Monterey Bay Aquarium Seafood Watch®

Chinook and Coho Salmon

Oncorhynchus tshawytscha, Oncorhynchus kisutch

British Columbia: South, North, Central Coast and Vancouver Island: West Coast

Unassociated purse seine, Drift gillnets (driftnets), Troll/Pole

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Randy Ericksen, Jocelyn Drugan, Greg Ruggerone - Consulting Researchers

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About Seafood Watch

Monterey Bay Aquarium's Seafood Watch® program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch® defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. Seafood Watch® makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from www.seafoodwatch.org. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Report. Each report synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's conservation ethic to arrive at a recommendation of "Best Choices," "Good Alternatives" or "Avoid." The detailed evaluation methodology is available upon request. In producing the Seafood Reports, Seafood Watch® seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch® Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch®'s sustainability recommendations and the underlying Seafood Reports will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Reports in any way they find useful. For more information about Seafood Watch® and Seafood Reports, please contact the Seafood Watch® program at Monterey Bay Aquarium by calling 1-877-229-9990.

Guiding Principles

Seafood Watch defines sustainable seafood as originating from sources, whether fished[1] or farmed, that can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems.

Based on this principle, Seafood Watch had developed four sustainability **criteria** for evaluating wildcatch fisheries for consumers and businesses. These criteria are:

- How does fishing affect the species under assessment?
- How does the fishing affect other, target and non-target species?
- How effective is the fishery's management?
- How does the fishing affect habitats and the stability of the ecosystem?

Each criterion includes:

- Factors to evaluate and score
- Guidelines for integrating these factors to produce a numerical score and **rating**

Once a rating has been assigned to each criterion, we develop an overall recommendation. Criteria ratings and the overall recommendation are color-coded to correspond to the categories on the Seafood Watch pocket guide and online guide:

Best Choice/Green: Are well managed and caught in ways that cause little harm to habitats or other wildlife.

Good Alternative/Yellow: Buy, but be aware there are concerns with how they're caught.

Avoid/Red Take a pass on these for now. These items are overfished or caught in ways that harm other marine life or the environment.

[1] "Fish" is used throughout this document to refer to finfish, shellfish and other invertebrates

Summary

This report evaluates management of commercial salmon fisheries that harvest wild Chinook and coho salmon in British Columbia (BC). Overall, the report rated 10 fisheries as "Good Alternatives" and suggested that products from 4 fisheries be avoided. Fisheries receiving the "Good Alternative" recommendation include those in the U.S.-Canada transboundary rivers and along the north and central BC coast. Fisheries receiving the "Avoid" recommendation include southern BC Chinook and coho fisheries. Most fisheries receiving the "Avoid" recommendation have very small catches of coho and Chinook salmon that are often taken incidentally in fisheries targeting other salmonids.

Progress in fisheries management has occurred in recent years, largely in response to the development of the Wild Salmon Policy and other efforts to address conservation concerns. The status of many coho and Chinook populations has been very low for the past decade or more, especially in southern British Columbia and along the west coast of Vancouver Island. In response to the declining abundances of coho and Chinook, management has taken actions to reduce fishing impacts, including time and area closures and the use of selective fishery techniques. Some fisheries are allowed in terminal areas when the numbers of fish exceed spawning targets. Management decisions for coho and Chinook salmon are typically based on analyses of exploitation rates and, to a lesser extent, spawning escapement goals.

A number of weak salmon stocks constrain the level of fishing effort for coho and Chinook salmon. Weak stocks include those considered to be "Threatened" or "Endangered" by COSEWIC (Interior Fraser River coho, Okanogan Chinook, Cultus Lake sockeye, and Sakinaw sockeye) as well as several ESA-listed stocks of Chinook salmon bound for Puget Sound and other areas south of BC. There are also a number of stocks of concern, including Stikine Chinook, WCVI Chinook, Fraser River early Chinook, and Skeena-Nass chum. To minimize incidental harvest of these weak stocks, there are regulations for catch and live-release using revival boxes. Catch and release mortality estimates are incorporated into management decisions. There is a small chance for nearly any of these weak stocks to be taken in commercial fisheries, but fishing mortality on weak stocks in the commercial fisheries directed at coho and Chinook salmon was typically of low concern (Criterion 2).

There is some monitoring of coho and Chinook spawning escapements in British Columbia, but effort is not comprehensive and has declined in recent years, resulting in greater uncertainty about the status of populations. Hatchery production of coho and Chinook is low in northern BC and greater in southern BC. Hatchery fish contribute to counts of adult salmon on spawning grounds, further confounding evaluation of stock status, especially in southern BC. Hatcheries typically use natural-origin broodstock and encourage hatchery fish to spawn in streams as a means to rebuild depleted stocks. But a complete rebuilding plan will also require improving survival in freshwater and marine habitats.

Management effectiveness (Criterion 3) typically was scored as moderately effective. Management of these fisheries is complicated by the presence of weak stocks, a broad mixture of natural populations and hatchery stocks, gauntlet fisheries, multiple user groups (sport, commercial, First Nations), and hatchery fish entering the spawning grounds. Nevertheless, most fisheries are managed with a reasonable strategy, recovery objectives, scientific advice, research, and track record. Inclusion of stakeholders in a transparent process was considered highly effective. Following of scientific advice regarding bycatch was scored as highly effective when actions were taken to avoid catching weak stocks. Research has led to catch and release survival estimates that are incorporated into management.

Impacts on Habitat and Ecosystem (Criterion 4) received a very low concern with regard to impacts of the fishery on the substrate because salmon fishing gear usually has little contact with the bottom. But ecosystem-based fisheries management was scored as a moderate concern because spawning targets did not clearly address ecosystem needs, such as providing adequate prey for bears, and in some areas many hatchery fish are allowed to spawn in the rivers, leading to potential genetic and ecological impacts on wild populations.

Context of Salmonid Assessments

Salmon and steelhead are anadromous fish, meaning that they spawn in freshwater, where juveniles hatch from eggs and spend some time in freshwater habitats (this period varies among species, life history types, and populations) before migrating to sea for a period of continued growth and maturation. When mature, salmon return to their natal freshwater habitats to spawn. Salmon are the most abundant anadromous species on the West Coast of North America and are targeted by a number of socially, culturally, and economically important fisheries; however, their complex life history also means that they are subject to many other challenges and threats. Many salmonid populations are depressed, with some considered "Threatened" or "Endangered" under the U.S. Endangered Species Act (ESA) and by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The causes of these declines and continued threats to longevity are wide ranging and numerous, including the obstruction of natural migration routes by dams, deforestation, water extraction, pollution, urbanization, climate change, fisheries, salmon hatcheries, and aquaculture operations. Seafood Watch has assessed salmon fisheries in the context of these wide ranging impacts, some of which are beyond the control of fishery management agencies. As a result, the listing of a stock as endangered and the capture of such stocks do not automatically result in an "Avoid" recommendation; nor do other threats result in a "free ride" for fisheries and fisheries managers. Seafood Watch believes that where there are interactions with depleted or listed stocks, managers and fishers should implement measures to reduce these interactions to the extent possible to allow rebuilding to occur, and they should work with other stakeholders and agencies to find solutions to the other threats to salmonid populations along the West Coast of North America.

Because of the unique nature of salmonid population dynamics and the variety of salmonid populations encountered by an individual fishery (an individual salmon fishery may interact with more than 20 salmon stocks), Seafood Watch has modified the approach to assessing salmonid fisheries. Rather than provide a recommendation for each stock caught by the fishery (as we would for a cod or tuna fishery, for example), we have provided a recommendation for each fishery, defined as a species caught by a particular gear in a specific region; for example, Chinook salmon caught by drift gillnet in Puget Sound.

For each fishery, the abundance of the stocks caught and the impact of the fishery are assessed collectively. Stocks that constitute 5% or more of the landings from a fishery are considered "major" components of that fishery and are assessed in Criterion 1. Stocks accounting for less than 5% of a fishery's landings are considered "minor" components of that fishery and assessed in Criterion 2. This distinction is made to account for minor stocks of the target species that the fishery may be trying to avoid because of low abundance, and to recognize management efforts to minimize the impact of the fishery.

When assessing the abundance of salmon stocks, we consider the abundance of wild salmon. A wild salmon is defined as "a salmon which was spawned in the natural environment," as opposed to a hatchery salmon that was spawned in an artificial environment. We consider the abundance of wild salmon to be unknown if there is no distinction between wild salmon and hatchery salmon in abundance estimates, unless it is unlikely that hatchery-origin fish are present. We recognize that some hatcheries exist in order to help conserve salmon populations, so the aim is for hatchery salmon to reach natural areas and spawn; however, we believe that in order to effectively manage these programs, the contribution of hatchery salmon to natural spawning should be quantified and the hatcheries should be operating using guidelines described by the Hatchery Scientific Reform Group (HSRG) (http://www.hatcheryreform.us/).

Understanding the recommendation

Because of the complexity of salmonid fisheries, often the same gear type is used to target different species at different times of the year with different bycatch profiles. Thus, we have added a species component to the gear type. The result is a recommendation that looks slightly different to the typical Seafood Watch recommendation, so following is an example to clarify the different terms used.

Chinook Salmon
North Pacific: Horse Mt. to U.S./Mexico Border - Trolling Lines

In the recommendation above, "Chinook salmon" refers to the species for which the recommendation pertains. "Horse Mt. to U.S./Mexico Border" refers to the geographical region for the recommendation. "North Pacific" is the body of water, and "Trolling Lines–Chinook" identifies the gear type used and the species being targeted. It is important to realize that the species for which we are seeking a recommendation may not be the target species in all cases.

Final Seafood Recommendations

SPECIES/FISHERY	CRITERION 1: IMPACTS ON THE SPECIES	CRITERION 2: IMPACTS ON OTHER SPECIES	CRITERION 3: MANAGEMENT EFFECTIVENESS	CRITERION 4: HABITAT AND ECOSYSTEM	OVERALL RECOMMENDATION
Chinook salmon Canada South Coast BC, Unassociated purse seine	Red (2.159)	Red (1.916)	Yellow (3.000)	Green (3.571)	**Avoid (2.580)**
Chinook salmon Canada South Coast BC, Drift gillnets (driftnets)	Red (2.159)	Red (1.526)	Yellow (3.000)	Green (3.571)	**Avoid (2.437)**
Coho salmon Canada South Coast BC, Unassociated purse seine	Red (2.159)	Red (1.916)	Yellow (3.000)	Green (3.571)	**Avoid (2.580)**
Coho salmon Canada South Coast BC, Drift gillnets (driftnets)	Red (2.159)	Red (1.526)	Yellow (3.000)	Green (3.571)	**Avoid (2.437)**
Chinook salmon Canada North Coast BC, Drift gillnets (driftnets)	Green (3.318)	Yellow (2.709)	Yellow (3.000)	Green (3.571)	**Good Alternative (3.132)**
Coho salmon Canada North Coast BC, Unassociated purse seine	Green (3.318)	Yellow (2.709)	Yellow (3.000)	Green (3.571)	**Good Alternative (3.132)**
Chinook salmon Canada Central Coast BC, Drift gillnets (driftnets)	Green (3.318)	Yellow (2.709)	Yellow (3.000)	Green (3.571)	**Good Alternative (3.132)**
Coho salmon Canada Central Coast BC, Drift gillnets (driftnets)	Green (3.318)	Yellow (2.709)	Yellow (3.000)	Green (3.571)	**Good Alternative (3.132)**

Chinook salmon Canada West Coast Vancouver Island, Troll/Pole	Yellow (2.644)	Red (1.000)	Yellow (3.000)	Green (3.873)	**Good Alternative (2.354)**
Coho salmon Canada West Coast Vancouver Island, Troll/Pole	Yellow (2.709)	Red (1.000)	Yellow (3.000)	Green (3.873)	**Good Alternative (2.368)**
Chinook salmon Canada North Coast BC, Troll/Pole	Yellow (2.644)	Red (1.916)	Yellow (3.000)	Green (3.873)	**Good Alternative (2.769)**
Coho salmon Canada North Coast BC, Troll/Pole	Green (3.318)	Red (1.916)	Yellow (3.000)	Green (3.873)	**Good Alternative (2.931)**
Chinook Salmon: Transboundary Canada, Drift gillnets (driftnets)	Green (4.284)	Red (2.159)	Green (3.464)	Green (4.123)	**Good Alternative (3.390)**
Coho Salmon: Transboundary Canada, Drift gillnets (driftnets)	Yellow (2.644)	Red (2.159)	Green (3.464)	Green (4.123)	**Good Alternative (3.004)**

Summary

This report evaluates management of commercial salmon fisheries that harvest wild Chinook and coho salmon in British Columbia. Overall, ten fisheries were recommended as a good alternative, and the recommendation was to avoid products stemming from four fisheries. Fisheries receiving the Good Alternative recommendation include the North and Central cost fisheries, transboundary rivers and West Coast Vancouver Island fisheries for Chinook and coho. Fisheries receiving the recommendation to avoid include those in southern British Columbia for Chinook and coho. Most fisheries receiving the avoid recommendation have very small catches of coho and Chinook salmon; catch is often incidental to fisheries for other salmonids.

Scoring Guide

Scores range from zero to five where zero indicates very poor performance and five indicates the fishing operations have no significant impact.

Final Score = geometric mean of the four Scores (Criterion 1, Criterion 2, Criterion 3, Criterion 4).

- **Best Choice/Green** = Final Score >3.2, and no Red Criteria, and no Critical scores
- **Good Alternative/Yellow** = Final score >2.2-3.2, and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern2, and no more than one Red Criterion, and no Critical scores
- **Avoid/Red** = Final Score ≤2.2, or either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern or two or more Red Criteria, or one or more Critical scores.

[2] Because effective management is an essential component of sustainable fisheries, Seafood Watch issues an Avoid recommendation for any fishery scored as a Very High Concern for either factor under Management (Criterion 3).

Introduction

Scope of the analysis and ensuing recommendation

The overall objective of this analysis is to assess British Columbia wild salmon fisheries in the Northeast Pacific, particularly those that have not been certified as sustainable to the Marine Stewardship Council (MSC) standard. This report includes British Columbia fisheries for Chinook *(Oncorhynchus tshawytscha)* and coho salmon *(O. kisutch)*. Most British Columbia fisheries for chum, sockeye, and pink salmon have been certified to the MSC standard.

Species Overview

Chinook salmon

Chinook salmon is the largest of the Pacific salmon species. As with all Pacific salmon, it is anadromous, spawning in freshwater but spending the majority of its life in the ocean. In North America, Chinook salmon spawns in freshwater rivers draining into the Pacific Ocean, from San Francisco Bay to western Alaska. It also spawns in Russian rivers from Chukotka to Kamchatka but is less abundant there than in North America (Augerot 2005). Chinook salmon is classified into two distinct races, depending on the juvenile life history strategy: “stream-type” Chinook resides in freshwater for a year or more before migrating to the ocean; "ocean-type" typically migrates to the ocean within a few months after emergence.

Coho salmon

Coho salmon is an anadromous species of Pacific salmon that occurs at relatively low abundances in small populations (Sandercock 1991). In North America, it spawns in rivers from central California to Alaska, with higher concentrations of fish occurring from central Oregon to southeast Alaska. In Asia, it occurs mostly in Russia from the Anadyr River basin to Sakhalin (Augerot 2005). It has also been introduced to all the Great Lakes and many landlocked reservoirs for recreational fishing. Juvenile coho typically rear in freshwater for 1-2 years and utilize a range of freshwater habitats (Sandercock 1991). Nearly all coho return to spawn after 12-18 months at sea.

Chum salmon

Chum salmon is the most widely distributed of the Pacific salmon species (Augerot 2005). It spawns as far north as the McKenzie River on the Arctic coast of Canada and historically as far south as Monterey, California, but it currently occurs only as far south as Tillamook Bay on the northern Oregon coast. In Asia, it is found in Korea, Japan, and the far north of Russia. Chum salmon does not rear in freshwater for extended periods, and typically migrates to estuarine or marine waters shortly after emerging from gravel. It is one of the larger Pacific salmon species.

Sockeye salmon

Sockeye salmon is a smaller species of Pacific salmon that typically rears in lakes for 1-3 years during the juvenile stage. Sockeye shows a high diversity of life history strategies, with fish spawning in streams, rivers, and on lake shores (Burgner 1991). Most sockeye are anadromous, but there is a non-anadromous form known as kokanee that spends its whole life in freshwater. In North America, anadromous sockeye spawns from the Columbia River to Point Hope in northwestern Alaska. In Russia, it occurs from the Anadyr River area of Siberia to the Kuril Islands. Sockeye have also been transplanted from the Kuril Islands to Hokkaido and Honshu, Japan, but most of these are landlocked kokanee (Augerot 2005).

Pink salmon

Pink salmon is an anadromous species of Pacific salmon that is notable for its abundance and fixed age at maturity. Pink salmon is broadly distributed across the North Pacific: its current spawning grounds range from Sakhalin and Kamchatka in Russia to Oregon in the United States (Augerot 2005). It is the most abundant of the Pacific salmon *(Oncorhynchus spp.)*, especially at higher latitudes. Pink salmon has a fixed 2-year lifespan, which results in minimal interbreeding between populations that spawn in odd and even years (Heard 1991). As a result, odd- and even-year pink salmon are often treated as separate stocks. Juveniles spend minimal time in freshwater before migrating to the ocean. Pink salmon has a relatively high rate of straying, in which individuals do not return to their natal site to spawn (Quinn 2011).

Management bodies

British Columbia commercial salmon fisheries are primarily managed by the Department of Fisheries and Oceans Canada (DFO), the U.S.-Canadian Pacific Salmon Commission, and First Nations. Management includes input from a variety of stakeholders within British Columbia, as well as salmon management agencies in the United States. Fisheries are often guided, in part, by the U.S.-Canada Pacific Salmon Treaty.

DFO develops two annual Integrated Fishery Management Plans (IFMPs) for Pacific salmon in British Columbia: one for the northern part of the province, and a second for the southern part. The fisheries covered in this report are described in the following table and map except as noted. A separate management document is prepared for the Transboundary Rivers discharging into Alaska (Alsek, Taku, and Stikine) for the Pacific Salmon Commission (e.g. PSC 2014f).

Pacific Salmon Fishing Area	Gear	Corresponding Pacific Fisheries Management Areas (PFMA)
Salmon Area A	Seine (North and Central Coast)	Areas 1 to 10, Subarea 101-7
Salmon Area B	Seine (South Coast)	Areas 11 to 29 and 121
Salmon Area C	Gill net (North and Central Coast)	Areas 1 to 10, Subarea 101-7
Salmon Area D	Gill net (South Coast)	Areas 11 to 15 and 23 – 27
Salmon Area E	Gill net (South Coast)	Areas 16 to 22, 28, 29 and 121
Salmon Area F	Troll (North Coast)	Areas 1 to 10, 101 to 110, 130 and 142
Salmon Area G	Troll (West Coast Vancouver Island)	Areas 11, 20 to 28, 111, 121, 123 to 127 and Subareas 12-5 to 12-16
Salmon Area H *	Troll (Inside Vancouver Island)	Areas 12 to 19, 28 and 29

* Chinook and coho catches in Area H are extremely small (average less than 100 fish) so this fishery was not assessed in this report.

Figure 1 British Columbia commercial salmon license areas, gear specifications, and Pacific fisheries management areas.

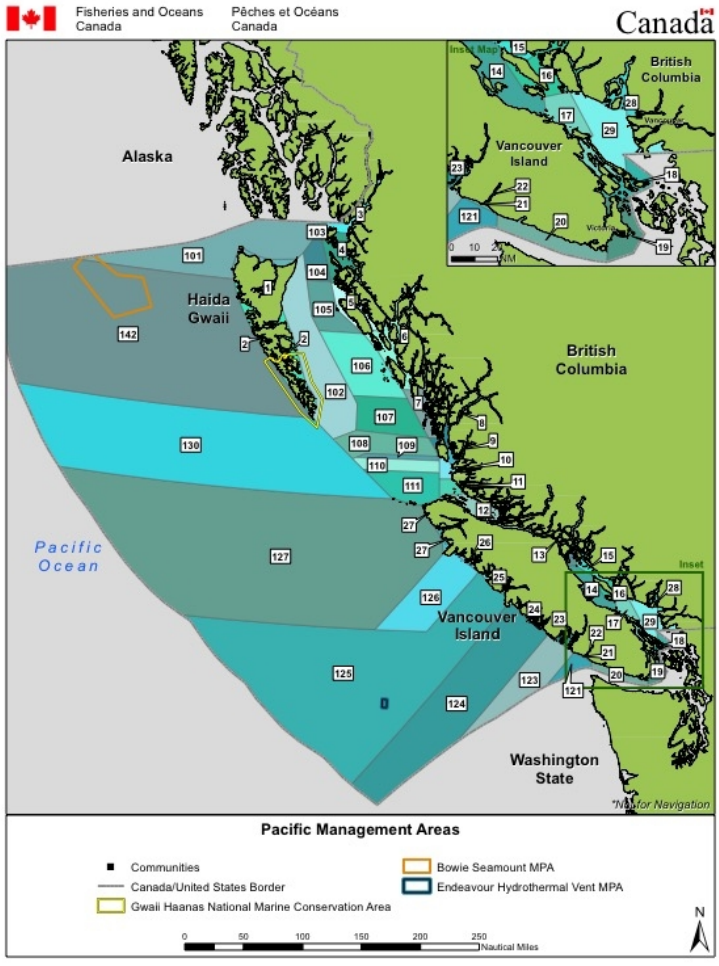

Figure 2 Pacific fishery management statistical areas covered in this report. Not shown are the Taku and Stikine Transboundary rivers, which flow from British Columbia into Southeast Alaska. Available at http://www.pac.dfo-mpo.gc.ca/fm-gp/maps-cartes/areas-secteurs/index-eng.html.

History of the fisheries

Pacific salmon have long been an important food and cultural resource for many First Nations people inhabiting British Columbia. Commercial fishing for salmon began shortly after the arrival of Europeans on the West Coast in the late 1850s and has continued into the present. In response to diminishing returns of wild fish in the Fraser River, salmon hatcheries started to be built and operated in Canada in the early 1900s (Robson 2006). Production from British Columbia salmon farms (raised in captivity) was initially limited but expanded rapidly in the late 1980s, peaking in 2002 (84,000 metric tons farmed) and remaining roughly stable since (Robson 2006).

In 1992, DFO initiated the Aboriginal Fisheries Strategy (AFS) in response to a Supreme Court ruling that affirmed the right of First Nations people to fish for food, social, and ceremonial (FSC) purposes. Current fisheries management prioritizes FSC harvests, opening commercial fisheries only after FSC and First Nations treaty obligations have been fulfilled. Under the Allocation Policy for Pacific Salmon, the recreational fishing sector has priority access to coho and Chinook after First Nations priorities (DFO 1999). Commercial fisheries

have directed access only when salmon abundance permits, though they also have non-retention allowances for coho and Chinook bycatch in sockeye, pink, and chum salmon fisheries. In practice, the fishing industry typically regards only the following as directed commercial fisheries for Chinook and coho: troll fisheries in Northern British Columbia (Area F; Chinook and coho) and West Coast Vancouver Island (Chinook).

Production Statistics

According to North Pacific Anadromous Fish Commission (NPAFC) statistical yearbooks (NPAFC 2010), global production of Pacific salmon is on the order of 926,000 metric tonnes (MT) per year. Major producers include the United States (with the large majority of fish caught in Alaska), Canada, Russia, and Japan. Within the global context, British Columbia salmon fisheries are relatively small producers, having landed an annual average of about 25,000 MT from 1999 to 2012 (Irvine et al. 2012).

The productivities of the Chinook and coho fisheries assessed in this report relative to Canadian and North American catches are shown in the table below. None of these fisheries produces a significant portion (> 10%) of the total North American catch. Within British Columbia, the most productive fisheries are the Aggregate Abundance Based Management (AABM) North Coast and West Coast Vancouver Island troll fisheries for Chinook and the AABM North Coast fishery for coho.

The table below displays catches (in numbers of fish) and proportions of total catches (for Canada and North America) by species for the fisheries assessed in this report. Annual data were obtained from the North Pacific Anadromous Fish Commission and were averaged over the past 10 years (2004-2013).

Area	Species	Gear	Catch	Prop. BC catch	Prop. NA catch
Canada, transboundary	Chinook	gillnet	10,219	0.05	0.01
Canada, transboundary	coho	gillnet	10,801	0.04	0.00
Central Coast	Chinook	gillnet	12,255	0.06	0.01
Central Coast	coho	gillnet	15,605	0.06	0.00
North Coast	Chinook	gillnet	10,641	0.05	0.01
North Coast	Chinook	purse seine	1	0.00	0.00
North Coast	coho	gillnet	5,908	0.02	0.00
North Coast	coho	purse seine	29,131	0.11	0.01
North Coast, AABM	Chinook	troll	101,493	0.46	0.07
North Coast, AABM	coho	troll	224,084	0.84	0.04
South Coast	Chinook	gillnet	2,576	0.01	0.00
South Coast	Chinook	purse seine	2,437	0.01	0.00
South Coast	coho	gillnet	28	0.00	0.00
South Coast	coho	purse seine	1,503	0.01	0.00
WCVI, AABM	Chinook	troll	94,218	0.43	0.07
WCVI, AABM	coho	troll	1,529	0.01	0.00

Harvests of Chinook and coho salmon generally peaked in the 1970s but decreased rapidly starting in the 1990s, with coho showing an especially precipitous decline (see Figure 3).

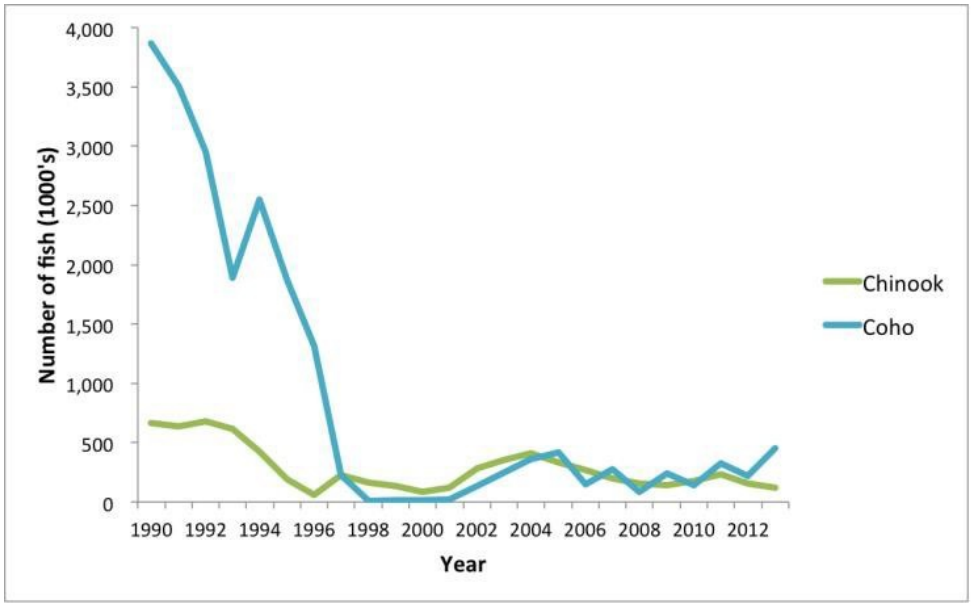

Figure 3 Production of Chinook and coho salmon (in thousands of fish) from 1990 to present. Data from the North Pacific Anadromous Fish Commission.

