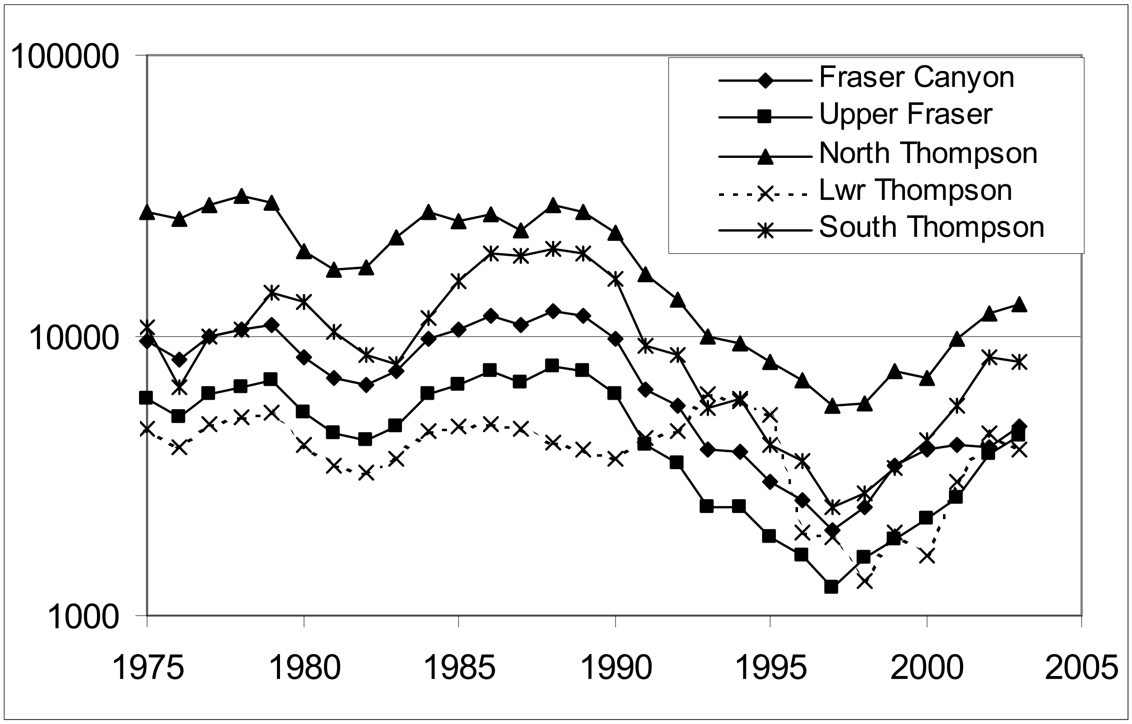

Figure 9. Trends in interior Fraser River coho salmon escapement, by population (excludes hatchery fish). Data are 3-year running geometric means plotted on a $\log_{10}$ scale).

1.5 Description of Species Needs

1.5.1 General Habitat Requirements

The definition of habitat for Interior Fraser Coho includes spawning grounds and nursery, rearing, food supply, migration, and any other areas on which the population depends, directly or indirectly, in order to carry out their life processes. This broad definition means that essentially anywhere that Interior Fraser Coho are found is considered to be coho salmon habitat.

Interior Fraser Coho require adequate freshwater and marine habitats to survive and reproduce. These fish spawn in freshwater and the juveniles normally spend one full year in freshwater before migrating to the sea as smolts. The distribution of spawning habitat for coho salmon is usually clumped within watersheds, often at the heads of riffles in small streams and in side-channels of larger streams. However, Interior Fraser Coho are commonly observed spawning in mainstems of larger rivers during periods of low flow, presumably when tributary and side-channel habitats are less accessible. Females generally dig redds in shallow, well oxygenated water (approximately 30cm deep) where the gravel particles are less than about 15cm diameter (Sandercock 1991). Low and high stream flows, freezing temperatures, siltation, predation, and disease can reduce egg to fry survival. Following emergence, fry disperse from spawning sites (Chapman 1962) and move into small tributaries and off-channel rearing habitat. In the interior Fraser River watershed, fry emergence corresponds with periods of high discharge, and fry likely colonize flooded habitats created by the spring freshets. Juvenile densities are generally higher in pools than riffles. Juvenile coho salmon tend to cluster in areas of suitable habitat, most frequently in streams with gradients less than 3%. Structurally complex habitat, *i.e.* habitat with abundant large organic debris and large substrate, or habitat with deep pools and slow moving water are necessary to ensure high over-winter survival of young coho salmon. At various times of the year, juvenile coho salmon move into small tributaries and off-channel habitat associated with groundwater to avoid freshets or harsh winter conditions such as anchor ice (Swales and Levings 1989; Bratty 1999; Bennett 2004). In general, coho salmon utilize lakes for rearing less frequently than streams, and are usually restricted to the littoral regions of lakes.

Juvenile coho salmon from the interior migrate down the Fraser River, normally in the spring as one year old smolts. They reside for an unknown time in the developed and constrained estuary of the Fraser River, and then spend the majority of their oceanic residence time in the Strait of Georgia or near the outer coast of southern BC and Washington State. In their marine habitat, coho salmon grow rapidly and require large areas of nutrient rich water to maintain an adequate growth rate. Coho salmon spend the majority of their marine life in areas that, compared to other salmon species, are relatively near-shore. During that period, coho salmon are particularly vulnerable to a variety of predators, including human fishers.

Habitat becomes important if its loss jeopardizes the survival or recovery of Interior Fraser Coho or any of its constituent populations. Important habitat therefore is the minimum extent and configuration of habitat throughout the life history of each population of Interior Fraser Coho that is necessary to provide an acceptable probability that these fish will survive or recover according to specific recovery objectives. It follows that certain amounts of habitat at each life stage for each population may be important.

1.5.2 Important Habitat and Requirements for Survival and Recovery

The identification of important habitat for interior Fraser River coho salmon is problematic. Although there is spawning area accessible to coho salmon in 274 streams in the interior Fraser River watershed (Appendix 2), they regularly spawn in only 75 of those streams. The mainstem Fraser River and the Fraser estuary are used as a migration corridor and the Strait of Georgia and waters off the West coast of Vancouver Island are used for feeding and growth. The survival and recovery of Interior Fraser Coho requires sufficient amounts of diverse freshwater, estuarine, and marine habitat to maintain each of the five Interior Fraser Coho populations at or above the levels specified in the recovery objectives (see section 3.3). More work is needed to define and identify these important areas.

Genetic diversity, required for populations to survive or recover, results from a variety of adaptations to different habitats. Interior Fraser Coho use a large number of different habitat types over their lives and those habitat areas are spread over a broad geographic range. As a result, it is likely that there are numerous genetically based local adaptations that may be necessary for Interior Fraser Coho to recover or survive. As well, populations and sub-populations within the interior Fraser River watershed must not be allowed to become isolated from each other. In addition, habitat areas within the range of the known populations and sub-populations must remain suitable for coho salmon rearing and reproduction.

Within the context of this conservation strategy, if a habitat area is deemed important, it must also be manageable. Although climate-driven natural variability in ocean productivity may strongly influence the survival and recovery potential of Interior Fraser Coho, the management of marine areas as important habitat, other than the migratory corridor for migrating coho salmon, is unlikely to be possible. Therefore the IFCRT did not contemplate the definition of specific important marine habitats.

An attempt was made to identify a network of freshwater habitats necessary for Interior Fraser Coho to survive or recover. However, this approach was not deemed acceptable to the IFCRT since it could result in other important habitats outside of the identified important habitat network being ignored. At this time, it is recommended that Sections 35 to 43 of the *Fisheries Act* (R.S. 1985, c. F-14) (see http://laws.justice.gc.ca/en/F-14/) should be the primary tools to protect all Interior Fraser Coho habitats.

Interior Fraser Coho appear to be an example of a species recognised to have functional habitat that may be dynamic (e.g. spawning gravel, cover refugia) and difficult to map precisely (DFO 2004). Functional important habitat is contained within areas of important spatial habitat. The spatial limits of important habitat need to be accurately located at a scale appropriate to the species of interest (Randall et al. 2003). The definition of a spatial scale suitable for operational mapping is needed for managers (DFO 2004); however, the appropriate spatial scale for use with Interior Fraser Coho has not been established.

Important habitat for Interior Fraser Coho may be more specifically identified during the program plan development phase of species recovery planning. To help prepare for this process, we describe a generalized life cycle for Interior Fraser Coho and identify some areas that may, based on additional study, be identified as important habitat. This type of analysis needs to be completed by identifying distinguishing characteristics for each Interior Fraser Coho population.

Freshwater Migratory Habitat

Adult Interior Fraser Coho require habitat that permits them access to holding and spawning areas within the drainage. Smolts require habitat that allows them to leave the interior Fraser River watershed and migrate to the estuary. Both of these life stages require waters of sufficient depth and velocity for migration. In addition, water temperatures must be within an acceptable range and refuge or holding areas are required.

Under certain conditions, water velocities in the Fraser River near Hells Gate in the Fraser Canyon (Figure 2), and in the area referred to as Little Hells Gate in the North Thompson River (Figure 3) can restrict upstream passage of coho salmon. Further review should determine whether these two areas are important habitat. For all five of the populations of Interior Fraser Coho and for the Upper North Thompson sub-population to recover or survive, passage through Hells Gate and Little Hells Gate, respectively, needs to be minimally obstructed.

Spawning and Egg Incubation Habitat

Spawning takes place over a wide variety of habitats and the overall abundance of spawning habitat is not generally limiting. The one known exception is within the Nahatlatch River.

The only accessible spawning habitat in the Nahatlatch River is 6-7 km along the Nahatlatch River mainstem upstream of Frances Lake to the confluence of the Nahatlatch River and Mehatl Creek (Figure 10). Numerically, virtually all coho in the Fraser Canyon population spawn and rear in the Nahatlatch River. Therefore, further review should determine if spawning areas in the Nahatlatch River are important habitat. For the Fraser Canyon population to recover or survive, the integrity of this area must be maintained. Further work may be necessary to determine the precise extent of the proposed important area.

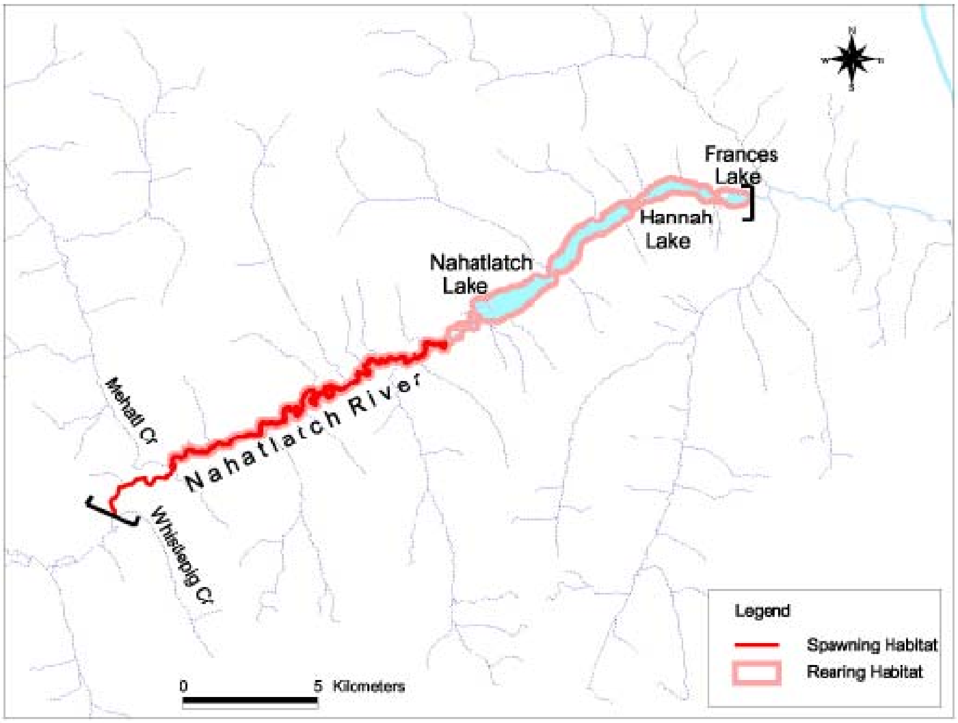

Figure 10. Spawning and rearing habitats for interior Fraser River coho salmon within the Nahatlatch River watershed (Fraser Canyon population).

Fry and Juvenile Rearing Habitat

Young coho salmon feed and grow in a wide variety of habitats. These habitats are generally abundant and do not appear to limit any of the populations at this time, with the possible exception of the Nahatlatch River watershed (Figure 10). Additional work is needed to identify the minimum areas required to achieve survival and recovery targets.

Summary

With the existence of significant knowledge gaps for Interior Fraser Coho, it is currently impossible to identify many specific rearing or spawning areas that are important for the continuing survival of the designated unit (DU). While many spawning and rearing areas within the five known populations are known to be important, and are needed to maintain the potential for recovery, it cannot be generally said that any of these individual areas are essential for the survival or recovery of either the population or the DU. There are three possible exceptions, that should be the initial focus of important habitat considerations during the development of any recovery program plan:

- That portion of the Nahatlatch River above Frances Lake to the confluence of Nahatlatch River and Mehatl Creek. Without this section of the Nahatlatch River, the Fraser Canyon coho salmon population would lose more than 90% of its spawning habitat and a significant percentage of its rearing habitat;
- The Fraser Canyon in the vicinity of the Hells Gate fishways. Without maintenance of upstream fish passage, coho salmon would not have access to spawning areas in all or part of the interior Fraser River; and
- The North Thompson River in the vicinity of Little Hells Gate. Without maintenance of upstream fish passage, coho salmon would not have access to upper North Thompson spawning areas.

Mechanisms for the Protection of Important Habitat

There are various mechanisms for the protection of coho salmon habitat, including legislative tools such as acts, regulations, government policy and programs, as well as best practices, education, and stewardship programs. The three areas discussed above are within the mandate of the *Fisheries Act,* which provides for the protection of habitat from physical alteration and from the introduction of deleterious substances. Proactive efforts, to ensure that in, or near, stream activities are assessed and controlled, or that mitigative measures are implemented, are vital to the protection of the habitat for Interior Fraser Coho. Proactive activities, such as those required by the provincial *Forest Range and Practices Act (FRPA)*, federal *Fisheries Act*, or under the *Canadian Environmental Assessment Act (CEAA)* are essential mechanisms for directly or indirectly protecting habitat. Monitoring and enforcement of all regulations is essential and should complement the programs listed above to ensure compliance.

Under the previous British Columbia Forest Practices Code and the Watershed Assessment Procedure, the province of British Columbia proposed to manage increases in flood peaks that can result from logging by controlling the rate of forest harvest. In the Nahatlatch River and its tributaries upstream of Frances Lake, current hydrologic assessments will assist forest managers in assessing potential impacts of existing and proposed forest harvesting on the hydrologic regime of the mainstem Nahatlatch River.

In the Nahatlatch River, road construction is thought to be an important source of debris slides and debris flows. Construction needs to be carefully planned and reviewed in unstable areas. As well, continued management of the Nahatlatch riparian area, per the *Forest Practices Act*, will assist in maintaining the integrity of spawning and rearing habitat areas.

Education and stewardship programs can be used to complement government regulations and allow Canadians to take action at an individual level to protect habitat. In those areas where important habitat falls within traditional territories held by First Nations, their participation and cooperation in protection should be encouraged.

At Hells Gate, and Little Hells Gate, the main issue is safe-guarding fish passage. Fish passage at each site requires adequate discharge, and since the flows in the Fraser and Thompson rivers are largely unregulated, most sources of variability are natural. It is not known whether flow control of the Nechako River has any influence on the ability of adult coho salmon to migrate through the Fraser Canyon and past Hells Gate. Regardless, it will be necessary to ensure proper maintenance of fish passage facilities at each site, and ensure habitat modifications at each site do not affect fish passage.

Studies Needed to Identify Important Habitat

Recommending studies to accurately identify important habitat is necessary when habitat is dynamic, spatially extensive, and difficult to map (DFO 2004). Establishing recovery goals, determining acceptable levels of risk to recovery, and assessing viability of the populations are fundamental to the identification of important habitat. The IFCRT has established short term recovery goals; however, long term goals, acceptable risk levels, and quantification of the viability of the populations have not been determined.

Furthermore, the identification of specific important habitat areas requires detailed knowledge about the habitat, particularly those aspects of the habitat that are vital to each life stage of Interior Fraser Coho. Much additional work is needed to properly define and confirm the status of the proposed important habitat areas, and a number of studies are needed to determine if there are additional habitat areas that are important to some or all Interior Fraser Coho. Table 5 presents a preliminary list of proposed studies, along with a brief comment on their probable duration.

Table 5. Studies needed to identify important habitat for interior Fraser River coho salmon.

Study	Duration[3]
Map spawning and rearing habitat in the area used by the Fraser Canyon coho salmon population; determine proportions that are within the Nahatlatch River.	2 years
Quantify the relationship between river discharge, velocity, and depth and coho salmon passage success at Hells and Little Hells gates.	2 years
For each coho salmon life history stage, characterize the habitat features that support essential life history attributes of Interior Fraser Coho.	2 years
Determine the amount and configuration of habitat features, including stream flow requirements, required to support each Interior Fraser Coho population and sub-population at or above the recovery objectives.	3 years
Determine the amount and configuration of habitat features currently available for each Interior Fraser Coho population and sub-population.	4 years
Map the habitat required to meet population recovery objectives.	5 years
Compare the habitat available with the habitat required for each Interior Fraser Coho sub-population with the objective of determining the need for additional important habitat.	5 years
Develop an age-structured model and carry out population viability analyses to evaluate relationships among combinations of habitat, marine survival, and fishery exploitation rates to estimate probabilities of population extinction, decline, survival, or recovery.	4 years
Map ephemeral streams and assess the importance of ephemeral areas to coho salmon rearing and over-wintering behaviour.	4 years
Assess the importance of groundwater levels during winter low water and summer drought periods.	4 years

[3] Timeframes subject to further refinement and funding availability.

1.5.3 Habitat Status and Trends

Habitat for coho salmon may undergo change from natural or man made sources. Naturally caused habitat changes, including catastrophic ones, may occur in the interior Fraser River watershed (*e.g.* Farwell Canyon mud slide); however, as they are neither predictable nor controllable, they are not included in the following discussion.

To assist the IFCRT in determining if the areas available to coho salmon have been significantly impacted by man-made changes, the IFCRT Habitat Working Group qualitatively determined an impact assessment for each stream accessible to Interior Fraser Coho (Appendix 4). A summary of the specific and cumulative impacts for each sub-population are presented (Figures 11 through 18).

The impact assessments are qualitative in nature and, as such, may give rise to challenges from peers or stakeholders regarding the assessment made by individual working group members. To reduce the number of questions regarding the assessments, the working group members attempted to be consistent in their approaches to determining if an impact was, in their professional opinion, low, medium, or high.

For each resource development category assessed, a variety of associated characteristics were considered prior to determining the level of impact for that development type. For example, characteristics related to forestry development include the percent total and percent recent logging, the equivalent clearcut area, and the riparian condition. These data were already compiled to assist DFO in identifying watersheds that have a level of forest harvesting that warranted increased attention (*e.g.* greater than 20%). For the assessment of coho habitat impacts in the interior Fraser River, impacts resulting from forestry, urbanization, agriculture, mining, linear development, hydroelectric development, and water withdrawal were reviewed. As a final step, the impacts from all development activities in or near a stream were reviewed to arrive at a cumulative impact assessment. The individual stream impact assessments and the sources of the data used to determine those assessments can be found in Appendix 4.

The figures within the following sections summarize the individual stream habitat assessments for each of the 11 sub-populations of Interior Fraser Coho found in Appendix 4. Figures 11 through 18 graphically present the relative contribution of low, medium and high habitat impacts within a sub-population. These relative contributions are shown as percentages of the total number (n) of streams within a sub-population that were assigned low, medium, or high impact assessments. For example, Figure 11 shows that there are 10 streams accessible to coho in the Middle Fraser sub-population (n=10) and 80% of those (*i.e.* eight streams) were assessed to have had a low impact from forestry related activities. Similarly, within the Middle Fraser sub-population, a high forestry related impact was assigned to 10% of the total number of streams in the Middle

Fraser (*i.e.* a single stream). Refer to Appendix 4 to determine which streams were assigned to which category.

1.5.3.1 Forestry

Forest development on crown land, managed by the British Columbia Provincial Government, as well as private land logging, is the major resource activity in each of the five Interior Fraser Coho populations' geographic areas. Excessive timber harvest in a watershed can result in changes in peak flows, thereby increasing erosion and sedimentation, and impacting spawning and rearing habitat. High timber harvest rates, improper road building practices, and high road densities can result in impacts such as the alteration of the hydrologic regime, increased landslide activity, destabilization of the stream channel, and increased sedimentation affecting adjacent and downstream fish habitat. Within the interior Fraser watershed the Fraser Canyon and Adams River sub-populations are the most significantly impacted by forestry practices (Figure 11).

At present, to address salvage of insect infested trees, the annual allowable cut is on the rise in a number of watersheds accessible to Interior Fraser Coho. The resulting increases in the amount of area harvested over a shorter period of time may increase the risk of watershed wide changes in hydrology and stream morphology.

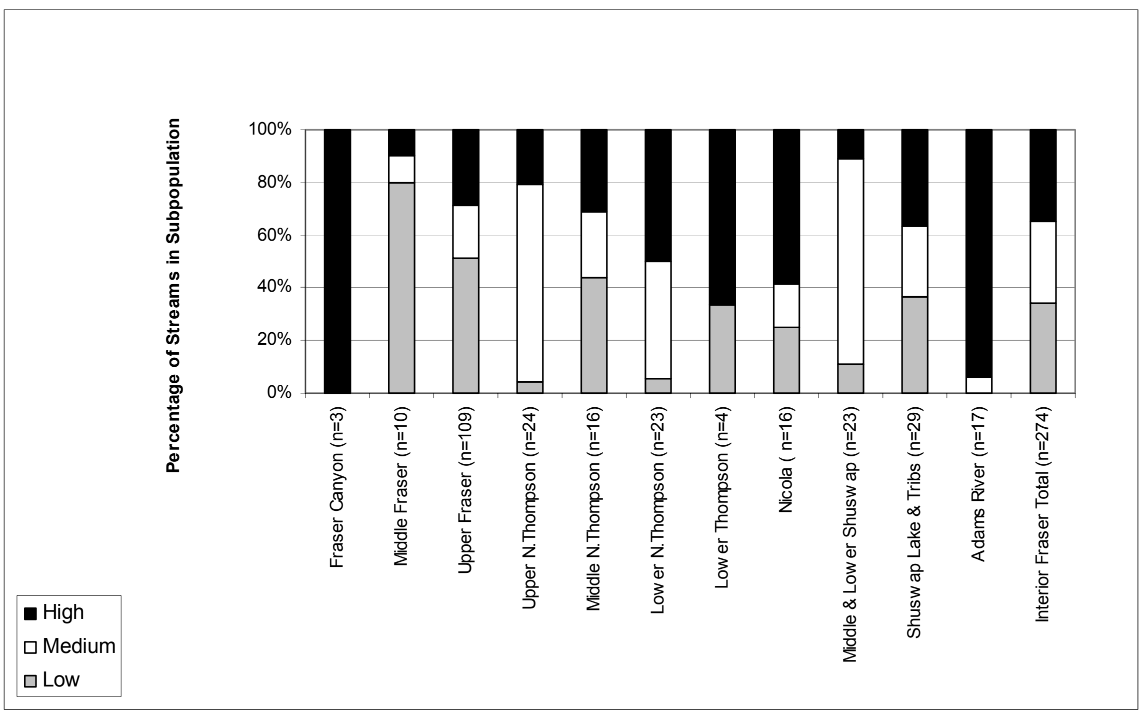

Figure 11. Qualitative assessment of the historical impact of forestry practices on coho salmon sub-populations within the interior Fraser River watershed (source: Appendix 4; see Section 1.5.3 for an explanation of the figure)

1.5.3.2 Agriculture

Agriculture is an important industry that is well established throughout most of the interior Fraser River watershed. Crop production and livestock operations occur mainly in the valley bottoms on private lands while livestock summer grazing takes place on crown lands at higher elevations. While the overall percentage of farmland in each watershed may be relatively low, agricultural activities are typically concentrated along stream corridors where impacts to stream habitat have and can occur. Loss of riparian vegetation is evident along streams due to land clearing for crop production, buildings, or grazing activities. Where this occurs, it can result in wider and shallower streams, higher water temperatures, reduced cover, increased erosion, and altered stream substrates; all of which can have an impact on spawning and rearing habitats and migration routes. Within the interior Fraser watershed, the Nicola River, Lower Thompson, and Middle and Lower Shuswap sub-populations are most impacted by agricultural activities (Figure 12).

With recent initiatives such as the Environmental Farm Planning process by the BC Agriculture Council and the BC Cattlemen's Livestock Management & Water Stewardship Program, improvement in agricultural management practices is occurring. The agriculture industry is also involved as members of various watershed stewardship and roundtable groups that focus on riparian management issues.

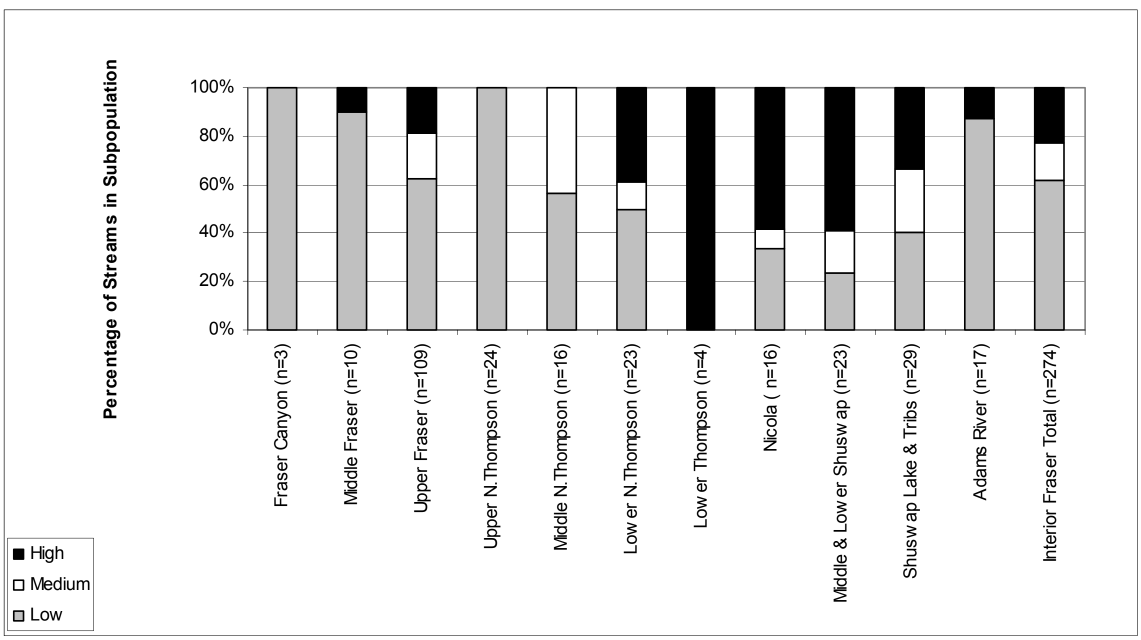

Figure 12. Qualitative assessment of the historical agricultural impacts on coho salmon sub-populations within the interior Fraser River watershed (source: Appendix 4; see Section 1.5.3 for an explanation of the figure).

1.5.3.3 Water Use

The management of storage and extraction of surface and ground water is the responsibility of the Provincial Government. In the North, South, and Lower Thompson population units there are high demands for water extraction for crop irrigation during summer low flow periods, frequently resulting in high impacts on coho salmon habitat (Figure 13). When this demand is coupled with prolonged periods of significant drought, there are major impacts affecting spawning and rearing habitat and migration routes (Rosenau and Angelo 2003). For example, in recent years, there have been significant reductions in flows in the Salmon River (South Thompson population) resulting in a significantly reduced survival of the juvenile coho salmon rearing population. These low flows have also impeded the adult coho salmon spawning migration and limited their access to tributary habitats.

Water storage for hydroelectric development is a complex issue that involves both Federal and Provincial governments. At present the only area with a significant amount of high impact is in the Middle Fraser sub-population, specifically on the Bridge and Seton rivers (Figure 14).

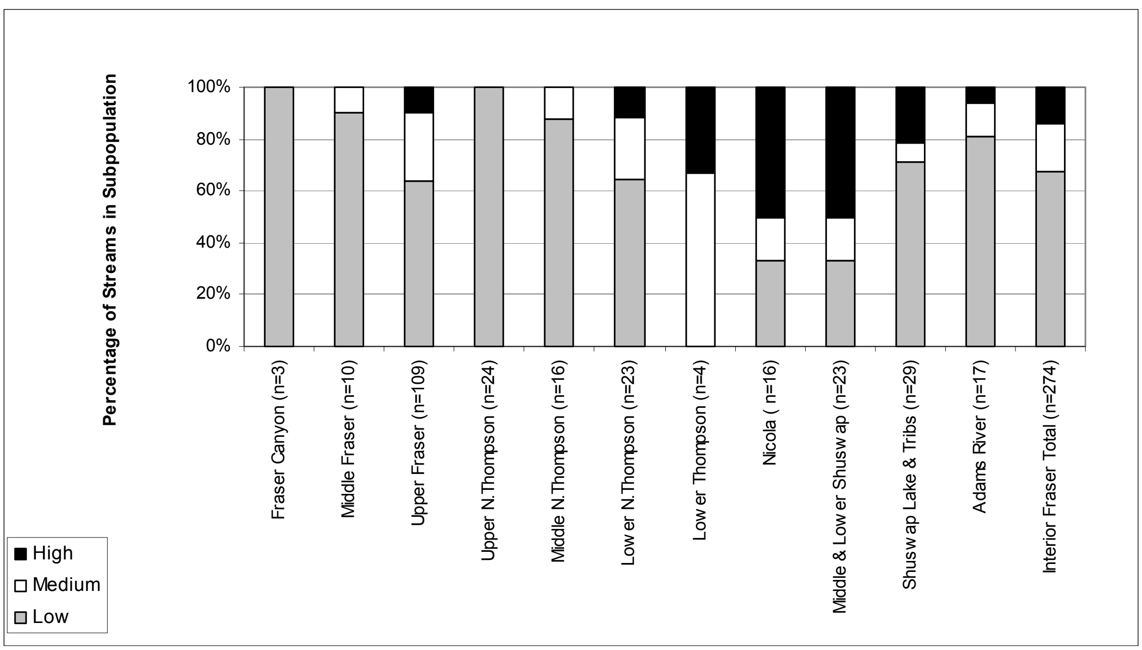

Figure 13. Qualitative assessment of the historical water withdrawal impacts on coho salmon sub-populations within the interior Fraser River watershed (source: Appendix 4; see Section 1.5.3 for an explanation of the figure).

