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Science — Sciences

Pacific Region

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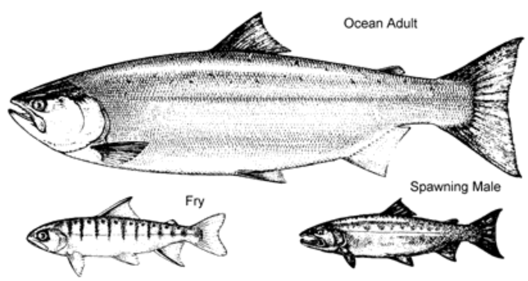
RECOVERY POTENTIAL ASSESSMENT FOR INTERIOR FRASER COHO SALMON (*Oncorhynchus kisutch*)



Major life history stages of coho salmon (not to scale)

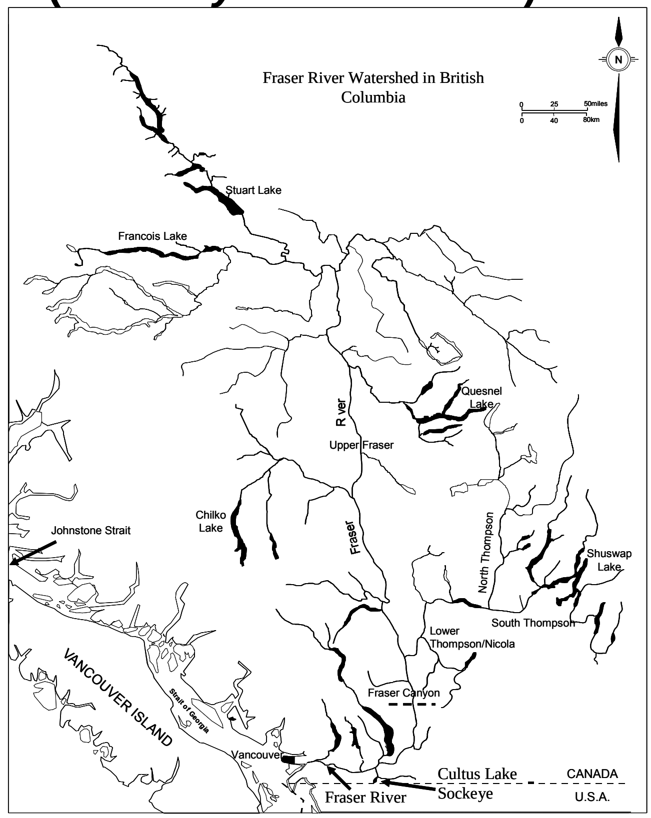


Figure 1: The Fraser River watershed - Interior Fraser coho spawn upstream of Fraser Canyon..

Context

In 2002, Interior Fraser River coho salmon (IFC) were recognized as a 'species' under the Species At Risk Act (SARA) and designated as endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). A final decision on whether this species will be legally listed under SARA is pending. When a species under the jurisdiction of Fisheries & Oceans Canada (DFO) becomes listed with SARA, DFO is responsible for initiating a chain of events that must take place in order to protect the species. Included in DFO's responsibilities is a request from Fisheries Management Branch to Science Branch for the preparation of an Allowable Harm Assessment (AHA). An AHA is intended to help define the current status of the species, targets and time frame for recovery, and the uncertainty of outcome associated with management actions during the two year permitting period and beyond.

SUMMARY

- Interior Fraser River coho salmon were designated as endangered by COSEWIC in 2002.
- Since the COSEWIC assessment, numbers of coho returning to the Interior Fraser have generally improved with individual populations increasing by 8% (North Thompson) and

Canada

132% (South Thompson). (Note, the most recent escapement data available for this report were for 2004).

- Recent escapements have exceeded the immediate recovery objective established by the Interior Fraser Coho Recovery Team. However the recent average remains half of the mean escapement previous to 1991.
- We cannot accurately forecast future marine survival. However, we can indicate the likely future status given differing levels of future survival. Simulation modelling suggests that, at the current exploitation rate and recent survival, the short term (2 year) probability of remaining above the survival benchmark is ~90%, however the probability of remaining above that level in the longer term (3 generations) is ~50%. At the current exploitation rate and marine survival, the longer term probability of positive growth is <50%.
- Considering the uncertain nature of marine survival forecasting, it would be prudent to wait several more years before providing specific advice with regards to changing fisheries.