Importance to the US/North American market.

The majority of BC wild salmon is exported, particularly to the United States, Japan, and Europe. In 2014, the BC export values of wild Chinook and wild coho salmon were CAD 21 million and CAD 4.8 million, respectively, and the U.S. was a top market for both species (Agriservice BC 2015). In 2012, exports of wild salmon caught in British Columbia (all species) represented approximately 10% of all seafood exported from BC to the United States (BC Ministry of Agriculture 2012).

Common and market names.

Chinook salmon: king salmon, spring salmon, Quinnat salmon, tyee salmon

Coho salmon: silver salmon

Primary product forms

Chinook salmon: fillets and steaks (fresh and frozen), whole fish (fresh and frozen), smoked, dried, salted, roe.

Coho salmon: fillets (fresh and frozen), whole fish (fresh and frozen), smoked, dried, salted, roe.

Assessment

This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Criteria for Fisheries, available at http://www.seafoodwatch.org.

Criterion 1: Impacts on the species under assessment

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. The inherent vulnerability to fishing rating influences how abundance is scored, when abundance is unknown.

The final Criterion 1 score is determined by taking the geometric mean of the abundance and fishing mortality scores. The Criterion 1 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and ≤3.2=Yellow or Moderate Concern*
- *Score ≤2.2=Red or High Concern*

Rating is Critical if Factor 1.3 (Fishing Mortality) is Critical

Criterion 1 Summary

CHINOOK SALMON				
Region / Method	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Score**
Canada/South Coast BC Unassociated purse seine	2.00: Medium	2.00: High Concern	2.33: Moderate Concern	Red (2.159)
Canada/South Coast BC Drift gillnets (driftnets)	2.00: Medium	2.00: High Concern	2.33: Moderate Concern	Red (2.159)
Canada/North Coast BC Drift gillnets (driftnets)	2.00: Medium	3.00: Moderate Concern	3.67: Low Concern	Green (3.318)
Canada/Central Coast BC Drift gillnets (driftnets)	2.00: Medium	3.00: Moderate Concern	3.67: Low Concern	Green (3.318)
Canada/West Coast Vancouver Island Troll/Pole	2.00: Medium	3.00: Moderate Concern	2.33: Moderate Concern	Yellow (2.644)
Canada/North Coast BC Troll/Pole	2.00: Medium	3.00: Moderate Concern	2.33: Moderate Concern	Yellow (2.644)

CHINOOK SALMON: TRANSBOUNDARY				
Region / Method	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Score**
Canada Drift gillnets (driftnets)	2.00: Medium	5.00: Very Low Concern	3.67: Low Concern	Green (4.284)

COHO SALMON				
Region / Method	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Score**
Canada/South Coast BC Unassociated purse seine	2.00: Medium	2.00: High Concern	2.33: Moderate Concern	Red (2.159)
Canada/South Coast BC Drift gillnets (driftnets)	2.00: Medium	2.00: High Concern	2.33: Moderate Concern	Red (2.159)
Canada/North Coast BC Unassociated purse seine	2.00: Medium	3.00: Moderate Concern	3.67: Low Concern	Green (3.318)
Canada/Central Coast BC Drift gillnets (driftnets)	2.00: Medium	3.00: Moderate Concern	3.67: Low Concern	Green (3.318)
Canada/West Coast Vancouver Island Troll/Pole	2.00: Medium	2.00: High Concern	3.67: Low Concern	Yellow (2.709)
Canada/North Coast BC Troll/Pole	2.00: Medium	3.00: Moderate Concern	3.67: Low Concern	Green (3.318)

COHO SALMON: TRANSBOUNDARY				
Region / Method	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Score**
Canada Drift gillnets (driftnets)	2.00: Medium	3.00: Moderate Concern	2.33: Moderate Concern	Yellow (2.644)

Criterion 1 Assessment

SCORING GUIDELINES

Factor 1.1 - Inherent Vulnerability

- *Low—The FishBase vulnerability score for species is 0-35, OR species exhibits life history characteristics that make it resilient to fishing, (e.g., early maturing).*
- *Medium—The FishBase vulnerability score for species is 36-55, OR species exhibits life history characteristics that make it neither particularly vulnerable nor resilient to fishing, (e.g., moderate age at sexual maturity (5-15 years), moderate maximum age (10-25 years), moderate maximum size, and middle of food chain).*
- *High—The FishBase vulnerability score for species is 56-100, OR species exhibits life history characteristics that make is particularly vulnerable to fishing, (e.g., long-lived (>25 years), late maturing (>15 years), low reproduction rate, large body size, and top-predator). Note: The FishBase vulnerability scores is an index of the inherent vulnerability of marine fishes to fishing based on life history parameters: maximum length, age at first maturity, longevity, growth rate, natural mortality rate, fecundity, spatial behaviors (e.g., schooling, aggregating for breeding, or consistently returning to the same sites for feeding or reproduction) and geographic range.*

Factor 1.2 - Abundance

- *5 (Very Low Concern)—Strong evidence exists that the population is above target abundance level (e.g., biomass at maximum sustainable yield, BMSY) or near virgin biomass.*
- *4 (Low Concern)—Population may be below target abundance level, but it is considered not overfished*
- *3 (Moderate Concern) —Abundance level is unknown and the species has a low or medium inherent vulnerability to fishing.*
- *2 (High Concern)—Population is overfished, depleted, or a species of concern, OR abundance is unknown and the species has a high inherent vulnerability to fishing.*
- *1 (Very High Concern)—Population is listed as threatened or endangered.*

Factor 1.3 - Fishing Mortality

- *5 (Very Low Concern)—Highly likely that fishing mortality is below a sustainable level (e.g., below fishing mortality at maximum sustainable yield, FMSY), OR fishery does not target species and its contribution to the mortality of species is negligible (≤ 5% of a sustainable level of fishing mortality).*
- *3.67 (Low Concern)—Probable (>50%) chance that fishing mortality is at or below a sustainable level, but some uncertainty exists, OR fishery does not target species and does not adversely affect species, but its contribution to mortality is not negligible, OR fishing mortality is unknown, but the population is healthy and the species has a low susceptibility to the fishery (low chance of being caught).*
- *2.33 (Moderate Concern)—Fishing mortality is fluctuating around sustainable levels, OR fishing mortality is unknown and species has a moderate-high susceptibility to the fishery and, if species is depleted, reasonable management is in place.*
- *1 (High Concern)—Overfishing is occurring, but management is in place to curtail overfishing, OR fishing mortality is unknown, species is depleted, and no management is in place.*
- *0 (Critical)—Overfishing is known to be occurring and no reasonable management is in place to curtail overfishing.*

CHINOOK SALMON

Factor 1.1 - Inherent Vulnerability

CANADA/SOUTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA/SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA/NORTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA/CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA/WEST COAST VANCOUVER ISLAND, TROLL/POLE
CANADA/NORTH COAST BC, TROLL/POLE

Medium

The FishBase vulnerability score for Chinook salmon is 68 (Froese and Pauly 2014), which corresponds to high inherent vulnerability. But productivity-susceptibility analysis (PSA) suggests moderate vulnerability based on attributes including age at maturity, maximum size, reproductive strategy, and trophic level. Additionally, Chinook salmon has high diversity in life history traits such as age at maturation, which should increase its resiliency to environmental changes. We rated inherent vulnerability as "medium."

Rationale:

The FishBase score is based on life history traits and ecological characteristics including maximum length, age at first maturity, and geographic range (Cheung et al. 2005). Data used for the productivity susceptibility analysis were obtained from Fishbase.org.

Trait	Estimate	Score
Average at maturity (years)	4	3
Average maximum age (years)	8	3
Average maximum size (cm)	150	2
Average size at maturity (cm)	76.7	2
Reproductive strategy	demersal egg layer	2
Trophic level	4.4	1
Average score		2.17

Figure 4 Chinook salmon trait estimates and scores; used for determining inherent vulnerability using productivity and susceptibility analysis.

Factor 1.2 - Abundance

CANADA/SOUTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA/SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)

High Concern

South Coast BC purse seine and gillnet fisheries catch Chinook when fishing for other, more abundant species of salmon. The stocks that are considered major components of the Chinook catch (> 5%) are hatchery (e.g., WCVI net) and some Fraser River stocks (early and late components) (PSC 2014c). Spawner abundances of most Chinook populations (conservation units) in southern BC have decreased substantially over the most recent three generations (9-15 years prior to 2012) (Riddell 2013). Most of the 35 populations declined 50% or more, but a few populations increased in abundance. Most stocks do not have biological escapement goals. Stocks having Chinook Technical Committee-approved goals include natural spawning Cowichan and Harrison stocks (PSC 2014a); less robust goals are also used for managing Chinook stocks. More than 75% of stocks are listed as stocks of conservation concern (with or without reference points) or are not meeting escapement goals (see graph) (PSC 2014a). The contribution of hatchery Chinook to the spawning estimates is often unknown but has been exceptionally high for some monitored populations, e.g., ~65% for Big Qualicum, ~30% for Cowichan fall, 60%-100% for Puntledge summer, and 70% for Quinsam (Riddell 2013). Although the status of many Chinook stocks in southern British Columbia is low, fisheries target more robust hatchery stocks (e.g., WCVI net) and Fraser River stocks (early and late components (PSC 2014c). Nevertheless, some Fraser stocks remain stocks of concern, including spring Chinook (age 42 and 52) and summer Chinook (age 52) (DFO 2014c).

The abundance of Chinook salmon in Southern BC is judged to have a "high" conservation concern because many populations have declined substantially and some are listed as stocks of conservation concern, but fisheries target stocks that are more robust (PSC 2014a). In addition, the substantial hatchery contribution to many populations complicates evaluation of wild stock status.

Rationale:

2.3.2.3.3 Lower Strait of Georgia

The Lower Strait of Georgia (LGS) natural rivers monitored for naturally spawning fall Chinook salmon escapement are the Cowichan and Nanaimo rivers (Figure 2.21 and Figure 2.22).

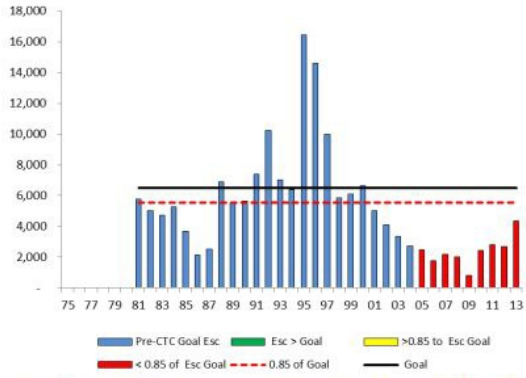

Figure 2.21.–Cowichan River escapements of Chinook salmon, 1981–2013.

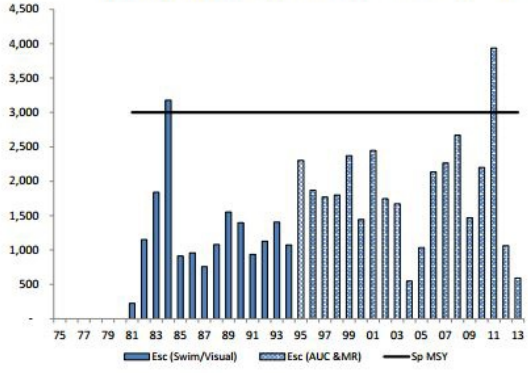

Figure 2.22.–Nanaimo River escapements of Chinook salmon, 1981–2013.

Figure 5 Examples of Chinook spawning escapements relative to goals in two southern BC rivers (CTC 14-2).

CANADA/NORTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA/CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)

Moderate Concern

Gillnet fisheries in North and Central BC catch Chinook salmon when targeting more abundant species of salmon. The stocks that are considered major components of the Chinook catch (> 5%) are not well defined by DFO but likely involve Skeena River Chinook and Area 8 Chinook salmon when abundance is sufficient to allow a directed fishery. Abundance trends of north and central coast Chinook are variable and somewhat uncertain (PSC 2014a). The Chinook Technical Committee reported trends for only four areas; data for two other watersheds (Yakoun and Dean R) are no longer monitored. Escapements to the Nass River during the past 15 years have been very near or above the minimum escapement level (10,000 fish) that serves as a limit reference point. Spawning escapements to the Kitsumkalum River (Skeena watershed) have exceeded the point estimate of S_{MSY} in every year since 1998. Chinook escapement to the Atnarko River has met the escapement goal in all but one year since 1998. In contrast, two of three indicator stocks in Rivers Inlet have declined since 1997-2002 and total spawner counts are not available for comparison with reference points. Most areas have relatively few hatchery Chinook salmon (Ogden et al. 2014).

Escapement goals for select Chinook stocks in northern BC were initially based on doubling the average escapements recorded from 1979-1982, a period when the stocks were overfished (PSC 2014a). Goals for entire watersheds have been developed more recently based on a habitat approach, but escapement data are often not available for the entire watershed for comparison to these goals, e.g., Rivers Inlet. None of the Chinook escapement goals has been approved by the Chinook Technical Committee, indicating that goals have some uncertainty in regard to maintaining abundant sustainable populations.

North and Central Coast Chinook salmon abundance is judged to be a "moderate" conservation concern because two indicator stocks have declined over time, two other stocks are no longer monitored, and there is some uncertainty in the overall status of Chinook salmon in this region.

Rationale:

The following information was extracted from (PSC 2014a).

Yakoun R. No escapement data since 2005.

Nass R. Escapements during the past 15 years have been very near (9,305 in 2013) or above the minimum escapement level (10,000 fish) that serves as a limit reference point. Escapements have exceeded the operational goal (20,000 fish) during 53% of the past 15 years. But escapements during 2010-2013 were low (~10,000 fish).

Skeena R. This is the second-largest watershed in British Columbia. The Kitsumkalum River is used as an indicator stock. Spawning escapements to the Kitsumkalum River have exceeded the point estimate of S_{MSY} every year since 1998. Habitat-based escapement goals were developed for the Skeena watershed but total escapement counts are not yet available.

Dean R. No escapement data since 2011.

Rivers Inlet. Habitat-based escapement goals are available but total escapement counts are needed to determine whether escapement is meeting the reference points. Three indicators streams are monitored. One indicator has stable escapement over time whereas escapement to the other two watersheds has declined since peak escapement in 1997-2002. Hatchery fish are present in this area but their contribution to escapement counts is unknown.

Atnarko R. Wild Chinook escapement in this watershed has met the escapement goal in all but one year since 1998. Significant hatchery production occurs here but estimates are available.

CANADA/WEST COAST VANCOUVER ISLAND, TROLL/POLE

Moderate Concern

The WCVI troll fishery catches migratory Chinook salmon from multiple stocks. The major natural stocks caught in this fishery include Fraser River late and Columbia upriver bright Chinook (PSC 2014d). Both Fraser late and Columbia upriver bright Chinook have met escapement goals in the majority of the past 15 years (1999 to 2013) (PSC 2014a) (PFMC 2014). But the Fraser late stock had low returns in 2012 and 2013 that were below 85% of the minimum escapement goal. The Fraser late stock has a low proportion (3%) of hatchery-produced fish (PSC 2014a), while the proportion of hatchery fish in upriver bright fall Chinook escapements may be around 30% in some areas (Evenson et al. 2002). Hatchery-origin fish spawning in natural areas may be included in escapement counts. Because there is a lack of differentiation between natural and hatchery-origin fish in escapement monitoring, and the majority of major stocks appear to have stable population trends, conservation concern was rated “moderate.”

Rationale:

Harrison River is the indicator stock for Fraser River late run Chinook. Escapements are estimated using mark-recapture methods. An escapement goal range for achieving S_{MSY} was developed in 2001, using a Ricker stock-recruit approach, and has been accepted by the Chinook Technical Committee. Escapements have fluctuated around the escapement goal range and exceeded the minimum goal of 75,100 fish in 67% of the past 15 years from 1999 to 2013 (PSC 2014a). But the 2012 and 2013 escapements were both below 85% of the minimum goal (see Figure 6). The escapement goal for Columbia upriver bright Chinook is also designed to achieve S_{MSY} and is based on

stock-recruitment analyses (PSC 2014a). Columbia upriver bright Chinook have an escapement goal of 60,000 fish above McNary Dam, and this goal has been met in 93% of the past 15 years from 1999 to 2013 (PSC 2014a).

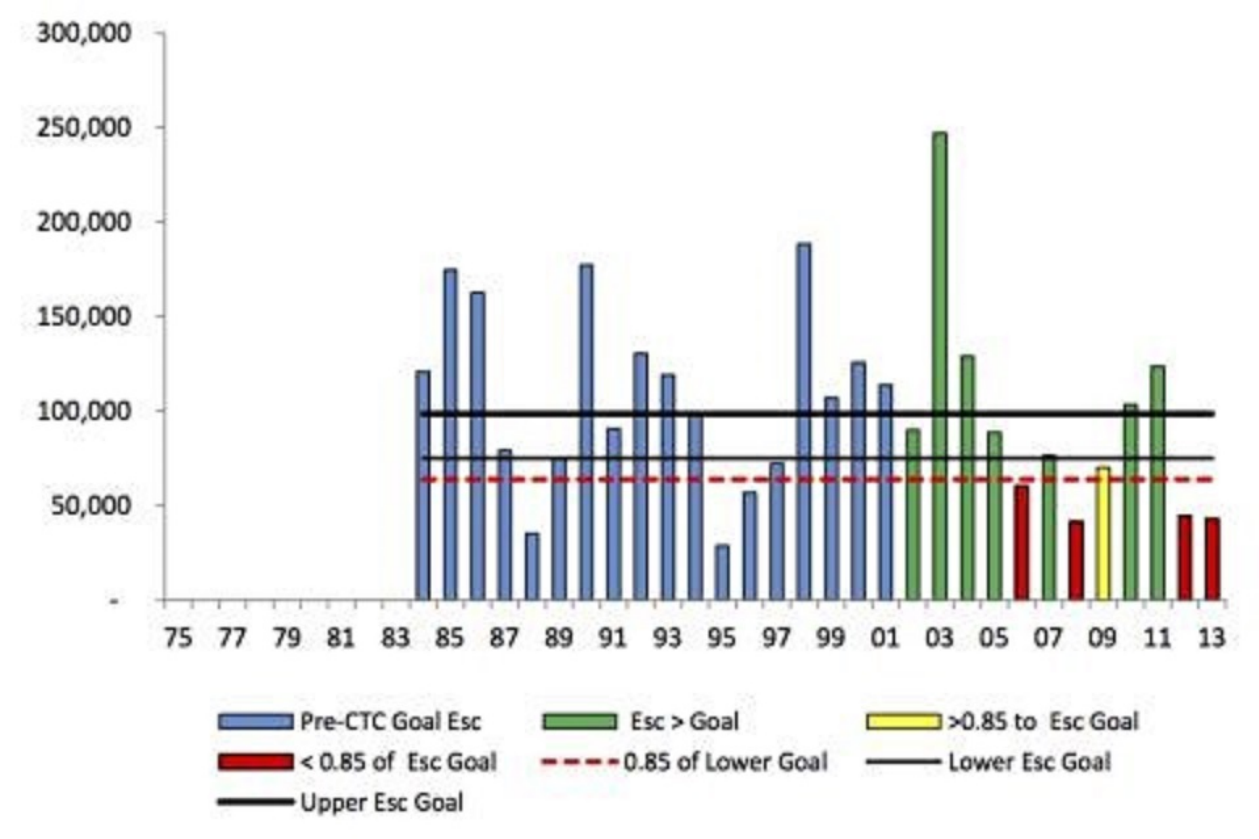

Figure 6 Fraser River late (Harrison River) escapements of Chinook salmon, 1984-2013. Figure from Pacific Salmon Commission Chinook Technical Committee report 14-2.

West Coast Vancouver Island wild Chinook is a stock of concern (DFO 2014b) and makes up less than 5% of the total catch, so it is not evaluated under this factor.

CANADA/NORTH COAST BC, TROLL/POLE

Moderate Concern

The North Coast BC troll fishery catches migratory Chinook salmon from multiple stocks. The major natural stocks caught in this fishery include North/Central Coast British Columbia, Oregon Coast north migrating, and Columbia upriver bright Chinook (PSC 2014d). For the past 15 years (1999 to 2013), North and Central BC stocks have been near or above the minimum escapement level, while Oregon Coast north migrating and Columbia upriver bright Chinook have met escapement goals the majority of years. North and Central Coast BC Chinook stocks include minimal hatchery production (Ogden et al. 2014), while the Columbia upriver bright stock includes substantial hatchery production (PFMC 2014). Both natural and hatchery-origin fish may be included in escapement counts for Columbia upriver bright Chinook. Based on the variation in stock status and lack of differentiation between natural and hatchery-origin fish in escapement monitoring, conservation concern was rated “moderate.”

Rationale:

North and Central British Columbia stocks include the following indicator stocks: Yakoun River, Nass River, Skeena River, Atnarko River, Dean River, Rivers Inlet, and Smith Inlet. The Chinook Technical Committee reported trends for only four areas; data for two other watersheds (Yakoun and Dean Rivers) are no longer monitored. Escapements to the Nass River during the past 15 years have been very near (9,305 in 2013) or above the minimum escapement level (10,000 fish) that serves as a limit reference point. Escapements have exceeded the operational goal (20,000 fish) during 53% of the past 15 years. But escapements during 2010-2013 were low (~10,000 fish). Spawning escapements to the Kitsumkalum River (Skeena watershed) have exceeded the point estimate of S_{MSY} in every year since 1998 (Figure 7). The Chinook escapement to the Atnarko River has met the wild escapement goal (5,009 fish) in all but one year since 1998. In Rivers Inlet, two of three indicator stocks have declined since 1997-2002. Most areas have relatively few hatchery-origin Chinook salmon (Ogden et al. 2014), but wild escapement counts include hatchery-origin fish spawning in natural areas. The escapement goal of 60 adults per mile for Oregon Coast north migrating stocks has been achieved 87% of the 15 years from 1999 to 2013. Columbia upriver bright Chinook have an escapement goal of 60,000 fish above McNary Dam, and this goal has been met in 93% of the past 15 years from 1999 to 2013 (PFMC 2014a).

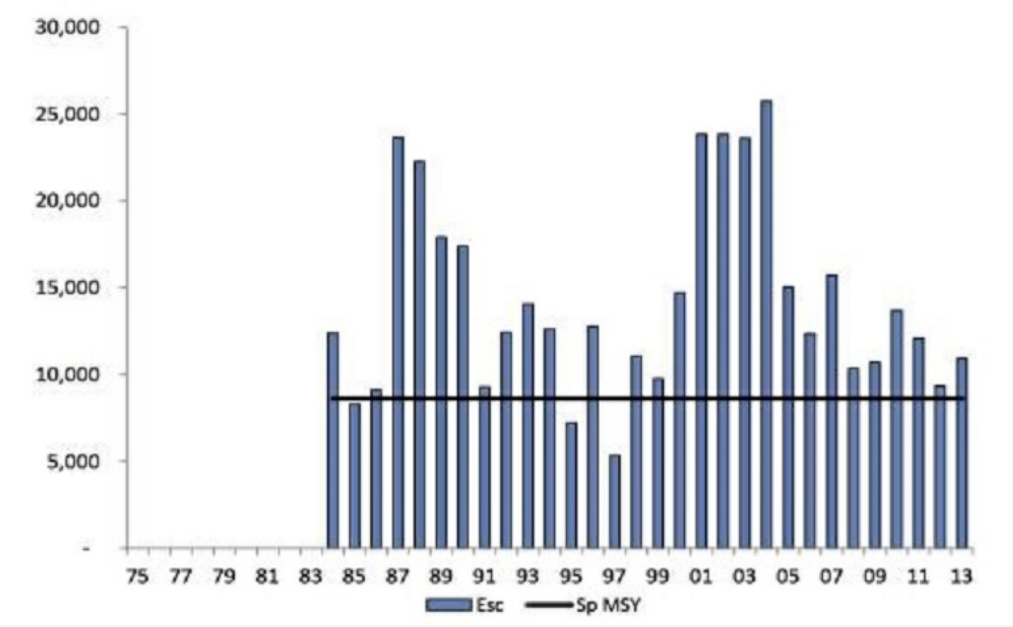

Figure 7 Skeena (Kitsumkalum River) escapements of Chinook salmon, 1984-2013. Figure from Pacific Salmon Commission Chinook Technical Committee report 14-2.

Escapement goals for select Chinook stocks in northern BC were initially based on historical escapement estimates (doubling the average escapements recorded from 1979-1982, a period when the stocks were overfished) (PSC 2014a). Goals for entire watersheds have been developed more recently based on a habitat approach, but often escapement data are not available for the entire watershed for comparison to these goals. None of the BC Chinook escapement goals has been approved by the Chinook Technical Committee, indicating that goals have some uncertainty in regard to maintaining abundant sustainable populations. For Oregon North Coast Chinook, escapement goals for indicator stocks are based on historical escapement estimates and information on available spawning habitat (PSC 2014a). The escapement goal for Columbia upriver bright Chinook is designed to achieve S_{MSY} and was determined using stock-recruitment analyses (PSC 2014a).

Factor 1.3 - Fishing Mortality

CANADA/SOUTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA/SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)

Moderate Concern

ISBM (individual stock based management) commercial fisheries in Southern BC are mostly represented by Strait of Georgia troll, WCVI net, Juan de Fuca net, Johnstone Strait net, and Fraser net. The large majority of Chinook are now taken in the Fraser net (Fraser Chinook salmon) and WCVI net fisheries (local WCVI Chinook stocks) in order to avoid most stocks of concern (PSC 2014c) (DFO 2014c). In the ISBM management area inside of Vancouver Island, all the aforementioned fisheries (gear types) are constrained in order to meet Pacific Salmon Treaty obligations to reduce Chinook harvest rates and adult equivalent mortality levels. To meet this requirement in mixed-stock fisheries, there are periods and areas with non-retention of Chinook in commercial fisheries (though bycatch retention may be allowed in some troll and gillnet fisheries), and First Nations are provided opportunities for FSC (food, social, ceremonial) purposes only.