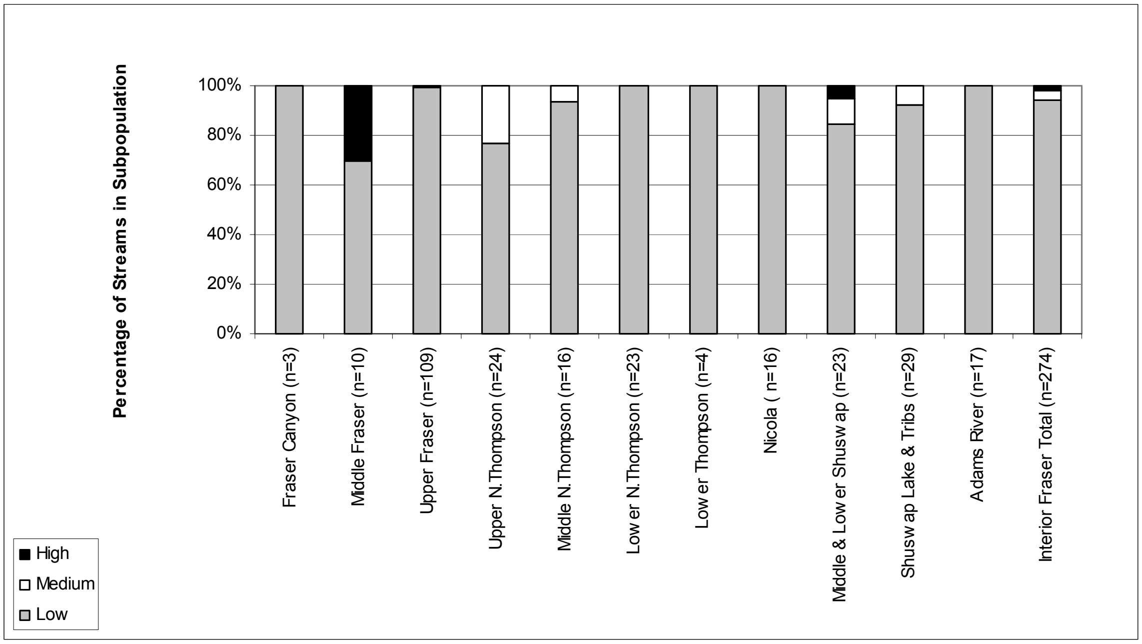

Figure 14. Qualitative assessment of the historical hydroelectric development impacts on coho salmon sub-populations within the interior Fraser River watershed (source: Appendix 4; see Section 1.5.3 for an explanation of the figure).

The area of greatest concern centers on the licensing and utilization of water. Currently there is little monitoring of water utilization conducted by Land and Water British Columbia, even though several watersheds have documented low flow issues with related negative impacts on fish and fish habitat (Rosenau and Angelo 2003). With a continuation of weather patterns that result in drought conditions, the need for effective water management protocols to limit impacts on fish and fish habitat will increase.

No major hydro developments are expected within the watersheds supporting Interior Fraser Coho; however, the British Columbia Provincial Government has developed a framework to encourage the development of independent power projects on streams tributary to the Fraser River.

1.5.3.4 Linear Development

Rip-rapping and channelization of streams, encroachment from road, rail, electric transmission, and pipeline developments, and other stream side linear development activities have resulted in a reduction of the complexity and diversity of fish habitat in some areas. Also, important rearing habitat (*e.g.* side channels, off-channel habitat, ponds, and wetlands) have often been cut off from the parent stream channel following such developments. Within the Interior Fraser Coho sub-populations, the Middle Upper Fraser and Middle North Thompson have had the greatest amount of such impact (Figure 15).

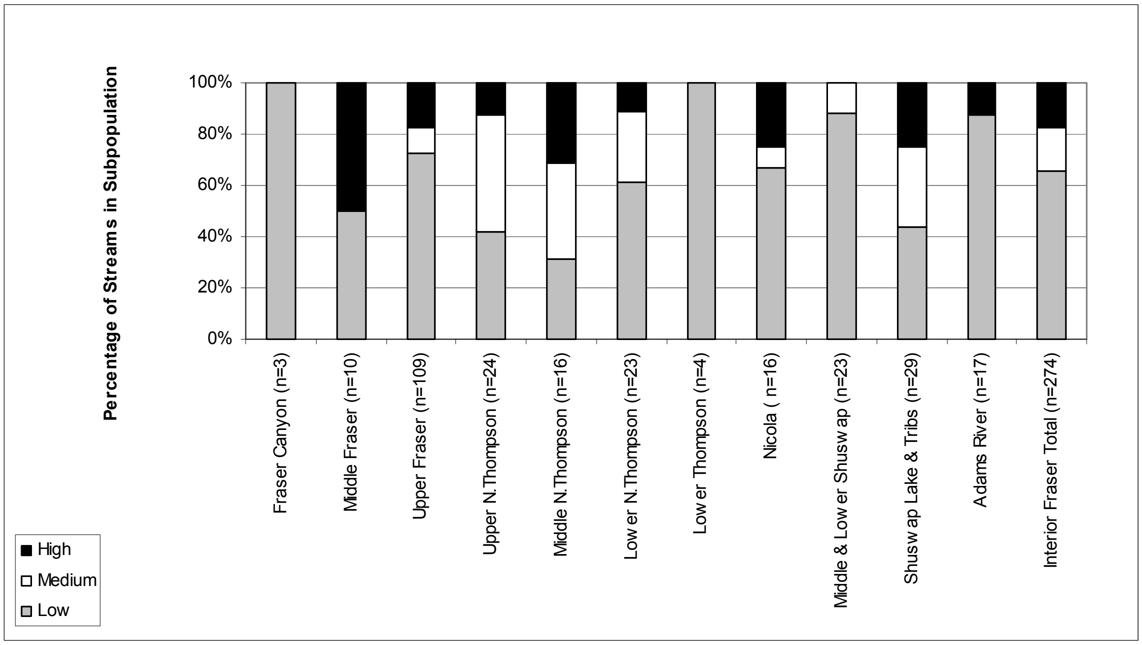

Figure 15. Qualitative assessment of the historical linear development impacts on coho salmon sub-populations within the interior Fraser River watershed (source: Appendix 4; see Section 1.5.3 for an explanation of the figure)

Improper road, gas and oil pipeline, and electric transmission line developments have the ability to introduce sediments during and/or after construction. In addition, some existing stream crossing structures are barriers to fish migration, which may limit coho salmon access to suitable rearing and spawning habitats available within the interior Fraser River watershed.

1.5.3.5 Urban and Rural Development

Urban and rural development, particularly such growth centered around Shuswap Lake and near the communities of Kamloops and Merritt, has increased the amount of impervious surface area in the watershed. Although there are many government agencies involved in planning such development, this type of activity is not directly under the control of any single government body. A lack of integrated planning can produce urban projects or rural recreational developments that create site specific alterations in stream hydrology with increased peak or decreased low flows and produce degraded water quality from urban storm-water runoff. Development pressures along lakeshores and lakeshore recreational development related activities (*e.g.* filling, dredging, sewage disposal, removal of gravel and cobble, removal or alteration of riparian vegetation, installation of water intakes) threaten important nursery areas along the foreshore areas utilized by rearing coho salmon. Within the interior Fraser River watershed, the greatest impacts are in the Middle and Lower Shuswap rivers and Shuswap Lake sub-populations (Figure 16).

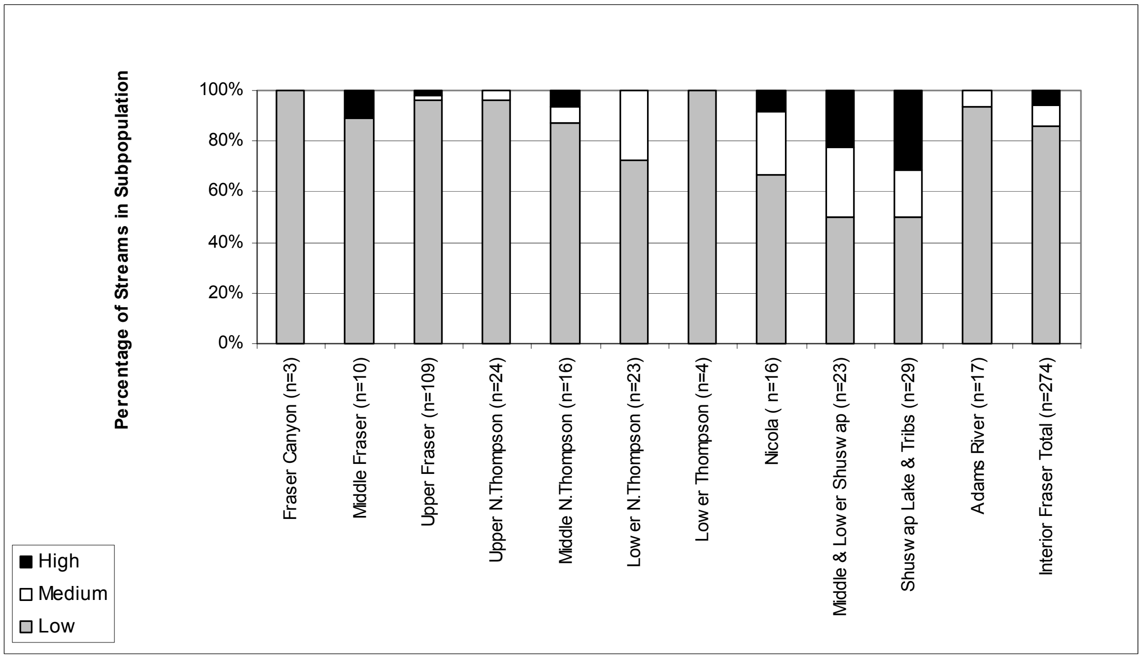

Figure 16.Qualitative assessment of the historical impacts of urban development on coho salmon sub-populations within the interior Fraser River watershed (source: Appendix 4; see Section 1.5.3 for an explanation of the figure).

Several major communities, such as Prince George, Quesnel, and Williams Lake, have taken steps to improve their citizens' awareness and understanding of local fisheries issues. With improvements in city bylaws regarding streamside riparian protection and support of stewardship centers, the various municipal governments will reduce the overall impacts on fish and fish habitat over the long term. Increases in populations for these communities does not compare to the dramatic increases of the southern interior of British Columbia.

1.5.3.6 Mining Development

Mining activity is an important resource activity in the interior Fraser River watershed, and it consists mainly of placer mining (gold), hard-rock or open-pit mining (copper, molybdenum, and gold), and sand and gravel quarries. Of these types of mining, placer mining results in the most significant direct impacts on salmon habitat. Placer mining involves mechanical dredging, sifting, washing, and re-deposition of fluvial substrates and stream side deposits, in search of gold. Distribution of placer mining activity in the interior Fraser River watershed is concentrated in the eastern tributaries of the Fraser River from Williams Lake to Hixon, as well as in the Fraser River mainstem. Approximately 2,000 active placer mining claims and leases are present in this region.

Placer mining has occurred in portions of the mainstem Fraser River and its eastern tributaries since the 1850's, and was generally unregulated until the mid-1970's. Mining practices during this period resulted in significant long-term negative effects on fish habitat. Hydraulic mining, stream channel diversion, suction dredging, and discharge of mine tailings into streams were responsible for much of this damage. Loss of riparian vegetation, development of floodplains, mobilization of sediment, and destabilization of stream channels continue to affect the productive capacity of numerous streams east of Williams Lake and Quesnel.

Placer mining operations have improved from an environmental standpoint, but productivity of fish habitat for some Interior Fraser Coho sub-populations continues to be affected from present-day placer operations (Figure 17). Physical effects of placer operations on fish habitat at the present time include mining impacts on important floodplain areas that provide seasonal fish habitat, losses in riparian vegetation, and increased sediment loads in fish streams. While provisions to protect fish habitat are present in the BC *Mines Act,* enforcement of this law is limited due to budget and staff reductions within the BC Ministry of Energy and Mines.

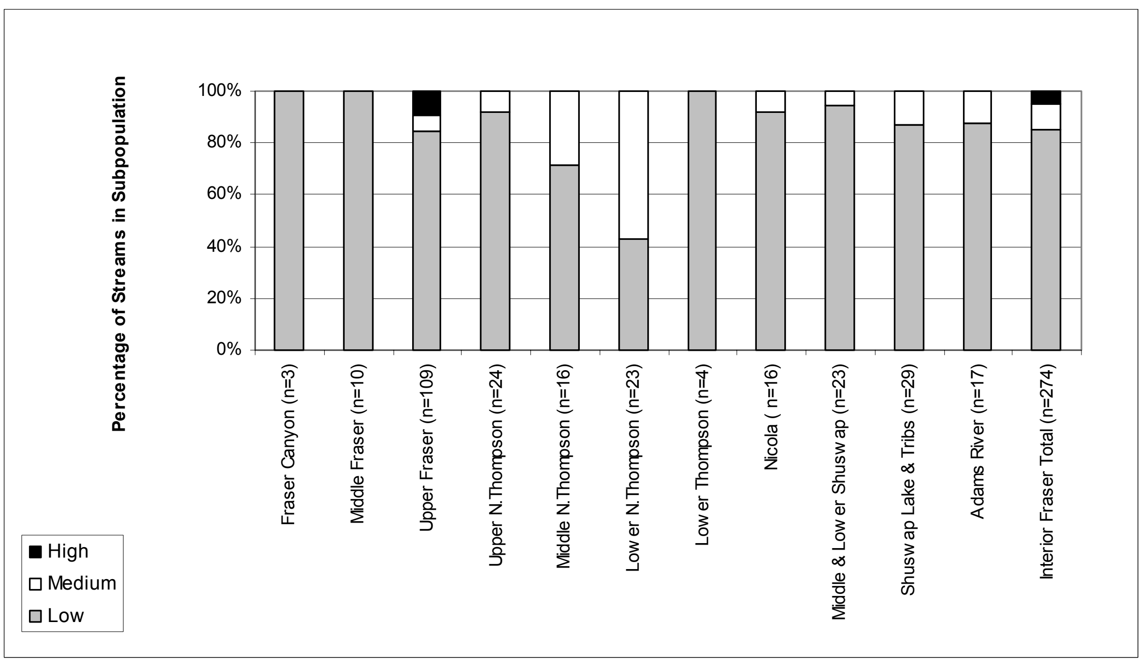

Figure 17. Qualitative assessment of the historical mining impacts on coho salmon sub-populations within the interior Fraser River watershed (source: Appendix 4; see Section 1.5.3 for an explanation of the figure).

Both placer and open-pit mining are on the increase, especially in the Quesnel and Cariboo River watersheds. These activities have the ability to seriously affect local fish and fish habitat, primarily through the introduction of deleterious substances, and in particular, sediments. Both types of mining operations are bound by regulations under provincial jurisdiction as well as the *Fisheries Act*. Routine monitoring and participation of habitat protection staff during mine development stages are required to ensure local habitat impacts are minimized or avoided.

1.5.3.7 Cumulative Impacts

The primary land uses that have contributed to habitat loss and deterioration are forestry, agriculture, urban and rural development, linear development and water extraction. Habitat alterations from these activities should be viewed as having cumulative impacts rather than as a series of unrelated individual impacts.

Cumulative impacts, unlike impacts from specific development activities, generally occur over an extended period of time and as a result of a combination of a variety of activities. A major concern surrounding cumulative impacts is the ability of agencies or proponents to conduct development project reviews. Regulatory requirements of the *Canadian Environmental Assessment Act* (CEAA) ensure that the assessing biologist review, amongst other things, the cumulative impacts on the habitat that would occur as a result of the project. However, this mandatory consideration is only a requirement for projects subject to CEAA and does not apply to the majority of development activities reviewed by fisheries agencies. In order for a project review to properly assess cumulative impacts, analysis of the current condition of the watershed is required. This information is not provided for most development activities; therefore, assessors may have to rely on a combination of personal knowledge of the state of the watershed, existing literature, and advice of other professionals. Much of this information is qualitative in nature.

There have been attempts to provide professional opinions based on an increased level of quantitative data. For example, an Interior Watershed Assessment Procedure (IWAP) can be conducted for community watersheds or in watersheds where the need is demonstrated or where risks are recognized. The IWAP has a number of measurable indices that permitted agencies to quantitatively assess impacts. Such efforts produce defensible opinions on cumulative impacts; however, because such processes are relatively recent, much of the available opinion on impact is still qualitatively based.

One purpose of DFO's *Policy for the Management of Fish Habitat* and its *No Net Loss Guiding Principle* is to address cumulative impacts. Although viewed as restrictive by some, the guiding principle should, if no net habitat loss occurs as a result of a development activity, prevent cumulative impacts. If incremental loss is permitted or occurs, the destruction of fish habitat may be minimal at the specific development site; however, when combined with other such limited impacts, the result can be significant. For example, a single dyke along a stream reach wouldn't significantly alter the stream hydrology, however continuous dyking could reduce overall stream length leading to significant hydrological changes that can detrimentally affect the fish habitat.

Within the interior Fraser River watershed the coho salmon stream areas showing the greatest amount of high cumulative impact are in the areas that have seen the most human development, *i.e.* within the Lower Thompson, Nicola, and Shuswap sub-population areas (Figure 18). Further development continues in these sub-population areas and, even with the use of the *No Net Loss Principle*, there are concerns over these high levels of cumulative impact.

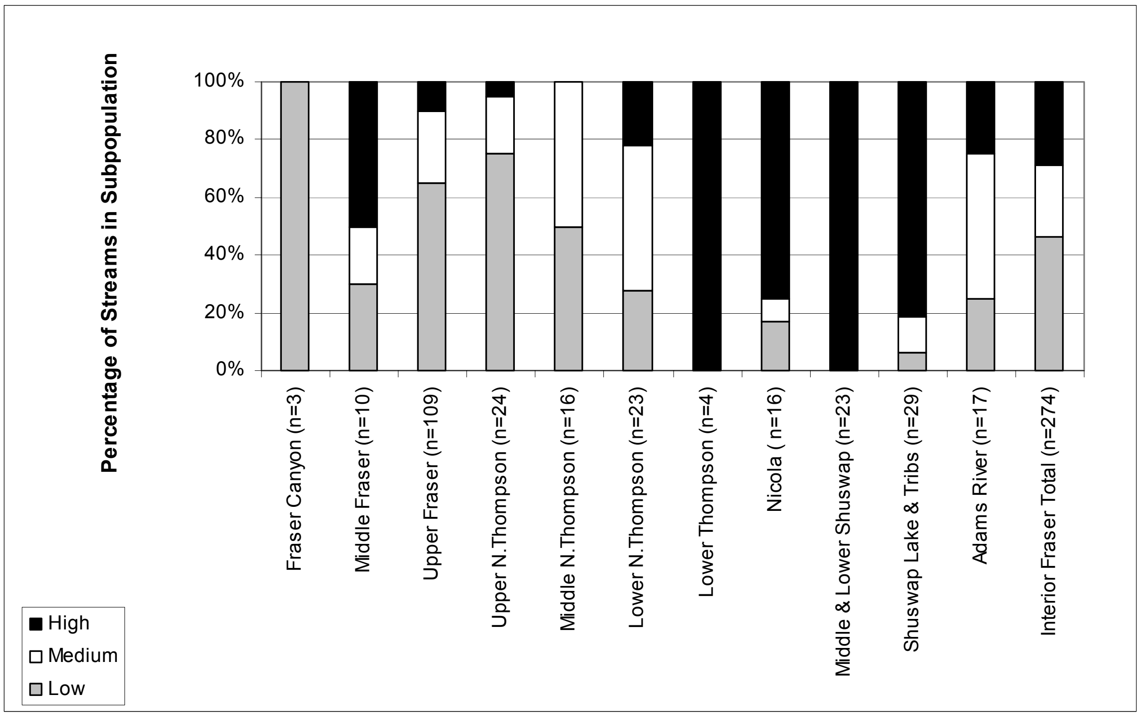

Figure 18. Qualitative assessment of the historical cumulative effects of habitat alterations on coho salmon sub-populations within the interior Fraser River watershed (source: Appendix 4; see Section 1.5.3 for an explanation of the figure).

1.5.3.8 Habitat Issues Outside of the Interior Fraser River Watershed

In addition to the habitat impacts identified within the interior Fraser River watershed, further concern is warranted for the ocean, estuarine, and lower Fraser River habitats used by Interior Fraser Coho. Two-thirds of British Columbia's population lives in the three percent of the province's land that makes up the Georgia Basin and intense urban and rural development pressures over the last century have affected many of the components of fish habitat in this area. Residential, industrial, and recreational development will continue to expand in the Georgia Basin area, in response to the needs of one of North America's most rapidly growing populations.

The lower Fraser Valley is presently home to over half of BC's population, but also supports some of BC's richest fish habitats. In addition to providing a migration corridor for juvenile and adult Interior Fraser Coho, the varied habitat features of the lower Fraser Valley provide important rearing habitat for juvenile coho salmon. Land development activities have affected this fish habitat, as forests and riparian areas are cleared for agricultural, industrial, housing, or other urban land uses. For example, since records first started being kept, approximately 117 streams have been physically lost from the lower Fraser Valley (DFO 1997a). Similarly, over 700 km of stream habitat have been relegated to storm sewer status, were culverted or paved over (DFO 1997b). Loss or degradation of this stream habitat and riparian vegetation has reduced the capacity of the lower Fraser River and its tributaries to support rearing of coho salmon, including those from the interior Fraser River area.

Estuarine and near shore marine habitats in the Georgia Basin are also vulnerable to loss or degradation, due to their proximity to human activities. The 155 square km estuarine component of the Fraser River is at the heart of Vancouver's metropolitan area, and has been intensively developed. Navigational dredging, log storage, boat traffic, waste discharges, fishing, logging, dyking, recreation, agriculture, as well as residential, commercial, and industrial development have all affected the natural habitats that the Fraser River estuary once provided for migrating and rearing salmon.

The near shore marine areas used by Interior Fraser Coho are less developed than the Fraser River estuary; however, fish still face a variety of habitat impacts within the near shore ocean environment. Since the 1880's over 80 percent of foreshore wetlands and marshes in the lower Fraser Valley have been dyked, drained, and converted to urban/agricultural uses (DFO 1997a).

A significant fish habitat issue throughout the lower Fraser Valley and Georgia Basin is deteriorating water quality; largely a result of human influences in the Fraser River watershed. Point and non-point source pollutants affect water quality throughout the range of freshwater and marine habitats of Interior Fraser Coho. More than 300 outfalls discharge into the Georgia Basin, carrying municipal sewage, urban storm-water runoff, and various chemicals from industrial operations. With continued population growth, the cumulative impact of human activities will put increasing pressure on this area's water resources, and will continue to affect the viability of aquatic organisms, including Interior Fraser Coho.

1.5.4 Habitat Protection

Fisheries and Oceans Canada (DFO) has a legal obligation to protect fish and fish habitat. The federal *Fisheries Act* provides powers to deal with harmful alteration to fish habitat, destruction of fish, destruction of fish habitat, obstruction of fish habitat, necessary flow requirements for fish, water intake screening, and deposits of deleterious substances. In spite of this, there exists a general consensus that many of the problems facing salmon in British Columbia, particularly the decline in abundance due to loss or deterioration of habitat, can be attributed to inadequate or inappropriate enforcement of the *Fisheries Act*. Considering the powers defined in the *Fisheries Act* related to habitat protection there should be little concern regarding the actual or potential loss of fish habitat in the interior Fraser River watershed. However, as indicated earlier in this report, there are a number of activities that have impacted interior Fraser River fish habitat.

While it may appear that habitat protection is straight forward, it is a complex assemblage of Federal and Provincial government departments, ministries, branches, and other jurisdictions, as well as a variety of Regional and Municipal government bylaws, and community and business interests. There is a need for a process that respects the legal obligations of the various agencies while avoiding inter-agency and jurisdictional bottlenecks that surface whenever problems of fish habitat concerns are raised.

In DFO's *Policy for the Management of Fish Habitat*, the first goal is fish habitat conservation. The conservation goal is implemented by, and fundamental to, the *No Net Loss Guiding Principle*. Under this principle, DFO strives to balance unavoidable habitat losses with habitat replacement on a project-by-project basis so that further reductions to Canada's fisheries resources due to habitat loss or damage may be prevented.

In situations where damage to fish habitat has occurred, DFO has the legislative authority under the *Fisheries Act* to proceed with charges against those who damage fish habitat. The onus lies on the Federal Crown to prove beyond a reasonable doubt that harmful alteration, disruption, or destruction of fish habitat has occurred. In the event that the Crown is unable to assemble sufficient evidence against the accused, DFO does not proceed with a *Fisheries Act* charge. This may result when the magnitude of the damage is deemed insufficient to warrant *Fisheries Act* charges, or when DFO is unable to assemble conclusive evidence to prove damage beyond a reasonable doubt. Prosecution under the *Fisheries Act* is a reactive tool used by DFO, often taking several years and considerable resources to complete. Due to this burden of proof, DFO does not proceed with charges on a great number of cases where damage to fish habitat has occurred. Clearly a more proactive approach to fish habitat would be beneficial; an approach in which damage to fish habitat can be prevented and the resulting cumulative, incremental losses of fish habitat are avoided.

Protection of existing habitat and rehabilitation of damaged or altered habitat is considered vital to the recovery of the Interior Fraser Coho. DFO, because of its mandate, must take a leading role to protect and enhance the in-stream and riparian habitat available to Interior Fraser Coho. However, the Province of British Columbia, because of the division of responsibility for

Canada's common property resources, must also participate in the protection of fish and fish habitat.

The Province of British Columbia owns the water in BC and has the proprietary right to ensure its protection and sustainable use. The provincial *Water Protection Act* confirms that surface water and groundwater are vested in the provincial Crown, except in so far as private rights to water have been established.

As a provincial Crown corporation, Land and Water BC (LWBC) is responsible for the management of water in BC. LWBC is governed by many acts, agreements, and protocols that establish guidelines, roles and responsibilities to allow LWBC to work effectively with other government agencies and departments. These acts and agreements establish the legal framework and principles by which Land and Water British Columbia Inc. operates. The main acts and guidelines governing the actions of LWBC are the *Fish Protection Act*, the *Water Act*, the *Water Protection Act*, the *Water Utility Act*, the *Environmental Assessment Act*, the *Land Act*, the *Ministry of Lands, Parks and Housing Act*, and the Province's First Nations Consultation Guidelines.

In recent years, declining fish stocks have emerged as a pressing issue in a number of areas, along with increasing concern about protecting aquatic habitat and, consequently, water management has become an important issue. The relationship between fish, flood protection, recreation, industrial, and other water uses has received considerable attention and a variety of environmental and other interests groups have been calling for greater protection of fish resources.

The Water Use Planning process will involve the participation of the licensee, government agencies, First Nations, key stakeholders, and the general public in the development of Water Use Plans for the licensee's facilities. The Water Use Plans will describe a set of operating rules for each facility that addresses the various interests at stake, while respecting legislative and other boundaries.

The division of responsibility between the federal and provincial governments for the common property resources of freshwater and anadromous fish has created conflicts within the interior Fraser River watershed. Habitat protection must address the complex inter-jurisdictional situation as well as the impacts from development activities. Over time, a variety of government programs and policies have attempted to prevent continued loss of existing habitat while also carrying out habitat restoration activities. While many successes can be noted, a concerted effort needs to be made to ensure that agencies and stakeholders take advantage of the strength of partnerships aimed at minimizing habitat losses. In recent years, effective partnerships have been developed, such as that formed by the Nicola Tribal Association and the Nicola Watershed Community Roundtable and that formed by the Salmon River Watershed Roundtable. With sponsorship and funding from the Pacific Salmon Foundation and the Pacific Salmon Endowment Fund Society, these partnerships are participating in local salmon recovery projects (Nelson et al. 2001; Salmon

River Watershed Society 2004). One of the key focus areas within these watershed based recovery plans is the protection of fish habitat within the watersheds of concern. Cooperative approaches to habitat maintenance and restoration have also been initiated in other parts of the interior Fraser River watershed (Appendix 1).

1.5.5 Biological Limiting Factors

Much of the understanding of the biological limiting factors for coho salmon comes from research in small, coastal streams. That work has indicated that coho salmon production is usually limited by the amount of rearing habitat available to juveniles, either during low flow periods, or as refuge habitat during high flows. Analysis of the production of smolts from spawning populations of different sizes indicate that relatively few spawners may be required to fill the available rearing habitat to capacity, and that spawning habitat may rarely be limiting (Bradford et al. 2000). This view of the limiting factors on coho salmon production may not be accurate for Interior Fraser Coho populations where additional rearing environments exist in the mainstems of large rivers and in lakes.

Since juvenile coho salmon spend a full year in freshwater they are particularly susceptible to freshwater habitat conditions. Furthermore, maturing coho salmon may spend weeks or months in freshwater migrating, holding, or spawning, and are also vulnerable to freshwater habitat conditions. Bradford and Irvine (2000) and Irvine et al. (2000) related the decline in abundance of spawning coho salmon in a watershed to the extent of human activity in that watershed. The authors showed that rates of decline were correlated with agricultural land use, road density, and a qualitative index of stream habitat status. While not determining the actual limiting factors involved, the authors' data do indicate that there are significant biological limiting factors in the freshwater ecosystem.

Productive freshwater spawning and rearing habitats can help sustain salmon populations during periods of adverse marine conditions or high fishery exploitation rates; however, degraded or diminished freshwater habitats may not be adequate to sustain those populations and/or may not permit the populations to recover from low levels of abundance. Thus, both the recovery and long term sustainability of coho salmon will be improved through a program of habitat protection and watershed restoration.

1.6 Threats

The survival and recovery of Interior Fraser Coho depends heavily on reducing the impacts resulting from the four major potential threat sources identified by COSEWIC, *i.e.* over-fishing, habitat perturbations, hatchery production, and climate change (Table 6). The human population in the Pacific

Northwest (including British Columbia) is expected to increase by 2-7 fold this century (Lackey 2001); such an increase can produce serious habitat impacts. Hartman et al. (2000) discussed how human activities affect salmon at local, regional, and global levels and concluded that human population growth likely represents the greatest threat to Pacific salmon.

Lack of sufficient knowledge about the various threats meant that the IFCRT was unable to rank these threats by level of importance. The determination of the relative importance of the following threats is central to determining if survival and recovery of Interior Fraser Coho is possible and a key component of assembling one or more program plans.

Table 6. Potential threats to the survival or recovery of interior Fraser River coho salmon by life stage and population.

Potential Threat	Sub-category	Natural or Human-Controlled [b]	Potential Severity	Affected Life Stage [a]	Affected Populations
Harvest	Fresh-water	Human	High	Adult	All
	Marine	Human	High	Sub-adult, adult	All
Climate Change	Fresh-water	Natural	High	Egg, fry, Juvenile, adult	All
	Marine	Natural	High	Juvenile, adult	All
Habitat Change	Forestry	Human	High	Egg, fry, juvenile, adult	All
	Agriculture	Human	High	Egg, fry, juvenile, adult	All but Fraser Canyon
	Water Withdrawal	Human	High	Egg, fry, juvenile, adult	All
	Hydro-electric	Human	Moderate	Egg, fry, juvenile, adult	All
	Linear Routes	Human	Moderate	Egg, fry, juvenile, adult	All
	Urban growth	Human	High	Egg, fry, juvenile, adult	All but Fraser Canyon
	Mining	Human	Moderate	Egg, fry, juvenile, adult	All
Hatchery Production	Fresh-water	Human	Moderate	Fry, juvenile	North, South, and Lower Thompson
	Marine	Human	High	Juvenile, adult	All

1.6.1 Harvest

The control of coho salmon harvesting is the responsibility of DFO. Over-harvesting, as it applies to Interior Fraser Coho, refers to the occurrence of exploitation rates beyond the productive capacity of the population (*i.e.* more fish are caught than are produced). Productive capacity is measured by comparing the number of adults produced (***R*** - recruits) from the parental broodstock (***S*** - spawners). The amount of recruitment in excess of the original number of spawners may be deemed to be available for harvest if the spawning goal for the population will be achieved. At present no spawning goals have been developed for Interior Fraser Coho.