INTRODUCTION

In 2002, Interior Fraser River coho salmon (IFC) were recognized as a ‘species’ under the Species At Risk Act (SARA) and designated as endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). When IFC were assessed by COSEWIC, the rate of decline during the 3 most recent generations was ~60%, and therefore within IUCN’s endangered status criteria range. There are now four additional years of data during which exploitations remained relatively low and escapements generally increased. The recent three generations experienced increases ranging between 8% (North Thompson) and 132% (South Thompson). An immediate recovery goal for the Designated Unit (DU) was defined by the Interior Fraser Coho Recovery Team as exceeding a lower benchmark (three year geometric mean) of 20,000-25,000 wild spawners. Although escapements remain low relative to historical highs, recent escapements for the DU exceed this benchmark. The current exploitation rate (ER) is estimated at ~13% (3% domestic, 10% U.S.).

Species Biology

Most IFC salmon spend their first year in freshwater, live and grow in the coastal marine environment for approximately one and a half years, and then return to their watersheds to spawn and die at 3 years of age. The distribution of spawning habitat is usually clumped within watersheds, often at the heads of riffles in small streams, in side-channels, and the main channels of large rivers. Fry emergence corresponds with periods of high discharge, and fry often colonise flooded habitats created by spring freshets. Juvenile densities are generally higher in pools than riffles, most frequently in streams with gradients less than 3%. Most juvenile coho migrate down the Fraser River in spring as one year old smolts.

Studies of the genetic structure of IFC indicate that there are five populations (Figure 1); three within the Thompson (North Thompson, South Thompson, and Lower Thompson/Nicola 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). Moreover, due to the vast areas of the Fraser River basin, additional demographically independent groups (sub-populations) also exist. IFC are genetically distinct from all other coho including those found in the lower Fraser.

ASSESSMENT

Current Species Status & Trajectory

Since only discontinuous estimates of marine survival are available for IFC, data from Georgia Strait wild stocks are used to assess trends in marine survival. Survivals have improved since lows in the mid-1990's, but remain low (4-6%) compared to the 1980's (>12%). Exploitation rates from the 1980's to the mid 1990's ranged between 45 and 85%. Since 1997, the Canadian exploitation rate has been reduced to around 3%, while the U.S. fishery exploitation rate is ~10% (totalling ~13%).

Rates of increase for wild spawners were updated given additional years of escapement since the COSEWIC report was released in 2002. The most recent 3 generation time series begins in 1994, near the historical low escapement in 1996. Recent improvements in escapement indicate mean rates of increase for North and South Thompson populations averaging 70% (COSEWIC method).

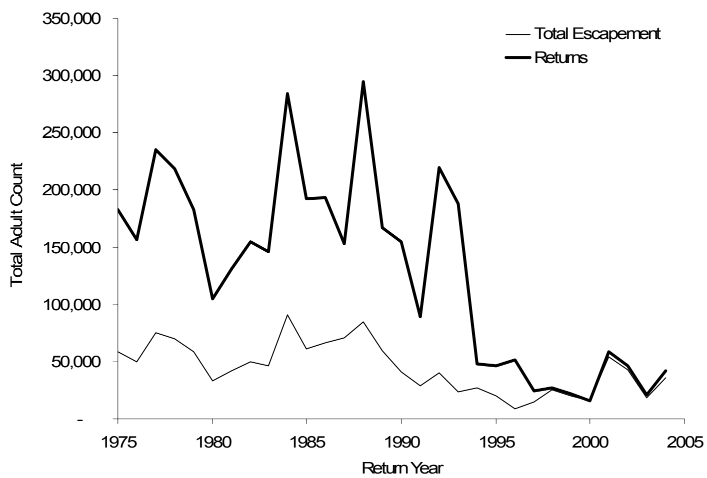


Figure 2: Estimated total returns (catch plus escapement) and escapement of Interior Fraser coho.