Total exploitation rates (all fisheries, including those in Southeast Alaska, northern BC, and southern U.S. waters) on southern BC Chinook salmon declined from about 75% in the 1980s to ~40%-50% in the 2000s. Fisheries in southern BC (all gear types) have been constrained to reduce their impacts on Chinook salmon, whose abundance has declined significantly. During 2001-2013, approximately 14,700 Chinook per year were harvested in southern BC ISBM commercial fisheries (all gear types, Areas B, D, E, H, excluding First Nation harvests in terminal areas). In comparison, approximately 200,000 to 300,000 Chinook originating from southern BC were harvested each year in all ocean fisheries (e.g., Alaska, northern BC, WCVI) from 1995-2012 (Riddell 2013). Approximately 90% of the ISBM catch (14,700 Chinook) occurred in gillnet fisheries, 9% in seine fisheries, and 1% in troll fisheries (excluding aggregate abundance-based management [AABM] harvests). Although management has constrained Chinook fisheries, especially in the southern BC ISBM fisheries, a recent review of southern BC Chinook salmon indicated that the total exploitation rates (all fisheries) may still be too high, given the low current productivity of the populations (Riddell 2013).

The southern BC ISBM fisheries largely attempt to avoid impacts on depleted Chinook salmon stocks, especially in the troll and seine fisheries. Directed gillnet harvests typically focus on healthier stock components. The majority of Chinook are now taken in the Fraser net and WCVI net fisheries to avoid most stocks of concern (PSC 2014c) (DFO 2014c). Fishing mortality in the southern BC Chinook fisheries is judged to have a "moderate" conservation concern. The ISBM Chinook fishery does not warrant a high concern because harvest rates have declined and harvests are very small compared with the take of southern BC Chinook in fisheries outside this region. A low concern is not warranted because some Chinook are still taken in these ISBM fisheries even though stock status is typically poor.

Rationale:

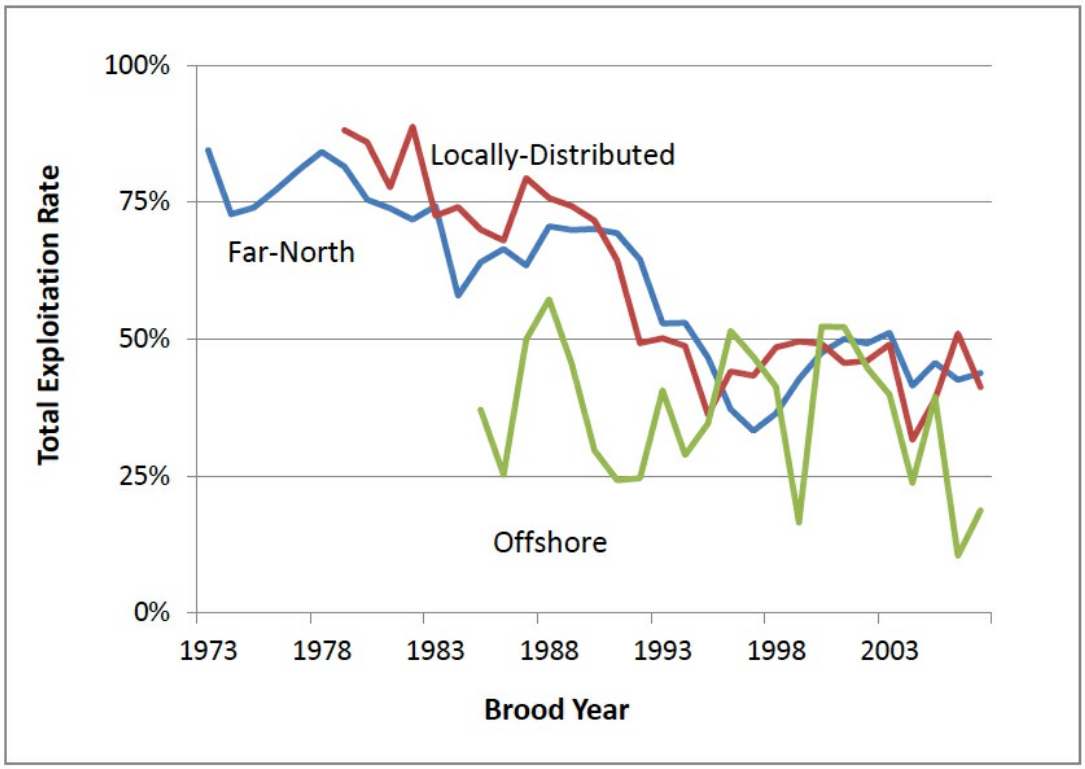

Figure H-13. Average estimated total exploitation rates by brood year for AD+CWT indicator stocks exhibiting one of three general ocean distribution patterns: far north-migrating, locally-distributed and offshore. Graph modified from one provided by C. Parken, DFO; reproduced with permission.

Figure 8 Estimated average total exploitation rates for southern BC Chinook salmon vary, depending on ocean migration pattern of the stocks. Offshore Chinook are stream-type fish such as those from the upper Fraser. Far-north stocks are harvested, in part, in Alaska (Riddell et al. 2013).

CANADA/NORTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA/CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)

Low Concern

During 2001-2013, the commercial troll fishery in North and Central Coast BC took approximately 88% of the total commercial harvest of Chinook salmon, followed by 11% in the gillnet fishery and <1% in the seine fishery (DFO 2014h). There are no directed Chinook fisheries on the North Coast of BC for the seine fleet. Directed gillnet fisheries occur in Areas 4 and 8, based on the availability of surplus Chinook in the Skeena River (Area 4) and Area 8. Some bycatch of Chinook occurs in North and Central Coast fisheries that target other species. Non-retention and live release of Chinook salmon using revival boxes may be required in some areas when abundance is low.

Fishing mortality in the seine and gillnet fisheries is judged to have a "low" conservation concern because relatively few Chinook are taken in these fisheries, and directed gillnet fisheries occur in terminal areas where Chinook status is monitored more readily.

CANADA/WEST COAST VANCOUVER ISLAND, TROLL/POLE

Moderate Concern

The WCVI troll fishery for Chinook salmon is managed under an aggregate abundance-based management (AABM) model, in which a total allowable catch is set for all harvested Chinook stocks based on the year's abundance index (Pacific Salmon Treaty 2014). The WCVI Chinook troll and sport fisheries combined exceeded their post-season allowable catch limit eight times in a 15-year period (1999–2013). In addition to catch limits, some measures are taken to reduce fishery impacts on depleted stocks, such as selective fishing practices and strategic fishery closures. Both major stocks caught in this fishery (Fraser River late and Columbia upriver bright Chinook) appear to have stable abundances (PSC 2014a) (PFMC 2014). But because the allowable catch limit was exceeded in the majority of years, conservation concern was rated "moderate."

Rationale:

For stocks managed by AABM, the Pacific Salmon Treaty specifies that an allowable harvest level be determined using preseason abundance indices. A postseason abundance index is subsequently used to compute the final allowable catch for each fishery (PSC 2014c). When comparing observed catches to catch limits, we used the postseason allowable catch limit (see Table 3.5 in (PSC 2014c)).

WCVI troll fishery openings and closures are shaped by conservation concerns for some depleted stocks (Fraser River spring run age 1.2, Fraser River spring run age 1.3, Fraser River summer run age 1.3, WCVI natural, Lower Strait of Georgia Chinook, and interior Fraser River coho). To reduce fishery impacts on WCVI Chinook salmon, nearshore areas are closed to fishing from August through mid-September. To reduce fishery impacts on Lower Strait of Georgia Chinook salmon, catch levels are reduced during the spring period when impacts are likely highest. Use of single barbless hooks and revival tanks are required to increase survival of released fish, although there is little

enforcement on usage of the revival tanks.

CANADA/NORTH COAST BC, TROLL/POLE

Moderate Concern

The North Coast BC troll fishery for Chinook salmon is managed under an aggregate abundance-based management (AABM) model, in which a total allowable catch is set for all harvested Chinook stocks based on the year's abundance index (Pacific Salmon Treaty 2014). Fishery catches were below post-season allowable catch limits for 80% of the years from 1999 to 2013 (PSC 2014c). The major stocks caught in this fishery, which include North/Central Coast British Columbia, Oregon Coast north migrating, and Columbia upriver bright Chinook (PSC 2014d), show varying trends in abundance but, overall, more than 50% of monitored major stocks appear to be stable or increasing (PSC 2014a). Because fishing mortality is regulated by fishery management and there is variability in the abundances of major stocks, conservation concern regarding fishing mortality was deemed "moderate."

Rationale:

For stocks managed by AABM, the Pacific Salmon Treaty specifies that an allowable harvest level be determined using preseason abundance indices. A postseason abundance index is subsequently used to compute the final allowable catch for each fishery (PSC 2014c). When comparing observed catches to catch limits, we used the postseason allowable catch limit (see Table 3.5 in (PSC 2014c)).

The largest watersheds and producers of salmon in Northern BC are the Nass and Skeena rivers. Fishing on Nass River Chinook is not recommended when the escapement is projected to be below 10,000 fish, though it is unclear what specific actions are taken to reduce harvest of Nass Chinook in those situations. Cumulative exploitation rates on Skeena River Chinook have been below the U_{MSY} (threshold reference line) of 0.61 in all years from 1985 to 2013. Recent exploitation rates from 2009 to 2013 have varied between about 20% and 38% (PSC 2014a).

The Atnarko River is home to the largest complex of Chinook salmon in Central British Columbia. Hatchery releases have averaged about 2 million fish annually, and about 20% of hatchery fish are marked with a coded wire tag. This is an exploitation rate indicator stock, where exploitation rates are estimated using coded wire tag data. Cumulative exploitation rates have been below the U_{MSY} of 0.77 in all years from 1990 to 2013. Recent exploitation rates from 2009 to 2013 have fluctuated between about 30% and 62% (PSC 2014a).

Some measures are taken to reduce fishery impacts on depleted stocks. For example, the annual exploitation rate on WCVI Chinook, a stock of concern, is limited to 3.2% for the BC North Coast troll fishery (DFO 2014b). The fishery is also size-selective, in that undersized Chinook must be released to help protect juveniles (PSC 2014a). Use of single barbless hooks and revival tanks are required to increase survival of released fish, although there is little enforcement on usage of the revival tanks. All Chinook landings are made at designated sites, where independent contractors validate ~20% of catches.

CHINOOK SALMON: TRANSBOUNDARY

Factor 1.1 - Inherent Vulnerability

CANADA, DRIFT GILLNETS (DRIFTNETS)

Medium

The FishBase vulnerability score for Chinook salmon is 68 (Froese and Pauly 2014), which corresponds to high inherent vulnerability. But productivity-susceptibility analysis (PSA) suggests moderate vulnerability based on attributes including age at maturity, maximum size, reproductive strategy, and trophic level. Additionally, Chinook salmon has high diversity in life history traits such as age at maturation, which should increase its resiliency to environmental changes. We rated inherent vulnerability as "medium."

Rationale:

The FishBase score is based on life history traits and ecological characteristics including maximum length, age at first maturity, and geographic range (Cheung et al. 2005). Data used for the productivity susceptibility analysis were obtained from Fishbase.org.

Trait	Estimate	Score
Average at maturity (years)	4	3
Average maximum age (years)	8	3
Average maximum size (cm)	150	2
Average size at maturity (cm)	76.7	2
Reproductive strategy	demersal egg layer	2
Trophic level	4.4	1
Average score		2.17

Figure 9 Chinook salmon trait estimates and scores; used for determining inherent vulnerability using productivity and susceptibility analysis.

Factor 1.2 - Abundance

CANADA, DRIFT GILLNETS (DRIFTNETS)

Very Low Concern

Transboundary River Chinook salmon stocks include the fish returning to the Taku, Stikine, and Alsek Rivers (PSC 2014e). Canadian commercial fisheries occur only on the Taku and Stikine Rivers, so the Alsek River stock was not considered for scoring this factor.

Escapements have generally been declining in recent years because of lower marine survival (PSC 2014a). Taku and Stikine stocks have met escapement goals at least 12 of the past 15 years (1999 to 2013) (PSC 2014a). There are no hatcheries located on these rivers, so contribution of hatchery Chinook to the spawning estimates is thought to be negligible.

The abundance of Transboundary Chinook salmon is judged to have a "very low" conservation concern because both stocks have met escapement goals over 75% of the time (PSC 2014a).

Rationale:

Taku, Stikine, and Alsek River Chinook salmon stocks are managed under obligations of the Pacific Salmon Treaty. DFO (Canada) manages the inriver commercial fisheries in the Taku and Stikine Rivers considered in this analysis. These are terminal fisheries that exclusively harvest salmon returning to those rivers. There is no Canadian inriver commercial fishery in the Alsek River drainage. Chinook salmon escapements to the Taku and Stikine Rivers were above the lower end of the escapement goal ranges in at least 12 of the past 15 years (PSC 2014a). Escapements have met or exceeded lower escapement goals in 12 of the past 15 years for the Taku River, and 14 of 15 for the Stikine River.

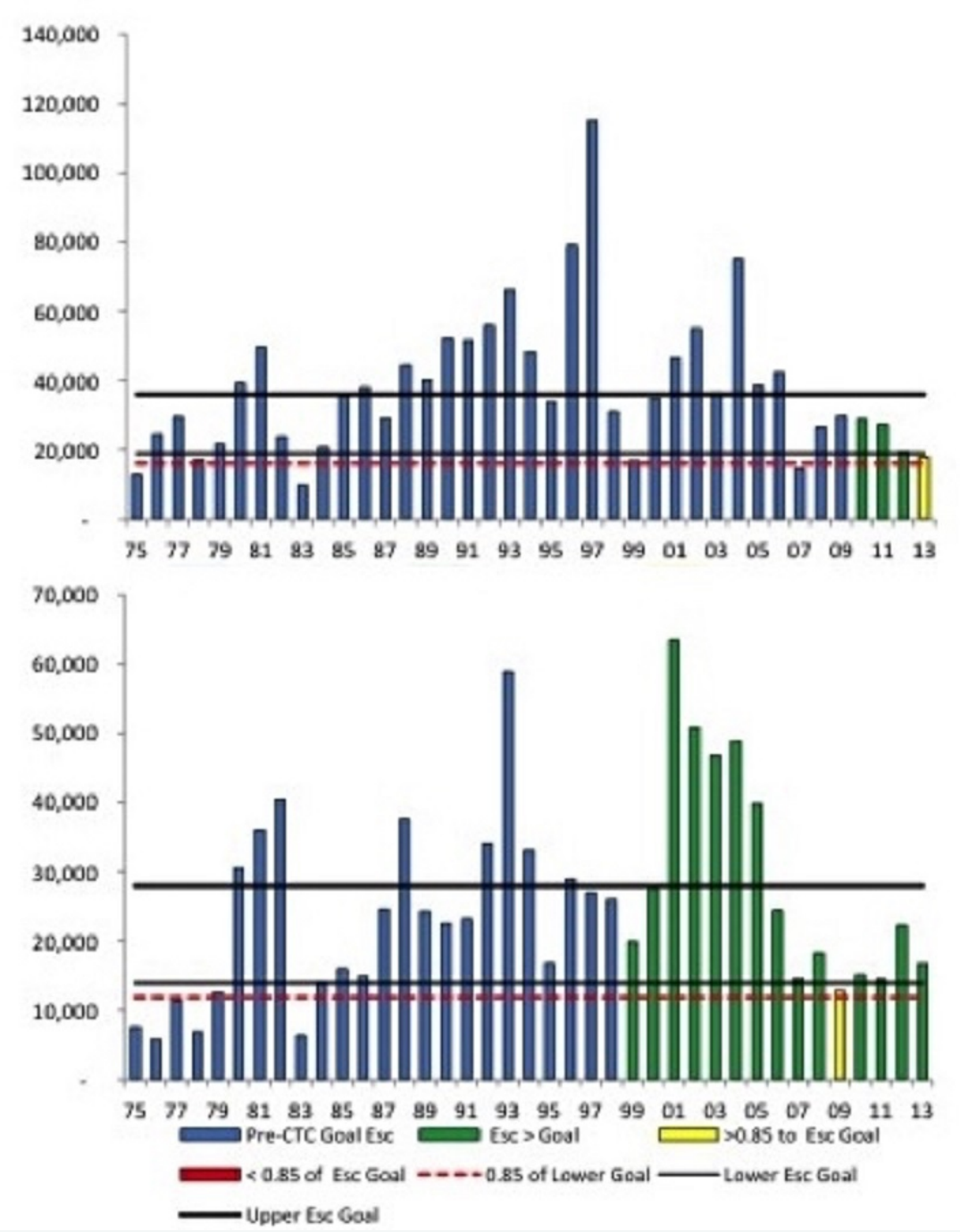

Figure 10 Chinook spawning escapements relative to goals in the Taku River (top) and Stikine River (bottom). Figures from Pacific Salmon Commission Chinook Technical Committee report 14-2 (PSC 2014a).

These biological escapement goal (BEG) ranges are set to achieve MSY +/- 90%.

Hatchery Chinook salmon straying into wild spawning populations has been documented in these systems but is not considered a

significant problem. There are no hatcheries located on or hatchery Chinook salmon released in these systems. Escapements are routinely sampled for fish with coded wire tags (both wild and hatchery-origin) on an annual basis (Pahlke 2010). Overall, the number of hatchery fish (expanded) represents less than 1% of those sampled.

Factor 1.3 - Fishing Mortality

CANADA, DRIFT GILLNETS (DRIFTNETS)

Low Concern

U.S. and Canada terminal fisheries that target salmon returning to the Taku, Stikine, and Alsek Rivers are managed to meet harvest-sharing provisions under the Pacific Salmon Treaty. The primary goal in these fisheries is to meet escapement goals. Although Chinook runs to these rivers have been declining in recent years, fisheries have been managed to meet escapement goals. As a result, escapements have met or exceeded goals about 75% over the past 15 years.

Fishing mortality in the transboundary BC Chinook fisheries is judged to have a "low" conservation concern because escapements have been relatively stable in recent years despite smaller runs. We did not judge it to be a very low concern because Chinook runs have been generally trending downward over the past 15 years because of lower marine survival (PSC 2014a).

Rationale:

There is no directed commercial fishery that targets Alsek Chinook salmon, but it is taken incidentally in U.S. commercial fisheries and in Canada sport and aboriginal fisheries in the Alsek River. Since 2005, Taku and Stikine River Chinook fisheries have been managed under an abundance-based management regime (PSC 2014e). This regime allows directed Chinook salmon fishing during years of surplus production (when the run is projected to exceed the upper end of the escapement goal). When Chinook runs are projected at or below the upper end of the escapement goal, Chinook are taken incidental to terminal sockeye fisheries. This management regime has a very good record for achieving escapement goals over the past 15 years (PSC 2014a).

Total exploitation rates for transboundary stocks vary by stock and year. Between 2009 and 2013, exploitation rates ranged from about 15% to 35% for Taku River and 20% to 30% for Stikine River Chinook salmon.

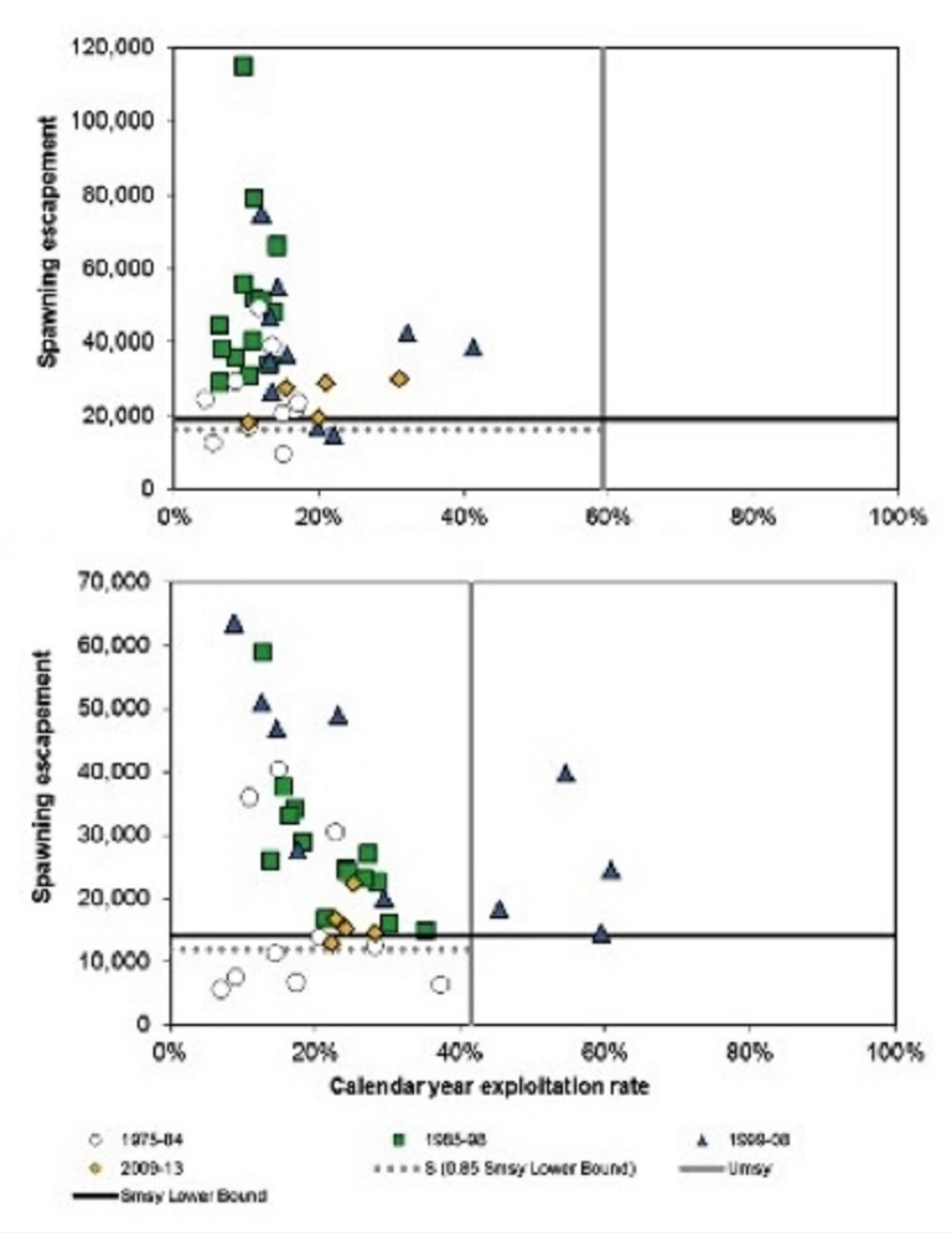

Figure 11 Exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by calendar year for the Taku River (top) and Stikine River (bottom) Chinook salmon stocks, 1975– 2013. Figures from Pacific Salmon Commission Chinook Technical Committee report 14-2 (PSC 2014a).

COHO SALMON

Factor 1.1 - Inherent Vulnerability

CANADA/SOUTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA/SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA/NORTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA/CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA/WEST COAST VANCOUVER ISLAND, TROLL/POLE
CANADA/NORTH COAST BC, TROLL/POLE

Medium

The FishBase vulnerability score for coho salmon is 53, making inherent vulnerability medium. The FishBase score is based on life history traits and ecological characteristics including maximum length, age at first maturity, and geographic range (Cheung et al. 2005). Coho salmon has medium vulnerability because it is widely distributed but occurs in somewhat small and isolated populations.

CANADA/SOUTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA/SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)

High Concern

South Coast BC fisheries catch coho from a variety of watersheds. The stocks that are considered major components of the coho catch (> 5%) are not well defined by DFO because directed fisheries for coho have been greatly reduced and typically involve hatchery fish in terminal areas when abundance is sufficient (DFO 2014c). Canadian coho salmon abundance has declined during the past 20 years, particularly in southern BC (PSC 2013a). Direct estimates of coho abundance (total and escapement) for many Canadian Management Units (MUs) are not available. Instead, the coho FRAM (Fishery Regulation Assessment Model) is used to generate estimates of cohort abundance and exploitation rates using post-season data (see graph). Abundance of all four major coho stocks in southern BC has been very low in recent years compared with abundance in the 1980s. Escapement goals (reference points) have not been established for southern BC coho, except for preliminary objectives for the Endangered Interior Fraser River coho management Unit (see Criterion 2). Less than 10% of the spawning coho in this region appear to originate from hatcheries (Ogden et al. 2014).

The abundance factor for coho is judged to be a "high" concern because coho abundances are very low and insufficient to support directed fisheries. Many of the very few coho harvested in this area appear to be incidental harvests and likely stem from weak local coho stocks. Endangered Interior Fraser River coho is assessed in Criterion 2 because it represents less than 5% of coho catch.

Rationale:

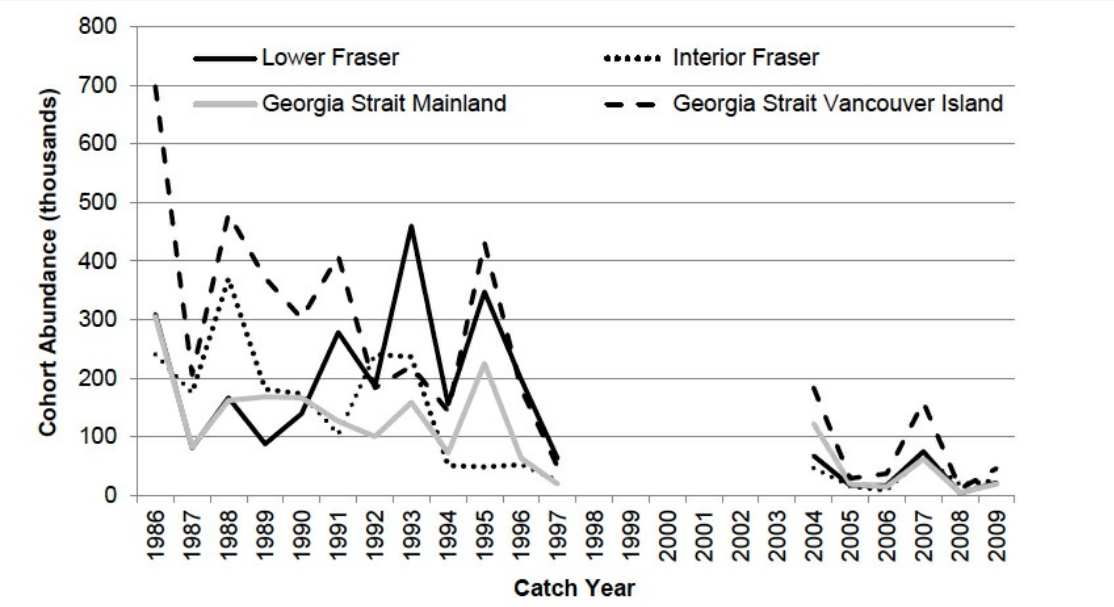

Figure 4.1. Estimated ocean age-3 abundances of Southern B.C. Coho Salmon Management Units; catch years 1986-1997 and 2004-2009.