Irvine et al. (1999b) first documented trends in the rate of population growth for the North and South Thompson populations of Interior Fraser Coho for the brood years between 1975 and 1997. They measured the rate of population growth ***r*** by calculating the natural log of the number of recruits per spawner ***r* = ln(R/S)** for each parental brood year. That analysis has been updated for this report by using revised and recent escapement data (Appendix 3). Over the updated time series (1975-2000 brood years), the rate of population growth has fluctuated, but there were declining trends in the 1980's and early 1990's (Figure 19). These data indicate that for some brood years, the number of recruits produced per spawner (***R/S***) was less than 1.0 (*i.e.* an ***r*** value of less than zero). For those same brood years, the resulting adults are unable to replace the original number of spawners, even in the absence of fishing. During such periods, weaker, less productive components of the Interior Fraser Coho designated unit may become less abundant (Bradford and Irvine 2000). During other periods, ***r*** values of greater than 2.0 were observed (*i.e.* ***R/S*** of over 7.4). Depending on the escapement goal used during those periods, significant exploitation rates or increases in escapement would be achievable.

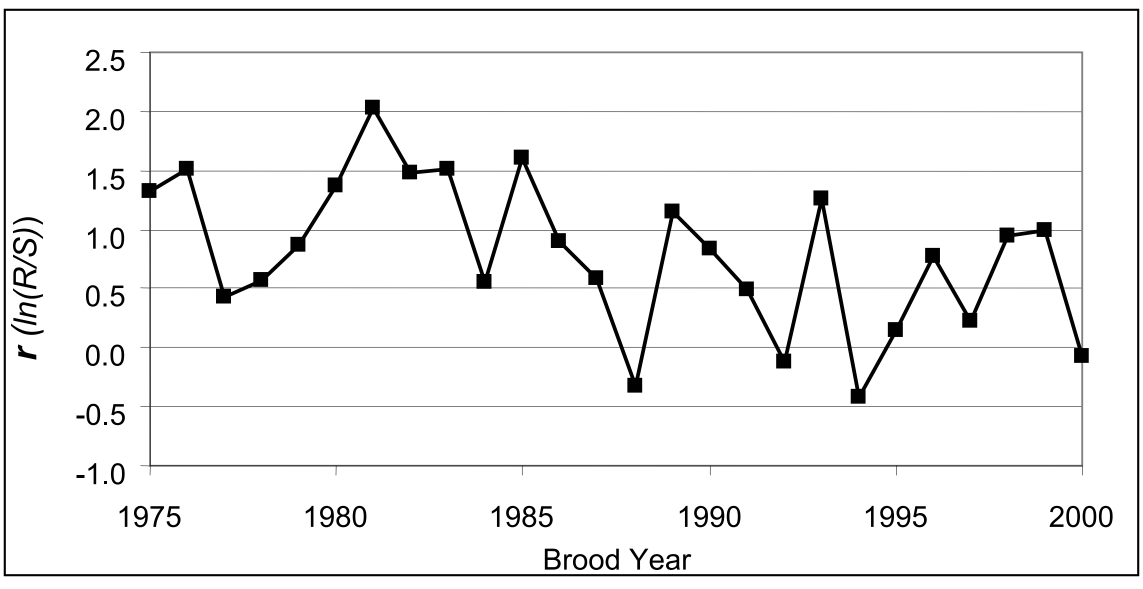

Figure 19. Natural logarithm of recruits per spawner (***r***) for the North and South Thompson coho salmon populations for the 1975 to 2000 brood years (data updated from Irvine et al. 1999b)

Interior Fraser Coho rear in the Strait of Georgia, in Juan de Fuca Strait, on the continental shelf area of the Pacific Ocean off southwest Vancouver Island, and adjacent to the Washington and Oregon coasts. Within these areas, Interior Fraser Coho are harvested by First Nations, commercial, and recreational fisheries in the Juan de Fuca and Johnstone straits, in the Strait of Georgia, along the west coasts of Washington and Oregon, off the west coast of Vancouver Island, and in the Fraser River. As a consequence of their relatively near-shore ocean distribution and the large number of fisheries in these waters, Interior Fraser Coho were subjected to heavy fishing pressure from the early 1900's through to 1998, at which time harvests were drastically curtailed to conserve these and other coho salmon populations.

Historically, exploitation rates for Interior Fraser Coho were estimated through coded wire tag (CWT) returns to hatchery demes, and by sampling marine and freshwater fisheries. Since 1997, DNA sampling and other methods of determining catch composition have been used. Exploitation rates varied from a high of 88% in 1993 to a low of 4% in 2000. Exploitation rates exceeded 60% for all but two years between 1985 and 1996. The rate was reduced to approximately 40% in 1997 and exploitation rates have remained between 4 and 9% since 1998 (Figure 20).

Ocean troll fisheries off the west coast, in both Canadian and US waters, were the largest sources of exploitation, especially in years when Interior Fraser Coho reared in the waters outside of the Strait of Georgia. Total coho salmon troll harvests in the west coast of Vancouver Island (WCVI) troll fishery were capped at 1.8 million during the 1990's. The ceiling was reduced annually from 1994 to 1997, and the WCVI coho salmon troll fishery was closed completely in 1998 (Appendix 5).

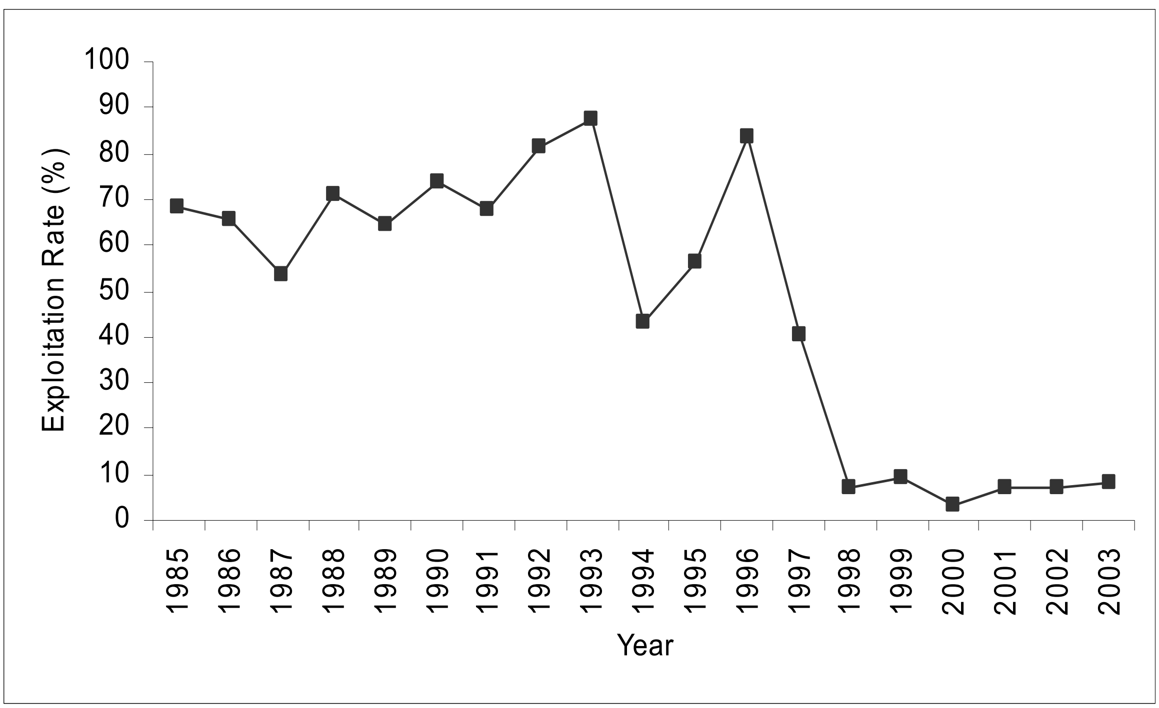

Figure 20. Estimated exploitation rates for the interior Fraser River coho salmon designated unit, 1985 – 2003.

Interior Fraser Coho are also harvested in Juan de Fuca Strait by American and Canadian fisheries, in both commercial and recreational fisheries, but particularly by net fisheries targeting returning Fraser River sockeye and pink salmon. Interior Fraser Coho are vulnerable annually in Juan de Fuca Strait from early April until mid-October. By mid-October virtually all have departed on their return migrations to the interior Fraser River spawning areas.

Similar to the high catches recorded off the west coast of Vancouver Island, coho salmon catches in the Strait of Georgia were large throughout the 1970's and 1980's, averaging about 750,000 through that period. The last large Strait of Georgia coho salmon catch occurred in 1993, when over 1 million were caught. After 1993, the changing marine environment resulted in coho salmon that typically reared inside the Strait of Georgia, rearing more abundantly in Juan de Fuca Strait and off the west coast of Vancouver Island (WCVI). As a result, catches in the Strait of Georgia declined.

Overall exploitation rates remained in excess of 50% throughout the mid to late 1980's and reached a peak of 87.6% in 1993 (Figure 20). Harvest reductions began in 1995 with adjustments to the WCVI troll catch based on forecasted coho salmon abundance and the closure of the Strait of Georgia commercial troll fishery for coho salmon. These harvest management adjustments were ineffective as the exploitation rate was in excess of 80% in 1996. In 1997, in recognition of a crisis in coho salmon abundance, catches in southern BC fisheries were limited to 221,000; nevertheless, the exploitation rate was still 40%. Coho salmon fisheries were closed the following year and the exploitation rate on Interior Fraser Coho dropped to 7% (Figure 20).

Many salmon fisheries, including those directed at harvesting other salmon species, are currently limited in time and area to prevent both directed and incidental harvest of Interior Fraser Coho. However, there is pressure from many harvesting sectors to relax fishery restrictions that were established to protect Interior Fraser Coho. Until consistent and conspicuous improvement occurs in Interior Fraser Coho survival, any increase in exploitation could jeopardize their potential for recovery.

1.6.2 Climate Change

The abundance and productivity of salmon populations has been related to changes, including cycles, in the climate (e.g., Francis et al. 1998). The recent downward trend in productivity of Interior Fraser Coho (Figure 20) suggests these populations are similarly susceptible to climate-change induced effects on their habitats. Given the existing low abundance of Interior Fraser Coho, a series of adverse climatic events would be a serious threat.

Climate related changes have had a major influence on the ability of the marine environment to support salmon. Over the past ten years, considerable research has demonstrated the existence of long term cyclic variations in the marine environment, linked to climate cycles. Within the North Pacific Ocean, climate driven changes in current patterns, such as that related to the *El Niño*

Southern Oscillation event, have profound effects on coastal productivity by creating conditions favorable or unfavorable for upwelling, thus influencing the availability of nutrients on the continental shelf (Francis et al. 1998). Within the Gulf of Georgia, nutrient availability is driven by the availability of nutrients on the continental shelf and by complex currents delivering water from the continental shelf into the Georgia Basin.

Regional salmon catches and abundance have fluctuated with the climatic changes (Mantua et al. 1997). Production in Alaskan waters is negatively correlated with production in southern British Columbia, Washington, and Oregon. These climate related cycles of salmon abundance are reflections of the impact of those climate regimes on the early marine survival of juvenile coho salmon (Ryding and Skalski 1999).

Regimes shifts, which are rapid changes in the marine conditions that may be climate driven, profoundly impact early ocean survival. Since the early 1970's there have been several regime shifts. A major shift occurred in 1976, and other shifts occurred in 1989-90 and 1998-99. Around the time of the 1976 regime shift, early marine survival of some Georgia basin salmon populations was in the vicinity of 20% (e.g. Clark and Irvine 1989). Since the late 1970's, survival of Georgia Basin coho salmon has declined steadily to a low of near two percent in the mid- to late- 1990's. The rate of decline steepened coinciding with the 1989-90 regime shift.

Since a subsequent regime shift in 1998-99, marine survival rates for Georgia Basin coho salmon have been trending upwards, although they still exhibit significant fluctuations (K. Simpson, DFO, unpublished data). A similar trend is likely to be present for Interior Fraser Coho; however, there are no data available for wild-origin Interior Fraser Coho.

Climate change is also related to changes within the freshwater habitat of Interior Fraser Coho. Above normal summer and winter air temperatures and below normal rain and snow falls can combine to produce periods of below normal summer and winter stream flows and higher than normal summer water temperatures. These habitat changes can have a direct impact on coho salmon survival. Other impacts related to climate change, such as the increase in insect infestation of the boreal forest, may affect Interior Fraser Coho by altering riparian and instream habitats.

The threat that climate change will alter the suitability of the marine and freshwater habitats for continuing use by coho salmon is genuine; however, future conditions can neither be predicted nor controlled.

1.6.3 Habitat Change

Historical habitat loss, rapid population growth and urban development, ongoing resource extraction, combined with limited capability to control land uses has likely caused freshwater production of coho salmon to decline within the DU. Numerous stream channels have undergone human induced changes that have resulted in the loss of natural stream complexity and function, with the direct consequence of either deteriorating habitat quality or habitat loss (for further details see Appendix 4 and section 1.5.3). In some areas of the interior Fraser River watershed, streams exhibit high degrees of channel instability with substrate degradation or aggradation resulting from altered suspended sediment levels. In addition, natural riparian vegetation in many areas has been removed or replaced with limited or un-natural types of vegetation. These changes can contribute to channel instability, increased summer water temperatures, loss of in- and over-stream cover, and loss of pool habitat. Furthermore, in some areas, side- and off-channel habitat has been alienated from stream mainstems through infilling and channelization. Also, fish access to historically available main channel habitat has been restricted or denied through the construction of physical barriers, low flow conditions, and channel aggradation. In addition, point source and non-point source pollution from a variety of industrial sources has contributed to declines in water quality. Finally, hydrological regime alterations, as well as stream- and ground-water extractions, have aggravated climate related low flow conditions.

The threat to Interior Fraser Coho from habitat loss and alteration caused by a variety of man-made actions continues to be important, and is discussed in detail in section 1.5.3. These activities will be managed within provincial and federal guidelines. To date, there have been no changes to habitat management or protection specifically addressing the key coho salmon issues identified in Table 6. Continual urban and rural development, increasing forest harvesting rates, and lack of control of water withdrawals are the key issues that need to be addressed in any Interior Fraser Coho program plan.

1.6.4 Hatchery Production

In the interior Fraser River area, coho salmon enhancement takes one of three forms. The first is conservation enhancement, used in systems where coho salmon abundance is at a low level. Examples of this are the hatchery programs on the Deadman River in the Lower Thompson population (Figure 5), and on the Salmon River and Bessette Creek in the South Thompson population (Figure 4). The second is assessment enhancement, where releases of marked fish provide information for assessment of coho salmon survival and exploitation rates. Examples of this are the hatchery programs on the Coldwater River and on three North Thompson River tributaries (Louis, Lemieux, and Dunn creeks). The third is rebuilding enhancement, where hatchery supplementation is used to increase escapements. While this approach is often coupled with an abundance assessment objective, this is not always the case. An example of the rebuilding approach is the enhancement of Spius Creek coho salmon in the Lower Nicola sub-population (Figure 5).

It should be noted that, given increasing or increased and stable escapements to some Interior Fraser Coho systems, the use of hatchery production to enhance those demes may no longer be needed. Examples of this are enhancement efforts on the Bridge River in the upper Fraser population (Figure 7), the Eagle River in the South Thompson population (Figure 4), and on Spius Creek (Lower Thompson population, Figure 5) where hatchery programs have either been terminated (Bridge and Eagle rivers) or are being phased out (Spius Creek).

Evaluations of individual hatchery programs in the interior Fraser River watershed have been carried out every year since the start of enhancement in the early 1980’s. Hatchery fish from several of the enhancement facilities are tagged prior to release to provide identification of hatchery fish in various fisheries and on the spawning grounds. Fence enumeration and mark-recapture programs have been conducted on several enhanced streams over the years, but unfortunately some of these projects have been curtailed because of a lack of funding. Exploitation and survival rates, and enhanced contributions to escapement are determined from these programs and are used by both hatchery and stock assessment biologists. Information from these programs is also used to make changes to the hatchery programs, including changes to the demes being enhanced, the numbers of fish produced, and the juvenile release strategies used.

The original objectives of the larger interior Fraser River hatcheries were to rebuild chinook populations and to provide increased fishing opportunities. Some of these hatcheries have been closed. The production from the remaining hatcheries is shared between assessment enhancement and small scale rebuilding enhancement aimed at increasing the abundance of selected chinook and coho salmon demes. There is a wide range of opinion in the scientific community about the potential threats that may accompany the inappropriate use of fish culture facilities. The key issue revolves around the possible impacts of hatchery fish on wild populations (Orr et al. 2002).

The sources of uncertainty and the concern over the consequent risks regarding hatchery impacts on wild salmon are as follows:

- ***Hatchery fish can create competition with wild fish when resources are limited in the marine or freshwater environment*** (Orr et al. 2002).

The current level of coho salmon enhancement in the interior Fraser River watershed is relatively small as compared to production from hatcheries in the lower Fraser River and Strait of Georgia areas (Table 7). While total hatchery production may create competition between hatchery and wild coho salmon juveniles in the Strait of Georgia, the production from interior Fraser River hatcheries is unlikely to cause significant competition with wild fish for marine resources. Furthermore, reductions in the amount of coho salmon enhancement in the Nicola sub-population are planned. The Lower Thompson, the other sub-population with a relatively high number of hatchery releases, consists mainly of the Deadman River coho salmon, which are of conservation concern. There are no plans to reduce hatchery production in the non-Nicola Lower Thompson sub-population.

The question of whether hatchery fish produced from facilities in the lower Fraser River and the Strait of Georgia are having a negative effect on wild Interior Fraser Coho has not been fully explored; however, the risk of a significant negative impact in some years cannot be ignored. Additional research is required before this issue can be resolved.

Table 7. Releases of coho salmon fry and smolts from interior Fraser River and lower Fraser River and Strait of Georgia enhancement facilities, by year of release.

	Interior Fraser River		Lower Fraser and Strait of Georgia	
Release Year	Number of Fry	Number of Smolts	Number of Fry	Number of Smolts
1981	23,500	0	1,971,066	3,862,380
1982	16,800	0	5,326,280	4,263,714
1983	110,365	0	6,374,871	3,966,990
1984	800,055	0	5,030,099	5,613,758
1985	1,545,613	0	7,824,276	11,196,591
1986	1,375,926	27,114	4,779,361	9,560,777
1987	1,896,268	114,775	4,438,401	7,630,935
1988	1,539,289	141,162	3,109,943	7,668,253
1989	1,436,979	192,671	3,714,448	7,343,509
1990	1,586,429	267,934	4,162,453	7,855,966
1991	1,590,037	288,857	4,022,016	8,149,374
1992	894,761	266,433	4,023,909	8,721,867
1993	749,371	232,799	3,103,610	8,232,926
1994	423,499	146,746	3,873,896	8,893,942
1995	262,654	202,069	4,285,408	8,953,420
1996	357,355	276,820	3,986,565	9,262,914
1997	89,876	195,760	3,295,593	9,366,887
1998	93,805	180,965	2,947,028	9,620,631
1999	314,306	174,188	3,655,820	9,571,183
2000	476,801	214,976	4,611,037	10,239,092
2001	296,916	367,129	5,736,493	10,201,922
2002	420,555	321,859	4,461,702	10,054,120
2003	383,900	320,822	3,057,127	9,570,810

Interior Fraser Coho hatcheries use both fry and smolt release strategies (Table 7). A strategy that emphasizes the release of smolts results in limited freshwater residency by hatchery juveniles, thereby minimizing competition for in-stream rearing areas between hatchery and wild fish. Releases of under-yearling fry into habitat that has been determined, either through fence operations or fry density studies, to be underutilized, are also undertaken (Table 7). In recent years the coho salmon fry release strategy has been refined. In order to limit competition with naturally produced fry, hatchery fry are now released at the same size as natural fry and as closely as possible to the same time as natural fry emerge.

- ***Interbreeding between hatchery and wild fish may have genetic impacts on wild demes*** (Orr et al. 2002).

A genetic impact may result when hatchery fish have originated from a different portion of the population than the wild fish. However, for Interior Fraser Coho hatchery programs, and in particular for those streams with specific conservation programs, attempts are made to take broodstock from representative portions of the population. Some of the resulting hatchery adults return to spawn in natural habitats and may interbreed with their wild counterparts. This provides additional spawners to the natural habitat in order to contribute to increasing or maintaining the abundance of the population. The concern over how much hatchery production, as a percentage of the total spawning population, should be allowed to spawn in natural habitat before the genetic characteristics of the wild population are altered is real, but has not been addressed.

The Interior Fraser Coho hatchery program was designed to maintain the diverse genetic characteristics of the parent wild population. Key practices in maintaining such characteristics are: the use of native broodstock whenever possible, following prescribed broodstock collection and spawning practices, and evaluating survival and return rates and contribution to fisheries. DFO hatchery practices follow stringent genetic guidelines, particularly for demes of conservation concern. These guidelines were first developed in the early 1980's and have been modified as DFO's understanding of salmonid genetics has improved. The guidelines emphasize the removal of representative broodstock over the entire period of the run, but in some instances the guidelines have not or cannot be followed as stringently as is desirable. By and large, however, Interior Fraser Coho hatcheries operate in accordance with the general strategies recommended by the scientific community (Orr et al. 2002).

- ***Abundance of hatchery fish in a mixed stock fishery may encourage excessive fishing which may negatively affect wild populations*** (Orr et al. 2002).

Hatchery coho salmon in southern BC are produced primarily to support mixed stock ocean recreational fisheries. Over-exploitation of wild coho salmon may occur if exploitation rates are based on the abundance of hatchery produced coho salmon. Fishery closures to protect interior Fraser River and Georgia Basin wild coho salmon at times and places they are known to occur, and programs to mark lower Fraser River and Strait of Georgia hatchery coho salmon have created recreational fisheries that retain marked hatchery fish and release unmarked coho salmon. The impact of these hatchery mark selective (HMS) fisheries on wild stocks is difficult to estimate. For example, a significant number of hooked coho salmon never reach the boat, possibly dying after escape from the hook or being taken by seals. Seals may also kill coho salmon following a successful release by the fisher. There are no estimates available for these types of mortality. In many cases, estimates of hook and release mortality rates for coho salmon are based on short-term studies on coho salmon held in pens, or were derived from studies done in other areas and under different conditions.

The many assumptions concerning the marine distribution of Interior Fraser Coho, the catch rates for these fish in HMS fisheries, and the mortality rates for wild coho salmon caught and/or released introduces considerable uncertainty in the estimates of the impact of HMS fisheries.

The estimated total fisheries related mortality on Interior Fraser Coho over the period 1998 through 2003 has ranged from 4% to 9% (Figure 20) with total allowable impacts in Canada set at 3%; some of that mortality is caused by HMS fisheries for coho salmon. While there are no insignificant mortalities when dealing with populations at risk of extinction, and there are significant uncertainties in the estimation of these impacts, the current estimated fishing mortality for Interior Fraser Coho in HMS fisheries is not likely to prevent rebuilding. However, these HMS fisheries do contribute to overall fishing related mortality. Such mortality may be an impediment to the recovery of Interior Fraser Coho.

1.7 Knowledge Gaps

There are significant knowledge gaps that limit the capability of the IFCRT to determine if the recovery objectives and recommended approaches will be fully effective. These gaps combine to produce a lack of understanding of the relationships between spawners and recruits for Interior Fraser Coho. Determining the levels of spawner abundance for each of the populations within the DU that are required to reach maximum sustainable yield is beyond the scope of existing knowledge. There are limited data for some demes that indicate their productive capacity, but determining an appropriate level of abundance that will produce a sustainable yield for one or all of the populations is not currently possible.

To further complicate matters, the IFCRT is unable to determine the main cause of the decline in abundance of Interior Fraser Coho. The following knowledge gap descriptions indicate areas of research that are necessary for determining which threats are the most critical to address.

1.7.1 Distribution

A major gap is the lack of accurate knowledge about the distribution of coho salmon within the Upper Fraser population. With the exception of the Quesnel River watershed, the knowledge of the spawning and rearing areas for coho salmon in several large tributaries located upstream of the Bridge River rapids is limited. A concerted effort at gathering additional local and aboriginal tribal knowledge and at increasing spawning and rearing inventory studies would reduce the size of this gap.

1.7.2 Life History

The details of the life history of Interior Fraser Coho are only partially understood as most of the current understanding is based on research performed on coastal populations of coho salmon. There are no data to accurately estimate egg to emergent fry survival rates in a region where, typically, autumn droughts are followed by severe winter freezing conditions. In addition, there are insufficient data to accurately estimate emergent fry to smolt survival rates in a region with spring and early summer freshets followed by fall and winter droughts or freshets. The use of large and small lakes by coho salmon for rearing or over-wintering purposes, the importance of groundwater levels for over-winter habitats, and the location of other over-wintering habitats in a cold climate area have not been adequately researched.

In addition, there are few studies available on the use of non-natal areas for rearing and over-wintering and limited data demonstrating the rates at which wild origin adult coho salmon return to natal or non-natal areas.

1.7.3 Habitat Impact Levels

The assessments of the impacts of habitat alteration on coho salmon production assembled for this document were, because of a lack of knowledge, qualitative in nature. Qualitative assessments, as they are not based on repeatable measurements, are inherently more easily subject to criticism than quantitative ones. In addition, in situations where there are significant amounts of vested interest, opposing opinions are quickly aroused and criticism is not always constructive. Assembly of quantitatively based habitat impact assessments would minimize confrontations over differing qualitative opinions. Although an overview level assessment of habitat impacts has been conducted (Bradford and Irvine 2000), with the current level of knowledge, assigning impacts a specific impact category is difficult.

1.7.4 Water Supply

To further limit the understanding of the use of the available habitat for incubation, rearing, and over-wintering purposes, there exists little data on the relationship between, and the importance of, groundwater and surface water sources. Also, there are few studies that indicate the impact of current or further development, both industrial and urban, on the surface and ground water resources within the interior Fraser River drainage area.

1.7.5 Important Habitat

The lack of knowledge related to the life history and distribution of Interior Fraser Coho results in a significant gap in the capability to determine what constitutes important habitats for Interior Fraser Coho populations. The lack of quantitative information on habitats, and the impacts on those habitats, also contributes to this gap. These knowledge gaps mean that it is not possible to determine specific important habitats for most of the sub-populations within the Interior Fraser Coho DU. An exception is the Fraser Canyon population where over 90% of the spawning area for the population is located in one tributary, the Nahatlatch River. Two additional areas proposed by the IFCRT as important habitat are in, and adjacent to, Hells Gate in the Fraser Canyon and Little Hells Gate on the North Thompson River. These areas should be protected so that fish passage can be maintained. Additional information is needed to confirm whether these areas are definitively important habitat, and to consider the identification of other freshwater, estuarine, and marine areas that may be important to Interior Fraser Coho.

1.7.6 Migration routes, timing, and survival

Marine survival estimates are scanty and there are few data indicating the migration routes and timing for several of the populations. These knowledge gaps are especially true for the Upper Fraser coho salmon population.

A further item that limits the understanding of marine survival is the relationship between hatchery and wild origin coho salmon during the initial occupation of the Strait of Georgia by coho salmon smolts. While Interior Fraser Coho of hatchery origin represent a small proportion of the fish rearing in the Strait of Georgia, one study has shown that in some years, hatchery coho salmon from all sources may comprise more than 50% of the rearing coho salmon (Noakes et al. 2000). The majority of the hatchery coho in the Strait of Georgia are produced by lower Fraser River and East Vancouver Island hatcheries. Competition between hatchery and wild origin coho salmon for space and food may impact the survival of either or both of these groups; however, there is little information to indicate the level or direction of the impact.

1.7.7 Exploitation Rates

Exploitation rates are determined by comparing the estimated total catch and mortality in the various fisheries to the estimated total abundance (catch plus mortality plus escapement). Observed catch is reported to DFO as part of a variety of catch monitoring programs for the different fisheries but does not include drop-off, incidental catch missed in large catches of the targeted species, loss to predators, or unobserved losses from other sources. Mortality rates of coho salmon taken incidentally in fisheries directed at other species are primarily estimated from data provided by short term holding studies. Immediate mortality of coho salmon and mortality for up to the following 48 hours after capture by troll, gill net, seine, or recreational hook and line gears are assessed in this manner. This method does not take into account long term mortality or sub-lethal effects, such as impacts on fitness, the ability to avoid predators, the ability to complete migration, or the possible effects on spawning success. The lack of knowledge of actual catch and true mortality rates can have a significant effect on the calculation of exploitation rates, particularly when dealing with small populations such as is the case with Interior Fraser Coho.

1.7.8 Genetic Uniqueness

Another significant knowledge gap is the scarcity of genetic samples from the Upper Fraser population. The data from these samples may indicate the level of genetic uniqueness within the Upper Fraser region. This gap, along with a limited knowledge about the fidelity of spawners to their natal area, deme, or sub-population, has resulted in a limited understanding of the existence of additional populations within the DU. Spatially representative genetic samples are required to assess population structure within the Upper Fraser region.

1.7.9 Threat Importance

Another significant knowledge gap is the unknown relative importance of the multiple threats that have been identified to date. Bradford and Irvine (2000) stated that a decline in ocean survival and a failure to reduce fishing were two causes of declines in abundance. However, they also noted that coho salmon abundance in watershed areas that were highly impacted by development declined more rapidly than those in less impacted basins, and that more work needed to be undertaken to determine the relative merits of different actions directed at reducing the threats to recovery. Program planning for the recovery of Interior Fraser Coho will need to determine which approaches will best serve the species' recovery objectives.

1.7.10 Possible Research Topics

A few examples of studies that will help to reduce some of the knowledge gaps are:

- Identify long term indicator demes to monitor rebuilding. This should contain both intensive and extensive escapement indicators, and be sensitive to the opportunistic use of habitats by sub-populations.
- Identify instream conservation flow needs for Interior Fraser Coho. This involves defining flows and/or flow periods required to maintain inter-connectivity among important rearing habitats to allow fish to move among habitats freely.
- Identify important habitat. This may include quantification for each life stage of important habitat, development of a stochastic age-structured model, and evaluating impacts on population performance and viability if the important habitats are lost or degraded. Population viability analysis

may be used to evaluate relationships between combinations of important habitat, marine survival, and fishery exploitation rates with the probability of population extinction, decline, or recovery.