Recovery Targets

Information sources

This document relies on field derived estimates of spawner escapements for the whole IFC Designated Unit (DU). Most escapement data were collected by visual surveys of coho salmon on the spawning grounds although there is some 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) were re-assessed using these recent data, thereby allowing DFO to fill in missing data and adjust older, less reliable data. Prior to 1998, reliable continuous series exist for only the North and South Thompson. Historical escapement estimates to other systems were extrapolated from the North and South Thompson using 1998-2003 proportions (Irvine, 2002; IFCRT, 2006).

Total abundance (i.e. catch plus escapement) was calculated from escapement and exploitation rate estimates. Methods to compute exploitation have varied during the time series. Early estimates were based on catches and escapements of coded-wire tagged coho. A DNA based approach was used during 1998-2000 when coded-wire tag data were inadequate. Specifically, stock identification estimates by catch area was applied to estimates of coho encounters. Since 2001, IFC exploitation rates have been estimated by the Coho Technical Committee of the Pacific Salmon Commission through methods using historical estimates of CWT recoveries and effort (Simpson, 2004).

Characteristics of recovery

As stated in the draft Recovery Strategy, the recovery goal is to secure the long term viability of naturally spawning coho salmon within the interior Fraser River watershed. In order to meet this goal, the Recovery Team identified two short-term objectives; a specific escapement target (see below), and a more general objective designed to ensure that threats to recovery were addressed. The escapement objective was regarded to be the minimum level required to maintain the genetic integrity of the eleven subpopulations, and was not intended to represent a long term target for wild escapement. Possible longer term objectives were identified but their prioritization was considered beyond the scope of the Recovery Team as this would require socio-economic analysis.

Model Assumptions

All escapement benchmarks rely on historical estimates of spawner abundance. Spawner estimates for the Fraser canyon, upper Fraser, and lower Thompson populations were derived from indices of the North and South Thompson. Thus, we must assume that historical escapement trends were similar across the five populations.

While estimates of marine survival for IFC hatchery stocks are available, they are limited to the North and South Thompson, and are not consistently available for a sufficient number of years to be a reliable time series. Therefore, annual average marine survival rates for two Strait of Georgia wild indicator stocks were used as a survival index for IFC. The spawner to smolt recruitment relationship has been represented by three recruitment models: hockey stick, Beverton-Holt, or Ricker. We make no presumption about which model is likely to better represent the recruitment dynamics of these stocks. In relying on the time series of spawner escapement, we assume that habitat capacity has not degraded such that historical estimates are no longer applicable.

Advised target(s)

An immediate, short term, recovery benchmark for IFC was defined by the Interior Fraser Coho Recovery Team as a three year geometric mean ≥20,000-25,000 wild spawners. Although escapements remain low relative to historical highs, the three year running geometric mean escapement (2001-2003: 34,000 spawners & 2002-2004: ~30,400 spawners) for the DU is above upper range of the 25,000 spawners benchmark.

IFCRT (2006) provide six examples of possible long term goals: 1) achieve three year average escapements exceeding 1,000 naturally spawning coho salmon in all sub-populations (excluding hatchery fish spawning in natural habitats); 2) recover each of the five populations to the maximum sustainable yield (MSY) abundance level; 3) recover each of the five populations to their maximum historic abundance levels; 4) recover to a level where the freshwater productive capacity within each of the five populations is optimized (e.g. maximum capacity as smolts/km); 5) increase adult returns so that sufficient marine origin nutrients enter each population to optimize ecosystem function; and 6) 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. Table 1 summarizes some of these possible escapement benchmarks.