Figure 12 Source: PSC 2013.

CANADA/NORTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA/CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)

Moderate Concern

Purse seine and gillnet fisheries in Northern and Central BC typically catch local stocks while targeting species other than coho salmon; most coho are released in these fisheries. Wild coho abundance in northern British Columbia is not well documented, and there are no reference points (escapement goals). Nevertheless, there are some approximations of spawning coho abundances in some areas. Coho escapement in Area 3 was approximately 50% lower during 2000-2009 (18,000 fish) compared with 1980-1989 (33,400 fish), but escapement increased substantially to 320,000 fish in 2013 (PSC JNB 2014). Escapement in Area 5, which has relatively few coho (up to 33,000 fish), has declined approximately 90% in the recent decade. Coho escapement in the Skeena River (Area 4) has fluctuated around 200,000 coho salmon (English et al. 2012) (see graph). Escapement into Area 1 has not been monitored since 2006.

In contrast to these data, preliminary analyses indicate that the summed total estimated escapement of North Coast coho salmon (including the central coast) increased from ~400,000 coho during the 1990s to ~600,000 coho in the 2000s (Ogden et al. 2014). The percentage of hatchery coho on the spawning grounds appears to be less than 5%, because there is relatively little hatchery coho production along the North Coast.

North and Central Coast coho abundance is judged to have a "moderate" conservation concern because abundances of some smaller stocks have declined over time (Area 5), data are no longer collected (or reported) in some areas (Area 1 and others), and there are no reference points to evaluate sustainability. This leads to some uncertainty in the overall status of coho salmon in the region. A high concern is not warranted because coded wire tag analysis suggests an increase in overall abundance, and there is relatively little coho hatchery production. A low concern is not warranted because data are not certain.

Rationale:

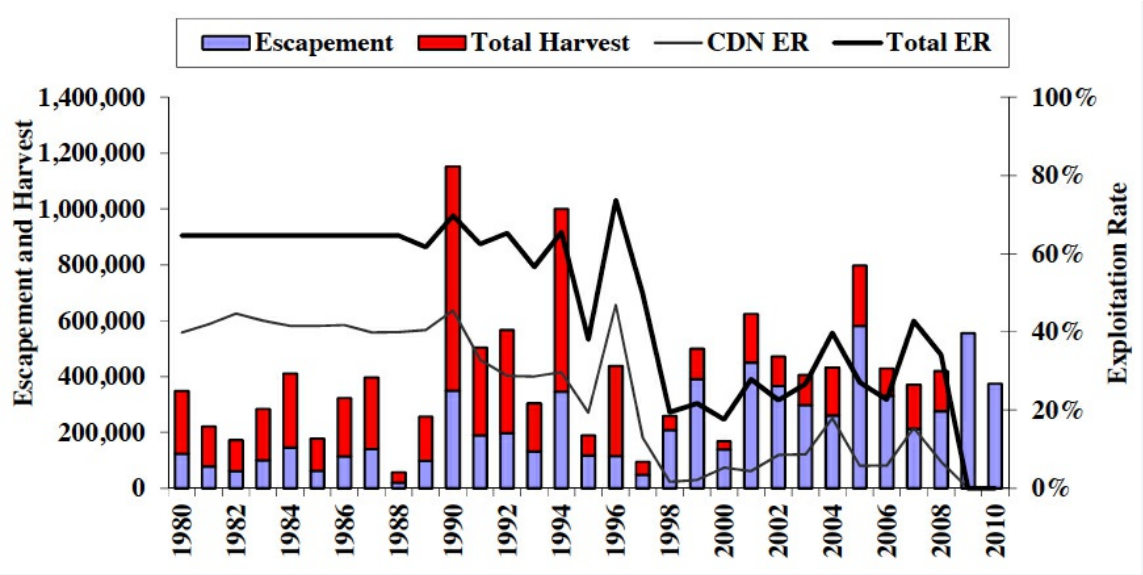

Figure 13 Skeena River coho abundance reconstruction and exploitation rate (English et al. 2012).

CANADA/WEST COAST VANCOUVER ISLAND, TROLL/POLE

High Concern

BC troll fisheries have not targeted coho in recent years, although coho are sometimes caught incidentally in troll fisheries targeting Chinook. The major coho stock groups most likely to be encountered in the WCVI troll fishery are Central Coast BC and Southern BC coho (Northwest Vancouver Island, Southwest Vancouver Island, and Strait of Georgia stocks) (Weitkamp and Neely 2002). Canadian coho salmon abundance has declined during the past 20 years, particularly in southern BC (PSC 2013). Wild coho abundance in central BC is not well documented. There are no official escapement goals for Canadian coho stocks, except for preliminary goals for endangered Interior Fraser coho. Central BC has relatively little hatchery production, while southern BC coho escapements have included about 10% or less hatchery-origin fish since 2000 (Ogden et al. 2014).

The abundance factor for coho is judged to be a "high" concern because stock abundances for coho salmon caught in this area are very low and insufficient to support directed fisheries.

Rationale:

Direct estimates of coho abundance (total and escapement) for many Canadian Management Units (MUs) are not available. Instead, the coho FRAM (Fishery Regulation Assessment Model) is used to generate estimates of cohort abundance and exploitation rates using post-season data (Figure 14). Escapement goals (reference points) have not been established for British Columbia coho, except for preliminary objectives for the endangered Interior Fraser River coho Management Unit (see Criterion 2). Abundance of all four major coho stocks in southern BC has been very low in recent years compared with abundance in the 1980s (Figure 15).

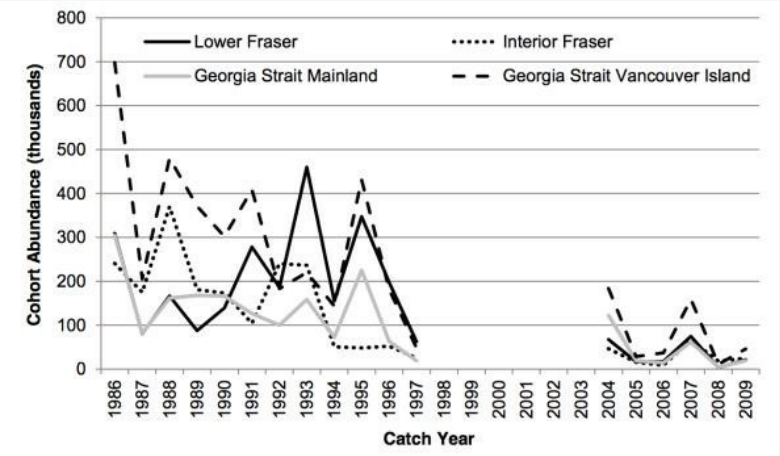

Figure 14 Estimated ocean age-3 abundances of southern BC coho salmon management units, from FRAM. Figure from Pacific Salmon Commission Coho Technical Committee Report 13-1.

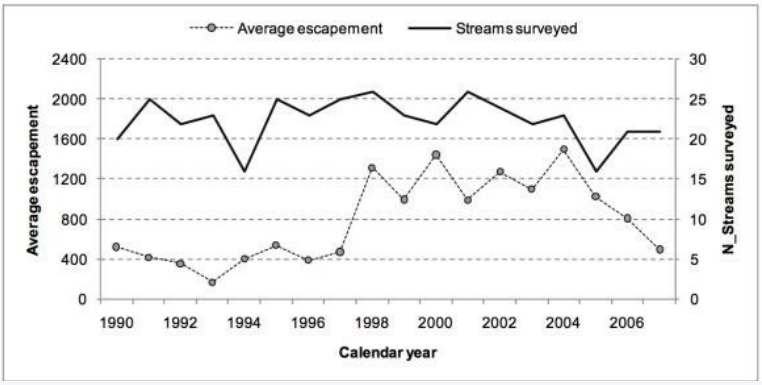

Figure 15 WCVI coho escapements (grey circles) and number of streams surveyed (black line) over time (Labelle 2009).

CANADA/NORTH COAST BC, TROLL/POLE

Moderate Concern

BC troll fisheries have not targeted coho in recent years, although coho are sometimes caught incidentally in troll fisheries targeting Chinook. The coho stocks most likely to be encountered in the North Coast BC troll fishery are North and Central Coast BC stocks, particularly Skeena River coho. Wild coho abundance in northern BC is not well documented, and there are no reference points (escapement goals). Nevertheless, there are some approximations of spawning coho abundances that suggest declines for some areas (Area 5) and stability or recovery in others (Areas 3, 4). Data are no longer collected (or reported) in some areas (Area 1 and others). Modeled aggregate abundances of North and Central Coast coho salmon increased from the 1990s to the 2000s and fluctuated about this

North and Central Coast coho abundance is judged to have a "moderate" conservation concern because abundances of some stocks have declined over time. A high concern is not warranted because there has been an increase in overall abundance, and there is relatively little coho hatchery production.

Rationale:

Coho escapement in Area 3 was approximately 50% lower during 2000-2009 (18,000 fish) compared with 1980-1989 (33,400 fish), but escapement increased substantially to 320,000 fish in 2013 (PSC JNB 2014). Escapement in Area 5, which has relatively few coho (up to 33,000 fish), has declined approximately 90% in the recent decade. Expanded coho escapement estimates for the Skeena River (Area 4) have fluctuated around 200,000 coho salmon (English et al. 2012) (Figure 16). Escapement into Area 1 has not been monitored since 2006.

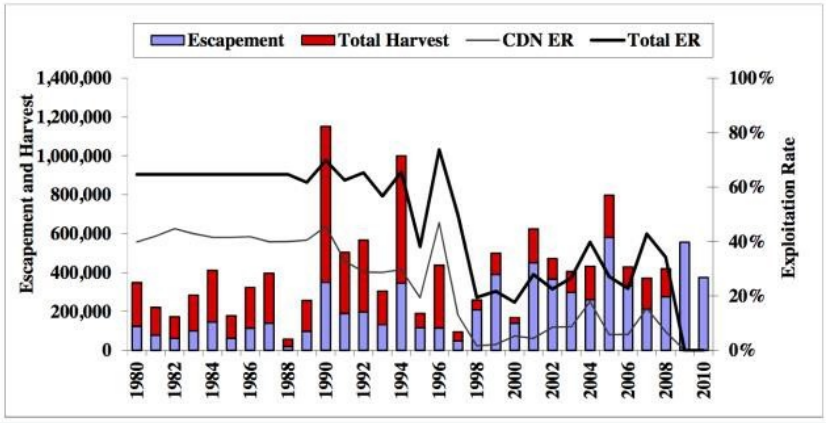

Figure 16 Escapement, harvests, and exploitation rate trends for Skeena coho (Area 4) in the North and Central Coast area of British Columbia (English et al. 2012).

In contrast to these data, preliminary analyses indicate that the summed total estimated escapement of BC North Coast coho salmon (including the central coast) increased from ~400,000 coho during the 1990s to ~600,000 coho in the 2000s (Ogden et al. 2014). The percentage of hatchery coho on the spawning grounds appears to be less than 5% (Figure 17), because there is relatively little hatchery production of coho along the North Coast.

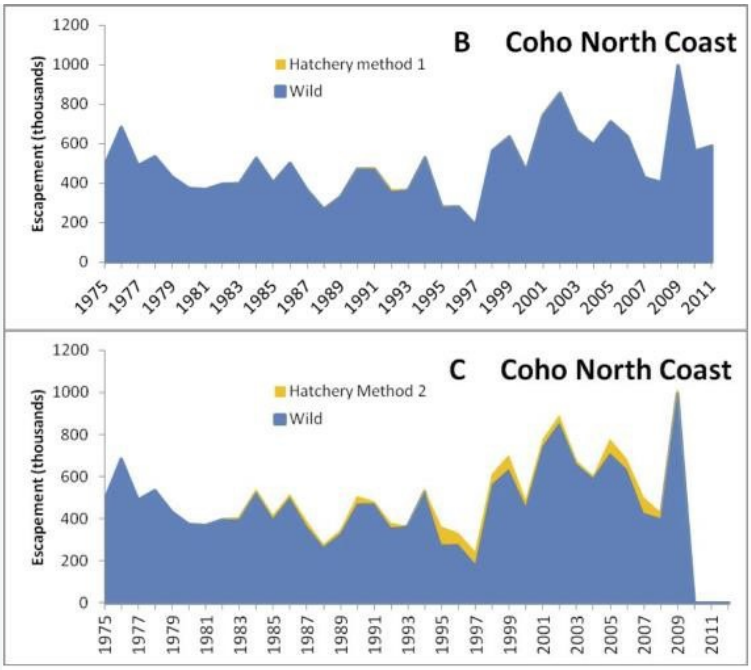

Figure 17 BC North and Central Coast coho escapements, with estimated proportions of hatchery and wild-origin fish. The proportion of hatchery-origin fish estimated using Hatchery Method 1 (B) is based on data from coded wire tags, whereas proportions estimated using Hatchery Method 2 (C) are based on reported hatchery releases (Ogden et al. 2014).

Factor 1.3 - Fishing Mortality

CANADA/SOUTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA/SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)

Moderate Concern

The basis for managing fisheries that affect wild coho originating from southern BC (and Washington and Oregon) is set out in the Pacific Salmon Treaty (DFO 2014c). Coho fisheries management is based on forecasted abundance and exploitation rates of coded-wire-tagged coho salmon hatchery stocks. Coho catches on the South Coast of BC have declined since the mid-1980s, initially because of declining abundance and more recently because of severe conservation measures in response to the declining abundance (see graph).

Fisheries in Johnstone Strait, the Strait of Juan de Fuca, and the Strait of Georgia harvest coho incidentally during directed fisheries on sockeye, pink, and chum salmon (DFO 2014c). Coho may be present in these fisheries from May through September. Non-retention of coho in commercial fisheries and time/area closures are used to minimize bycatch. Some First Nation Food, Societal, and Ceremonial (FSC) and Excess to Salmon Spawning Requirements (ESSR) fisheries may keep coho in terminal areas when abundance is sufficient. Some fisheries may keep marked hatchery coho. Assumed catch and release mortality rates for each gear type (and area) are applied to bycatch, although the level of byctach monitoring appears to be minimal (DFO 2014c).

Total fishery exploitation rates (ERs) in Canada were reduced from a range of 75% to 80% in the mid-1980s to 60% in 1995, 37% in 1997, 5% in 1998, and are currently estimated by Backwards Coho FRAM at less than 10% (PSC 2013a). Available data indicate that management is achieving its goal to limit incidental mortality on Interior Fraser River coho to 3% or less, although there is uncertainty in the exploitation estimates in Canada (Decker et al. 2014). Slightly higher exploitation on southern BC coho occurs in U.S. fisheries (Alaska and Washington), where estimates of exploitation are more precise; the mortality goal of 10% or less was achieved from 2004 through 2009 (PSC 2013a). In 2014, the Canadian exploitation rate was allowed to increase to 16% in response to larger runs in recent years; post-season estimates indicated a range from 10% to 19% and an escapement of 18,530 coho, a level that is lower than the past 3 years (DFO 2015).

Commercial fishing mortality of coho in southern BC fisheries is judged to have a "moderate" conservation concern because management has greatly reduced commercial fishing mortality on coho salmon (all gears), yet some mortality occurs on the depleted populations.

Rationale:

Southern BC coho salmon are caught in First Nations, recreational, and commercial troll and net fisheries. Because coho salmon rear in areas near the coast, they are readily caught in directed fisheries and as bycatch in fisheries targeting other species. As a result, coho are harvested in mixed-stock fisheries.

Under the abundance-based management (ABM) regime outlined in the 2008 PST Southern Coho Agreement, ERs for each Party's fisheries are to be constrained for each Management Unit, depending on status determinations provided by each Party (PSC 2013a). Under the Agreement, the Parties are required to establish escapement goals or ERs (Canada manages for coho ERs). Total ER caps are established for Management Units having a low status (up to 20% ER), moderate status (21%-40% ER) or abundant status (41&-65% ER).

CANADA/NORTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA/CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)

Low Concern

Exploitation rates (all gear types) on North and Central Coast coho were reduced substantially during the 1998 “coho crisis,” when management changes were implemented in response to low coho returns. Total exploitation rates from the Canada and U.S. combined have generally been 43% or lower since then (English et al. 2012). Exploitation rates in Canada have been about 10% (all gears).

During 2001 to 2013, approximately 88% of the commercial catch of coho salmon in North and Central Coast fisheries occurred in troll fisheries, 10% in seine fisheries, and 2% in gillnet fisheries (DFO 2014h). Northern gillnet and seine fisheries typically do not retain coho salmon, and they must release coho with “the least possible harm.” This requirement may change depending on the status of coho salmon and in some terminal areas where there is surplus of local fish (DFO 2014b). Revival tanks conforming to the Conditions of License are required. But there is little enforcement of this regulation (J. Sawada, CDFO, pers. comm., 2014).

Fishing mortality of North and Central Coast coho by gill net and seine fishers is judged to have a "low" conservation concern because these gear types typically live-release rather than retain coho salmon. Therefore, exploitation rate by these gears is low.

CANADA/WEST COAST VANCOUVER ISLAND, TROLL/POLE

Low Concern

WCVI troll fisheries have generally not targeted coho salmon since 1998 because of concerns about low returns of South Coast BC coho stocks. Total exploitation rates have been reduced significantly from about 70% to 10% (PSC 2014c), and measures are taken to reduce fishery impacts on stocks of concern. For example, WCVI fisheries are typically closed from mid-June to late August to avoid encounters with Interior Fraser River coho, Thompson River coho, and WCVI Chinook salmon.

Marked hatchery-produced coho are allowed to be retained in some fisheries targeting Chinook, which occurs in the fall when stocks of concern are not encountered (PSC 2013b) (PSC 2014a). Unmarked coho must be placed in revival boxes and released, and there are specific gear requirements aimed at reducing incidental mortality (e.g., barbless hooks) (PSC 2014a). Despite these management measures, the limited data available indicate declining population trends for these stocks, and very low current abundances (Fig. x2) (PSC 2013a). Because management is in place to protect depleted populations and fishing mortality is at a low level that may allow for population rebuilding, conservation concern was rated “low.”

Rationale:

Exploitation rates are estimated using the coho Fishery Regulation Assessment Model. Exploitation rates have been reduced significantly since 1997 (Figure 18) (PSC 2014c).

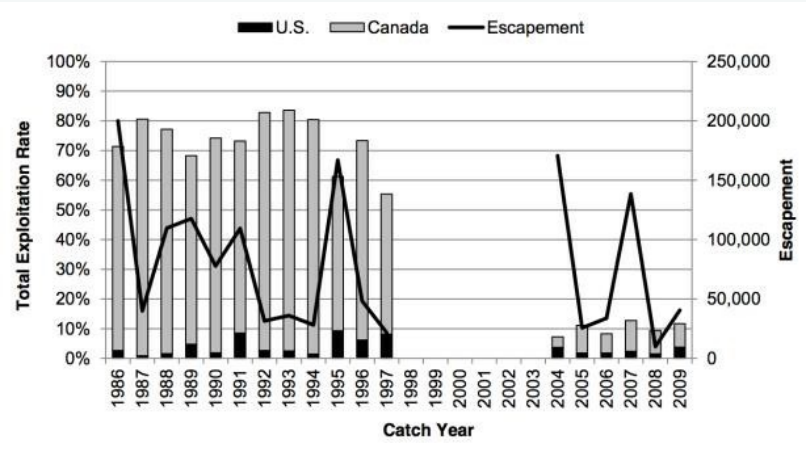

Figure 18 Estimated exploitation rates and escapements for the Strait of Georgia Vancouver Island coho management unit. Figure from Pacific Salmon Commission Coho Technical Committee report 13-1.

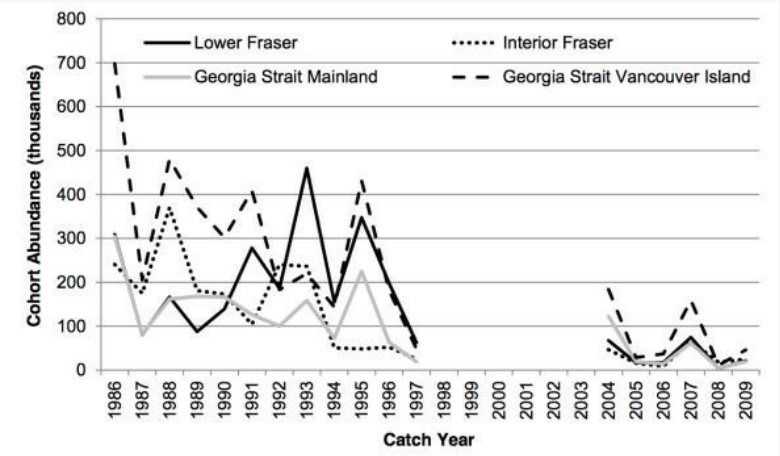

Figure 19 Estimated ocean age-3 abundances of southern BC coho salmon management units, from FRAM. Figure from Pacific Salmon

Commission Coho Technical Committee Report 13-1.

CANADA/NORTH COAST BC, TROLL/POLE

Low Concern

BC troll fisheries do not currently target coho, although North and Central Coast BC coho stocks, including Skeena coho, may be incidentally caught in the North Coast BC troll fishery targeting Chinook. Exploitation rates on North and Central Coast coho were reduced substantially during the 1998 "coho crisis," when management changes were implemented in response to low coho returns. Total exploitation rates on Skeena coho from the Canada and United States combined have generally been 43% or lower since then, and the exploitation rate was essentially 0% in 2009 and 2010 (Fig. 20) (English et al. 2012). The limited escapement data available suggest that while coho population trends are stable, stocks have not yet recovered. Because fishing mortality is at a very low level that will likely allow for population maintenance and rebuilding, and stocks appear stable, conservation concern was rated "low."

Rationale:

Commercial harvest of coho salmon occurs when abundance permits, after priorities for First Nations and recreational fisheries have been met (DFO 2014b). Under the Pacific Salmon Treaty (PST) abundance-based management regime, exploitation rates are constrained for each PST Management Unit depending on its biological status (low, moderate, or abundant). Unless other limits have been set, exploitation rates are limited to 20% or less for units with low status, 21%-40% for units with moderate status, and 41%-65% for units with abundant status. The PST also includes rules for closing Alaska and BC troll fisheries when coho catch per unit effort falls below specific thresholds (Pacific Salmon Treaty 2014).

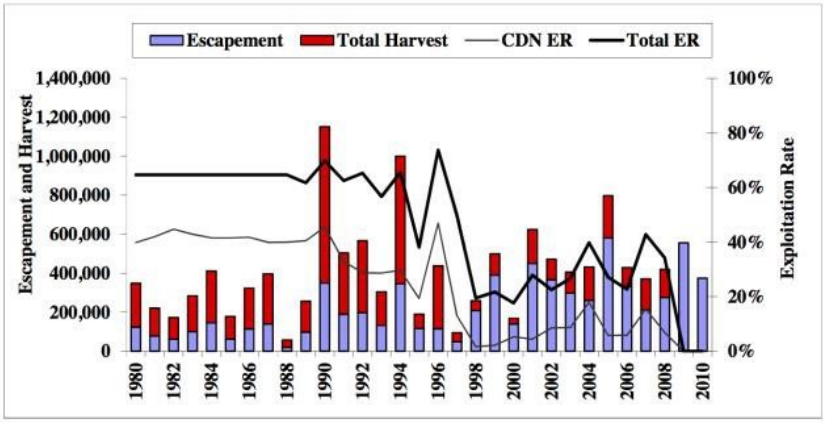

Figure 20 Escapement, harvests, and exploitation rate trends for Skeena coho (Area 4) in the North and Central Coast area of British Columbia (English et al. 2012).

COHO SALMON: TRANSBOUNDARY

Factor 1.1 - Inherent Vulnerability

CANADA, DRIFT GILLNETS (DRIFTNETS)

Medium

The FishBase vulnerability score for coho salmon is 53, making inherent vulnerability medium. The FishBase score is based on life history traits and ecological characteristics including maximum length, age at first maturity, and geographic range (Cheung et al. 2005). Coho salmon has medium vulnerability because it is widely distributed but occurs in somewhat small and isolated populations.

Factor 1.2 - Abundance

CANADA, DRIFT GILLNETS (DRIFTNETS)

Moderate Concern

Transboundary River coho salmon stocks include the fish returning to the Taku, Stikine, and Alsek Rivers (PSC 2014e). Canadian commercial fisheries occur only on the Taku and Stikine Rivers, so the Alsek River stock was not considered for scoring this factor. Coho escapement is estimated only in the Taku River through an annual mark-recapture program. Taku River escapements have been above the official minimum escapement threshold except for 1 year since 1997 (Skannes et al. 2014). Escapement monitoring in the Stikine River is conducted through indices of abundance (e.g., test fishery CPUE, partial weir counts on tributary streams, and/or limited aerial surveys). There are no hatcheries located on these rivers, so contribution of hatchery coho to the spawning estimates is thought to be negligible.

Although the Taku River stock has consistently met the management target in 14 of the past 15 years, the abundance of Transboundary coho salmon is judged to be a "moderate" conservation concern because there is no formal escapement goal for Stikine River coho and escapement for this stock is only monitored using indices of abundance, which have not been shown to be accurate (PSC 2014e).

Rationale:

Taku, Stikine, and Alsek River coho salmon stocks are managed under obligations of the Pacific Salmon Treaty. DFO (Canada) manages inriver commercial fisheries in the Taku and Stikine Rivers. There is no Canadian inriver commercial fishery in the Alsek River drainage.