- Identify hatchery-based obstructions to recovery. Included are impacts from early marine survival (i.e. competition for limited marine resources), and fishery and genetic impacts from mixing hatchery and wild fish.
- Identify appropriate spawner goals. These will be population specific and will ultimately require some assessment of the relative productivities of the populations.
- Identify appropriate exploitation rates. This will involve development of a model similar to the approach presented by Bradford et al. (2000) whereby exploitation rates can be determined for a variety of probable levels of marine survival.

2 Biological and Technical Feasibility of Recovery

A draft policy on the feasibility of recovery of species at risk stated that recovery feasibility should be based on specific criteria and be defensible (Government of Canada 2004). It was further stated in the policy that recovery of a species should not be deemed *feasible* if the answer to any one of the following questions is *no*:

1. Are individuals capable of reproduction currently available to improve the population growth rate or population abundance?

The 2000-2003 average spawning escapement abundance for Interior Fraser Coho was 38,595 naturally spawning fish with the lowest level being 18,484 (Table 4). The biological feasibility of recovery depends on the potential of populations to increase in abundance, in the face of risk factors. Population growth can occur when the number of recruits (**R**, the number of returning, pre-fishery adults, three years later) exceeds the parent population size (**S**, spawners), that is, when **R/S** is greater than 1.0. The overall population growth rate for coho salmon is the result of the combination of freshwater and marine survival rates. For example, a reduced or degraded freshwater habitat can reduce freshwater survival, resulting in a lower number of smolts produced per spawner, which may result in low or negative population growth rates when combined with a low smolt to adult marine survival rate.

The productivity of Interior Fraser Coho can be evaluated using spawner and recruitment estimates and the corresponding exploitation rate estimate. Productivity estimates were made for the North and South Thompson populations for which the escapement data are the most reliable (1984-2003) (Figure 19). Those annual **R/S** values when plotted against the Strait of Georgia wild coho salmon marine survival rate illustrate the influence of marine conditions on Interior Fraser Coho productivity.

The number of North and South Thompson River coho salmon recruits per spawner is positively correlated with marine survival rates for coastal coho salmon populations and, for most of the historical record, the number of recruits per spawner is greater than one (Figure 21). Declines in the abundance of Interior Fraser Coho during this period were the result of excessive fishing mortality when productivity was low (Bradford and Irvine 2000). The relationship between marine survival and **R/S** suggests that, on average, **R/S** will be near one when coastal coho salmon marine survival rates are between 2 to 4%. At survival rates of 10% or greater, the North and South Thompson coho salmon **R/S** averages greater than two.

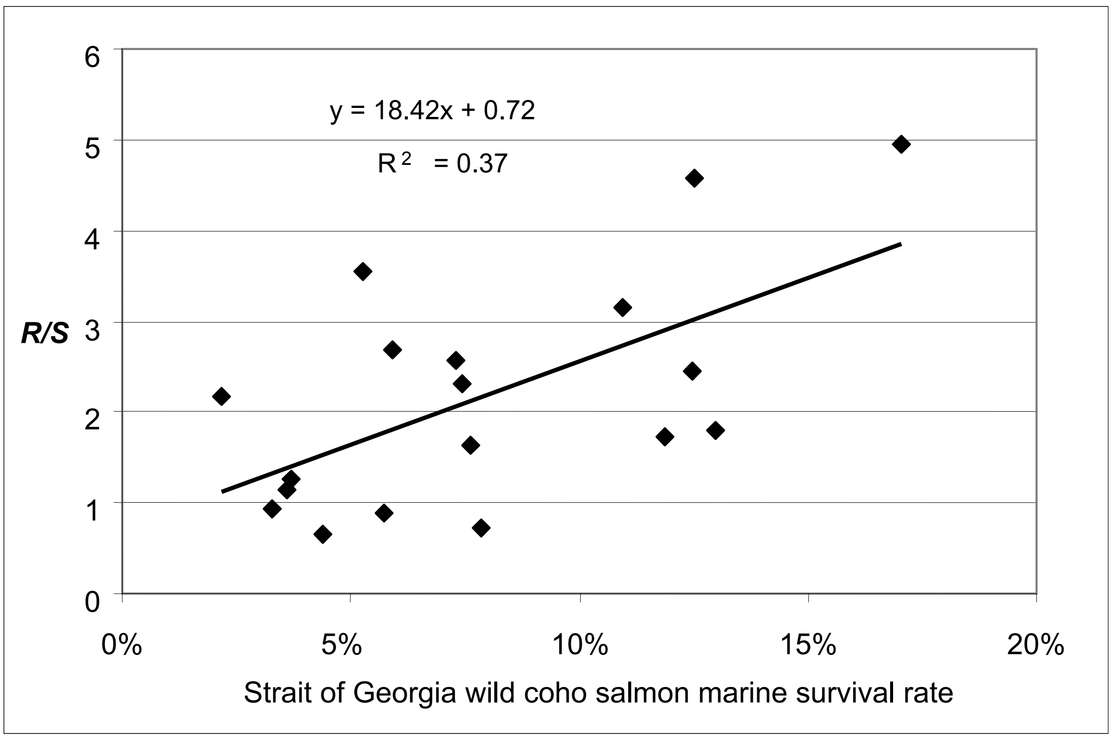

Figure 21. Relation between average recruits per spawner (1984-2000_brood years) for North and South Thompson coho salmon populations and the average marine survival rate for Strait of Georgia wild coho salmon indicator populations (Strait of Georgia data from K. Simpson, DFO, unpublished data).

From this analysis it can be concluded that the North and South Thompson coho salmon populations were sufficiently productive to permit population growth in all but the lowest marine survival conditions, and that recovery is biologically feasible.

During periods of low ocean survival, interior Fraser River coho salmon may be unable to reproduce at rates that will produce population growth and the escapements will decline, even in the absence of fishing. The level of success of recovery will be dependent on ocean conditions, random events, harvest levels, and changes in freshwater habitat conditions.

2. Is sufficient suitable habitat available to support the species or could it be made available through habitat management or restoration?

The most recent assessments of the available spawning and rearing areas (Table 1) indicate that there is sufficient habitat available to maintain a viable population of Interior Fraser Coho. Furthermore, although much of this habitat has been negatively impacted by habitat alterations, much of the available habitat is still suitable for spawning and rearing of coho salmon (Figure 18). If the existing freshwater and estuary habitats remain intact, and continue to be as productive as has been observed in the recent past, the recovery of Interior Fraser Coho is feasible. However, continued development pressures in portions of the interior Fraser River watershed may constrain the recovery of some sub-populations. This is especially true if the trend to a drier, warmer climate continues.

The extent to which recovery may be feasible varies among the populations and sub-populations. Some areas are relatively pristine, and large tracts of the habitats occupied by coho salmon are intact and productive. Other areas are much more impacted. Within the Lower Thompson, the lower North Thompson and the Lower and Mid Shuswap sub-populations, much of the freshwater habitat has been significantly impacted, lowering freshwater productive capacities (see section 1.5.3).

Although freshwater habitat conditions in some Interior Fraser Coho sub-populations may be degraded at the population level, habitats are likely productive enough to make recovery biologically feasible.

3. Can significant threats to the species or its habitat be avoided or mitigated through recovery actions?

Fishing mortality has been reduced to low levels and it is technically feasible to regulate fishing to an appropriate level for recovery to be successful. Similarly, hatchery practices can be managed to reduce adverse interactions. Efforts will continue to reduce the impacts of human development on freshwater habitats, although continued human population growth and related resource extraction are inevitable, especially in the Thompson River drainage areas. Little can be done about climate change at the local level, and this threat has the potential to limit recovery as it affects both ocean and freshwater habitat conditions. The prognosis for the recovery of Interior Fraser Coho is dependent on the existence of favorable marine, estuary, and freshwater conditions. If marine survival rates continue on the current upward trend, then increased recruits per spawner should result, thereby facilitating increased abundance of

Interior Fraser Coho. Relatively small changes in marine survival can have profound impacts on adult returns; for example, if marine survival improved from 5% to 7%, a 40% increase in abundance could result (Ryding and Skalski 1999). Conversely, should marine survival remain poor or decline, continued reductions in total abundance are predicted, even in the absence of exploitation. Thus, with the exception of climate change, the significant threats to Interior Fraser Coho will not make recovery infeasible.

4. Do the necessary recovery techniques exist and are they demonstrated to be effective?

Recovery actions already underway include reductions in fishing mortality, programs to protect the habitat, and augmentation of production through the use of various hatchery practices. Each of these techniques is available to DFO, and, based on the current levels of abundance of Interior Fraser Coho, have been demonstrably effective. Therefore, recovery of Interior Fraser Coho is feasible; however, without ongoing commitments to provide adequate water and functioning habitats, and set harvest appropriate exploitation rates, the recovery of some of the sub-populations is unlikely.

Summary

Following the review of the available data, the recovery team has concluded: that there are sufficient coho salmon, capable of reproduction, available to improve Interior Fraser Coho population abundance; that there is sufficient, suitable habitat available to support Interior Fraser Coho; that the significant threats to Interior Fraser Coho or its habitat can be avoided or mitigated through recovery actions; and that recovery techniques exist and can be effective. Thus, it is feasible to recover Interior Fraser Coho.

2.1 Recommended Scope of Recovery

The scope of recovery of Interior Fraser Coho will be determined by the willingness of affected persons, communities, and industrial operations to undertake those measures required for recovery at the population and sub-population levels. In some situations, recovery of all sub-populations to viable levels would be desirable; however, this may not be possible without extraordinary impacts on local residents and industries.

As identified in section 1.5.3, some freshwater habitats required by Interior Fraser Coho have been impacted by urbanization, linear development, loss of riparian vegetation and stream canopy cover, agricultural activities, and dewatering in several of the sub-population's regions. Restoration of viable populations of coho salmon in these areas will require reversal of these impacts, and, in particular, provision of continuing access to adequate spawning and rearing habitats.

Population and distribution objectives intended to assist in survival and recovery have been proposed in the Wild Pacific Salmon Policy (DFO 2005) in terms of achieving a desired position within certain biological status zones. Two benchmarks have been defined that delimit three biological status zones (red, amber, and green in Figure 22). The lower benchmark should ensure a substantial buffer between it and a level of abundance that could lead to the DU being considered at risk of extirpation. There are various ways one can compute the higher abundance benchmark (Figure 22), including the number of spawners estimated to provide maximum sustainable yield (MSY) on an average annual basis given existing environmental conditions, or a reasonable approximation of that theoretical value.

When units are designated at risk by COSEWIC, they are in the Red Zone. Recovery objectives should safeguard a Red Zone population by increasing spawner abundance and distribution in order to move the unit into the Amber Zone. A population in the Amber Zone may not be at risk of extirpation, but there will be less than maximum production from the DU. Achieving Amber Zone status may be suitable for lower productivity species, particularly those that share risk factors with more productive populations, *e.g.* a less productive unit that co-migrates with more productive populations and is caught in fisheries directed at the more productive populations.

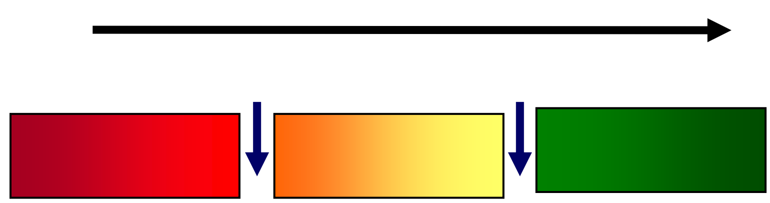

Figure 22. Diagrammatic representation of benchmarks separating three escapement abundance status zones (red, amber, and green). Units designated and listed by COSEWIC are in the Red Zone. Short term recovery objectives are intended to move the unit into the Amber Zone. Longer term objectives may move the unit into the Green Zone, an area where maximum sustainable yield (MSY) may be possible.

Benchmarks associated with achieving maximum sustainable yield (MSY) are widely used by fisheries scientists and have been calculated for some species. Units in the Green Zone can sustain fisheries, provide ecosystem benefits, and may have achieved some of the possible longer term Recovery Objectives (see section 3.3). The estimation of MSY values requires a relatively long-term historical set of spawner and recruit data. Such data are unavailable for most Interior Fraser Coho populations.

3 Recovery

3.1 Recovery Goal

The recovery goal is to secure the long term (*i.e.* greater than a human life time) viability and diversity of naturally spawning coho salmon within the interior Fraser River watershed.

3.2 Recovery Principles

Coho salmon are found at different levels of abundance throughout the Interior Fraser River drainage area and Interior Fraser Coho exhibit biodiversity within the watershed. This diversity is expressed as quantitative variation in neutral alleles, and as quantitative and qualitative diversity in life history traits, such as adult migration timing, fecundity, and body size. This diversity is the basis for the continued production and survival of populations and species, and hence their ability to adapt to change, and to withstand harvest.

To guide the development of recovery objectives, three principles apply:

- *Principle 1: The recovery of Interior Fraser Coho will require the maintenance of sufficient levels of abundance and spatial diversity to achieve the recovery goal.*

Recovery will not be achieved by having one large spawning aggregation while allowing the remainder to be extirpated, nor does it mean large abundances of fish in every stream that historically may have had coho salmon. The challenge is to determine appropriate levels of abundance and distribution that will satisfy this first principle.

- *Principle 2: The spatial structure and distribution of Interior Fraser Coho will be considered at the level of populations and sub-populations.*

Five populations have been identified that correspond to major drainage basins within the interior Fraser River watershed (see section 1.4). Within each of these populations, coho salmon interbreed to varying degrees; however, the populations are sufficiently isolated from each other that there will be persistent local adaptations and limited exchange or migration amongst the populations.

One or more sub-populations have been identified within each of the five populations (Section 1.4). Sub-populations are considered to be demographically independent units, that is, their population dynamics or probabilities of persistence are independent of events in adjacent sub-populations. Migrations may occur among sub-populations that may reduce genetic differentiation, but are relatively limited in scope. Procedures for defining sub-populations are inexact and the relevant data are scarce; some of the factors that have been considered include genetic and phenotypic differentiation, independence in trends in abundance, estimates of straying or interchange, and habitat and ecological considerations.

Most sub-populations contain many spawning aggregations or demes. Observations of year to year variation in the distribution of spawners and straying of marked fish among streams suggest that considerable interchange can occur among nearby natal streams; thus, demes are not necessarily persistent features of a population's structure. Therefore, the preservation of all demes is not considered a prerequisite for the recovery of Interior Fraser Coho.

- *Principle 3: The recovery goal is considered achieved when there are one or more viable sub-populations in each of the five populations.*

This principle is designed to ensure that there is representation from each of the five genetically distinct populations of Interior Fraser Coho. Ensuring that more than one sub-population is viable within a population is desirable as it insures against catastrophic events, and would likely lead to protection of a greater proportion of the biodiversity of a population.

The term viable in Principle 3 means that the abundance and productivity (as affected by the combination of freshwater and marine habitat conditions, and fishing mortality) of the sub-population are sufficient for it to persist over the long-term. Viability is achieved by establishing minimum population levels and by ensuring that habitat conditions and fishing mortality are at levels that can sustain long-term productivity.

A provisional operational rule for application of Principle 3 is that within each of the five populations, at least half of the sub-populations must be viable. This means that for the North and South Thompson populations, two of the three sub-populations within each must be viable, one of the two sub-populations in each of the Upper Fraser and Lower Thompson populations must be viable, and the single sub-population within the Fraser Canyon population must be viable.

3.3 Recovery Objectives

The following two objectives need to be achieved in order for Interior Fraser Coho to be considered to have met the recovery goal.

OBJECTIVE 1: The 3-year average escapement in at least half of the sub-populations within each of the five populations is to exceed 1,000 naturally spawning coho salmon, excluding hatchery fish spawning in the wild. This objective is designed to provide the abundance and diversity required to satisfy the recovery goal.

If the historical patterns of distribution within the interior Fraser River watershed continue into the future, this objective will be achieved when the escapement to the designated unit is at least 20,000 to 25,000 wild spawners (see section 3.4.3).

OBJECTIVE 2: Maintain the productivity of Interior Fraser Coho so that recovery can be sustained. This objective is designed to ensure that the threats to recovery are addressed.

This objective may be met by addressing the causes for the decline that were identified by COSEWIC as follows:

- Development of a harvest management plan to ensure that exploitation rates are appropriate to changes in productivity caused, for example, by fluctuations in ocean conditions.
- Identification, protection, and, if necessary, rehabilitation of important habitats.
- Ensure that the use of fish culture methods is consistent with the recovery goal.

POSSIBLE LONGER TERM OBJECTIVES: Over the long term it may be desirable to recover Interior Fraser Coho so that other societal objectives can be achieved. The IFCRT identified the following possibilities:

- To achieve three year average escapements in all sub-populations within each of the five populations exceeding 1,000 naturally spawning coho salmon (excluding hatchery fish spawning in natural habitats).
- To recover each of the five populations to the Green Zone (Figure 22).
- To recover each of the five populations to their maximum historic abundance levels.
- To recover to a level where the freshwater productive capacity within each of the five populations is optimized. A possible approach would be to estimate the maximum capacity as smolts/km and apply this to the designated unit.
- To increase adult returns so that sufficient marine origin nutrients enter each population to optimize ecosystem function.
- To recover to a level that will allow for harvesting at higher levels than are currently allowed; including, but not limited to, terminal area (*i.e.* in estuary or freshwater areas near natal streams) harvesting for consumptive and non-consumptive purposes.

3.4 Technical Support for Setting Objectives

Interior Fraser Coho population recovery objectives are expressed in terms of the number of reproducing individuals. In the following sections abundance levels are identified that are considered to address specific conservation issues.

Bradford and Wood (2004) review the literature and theory involved in establishing minimum viable population sizes and recovery objectives.

3.4.1 Genetic Issues

There are genetic consequences to small population sizes that might affect the long-term viability of the population. Reductions in population size can result in the loss of genetic diversity, and small populations can suffer from cumulative effects of inbreeding.

There is scientific debate over the number of effective breeders required in a population to maintain long term genetic variation, but the range is about 500 - 5,000 individuals. In population genetics, the number of effective breeders in each generation (N_e) roughly refers to the number of individuals that contribute to the next generation. In most cases, the number of effective generation breeders is substantially less than the actual (or censused) number of adults (N_c) because of uneven sex ratios, uneven mating success, and differential survival and contribution from individual matings. N_e is also reduced by variations in population size and is affected by the age structure of the population.

In the case of salmon, N_e (effective breeders per generation) can be approximated as $N_e = k\ g\ \tilde{N}_c$ (equation 1) (Waples 2002). In this equation k is an estimate of the ratio of N_b/N_c within a year, where N_b is the annual number of effective spawners and_N_c is the census or escapement estimate in that year. Waples (2002) suggested a value of k = 0.3 for salmon. A lower value might be appropriate in the case of diminished coho salmon populations if small numbers of fish are distributed over a large area, potentially resulting in difficulties in finding mates and uneven sex ratios in spawning aggregations. Conversely Arden and Kapuscinski (2002) in a study of steelhead trout suggested a higher value for k at low population sizes because reduced competition decreases the variation in survival among individual families. The parameter g is generation length, which is typically three years in coho salmon.

Equation 1 was tested using a model population in which adults from a single cohort mature at three different ages, and was found to be robust to variations in the maturity schedule (Waples 2002). If there is a single age at maturity the population can be considered to consist of three separate lineages. Consequently N_e will be smaller and the loss of alleles and inbreeding effects may be greater during periods of low populations. The effective population size (per generation) for each lineage can then be calculated as $N_e = k\ N_c$ (equation 2).

In the case of Interior Fraser Coho, nearly all adults are three years old; however, some four year olds are known to occur. Thus N_e probably lies somewhere between the values calculated from equations 1 and 2. Depending on the assumed age structure of maturing adults, this will result in an effective population size (N_e) ranging from about 300 to 900 fish.

To calculate N_e over the long-term the harmonic mean of the number of effective breeders per generation from equations 1 or 2 should be used (Waples

2002). Use of the harmonic mean provides greater weighting to years of low abundance in which the genetic effects are most likely to be significant.

Neutral genetic marker information suggests that Interior Fraser Coho can be divided into five distinct populations, within which interbreeding occurs; therefore, genetic conservation criteria should be applied to each of the five populations.

3.4.1.1 Genetic Conservation Recommendation

Under ideal conditions, an abundance level of 1,000 spawners in each of the five populations is probably adequate for the maintenance of genetic variation in the short and medium term, but is probably too small for maintaining genetic diversity in the long term.

However, some Interior Fraser Coho populations encompass a large geographical area so that a population of 1,000 spawners could be fragmented into smaller groups isolated by distance. The calculations described above are based on the assumption that the populations are homogenously mixed during the breeding season so that every individual could mate with any other. Because of the potential fragmentation of Interior Fraser Coho populations into small groups, the 1,000 spawner recommendation may be too small to achieve the goal of maintaining genetic diversity[4]. In order to recommend appropriate levels of overall abundance in fragmentation cases, a complex model is needed; at present, there are insufficient data to develop such a model.

Abundances required to conserve genetic variation should be met in all five populations at all times as a minimum to maintain genetic diversity throughout the range of Interior Fraser Coho. Examination of the historic time series of escapement data indicates that the 1,000 spawner level has always been achieved in the recent past (1975 - 2003).

3.4.2 Demographic Issues

Small populations are at risk of becoming extirpated because of chance events, or because of their reduced capacity to survive periods of poor environmental conditions. The goal of this section is to consider levels of abundance that minimize the risk of a sub-population falling to critically low levels or becoming extirpated.

The probability that a population or sub-population will go extinct within a specified time frame is a function of its initial population size and the long term population growth rate. For salmon, the population growth rate is often expressed as the number of recruits per spawner (**R/S**), which is the ratio of returning adults

[4] Chen et al. (2002) present evidence that reproductive success of North Thompson coho is less at low population sizes (i.e. depensatory mortality).

to parent spawners. Extinction can result when the population is below a level at which the likelihood of the population recovering is poor. For example, an abundance level of less than 100 spawners for four consecutive years has been proposed for Cultus and Sakinaw sockeye salmon populations as an extinction threshold (Bradford and Wood 2004). Similarly, an appropriate level of abundance that addresses demographic concerns would result in an acceptably low risk of extinction for a sub-population.

Extinction thresholds can be investigated by population modelling methods; however, the outputs are extremely sensitive to input theories and parameters. In the case of salmon populations, model results are sensitive to assumptions about future environmental conditions. Nonetheless, there are generalizations that can be drawn from this type of modelling that can be of assistance. The following comments are adapted from the results of the Cultus Lake sockeye simulation model (Schubert et al. 2002 and unpublished results) and work of the Willamette/Lower Columbia Technical Recovery Team (Willamette/Lower Columbia Technical Recovery Team 2003):

- Many salmon populations are inherently productive so that a few hundred individuals have been found to be acceptable as minimum viable population abundances (MVP) because the population can grow quickly from a small initial population size.
- Cyclical oceanic conditions raise the MVP substantially if there are periods in which ocean conditions result in recruits per spawner (**R/S**) values of less than 1.0.
- The risk of extinction declines with increasing population size. The lowest risk of extinction occurs when the starting population size increases from the extinction threshold to about 500 individuals.
- When all lineages or cohorts are below the extinction threshold, there is a high probability that, after 100 years, the population will consist of only one non-extinct cohort, with all other lineages being extinct. The risk of one or more lineages becoming extinct during a 100-year simulation is substantial; however, that risk is reduced if the starting population is in the range of 500-1,000 individuals. Starting populations larger than 1,000 individuals do not result in a significantly reduced risk of extinction.
- The existence of depensatory mortality (mortality is depensatory when its rate increases as the size of the population decreases). For example, reproduction may be less successful at low population densities because of the difficulty in finding mates in a large geographic area (Chen et al. 2002).

3.4.2.1 Demographic Conservation Recommendation

Detailed modeling studies suggest that sub-populations with a reasonable expectation of growth should recover if they start with an initial size of 1,000 spawners annually. In the analysis of Interior Fraser Coho, the average sub-population size is based on the 3-year geometric mean, calculated as a running average (*i.e.* 3-year mean). This 3-year mean represents average abundance per generation (three consecutive years in coho salmon) and is used to smooth out annual variations. The geometric mean is used to place greater weight on the years of smaller abundance ensuring, for example, that sub-population status does not change on the basis of a single large return.

3.4.3 Application of Abundance Recommendations to the Recovery Objectives

Salmon populations are inherently variable and it is unlikely that all 11 sub-populations would have the same status at any one time. The application of Recovery Principle 3 and Recovery Objective 1 (see sections 3.1 and 3.2) suggest that at least half of the sub-populations within each of the five Interior Fraser Coho populations should be viable. The review of demographic concerns suggests that a sub-population should be considered viable when the 3-year mean abundance is greater than 1,000 spawners and if the population has the potential for positive growth. Having 1,000 individuals in each sub-population would help address the concerns about fragmentation raised in the discussion of genetic issues.

However, there are additional considerations when considering an abundance-based recovery goal for Interior Fraser Coho:

- The 11 sub-populations are different in geographical size, and historically, have differed considerably in abundance. Thus, some sub-populations are more likely to exceed the 1,000 benchmark than others.
- The recovery objective is to be expressed as the number of spawners for the whole designated unit. This number is greater than the minimum value of 7,000 spawners (the minimum number of fish in the minimum number of viable sub-populations in each population) because of differences in productive capacity and size of the sub-populations. Those differences affect the spatial distribution of spawners within the DU.

Interior Fraser Coho have undergone fluctuations in abundance in the past 20 years, and reconstructed spawner estimates allow an evaluation of the performance of Recovery Objective 1 using historical data. In particular, the relation between the abundance of fish in individual sub-populations and the total DU abundance can be examined.

3.4.4 Evaluation of Population Size

Table 8 provides the geometric mean natural-origin spawner abundance for the 11 Interior Fraser Coho sub-populations for the period 1998 through 2003. These years represent an era of relatively low marine survival rates and a period of significantly reduced fishing mortality. This is also the period containing the highest quality escapement data.

Table 8. Geometric mean escapement size of interior Fraser River coho salmon sub-populations, 1998 – 2003 (excludes hatchery fish).

Population	Sub-population	1998-2003 Mean
Fraser Canyon	Fraser Canyon	4,299
Upper Fraser	Middle	1,402
	Upper	1,380
Lower Thompson	Lower	611
	Nicola River	1,769
North Thompson	Upper	1,086
	Middle	3,730
	Lower	4,412
South Thompson	Shuswap River	1,402
	Shuswap Lake	3,267
	Adams River	996

While there is considerable variation in the average size of each sub-population nearly all have been near, or above, the 1,000 fish objective. With the exception of the Upper Fraser population there appears to be at least one relatively dominant sub-population within each population. These data provide evidence that Recovery Objective 1 has, on average, been achieved. These data indicate that Recovery Objective 1 is realistic and may be achievable if Recovery Objective 2 is implemented.

3.4.5 Performance of Recovery Objective 1 using 1975 - 2003 Data

The historical data can be used to find the total DU abundance level that will lead to the achievement of the recovery objective (Objective 1) of having at least half of the sub-populations in each population with a 3-year mean of at least 1,000 spawners. A major assumption of this analysis is that the relationship between the distribution of fish in the DU and total abundance that has been observed in the past will hold in the future.

Figure 23 shows the number of the 11 sub-populations with less than 1,000 spawners (calculated as the running 3-year geometric mean) as a function of the estimated abundance of spawners in the whole DU (also the geometric mean of three years of data). This figure shows that the number of sub-populations that fall below 1,000 individuals increases significantly when the aggregate DU abundance is less than about 20,000 to 25,000 wild spawners. However, this analysis does not address the objective of having viable sub-populations in each of the five populations because it does not consider the distribution of viable sub-populations within the five populations.

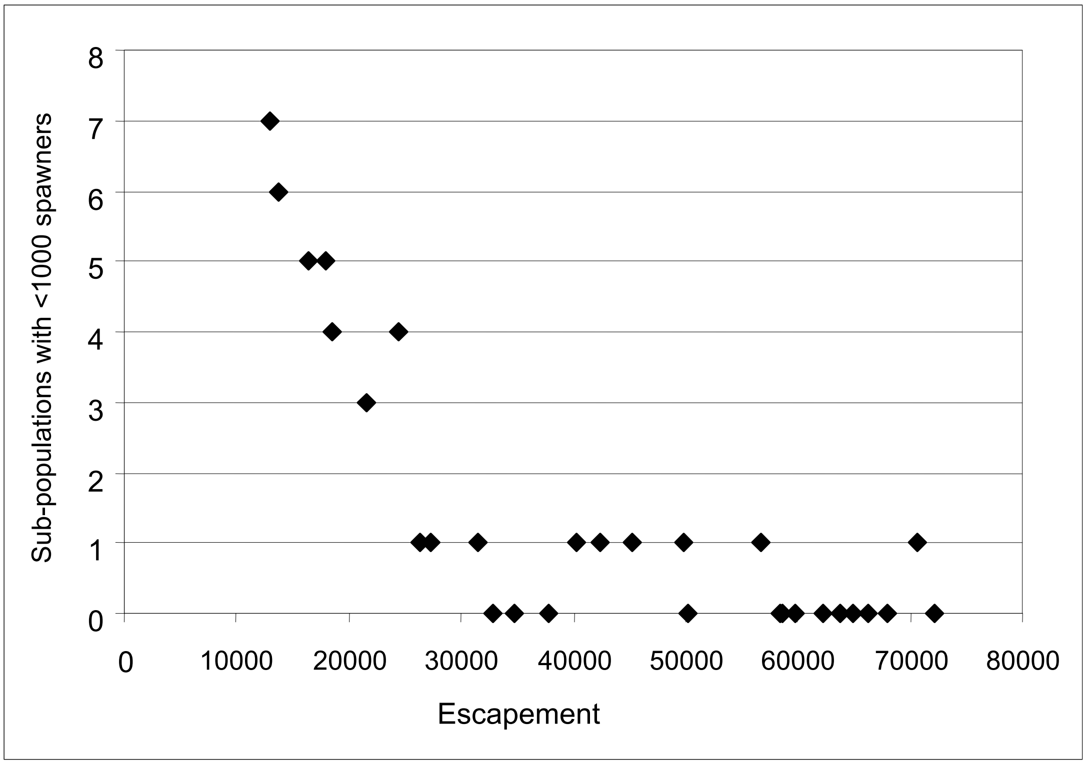

Figure 23. Number of interior Fraser River coho salmon sub-populations with less than 1,000 spawners in relation to the total interior Fraser River coho salmon escapement, 1975-2003 (excludes hatchery fish).

Figure 24 shows the number of populations of the five in the DU that fail to meet the recovery objective criteria of one or two sub-populations with 1,000 or more wild spawners within each population. This analysis also suggests that below a level of approximately 20,000 coho salmon spawners (3-year running geometric mean) in the DU, the recovery goal would not be met. The years in which at least one population fails the recovery objective all lie between 1995 and 1999.

Thus, the historical data suggest that a level of abundance of 20,000 to 25,000 spawners in the Interior Fraser Coho designated unit is required to achieve Recovery Objective 1.