Table 1: Various possible escapement benchmarks for IFC

Escapement Objective Approach	*Target Spawners*
Minimum tolerable (demographic & genetic)	20,000-25,000
1000 spawners in all 11 subpopulations	30,000-50,000
Maximum historical escapement	91,000
Smolt capacity from hockey stick spawner-recruit	46,000
Smolt capacity from Ricker spawner-recruit	77,000
Smolt capacity from Beverton-Holt spawner-recruit	80,000
S_{msy} from females/km	116,000
50% of maximum return	147,500

Source of uncertainties

Escapement estimates rarely have complete geographic or temporal coverage. While efforts are made to address the incomplete survey process, there is always a possibility that estimates will be biased. Methods of estimation (visual counts, mark-recovery, fence counts) have varying error which is not accounted for in the data series. Thus target spawner benchmarks, based on historical escapement data, do have a broad, un-assessed error. This uncertainty becomes apparent when comparing spawner benchmarks depending on ‘approach’ (Table 1).

Recovery Potential

Assumptions about population growth potential

Assumptions discussed in the “Recovery Targets” section also pertain to the analysis of *recovery potential*. Models representing the stock to smolt recruitment dynamics were limited to the Ricker and Beverton-Holt. The Ricker model is more conservative as compensation effects are greater as escapement exceeds 80,000 spawners. It is assumed future marine survival variability will be similar to that seen in the recent past. It is important to note that the recovery of IFC beyond current levels of escapement is extremely sensitive to marine survival.

Since juvenile IFC spend a full year in freshwater, and adults may spend weeks or months in freshwater prior to spawning, the recovery potential of IFC is also related to freshwater habitat conditions. Bradford and Irvine (2000) showed that rates of decline for IFC were correlated with agricultural land use, road density, and a qualitative index of stream habitat status. Productive freshwater spawning and rearing habitats can help sustain salmon populations during periods of adverse marine conditions or high fishery exploitation rates. This assessment does not estimate habitat requirements or assess impacts of habitat change on recovery potential.

Analytical methods

Future harvest impacts on escapement were assessed in a dynamic model for both a two year (Table 2a) and three generation (nine years, Table 2b) time frame. Results from the model indicate the probabilities of IFC escapement falling below a minimum survival threshold, as well as the probable level of escapement at the end of each time frame. The latter is an indication of recovery probability.

Evaluation of possible recovery trajectories

The recent (2002-2004) generational average escapement is 30,400 coho. At current exploitations (13%) and marine survival there is less than 25% chance that spawner levels will double (i.e. R≥2) by the end of three generations (Table 2B). The realized recovery rate however will be highly dependent on future marine survivals.

Impacts of harvest on recovery

Under current exploitation rates (~13%), the immediate probability of survival (remaining above 23,000 wild spawners) is approximately 90% assuming recent marine survival does not change (Table 2A). The short term probability of survival drops to 86% at 20% ER. In a longer term scenario, there is a 51% probability of remaining above 23,000 spawners at current exploitations and survivals (Table 2B). This drops to 46% if ER is increased to 20%. In the longer term, given the present inter-annual variations in escapement, current exploitations (i.e. 13%) could result in one of every two years having a generational average escapement below the desired benchmark needed to maintain genetic diversity in the DU.

The longer term probability of having escapements increase is ~46% assuming no change in exploitation and survival. This drops to 40% if exploitations increase to 20%. Thus, at current exploitation rates, there is a near equal chance that the population could increase or not increase.

Table 2: Effect of exploitation rate on probability of survival and recovery. The shaded rows indicate the present fishery breakpoints by exploitation rate (see footnotes).

A. Short term (2-year) projection

Exploitation Rate (ER)	*Probability of survival (remaining above 23,000 spawners)*	*Absolute change in the probability of survival from status quo ER (13%)*	*Probability of recovery (growth beyond recent 3-year mean escapement) based on the ratio R of terminal series:initial escapement*				
			R≤0.5	*0.5< R ≤1.0*	*1.0< R ≤1.5*	*1.5< R ≤2.0*	*R >2.0*
0%	95%	4.8%	0.00%	24%	57%	16%	2%
10%[a]	92%	1.5%	0.02%	33%	54%	11%	1%
11%[b]	91%	0.9%	0.01%	34%	54%	10%	1%
12%	90%	0.2%	0.00%	35%	54%	10%	1%
13%[c]	90%	0.0%	0.01%	36%	53%	10%	1%
14%	90%	-0.2%	0.02%	38%	52%	10%	1%
15%	89%	-1.1%	0.01%	39%	51%	9%	1%
25%[d]	82%	-8.5%	0.04%	52%	43%	5%	0%