The Taku River coho salmon stock assessment is classified as a full indicator stock program that includes annual estimates of smolt production, fishery contributions, and adult escapements (Shaul et al. 2011). This stock is used to index relative marine survival, total run size, marine harvest rates, and escapements to Southeast Alaska and Transboundary coho stocks. The stock was managed for a minimum escapement goal of 38,000 fish (PSC 2014e) until 2012. Escapements have been above this goal since 1998

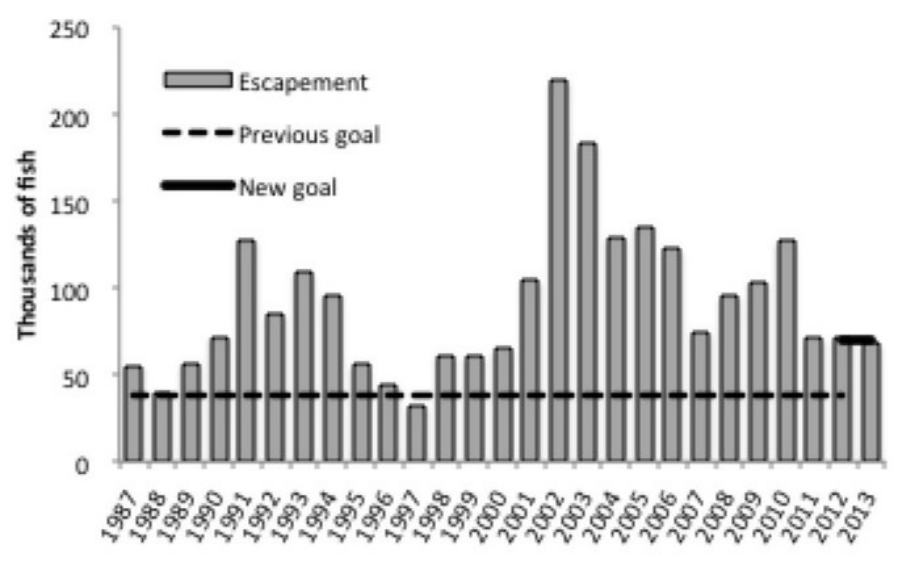

Figure 21 Taku River coho salmon spawning escapements (bars) relative to the minimum escapement target (line), 1987-2013. Data taken from (Shaul et al. 2011) and updated from (Munro and Volk 2014).

Based on a preliminary analysis of spawner-recruit data, it appeared that MSY was likely to be achieved at escapements between 60,000 and 80,000 coho salmon. Subsequently, an interim minimum escapement goal was raised to 70,000 fish in 2013 until an escapement goal is bilaterally agreed to (PSC 2014f). Escapements have been above the revised goal since 2001 except for 1 year (2013).

Relative escapement of coho salmon is monitored using indices of abundance in the Stikine River (PSC 2014e). The reliability of these indices is uncertain. Escapements to the Stikine River are indexed using test fishery CPUE (catch per unit effort) data and limited aerial survey counts (usually conducted once per season) (PSC 2014e). These indices can be influenced by environmental conditions. A formal coho escapement goal has not been adopted for the Stikine River, although an interim escapement goal of 30,000 to 50,000 fish is currently assumed for management purposes (PSC 2014f). But there is currently no means to manage the fishery in-season to achieve this goal.

Hatchery coho salmon straying into wild spawning populations has been documented in Transboundary Rivers but is not considered a significant problem. There are no hatcheries located on or hatchery coho salmon released in these systems. A study that reviewed coded wire tag recoveries from wild coho systems between 1976 and 2007 found that none of 443 tags recovered from the Taku River and 2 out of 27 tags recovered from the Stikine River were of hatchery origin (Shaul 2010).

Factor 1.3 - Fishing Mortality

CANADA, DRIFT GILLNETS (DRIFTNETS)

Moderate Concern

U.S. and Canada terminal fisheries that target coho salmon returning to the Taku, Stikine, and Alsek Rivers are managed to harvest excess salmon to spawning requirements (ESSR) provisions under the Pacific Salmon Treaty. The primary goal in these fisheries is to meet escapement requirements. The Taku River coho salmon minimum escapement goal has been consistently met since 1997; however, coho escapement goals have not been established for the Alsek and Stikine Rivers. There is no Canada commercial inriver fishery on the Alsek River, so we did not consider the Alsek River stock for this factor. Marine exploitation of Stikine coho salmon is assumed to be relative to stock abundance indicators in Southeast Alaska, including the Taku River (Shaul et al. 2011). Although Taku escapements have been

relatively stable in the short- and long-term, fishing mortality in the Transboundary BC coho fisheries is judged to have a moderate conservation concern because escapement and exploitation rate data for Stikine coho salmon are not directly estimated.

Rationale:

U.S. and Canada terminal fisheries that target salmon returning to the Taku, Stikine, and Alsek Rivers are managed to meet harvest-sharing provisions under the Pacific Salmon Treaty. The primary goal in these fisheries is to meet escapement requirements. There is no directed commercial fishery that targets Alsek coho salmon, but it is taken incidentally in U.S. commercial fisheries and in Canada sport and aboriginal fisheries in the Alsek River.

Total exploitation rates for the Taku River coho salmon stock ranged between 28% and 72% between 1992 and 2010 (Shaul et al. 2011). Most of the harvest typically occurs in the Southeast Alaska troll fishery. Canada inriver fishery exploitation rates (including commercial, recreational, and aboriginal harvests) ranged between 1% and 8% during the same time period. Most of the inriver harvest occurs in the commercial fishery and the associated test fishery (PSC 2014e).

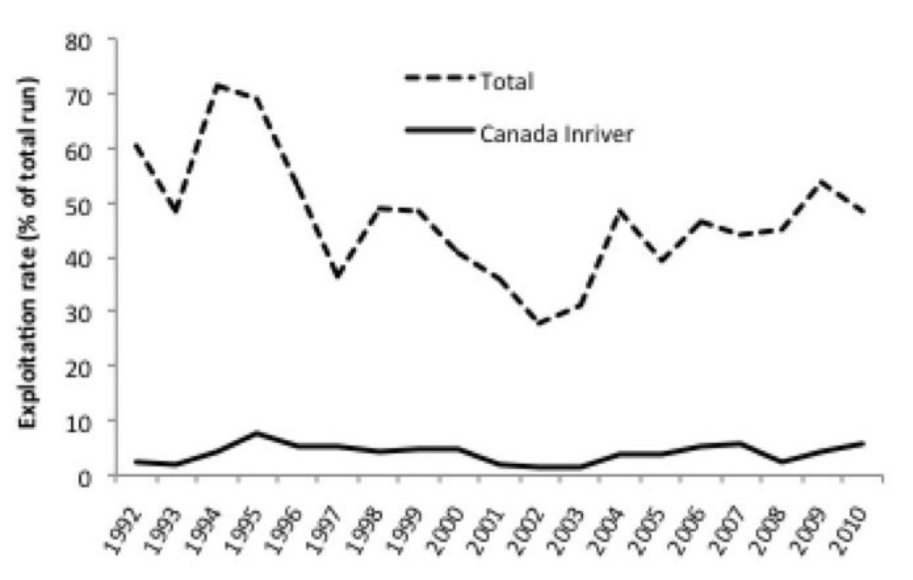

Figure 22 Estimated total and inriver (including Canada commercial, recreational, and aboriginal) fishery exploitation rates of Taku River coho salmon, 1992 & 2010. Data taken from ADFG report SP 11-23 (Shaul et al. 2011).

Criterion 2: Impacts on other species

All main retained and bycatch species in the fishery are evaluated in the same way as the species under assessment were evaluated in Criterion 1. Seafood Watch® defines bycatch as all fisheries-related mortality or injury to species other than the retained catch. Examples include discards, endangered or threatened species catch, and ghost fishing.

To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard rate score (ranges from 0-1), which evaluates the amount of non-retained catch (discards) and bait use relative to the retained catch. The Criterion 2 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and ≤3.2=Yellow or Moderate Concern*
- *Score ≤2.2=Red or High Concern*

Rating is Critical if Factor 2.3 (Fishing Mortality) is Crtitical

Criterion 2 Summary

Only the lowest scoring main species is/are listed in the table and text in this Criterion 2 section; a full list and assessment of the main species can be found in Appendix B.

CHINOOK SALMON - CANADA/CENTRAL COAST BC - DRIFT GILLNETS (DRIFTNETS)					
Subscore:	**2.709**	**Discard Rate:**	**1.00**	**C2 Rate:**	**2.709**
Species	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Subscore**	
Chum salmon	2.00:Medium	2.00:High Concern	3.67:Low Concern	Yellow (2.709)	
Coho salmon	2.00:Medium	3.00:Moderate Concern	3.67:Low Concern	Green (3.318)	

CHINOOK SALMON - CANADA/NORTH COAST BC - DRIFT GILLNETS (DRIFTNETS)					
Subscore:	**2.709**	**Discard Rate:**	**1.00**	**C2 Rate:**	**2.709**
Species	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Subscore**	
Chum salmon	2.00:Medium	2.00:High Concern	3.67:Low Concern	Yellow (2.709)	
Coho salmon	2.00:Medium	3.00:Moderate Concern	3.67:Low Concern	Green (3.318)	

CHINOOK SALMON - CANADA/NORTH COAST BC - TROLL/POLE					
Subscore:	**1.916**	**Discard Rate:**	**1.00**	**C2 Rate:**	**1.916**
Species	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Subscore**	
Chinook Salmon: Minor stock	2.00:Medium	1.00:Very High Concern	3.67:Low Concern	Red (1.916)	
Coho salmon	2.00:Medium	3.00:Moderate Concern	3.67:Low Concern	Green (3.318)	

CHINOOK SALMON - CANADA/SOUTH COAST BC - DRIFT GILLNETS (DRIFTNETS)					
Subscore:	**1.526**	**Discard Rate:**	**1.00**	**C2 Rate:**	**1.526**
Species	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Subscore**	
Coho Salmon: Minor stock	2.00:Medium	1.00:Very High Concern	2.33:Moderate Concern	Red (1.526)	
Coho salmon	2.00:Medium	2.00:High Concern	2.33:Moderate Concern	Red (2.159)	

CHINOOK SALMON - CANADA/SOUTH COAST BC - UNASSOCIATED PURSE SEINE					
Subscore:	**1.916**	**Discard Rate:**	**1.00**	**C2 Rate:**	**1.916**
Species	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Subscore**	
Coho Salmon: Minor stock	2.00:Medium	1.00:Very High Concern	3.67:Low Concern	Red (1.916)	
Coho salmon	2.00:Medium	2.00:High Concern	2.33:Moderate Concern	Red (2.159)	

CHINOOK SALMON - CANADA/WEST COAST VANCOUVER ISLAND - TROLL/POLE					
Subscore:	**1.000**	**Discard Rate:**	**1.00**	**C2 Rate:**	**1.000**
Species	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Subscore**	
Chinook Salmon: Minor stock	2.00:Medium	1.00:Very High Concern	1.00:High Concern	Red (1.000)	
Coho Salmon: Minor stock	2.00:Medium	1.00:Very High Concern	3.67:Low Concern	Red (1.916)	

Coho salmon	2.00:Medium	2.00:High Concern	3.67:Low Concern	Yellow (2.709)

CHINOOK SALMON: TRANSBOUNDARY - CANADA - DRIFT GILLNETS (DRIFTNETS)					
Subscore:	**2.159**	**Discard Rate:**	**1.00**	**C2 Rate:**	**2.159**

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
Chum Salmon: Transboundary	2.00:Medium	2.00:High Concern	2.33:Moderate Concern	Red (2.159)
Coho Salmon: Transboundary	2.00:Medium	3.00:Moderate Concern	2.33:Moderate Concern	Yellow (2.644)

COHO SALMON - CANADA/CENTRAL COAST BC - DRIFT GILLNETS (DRIFTNETS)					
Subscore:	**2.709**	**Discard Rate:**	**1.00**	**C2 Rate:**	**2.709**

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
Chum salmon	2.00:Medium	2.00:High Concern	3.67:Low Concern	Yellow (2.709)
Chinook salmon	2.00:Medium	3.00:Moderate Concern	3.67:Low Concern	Green (3.318)

COHO SALMON - CANADA/NORTH COAST BC - TROLL/POLE					
Subscore:	**1.916**	**Discard Rate:**	**1.00**	**C2 Rate:**	**1.916**

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
Chinook Salmon: Minor stock	2.00:Medium	1.00:Very High Concern	3.67:Low Concern	Red (1.916)
Chinook salmon	2.00:Medium	3.00:Moderate Concern	2.33:Moderate Concern	Yellow (2.644)

COHO SALMON - CANADA/NORTH COAST BC - UNASSOCIATED PURSE SEINE					
Subscore:	**2.709**	**Discard Rate:**	**1.00**	**C2 Rate:**	**2.709**

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
Chum salmon	2.00:Medium	2.00:High Concern	3.67:Low Concern	Yellow (2.709)
Chinook salmon	2.00:Medium	3.00:Moderate Concern	3.67:Low Concern	Green (3.318)

COHO SALMON - CANADA/SOUTH COAST BC - DRIFT GILLNETS (DRIFTNETS)					
Subscore:	**1.526**	**Discard Rate:**	**1.00**	**C2 Rate:**	**1.526**

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
Coho Salmon: Minor stock	2.00:Medium	1.00:Very High Concern	2.33:Moderate Concern	Red (1.526)
Chinook salmon	2.00:Medium	2.00:High Concern	2.33:Moderate Concern	Red (2.159)

COHO SALMON - CANADA/SOUTH COAST BC - UNASSOCIATED PURSE SEINE					
Subscore:	**1.916**	**Discard Rate:**	**1.00**	**C2 Rate:**	**1.916**

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
Coho Salmon: Minor stock	2.00:Medium	1.00:Very High Concern	3.67:Low Concern	Red (1.916)
Chinook salmon	2.00:Medium	2.00:High Concern	2.33:Moderate Concern	Red (2.159)

COHO SALMON - CANADA/WEST COAST VANCOUVER ISLAND - TROLL/POLE					
Subscore:	**1.000**	**Discard Rate:**	**1.00**	**C2 Rate:**	**1.000**

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
Chinook Salmon: Minor stock	2.00:Medium	1.00:Very High Concern	1.00:High Concern	Red (1.000)
Coho Salmon: Minor stock	2.00:Medium	1.00:Very High Concern	3.67:Low Concern	Red (1.916)
Chinook salmon	2.00:Medium	3.00:Moderate Concern	2.33:Moderate Concern	Yellow (2.644)

COHO SALMON: TRANSBOUNDARY - CANADA - DRIFT GILLNETS (DRIFTNETS)					
Subscore:	**2.159**	**Discard Rate:**	**1.00**	**C2 Rate:**	**2.159**

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
Chum Salmon: Transboundary	2.00:Medium	2.00:High Concern	2.33:Moderate Concern	Red (2.159)
Chinook Salmon: Transboundary	2.00:Medium	5.00:Very Low Concern	3.67:Low Concern	Green (4.284)

Southern BC

Several depleted Chinook stocks may be caught in BC South Coast fisheries, including WCVI natural, Fraser River early, Puget Sound natural, and Snake River fall Chinook {PSC 2014d}. WCVI natural Chinook and some Fraser River early stock groups (Spring 4.2, Spring 5.2, Summer 5.2) are stocks of concern because of low escapements {DFO 2014a}. Puget Sound natural and Snake River fall Chinook are both listed under the U.S. Endangered Species Act as "Threatened" {NOAA 2014}. But in this area, Interior Fraser coho is the primary stock of concern in both Chinook and coho fisheries because of its determination as an "Endangered" stock by COSEWIC {COSEWIC 2014}.

Non-target species with depleted stocks that may be encountered in South Coast fisheries include sockeye salmon (Cultus Lake, Sakinaw Lake; designated by COSEWIC as "Endangered"), steelhead (Interior Fraser River), and some inshore rockfish species {DFO 2014c}. But catches of these species are likely very limited for fisheries targeting Chinook and coho, and the 2014 Integrated Fisheries Management Plan (IFMP) describes management measures for limiting incidental harvest {DFO 2014c}. DFO has developed recovery plans for COSEWIC stocks of concern (Interior Fraser coho, Cultus Lake sockeye, and Sakinaw Lake sockeye).

Northern and Central BC

Wild coho abundance in North and Central BC is not well documented, but available information suggests that escapements are stable {Ogden et al. 2014}. Interior Fraser coho, considered to be "Endangered" by COSEWIC, is unlikely to be encountered in this area.

Other non-target species with depleted stocks that may be encountered in northern BC fisheries include sockeye salmon (Rivers and Smith Inlet, Skeena River, Nass River), chum salmon (North Coast chum), steelhead (Skeena River), and some inshore rockfish species. But catches of these species are likely very limited for troll fisheries targeting Chinook and coho, and the 2014 Integrated Fisheries Management Plan (IFMP) describes management measures for limiting incidental harvest {DFO 2014c}. North Coast chum may be caught in purse seines and gillnets and is evaluated under Criterion 2 for ISBM fisheries.

Criterion 2 Assessment

SCORING GUIDELINES

Factor 2.1 - Inherent Vulnerability

(same as Factor 1.1 above)

Factor 2.2 - Abundance

(same as Factor 1.2 above)

Factor 2.3 - Fishing Mortality

(same as Factor 1.3 above)

Chum salmon

Factor 2.1 - Inherent Vulnerability

CANADA/NORTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA/NORTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA/CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)

Medium

The FishBase vulnerability score for chum salmon is 49, making inherent vulnerability medium. The FishBase score is based on life history traits and ecological characteristics including maximum length, age at first maturity, and geographic range (Cheung et al. 2005).

Factor 2.2 - Abundance

CANADA/NORTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA/NORTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA/CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)

High Concern

Abundances of North and Central Coast wild chum stocks have been depressed for at least a decade (DFO 2014b) (PSC 2014b). For example, in 2013, chum salmon escapement to Areas 3, 4, and 5 (i.e., including the Nass and Skeena Rivers) was only 16,399 chum salmon (PSC 2014b). The minimum escapement goal for the Nass River is 30,000 chum, indicating that chum abundance is well below the Nass River goal. Chum escapement to the Skeena River conservation units has been below the targeted goal (Korman, J. and K. English 2013). Chum returning to the Nass and Skeena Rivers are stocks of concern. Formal spawning escapement goals have not been established for chum in most areas of the North and Central Coast. Chum salmon are therefore considered to be the key Criterion 2 species for ISBM Chinook and coho fisheries along the North and Central Coast of British Columbia. The abundance concern for chum is "high" because spawning escapements remain relative low.

Factor 2.3 - Fishing Mortality

CANADA/NORTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA/NORTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA/CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)

Low Concern

Relatively few chum are incidentally caught in net fisheries that target Chinook or coho salmon in this region. By regulation, chum are not retained in most areas unless abundance in terminal areas is determined to be sufficient, such as in a hatchery terminal area (DFO 2014b). Exploitation rates are typically very low in British Columbia (English et al. 2012). Fishing mortality is judged have a "low" conservation concern. A very low concern is not warranted because some chum mortality occurs in the fisheries, there is some uncertainty in this mortality, and chum abundance in this region is very low.

Factor 2.4 - Discard Rate

CANADA/NORTH COAST BC, UNASSOCIATED PURSE SEINE

< 20%

Purse seine fisheries may catch all Pacific salmon species, and in BC fisheries, Chinook, coho, sockeye, chum, and steelhead may be released (DFO 2014b). BC fisheries are required to use revival boxes for released fish, although there is limited enforcement. In the 2013 BC North Coast purse seine fishery, there were an estimated 959 incidental mortalities of Chinook (PSC 2014a). Incidental mortality data for other species were not found. Determining the total numbers of fish landed is not straightforward because of the diversity of species caught, but the ratio of dead discards to landed fish is thought to be below 20%.

Rationale:

For all species, the estimated post-release discard mortality rate for BC commercial seine fisheries is 15% (DFO 2014b).

For Chinook salmon, incidental mortalities are estimated using logbook data on releases and size-specific mortality rates from the Pacific Salmon Commission Joint Chinook Technical Committee (PSC 1997).

CANADA/NORTH COAST BC, DRIFT GILLNETS (DRIFTNETS)

< 20%

Gillnet fisheries may catch all Pacific salmon species, and in BC fisheries, Chinook, coho, sockeye, chum, and steelhead may be released (DFO 2014b). BC fisheries are required to use revival boxes for released fish, although there is limited enforcement. In the 2013 BC North Coast gillnet fishery, there were an estimated 356 incidental mortalities of Chinook (PSC 2014a). Incidental mortality data for other species were not found, although 2,226 coho were released in the 2013 BC northern net fishery (PFMC 2014). Determining the total numbers of fish landed is not straightforward because of the diversity of species caught, but the ratio of dead discards to landed fish is thought to be below 20%.

Rationale:

The estimated post-release mortality rate for northern BC commercial gillnet fisheries is 60%, with provisions for rates as low as 26% (DFO 2014b) when appropriate selective techniques are used.

For Chinook salmon, incidental mortalities are estimated using logbook data on releases and size-specific mortality rates from the Pacific Salmon Commission Joint Chinook Technical Committee (PSC 1997).

CANADA/CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)

< 20%

Gillnet fisheries may encounter all Pacific salmon species, and in BC fisheries, Chinook, coho, sockeye, chum, and steelhead may be released (DFO 2014b). BC fisheries are required to use revival boxes for released fish, although there is limited enforcement. In the 2013 BC Central Coast gillnet fishery, there were an estimated 644 incidental mortalities of Chinook (PSC 2014a). Incidental mortality data for other species were not found, although 24,717 coho were released in the 2013 BC Central net fishery (PFMC 2014). Determining the total numbers of fish landed is not straightforward because of the diversity of species caught, but the ratio of dead discards to landed fish is thought to be below 20%.

Rationale:

The estimated post-release mortality rate for northern BC commercial gillnet fisheries is 60%, with provisions for rates as low as 26% (DFO 2014b) when appropriate selective techniques are used.

For Chinook salmon, incidental mortalities are estimated using logbook data on releases and size-specific mortality rates from the Pacific Salmon Commission Joint Chinook Technical Committee (PSC 1997).

Chum Salmon: Transboundary

Factor 2.1 - Inherent Vulnerability

CANADA, DRIFT GILLNETS (DRIFTNETS)

Medium

The FishBase vulnerability score for chum salmon is 49, making inherent vulnerability medium. The FishBase score is based on life history traits and ecological characteristics including maximum length, age at first maturity, and geographic range (Cheung et al. 2005). Chum salmon has medium vulnerability because although it is a relatively large salmon, it has the widest natural geographic distribution of all Pacific salmon species.

Factor 2.2 - Abundance

CANADA, DRIFT GILLNETS (DRIFTNETS)

High Concern

Chum salmon is incidentally caught in the Taku and Stikine Rivers commercial fisheries, but information on the status of chum is limited (PSC 2014e). Available information indicates that Taku River fall-run chum salmon has been depressed for over two decades (Piston and Heinl 2014). In contrast, Stikine River summer-run chum salmon stocks are relatively stable (Johannes 2011). The abundance of Transboundary chum salmon is judged to have a "high" conservation concern because abundance is unknown, but the Taku fall-run has likely been below the escapement goal, based on available information.

Rationale:

Chum salmon are incidentally caught in the Taku and Stikine Rivers commercial fisheries, but information on the status of these stocks is lacking (PSC 2014e). Taku River chum salmon is classified as fall-run that is typically caught during the fall coho fishery (Piston and Heinl 2014). In contrast, Stikine River chum is considered summer-run and is typically caught during the sockeye fishery (PSC 2014e). Taku River chum salmon runs have been depressed since the late 1990s. Currently, Canyon Island fish wheel catches are used to monitor relative abundance of chum salmon above the Canada border. This information and catch of chum salmon-per-boat-day in the U.S. fall drift gillnet fishery indicate that runs declined dramatically between 1987 and 1992 and have not rebounded.

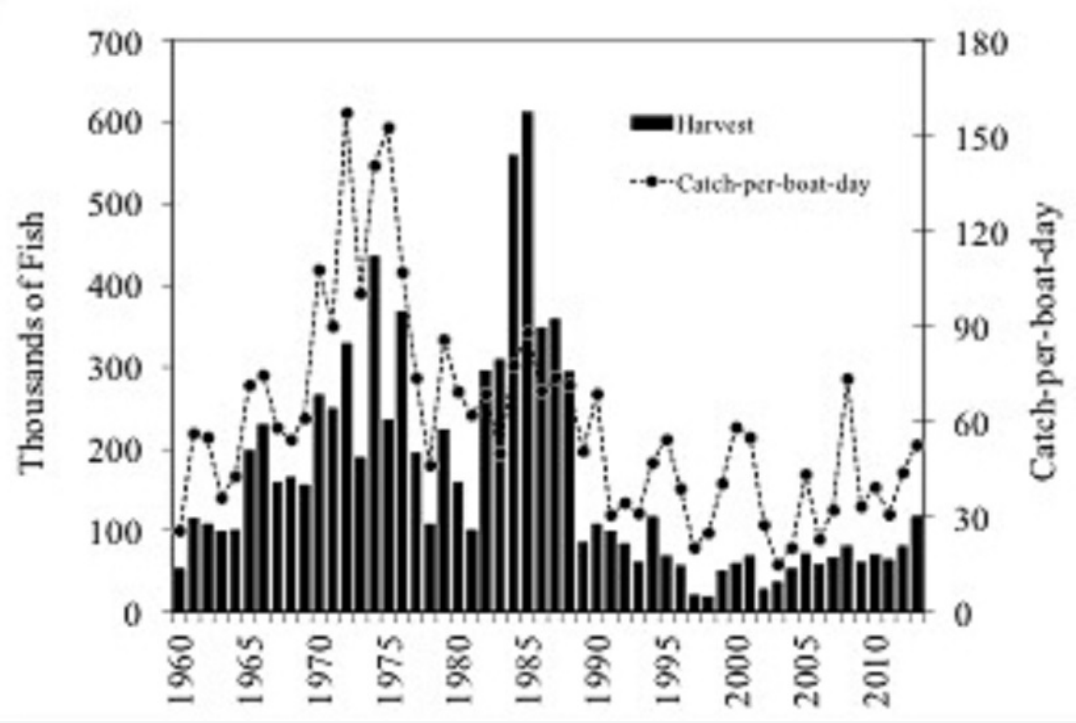

Figure 23 U.S. commercial drift gillnet catch-per-boat-day of fall-run chum salmon in Taku Inlet plotted with Taku River fish wheel chum salmon catch, 1987-2013. Figure from Alaska Department of Fish and Game special publication 14-13 (Piston and Heinl 2014).

An escapement goal of 50,000 to 80,000 chum salmon was adopted by the Transboundary Technical Committee in the mid-1980s, but there is currently no way to estimate escapements relative to this goal. It is unlikely that this goal has been achieved in recent years (PSC 2014e). Available information on the status of Stikine River summer-run chum salmon suggests that the population has been relatively stable or increasing in recent years. Alaska Department of Fish and Game has monitored chum salmon escapements into North Arm Creek, a lower tributary of the Stikine River, since 1960 (Piston and Heinl 2014). Counts have been variable but have been relatively high in recent years.