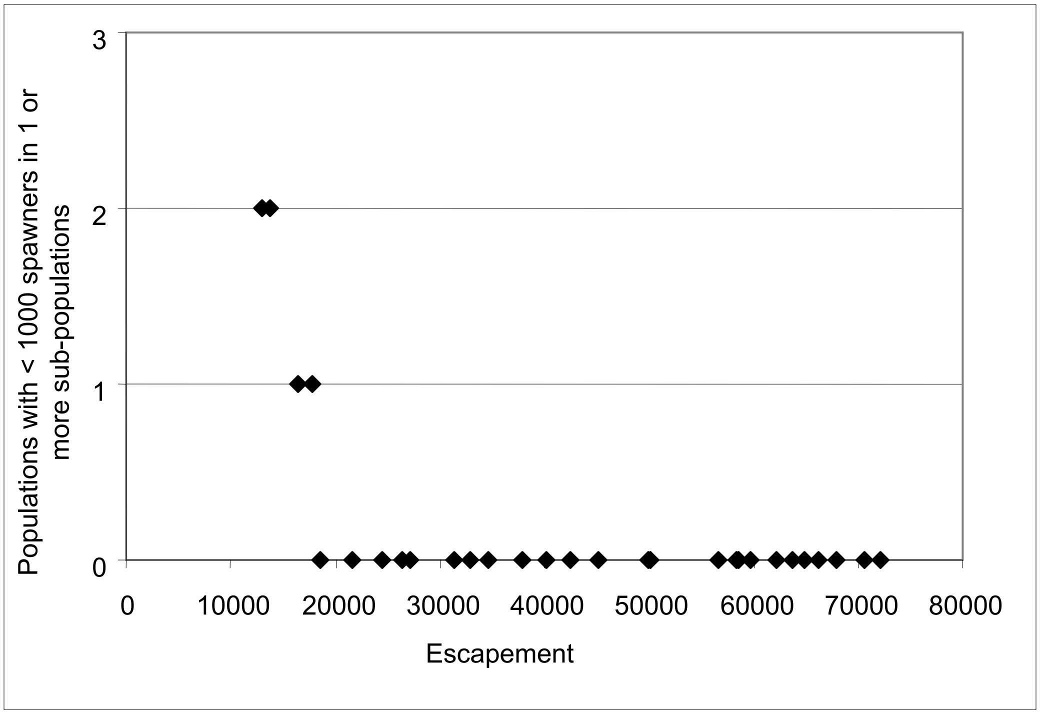

Figure 24. Relation between the number of interior Fraser River coho salmon populations with less than 1,000 spawners in one or more sub-populations and the total interior Fraser River coho salmon escapement, for the years 1975-2003 (excludes hatchery fish).

3.5 Strategies to be Taken to Address Threats

The IFCRT is sensitive to the fact that the recovery strategies proposed in this document must be taken within the context of other users of the landscape, especially agriculture, forestry, mining, fishing, as well as urban, suburban, and rural developments. It is understand that coho salmon recovery must occur within the context of the larger socio-economic environment within which Interior Fraser Coho live, and that trade-off decisions need to be determined. *S*ocio-economic issues may be considered in more detail during preparation of an Interior Fraser Coho program plan. In order for Recovery Objective 1 to be met, the causes for the decline in abundance of Interior Fraser Coho that were identified by COSEWIC and detailed further in this report must be addressed. That requires the implementation of Recovery Objective 2*, i.e.* maintaining the productivity of Interior Fraser Coho by addressing the threats to recovery. Recommended strategies for addressing each of the potential threats to recovery are discussed below and summarized in Table 8.

3.5.1 Threat — Harvest

Abundance-based harvest management has been agreed to under the Treaty between the Government of Canada and the Government of the United States of America Concerning Pacific Salmon (Pacific Salmon Treaty) (see http://www.psc.org/Treaty/Treaty.pdf). Current abundance-based coho salmon harvest management approaches need to be refined and annual exploitation rates set at levels that are based on forecasts of survival and abundance. To do this, it would be desirable to:

- Determine the productive capacity of the five populations of Interior Fraser Coho, either by stock-recruit or habitat-based methods.
- Develop production model(s) for Interior Fraser Coho to provide annual forecasts of smolt production, based on parental brood escapements and habitat measures.
- Develop methods to forecast marine survival using such methods as sibling models or coho salmon jack escapement abundances to estimate annual marine survival.
- Develop ocean abundance forecasts using estimates of juvenile production.
- Refine or develop methods to forecast in-season abundance of Interior Fraser Coho to assist in the development of, and adjustments to, annual fishing plans.

Strategy: Refine abundance-based harvest management methods to set exploitation targets based on survival and abundance forecasts.

All populations and sub-populations should be maintained at levels of escapement that will permit expansion of fishing effort upon entry into a period where marine survival is consistently above recent average survival rates. Survival rates will likely continue to fluctuate, and periods of below or above average survival will be experienced. To ensure that Interior Fraser Coho recover and remain viable while experiencing these fluctuations in marine survival, fishery management plans should consider maintaining levels of abundance that would permit increases in exploitation rates during periods of above average survival rates.

Strategy: Manage escapement goals to allow Interior Fraser Coho to recover beyond the short term recovery objective (Recovery Objective 1).

3.5.2 Threat — Climate Change

The potential impacts of climate change on freshwater and marine areas occupied by Interior Fraser Coho were introduced in section 1.7.2 above. Trends in ocean survival rates have been demonstrated and both stream and ocean survival rates may be related to cycles or trends in climate.

Strategy: Recover all sub-populations so that the probability of remaining viable during periods of climate-related low marine and freshwater productivity is increased.

3.5.3 Threat — Habitat Change

Qualitative assessments of key habitat features within and adjacent to the Fraser River indicate that few coho salmon habitats remain in pristine condition. Identifying, protecting, and if necessary, rehabilitating coho salmon habitat are key items within the mandate of current habitat management agencies. Unfortunately, however, there is a lack of knowledge about the linkages between several of these habitat features and their relationship to subsequent coho salmon production. It is recommended that habitat management:

- Focus on determining those actions that will ensure recovery.
- Protect important known coho salmon habitat areas through diligent use of current habitat protection practices and through the use of current and developing best management practices.
- Develop a habitat assessment model using key areas within each of the five populations to assist in forecasting annual survival rates.
- Promote an increase in fish stewardship activities to assist the various government agencies to resolve habitat use conflicts.

Strategies:

Maintain and restore functionality and productivity in as many habitats within each population as is feasible.

Investigate the relationships between habitat and coho salmon throughout their life history and range and determine important habitat requirements.

Improve public awareness and increase stewardship.

These approaches must include ensuring the continuing presence of adequate stream flows, suitable water temperatures, and functional riparian and in-stream habitats for the survival and maintenance of coho salmon. To accomplish this, a variety of actions will need to be taken in each of the sub-populations.

3.5.4 Threat — Hatchery Production

Although the current scope of coho salmon enhancement in the interior Fraser River watershed is relatively small, there are concerns that hatchery fish may be competing or inter-breeding with wild Interior Fraser Coho. An additional concern is that fishery harvest plans may be based on total abundance levels (hatchery plus wild abundance) rather than on the abundance of wild Interior Fraser Coho. To minimize these threats the following approaches are recommended:

Strategies:

Hatchery fish may be used as part of the conservation strategy or to assess abundance and/or survival of selected populations or sub-populations.

Develop specific rules for initiation, continuation, and modification of hatchery activities, including the consideration of whether hatchery production should cease once recovery objectives are achieved.

Select gametes from the native population so as to minimize the risk of losing genetic information from within a population.

Return juveniles to the wild as soon as is feasible with juvenile release timing dependent on the conservation strategy chosen.

Annually assess hatchery contribution to the escapement.

Continue to mass mark lower Fraser and Strait of Georgia hatchery releases to encourage the use of selective harvesting of visibly marked hatchery fish.

Table 9. Summary of strategies for the recovery of interior Fraser River coho salmon

Recovery Objective #	Threat	Strategy	Anticipated Effect	Status
1	Harvest	Refine abundance-based harvest management methods to set exploitation targets based on survival and abundance forecasts.	Increase number of spawners.	Proposed
1	Harvest and Climate Change	Manage escapement goals to allow Interior Fraser Coho to recover beyond the short term recovery objective (Recovery Objective 1).	Increase number of spawners.	Proposed
2	Climate Change	Recover all sub-populations so that they will be viable during periods of climate related low marine and freshwater productivity.	Increase number of spawners.	Proposed
2	Habitat Change	Maintain and restore functionality and productivity to as many habitats within each population as is feasible.	Increase survival at all life stages and improve spawning and rearing success.	Proposed
2	Habitat Change	Investigate the relationships between habitat and coho salmon throughout their life history and range and determine important habitat requirements.	Improve understanding of life history. Increase survival of populations.	Proposed
2	Habitat Change	Improve public awareness and increase amount of stewardship.	Increase survival of populations.	Under-way
1 & 2	Hatchery Production and Harvest	Hatchery fish may be used as part of the conservation strategy or to assess abundance and/or survival of selected populations or sub-populations.	Maintain ability to assess threats and progress of recovery. Increase successful spawners.	Under-way

1 & 2	Hatchery Production and Harvest	Develop specific rules for initiation, continuation, and modification of hatchery activities, including the consideration of whether hatchery production should cease once recovery objectives are achieved.	Reduce genetic risk. Revise long-term production goals.	Proposed
2	Hatchery Production	Select gametes from the native population so as to minimize the risk of losing genetic information from within a population.	Reduce genetic risk.	Under-way
2	Hatchery Production	Return juveniles to the wild as soon as is feasible with juvenile release timing dependant on the conservation strategy chosen.	Reduce competition in freshwater habitat.	Under-way
2	Hatchery Production	Annually assess hatchery contribution to the escapement.	Maintain ability to assess threats and progress of recovery.	Under-way
1 & 2	Hatchery Production and Harvest	Continue to mass mark lower Fraser and Strait of Georgia hatchery releases to encourage the use of selective harvesting of visibly marked hatchery fish.	Increase number of interior Fraser River wild and hatchery coho salmon spawning in the wild. May increase genetic risk.	Under-way

3.6 Potential Impact on Other Species / Ecological Processes

The impact on other species or ecological processes of increasing the abundance of Interior Fraser Coho through implementation of a conservation strategy are not fully understood and should be a topic for further research. However, it is likely that the implementation of Interior Fraser Coho Recovery Objectives 1 and 2 will benefit other salmonids, especially lower Fraser River coho salmon, Fraser River chinook salmon, and interior Fraser River steelhead trout. Harvest restrictions along with habitat maintenance and improvement should benefit a wide variety of other native aquatic species. No negative impacts on other species resulting from implementation of the Interior Fraser Coho recovery objectives are envisioned.

3.7 Acceptable Activities

The Pacific Salmon Sub-committee of the Pacific Science Advice Review Committee (PSARC) held three meetings in 2004 and 2005 to assess scientific analysis done on the levels of mortality that would not jeopardize survival or recovery of interior Fraser River coho salmon (Folkes et al. 2005). The authors concluded that over the short term, under recent ocean survival rates (recent 5-year median of 4.8%) and the current target exploitation rate of 13%, some human-induced mortality may occur without jeopardizing survival or recovery of the Interior Fraser Coho. For example, incidental capture of Interior Fraser Coho in various southern BC and Fraser River commercial, aboriginal, recreational, or test fisheries is acceptable.

3.8 Activities Completed or Underway

The status evaluation, recovery objectives, and approaches suggested by the IFCRT, if followed by the assembly of one or more program plans, should ensure the survival and recovery of Interior Fraser Coho. Within the watershed there are partnership groups that are developing localized salmon recovery plans. For example, with sponsorship and funding from the Pacific Salmon Foundation and the Pacific Salmon Endowment Fund Society, the Nicola Tribal Association and the Nicola Watershed Community Roundtable formed a partnership to coordinate the implementation of the Coldwater River Watershed Recovery Plan (Nelson et al. 2001). To date, that partnership has undertaken three years of recovery implementation activities. With similar sponsorship and funding, the Salmon River Watershed Roundtable partnership has developed a watershed salmon recovery plan for the Salmon River (Salmon River Watershed Society 2004). There are several other local stewardship groups working in the interior Fraser River watershed (Appendix 1).

3.8.1 Control of exploitation

Within southern BC, small numbers of Interior Fraser Coho are harvested incidentally by various First Nations, commercial, and recreational fisheries in the Strait of Georgia, Johnstone Strait, along the west coast of Vancouver Island (WCVI), and in the Fraser River. Since 1989, a series of management measures to reduce the exploitation rate on coho salmon populations, including those from the interior Fraser River, have been taken (Appendix 5). These measures became increasingly more stringent over time, but as recently as 1996, over one million coho were harvested in South Coast fisheries. Beginning in 1997 there were no commercial fisheries permitted that were primarily directed at harvesting coho salmon; however, a coho salmon recreational fishery was allowed to continue with a reduced daily retention limit on coho salmon.

South Coast origin BC coho salmon, particularly those from the interior Fraser River, were at a low level of abundance in 1998 and a series of comprehensive fishery management measures were implemented (Appendix 5). DFO considered these measures essential in order to reverse the trend of decreasing abundance and suggested that coho salmon could be rebuilt through the coordinated actions of all fishing sectors. The broad distribution of Interior Fraser Coho and the sequential nature of many of the fisheries involved in their harvest meant that, for more fish to reach the spawning grounds, management measures taken in one fishery need to be complemented by measures in other fisheries. DFO also suggests rebuilding required favourable marine survival conditions and careful stewardship and restoration of habitat.

In 1998 DFO announced that the objective of their fishery management actions would be to produce no mortality on Thompson River coho salmon. To meet that goal, selective fishing techniques were required for all appropriate salmon fisheries. Further actions implemented by DFO included no directed coho salmon fisheries except on enhanced populations in terminal areas and non-retention of coho salmon in all southern BC salmon fisheries. For all Fraser River mainstem fisheries (aboriginal, commercial, and recreational) there would be moving window salmon fishing closures (*i.e.* variable start and end dates for closures in specified sections of the Fraser River mainstem to coincide with the presence of migrating coho salmon) to protect migrating Thompson River coho salmon during the months of September and October.

In addition, southern BC was classified into red zones (*i.e.* areas where, and times when, Thompson River coho salmon (a proxy for Interior Fraser Coho) were present and prevalent) and yellow zones (*i.e.* areas where, and times when, Thompson River coho salmon were not prevalent). No salmon fishing was allowed in red zones. Selective fisheries with coho salmon non-retention were allowed in yellow zones. No directed, First Nations coho salmon fisheries were allowed, no directed recreational coho salmon fisheries were allowed, and barbless hooks became a coast wide requirement. Furthermore, there was no recreational salmon fishing allowed in Juan de Fuca Strait or in the Fraser River during times when coho salmon were prevalent and no recreational salmon fishing outside the surf line along the west coast of Vancouver Island (WCVI).

Also in 1998, commercial salmon fishers were required to install revival tanks on their vessels. No commercial salmon fishing was allowed in Juan de Fuca Strait and no commercial salmon trolling was allowed off the WCVI when Thompson River coho salmon were present. All salmon trollers were restricted to using barbless hooks. Gill nets were restricted to no more than 30 minute soak times except for the Fraser River gill net fishery which was closed during the Thompson River coho salmon migration period. Seine boats were required to brail and sort their catch.

The above measures resulted in an estimated Canadian exploitation rate in 1998 of approximately 2% for Thompson River coho salmon. Measures taken in the United States resulted in an estimated American exploitation rate of approximately 4%, for a combined total exploitation rate of approximately 7%; far less than exploitation rates in excess of 80% during the 1980's.

In 1999, there were some modifications to the 1998 management actions. The objective of no mortality on Thompson River coho salmon remained in place and estimated total mortality in Canadian waters was not to exceed 2%. Selective fishing techniques were used in all appropriate salmon fisheries. Some flexibility was introduced with respect to coho salmon harvesting in areas where Thompson River coho salmon were not prevalent. These Special Management Zones were areas where local stocks could sustain harvest. Yellow Zones remained for those areas where Thompson River coho salmon were not prevalent and where fisheries could be conducted in a selective fashion. Improved catch monitoring was required for all salmon fisheries.

Since 1999 there have been changes to some fishery management actions as more information about coho salmon marine distribution and migration timing and routes have become available. There are still no directed fisheries on Interior Fraser Coho. First Nations fisheries are allowed to retain dead incidentally caught coho salmon; however, the times and areas of their fisheries remain restricted to Yellow Zones. There has been an expansion of marked coho only fisheries (*i.e.* fisheries aimed at harvesting hatchery coho marked by a clipped adipose fin) for recreational fisheries. In addition, commercial salmon fisheries have not been allowed to retain any coho salmon mortalities nor any incidental coho salmon caught, and the times and areas of these fisheries have been selected to avoid Interior Fraser Coho. The current objective is to produce a fishery-related mortality rate on Interior Fraser Coho of less than 3% in Canadian fisheries; additional mortality occurs in American waters. The 1999 amendments to the Pacific Salmon Treaty provide for a limit on American fishery mortality on Thompson River coho salmon (a proxy of Interior Fraser Coho) of 10% while the population status remains poor (for details see http://www.psc.org/Treaty/Treaty.pdf). The Joint Coho Technical Committee of the Pacific Salmon Commission discusses the status of Interior Fraser Coho and ways to regulate harvest on an annual basis. There has been a coordinated effort by enforcement agencies to ensure that these regulations are enforced.

If climate conditions prove favourable, and sufficient productive habitat is available, reductions in exploitation rates such as those initiated in 1997 and continued through 2004 should provide the opportunity for Interior Fraser Coho to increase in abundance. Such exploitation should take place within the policy of abundance-based harvest management which has been agreed to under the Pacific Salmon Treaty. Implementation of such a harvest management approach for Interior Fraser Coho will require additional data and analyses before escapement goals and annual exploitation rates can be set at levels appropriate to the forecasts of survival and abundance.

3.8.2 Habitat protection

DFO's *Fisheries Act* along with the *Policy for the Management of Fish Habitat* and its *No Net Loss Guiding Principle*, as well as a variety of Provincial Government acts and policies are being used to protect fish and fish habitat. In addition, there are several stewardship groups and First Nations organizations active in maintaining and enhancing fish and fish habitat within the interior Fraser River watershed (Appendix 1). There has been focused enforcement to combat unscreened irrigation intakes and unauthorized water withdrawals within the interior Fraser River watershed.

3.8.3 Hatchery production

Broodstock capture and fry and smolt release programs have been underway in the South and Lower Thompson coho salmon populations for several years. These enhancement efforts have been used to protect several coho salmon demes from extirpation. Examples of this are the hatchery programs on the Nicola and Salmon rivers and on Bessette Creek. The majority of the hatchery produced fish are released as yearling smolts, a strategy that results in limited freshwater residency by hatchery fish, thereby minimizing competition with wild fish. Some releases of under-yearling fry do occur, but only into habitat that has been determined to be underutilized. In the interior Fraser River watershed, hatchery broodstock are always captured from within the drainage area being enhanced and transplants from one sub-population to another have never taken place.

3.8.4 Population assessment

Hatchery releases, catches, and returns are being used for population abundance and exploitation rate assessment. With the exception of a project to determine freshwater survival rates of wild coho salmon in the Eagle River, no similar information is being gathered for wild-origin coho salmon. Thus, at present, hatchery based information is being applied to wild coho salmon populations. In addition, the hatchery programs on the Coldwater River and on three North Thompson tributaries (Louis, Lemieux and Dunn Creeks) are key streams for coho salmon population assessment within the interior Fraser River watershed.

3.9 Next Steps

Interior Fraser Coho are designated as endangered by COSEWIC. The Department of Fisheries and Oceans is committed to ensuring the survival and recovery of Interior Fraser Coho and suggests that one or more program plans should be completed. One or more program planning groups may be needed to further refine and act upon the recovery approaches developed in this conservation strategy.

3.10 Evaluation

The success of any conservation strategy is dependent on the measures implemented. In order to evaluate the success of the Interior Fraser Coho Conservation Strategy, performance measures must be defined. For Interior Fraser Coho, recovery performance will initially be evaluated by annual monitoring of the quantitative goal of increasing the generational average escapement, with the aim that the average escapement will be consistently above the recovery objectives. Further evaluation criteria may be developed during program planning.

3.11 Synopsis

The Interior Fraser River coho salmon recovery goal is "…**to secure the long term viability and diversity of naturally spawning coho salmon within the interior Fraser River watershed**."

The recovery principles identified to attain this goal were:

- *Principle 1. The recovery of Interior Fraser Coho will require the maintenance of sufficient levels of abundance and spatial diversity to achieve the recovery goal.*
- *Principle 2. The spatial structure and distribution of Interior Fraser Coho will be considered at the level of populations and sub-populations.*
- *Principle 3. The recovery goal is considered achieved when there are one or more viable sub-populations in each of the five populations.*

In concert with these principles, two recovery objectives were identified:

Objective 1. Maintain the generational average escapement (3-year running geometric mean), in at least half of the sub-populations within each of the five Interior Fraser populations, above 1,000 naturally spawning coho salmon.

Objective 2. Maintain the productivity of Interior Fraser Coho so that recovery can be sustained.

The key threats to recovery are harvest related mortality, climate change, habitat change, and hatchery production. Approaches identified to minimize the impacts of each of those threats are:

- improving harvest management planning by establishing exploitation rates based on survival and abundance forecasts,
- defining escapement goals,
- recovering all sub-populations to abundance levels that will maintain Interior Fraser Coho during periods of negative climate impacts,
- maintaining functionality and productivity in as many habitats as is feasible,
- investigating the relationships between habitat types and coho salmon throughout their life history in order to assist in the determination of important habitats,
- using hatchery fish as part of the conservation strategy as well as for assessment of abundance and survival,
- monitoring and minimizing possible genetic and competitive impacts of hatchery production, and
- continuing to mass mark selected hatchery releases.

The effectiveness of these recommended approaches is significantly affected by the gaps in knowledge about Interior Fraser Coho.

4 Glossary [1]

Allele. One of a group of genes that occur alternatively at a given chromosome locus (locality).

Anadromous. A life history pattern characteristic of mature organisms returning from the sea in order to reproduce in fresh water.

Aquaculture.[2] The farming of aquatic organisms in the marine or freshwater environment.

Biodiversity.[3] The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

Broodstock. Mature salmon from which gametes (milt and roe) are extracted to produce the next generation of *cultivated* fish.

Brood year. The year in which parents spawned to produce juvenile or adult individuals.

Cohort. A group sharing a particular statistical or demographic characteristic.

Conservation. The protection, maintenance, and rehabilitation of genetic diversity, species, and ecosystems to sustain biodiversity and the continuance of evolutionary and natural production processes*.* See also *preservation* and *protection*.

COSEWIC. The Committee on the Status of Endangered Wildlife in Canada, This is a committee of experts that assesses and designates which wild species are in some danger of disappearing from Canada.

Cultivated. Characteristic of a species or population that is completely or partially artificially propagated in order to increase production. It includes both *aquaculture* and *enhancemen*t.

Deme. A group of salmon at a persistent spawning site or within a stream comprised of individuals that are likely to breed with each other *(i.e.* well mixed). A single population may include more than one deme and demes may be partially isolated from one another. Their partial isolation may or may not persist over generations.

Designatable Unit. A group of organisms below the species level, recognized on the basis of any one of the four criteria. Those criteria, in order of precedence, are: established taxonomy, genetic evidence, range disjunction, and bio-geographic distinction. See http://www.cosewic.gc.ca/eng/sct2/sct2_5_e.cfm for more detail.

Designated Unit. A group of organisms below the species level that has been recognized as a group by COSEWIC.

Effective spawners. The number of individuals that contribute to the next generation.

Endangered. A *wildlife species* that is facing imminent extirpation or extinction.

Enhancement. The application of biological and technical knowledge to increase the productivity of fish demes. It may be achieved by altering habitat attributes (*e.g.* habitat restoration) or by using fish culture techniques (*e.g.* hatcheries and spawning channels).

Ecosystem.[4] A community of organisms and their physical environment interacting as an ecological unit.

Escapement.[5] The number of mature salmon that pass through (or escape) the fisheries and return to their rivers of origin to spawn.

Extinction. The loss of a species that does not exist elsewhere in the world.

Extirpation. The local extinction of a species.

Fish culture. The use of hatcheries and other incubation facilities, including spawning channels, to protect fish during high mortality early life stages in order to increase the number of juvenile fish produced per parent.

Fish habitat.[6] Spawning grounds and nursery, rearing, food supply, and migration areas on which fish depend directly or indirectly to carry out their life processes.

Fish habitat stewardship.[7] Actions to protect and conserve fish habitat for present and future generations.

Gamete. Mature germ cell (sperm or egg) possessing a haploid chromosome set and capable of formation of a new individual by fusion with another gamete.

Gene. An element of a germ cell that controls the transmission of a hereditary character.

Genetic diversity. For a species, the genetic variation within that species, which includes both variability among individuals within a population and differences among populations.

Genotype. The total genetic information contained in an organism.

Geometric mean. The value derived by calculating the n^{th} root of the product of n positive numbers. For example, the geometric mean of 2 and 8 is 4. The geometric mean is always less than the arithmetic mean.

Habitat. The particular type of local environment occupied by an individual or population.

Habitat restoration.[8] The treatment or cleaning of fish habitat that has been altered, disrupted, or degraded. The purpose is to increase the capability of the habitat to sustain a productive fisheries resource.

Harmonic Mean. The mean obtained by taking the reciprocal of the arithmetic mean of the reciprocals of a set of non-zero numbers. For example, the harmonic mean of 2 and 8 is 3.2. The harmonic mean is always less than the geometric mean, which is always less than the arithmetic mean.

Hatchery fish. The progeny of adult fish spawned at a fish culture facility (hatchery) using human intervention in the pairing of males and females. This includes adults returning from hatchery-released fry and smolts. It excludes progeny of fish spawning or rearing in man-made semi-natural channels.

Important habitat. The minimum extent and configuration of habitat throughout the life history of each population of Interior Fraser Coho that is necessary to provide an acceptable probability that these fish will survive or recover according to specific recovery objectives.

Inbreeding.[4] Mating or crossing of individuals more closely related than average pairs in a population.

Life history traits. Various biological characteristics that represent the individual deme or population, *e.g*. fecundity, age and size at maturity, sex ratio, and migration timing.

Lineage. A grouping of local populations that have evolved independently from and that are genetically distinct from other such groups.

Maturity schedule. In some fish species adults from the same cohort can mature at different ages. The proportional distribution of the cohort among the various ages is the maturity schedule. Coho salmon mature predominately at age 3 and thus have a simple maturity schedule.

Maximum sustainable harvest (yield).[9] The largest catch (yield) that can be continuously taken from a deme or population under existing environmental conditions.

Migration.[4] The movement of an organism or group from one habitat or location to another.

Mixed stock fishery. A fishery which captures individuals from more than one deme.

*Natal. O*f or pertaining to the place of birth or hatching.

Natural spawning. Completing the spawning act in natural or man-made fish habitat without human assistance.

Not at risk. A species or designatable unit that has been evaluated by COSEWIC and found to be not at risk of extinction or extirpation.

Population. A group of individuals of one species or designated unit that is sufficiently isolated from other groups of the same species so that there will be persistent adaptations to the local habitat.

Preservation. Refers to actions taken to retard the deterioration of, or to prevent damage to, a natural resource. Implies no human consumptive use. See also *conservation* and *protection*.

Productive capacity.[8] The maximum natural capability of habitats to produce fish, or to support or produce aquatic organisms upon with fish depend.

Productivity. The capacity of an environment or population to produce numbers or biomass of organisms (*e.g.* fish).

Protection. Implies the idea of a threat and refers to regulatory measures, resource management, and public education programs aimed at ensuring that ecosystems are maintained in a natural state. See also *conservation* and *preservation*.

Recovery. The process by which the decline of an endangered, threatened or extirpated species is stopped or reversed, and threats reduced to improve the likelihood of the species' persistence in the wild.

Recruitment. The addition of new fish (an individual recruit) to the vulnerable portion of a population by growth from a smaller size.

Refugia. Areas where special environmental circumstances enabled a species or a community of species to survive after extinction in surrounding areas.

Restoration. See *recovery*.

Return year. The year in which recruits from a *brood year* return to spawn.

Riparian. Pertaining to, or situated or dwelling on, the bank of a river or other body of water.

Risk.[10] The expression of the likelihood and impact of an event.

Running mean. One of a succession of averages of data from a time series, where each average is calculated by successively shifting the interval by the same period of time.

Selective fishery.[5] A management approach that allows for the harvest of surpluses of target species, populations, or demes while minimizing or avoiding the harvest of species, populations, or demes with a *conservation* requirement, or to release non-target species, populations, or demes unharmed.

Self-sustaining. A population that is able to maintain itself without human intervention over an extended period of time.

Smolt. A juvenile salmon during seaward migration with the physiological capability to survive the transition from fresh to salt water.

Spawning.[4] The release of gametes or eggs into the water. In the case of salmon in natural streams, rivers, and lakes, spawning includes the deposition of eggs into nests dug in the substrate.

Species.[4] A taxon of the rank of species; in the hierarchy of biological classification it is the taxon category below genus; the basic unit of biological classification.

Stakeholder. An individual or group with a vested interest in a resource.

Stewardship.[13] An ethic, based upon individual and community values, derived from an understanding of the need to conserve wildlife and restore ecosystems for current and future generations of wildlife and people. Stewardship is not a technique. It is a philosophy, and behaviour of doing business in an environmentally and economically sound way.

Stock assessment.[11] The use of various statistical and mathematical calculations to make quantitative predictions about the reactions of fish demes or populations to alternative management choices.

Surf line. An imaginary line that extends from headland to headland along the west coast of Vancouver Island, mainland coast, and the Queen Charlottes, seaward of which no gill or seine net fisheries are permitted.

Terminal fishery / terminal area. A fishery or area in a stream or near the mouth of a stream where returning salmon pass through, or congregate, prior to spawning and where demes or populations are relatively unmixed.

Viability. The ability to continue to grow or survive.

Wild salmon. In this document, salmon are considered wild if they have spent their entire life cycle in the wild and originate from parents that were also produced by natural spawning and continuously lived in the wild.

Wildlife Species.[12] A species, subspecies, variety, designated unit, or geographically or genetically distinct population of animal, plant, or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.

Sources of Definitions

1. Unless indicated otherwise, definitions were developed by DFO staff or were taken from unpublished DFO reports.
2. DFO Office of Sustainable Aquaculture, Aquaculture Policy Framework, January 2002.
3. United Nations, Convention on Biological Diversity, Article 2, http://www.biodiv.org/convention/articles.asp.
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5. DFO, A Policy for Selective Fishing in Canada's Pacific Fisheries, January 2000.
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12. Bill C-5 of the First Session, Thirty-seventh Parliament, 49-50-51 Elizabeth II, 2001-2002.
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6 Annexes

6.1 Record of Consultations

Interior Fraser Coho are an aquatic species under federal government jurisdiction, and are managed by Fisheries and Oceans Canada, 200 – 401 Burrard Street, Vancouver, BC, V6C 3S4.

In November 2003, Fisheries and Oceans Canada (DFO) engaged an Interior Fraser Coho Recovery Team to work cooperatively in the development of a coho salmon recovery strategy. The Recovery Team membership is provided on page iii of this report. Representatives from the Cariboo Tribal Council, the Okanagan Nation Alliance, and the Secwepmc Fisheries Commission sit on the recovery team to ensure there is information exchanged on Interior Fraser Coho recovery, planning and activities with the respective communities. The Interior Fraser Coho Recovery Team membership also includes members of academia, industry, and the provincial government as well as representatives of stewardship groups. Each team member has brought important technical expertise or knowledge of Interior Fraser Coho to the development of the recovery strategy.