B. Long-term (3-generation) projection

Exploitation Rate (ER)	*Probability of survival (remaining above 23,000 spawners)*	*Absolute change in the probability of survival from recent ER (13%)*	*Probability of recovery (growth beyond recent 3-year mean escapement) based on the ratio R of terminal series: initial escapement*				
			R≤0.5	*0.5< R ≤1.0*	*1.0< R ≤1.5*	*1.5< R ≤2.0*	*R >2.0*
0%	58%	8%	2%	45%	13%	10%	30%
10%[a]	52%	2%	3%	51%	12%	10%	25%
11%[b]	52%	1%	3%	51%	13%	10%	24%
12%	51%	0%	3%	52%	12%	10%	24%
13%[c]	51%	0%	2%	52%	12%	10%	23%
14%	50%	-1%	2%	53%	12%	10%	22%
15%[c]	49%	-1%	3%	53%	12%	10%	22%
25%[d]	41%	-9%	3%	61%	11%	8%	18%

a: US fishing only
b: no Canadian sport
c: status quo
d: next step in PST Annex Agreement

Uncertainties

As mentioned previously, survival and recovery probabilities hinge on assumptions of marine survival levels during the next 9 years. We have no capacity to accurately predict what future survival will be and must assume that it will show a similar variability to historical levels. We rely on the historical series of escapement to generate capacity estimates, and have not considered future habitat degradation or improvements that could occur.

Allowable Harm / Provision of Recovery Plan

Identification of mortality sources and quantification of each mortality sources

Following is a summary of the potential impact and an estimate of the level of impact.

Name of Impact	Description	Level
Directed fishing	- fishing by First Nations in selected terminal systems	~0.3%
By-catch mortality	- fishing by First Nations, recreational and commercial fisheries in approach areas	3.0%
Detrimental impact of permitted habitat activities	- forestry, agriculture, water withdrawal, hydroelectric, linear development, urban growth, mining etc.	Generally moderate but difficult to quantify and assessments are limited (see Bradford and Irvine, 2000; IFCRT 2006).
Scientific Research	- test fishing	0.5%
International	- by catch in US fisheries	10.0%

Alternatives to Activities causing harm

It was determined there were no reasonable alternatives for each of the impacts listed above.

Feasible Mitigation Measures

Measures to reduce bycatch mortality in Canadian waters would probably have little benefit since bycatch appears to be low. Nevertheless, the stock composition of coho caught as bycatch in non-coho fisheries, and of coho caught in fisheries targeting non-interior Fraser coho, including those in Washington State, should be monitored.

A detailed evaluation of critical habitat and human impacts on habitat is required. Measures to minimize habitat impacts could conceivably include the cessation of issuing permits in areas that could impact on coho spawning and rearing habitat. While the complete cessation of habitat alteration activities would not be feasible or probably desirable, there are opportunities to identify viable habitat protection and watershed restoration activities. In addition, cooperative proactive actions with the Province of B.C. should be taken to develop effective provincial protection standards regarding forestry, water management, and riparian protection.

It is felt that the impacts from Scientific Research activities have already been minimized and there are no further steps that can be taken.

No feasible measures to reduce the impact of International fisheries on IFC were considered.

CONCLUSIONS AND ADVICE

The recovery of IFC to historical levels is highly sensitive to marine survival. The impact of varying exploitation from 13% (status quo) to 0% has little impact on recovery potential in the next three generations given the assumption that the recent low survival rates will prevail. Escapement to the interior Fraser has recently exceeded the immediate level required to assure that genetic integrity is maintained. If recent survivals and exploitations continue, there is a 50% chance that escapement will drop below the 23,000 fish benchmark. The longer-term probability of remaining above the immediate goal is relatively low (i.e. ~50%), and increasing exploitations will reduce these probabilities further. Considering the uncertain nature of marine survival forecasting, several more years of returns are needed before being able to state whether increased mortalities resulting from changing fisheries or habitat alterations would jeopardize the survival or recovery of IFC.

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