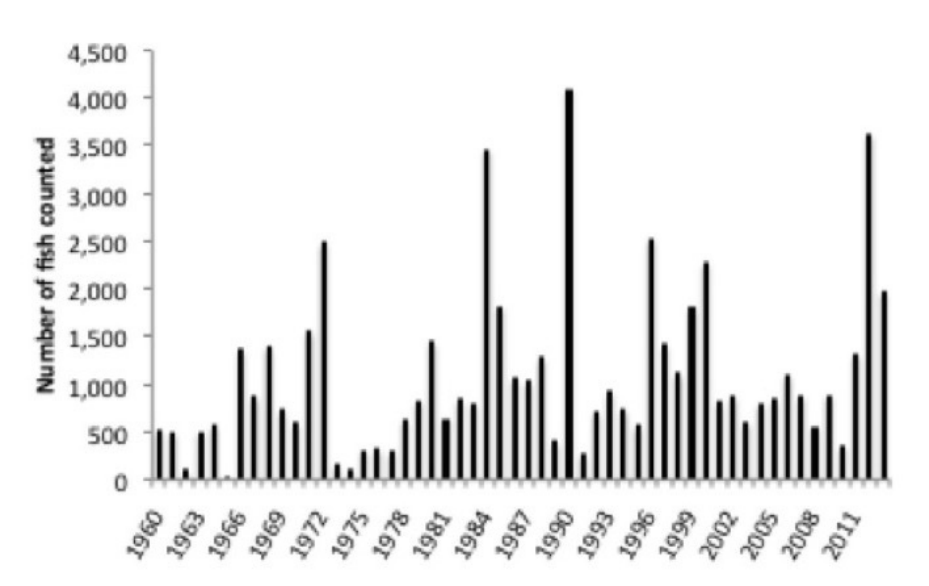

Figure 24 Number of chum salmon counted in North Arm Creek, a lower tributary of the Stikine River, 1960-2013. Data taken from Alaska Department of Fish and Game special publication 14-13 (Piston and Heinl 2014).

The best index of inriver chum salmon abundance within Canada is the test fishery just above the border.

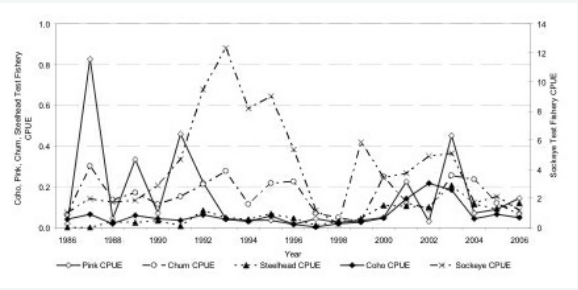

Figure 25 Lower Stikine River test fishery catch-per-unit-effort (CPUE), 1986-2006 (Johannes 2011).

Catch-per-unit-effort data suggest that chum abundance has been variable but similar to long-term averages (Johannes 2011). An escapement goal for Stikine River chum salmon has not been developed (PSC 2014e).

Factor 2.3 - Fishing Mortality

CANADA, DRIFT GILLNETS (DRIFTNETS)

Moderate Concern

U.S. and Canada terminal fisheries that target salmon returning to the Taku, Stikine, and Alsek Rivers are managed to meet harvest-sharing provisions under the Pacific Salmon Treaty. But there are no harvest-sharing provisions for chum salmon in these rivers. Chum salmon may not be retained in the Taku commercial inriver fishery because the stock is considered depressed (PSC 2014e). Chum salmon may be retained in the Stikine commercial inriver fishery, but the majority is voluntarily released (PSC 2014e). Post-release mortality of released chum salmon in these fisheries has not been directly estimated. Other studies estimated post-release mortality in commercial gillnet fisheries at 60%, or as low as 26% using selective harvest methods (DFO 2014b). One study found that chum is more resilient to handling and air exposure (Raby et al. 2013). Fishing mortality of chum salmon in the Transboundary BC fisheries is judged to have a "moderate" conservation concern, because the fishery contribution to mortality is unknown but is likely greater than 5%, and because at least one population is considered depleted.

Factor 2.4 - Discard Rate

CANADA, DRIFT GILLNETS (DRIFTNETS)

< 20%

Gillnet fisheries may catch all Pacific salmon species. Chinook, coho, and sockeye are generally retained in Transboundary gillnet fisheries, while chum, pink and steelhead are released (Davidson et al. 2013). Data on incidental mortality of pink, chum, and steelhead are not readily available, but these species made up 2%, 6%, and 1% of the catch, respectively, in a 2012 lower Stikine test fishery (Davidson et al. 2013), suggesting that fishery encounters are not very common. Determining the total numbers of fish landed is not straightforward because of the diversity of species caught, but the overall discard mortality rate is likely less than 20%.

Rationale:

For Chinook salmon, incidental mortalities are estimated using logbook data on releases and size-specific mortality rates from the Pacific Salmon Commission Joint Chinook Technical Committee (PSC 1997). The 2013 Chinook discard mortality rate for the Transboundary net fishery was estimated at 1% (58 incidental mortalities divided by 4,858 fish landed) (PSC 2014a). Coho discard mortalities are not estimated directly, but studies suggest that discard mortality can be reduced to well below 20% when revival boxes are used (Buchanan et al. 2002). BC fisheries are required to use revival boxes, although there is limited enforcement. Sockeye salmon is the primary target species in the Transboundary rivers, so intentional discards are rare. Fall chum salmon is occasionally caught in the inriver fisheries but is

not allowed to be retained.

Coho Salmon: Minor stock

Factor 2.1 - Inherent Vulnerability

CANADA/SOUTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA/SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA/NORTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA/NORTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA/CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA/WEST COAST VANCOUVER ISLAND, TROLL/POLE
CANADA/NORTH COAST BC, TROLL/POLE
CANADA, DRIFT GILLNETS (DRIFTNETS)
CANADA/SOUTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA/SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA/WEST COAST VANCOUVER ISLAND, TROLL/POLE

Medium

The FishBase vulnerability score for coho salmon is 53, making inherent vulnerability medium. The FishBase score is based on life history traits and ecological characteristics including maximum length, age at first maturity, and geographic range (Cheung et al. 2005). Coho salmon has medium vulnerability because it is widely distributed but occurs in somewhat small and isolated populations.

Factor 2.2 - Abundance

CANADA/SOUTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA/SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)

Very High Concern

The Interior Fraser River population of coho salmon was determined as "Endangered" by COSEWIC in 2002, and this conclusion was upheld in the last COSEWIC assessment conducted in 2006 (COSEWIC 2014) (Decker and Irvine 2013) (Decker et al. 2014). This is the primary stock of concern managed in this area, though other wild coho salmon in the Strait of Georgia remain a stock of concern and must be released. Interior Fraser coho has not been listed as "Endangered" by the Species at Risk Act (SARA) because of potential socioeconomic impacts on resource users (Canada Gazette 2006). Escapements of Interior Fraser coho declined sharply from the late 1980s to mid-1990s and have fluctuated around a low but stable level since then (Fig. 26) (Decker et al. 2014). Most escapements since 2008 have exceeded the short-term recovery objective of 20,000 spawners, though they have not yet reached the long-term objective of 40,000 spawners (Decker et al. 2014). A new COSEWIC assessment is expected to be completed in 2015 (CSAS 2014). Although there are some indications of increasing escapement, the abundance of Interior Fraser coho salmon is judged to be a "very high" conservation concern because the stock is still considered depleted.

Rationale:

According to the website, COSEWIC determined that Interior Fraser coho is 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 continues, and that use of hatcheries threatens recovery. COSEWIC concluded that there is a serious risk of extinction of Interior Fraser coho.” Escapements of Interior Fraser coho are shown in Figure 26.

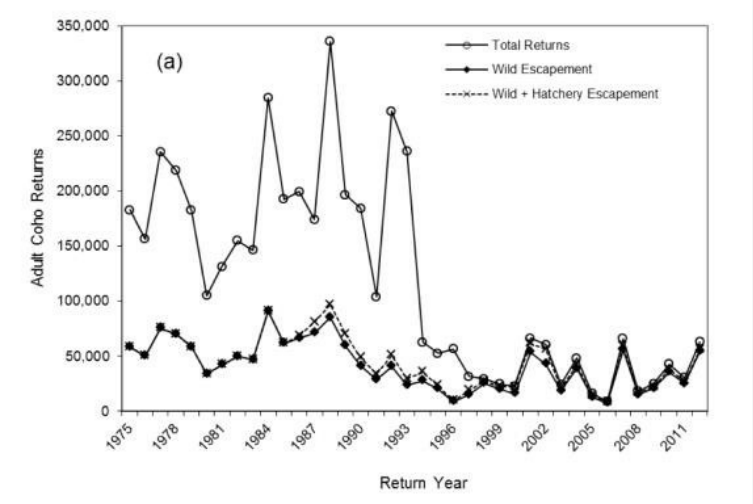

Figure 26 Reconstructed time series of wild coho salmon escapements, total escapements (wild + hatchery fish), and total returns (total escapement + catch) for the interior Fraser River watershed from 1975 to 2012 (Decker et al. 2014).

Other key weak salmon stocks potentially occurring in southern BC salmon fisheries, if they are prosecuted, include Cultus Lake sockeye (COSEWIC "Endangered") and Sakinaw Lake sockeye (COSEWIC "Endangered"), and Puget Sound Chinook (ESA "Threatened"). A number

of southern BC Chinook populations are identified as stocks of conservation concern, including wild Chinook along the West Coast of Vancouver Island (PSC 2014a) (Riddell 2013).

CANADA/WEST COAST VANCOUVER ISLAND, TROLL/POLE

Very High Concern

The only coho stock of concern caught in this fishery is Interior Fraser River coho. This population was determined as "Endangered" by COSEWIC in 2002, and this conclusion was upheld in the last COSEWIC assessment conducted in 2006 (COSEWIC 2014) (Decker and Irvine 2013) (Decker et al. 2014). Interior Fraser coho has not been listed as "Endangered" by the Species at Risk Act (SARA) because of potential socioeconomic impacts on resource users (Canada Gazette 2006). Escapements of Interior Fraser coho declined sharply from the late 1980s to mid-1990s and have fluctuated around a low but stable level since then (Fig. 27) (Decker et al. 2014). Escapements since 2008 have exceeded the short-term recovery objective of 20,000 spawners, though they have not yet reached the long-term objective of 40,000 spawners (Decker et al. 2014). A new COSEWIC assessment is expected to be completed in 2015 (CSAS 2014). Although there are some indications of increasing escapement, the abundance of Interior Fraser coho salmon is judged to be a "very high" conservation concern because the stock is still considered depleted.

Rationale:

According to their website, COSEWIC determined that Interior Fraser coho is 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 2014). 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 continues, and that use of hatcheries threatens recovery. COSEWIC concluded that there is a serious risk of extinction of Interior Fraser coho.” Escapements for Interior Fraser coho are shown in Figure 27.

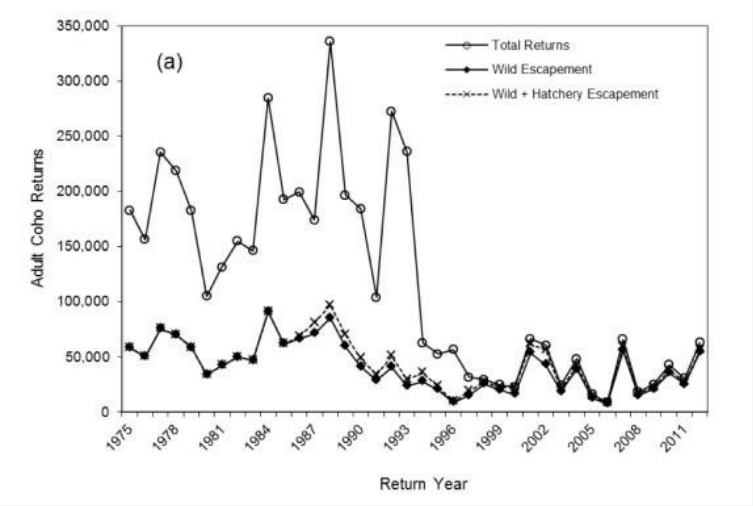

Figure 27 Reconstructed time series of wild coho salmon escapements, total escapements (wild + hatchery fish), and total returns (total escapement + catch) for the interior Fraser River watershed from 1975 to 2012 (Decker et al. 2014).

Factor 2.3 - Fishing Mortality

CANADA/SOUTH COAST BC, UNASSOCIATED PURSE SEINE

Low Concern

Interior Fraser coho is primarily taken as bycatch in fisheries targeting other species of salmon (Decker et al. 2014). Wild coho salmon must be live-released, but released fish may be more susceptible to mortality by marine mammals. The absence of directed fisheries on coho salmon in recent years has led to less monitoring and increased uncertainty in incidental exploitation rates on coho salmon. Modeled total exploitation rate averaged 11% during 2005-2009, of which 2.9% occurred in Canadian fisheries (i.e., within the goal of 3% or less) and 8.1% occurred in U.S. fisheries (PSC 2013a). In British Columbia, very little exploitation occurs in each fishery (<1% ER per fishery, North and South). Higher exploitation rates occur in U.S. fisheries, primarily those along the Washington coast (troll) and the San Juan Islands (net). In 2014, somewhat higher incidental exploitation of Interior coho was allowed because the coho spawning level was relatively high in 2013, and there was a strong desire to harvest the large return of Fraser sockeye salmon (J. Sawada, CDFO, pers. comm., 2014).

Fishing mortality on Interior Fraser coho salmon in British Columbia is judged to be a "low" concern because management has taken actions to reduce coho catch, and Canadian exploitation is typically less than the goal of 3% (goal established when abundance is considered to meet critically low status, as defined in the management plan). There are no directed coho fisheries in Southern BC (PSC 2013a). Coho bycatch in other BC salmon fisheries typically requires live release. The purse seine gear type is not likely to be involved in illegal fishing, therefore it does not warrant a moderate concern.

Rationale:

Fishing mortality was a key factor leading to the decline in Interior Fraser coho. Beginning in 1998, domestic (Canadian) and U.S. exploitation rates declined significantly and have halted the decline in the population. Nevertheless, in several recent years when productivity was below replacement (<1 recruit/spawner), even relatively modest exploitation contributed to negative population growth (Decker et al. 2014). The paucity of catch data in recent years, and the resultant high uncertainty in current estimates of domestic and U.S. exploitation rates, also places Interior Fraser Coho at risk, because current indices may not be sensitive enough to detect year-to-year changes in exploitation that could arise from factors such as changes in fishing regulations or fishing effort, or changes in the marine

distribution and migration timing of Interior Fraser Coho. Exploitation estimates for Interior Fraser Coho are also biased low to some degree because of unmonitored terminal fisheries upstream of Hells Gate and illegal fishing, which are not accounted for in current exploitation models. Uncertainties about survival of coho salmon released as bycatch in fisheries targeting other salmon species, and about survival of released wild coho salmon in recreational fisheries where only hatchery-marked coho may be retained, are additional sources of unquantified error in exploitation rate estimates. For the Interior Fraser Coho aggregate, the mean proportion of hatchery fish in escapements for the most recent generation (2009-2011) was 7%, compared to 15% at the time of the original COSEWIC assessment (1998-2000). Earlier studies had concluded that enhancement had a relatively minor impact on Interior Fraser coho.

CANADA/SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)

Moderate Concern

Interior Fraser coho is primarily taken as bycatch in fisheries targeting other species of salmon (Decker et al. 2014). Wild coho salmon must be live-released, but released fish may be more susceptible to mortality by marine mammals (Decker et al. 2014). The absence of directed fisheries on coho salmon in recent years has led to less monitoring and increased uncertainty in incidental exploitation rates on coho salmon. Modeled total exploitation rate averaged 11% during 2005-2009, of which 2.9% occurred in Canadian fisheries (i.e., within the goal of 3% or less) and 8.1% occurred in U.S. fisheries (PSC 2013a). A 3% ER in Canada is assumed to help achieve recovery. In British Columbia, very little exploitation occurs in each fishery (<1% ER per fishery, North and South). Higher exploitation rates occur in U.S. fisheries, primarily those along the Washington coast (troll) and the San Juan Islands (net). In 2014, somewhat higher incidental exploitation of Interior coho was allowed because the coho spawning level was relatively high in 2013, and there was a strong desire to harvest the large return of Fraser sockeye salmon (J. Sawada, CDFO, pers. comm., 2014).

Fishing mortality on Interior Fraser coho salmon in British Columbia is judged to be a "moderate" concern. Management has taken actions to reduce coho catch, and Canadian exploitation is typically less than the goal of 3% (goal established when abundance is considered to meet critically low status as defined in the management plan). There are no directed coho fisheries in Southern BC (PSC 2013a). Coho bycatch in other BC salmon fisheries typically requires live release. But the significance of impacts attributed to unmonitored and, especially, illegal fisheries is unknown---this raises the conservation concern to moderate.

Rationale:

Fishing mortality was a key factor leading to the decline in Interior Fraser coho. Beginning in 1998, domestic (Canadian) and U.S. exploitation rates declined significantly and have halted the decline in the population. Nevertheless, in several recent years, when productivity was below replacement (<1 recruit/spawner), even relatively modest exploitation contributed to negative population growth (Decker et al. 2014). The paucity of catch data in recent years, and the resultant high uncertainty in current estimates of domestic and U.S. exploitation rates, also places Interior Fraser Coho at risk, because current indices may not be sensitive enough to detect year-to-year changes in exploitation that could arise from factors such as changes in fishing regulations or fishing effort, or changes in the marine distribution and migration timing of Interior Fraser Coho. Exploitation estimates for Interior Fraser Coho are also biased low to some degree because of unmonitored terminal fisheries upstream of Hells Gate and illegal fishing, which are not accounted for in current exploitation models. Uncertainties about survival of coho salmon released as bycatch in fisheries targeting other salmon species, and about survival of released wild coho salmon in recreational fisheries where only hatchery-marked coho may be retained, are additional sources of unquantified error in exploitation rate estimates. For the Interior Fraser Coho aggregate, the mean proportion of hatchery fish in escapements for the most recent generation (2009-2011) was 7%, compared to 15% at the time of the original COSEWIC assessment (1998-2000). Earlier studies had concluded that enhancement had a relatively minor impact on Interior Fraser coho.

CANADA/WEST COAST VANCOUVER ISLAND, TROLL/POLE

Low Concern

There are no directed coho fisheries in Southern BC, and Interior Fraser coho is primarily taken as bycatch in fisheries targeting other species of salmon (PSC 2013a) (Decker et al. 2014). Wild coho salmon must be live-released, but released fish may be more susceptible to mortality by marine mammals (Ashbrook 2008). The absence of directed fisheries on coho salmon in recent years has led to less monitoring and increased uncertainty in incidental exploitation rates on coho salmon. Modeled total exploitation rates averaged 11% during 2005-2009, of which 2.9% occurred in Canadian fisheries (i.e., within the ceiling of 3%) and 8.1% occurred in U.S. fisheries (PSC 2013a). In British Columbia, very little exploitation (<1%) occurs in each of the North and South Coast salmon fisheries. Higher exploitation rates occur in U.S. fisheries, primarily those along the Washington coast (troll) and the San Juan Islands (net). In 2014, somewhat higher incidental exploitation of Interior Fraser coho was allowed because the coho spawning level was relatively high in 2013, and there was a strong desire to harvest the large return of Fraser sockeye salmon (J. Sawada, CDFO, pers. comm., 2014).

Fishing mortality on Interior Fraser coho salmon in British Columbia is judged to be a "low" concern, because management has taken actions to reduce coho catch and Canadian exploitation is typically less than the ceiling of 3%.

Rationale:

Fishing mortality was a key factor leading to the population decline in Interior Fraser coho. Beginning in 1998, domestic (Canadian) and U.S. exploitation rates declined significantly and have halted the population decline. Nevertheless, in several recent years, when productivity was below replacement (<1 recruit/spawner), even relatively modest exploitation contributed to negative population growth (Decker and Irvine 2013). The paucity of catch data in recent years, and the resultant high uncertainty in current estimates of domestic and U.S. exploitation rates, also places Interior Fraser Coho at risk, because current indices may not be sensitive enough to detect year-to-year changes in exploitation that could arise from factors such as changes in fishing regulations or fishing effort, or changes in the marine distribution and migration timing of Interior Fraser Coho. Exploitation estimates for Interior Fraser Coho are also biased low to some degree because of unmonitored terminal fisheries upstream of Hells Gate and illegal fishing, which are not accounted for in current exploitation models. Uncertainties about survival of coho salmon released as bycatch in fisheries targeting other salmon species, and about survival of released wild coho salmon in recreational fisheries where only hatchery-marked coho may be retained, are additional sources of unquantified error in exploitation rate estimates. For the Interior Fraser Coho aggregate, the mean proportion of hatchery fish

in escapements for the most recent generation (2009-2011) was 7%, compared to 15% at the time of the original COSEWIC assessment (1998-2000). Earlier studies had concluded that enhancement had a relatively minor impact on Interior Fraser coho.

Factor 2.4 - Discard Rate

CANADA/SOUTH COAST BC, UNASSOCIATED PURSE SEINE

< 20%

Purse seine fisheries may catch all Pacific salmon species, and in BC fisheries, Chinook, coho, sockeye, chum, and steelhead may be released (DFO 2014c). BC fisheries are required to use revival boxes for released fish, although there is limited enforcement. Incidental mortality data were not found for the BC South Coast purse seine fishery, and determining the total numbers of fish landed is not straightforward because of the diversity of species caught. But for all species, the estimated post-release discard mortality rate for BC commercial seine fisheries is 15% (DFO 2014b). Thus the ratio of dead discards to landed fish is likely below 20%.

CANADA/SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)

< 20%

Gillnet fisheries may encounter all Pacific salmon species, and in BC fisheries, Chinook, coho, sockeye, chum, and steelhead may be released (DFO 2014b). BC fisheries are required to use revival boxes for released fish, although there is limited enforcement. In the 2013 BC South Coast gillnet fishery, there were an estimated 916 incidental mortalities of Chinook (PSC 2014a). Incidental mortality data for other species were not found, although 18,808 coho were released in the 2013 BC southern net fishery (18,627 in Johnstone Strait, 88 in the Strait of Georgia, and 93 in Southwest Vancouver Island) (PFMC 2014). Determining the total numbers of fish landed is not straightforward because of the diversity of species caught, but the ratio of dead discards to landed fish is thought to be below 20%.

Rationale:

The estimated post-release mortality rate for southern BC commercial gillnet fisheries is 60%, with provisions for rates as low as 40% (DFO 2014c) when appropriate selective techniques are used.

For Chinook salmon, incidental mortalities are estimated using logbook data on releases and size-specific mortality rates from the Pacific Salmon Commission Joint Chinook Technical Committee (PSC 1997).

CANADA/WEST COAST VANCOUVER ISLAND, TROLL/POLE

< 20%

Troll fisheries may catch all Pacific salmon species, and in BC fisheries, Chinook, coho, sockeye, chum, and steelhead may be released (DFO 2014b). BC fisheries are required to use revival boxes for released fish, although there is limited enforcement. In the 2013 WCVI troll fishery, there were an estimated 2,586 incidental mortalities of Chinook (PSC 2014a). Incidental mortality data for other species were not found, although 1,640 coho were released in the 2013 Vancouver Island troll fishery (35 in the Northwest Vancouver Island troll and 1,605 in the Southwest Vancouver Island troll) (PFMC 2014). Determining the total numbers of fish landed is not straightforward because of the diversity of species caught, but the ratio of dead discards to landed fish is thought to be below 20%.

Rationale:

Estimated post-release mortality rates for this fishery are 10% for sockeye and 15% for coho (DFO 2014b).

For Chinook salmon, incidental mortalities are estimated using logbook data on releases and size-specific mortality rates from the Pacific Salmon Commission Joint Chinook Technical Committee (PSC 1997).

Chinook Salmon: Minor stock

Factor 2.1 - Inherent Vulnerability

CANADA/SOUTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA/SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA/NORTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA/NORTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA/CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA/WEST COAST VANCOUVER ISLAND, TROLL/POLE
CANADA/NORTH COAST BC, TROLL/POLE
CANADA, DRIFT GILLNETS (DRIFTNETS)
CANADA/WEST COAST VANCOUVER ISLAND, TROLL/POLE
CANADA/NORTH COAST BC, TROLL/POLE

Medium

The FishBase vulnerability score for Chinook salmon is 68 (Froese and Pauly 2014), which corresponds to high inherent vulnerability. But productivity-susceptibility analysis (PSA) suggests moderate vulnerability based on attributes including age at maturity, maximum size,

reproductive strategy, and trophic level. Additionally, Chinook salmon has high diversity in life history traits such as age at maturation, which should increase its resiliency to environmental changes. We rated inherent vulnerability as "medium."

Rationale:

The FishBase score is based on life history traits and ecological characteristics including maximum length, age at first maturity, and geographic range (Cheung et al. 2005). Data used for the productivity susceptibility analysis were obtained from Fishbase.org.

Trait	Estimate	Score
Average at maturity (years)	4	3
Average maximum age (years)	8	3
Average maximum size (cm)	150	2
Average size at maturity (cm)	76.7	2
Reproductive strategy	demersal egg layer	2
Trophic level	4.4	1
Average score		2.17

Figure 28 Chinook salmon trait estimates and scores; used for determining inherent vulnerability using productivity and susceptibility analysis.

Factor 2.2 - Abundance

CANADA/WEST COAST VANCOUVER ISLAND, TROLL/POLE
CANADA/NORTH COAST BC, TROLL/POLE

Very High Concern

The primary depleted Canadian stock caught in the North Coast troll fishery is WCVI natural Chinook (PSC 2014c), which is considered a stock of concern (DFO 2014a). There is no Chinook Technical Committee-accepted escapement goal (PSC 2014a), but WCVI natural Chinook populations have been below provisional rebuilding targets for at least 75% of the 15 most recent years (1999-2013) (CSAS 2012). Based on model estimates, North Coast BC and WCVI troll fisheries also catch ESA-listed Chinook stocks, such as the Snake River fall and Puget Sound stocks (PSC 2014d). Because these stocks have frequently failed to reach management targets and/or are federally listed, conservation concern is rated "very high."

Rationale:

WCVI natural Chinook escapements have been below the provisional rebuilding target level for most years of the past several decades (Fig. 29) (Fig. 30), despite harvest restrictions introduced in 1994. Currently, most WCVI Chinook production (~90%) is from hatcheries (CSAS 2012).