Integral to the recovery planning process is involving local communities at every step along the way to recovery. The Recovery Team has worked hard to develop a comprehensive recovery strategy that provides advice on protection and recovery measures for the Interior Fraser Coho population. The continuing contributions and participation of team members, individuals, and communities will play a key role in rebuilding this population.

On April 29th, 2004 DFO held a Technical Workshop for invited individuals to engage a broad group of experts and participants in the recovery strategy development process in order to review early drafts of the recovery strategies for the Cultus Lake Sockeye, Sakinaw Lake Sockeye, and Interior Fraser Coho populations. The intent of the workshop was to:

1. Share knowledge and information on Cultus Lake Sockeye, Sakinaw Lake Sockeye and Interior Fraser Coho with the communities, groups, and individuals likely to play a key role in, or be impacted by the recovery of these populations.

2. Receive technical advice on the draft recovery goals and objectives in the draft recovery strategies from workshop participants.

3. Receive technical advice on possible approaches for the recovery of Cultus Lake Sockeye, Sakinaw Lake Sockeye and Interior Fraser Coho. This advice will be summarized in a report that will be considered by the recovery teams when completing the draft recovery strategies, and may be used by action planning groups during the development of action plans.

4. Engage participants in the recovery process.

Specific topics for discussion were ‘Technical Comments on the Goals and Objectives in the Recovery Strategies,’ ‘Ideas for Recovery Approaches’ and ‘Challenges in Implementing Recovery Strategies and Possible Solutions.’ A series of questions were provided for use during breakout sessions to stimulate thinking and help focus discussions. Key points made regarding the Interior Fraser Coho Recovery Strategy included the need for more work on the recovery goals and objectives so that they take into account the large geographical extent of the area, the number of sub-populations, the difficulties of estimating total spawners, and the multiple levels at which recovery criteria may be set. The importance of clear recovery criteria, which would allow the populations to recover, and provide a basis for a forum where stakeholders can discuss levels of sustainable harvest and tradeoffs among different populations and fisheries, was also expressed. Protecting and restoring freshwater spawning and rearing habitat was also a concern and included the following themes: protecting, rehabilitating and maintaining water quantity and quality; defining and specifying important habitat; understanding levels of mortality in the estuary and oceanic life phases; and using an adaptive management approach, with monitoring of life history stages to assess the effectiveness of any implemented program plans, and to improve the recovery strategies employed. The need for individual, community, and industrial outreach and partnership programs to sustain the recovery efforts was also stressed. A summary report of the workshop was prepared and provided to the recovery teams for integration into the development of the recovery strategy report.

In October and November 2004, DFO conducted a series of information sessions (10) throughout BC on the Interior Fraser Coho draft recovery strategy. The DFO took a variety of steps to inform First Nations, stakeholders, and the public of the sessions. In summary, DFO announced the consultation process in early October 2004, with a press release throughout British Columbia. Invitation letters and agendas were mailed to 197 First Nations, as well as to First Nations’ organizations, tribal councils, and fisheries commissions, and to more than 5,000 stakeholders, including all commercially licensed fishermen, recreational fishing and conservation organizations, local governments, and stewardship groups. Display advertisements, with information about the sessions and associated open houses, were placed in all local newspapers that serve the communities in which the sessions were held. In addition, a number of follow-up telephone calls, emails, and personal contacts were made by DFO to encourage participation.

Consultations took place over a two day period at the following locations: Prince Rupert, Victoria, Nanaimo, Port Hardy, Campbell River, Vancouver, and Chilliwack. One day sessions were held at Lillooet and Williams Lake (stakeholder meeting only) and Quesnel (First Nations meeting only). At each two day session, the first day was an information meeting for First Nations followed by an open house in the evening for the public. The open house format was used to present information on the strategy through posters and fact sheets prior to the stakeholder meeting on the second day. Recovery team members were present throughout each session to answer questions and receive comments from the public. During the stakeholder meeting, DFO staff and recovery team members presented information on the draft strategies, specifically their development, the recovery team's scope of work, and the key elements of each strategy, *i.e.* historical and current population and habitat data, threats to recovery, recovery goals and objectives, and recovery approaches. DFO distributed a discussion guide consisting of questions on each of these key elements, which led to a facilitated discussion generating valuable comments from participants.

Representatives from the following organizations attended and provided input at the workshops: Yale First Nation, Cheam First Nation, Soowahlie First Nation, Seabird First Nation, Gwasala-nakwaxda'xw First Nation, Kwakiutl First Nation, Gwawaenuk Tribe, Cape Mudge First Nation, A-Tlegay Fisheries, Musqueam Fisheries, Heiltsuk Tribal Council, Tsartlip First Nation, Tsawout First Nation, Metlakatla First Nation, Gitanyow Fisheries, Kitkatla First Nations, Haisla Fisheries, Hartley Bay First Nations, Kitsumkalum Nation, Lake Babine Nation, Wet'suwet'en Nation, Williams Lake Indian Band, Nlakapamux Nation Tribal Council, Tlazten Nation, Carrier Sekani Tribal Council, Esketemc First Nation, Fraser Valley Regional District, Chilliwack Fish and Game, Central Valley Naturalists, Fraser Valley Angling Guides Association, Elk Creek Conservation Coalition, City of Chilliwack, Chilliwack High School, District of Mission, Fraser River Sturgeon Conservation Society, BC Federation of Drift Fishers, Pacific Fisheries Resource Conservation Council, Vancouver Aquarium, United Fishermen and Allied Workers Union, Fraser River Port Authority, Canadian Parks and Wilderness, David Suzuki Foundation, Northern Halibut Producers Association, Village of Tahsis, North Coast Trollers, Campbell River Community TV, Hook and Line Groundfish Association, District of Port Hardy, Qualicum Rivers Resorts, Living Oceans Society, Sport Fish Advisory Board, Area G Trollers, Hesquiat Tribe, Marine Conservation Council, Area C and E Gillnet, Sierra Club, Georgia Strait Alliance, Ahousat Nation, Sport Fishing Defence Alliance, T. Buck Suzuki Foundation, Royal Pride, Christau, Oona River Resources Association, World Wildlife Foundation, Golden Chalice, Baker Creek Enhancement Society, Quesnel River Watershed Alliance, William Lake Secondary School, Ministry of Forests, Cariboo Chilcotin Conservation Society, Weldwood of Canada, Williams Lake Tribune, and the Lillooet Naturalists Society.

The intent of the consultation sessions was to gather First Nations' and stakeholders' comments, information and feedback on the draft recovery strategy. In particular, team members solicited comments in relation to the four themes mentioned above. In general, participants expressed the view that the draft recovery strategy was thorough and recognized the challenges of developing a recovery strategy for Interior Fraser Coho. Participants identified a number of unknowns they felt required further research. Participants stressed that protecting and restoring habitat should be part of the strategy, and pointed out that watershed management is perhaps the greatest challenge to successfully implementing the strategy. Comments pertaining to the crucial role that management of ground and surface water in the interior of the province will play in determining the viability of Interior Fraser Coho was also a key point.

Participants pointed to enforcement, education, and coordination with water users and the province as necessary to successful water management. Given the vast size and extensive habitat variability of the Fraser River watershed, participants recommended applying separate goals and objectives to the management of each sub-population of Interior Fraser Coho.

The topics raised during these consultation sessions were individually discussed during the relevant consultation session and subsequently reviewed by individual members of the Interior Fraser Coho Recovery Committee, as well as by the full Committee. The consensus view was that most of the issues were already adequately discussed within the draft recovery strategy report. However, the Committee did agree that, although the discussion of habitat issues was complete in the main body of the report, there should be a greater emphasis on the role of habitat protection in the executive summary. This was done, and several minor clarifying comments were also added to the report.

A summary report was compiled that includes the input and feedback received at each of the sessions. The report and the individual meeting notes are available on the Fisheries & Oceans Canada website: http://www-comm.pac.dfo-mpo.gc.ca/pages/consultations/consult_e.htm

Fisheries & Oceans Canada has also engaged various First Nations in bilateral consultation through annual pre and post season fishery management planning meetings. These meetings provided several opportunities to discuss the recovery strategy during its development. Detailed records of these meetings are held by Fisheries & Oceans Canada.

7 Appendices

Appendix 1. Active organizations involved in habitat stewardship initiatives within the range of interior Fraser River coho salmon.

Stewardship Groups – NGO's

Baker Creek Enhancement Society
Bonaparte River Roundtable
Cariboo Chilcotin Conservation Society
Ducks Unlimited
Eagle River Watershed Roundtable
Kingfisher Environmental Interpretive Centre
Nicola River Community Watershed Roundtable
Penny Hatchery/Community of Dome Creek
Regional District of Fraser-Fort George
Rivershed Society of BC
Salmon River Watershed Roundtable
Spruce City Wildlife Association
Upper Fraser Headwaters Alliance
Williams Lake Naturalists

Partnerships

Fraser Basin Council – Thompson Region
City of Kamloops
BC Cattleman's Association

First Nations (including Nations and Bands that work with DFO and/or community roundtables on fish habitat stewardship initiatives)

Adams Lake Indian Band
Bridge River Indian Band
Cariboo Tribal Council
Carrier Sekani Tribal Council
Cayoose Indian Band
Coldwater Indian Band
L'heidl Tenneh Indian Band
Lillooet Indian Band
Lillooet Tribal Council
Lower Nicola Indian Band
Nicola Watershed Fisheries Stewardship Authority
North Thompson Indian Band
Secwepemc Fisheries Commission
Spallumcheen Indian Band

Upper Nicola Indian Band

Appendix 2. Total stream length and length accessible to spawning, rearing, and migrating interior Fraser River coho salmon by stream, sub-population, and population. Data collected by the Habitat Working Group of the Interior Fraser Coho Recovery Team.

Appendix 2. Total stream length and length accessible to spawning, rearing, and migrating Interior Fraser River coho salmon by stream, sub-population, and population. Data collected by the Habitat Working Group of the Interior Fraser Coho Recovery Team.

Population	Sub-population	Spawning Stream	Tributary	Total Stream Length (km)	Stream Length Accessible to Coho for Rearing, Spawning, and Migrating (km)	Percentage of Sub-population total	Stream Length Suitable for Spawning (km)	Percentage of Sub-population total
Fraser Canyon	Fraser Canyon	Anderson River ii		n/a	4.8	6%	4.8	6%
		Nahatlatch River a		73.0	73.0	93%	73.0	93%
		Kwoiek Cr. b		31.4	.5	1%	.5	1%
		Sub-population Total		104.4	78.3	100%	78.3	100%
Upper Fraser	Middle Fraser	Bridge River		154.5	39.5	31%	39.5	32%
			Yalakom River	55.0	15.0	12%	15.0	12%
		Seton River		2.1	2.1	2%	2.1	2%
			Cayoosh Cr.	64.7	1.3	1%	1.3	1%
		Portage River jj		2.9	2.9	2%	2.9	2%
			Spider Cr.	10.8	2.1	2%	2.1	2%
			Whitecap Cr.	16.3	1.0	1%	1.0	1%
		Gates River		14.5	14.5	12%	13.0	10%
			Haylemore Cr.	19.9	5.0	4%	5.0	4%
		Stein River		63.3	42.0	33%	42.0	34%
		Sub-population Total		403.9	125.4	100%	123.9	100%
	Upper Fraser	Baker Cr.		113.6	47.0	1%	47.0	3%
			Mount Cr.	47.5	47.5	1%	15.0	1%
		Blackwater R. (West Road)		218.0	218.0	5%	n/a	n/a
			Baezaeko R.	138.0	50.0	1%	50.0	3%
			Clisbako R.	100.1	7.0	0%	7.0	0%
			Coglistiko R.	69.4	14.0	0%	14.0	1%
			Euchiniko R.	44.5	44.5	1%	44.5	3%
			Nataniko R.	39.8	39.8	1%	39.8	2%
			Nazko R.	125.4	45.7	1%	45.7	3%
		Chilcotin R.		319.3	279.0	6%	n/a	n/a
			Brittany Cr.	48.4	48.4	1%	10.0	1%
			Chilcotin R. (upper)	110.0	90.0	2%	30.0	2%
			Zenzaco Cr.	25.9	25.9	1%	5.0	0%
			Puntzi Cr.	70.0	10.0	0%	10.0	1%
			Jorgensen Cr.	50.0	5.0	0%	5.0	0%
			Palmer Cr.	72.0	72.0	2%	20.0	1%
			Chesako Cr.	20.8	20.8	0%	5.0	0%
			Moore Cr.	34.2	34.2	1%	5.0	0%
			Anahim Cr.	52.7	40.0	1%	10.0	1%
			Haines Cr.	50.5	40.0	1%	5.0	0%
			Big Cr.	144.4	20.0	0%	5.0	0%
			Alexis Cr.	35.8	25.0	1%	5.0	0%
			Knoll Cr.	32.0	32.0	1%	32.0	2%
			Young Cr.	28.0	1.0	0%	.0	0%
			Punkutigenkut Cr.	50.0	50.0	1%	10.0	1%
			Chilanko R.	98.7	40.0	1%	10.0	1%
			Chilko R	89.0	89.0	2%	35.0	2%
			Bidwell Cr.	36.6	25.0	1%	5.0	0%
			Lingfield Cr.	29.0	29.0	1%	15.0	1%
			Clusko Cr.	59.9	59.9	1%	15.0	1%
			Minton Cr.	34.8	2.0	0%	2.0	0%
			Taseko R	131.7	116.0	3%	60.0	4%
			Elkin Cr.	36.8	36.8	1%	15.0	1%
			Tete Angela Cr.	48.1	48.1	1%	10.0	1%
			Chaunigan Cr.	11.0	11.0	0%	7.0	0%
			Fish Cr.	15.5	2.0	0%	1.0	0%
			Vick Cr.	4.5	4.0	0%	1.0	0%
		Cottonwood R. (Swift)		160.6	160.6	4%	80.0	5%
			Ahbau Cr.	73.9	37.0	1%	n/a	n/a
			John-Boyd Cr.	18.8	16.0	0%	13.2	1%
			Little Swift R.	28.7	28.7	1%	28.7	2%
			Sovereign Cr.	24.9	24.9	1%	24.9	2%
			Victoria Cr.	53.7	53.7	1%	53.7	3%
			Lightning Cr.	51.6	50.0	1%	50.0	3%
		Hawks Cr.		54.9	54.9	1%	54.9	3%
		Wayne Cr.		6.2	1.0	0%	1.0	0%
		Hixon Cr.		24.3	2.4	0%	2.4	0%
			Government Cr.	25.3	7.6	0%	7.6	0%
		Mackin Cr.		69.4	8.4	0%	8.4	1%
		Meldrum Cr.		42.6	12.7	0%	12.7	1%
		Narcosli Cr.		100.7	45.0	1%	45.0	3%
			Ramsey Cr.	59.4	1.0	0%	1.0	0%
			Deserters Cr.	27.6	27.6	1%	5.0	0%
			Twan Cr.	53.7	7.3	0%	7.3	0%
		Nechako R.		284.8	170.0	4%	170.0	10%
			Chilako R	219.4	100.0	2%	30.0	2%
			Greer Cr.	54.2	30.0	1%	5.0	0%
			Swanson Cr.	28.0	28.0	1%	5.0	0%
			Targe Cr.	33.2	33.2	1%	5.0	0%
			Cutoff Cr.	20.8	20.8	0%	4.0	0%
		Stuart R.		109.2	109.2	2%	n/a	n/a
			Tachie R	25.9	25.9	1%	n/a	n/a

continued…

Appendix 2. Total stream length and length accessible to spawning, rearing, and migrating Interior Fraser River coho salmon by stream, sub-population, and population. Data collected by the Habitat Working Group of the Interior Fraser Coho Recovery Team, continued.

Population	Sub-population	Spawning Stream	Tributary	Total Stream Length (km)	Stream Length Accessible to Coho for Rearing, Spawning, and Migrating (km)	Percentage of Sub-population total	Stream Length Suitable for Spawning (km)	Percentage of Sub-population total
Upper Fraser	Upper Fraser	Salmon R.		289.9	289.0	6%	n/a	n/a
			Youngs Cr.	33.2	33.2	1%	5.0	0%
		McGregor R.		218.4	57.0	1%	n/a	n/a
		Bowron R.		230.0	230.0	5%	n/a	n/a
			Indianpoint Cr.	35.5	35.5	1%	7.0	0%
			Antler Cr.	49.9	20.0	0%	5.0	0%
			Haggen Cr.	55.6	55.6	1%	10.0	1%
		Willow R.		220.1	50.0	1%	10.0	1%
			Wansa Cr.	52.3	52.3	1%	10.0	1%
		Upper Fraser (East of Bowron R)		300.0	280.0	6%	n/a	n/a
		Quesnel R.		109.6	109.6	2%	n/a	n/a
			Beaver Cr.	55.8	20.0	0%	20.0	1%
			Bill Miner	14.0	.5	0%	.5	0%
			Bluelead Cr.	16.6	3.0	0%	3.0	0%
			Edney Cr.	13.2	9.0	0%	9.0	1%
			Horsefly R	131.1	54.7	1%	54.7	3%
			Moffat Cr.	78.3	10.0	0%	10.0	1%
			Little Horsefly R	4.8	4.8	0%	4.8	0%
			McKinley Cr.	32.5	32.5	1%	32.5	2%
			Mitchell R	31.2	16.0	0%	16.0	1%
			Penfold Cr.	31.6	12.0	0%	12.0	1%
			Watt Cr.	18.9	n/a	n/a	1.0	0%
			Lynx Cr.	14.8	14.8	0%	1.0	0%
			Polly Cr.	7.2	7.2	0%	7.2	0%
			Summit Cr.	4.7	4.7	0%	2.0	0%
			Wasko Cr.	7.3	7.3	0%	7.3	0%
			Woodjam Cr.	20.8	20.8	0%	20.8	1%
			Tisdale Cr.	6.3	6.3	0%	6.3	0%
			Cariboo R	118.1	60.0	1%	40.0	2%
			Little R	39.8	20.0	0%	20.0	1%
		Watson Bar Cr.		29.4	7.6	0%	7.6	0%
		French Bar Cr.		28.8	28.8	1%	28.8	2%
		Churn Cr.		84.4	4.0	0%	4.0	0%
		Gaspard Cr.		87.5	10.0	0%	10.0	1%
		Riske Cr.		40.4	15.0	0%	3.0	0%
		Whiskey Cr.		11.5	1.0	0%	.5	0%
		Buckskin Cr.		6.9	1.4	0%	.5	0%
		Tingley Cr.		16.2	11.0	0%	2.0	0%
		Soda Cr.		17.2	.4	0%	.4	0%
		Cuisson Cr.		20.7	2.0	0%	2.0	0%
		Austrailian Cr.		30.9	30.9	1%	8.0	0%
		Menzinger Cr.		14.2	14.2	0%	4.0	0%
		Kersley Cr.		15.9	15.9	0%	4.0	0%
		Alix Cr.		17.1	17.1	0%	4.0	0%
		Stone Cr.		33.4	33.4	1%	6.0	0%
		Naver Cr.		98.7	25.0	1%	2.0	0%
		Williams Lake R.		18.1	18.1	0%	18.1	1%
		Sub-population Total		7,100.2	4,576.9	100%	1,630.5	100%
North Thompson	Upper North Thompson	Albreda R. [c]		30.2	30.2	12%	27.9	32%
			Allan Cr.	21.8	2.5	1%	1.0	1%
			Clemina Cr.	17.4	1.6	1%	.5	1%
			Dominion Cr.	16.7	1.1	0%	.6	1%
			Dora Cr.	7.5	.7	0%	.4	1%
		Blue R.		30.1	17.1	7%	17.1	20%
		Bone Cr. [cc]		n/a	1.2	0%	1.0	1%
		Canvas Cr. [d]		16.1	3.9	2%	.7	1%
		Cedar Cr.		6.0	3.3	1%	1.7	2%
		Chappell Cr.		11.7	2.2	1%	.5	1%
		Cook Cr.		7.3	1.2	0%	1.2	1%
		Goose Cr.		4.7	4.7	2%	3.0	3%
		Gum Cr. [dd]		n/a	n/a	n/a	n/a	n/a
		Lempriere Cr.		34.3	20.7	8%	8.8	10%
		Manteau Cr.		18.2	11.2	4%	7.4	8%
		Miledge Cr.		20.2	1.8	1%	1.0	1%
		Moonbeam Cr. [ee]		n/a	1.2	0%	1.2	1%
		Mud Cr.		35.2	9.1	4%	9.1	10%
		Upper North Thompson R.		132.3	132.3	52%	n/a	n/a
		Peddie Cr.		8.5	.4	0%	.4	1%
		WSC 129-663300 (Peedie 5)		n/a	n/a	n/a	n/a	n/a
		Pyramid Cr.		9.6	.5	0%	.5	1%
		Serpentine Cr.		14.1	.9	0%	.5	1%
		Thunder Cr.		28.0	4.8	2%	2.6	3%
		Sub-population Total		469.8	252.4	100%	87.2	100%

continued…

Appendix 2. Total stream length and length accessible to spawning, rearing, and migrating Interior Fraser River coho salmon by stream, sub-population, and population. Data collected by the Habitat Working Group of the Interior Fraser Coho Recovery Team, continued.

Population	Sub-population	Spawning Stream	Tributary	Total Stream Length (km)	Stream Length Accessible to Coho for Rearing, Spawning, and Migrating (km)	Percentage of Sub-population total	Stream Length Suitable for Spawning (km)	Percentage of Sub-population total
	Middle North	Avola Cr.		4.2	1.0	1%	1.0	1%
	Thompson	Brookfield Cr.		19.2	1.1	1%	1.1	1%
		Clearwater R. [e]		119.6	48.4	29%	48.4	44%
			Mahood R.	5.6	2.8	2%	2.8	3%
		Crossing Cr.		3.3	.5	0%	.5	0%
		Finn Cr.		25.8	4.2	3%	4.2	4%
		Lion Cr. [f]		16.6	2.5	2%	2.5	2%
		Mid North Thompson R.		94.5	94.5	57%	40.0	36%
North Thompson	Middle North		Pig Channel	1.3	1.3	1%	1.3	1%
	Thompson		Birch Island	1.0	1.0	1%	1.0	1%
			Slate Channel	n/a	n/a	n/a	n/a	n/a
		Raft River		78.0	4.7	3%	4.7	4%
		Shannon Cr.		10.2	1.2	1%	1.2	1%
		Tumtum Cr.		7.0	.8	0%	.8	1%
		Reg Christie Cr.		20.9	.4	0%	.4	0%
		Wire Cache Cr.		8.3	1.4	1%	1.4	1%
		Sub-population Total		415.4	165.7	100%	111.2	100%
	Lower North	Barriere R.		64.3	64.3	15%	50.0	13%
	Thompson		East Barriere R.	29.2	18.8	4%	18.8	5%
			Haggard Cr.	17.7	17.7	4%	14.6	4%
			Fennell Cr. [ff]	21.5	21.5	5%	21.5	6%
			Harper Cr.	26.2	26.2	6%	26.2	7%
			Vermelin Cr.	13.5	.9	0%	.5	0%
			Birk Cr.	15.1	1.7	0%	.9	0%
		Dairy Cr.		n/a	.3	0%	.0	0%
		Darlington Cr.		12.0	2.0	0%	2.0	1%
		Dunn Cr. [gg]		14.4	14.4	3%	14.4	4%
			McTaggart Cr.	4.5	2.4	1%	2.4	1%
		Fishtrap Cr.		22.2	5.6	1%	1.1	0%
		Heffley Cr.		17.3	.0	0%	.0	0%
		Jamieson Cr.		34.1	4.7	1%	1.8	0%
		Lanes Cr.		n/a	1.2	0%	1.2	0%
		Lemieux Cr.		30.8	13.4	3%	13.4	4%
		Lindquist Cr. [g]		18.7	3.3	1%	3.3	1%
		Louis Cr. [h]		57.9	57.9	14%	57.9	15%
		Lower North Thompson R.		138.7	138.7	33%	138.7	37%
		Mann Cr.		50.4	6.4	2%	6.4	2%
			Lolo and Gill creeks [hh]	n/a	8.0	2%	.0	0%
		Paul Cr. [i]		35.9	15.6	4%	1.8	0%
		Peterson Cr. [j]		27.2	1.0	0%	1.0	0%
		Sub-population Total		651.3	425.9	100%	377.8	100%
Lower Thompson	Lower Thompson	Bonaparte River [k]		145.1	145.1	73%	145.1	73%
		Cache Cr.		n/a	.1	0%	.1	0%
		Deadman River		89.9	48.9	25%	48.9	25%
		Tranquille Cr. [l]		57.2	5.0	3%	5.0	3%
		Sub-population Total		292.1	199.1	100%	199.1	100%
	Nicola	Nicola River (lower)		80.0	80.0	19%	40.0	10%
			Clapperton Cr.	29.5	2.0	0%	2.0	1%
			Guichon Cr.	80.6	50.0	12%	50.0	13%
			Skuhun Cr.	32.7	12.8	3%	12.8	3%
			Nooaitch Cr.	14.5	n/a	n/a	12.3	3%
			Shakan Cr. [kk]	17.3	3.0	1%	3.0	1%
			Pony Cr.	n/a	.1	0%	.1	0%
		Nicola River (upper)		108.0	22.0	5%	22.0	6%
			Spahomin Cr.	30.0	30.0	7%	30.0	8%
			Moore Cr.	93.8	30.0	7%	30.0	8%
			Quilchena Cr. [m]	26.5	5.0	1%	5.0	1%
		Coldwater River		91.7	91.7	46%	91.7	46%
			Brook Cr.	17.4	5.0	3%	5.0	3%
			Juliet Cr.	15.6	15.6	8%	15.6	8%
		Spius Cr.		48.6	48.6	12%	48.6	13%
			Maka Cr.	34.9	18.5	4%	18.5	5%
		Sub-population Total		721.0	414.3	129%	386.6	127%
South Thompson	Middle & Lower	Shuswap R. (lower)		88.6	88.6	30%	88.6	34%
	Shuswap		Ashton Cr.	14.5	.2	0%	.2	0%
			Brash Cr.	12.7	.5	0%	.5	0%
			Blurton Cr.	12.3	1.5	1%	1.5	1%
			Cooke Cr.	17.1	.5	0%	.5	0%
			Danforth Cr. [n]	13.6	13.6	5%	13.6	5%
			Fortune Cr. [o]	21.5	21.5	7%	2.0	1%
			Johnston Cr. [p]	11.0	11.0	4%	1.0	0%
			Kingfisher Cr.	28.3	28.3	10%	28.3	11%
			Trinity Cr. [q]	28.6	1.0	0%	1.0	0%

continued…

Appendix 2. Total stream length and length accessible to spawning, rearing, and migrating Interior Fraser River coho salmon by stream, sub-population, and population. Data collected by the Habitat Working Group of the Interior Fraser Coho Recovery Team, continued.