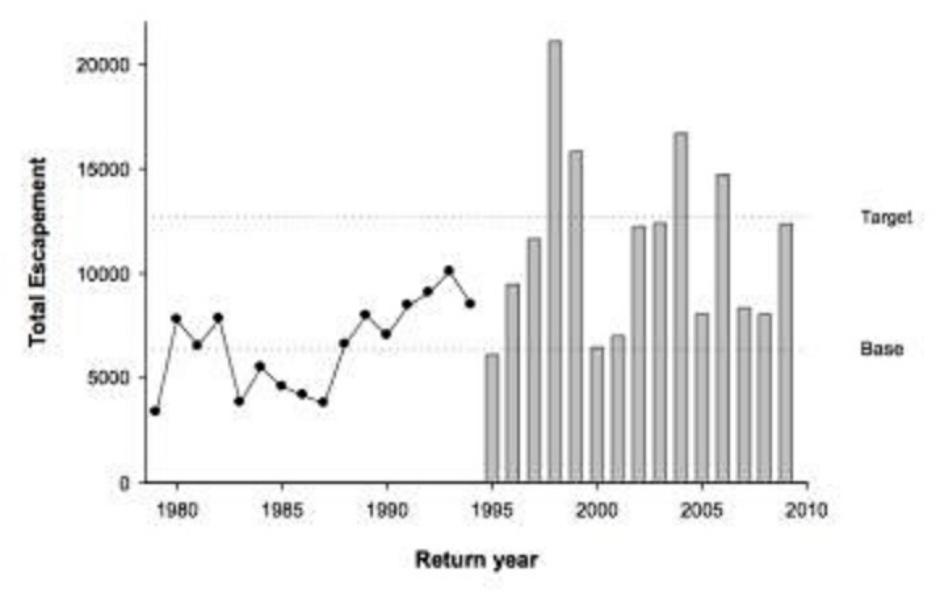

Figure 29 The 14-system Pacific Salmon Commission index of naturally spawning WCVI Chinook. The break from the line graph to the bar graph indicates a change in survey methods. Estimates after 1994 are more reliable. The target line is a provisional rebuilding target determined in 1984 (CSAS 2012).

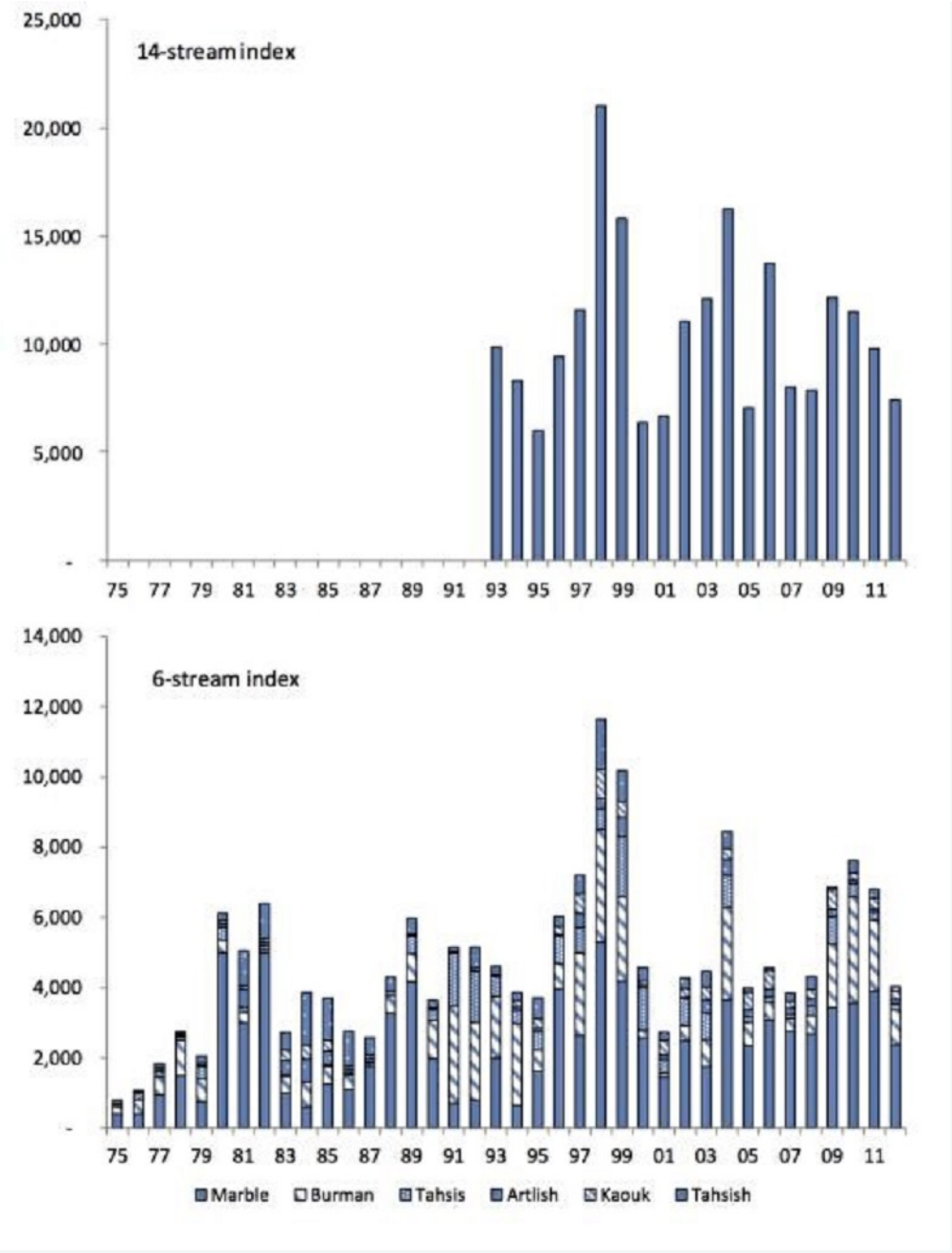

Figure 30 Pacific Salmon Commission indices of naturally spawning WCVI Chinook (PSC 2014a).

Factor 2.3 - Fishing Mortality

CANADA/WEST COAST VANCOUVER ISLAND, TROLL/POLE

High Concern

Stocks of concern caught in the WCVI troll fisheries include WCVI natural, Puget Sound, and Snake River fall Chinook (PSC 2014d). BC commercial troll fisheries for Chinook are primarily managed to limit harvest impacts on domestic stocks of concern, such as WCVI Chinook and Interior Fraser River coho. For example, one fishery objective in 2013/2014 was to reduce encounters with WCVI Chinook by restricting the troll fishery to offshore areas during the summer period (DFO 2014c). Puget Sound and Snake River fall Chinook make up small proportions (< 5% each) of WCVI troll catches, but BC catches are sometimes substantial contributors to total fishery mortality for these stocks (PSC 2015).

Of these stocks of concern, Puget Sound Chinook is the worst performing stock, based on abundance trends. NOAA Fisheries reported that the escapement of natural-origin returns of Puget Sound Chinook declined from 32,794 fish during 2000-2004 to 25,848 fish during 2005-2009 (the most recent period available in the report) (Ford et al. 2011). The estimated recent overall harvest rate of 42% on an ESA-listed population is high (Ford et al. 2011), especially for the natural-origin component. Though the WCVI fishery management plan includes harvest limits for Canadian stocks of concern such as WCVI Chinook, specific harvest limits for ESA-listed stocks are not apparent (DFO 2014b). The NMFS Biological Opinion on the Pacific Salmon Treaty fisheries concluded that the fisheries would not cause jeopardy to the Puget Sound Chinook ESU, but the fisheries are still having an adverse impact (NMFS 2008). The fishing mortality factor is judged to be a "high" concern based on this information.

Rationale:

According to model outputs, from 1985 to 2012, WCVI troll and outside sport fishery catches included averages of 0.91% WCVI natural, 2.25% Puget Sound natural, 1.66% Puget Sound yearling, and 0.66% Snake River fall Chinook. These represented 6.04%, 16.83%, 9.56%, and 21.4% of the total catch for each stock, respectively (PSC 2015). Thus, for this fishery, Puget Sound and Snake River fall Chinook are the main Criterion 2 species.

For Snake River fall Chinook, NOAA Fisheries reported that the escapement of natural-origin returns increased from 1,055 Chinook during 1997-2001 to 2,291 Chinook during 2003-2008 (the most recent periods available in the report) (Ford et al. 2011). Escapements have increased substantially in more recent years in response to larger runs. The total exploitation rate across all fisheries on this stock has been within the range of 40% to 50% since the mid-1990s (Ford et al. 2011).

CANADA/NORTH COAST BC, TROLL/POLE

Low Concern

Stocks of concern caught in the North Coast BC troll fishery include WCVI natural, Puget Sound, and Snake River fall Chinook (PSC 2014d). WCVI natural Chinook is the main stock of concern that constrains exploitation rates in this fishery (DFO 2014b). From 1997 to 2007, the management objective for WCVI natural Chinook was a 10% to 15% maximum exploitation rate in Canadian troll fisheries for Chinook stocks managed by AABM. The exploitation rate ceiling was lowered to 10% in 2008 (CSAS 2012). There is also an exploitation rate ceiling of 3.2% specifically for North Coast BC fisheries (DFO 2014c). The North Coast BC salmon fishery is closed during the first 3 weeks of June and the month of August, because these periods are known to have higher proportions of WCVI Chinook in the total catch (DFO 2014c). Robertson Creek fall Chinook, a hatchery stock, is used as an exploitation indicator stock for WCVI Chinook. From 1995 to 2009, the average estimated annual exploitation rate was 11.5% for Canadian ocean fisheries, and 3% for BC North Coast commercial troll fisheries (CSAS 2012). Despite management of exploitation rates to allow for population recovery, the WCVI Chinook population has not yet recovered, with stable but low abundances (Fig. 31).

Conservation concern is "low" because management has taken actions to reduce harvest, and Canadian ocean exploitation rates have typically been under the exploitation rate ceiling.

Rationale:

According to model outputs, from 1985 to 2012, North Coast BC troll fishery catch included an average of 1.78% WCVI natural, 0.17% Puget Sound natural, 0.27% Puget Sound yearling, and 0.34% Snake River fall Chinook. These represented 10.7%, 0.35%, 0.71%, and 5.4% of the total catch for each stock, respectively (PSC 2015). Thus, for this fishery, WCVI natural is the only main Criterion 2 species.

Exploitation rates of WCVI Chinook are estimated using the Chinook Technical Committee model. Some estimates of fishing mortality on WCVI Chinook in other fisheries were 22% for Canadian terminal (ISBM) fisheries and 18% for U.S. (Southeast Alaska) fisheries for Chinook stocks managed by AABM (CSAS 2012). Abundances for WCVI Chinook appear stable but low.

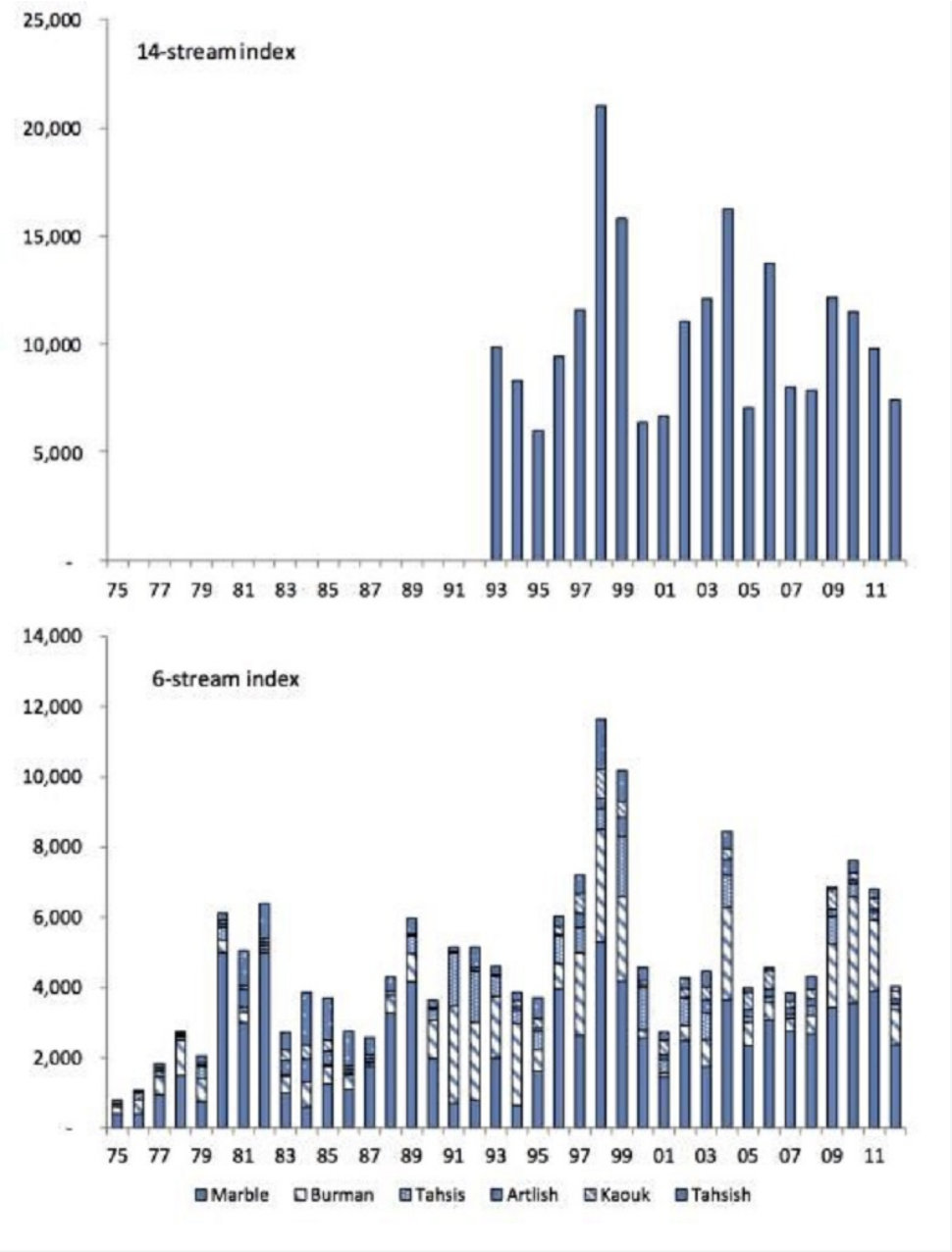

Figure 31 Pacific Salmon Commission indices of naturally spawning WCVI Chinook (PSC 2014a).

Factor 2.4 - Discard Rate

CANADA/WEST COAST VANCOUVER ISLAND, TROLL/POLE

< 20%

Troll fisheries may catch all Pacific salmon species, and in BC fisheries, Chinook, coho, sockeye, chum, and steelhead may be released (DFO 2014b). BC fisheries are required to use revival boxes for released fish, although there is limited enforcement. In the 2013 WCVI troll fishery, there were an estimated 2,586 incidental mortalities of Chinook (PSC 2014a). Incidental mortality data for other species were not found, although 1,640 coho were released in the 2013 Vancouver Island troll fishery (35 in the Northwest Vancouver Island troll and 1,605 in the Southwest Vancouver Island troll) (PFMC 2014). Determining the total numbers of fish landed is not straightforward because of the diversity of species caught, but the ratio of dead discards to landed fish is thought to be below 20%.

Rationale:

Estimated post-release mortality rates for this fishery are 10% for sockeye and 15% for coho (DFO 2014b).

For Chinook salmon, incidental mortalities are estimated using logbook data on releases and size-specific mortality rates from the Pacific Salmon Commission Joint Chinook Technical Committee (PSC 1997).

CANADA/NORTH COAST BC, TROLL/POLE

< 20%

Troll fisheries may encounter all Pacific salmon species, and in BC fisheries, Chinook, coho, sockeye, chum, and steelhead may be released (DFO 2014b). BC fisheries are required to use revival boxes for released fish, although there is limited enforcement. In the 2013 BC North

Coast troll fishery, there were an estimated 3,543 incidental mortalities of Chinook (PSC 2014a). Incidental mortality data for other species were not found, although 20,273 coho were released in the 2013 BC northern troll fishery (PFMC 2014). Determining the total numbers of fish landed is not straightforward because of the diversity of species caught, but the ratio of dead discards to landed fish is thought to be below 20%.

Rationale:

Estimated post-release mortality rates for this fishery are 10% for sockeye and 15% for coho (DFO 2014b).

For Chinook salmon, incidental mortalities are estimated using logbook data on releases and size-specific mortality rates from the Pacific Salmon Commission Joint Chinook Technical Committee (PSC 1997).

Criterion 3: Management Effectiveness

Management is separated into management of retained species (harvest strategy) and management of non-retained species (bycatch strategy).

The final score for this criterion is the geometric mean of the two scores. The Criterion 3 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and ≤3.2=Yellow or Moderate Concern*
- *Score ≤2.2 or either the Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern = Red or High Concern*

Rating is Critical if either or both of Harvest Strategy (Factor 3.1) and Bycatch Management Strategy (Factor 3.2) ratings are Critical.

Criterion 3 Summary

Region / Method	Harvest Strategy	Bycatch Strategy	Score
Canada / Drift gillnets (driftnets)	4.000	3.000	Green (3.464)
Canada / Central Coast BC / Drift gillnets (driftnets)	3.000	3.000	Yellow (3.000)
Canada / North Coast BC / Drift gillnets (driftnets)	3.000	3.000	Yellow (3.000)
Canada / North Coast BC / Troll/Pole	3.000	3.000	Yellow (3.000)
Canada / North Coast BC / Unassociated purse seine	3.000	3.000	Yellow (3.000)
Canada / South Coast BC / Drift gillnets (driftnets)	3.000	3.000	Yellow (3.000)
Canada / South Coast BC / Unassociated purse seine	3.000	3.000	Yellow (3.000)
Canada / West Coast Vancouver Island / Troll/Pole	3.000	3.000	Yellow (3.000)

Criterion 3 Assessment

SCORING GUIDELINES

Factor 3.1: Harvest Strategy

Seven subfactors are evaluated: Management Strategy, Recovery of Species of Concern, Scientific Research/Monitoring, Following of Scientific Advice, Enforcement of Regulations, Management Track Record, and Inclusion of Stakeholders. Each is rated as 'ineffective,' 'moderately effective,' or 'highly effective.'

- *5 (Very Low Concern)—Rated as 'highly effective' for all seven subfactors considered*
- *4 (Low Concern)—Management Strategy and Recovery of Species of Concern rated 'highly effective' and all other subfactors rated at least 'moderately effective.'*
- *3 (Moderate Concern)—All subfactors rated at least 'moderately effective.'*
- *2 (High Concern)—At minimum, meets standards for 'moderately effective' for Management Strategy and Recovery of Species of Concern, but at least one other subfactor rated 'ineffective.'*
- *1 (Very High Concern)—Management exists, but Management Strategy and/or Recovery of Species of Concern rated 'ineffective.'*
- *0 (Critical)—No management exists when there is a clear need for management (i.e., fishery catches threatened, endangered, or high concern species), OR there is a high level of Illegal, unregulated, and unreported fishing occurring.*

Factor 3.1: Harvest Strategy

Factor 3.1 Summary

FACTOR 3.1: MANAGEMENT OF FISHING IMPACTS ON RETAINED SPECIES							
Region / Method	**Strategy**	**Recovery**	**Research**	**Advice**	**Enforce**	**Track**	**Inclusion**
Canada / Drift gillnets (driftnets)	Highly Effective	N/A	Highly Effective	Highly Effective	Moderately Effective	Highly Effective	Highly Effective
Canada / Central Coast BC / Drift gillnets (driftnets)	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective
Canada / North Coast BC / Drift gillnets (driftnets)	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective
Canada / North Coast BC / Troll/Pole	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective
Canada / North Coast BC / Unassociated purse seine	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective

Canada / South Coast BC / Drift gillnets (driftnets)	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective
Canada / South Coast BC / Unassociated purse seine	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective
Canada / West Coast Vancouver Island / Troll/Pole	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective

Subfactor 3.1.1 – Management Strategy and Implementation

Considerations: What type of management measures are in place? Are there appropriate management goals, and is there evidence that management goals are being met? To achieve a highly effective rating, there must be appropriate management goals, and evidence that the measures in place have been successful at maintaining/rebuilding species.

CANADA, DRIFT GILLNETS (DRIFTNETS)

Highly Effective

Prior to the fishing season, U.S. and Canada managers review salmon terminal run forecasts to the Transboundary rivers to decide the number of fish available for harvest that are in excess of escapement requirements. The available harvest is allocated between the countries based on historic fishing patterns. Each country is responsible for managing its fisheries to stay within its share of the harvest using time and area restrictions. Only a certain number of permits are allowed to commercially fish in the Transboundary rivers. Managers can adjust fishing time and fishing areas, and control the amount of gear fished per permit, to control the catch to meet harvest allocations (PSC 2014f). In addition, salmon runs are monitored in-season (using a variety of tools including fishery catches, fish wheel catches, test fishery information, and weir counts) to assess run strength relative to the preseason forecast. Harvest limits can be adjusted during the fishing season based on monitoring data.

The management strategy is judged to be "highly effective" because it has appropriate strategies and goals. Annual escapement estimates provide evidence that the strategy has been successful at achieving escapement goals.

CANADA / CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, UNASSOCIATED PURSE SEINE

Moderately Effective

The BC North Coast/Central Coast ISBM (individual stock based management) gillnet and purse seine fisheries are managed by the Department of Fisheries and Oceans. In general, the fishing strategy is based on preseason forecasts, in-season monitoring, recent trends in abundance, and spawning escapements. Time and area closures are used to maintain appropriate harvest rates or escapement goals. Development of potential harvest rates in the ISBM fisheries considers harvest rates that occur in the AABM fisheries. In recent years, the ISBM fisheries typically do not retain coho salmon, and they must release coho with “the least possible harm.” Coho and Chinook are primarily taken in the troll fishery. First Nation and recreational fishery obligations must be met before allowing a directed harvest of coho by gillnet and seine. This requirement may change, depending on the status of coho and Chinook salmon in terminal areas where a surplus of fish has been determined (DFO 2014b). The status of coho and Chinook salmon in this region varies by stock, but some stocks are no longer monitored (see Factor 1.2) (English et al. 2012). In Canada and the United States, tagged salmon, typically from hatchery stock, are used to evaluate harvest rates on both hatchery and wild stocks; a key assumption is that hatchery fish represent nearby wild stocks. Chinook and coho hatchery production in the region is relatively small.

The harvest strategy for gillnet and purse seine fisheries is judged to be "moderately effective" because there is some effective management that is moderately successful at achieving goals.

CANADA / NORTH COAST BC, TROLL/POLE
CANADA / WEST COAST VANCOUVER ISLAND, TROLL/POLE

Moderately Effective

The Department of Fisheries and Oceans Canada (DFO) manages Canadian salmon stocks. For troll fisheries targeting Chinook salmon, DFO uses aggregate abundance-based management (AABM), where a total allowable catch is set based on preseason forecasting of the year’s abundance index (Pacific Salmon Treaty 2014). Landings are monitored at designated sites to determine when recommended catches have been reached, and an independent contractor validates about 20% of catches (PSC 2014a). One weakness of AABM is that abundances are difficult to forecast accurately, and if the allowable catch is set too high, depleted stocks may be subject to exploitation rates that hinder recovery. Some Chinook stocks have escapement goals, and escapements are monitored in-season using aerial or foot surveys.

The North Coast BC and WCVI troll fisheries do not target coho, but coho may be incidentally caught in the fisheries targeting Chinook. DFO manages coho stocks under an abundance-based management regime in which exploitation rates are constrained for key stock management units (PSC 2013a). Coho generally cannot be retained except in some First Nation food, social, and ceremonial fisheries. Most BC coho stocks lack escapement goals, but escapements are monitored in some areas.

A limited number of fishing licenses are issued under a system of individual transferable quotas (DFO 2014b). Mesh sizes, time and area openings and closures, and harvest limits are used to manage harvest impacts on specific stocks (DFO 2014b) (DFO 2014c). Fishery impacts on Chinook and coho stocks are estimated post-season using Fishery Regulation Assessment Models (FRAM). The harvest strategy appears "moderately effective," because there is some effective management and some stocks appear to be stable or increasing

whereas others are declining (PSC 2014a) (PSC 2013a).

Rationale:

Canadian salmon management is guided by the following policies: Canada's Policy for Conservation of Wild Pacific Salmon (Wild Salmon Policy), An Allocation Policy for Pacific Salmon, Pacific Fisheries Reform, A Policy for Selective Fishing, A Framework for Improved Decision Making in the Pacific Salmon Fishery, and the Pacific Region Fishery Monitoring and Reporting Framework (DFO 2014b). The Wild Salmon Policy includes objectives for setting and meeting escapement goals for individual management units, but implementation of these objectives is incomplete.

CANADA / SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / SOUTH COAST BC, UNASSOCIATED PURSE SEINE

Moderately Effective

The BC South Coast ISBM is managed by the Department of Fisheries and Oceans. The fishing strategy involves preseason forecasts of abundance, time/area closures, and recent trends in abundance and spawning escapement. Harvest limits are set using harvest rates or escapement goals; harvest rates in the ISBM fisheries consider harvest rates on the targeted stocks in the AABM fisheries. The BC South Coast ISBM gillnet and purse seine fisheries typically do not retain coho salmon and they must release coho with the least possible harm (DFO 2014c). The ISBM fisheries largely attempt to avoid impacts on depleted Chinook salmon stocks. Directed gillnet harvests typically focus on healthier Chinook stock components in terminal areas. The statuses of coho and Chinook salmon in this region are low (see Factor 1.2). Chinook and coho hatchery production in the region is large even though status of many of the natural components is low.

The harvest strategy for gillnet and purse seine fisheries is judged to be "moderately effective," because there is some effective management to reduce direct harvests on depleted stocks while targeting more robust stocks in terminal areas, and there is some monitoring of stock status.

Subfactor 3.1.2 – Recovery of Species of Concern

Considerations: When needed, are recovery strategies/management measures in place to rebuild overfished/threatened/ endangered species or to limit fishery's impact on these species and what is their likelihood of success? To achieve a rating of Highly Effective, rebuilding strategies that have a high likelihood of success in an appropriate timeframe must be in place when needed, as well as measures to minimize mortality for any overfished/threatened/endangered species.

CANADA, DRIFT GILLNETS (DRIFTNETS)

N/A

There are no threatened or endangered salmon populations designated in the transboundary rivers. Taku River chum salmon are considered depleted (PSC 2014e), but they are not targeted or retained in the BC commercial inriver fisheries. Therefore, the recovery strategy is considered "Not Applicable."