Population	Sub-population	Spawning Stream	Tributary	Total Stream Length (km)	Stream Length Accessible to Coho for Rearing, Spawning, and Migrating (km)	Percentage of Sub-population total	Stream Length Suitable for Spawning (km)	Percentage of Sub-population total
		Shuswap R. (middle)		76.1	21.0	7%	21.0	8%
			Bessette Cr.	38.0	38.0	13%	38.0	14%
			Bigg Cr.	n/a	n/a	n/a	n/a	n/a
			Creighton Cr.	30.7	4.1	1%	4.1	2%
			Falls Cr	n/a	n/a	n/a	n/a	n/a
			Duteau Cr.	49.6	10.8	4%	10.8	4%
			Harris Cr. [r]	31.8	18.1	6%	18.1	7%
			Blue Springs Cr.	n/a	n/a	n/a	n/a	n/a
			Ireland Cr.	25.3	3.2	1%	3.2	1%
			Vance Cr.	n/a	n/a	n/a	n/a	n/a
		Tsuius Cr.		30.6	.5	0%	.5	0%
		Noisey Cr.		15.4	1.1	0%	1.1	0%
		Wap Cr.		47.7	29.3	10%	29.3	11%
		Sub-population Total		593.5	292.8	100%	263.3	100%
South Thompson	Shuswap Lake & Tributaries	Anstey R.		30.1	7.0	1400%	7.0	1400%
		Canoe Cr.		10.6	4.5	900%	4.5	900%
		Celista Cr.		29.2	1.8	360%	1.8	360%
		Chase Cr.		n/a	n/a	n/a	n/a	n/a
		Eagle R.		75.9	75.9	11%	75.9	11%
			Crazy Cr.	20.3	.5	0%	.5	0%
			Owlhead Cr.	5.8	.8	0%	.8	0%
			Perry R.	41.5	28.0	4%	28.0	4%
			Unnamed @ CPR Mile 16.22	n/a	n/a	n/a	n/a	n/a
			Senn Cr.	10.1	1.0	0%	1.0	0%
			South Pass C	9.8	1.2	0%	1.2	0%
			Yard Cr.	21.2	.4	0%	.4	0%
		Hunakwa Cr.		7.5	7.5	1%	7.5	1%
		Little River		n/a	n/a	n/a	n/a	n/a
		Monte Cr.		n/a	n/a	n/a	n/a	n/a
		Onyx Cr.		16.7	2.0	0%	2.0	0%
		Reinecker Cr.		n/a	n/a	n/a	n/a	n/a
		Ross Cr. [s]		22.9	.5	0%	.5	0%
		Salmon R.		148.7	80.0	11%	80.0	12%
			Bolean Cr.	23.3	23.3	3%	23.3	3%
			Palmer Cr.	9.8	.5	0%	.5	0%
		Scotch Cr. [t]		56.5	16.0	2%	16.0	2%
		Seymour R.		71.0	14.6	2%	14.6	2%
			McNomee Cr.	20.3	8.7	1%	8.7	1%
		South Thompson R.		n/a	n/a	n/a	n/a	n/a
		Syphon Cr		n/a	n/a	n/a	n/a	n/a
		Tappen Cr.		6.8	1.5	0%	1.5	0%
		White Cr.		n/a	n/a	n/a	n/a	n/a
		Wright Cr. [u]		2.7	2.6	0%	2.6	0%
		Sub-population Total		1,579.3	697.2	2841%	667.7	2848%
	Adams River	Adams R. (lower)		11.3	11.3	5%	11.3	8%
			Huihill Cr.	15.0	.9	0%	.9	1%
			Gold Cr. (Nikwikwaia) [v]	21.4	1.2	1%	1.2	1%
		Momich R. [w]		9.9	9.9	5%	9.9	7%
			Cayenne Cr. [x]	42.9	2.2	1%	2.2	2%
		Sinmax Cr. [y]		19.5	12.0	6%	12.0	8%
		Tsikwustum Cr.		13.2	.3	0%	.3	0%
		Adams R. (upper)		130.0	130.0	62%	65.0	45%
			Burton Cr.	13.6	2.0	1%	2.0	1%
			Gollen Cr.	18.2	1.0	0%	1.0	1%
			Harbour Cr.	12.6	2.7	1%	2.7	2%
			Dudgeon Cr.	14.4	.5	0%	.5	0%
			Sunset Cr. [z]	15.6	1.3	1%	1.3	1%
			Gold Cr.	11.0	11.0	5%	11.0	8%
			Oliver Cr. [aa]	26.7	23.3	11%	23.3	16%
			Hemlock Cr.	11.1	.7	0%	.7	0%
			Mica Cr. [bb]	n/a	n/a	n/a	n/a	n/a
		Sub-population Total		386.5	210.3	100%	145.3	100%
			Grand Total	12,717.3	7,438.2	—	4,070.8	—

a. Total length changed from 85.9 to 73.0 km; this doesn't include the lengths of four lakes (lake total = 10 km); spawning occurs mainly between Grizzly Creek and West Nahatlatch Lake, an area 13 km long (A. Wall, Fisheries and Oceans Canada, Kamloops, BC, personal communication). The Middle Fraser HMA document (Komori 1997) indicates a falls at 43 km (J. Guerin, Fisheries and Oceans Canada, Kamloops, BC, personal communication).

continued…

Appendix 2. Total stream length and length accessible to spawning, rearing, and migrating Interior Fraser River coho salmon by stream, sub-population, and population. Data collected by the Habitat Working Group of the Interior Fraser Coho Recovery Team, continued.

b. Total length changed from 7.0km to 0.5 km; the CP Rail crossing is the current upstream limit of access (A. Wall, Fisheries and Oceans Canada, Kamloops, BC, personal communication).

c. Access to some wetlands is cut-off by roads and improper culverts (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication). Other than beaver dams, no known obstructions up to the headwater swamps; unable to find juvenile coho in three years of sampling in the swamps (T. Panko, Fisheries and Oceans Canada, Clearwater, BC, personal communication) .

d. Falls is a possible barrier to fish (H. Olynyk, Fisheries and Oceans Canada, Kamloops, BC, personal communication).

e. This length assumes no access upstream to the Horseshoe (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication). There is no known obstruction to coho accesss up to at least as far as the Myrtle River; however, they have only been observed as far as the Mahood River (T. Panko, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

f. Coho can access the area upstream of the railroad tracks but beaver dams may create access problems (T. Panko, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

g. Work was done on the culvert at the Highway 5 crossing in 2004; new upstream extent of spawning is unassessed (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

h. Coho may be able to migrate past the Whitecroft Road crossing (aproxmiately 35 km upstream), but there is no documentation to show coho upstream of this crossing (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, and T. Panko, Fisheries and Oceans Canada, Clearwater, BC, personal communications).

i. Unsure if 15.6 km is accessible as an upstream canyon may have barrier in it; access is also limited by man-made structures, including a water diversion for a cement plant (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

j. The Peterson Cr. Located north of Barriere is a coho spawning stream; Coho access above the highway is possible but may be limited at certain flows (K. Austin, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

k. This is total length of the Bonaparte; to suggest it is all useable is misleading as the area upstream of Young Lake is mainly slow and meandering with little to no gravel substrate (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

l. Access is limited by beaver dam obstructions approximately 500 m upstream of road crossing (only ~2 km may be accessible) (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

m. The Nicola Tribal Association reports an obstruction (7m falls) at approximately 30 km upstream (measured with map wheel) (A. Wall, Fisheries and Oceans Canada, Kamloops, BC, personal communication).

n. Access is limited by beaver dam obstructions approximately 500m upstream of road crossing (~2 km) (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

o. Access upstream of Hwy 97 is not possible due to low water; actual available spawning habitat is less than 2 km (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

p. Only accessible for a short distance upstream of highway; all spawning habitat is downstream of highway (>1 km) (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

q. Useable coho habitat is located below Trinity Valley road (about 1 km); another 400 m will become available once a rock weir for passage through a culvert becomes sedimented in (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

r. Actual useable habitat is less than 18.1 km (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

s. Unaware of any barrier to fish in the first 32 km to ravine; it is possible that barriers exist in or upstream of that ravine (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

t. Ravine at 13 km creates a barrier at low water; no obvious barriers past 16km, but gradient does increase (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

u. Actual accessible habitat is less than 2 km to lake; numerous beaver dams may reduce access to initial 1.5 km (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

v. Unaware of any useable habitat upstream of approximately 1.5km; we have walked beyond 2 km on this stream, without encountering a barrier to fish movement (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

w. Useable habitat is restricted to an approximate 200m long section downstream of first lake; another ~200m located between Momich and 3rd lake, and also approximately 2 km upstream of the 3rd lake (Little Momich) (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

x. Almost all spawning restricted to first kilometer (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

y. Logjam approximately 6 km upstream may be a barrier; most spawning substrate is restricted to area downstream of km 6 (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication). Historical evidence shows salmon spawning up to and above Alex Creek (~12km upstream); it is likely that coho have access to this section (K. Austin, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

z. No coho observed during brief surveys; steep stream with little useable habitat (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

aa. Only other tributary in Upper Adams in which coho have been oberved (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

bb. It is likely that this stream supports coho spawning but that has not been verified as human access to system is very difficult; likely has limited coho access; useable coho habitat observed during aerial overflights (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

cc. Limited coho spawning area in lower section; distance represents mouth to the Forest Service Road crossing (K. Austin, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

dd. Spawning area near mouth (K. Austin, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

ee. Limited Coho spawning has been documented in lower section; distance recorded is from mouth to first reach break (K. Austin, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

ff. All of Fennell may not be accessible or useable; past records indicate coho utililize only 1 km above its confluence with the Barriere River (T. Panko, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

gg. Only that portion of Dunn from the lake to Boulder Cr. is accessable or used by coho. The creek above the lake is steep, has poor substrate and I have only observed bull trout in that area (T. Panko, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

hh. Gill and Lolo creeks are known to contain rearing habitat (highwater periods only) and to provide limited overwintering areas to coho (K. Austin, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

ii. Potential spawning up to km 4.8 (Komori 1997) (J. Guerin, Fisheries and Oceans Canada, Kamloops, BC, personal communication).

jj. The Bridge-Seton HMA document (Komori 1997a) lists the length as 5.8 km (J. Guerin, Fisheries and Oceans Canada, Kamloops, BC, personal communication).

kk. The Thompson-Nicola HMA document (DFO 1998) reports an impassable falls at 3 km (J. Guerin, Fisheries and Oceans Canada, Kamloops, BC, personal communication).

Appendix 3. Description of method used to standardize the 1975 through 2003 spawning escapement data for interior Fraser River coho salmon.

Introduction

The status of Interior Fraser Coho has been assessed, in large part by analyzing their escapement time series (see Sections 1.4.2 and 1.4.3 in the main report). Since new information was available that had been unavailable the last time this time series was examined, the time series was revisited. These new data also provided the opportunity to estimate the contribution of the non-Thompson River populations prior to 1998 and Lower Thompson River populations prior to 1984. In addition, in order to assess the escapement resulting from naturally spawned parents, the first generation hatchery returns were subtracted from the population escapement estimates.

The time series of escapement data that was presented in the COSEWIC status report (Irvine 2002) and in recent assessments and forecasts for Interior Fraser Coho (e.g. Irvine et al. 2001, Simpson et al. 2001) relied on expanding partial counts and in-filling data gaps. In 1998 – 2000, more effort was expended to enumerate coho than in previous years. During these three years, two separate escapement estimates were obtained. The first was the best available estimate of the true number of coho in the system. The second was a trend estimate, which was the probable number of fish that would have been estimated if current survey effort had been similar to that in other recent years (Irvine et al. 1999, 2000). In general, trend estimates may be useful in monitoring inter-annual changes in abundance, but may not accurately reflect the actual number of fish spawning in a system.

When the previous escapement time series was generated (Irvine et al. 2001, Simpson et al. 2001), there were only two years of data to compare the trend estimate with the true number. The original procedure was:

- For streams where estimates of adjustment scalers (*i.e.* the true:trend ratio) were available for both 1998 and 1999, the geometric mean of the two scaler values was applied to the pre-1998 escapement estimates. For streams where only one adjustment scaler was available or where no estimate of the scaler was available, the geometric mean scaler for the sub-aggregate over both years was applied (Simpson et al. 2001)

- Missing values and zero estimates, were determined using a contingency table approach described by Brown (1974)

- All coho salmon escaping to Louis, Lemieux, and Dunn creeks, and to other streams with hatchery production, were assumed to be hatchery fish.

For this conservation strategy report, one more year of true *vs.* trend comparisons was available. These new data, along with a concern over the presence of high true:trend ratio values for some streams, prompted the reconstruction of the full time series (1975 – 2003) of coho salmon escapements for the interior Fraser River watershed.

Methods

The first step in standardizing the Interior Fraser Coho escapement data set was to re-examine differences between escapement estimates calculated using methods employed prior to 1998 (*i.e.* trend estimates) and estimates determined using methods undertaken during 1998 — 2000 (*i.e.* true estimates). For each year from 1998 to 2000, both true and trend estimates were calculated for each system within the North, South, and Lower Thompson River populations. For each population, the true estimates, by escapement survey technique (*i.e*. visual or enumeration fence estimate) for each year, were then summed. The ratio of the total true escapement to the total trend escapement was then calculated for each survey technique, in each population, and for all three years. The three-year average ratio was then determined for each survey method for the three separate Thompson River populations.

After the creation of the average true *vs.* trend ratio, the second step in the data normalization process was to expand the past trend escapement data to a true estimate using the populations' survey technique appropriate three-year average ratio. To do this, the survey method used to determine the true escapement estimate for each individual stream in the three populations was determined and then the technique appropriate ratio was applied. In the Lower Thompson River population, there were large discrepancies between historic visual estimates and estimates derived from recently employed survey methods; therefore, the visual adjustment scaler for the South Thompson population was used to expand the Lower Thompson population's estimates. Enumeration estimates calculated after 1998 or those in the historic data set that were derived with a known precision (*e.g.* mark/recapture estimates) were not adjusted.

The third step in standardizing the Interior Fraser Coho escapement data was to develop a process for in-filling any numeric gaps within a stream's escapement time series. Using the above described revised escapement data, an algorithm was developed that predicted the escapements for missing values in each system. In this algorithm, a distinction was made between observed zero counts and data missing due to an absence of survey effort.

To begin the in-filling, the algorithm calculated the average escapement, for each stream with data, across the available time series. Stream averages were then summed and the proportion that each stream contributed to the population's total average escapement was determined. This process was repeated for all years. In addition, the yearly average escapement for all streams in a population was determined and the proportion that each year contributed to the total average escapement for the time series was calculated. Subsequent to these steps, the sums of escapements across all years in the time series were computed. The algorithm then in-filled missing escapements by calculating the annual proportion of the system escapement in each missed year by dividing the total sum of all escapements in the data set by the proportion of the escapement in the missed year.

Following the reconstruction of the escapement data for the North, South, and Lower Thompson River populations, the escapement values for those streams in which hatchery fish contributed to their annual escapements were adjusted to exclude hatchery fish (see Table 4 in Recovery Report).

The final phase in the construction of the revised escapement data set for Interior Fraser Coho was to estimate the historic contributions of the two populations where data were most limited. Escapements prior to 1998 were estimated for the Fraser Canyon and Upper and Middle Fraser sub-populations and for the Lower Thompson and Nicola sub-population for the years from 1975 to 1984.

Historic escapements for the Fraser Canyon and Upper Fraser populations were determined by comparing the average annual ratio of escapements for the three sub-populations within those two populations to the total North and South Thompson population escapements over the period 1998 to 2002. Annual escapements to the Upper Fraser, Middle Fraser, and Fraser Canyon sub-populations for the years 1975 through 1997 were then computed by dividing the sum of the North and South Thompson population escapements by each sub-population's average ratio.

This ratio based process was repeated for the pre- 1984 Lower Thompson and Nicola sub-populations using the average ratio from 1984-2003 escapements. Missing escapements for the Lower Thompson and Nicola sub-populations for 1975 through 1983 were calculated by dividing the sum of the North and South Thompson population escapements by the appropriate sub-population's ratio.

Results

Differences between the original escapement estimates used by COSEWIC and others and the new estimates used in this conservation strategy report were relatively minor, except for the North Thompson population. Within the original North Thompson data set, an exceptionally high adjustment scaler for Fennell Creek had produced average escapements during 1984-1997 of approximately 19,000 coho salmon while the revised, standardized average escapement during this same period was only 1,600 fish. Fennell is a relatively small creek with a short, accessible mainstem length, and it is likely that the original adjustment scaler significantly overestimated the number of coho salmon spawning in Fennell Creek. The main reason that the new escapement estimates for the sum of the three Thompson River populations (Figure a) are lower than the original estimates (Irvine 2002) is the modification of the adjustment scaler for the Fennell Creek escapements.

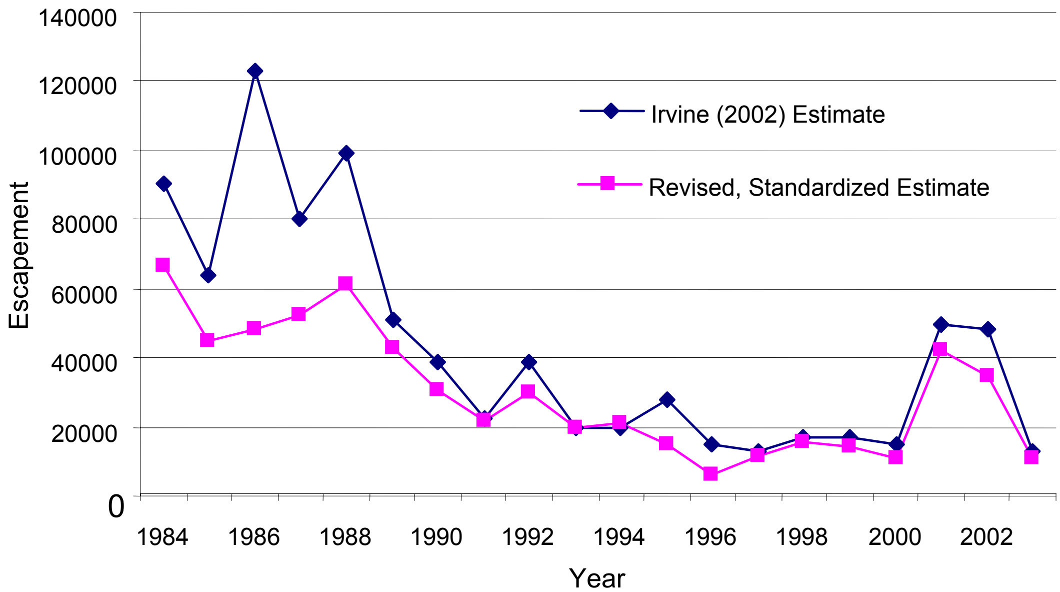

Figure a. Comparison of revised, standardized escapement and escapements reported in Irvine (2002) to the Thompson River system, 1984 to 2003.

Appendix 4. Qualitative assessment of historical probable impacts from human activities within the Interior Fraser watershed by stream, sub-population, and population. Assessments were derived by government and non-governmental professional staff who were familiar with the individual streams.

				Forestry				Urbanization				Agriculture				Mining				Linear				Hydro				Water Withdrawal				Cumulative Impacts			
Population	Sub-population	Spawning Stream	Tributary	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A
Fraser Canyon	Fraser Canyon	Anderson River					X				X				X				X				X				X				X				X
		Nahatlatch River				X		X				X				X				X				X				X				X			
		Kwoiek Cr.				X		X				X				X				X				X				X				X			
		Sub-population Total		**0**	**0**	**2**	**1**	**2**	**0**	**0**	**1**	**2**	**0**	**0**	**1**	**2**	**0**	**0**	**1**	**2**	**0**	**0**	**1**	**2**	**0**	**0**	**1**	**2**	**0**	**0**	**1**	**2**	**0**	**0**	**1**
Upper Fraser	Middle Upper Fraser	Bridge River		X				X				X				X						X				X			X				X		
			Yalakom River	X				X				X				X						X		X				X					X		
		Seton River		X				X				X				X						X				X		X						X	
			Cayoosh Cr.	X				X				X				X				X						X		X						X	
		Portage River		X						X		X				X						X		X				X						X	
			Spider	X				X				X				X				X				X				X				X			
			Whitecap	X				X				X				X				X				X				X				X			
		Gates River			X						X			X		X						X		X				X						X	
			Haylemore Cr.			X		X				X				X				X				X				X						X	
		Stein River		X				X				X				X				X				X				X				X			
		Sub-population Total		**8**	**1**	**1**	**0**	**8**	**0**	**1**	**1**	**9**	**0**	**1**	**0**	**10**	**0**	**0**	**0**	**5**	**0**	**5**	**0**	**7**	**0**	**3**	**0**	**9**	**1**	**0**	**0**	**3**	**2**	**5**	**0**
	Upper Upper Fraser a.	Baker Cr.				X				X		X				X				X				X				X					X		
			Mount Cr.		X			X				X				X				X				X				X					X		
		Blackwater R (West Road)			X			X					X			X				X				X				X				X			
			Baezaeko R.		X			X				X				X				X				X				X				X			
			Clisbako R.		X			X				X				X				X				X				X				X			
			Coglistiko R.		X			X				X				X				X				X				X				X			
			Euchiniko R.		X			X					X			X				X				X				X				X			
			Nataniko R.	X				X				X				X				X				X				X				X			
			Nazko R.			X		X						X		X				X				X					X					X	
		Chilcotin R		X				X						X		X				X				X					X			X			
			Brittany Cr.	X				X					X			X				X				X					X			X			
			Chilcotin R. (upper)	X				X					X			X				X				X					X			X			
			Zenzaco Cr.	X				X				X				X				X				X				X				X			
			Puntzi Cr.	X				X					X			X				X				X					X			X			
			Jorgensen Cr.	X				X				X				X				X				X				X				X			
			Palmer Cr.	X				X				X				X				X				X				X				X			
			Chesako Cr.	X				X				X				X				X				X				X				X			
			Moore Cr.	X				X				X				X				X				X				X				X			
			Anahim Cr.	X				X						X		X				X				X						X			X		
			Haines Cr.	X				X					X			X				X				X					X			X			
			Big Cr.	X				X						X		X				X				X						X			X		
			Alexis Cr.	X				X						X		X				X				X						X			X		
			Knoll Cr.	X				X					X			X				X				X				X				X			
			Young Cr.	X				X						X		X				X				X						X			X		
			Punkutigenkut Cr.	X				X				X				X				X				X				X				X			
			Chilanko R.	X				X					X			X				X				X					X			X			
			Chilko R	X				X				X				X				X				X				X				X			
			Bidwell Cr.	X				X				X				X				X				X				X				X			
			Lingfield Cr.	X				X				X				X				X				X				X				X			
			Clusko Cr.	X				X				X				X				X				X				X				X			
			Minton Cr.	X				X					X			X				X				X					X			X			
			Taseko R	X				X				X				X				X				X				X				X			
			Elkin Cr.	X				X						X		X				X				X				X				X			
			Tete Angela Cr.	X				X				X				X				X				X				X				X			
			Chaunigan Cr.	X				X				X				X				X				X				X				X			
			Fish Cr.	X				X				X				X				X				X				X				X			
			Vick Cr.	X				X				X				X				X				X				X				X			
		Cottonwood R. (Swift)				X		X				X						X				X		X				X				X			
			Ahbau Cr.			X		X						X		X						X		X					X					X	
			John-Boyd Cr.			X		X				X					X					X		X				X					X		
			Little Swift R.			X		X				X					X					X		X				X					X		
			Sovereign Cr.			X		X				X						X				X		X				X						X	
			Victoria Cr.			X		X				X						X				X		X				X						X	
			Lightning Cr.			X		X				X						X				X		X				X					X		
		Hawks Cr.			X			X						X				X		X				X						X				X	
		Wayne Cr.			X			X				X				X				X				X				X				X			
		Hixon Cr.			X				X			X					X			X				X				X				X			

continued…

Appendix 4. Qualitative assessment of historical probable impacts from human activities within the Interior Fraser watershed by stream, sub-population, and population, continued. Assessments were derived by government and non-governmental professional staff who were familiar with the individual streams.

				Forestry				Urbanization				Agriculture				Mining				Linear				Hydro				Water Withdrawal				Cumulative Impacts			
Population	Sub-population	Spawning Stream	Tributary	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A
			Government Cr.		X			X				X					X			X				X				X				X			
		Mackin Cr.		X				X						X		X					X			X						X				X	
		Meldrum Cr.			X			X				X				X				X				X						X		X			
		Narcosli Cr.			X			X						X		X				X				X					X				X		
			Ramsey Cr.		X			X						X		X				X				X					X				X		
			Deserters Cr.		X			X						X		X				X				X					X				X		
			Twan Cr.		X			X						X		X				X				X					X				X		
		Nechako R				X		X						X		X				X						X				X				X	
			Chilako R			X		X						X		X				X				X						X				X	
			Greer Cr.			X		X					X			X				X				X					X				X		
			Swanson Cr.			X		X					X			X				X				X					X				X		
			Targe Cr.			X		X				X				X				X				X				X				X			
			Cutoff Cr.			X		X				X				X				X				X				X				X			
		Stuart R		X				X					X			X					X			X				X				X			
			Tachie R	X				X				X				X					X			X				X				X			
		Salmon R				X		X				X				X						X		X				X					X		
			Youngs Cr.			X		X				X				X					X			X				X					X		
		McGregor R				X		X				X				X				X				X				X				X			
		Bowron R				X		X				X				X						X		X				X					X		
			Indianpoint Cr.			X		X				X				X						X		X				X					X		
			Antler Cr.			X		X				X						X				X		X				X					X		
			Haggen Cr.			X		X				X				X				X				X				X				X			
		Willow R				X		X				X						X				X		X				X					X		
			Wansa Cr.			X		X				X						X				X		X				X					X		
		Upper Fraser (East of Bowron R)			X			X				X				X					X			X				X				X			
		Quesnel R			X				X				X					X			X			X				X					X		
			Beaver Cr.		X			X						X			X				X			X						X			X		
			Bill Miner		X			X				X				X					X			X				X				X			
			Bluelead Cr.	X				X				X				X						X		X				X				X			
			Edney Cr.				X	X				X				X				X				X							X	X			
			Horsefly R			X		X						X		X						X		X					X					X	
			Moffat Cr.			X		X						X		X						X		X					X					X	
			Little Horsefly R	X				X				X				X				X				X				X				X			
			McKinley Cr.			X		X				X				X						X		X				X					X		
			Mitchell R	X				X				X				X				X				X				X				X			
			Penfold Cr.	X				X				X				X				X				X				X				X			
			Watt Cr.	X				X				X				X				X				X				X				X			
			Lynx Cr.	X				X				X				X				X				X				X				X			
			Polly Cr.				X	X				X					X			X				X							X	X			
			Summit Cr.	X				X				X				X				X				X				X				X			
			Wasko Cr.	X				X				X				X				X				X				X				X			
			Woodjam Cr.		X			X					X			X					X			X				X				X			
			Tisdale Cr.				X	X				X				X				X				X				X				X			
			Cariboo R			X		X				X						X				X		X				X					X		
			Little R			X		X				X				X				X				X				X				X			
		Watson Bar Cr.					X	X							X	X				X				X							X	X			
		French Bar Cr.					X	X							X	X				X				X							X	X			
		Churn Cr.					X	X					X			X				X				X					X			X			
		Gaspard Cr.					X	X							X	X				X				X							X	X			
		Riske Cr.		X				X					X			X				X				X					X			X			
		Whiskey Cr.		X				X				X				X				X				X							X	X			
		Buckskin Cr.		X				X				X				X				X				X							X	X			
		Tingley Cr.		X				X					X			X				X				X							X	X			
		Soda Cr.		X				X					X			X				X				X					X			X			
		Cuisson Cr.		X				X				X				X				X				X							X		X		
		Austrailian Cr.		X				X					X			X				X				X					X			X			
		Menzinger Cr.		X				X					X			X				X				X					X			X			
		Kersley Cr.		X				X				X				X					X			X					X			X			
		Alix Cr.		X				X				X				X				X				X					X			X			
		Stone Cr.		X				X				X					X			X				X					X			X			
		Naver Cr.			X			X				X					X				X			X					X			X			
		Williams Lake R		X						X				X		X						X		X				X						X	
		Sub-population Total		**54**	**22**	**30**	**8**	**107**	**3**	**3**	**1**	**68**	**21**	**21**	**4**	**93**	**9**	**11**	**1**	**81**	**12**	**20**	**1**	**110**	**1**	**2**	**1**	**66**	**27**	**11**	**10**	**73**	**28**	**12**	**1**

continued…

Appendix 4. Qualitative assessment of historical probable impacts from human activities within the Interior Fraser watershed by stream, sub-population, and population, continued. Assessments were derived by government and non-governmental professional staff who were familiar with the individual streams.

				Forestry				Urbanization				Agriculture				Mining				Linear				Hydro				Water Withdrawal				Cumulative Impacts			
Population	Sub-population	Spawning Stream	Tributary	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A
North Thompson	Upper North Thompson	Albreda R			X			X				X				X					X			X				X				X			
			Allan Cr.		X			X				X				X					X			X				X				X			
			Clemina Cr. gg		X			X				X				X					X				X			X							X
			Dominion Cr.		X			X				X				X				X				X				X							X
			Dora Cr.		X			X				X				X				X				X				X							X
		Blue R			X				X			X				X					X			X				X				X			
		Bone Cr. gg			X			X				X							X	X					X			X				X			
		Canvas Cr.			X			X				X							X	X				X				X				X			
		Cedar Cr. hh			X			X				X				X					X			X				X				X			
		Chappell Cr.				X		x				X							X		X						X				X		X		
		Cook Cr. hh			X			X				X				X					X			X				X						X	
		Goose Cr. gg, ii				X		X				X				X						X		X				X				X			
		Gum Cr jj			X			X				X							X		X				X			X				X			
		Lempriere Cr. kk				X		X				X							X	X				X				X				X			
		Manteau Cr.			X			X				X							X	X							X	X				X			
		Miledge Cr.			X			X				X				X					X			X				X				X			
		Moonbearm Cr.			X			X				X							X	X							X	X					X		
		Mud Cr. ll			X			X				X							X	X							X	X				X			
		Upper North Thompson R b.			X			X				X					X					X					X	X					X		
		Peddie Cr. mm				X		X				X				X						X					X	X							X
		WSC 129-663300 (Peedie 5)				X		X				X							X		X						X				X		X		
		Pyramid Cr. nn		X				X				X							X	X				X				X				X			
		Serpentine Cr. gg			X			X				X							X	X					X			X				X			
		Thunder Cr.			X			X				X							X		X			X				X				X			
		Sub-population Total		1	18	5	0	23	1	0	0	24	0	0	0	11	1	0	12	10	11	3	0	13	4	0	7	22	0	0	2	15	4	1	4
	Mid North Thompson	Avola Cr. oo		X						X		X							X			X		X					X				X		
		Brookfield Cr. pp				X			X			X					X				X			X					X				X		
		Clearwater R qq		X				X					X			X					X			X				X				X			
			Mahood R	X				X				X				X				X				X				X				X			
		Crossing Cr.		X				X				X				X					X			X				X				X			
		Finn Cr. gg				X		X				X					X			X					X			X					X		
		Lion Cr. c.				X		X				X				X						X		X				X					X		
		Mid N. Thompson R			X			X					X				X					X		X				X					X		
			Pig Channel	X				X					X			X				X				X				X				X			
			Birch Island	X				X					X			X						X		X				X				X			
			Slate Channel	X				X					X			X					X			X				X				X			
		Raft R d.				X		X					X				X			X				X				X					X		
		Shannon Cr. rr			X			X				X							X		X			X				X				X			
		Tumtum Cr. ss			X			X				X				X					X			X				X					X		
		Reg Christie Cr.				X		X					X			X				X				X				X				X			
		Wire Cache Cr.			X			X				X				X						X		X				X					X		
		Sub-population Total		7	4	5	0	14	1	1	0	9	7	0	0	10	4	0	2	5	6	5	0	15	1	0	0	14	2	0	0	8	8	0	0
	Lower North Thompson	Barriere R				X		X					X			X				X				X				X						X	
			E. Barriere R tt			X			X			X							X	X				X				X					X		
			Haggard Cr. uu		X				X			X							X	X				X				X					X		
			Fennell Cr. e.			X		X				X							X	X				X				X					X		
			Harper Cr.		X			X				X							X	X				X				X				X			
			Vermelin Cr.		X			X				X							X	X				X				X				X			
			Birk Cr.		X			X				X							X		X			X				X				X			
		Dairy Cr.					X				X				X				X				X				X				X				X
		Darlington Cr. vv				X		X						X					X		X			X					X				X		
		Dunn Cr.			X			X				X				X				X				X				X					X		
			McTaggart Cr.	X				X						X			X			X				X					X				X		
		Fishtrap Cr. ww				X		X				X							X	X				X				X				X			
		Heffley Cr.					X				X				X				X				X				X				X				X
		Jamieson Cr. ww				X		X				X							X	X				X							X		X		
		Lanes Cr.					X				X				X				X				X				X				X				X
		Lemieux Cr. f.				X			X					X			X					X		X						X				X	
		Lindquist Cr.				X		X						X					X		X			X					X				X		
		Louis Cr. f.			X				X					X			X			X				X						X				X	
		L. N Thompson R g.			X				X					X		X						X		X				X				X			
		Mann Cr.				X		X					X						X		X			X				X					X		
			Lolo and Gill Cr.				X				X				X				X				X				X				X				X
		Paul Cr. h.					X				X				X				X				X				X				X				X
		Peterson Cr.			X			X						X			X				X			X					X					X	
		Sub-population Total		1	8	9	5	13	5	0	5	9	2	7	5	3	4	0	16	11	5	2	5	18	0	0	5	11	4	2	6	5	9	4	5

continued…

Appendix 4. Qualitative assessment of historical probable impacts from human activities within the Interior Fraser watershed by stream, sub-population, and population, continued. Assessments were derived by government and non-governmental professional staff who were familiar with the individual streams.

Population	Sub-population	Spawning Stream	Tributary	Forestry				Urbanization				Agriculture				Mining				Linear				Hydro				Water Withdrawal				Cumulative Impacts			
				Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A
Lower Thompson	Non-Nicola	Bonaparte River f, i.				X		X						X		X				X				X					X					X	
		Cache Cr.					X				X				X				X				X				X				X				X
		Deadman River				X		X						X		X				X				X						X				X	
		Tranquille Cr. j.		X				X						X		X				X				X					X					X	
		Sub-population Total		1	0	2	1	3	0	0	1	0	0	3	1	3	0	0	1	3	0	0	1	3	0	0	1	0	2	1	1	0	0	3	1
	Nicola Basin	Nicola River (lower) l.				X				X				X		X						X		X						X				X	
			Clapperton Cr. m.		X			X						X		X				X				X						X				X	
			Guichon Cr. n.		X			X						X			X			X				X						X				X	
			Skuhun Cr.			X		X					X			X				X				X					X					X	
			Nooaitch Cr.	X				X				X				X				X				X				X				X			
			Shakan Cr.				X				X				X				X				X				X				X				X
			Pony Cr.				X				X				X				X				X				X				X				X
		Nicola River (upper)				X			X					X		X				X				X					X					X	
			Spahomin Cr. o.	X				X						X		X				X				X						X				X	
			Moore Cr.				X				X				X				X				X				X				X				X
			Quilchena Cr.				X				X				X				X				X				X				X				X
		Coldwater River k.				X			X					X		X						X		X						X				X	
			Brook Cr.	X				X				X				X				X				X				X				X			
			Juliet Cr.			X		X				X				X				X				X				X					X		
		Spius Cr. p.				X			X					X		X						X		X						X				X	
			Maka Cr. q.			X		X				X				X					X			X				X						X	
		Sub-population Total		3	2	7	4	8	3	1	4	4	1	7	4	11	1	0	4	8	1	3	4	12	0	0	4	4	2	6	4	2	1	9	4
South Thompson	Mid and Lower Shuswap	Shuswap R (lower)			X					X				X		X				X				X				X						X	
			Ashton Cr. r.		X					X					X				X				X	X						X				X	
			Brash Cr. s.				X				X				X				X				X	X					X					X	
			Blurton Cr. xx		X				X					X			X			X				X						X				X	
			Cooke Cr. s.		X				X			X				X					X			X							X			X	
			Danforth Cr. t.		X			X					X			X				X					X			X						X	
			Fortune Cr. u.	X				X						X		X				X				X						X				X	
			Johnston Cr. v.			X			X				X			X					X			X					X					X	
			Kingfisher Cr.		X			X				X				X				X				X					X					X	
			Trinity Cr. w.	X				X						X		X				X				X						X				X	
		Shuswap R (middle) x.				X		X						X		X				X						X		X						X	
			Bessette Cr. y.		X					X				X		X				X				X						X				X	
			Bigg Cr				X				X				X				X				X				X				X				X
			Creighton Cr.		X			X						X		X				X				X						X				X	
			Duteau Cr.		X					X				X		X				X				X						X				X	
			Falls Cr.				X				X				X				X				X				X				X				X
			Harris Cr.		X			X						X		X				X				X						X				X	
			Blue Springs Cr				X				X				X				X				X				X				X				X
			Ireland Cr.		X			X						X		X				X				X						X				X	
			Vance Cr				X				X				X				X				X				X				X				X
		Tsuius Cr. yy			X				X			X				X				X				X				X						X	
		Noisey Cr. yy			X				X			X				X				X				X				X						X	
		Wap Cr. zz			X			X					X			X				X					X			X						X	
		Sub-population Total		2	14	2	5	9	5	4	5	4	3	10	6	16	1	0	6	15	2	0	6	16	2	1	4	6	3	9	5	0	0	19	4
	Shuswap Lake & Tributaries	Anstey R			X			X				X				X				X				X				X						X	
		Canoe Cr. z.		X						X				X		X						X		X						X				X	
		Celista Cr. aa.		X							X				X				X				X				X				X				X
		Chase Cr.					X				X				X				X				X				X				X				X
		Eagle R			X					X				X		X						X		X				X						X	
			Crazy Cr.				X				X				X				X				X				X				X				X
			Owlhead Cr.	X					X				X			X				X				X				X						X	
			Perry R.			X		X				X				X				X				X				X						X	
			Senn Cr.				X				X				X				X				X				X				X				X
			South Pass C			X		X				X				X					X				X			X						X	
			Unnamed @ CPR Mile 16.22				X				X				X				X				X				X				X				X
			Yard Cr.		X						X				X				X				X				X				X				X

continued…

Appendix 4. Qualitative assessment of historical probable impacts from human activities within the Interior Fraser watershed by stream, sub-population, and population, continued. Assessments were derived by government and non-governmental professional staff who were familiar with the individual streams.

Population	Sub-population	Spawning Stream	Tributary	Forestry				Urbanization				Agriculture				Mining				Linear				Hydro				Water Withdrawal				Cumulative Impacts			
				Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A	Low	Med	High	N/A
	Shuswap Lake & Tributaries	Hunakwa Cr.		X				X				X				X				X				X				X				X			
		Little River					X				X				X				X				X				X				X				X
		Monte Cr.					X				X				X				X				X				X				X				X
		Onyx Cr. bb.				X		X						X		X				X				X						X				X	
		Reinecker Cr					X				X				X				X				X				X				X				X
		Ross Cr. yy		X						X					X				X			X					X				X				X
		Salmon R				X				X				X		X						X		X						X				X	
			Bolean Cr. aaa			X				X				X		X					X			X				X						X	
			Palmer Cr.		X				X				X				X				X						X				X			X	
		Scotch Cr. bbb.				X		X					X				X				X			X				X						X	
		Seymour R				X		X				X				X				X				X				X						X	
			McNomee Cr.		X			X				X				X				X				X				X						X	
		South Thompson R.					X				X				X				X				X				X				X				X
		Syphon Cr					X				X				X				X				X				X				X				X
		Tappen Cr.		X					X				X			X					X						X		X				X		
		White Cr.					X				X				X				X				X				X				X				X
		Wright Cr.		X							X				X				X				X				X				X		X		
		Sub-population Total		**9**	**6**	**8**	**11**	**10**	**4**	**6**	**14**	**8**	**5**	**6**	**15**	**15**	**3**	**1**	**15**	**9**	**6**	**5**	**14**	**14**	**2**	**1**	**17**	**12**	**2**	**4**	**16**	**3**	**3**	**14**	**14**
	Adams Lake Basin	Adams R (lower)				X		X				X				X				X				X				X				X			
			Huihill Cr.			X		X						X		X						X		X					X					X	
			Gold Cr. (Nikwikwaia)			X		X				X				X				X				X				X						X	
		Momich R. cc.				X		X				X				X				X				X				X				X			
			Cayenne Cr. ccc			X		X				X				X				X				X				X				X			
		Sinmax Cr. dd.				X			X					X			X					X		X						X				X	
		Tsikwustum Cr.				X		X				X							X	X							X	X				X			
		Adams R (upper) ee.			X			X				X				X				X				X				X						X	
			Burton Cr.			X		X				X				X				X							X	X					X		
			Gollen Cr.			X		X				X							X	X							X		X				X		
			Harbour Cr. ff.			X		X				X							X	X							X	X					X		
			Dudgeon Cr.			X		X				X							X	X							X	X					X		
			Sunset Cr.			X		X				X							X	X							X	X					X		
			Gold Cr.			X		X				X							X	X							X	X					X		
			Oliver Cr.			X		X				X							X	X							X	X					X		
			Hemlock Cr.			X		X				X							X	X							X	X					X		
			Mica Cr.				X				X				X				X				X								X				X
		Sub-population Total		**0**	**1**	**15**	**1**	**15**	**1**	**0**	**1**	**14**	**0**	**2**	**1**	**7**	**1**	**0**	**9**	**14**	**0**	**2**	**1**	**7**	**0**	**0**	**9**	**13**	**2**	**1**	**1**	**4**	**8**	**4**	**1**
			Grand Total	**86**	**76**	**86**	**36**	**212**	**23**	**16**	**33**	**151**	**39**	**57**	**37**	**181**	**24**	**12**	**67**	**163**	**43**	**45**	**33**	**217**	**10**	**7**	**49**	**159**	**45**	**34**	**46**	**115**	**63**	**71**	**35**

a. Assessments for the Upper Fraser River Tributaries are based on information reviewed by T.Salley, P.Nicklin, and D.Desrochers (D.Desrochers, Fisheries and Oceans Canada, Williams Lake, BC, personal communication). The assessments do not reflect all eraser River Tributaries are base omissions are a variety of recent Forest Renewal BC reports (e.g. Fish and Fish Habitat Inventory and Fish Habitat Asssessment Procedure reports). Assessments are solely reflective of our collective individual efforts and do not necessarily represent the Forest Renewal BC reports (e.g. organizations. Sources utilized in assigning habitat impact assessments were: COSEWIC (2002); Rowland and MacDonald (1996); L.B. MacDonald et al. (1997); Coho Enumerations Project Report: 2001 (Cariboo Tribal Council Traditional Territory); Department ofs utilized in assignin Enumeration Flight Records (2001-2003); Fish Wizard Website (2004); M.Sabur, Hydrologist, Ministy of Water Land and Air Protection, Williams Lake, BC, personal communciation; D.Bings, Environmental Protection, Ministry of Water Land and Air Protection, Wils (2001-2003); Fish Wizar communication; Department of Fisheries and Oceans Staff - Williams Lake, Quesnel, and Prince George (Personal and File Records); and Land and Water British Columbia (2003).

b. Note that good rearing habitat exists in the mainstem Thompson in upper areas, but the distribution of coho in such areas is not well documented (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication). Linear impact assessmearing habitat exists railway line, and gas pipeline running parallel to stream (K. Austin, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

c. Beaver dams upstream of railway tracks and within first 500 m of stream sometimes act as barriers (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication). Road and railway are both causing high impacts (K. Austin, Fisheries atream of railway t Clearwater, BC, personal communication).

d. Agricultural impacts and riparian encroachment, particularly related to cattle grazing, in some areas accessible to coho (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

e. Culverts in various locations could limit coho access - see FIA report by Shawn Clough (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication)

f. There are issues related to agriculture, riparian encroachment, and sedimentation as well as forestry impacts (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

g. There are agricultural impacts and riparian encroachment and sedimentation problems in the area accessible to coho; forestry impacts are likely in the upper watershed (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

h. Agricultural impacts with related riparian encroachment and sedimentation problems in areas accessible to coho; severe riparian encroachment in some areas (e.g. Schedan flats) resulting in excessive erosion; water use by Kamloops Indian Band at Harper lated riparian encroachment and in elevated summer temperatures and low flows; urbanization in accessible areas is also a concern (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

i. Extensive agriculture and cattle damage to riparian area; water withdrawals for crop production; extensive logging in watershed (~40% logged) (D. Coutlee, Nicola Watershed Stewardship Fisheries Authority, Merritt, BC, personal communication) .

j. There are coho access issues during low water years due to low lake level; also there is abundant gravel recruitment due to past placer mining in the lower 2 kms (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

k. Logging activity is mainly in tributaries to the Coldwater River; linear activity includes the abandoned Kettle Valley Railway, the Coquihalla Hwy, two pipelines (Duke, Terasen), and a fibre optic line (D. Coutlee, Nicola Watershed Stewardship Fisheriesributaries to the Coldwater River;

l. Logging mainly in tributaries to the Nicola River, some sediment impacts; high level of urbanization from Merritt to Shackan Indian reserve, medium level from Shackan to the confluence of the Thompson and Nicola rivers; high agricultural impact along vies to the Nicola River, some withdrawals; linear impact on natural drainage patterns from the abandoned Kettle Valley Railroad, the Coquihalla Highway, and numerous side roads (D. Coutlee, Nicola Watershed Stewardship Fisheries Authority, Merritt, BC, personal communication) .

m. Lower reaches are impacted by high water withdrawal resulting in dewatering and high water temperatures (D. Coutlee, Nicola Watershed Stewardship Fisheries Authority, Merritt, BC, personal communication).

n. Highland Valley Copper located in upper watershed; extensive agriculture and ranching in watershed; fully licensed for water withdrawal (D. Coutlee, Nicola Watershed Stewardship Fisheries Authority, Merritt, BC, personal communication) .

o. Past logging occurred in 1950's and 1960's; Upper Nicola Indian Band has recently conducted some logging in the watershed; open-ditch flood irrigation system in use; livestock grazing has increased in recent years; extensive erosion in lower reaches of and 1960's; Upper Nicola Indian Ban common (D. Coutlee, Nicola Watershed Stewardship Fisheries Authority, Merritt, BC, personal communication) .

p. Urbanization has increased with smaller hobby farms; high level of water withdrawal; extensive logging road system with road parallel to Spius Creek (D. Coutlee, Nicola Watershed Stewardship Fisheries Authority, Merritt, BC, personal communication).

q. Past forest fire damaged riparian habitat (D. Coutlee, Nicola Watershed Stewardship Fisheries Authority, Merritt, BC, personal communication) .

cont r. Low water impact as creek is dry most autumns near the mouth; accessible habitat is all cobble (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication). Fish kill in 2003 was likely related to irrigation water withdrawals (R. dry most autumns near the mout

continued…

Appendix 4. Qualitative assessment of historical probable impacts from human activities within the Interior Fraser watershed by stream, sub-population, and population, continued. Assessments were derived by government and non-governmental professional staff who were familiar with the individual streams.

s. Cobble habitat in all coho accessible areas (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

t. Open range for cattle; substantial recreational use (hunting, etc.) in watershed; forestry impacts; riparian impacts from point crossings of power lines (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication). Impacts from Bantial recreational use (hunting

u. Water use is an issue as this is a community watershed for the community of Armstrong (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

v. Substantial residential and agricultural impacts in accessible areas (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication). Rural development on the fan has had significant impacts on the stream; several improperly screenetial and agricultural i unlicenced water users on the stream; also, the Hwy 97 culvert is becoming perched (R. Harding, Fisheries and Oceans Canada, Salmon Arm, BC, personal communication).

w. Agricultural impacts, primarily riparian encroachment along accessible length but also in upstream inaccessible areas; forestry activities in the watershed (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

x. Downstream impacts related to operation of Wilsey dam (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

y. Entire watershed has impacts from water use related to general agricultural activities and related riparian encroachment; agriculture related sedimentation problems; forestry impacts; encroachment from residential areas (particularly in the Lumby area br use related to general agricultural act pollution related to industrial and urban settlements; genetic impacts from hatchery stock supplementation (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

z. Urbanization and agricultural impacts (grazing, riparian encroachment, pollutants); accessible area could be increased with some small remedial works in areas of small log jams (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communicization

aa. Logging impacts in the upper watershed area that is inaccessible to coho; however, there may be downstream effects (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

bb. Low flow conditions often prevent coho access; there may be impacts from upstream water withdrawals (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

cc. Logging activity throughout the watershed (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

dd. Low water annually in the fall. Agricultural impacts including cattle access, encroachment upon riparian areas, erosion, and sedimentation (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication). Abandoned minesite continuhe fall. Agricultural impa the development of the community of Agate Bay (K. Austin, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

ee. Gravel compaction a likely issue in many areas between Tum Tum and Mica Lake; considerable forestry activity in watershed (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication). The only road impacts are forestry related; ction a likely i

ff. Major coho producer for this system; logging within watershed is adjacent to main spawning area (M. Galesloot, Secwepmc Fisheries Commission, Kamloops, BC, personal communication).

gg. Hydro development proposal on file for this stream (K. Austin, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

hh. Low gradient stream sections will likely provide area for urban/rural sprawl of the community of Blue River (K. Austin, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

ii. Impacted by railway, gas line and highway rights of way; railway line has altered flow pattern of creek and likely affects fish access to stream. active and proposed logging in the headwaters and on the floodplain (K. Austin and T. Panko, Fisheries ane and highway rights of way; rail personal communications).

jj. Past railway activities are resulting in present day impacts (K. Austin, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

kk. Weyerhauser has plans for extensive logging throughout this watershed; at present there are forestry road related impacts (K. Austin, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

ll. Plans by Meeker and Weyerhauser are to harvest the accessible upper watershed area in the near future; road crossings and slope stability problems will result; lower portion including the lake is a provincial park (K. Austin, Fisheries and Oceans Canadrhauser are to harvest the a

mm. Railway and highways are producing the major impacts on this stream, mainly related to berms and poor culverts (K. Austin, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

nn. Hydro development proposal on record for this stream; however, recently designated as a protected area (K. Austin, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

oo. All of the valuable fish habitat is under urban pressure; there are high impacts from railway and highway culvert crossings; creek is the water supply for the community of Avola (K. Austin, Fisheries and Oceans Canada, Clearwater, BC, personal communic of the

pp. Slocan has an inactive water licence; recovering from high impacts from mill site, diversion of creek, and industrial activities (K. Austin, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

qq. Linear impact from old logging road (River Road is now a park access road); forestry on upslope plateaus do not have much impact; hydro development proposal in connection with community water supply for community of Clearwater is old and not likely to ng road (River Road is now a par be noted (K. Austin, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

rr. Creek runs in ditch along highway and has been partially diverted by highway (K. Austin, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

ss. Bedload movement makes linear related impacts high; highway culvert gets plugged (K. Austin, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

tt. Most urban impacts are centered on lake habitat and at lake outlet (K. Austin, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

uu. Recent logging on private land and subdivision activites are affecting the stream (K. Austin, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

v v. Recent fire and beetle related timber harvest make foresry a high impact; intensive dairy farm and grazing activities in the lower reaches (K. Austin, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

ww. There is intense cattle grazing on crown land in this watershed (K. Austin, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

xx. Irrigation weir on stream fan is impassable to fish at low flows (R. Harding, Fisheries and Oceans Canada, Salmon Arm, BC, personal communication).

yy. Development on stream fan has had significant impacts on fish habitat (R. Harding, Fisheries and Oceans Canada, Salmon Arm, BC, personal communication)

zz. Private hydro power generation site has impacted channel stability; also impacted by free range cattle (R. Harding, Fisheries and Oceans Canada, Salmon Arm, BC, personal communication).

aaa. Bolean Creek bridge on the Chase Creek road is too low and has caused a major avulsion in the past, and the risk of such an occurrence remains (R. Harding, Fisheries and Oceans Canada, Salmon Arm, BC, personal communication).

bbb. Main road located on stream fan; free range cattle impacts (R. Harding, Fisheries and Oceans Canada, Salmon Arm, BC, personal communication).

ccc. Forestry road related impacts; no other linear development on stream (K. Austin, Fisheries and Oceans Canada, Clearwater, BC, personal communication).

Appendix 5. Chronology of management actions taken by Fisheries and Oceans Canada to conserve interior Fraser River coho salmon.

1. Fraser River Commercial Fisheries

Early 1980's No directed net fisheries for coho since the early 1980's, although coho salmon were harvested incidentally in sockeye, pink, and chum salmon fisheries.

1980's Commercial net fisheries were closed from approximately the first week of September until the end of October to protect steelhead trout, Harrison River chinook salmon, and coho salmon

1997 A minimum mesh size of 158 mm (6 ¼") was instituted in the gill net fishery to minimize coho salmon and reduce steelhead trout by-catches.

1998 Non-retention of coho salmon was implemented. Revival boxes were required. Moving window closures (*i.e.* variable start and end dates of closures in specified sections of the Fraser River mainstem to coincide with the presence of migrating coho) from September through October were implemented to avoid interior Fraser River coho salmon. Daylight gill net fishing only.

1999-2005 Measures implemented in 1998 were maintained with some modification to the timing of the moving window closure as the coho salmon migration period was more precisely defined. In 2005 the window closure below Mission was September 6 to October 7.

2. Fraser River In-River Coho Salmon Recreational Fishery

Early 1980's The bag limit was reduced from four to two coho salmon per day.

1997 Non-retention of coho salmon and a 10-day angling closure (October 21-31) was implemented.

1998 A ban on fishing for salmon when Interior Fraser Coho were migrating in the river was implemented, as was a ban on retention of any coho salmon throughout the year. Barbless hooks became a coast wide requirement.

2001 Retention of two hatchery coho salmon (*i.e.* those without an adipose fin) was allowed following the Interior Fraser Coho migration window closure (*i.e.* the period with no fishing for salmon). Night fishing for salmon was prohibited in the Fraser River from September 1 to December 31. Retention of wild coho salmon continued to be prohibited at all times.

2002-2005 Retention of two hatchery (adipose fin absent) coho salmon per day was allowed from mid-October to December 31. The ban on salmon fishing during the Interior Fraser Coho migration period (September to mid-October) was continued during even numbered years (*i.e.* when pink salmon were not present). In 2003 and 2005, fishing for pink salmon was allowed during the Interior Fraser Coho migration window; however, all fishing with bait was prohibited.

3. Fraser River First Nations Fishery

1989-1990 Fishing times were restricted in October from three to one day/week from Mission to North Bend to reduce steelhead trout catch.

1992 Coho salmon allocations were established for the first time; 6,500 fish for native bands below Sawmill Creek. Allocations were not set for bands above Sawmill Creek. Below Sawmill Creek, the fishery was closed from mid-August to mid-October and opened for restricted times beginning in late October, for one week below the Port Mann Bridge and for three weeks from the Port Mann Bridge to Sawmill Creek.

1993 Coho salmon allocations for bands below Sawmill Creek were 17,000 and approximately 10,000 coho salmon for bands above Sawmill Creek. As in 1992, fishing times were restricted in order to meet allocations.

1994 Coho salmon allocations for bands below Sawmill Creek were 2,500 and 3,800 for bands above Sawmill Creek. The fishery below Sawmill Creek was closed for three weeks in October and opened for restricted periods in late October and early November.

1995 Coho salmon allocations for bands below Sawmill Creek were 2,500 and 3,500 for bands above Sawmill Creek. The fishery below Sawmill Creek was closed for five weeks (six weeks for the Musqueam and Tsawwassen area) from mid/late September to mid/late October, but was opened for restricted periods for three weeks beginning in late October and then closed.

1996 No coho salmon allocation was established for bands below Sawmill Creek. The combined allocation for all bands above Sawmill Creek was 395. The fishery below Sawmill Creek was closed from early September until late October, and opened for restricted periods each week in November. Above Sawmill Creek, the fishery was closed from Sawmill Creek to Deadman Creek after September 28. In addition, a number of Shuswap bands voluntarily agreed to zero coho allocations.

1997-1998 No fishing for salmon when Interior Fraser Coho were migrating through the river was authorized. Voluntary non-retention of all coho salmon was requested. The use of selective fishing techniques was encouraged. Some opportunities for coho salmon harvest were provided in those terminal areas with hatchery surpluses.

1999-2005 First Nations directed fishing for coho salmon has been restricted. Harvest of pink and chum salmon has been authorized, by selective means only (beach seine, etc.), in the Fraser River during the Interior Fraser Coho migration period with the requirement that wild coho salmon are to be released. First Nations fishers are authorized to retain coho mortalities during gill net and set net fisheries after the migration window for Interior Fraser Coho has passed. All live wild coho salmon are to be released unharmed.

4. South Coast Net Fisheries – Johnstone Strait (Area 12/13) & Juan de Fuca Strait (Area 20)

1977 Permanent area closures of Parson Bay, Goletas Channel, and Mainland Inlets (except for pink salmon surplus) in Johnstone Strait (Area 12/13), and gill net mesh size restriction.

1978 Permanent closure of Loughborough Inlet and Phillips Arm.

1979 Reduced fishing season (initial fishery openings delayed until July). Permanent closure of Bute Inlet (except for chum salmon surplus fisheries).

1980 A coast-wide (except Area 20) gear restriction limiting the maximum seine depth to 52m.

1981 Area 12/13 closed to all commercial fishing April 14 – June 17. Permanent closure of Deepwater Bay. Area closure known as the "Ribbon Boundary corridor" from Hanson Island (Area 12) to Discovery Passage (Area 13). Juan de Fuca seine fishery limited to a minimum 100 mm mesh size.

1982 Permanent closures of lower Knights Inlet and Growler Cove. Seine net gear restricted to so-called "fall bunts" implemented earlier in season.

1983 Reduced fishing times (number of days) in Areas 12 and 13 under the "Clockwork Chum Strategy".

1985-1986 Compliance boundary set at the 30 fathom contour in the Area 20 seine fishery. By-catch monitoring program ran from 1986-1990 in Areas 12 and 13.

1987 By-catch monitoring program ran from 1987-1990 in Area 20.

1989 Further reduction in fishing time in Areas 12 and 13.

1994 Reduced fishing times in Area 20. Coho salmon catch ceiling established with a monitoring program. Gear restrictions in Areas 12 and 13. Voluntary non-retention of coho salmon.

1995 Reduced fishing times in Area 20, no gill net fishing. Coho salmon catch ceiling established with a monitoring program. Reduced fishing areas and gear restrictions in Areas 12 and 13. Voluntary non-retention of coho salmon.

1996 Reduced fishing times in Area 20. Reduced fishing areas and gear restrictions in Areas 12 and 13. Voluntary non-retention of coho salmon in the seine fishery.

1997 In-season monitoring and closures in coho salmon sensitive areas. Mandatory non-retention of coho salmon in all seine fisheries. Implementation of coho salmon mortality ceilings for each net fishery. "Yellow Line/Red Line" fishing zone strategy for managing coho salmon mortality rates. Sorting and live release of coho salmon in seine fisheries in Juan de Fuca and Johnstone straits. Voluntary non-retention of coho salmon for gill net fisheries.

1998 No fishing for salmon in red zones (*i.e.* areas where coho salmon were prevalent). Mandatory non-retention of coho salmon in all fisheries. Functioning revival boxes required on all vessels actively fishing. Gill net length and set time shortened in some fisheries to reduce coho salmon encounters and mortalities in yellow zones. Daylight only fisheries implemented. Seine net fishers required to brail and sort catch with coho salmon released back to the water with least possible harm.

1999 Per the pre-season fishing plan, the chum assessment fishery in the third week of September was cancelled to protect returning coho salmon. Non-retention and non-possession of all coho salmon and mandatory revival tanks were license requirements. All coho salmon were to be released to the water with the least possible harm. Specific areas and times where coho salmon were expected to be present were closed.

2000-2001 No fishing for coho salmon and no possession of coho salmon in all Special Management Zones (*i.e.* those areas and times where or when Thompson River coho salmon or other coho salmon populations of concern are prevalent). Fishing for other salmon species within Special Management Zones has been permitted in some areas. Special Management Zones include: West Coast of Vancouver Island (Areas 23 to 27 and 123 to 127) from May 1 to September 30; Johnstone Strait and the mainland inlets (Areas 11-13) from May 1 to September 30; Strait of Georgia (Areas 14-18 and Area 28) May 1 to September 20; Southern Vancouver Island (Areas 19-21 and 121) May 1 to September 30; and vicinity of Fraser River (Area 29) August 1 to October 15. All coho salmon were to be released to the water with the least possible harm. Mandatory brailing and wet sorting of seine catch was required in some areas. Revival tanks were required.

2002-2005 Conservation measures for the protection of Interior Fraser Coho were similar to those implemented in 2001.

5. South Coast Troll

The west coast Vancouver Island (WCVI) troll fishery has undergone major changes to address coho salmon conservation concerns. In summary, the WCVI troll fishery has gone from a 1.75M coho salmon catch in 1985, to 1.3M in 1993, to 1.0M in 1996, to no troll fishery in 1997. Management actions since 1990 include:

1990-1993 The “red line/green line” management strategy was implemented to extend the season and minimize “shaker” mortality. Selected conservation areas were closed. In-season catch monitoring via the hail-in program was started. Non-retention of coho salmon after the catch ceiling was reached was required.

1994 Continued the red line/green line management strategy to extend the season and minimize shaker mortality. Selected conservation areas were closed. Monitored coho salmon catch via the hail-in program. Reduced fishing time. Non-retention of coho salmon after catch ceiling was reached was required.

1995 Selected conservation areas were closed. Time and area closures implemented to reduce exploitation rate. Monitored in-season catches via the hail-in program. Reduced fishing time. Non-retention of coho salmon after catch ceiling was reached was required.

1996 Closure of chinook salmon sensitive areas off WCVI to address conservation concerns for WCVI chinook salmon stocks. This action also minimized access by the fishery to other salmon species including coho salmon. Area closures used to reduce exploitation rate on coho salmon. In-season catch monitoring program via a hail-in program. Managers used data to conduct in-season alterations to time and area openings. Non-retention of coho salmon after catch ceiling reached was required.

1997 No directed commercial fishery for coho salmon in southern B.C. Non-retention and non-possession of coho salmon in the WCVI troll fishery. Closure of coho salmon sensitive areas off WCVI to address conservation concerns for southern BC coho salmon. This action minimized access by the fishery to other salmon species. In-season catch monitoring program along with a hail-in program to record catches. Managers used data to conduct in-season changes to time and area openings to minimize coho salmon by-catch.

1998-1999 No fishing for salmon in red zones. Non-retention of all coho salmon. A functioning revival box was required on all boats actively fishing. All coho salmon were to be released to the water with the least possible harm. Barbless hooks became a requirement.

2000-2001 No fishing for coho salmon and no possession of coho salmon in all Special Management Zones (i.e. those areas and times where or when Thompson River coho or other coho stocks of concern are prevalent). Fishing for other salmon species within Special Management Zones permitted in some areas. Special Management Zones included: West Coast of Vancouver Island (Areas 23 to 27 and 123 to 127) from May 1 to September 30; Johnstone Strait and the mainland inlets (Areas 11-13) from May 1 to September 30; Strait of Georgia (Areas 14-18 and Area 28) May 1 to September 20; Southern Vancouver Island (Areas 19-21 and 121) May 1 to September 30; and vicinity of Fraser River (Area 29) August 1 to October 15. All coho salmon were to be released to the water with the least possible harm. Mandatory brailing and wet sorting of seine catches were required in some areas. Revival tanks were required.

2002-2005 Conservation measures for the protection of Interior Fraser Coho were similar to those implemented in 2001.

6. Recreational Fishery

1995 Reduction of the daily catch and possession limit in Juan de Fuca Strait to two and four coho salmon from four and eight coho salmon.

1997 Effective July 2, reduction of the daily catch and possession limit for coho salmon to two and four fish from four and eight on the west coast of Vancouver Island from Port Renfrew to Cape Scott. Effective July 2, the daily bag and possession limits in the Strait of Georgia remained at the previously reduced levels of two and four coho salmon. Non retention of coho salmon was instituted in the mainstem Fraser River, including the mouth, tidal, and non-tidal waters. Effective July 2, existing area closures in the majority of Vancouver Island, Sunshine Coast, and southern mainland stream areas were re-instituted. In-season area closures were expanded in a number of areas to increase the amount of protected area for coho salmon.

1998 No fishing for coho salmon in red zones. Non-retention of coho salmon in all South Coast fishery areas was required. Barbless hooks required when salmon fishing. The only coho salmon retention fisheries allowed were in terminal areas where hatchery fish (adipose fin absent) were available for harvest.

2000 Some expansion of areas open to selective fishing for hatchery marked fish. Non-retention of wild coho salmon maintained.

2001 Some retention of wild coho salmon was allowed in areas where local populations were in abundance and where Interior Fraser Coho were not present (*i.e.* north end of Johnstone Strait and some WCVI inlets).

2002 Selective hatchery marked coho salmon fishing opportunities were expanded from those provided in 2001. Selective hatchery mark coho salmon fisheries in the recreational fishery were allowed in marine areas targeting on coho salmon which have a hatchery mark (*i.e.* adipose fin absent). These fisheries also occurred in some terminal areas adjacent to hatchery facilities where there was a surplus of coho salmon. These measures were subject to in-season changes if additional conservation concerns developed. Effective August 1 the retention of two hatchery marked coho was permitted in Queen Charlotte Sound and Strait (Area 11 and 12), Johnstone Strait and Strait of Georgia (Areas 23-19, 28 and 29 excluding the tidal waters of the Fraser River, the West Coast Vancouver Island (Areas 23-27 and 123-127), and Juan de Fuca Strait (Area 20). Fraser River tidal and non-tidal waters downstream of Alexandra Bridge (Area 29) daylight only selective hatchery marked coho fishery were permitted during October.

2003-2005 Selective hatchery mark coho fisheries became more prevalent. They expanded to include most of DFO's South Coast recreational fishing areas. In 2005 retention of marked coho was allowed in some commercial South Coast fisheries (*e.g.* WCVI chinook fisheries after mid-Sept).