CANADA / CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA / SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / SOUTH COAST BC, UNASSOCIATED PURSE SEINE

Moderately Effective

Managers have developed strategies for recovering stocks of concern and stocks identified by COSEWIC as threatened or endangered (Committee on the Status of Endangered Wildlife in Canada), mostly via measures aimed at restricting exploitation rates on depleted stocks. Measures include time/area closures and selective fishing techniques (DFO 2014b). These measures are generally followed and may eventually lead to recovery. Canada's Wild Salmon Policy states that hatchery salmon are used to rebuild natural populations by encouraging enhanced fish to spawn in the wild. The enhancement program attempts to minimize genetic impacts to natural salmon by using spawning channels and by using natural origin fish as broodstock in hatcheries (MacKinlay et al. 2004). The recovery strategy is considered only "moderately effective," because the needs for recovery are sometimes balanced against the need to provide harvests, leading to incidental harvests of depleted populations. To score highly effective, evidence is needed to demonstrate that harvest rates on depleted stocks will allow for recovery.

CANADA / NORTH COAST BC, TROLL/POLE

Moderately Effective

Managers have developed strategies for recovering stocks of concern and stocks designated as "Threatened" or "Endangered" under COSEWIC (Committee on the Status of Endangered Wildlife in Canada), mostly via measures aimed at restricting exploitation rates on depleted stocks. For example, the annual exploitation rate on WCVI Chinook, a stock of concern, is limited to 3.2% for the BC North Coast troll fishery (DFO 2014b). Additionally, Canada's Wild Salmon Policy states that enhanced fish will be encouraged to spawn in the wild to help rebuild natural populations. Enhancement programs are supposed to minimize genetic impacts to natural salmon by using spawning channels where feasible and by using natural origin fish as broodstock in hatcheries (MacKinlay et al. 2004).

These measures are generally followed, but they may not be sufficient to support population recovery. In the case of BC troll fisheries targeting Chinook stocks managed by AABM, allowable catches are set based on preseason indices of abundance. If the abundance forecast is inaccurate, the allowable catch may be set too high, potentially hindering recovery of depleted stocks. Thus far, depleted stocks such as WCVI Chinook and Interior Fraser coho have not recovered. The recovery strategy can be considered highly effective only if there

is evidence that harvest rates on depleted stocks allow for recovery. Because such evidence is currently lacking, we rated the recovery strategy as "moderately effective."

Rationale:

DFO has developed conservation strategies for Interior Fraser River coho and Sakinaw and Cultus Lake sockeye, which are all designated as "Endangered" or "Threatened" under COSEWIC.

CANADA / WEST COAST VANCOUVER ISLAND, TROLL/POLE

Moderately Effective

Managers have developed strategies for recovering stocks of concern and stocks designated as "Threatened" or "Endangered" under COSEWIC (Committee on the Status of Endangered Wildlife in Canada), mostly via measures aimed at restricting exploitation rates on depleted stocks. Additionally, Canada's Wild Salmon Policy states that enhanced fish will be encouraged to spawn in the wild to help rebuild natural populations. Enhancement programs are supposed to minimize genetic impacts to natural salmon by using spawning channels where feasible and by using natural origin fish as broodstock in hatcheries (MacKinlay et al. 2004).

These measures are generally followed, but they may not be sufficient to support population recovery. In the case of BC troll fisheries targeting Chinook stocks managed by AABM, allowable catches are set based on preseason indices of abundance. If the abundance forecast is inaccurate, the allowable catch may be set too high, potentially hindering recovery of depleted stocks. Another point of concern is that WCVI troll and sport fisheries have exceeded total allowable catches (postseason) in more than 50% of the past 15 years (PSC 2014c). Thus far, depleted stocks such as WCVI Chinook and Interior Fraser coho have not recovered. The recovery strategy can be considered highly effective only if there is evidence that harvest rates on depleted stocks allow for recovery. Because such evidence is currently lacking, we rated the recovery strategy as "moderately effective."

Rationale:

DFO has developed conservation strategies for Interior Fraser River coho and Sakinaw and Cultus Lake sockeye, which are all designated as "Threatened" or "Endangered" under COSEWIC.

Subfactor 3.1.3 – Scientific Research and Monitoring

Considerations: How much and what types of data are collected to evaluate the health of the population and the fishery's impact on the species? To achieve a Highly Effective rating, population assessments must be conducted regularly and they must be robust enough to reliably determine the population status.

CANADA, DRIFT GILLNETS (DRIFTNETS)

Highly Effective

U.S. and Canada fishery managers jointly implement monitoring and evaluation programs for Transboundary salmon stocks. Mark-recapture techniques are used to estimate annual Chinook salmon escapements to the Taku and Stikine Rivers and coho salmon escapements to the Taku River(PSC 2014e). Escapement sampling provides information on age and size compositions as well as documentation of hatchery strays (through recoveries of hatchery coded wire tags). In addition, smolts are captured and coded wire tagged as they emigrate from these rivers each year (PSC 2014a). Coded wire tag recoveries are used to describe the geographic range of these stocks and to estimate harvests in mixed-stock marine fisheries. Terminal harvests are reported on fish tickets and logs. Sockeye salmon are also commercially important stocks for these fisheries. Sockeye escapements are monitored through a combination of mark-recapture estimates, weir counts, and test fishery catch per unit effort (CPUE) data. Stock composition of catches is estimated through otolith sampling (to segregate enhanced stocks) and genetic stock identification sampling (PSC 2014f). There are no hatchery programs for Chinook and coho salmon in the Transboundary rivers. Thus, escapement monitoring reflects wild stock status. Though research and monitoring programs are generally well developed, the stock assessment program for Stikine River coho salmon is less so and relies on unproven assumptions. But coho are a small component of the Stikine inriver commercial fishery, and Stikine coho salmon are not considered a stock of concern. Based on this information, the research and monitoring program was rated "highly effective."

CANADA / CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, UNASSOCIATED PURSE SEINE

Moderately Effective

Fishery managers have implemented monitoring and evaluation programs for most major BC stocks. Escapements are monitored in-season using aerial or foot surveys, but some indicator stocks are no longer being surveyed because of reductions in financial support, and some counts have not been expanded to cover the watershed area reflected in the escapement goal. Coho salmon escapements in particular are not well monitored, because surveying streams at the times that coho spawn can be difficult. A review of spawning escapement count quality identified a number of coho and Chinook index streams having poor to fair quality (English et al. 2012). Some Chinook and coho salmon (mostly hatchery fish) receive coded wire tags (CWT), and data from tagged fish are used to infer natural stock-specific distribution patterns, marine survival, and harvest rates. CWT data are also used to estimate proportions of hatchery-origin fish on the spawning grounds for some Chinook stocks, but escapement counts typically include both hatchery and natural origin salmon (i.e., separate counts are not made for hatchery fish). Catches are monitored in-season and validated by independent contractors (20% of landed catch) at designated landing sites (PSC 2014a) (DFO 2014b). Bycatch is recorded in logbooks and bycatch mortality rates are assumed (DFO 2014b). Research was rated as "moderately effective" because, although fundamental monitoring programs are in place, levels of escapement monitoring have declined.

CANADA / NORTH COAST BC, TROLL/POLE
CANADA / WEST COAST VANCOUVER ISLAND, TROLL/POLE

Moderately Effective

Fishery managers have implemented monitoring and evaluation programs for major BC stocks. Escapements are monitored in-season using aerial or foot surveys, but some indicator stocks are no longer being surveyed because of reductions in financial support. Coho salmon escapements in particular are not well monitored, because surveying streams at the times that coho spawn can be difficult. A recent report suggested that 16% of 98 coho index streams and 28% of 36 Chinook index streams have poor survey quality (English et al. 2012). Some Chinook and coho salmon (mostly hatchery fish) receive coded wire tags (CWT), and data from tagged fish are used to infer natural stock-specific distribution patterns, marine survival, and harvest rates. CWT data are also used to estimate proportions of hatchery-origin fish on the spawning grounds for some Chinook stocks, but hatchery-origin fish are generally included in escapement counts. Catches are monitored in-season and validated by independent contractors (20% of landed catch) at designated landing sites (PSC 2014a). Research was rated as "moderately effective" because, although fundamental monitoring programs are in place, levels of escapement monitoring have declined. Additionally, escapement counts include hatchery-produced fish.

Rationale:

There are some sources of uncertainty in monitoring data. Some management units are represented by indicator stocks that are significantly supplemented by hatchery production, or by indicator stocks that have inadequate CWT data. Mass marking of hatchery fish (adipose clipping) and mark-selective fisheries have also increased uncertainty in analyses based on CWT data (PSC 2013b).

CANADA / SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / SOUTH COAST BC, UNASSOCIATED PURSE SEINE

Moderately Effective

Fishery managers have implemented monitoring and evaluation programs for major BC stocks. Escapements are monitored using aerial or foot surveys, but some indicator stocks are no longer being surveyed because of reductions in financial support. Coho salmon escapements in particular are not well monitored, because surveying streams at the times that coho spawn can be difficult. Some Chinook and coho salmon (mostly hatchery fish) receive coded wire tags (CWT), and data from tagged fish are used to infer natural stock-specific distribution patterns, marine survival, and harvest rates. CWT data are also used to estimate proportions of hatchery-origin fish on the spawning grounds for some Chinook stocks, but escapement counts typically include both hatchery and natural origin salmon. Catches are monitored in-season and validated by independent contractors (20% of landed catch) at designated landing sites (PSC 2014a) (DFO 2014c). Bycatch is recorded in fisher's logbooks and bycatch mortality rates are assumed (DFO 2014c). Research was rated as "moderately effective" because, although fundamental monitoring programs are in place, levels of escapement monitoring have declined, and because hatchery fish are included in escapement counts, making it difficult to determine whether natural populations are at sustainable levels.

Subfactor 3.1.4 – Management Record of Following Scientific Advice

Considerations: How often (always, sometimes, rarely) do managers of the fishery follow scientific recommendations/advice (e.g. do they set catch limits at recommended levels)? A Highly Effective rating is given if managers nearly always follow scientific advice.

CANADA, DRIFT GILLNETS (DRIFTNETS)

Highly Effective

Co-managers incorporate scientific information, such as forecasts and inseason run information, into management decisions when setting harvest limits in Transboundary fisheries (PSC 2014e). There is no evidence that scientific advice is disregarded. Therefore, this indicator is judged to be "highly effective."

CANADA / CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA / SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)

Moderately Effective

Managers incorporate scientific information, such as forecasted abundances, into management decisions when setting allowable catches for ISBM and AABM fisheries (Pacific Salmon Treaty 2014). Attempts are made to minimize bycatch of depleted stocks. Managers generally follow scientific advice but sometimes balance the need to provide harvest against recommended reductions in exploitation on depleted stocks. To score highly effective, evidence is needed to demonstrate that harvest rates on depleted stocks will allow for recovery. Thus, this factor was rated as "moderately effective.'

CANADA / NORTH COAST BC, TROLL/POLE
CANADA / WEST COAST VANCOUVER ISLAND, TROLL/POLE

Moderately Effective

Managers incorporate scientific information, such as forecasted abundances, into management decisions when setting allowable catches for BC troll fisheries (Pacific Salmon Treaty 2014). Managers generally follow scientific advice but sometimes balance the need to provide harvest against recommended reductions in exploitation on depleted stocks. From a conservation perspective, harvesting depleted stocks in a manner that may prevent recovery cannot be considered part of a highly effective management strategy. This factor was rated as "moderately effective." To score this factor as highly effective, we would need evidence that harvest rates on depleted stocks will allow for recovery. We did not find such evidence.

CANADA / SOUTH COAST BC, UNASSOCIATED PURSE SEINE

Moderately Effective

Managers incorporate scientific information, such as forecasted abundances, into management decisions when setting allowable catches for ISBM and AABM fisheries (Pacific Salmon Treaty 2014). Attempts are made to minimize bycatch of depleted stocks. Managers generally follow scientific advice but sometimes balance the need to provide harvest against recommended reductions in exploitation on depleted stocks. To score highly effective, evidence is needed to demonstrate that harvest rates on depleted stocks will allow for recovery. Thus this factor was rated as "moderately effective."

Subfactor 3.1.5 – Enforcement of Management Regulations

Considerations: Do fishermen comply with regulations, and how is this monitored? To achieve a Highly Effective rating, there must be regular enforcement of regulations and verification of compliance.

CANADA, DRIFT GILLNETS (DRIFTNETS)

Moderately Effective

Canadian authorities are responsible for enforcement and monitoring of Transboundary river fisheries within Canada to meet goals and objectives of fisheries management identified in the Pacific Salmon Treaty. But the effectiveness of enforcement and monitoring is uncertain because these fisheries are located in remote areas, so the cost of accessing these areas may limit enforcement efforts. This indicator was judged to be "moderately effective."

CANADA / CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, TROLL/POLE
CANADA / NORTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA / SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / SOUTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA / WEST COAST VANCOUVER ISLAND, TROLL/POLE

Moderately Effective

Government authorities (Conservation and Protection) are responsible for enforcement and monitoring to ensure compliance with fishery regulations, as described by the Fisheries Act. Level of enforcement effort varies with the conservation risk. Commercial salmon fishers are required to maintain harvest logs of all harvest operations, and independent contractors verify ~20% of the landed catch (DFO 2014b). Because of the dispersed nature of the fishery over a large area with multiple ports of landing, it is difficult to maintain consistent enforcement effort across the fishery. Enforcement officers typically examine issues such as failure to have a functional revival box, retention of prohibited species/incidental catch, fishing during a closed time/area, or failure to complete a log book. Assessments by the Marine Stewardship Council documented some noncompliance in the Northern/Central Coast fisheries, although it was concluded that noncompliance was not widespread (Marine Stewardship Council 2014). Less enforcement and compliance information was readily available for the South Coast fisheries but the MSC report suggested that compliance was less of an issue in the southern fisheries. This indicator was judged to be "moderately effective."

Subfactor 3.1.6 – Management Track Record

Considerations: Does management have a history of successfully maintaining populations at sustainable levels or a history of failing to maintain populations at sustainable levels? A Highly Effective rating is given if measures enacted by management have been shown to result in the long-term maintenance of species overtime.

CANADA, DRIFT GILLNETS (DRIFTNETS)

Highly Effective

The Pacific Salmon Treaty signed in 1985 established a bilateral management approach between the United States and Canada. Significant revisions to the treaty were adopted in 1999 and 2009. Since the treaty was first signed, many salmon escapement goals have been adopted, and monitoring programs have improved substantially. The current Chinook and salmon escapement goals have generally been met or exceeded since the mid-1980s (PSC 2014a) (Shaul et al. 2011) (Munro and Volk 2014). Therefore, the management track record was rated "highly effective."

CANADA / CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, TROLL/POLE
CANADA / NORTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA / SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / SOUTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA / WEST COAST VANCOUVER ISLAND, TROLL/POLE

Moderately Effective

Management measures have been taken to maintain stock abundances and to enable population rebuilding by restricting fishery exploitation rates. One example is the substantial reduction in coho harvests after 1997. These measures have been in place for many years, and some stocks, such as upper Skeena coho, appear to have recovered in response (PSC 2002) (DFO 2014a). But some stocks are no longer monitored, leaving gaps in the track record. There is no evidence that measures have maintained ecosystem integrity in the long-term, although DFO has stated intentions to incorporate ecosystem considerations into management (DFO 2014b). The management track record is considered "moderately effective."

Subfactor 3.1.7 – Stakeholder Inclusion

Considerations: Are stakeholders involved/included in the decision-making process? Stakeholders are individuals/groups/organizations that have an interest in the fishery or that may be affected by the management of the fishery (e.g., fishermen, conservation groups, etc.). A Highly Effective rating is given if the management process is transparent and includes stakeholder input.

CANADA, DRIFT GILLNETS (DRIFTNETS)

Highly Effective

Management is transparent and the inclusion of stakeholders in the management process is judged to be "highly effective." Annual pre- and postseason Pacific Salmon Commission meetings offer the public access to salmon status information and opportunity to interact with the co-managers in developing annual fishing regimes. Conservation concerns for any management unit are identified and discussed early in the process.

CANADA / CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, UNASSOCIATED PURSE SEINE

Highly Effective

Inclusion of stakeholders in the fishery management process is judged to be "highly effective." Management is guided by integrated fisheries management plans (IFMPs), which are produced annually for BC North Coast salmon and BC South Coast salmon. Each IFMP incorporates the results of consultations and input from the Integrated Harvest Planning Committee (IHPC; composed of First Nations), recreational and commercial advisors, and the Marine Conservation Caucus (MCC), which represents a coalition of conservation organizations. The Consultation Secretariat works to improve the flow of information between stakeholders and the Department.

Rationale:

The Pacific Salmon Commission (PSC) helps implement management of salmon stocks harvested by both the United States and Canada, which include many of the stocks originating in BC. PSC committees include personnel from the Canadian Department of Fisheries and Oceans (DFO), the National Marine Fisheries Service (NMFS), Alaska Department of Fish & Game, and other public agencies. Within Canada, DFO consults and collaborates with First Nations on fishery management (DFO 2014b).

CANADA / NORTH COAST BC, TROLL/POLE
CANADA / WEST COAST VANCOUVER ISLAND, TROLL/POLE

Highly Effective

Inclusion of stakeholders in the fishery management process is judged to be "highly effective." Management is guided by integrated fisheries management plans (IFMPs), which are produced annually for BC North Coast salmon and BC South Coast salmon. Each IFMP incorporates the results of consultations and input from the Integrated Harvest Planning Committee (IHPC; made of First Nations), recreational and commercial advisors, and the Marine Conservation Caucus (MCC), which represents a coalition of conservation organizations. The Consultation Secretariat works to improve the flow of information between stakeholders and the Department.

Rationale:

The Pacific Salmon Commission (PSC) helps implement management of salmon stocks harvested by both the United States and Canada, which include many of the stocks originating in BC. PSC committees include personnel from the Canadian Department of Fisheries and Oceans (DFO), the National Marine Fisheries Service (NMFS), Alaska Department of Fish & Game, and other public agencies. Within Canada, DFO consults and collaborates with First Nations on fishery management (DFO 2014b).

CANADA / SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / SOUTH COAST BC, UNASSOCIATED PURSE SEINE

Highly Effective

Inclusion of stakeholders in the fishery management process is judged to be "highly effective." Management is guided by integrated

fisheries management plans (IFMPs), which are produced annually for BC North Coast salmon and BC South Coast salmon. Each IFMP incorporates the results of consultations and input from the Integrated Harvest Planning Committee (IHPC; made of First Nations), recreational and commercial advisors, and the Marine Conservation Caucus (MCC), which represents a coalition of conservation organizations. The Consultation Secretariat works to improve the flow of information between stakeholders and the Department.

Rationale:

The Pacific Salmon Commission (PSC) helps implement management of salmon stocks harvested by both the United States and Canada, which include many of the stocks originating in BC. PSC committees include personnel from the Canadian Department of Fisheries and Oceans (DFO), the National Marine Fisheries Service (NMFS), Alaska Department of Fish & Game, and other public agencies. Within Canada, DFO consults and collaborates with First Nations on fishery management (DFO 2014b).

Factor 3.2: Bycatch Strategy

FACTOR 3.2: BYCATCH STRATEGY						
Region / Method	**All Kept**	**Critical**	**Strategy**	**Research**	**Advice**	**Enforce**
Canada / Drift gillnets (driftnets)	No	No	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective
Canada / Central Coast BC / Drift gillnets (driftnets)	No	No	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective
Canada / North Coast BC / Drift gillnets (driftnets)	No	No	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective
Canada / North Coast BC / Troll/Pole	No	No	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective
Canada / North Coast BC / Unassociated purse seine	No	No	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective
Canada / South Coast BC / Drift gillnets (driftnets)	No	No	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective
Canada / South Coast BC / Unassociated purse seine	No	No	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective
Canada / West Coast Vancouver Island / Troll/Pole	No	No	Moderately Effective	Moderately Effective	Highly Effective	Moderately Effective

Subfactor 3.2.2 – Management Strategy and Implementation

Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and how successful are these management measures? To achieve a Highly Effective rating, the primary bycatch species must be known and there must be clear goals and measures in place to minimize the impacts on bycatch species (e.g., catch limits, use of proven mitigation measures, etc.).

CANADA, DRIFT GILLNETS (DRIFTNETS)

Moderately Effective

Steelhead and Taku River chum salmon cannot be retained in Transboundary Canada inriver commercial fisheries (PSC 2014e). But the effectiveness of this strategy is uncertain because there is no effective monitoring of these populations. As a result, this indicator was judged to be "moderately effective."

CANADA / CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, UNASSOCIATED PURSE SEINE

Moderately Effective

Measures are taken to reduce harvest impacts on some non-targeted, depleted stocks, using time/area closures and selective fishing techniques. For example, DFO has management measures for reducing incidental harvest of Interior Fraser steelhead, inshore rockfish, North Coast chum, and several sockeye stocks. Gillnet and seine fisheries practice selective fishing practices, such as the use of troll plugs, Alaska twist gill nets, maximum gill net set time and net length, gill net mesh size, gill net depth, brailing for seine vessels, and revival tanks. Regulations require that fish be released with “the least possible harm.” Bycatch is reported in fishers' logbooks. (DFO 2014b) identifies catch and release mortality rates for each species and gear type. DFO maintains a significant concern for compliance with selective fishing practices (DFO 2014b). But the efficacy of implementation is uncertain, and bycatch reporting in logbooks may not be completely reliable. The bycatch strategy is rated as "moderately effective."

CANADA / NORTH COAST BC, TROLL/POLE

Moderately Effective

Measures are taken to reduce harvest impacts on some non-targeted, depleted stocks. For example, the annual exploitation rate on WCVI Chinook, a stock of concern, is limited to 3.2% for the BC North Coast troll fishery (DFO 2014b). DFO also has management measures for reducing incidental harvest of Interior Fraser steelhead, inshore rockfish, North Coast chum, and several sockeye stocks. Bycatch is reported in fishers' logbooks, and the IFMP identifies catch and release mortality rates for each species and gear type (DFO 2014b). The North Coast troll fishery is not generally mark-selective, but there are size restrictions on Chinook, and barbless hooks and revival boxes are required on all boats to increase survival of released fish (PSC 2014a). Regulations require that fish be released with “the least possible harm.” But the efficacy of implementation is uncertain, and bycatch reporting in logbooks may not be completely reliable. The bycatch strategy is rated as "moderately effective."

CANADA / SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / SOUTH COAST BC, UNASSOCIATED PURSE SEINE

Moderately Effective

Measures are taken to reduce harvest impacts on some non-targeted, depleted stocks, using time/area closures and selective fishing techniques. For example, DFO has management measures for reducing incidental harvest of Interior Fraser steelhead, inshore rockfish, North Coast chum, and several sockeye stocks. Gillnet and seine fisheries practice selective fishing practices, such as the use of troll plugs, Alaska twist gill nets, maximum gill net set time and net length, gill net mesh size, gill net depth, brailing for seine vessels, and revival tanks. Regulations require that fish be released with “the least possible harm.” Bycatch is reported in fishers' logbooks. (DFO 2014c) identifies catch and release mortality rates for each species and gear type. DFO maintains a significant concern for compliance with selective fishing practices (DFO 2014c). But the efficacy of implementation is uncertain, and bycatch reporting in logbooks may not be completely reliable. The bycatch strategy is rated as "moderately effective."

CANADA / WEST COAST VANCOUVER ISLAND, TROLL/POLE

Moderately Effective

Measures are taken to reduce harvest impacts on some non-targeted, depleted stocks. For example, fishery openings and closures are designed to reduce encounters with Interior Fraser coho and WCVI, Fraser River Spring 42, Fraser River Spring 52, and Fraser River Summer 52 Chinook (DFO 2014c). DFO also has management measures for reducing incidental harvest of Interior Fraser steelhead, inshore rockfish, and Sakinaw and Cultus Lake sockeye. Bycatch is reported in fishers' logbooks, and the IFMP identifies catch and release mortality rates for each species and gear type (DFO 2014c). Unmarked (natural-origin) coho salmon cannot be retained in spring and summer Chinook fisheries, and barbless hooks and revival boxes are required on all boats to reduce mortality of released fish. Regulations require that fish be released with “the least possible harm.” But the efficacy of implementation is uncertain, and bycatch reporting in logbooks may not be completely reliable. The bycatch strategy is rated as "moderately effective."

Subfactor 3.2.3 – Scientific Research and Monitoring

Considerations: Is bycatch in the fishery recorded/documented and is there adequate monitoring of bycatch to measure fishery’s impact on bycatch species? To achieve a Highly Effective rating, assessments must be conducted to determine the impact of the fishery on species of concern, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are being met

CANADA, DRIFT GILLNETS (DRIFTNETS)

Moderately Effective

Commercial fishers are required to record bycatch in logbooks that are turned in to managers at the end of the season (PSC 2014e). There was no evidence that observers are used to verify these records. As a result, the research and monitoring was judged to be "moderately effective."

CANADA / CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, UNASSOCIATED PURSE SEINE

Moderately Effective

Information on bycatch and discards is recorded in logbooks. Incidental Chinook mortalities are estimated for Chinook and coho fisheries using logbook data and estimated mortality rates (PSC 2014a) (DFO 2014b) (PFMC 2014). Verification of logbook data has occurred sporadically. But data describing bycatch quantities of other non-target species were not found. Research and monitoring is deemed "moderately effective."

CANADA / NORTH COAST BC, TROLL/POLE
CANADA / WEST COAST VANCOUVER ISLAND, TROLL/POLE

Moderately Effective

Information on bycatch and discards is recorded in logbooks. Incidental Chinook mortalities are estimated for Chinook AABM fisheries using logbook data and estimated mortality rates (PSC 2014a), and numbers of fish caught and released are estimated for coho AABM fisheries (PFMC 2014). But data describing bycatch quantities of other non-target species were not found. Research and monitoring is deemed "moderately effective."

CANADA / SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / SOUTH COAST BC, UNASSOCIATED PURSE SEINE

Moderately Effective

Information on bycatch and discards are recorded in logbooks. Incidental Chinook mortalities are estimated for Chinook and coho fisheries using logbook data and estimated mortality rates (PSC 2014a) (DFO 2014c) (PFMC 2014). Verification of logbook data has occurred sporadically. But data describing bycatch quantities of other non-target species were not found. Research and monitoring is deemed "moderately effective."

Subfactor 3.2.4 – Management Record of Following Scientific Advice

Considerations: How often (always, sometimes, rarely) do managers of the fishery follow scientific recommendations/advice (e.g., do they set catch limits at recommended levels)? A Highly Effective rating is given if managers nearly always follow scientific advice.

CANADA, DRIFT GILLNETS (DRIFTNETS)

Highly Effective

There is little scientific information available on Transboundary steelhead and chum salmon stocks. But there is no evidence that scientific advice on bycatch is disregarded. Therefore, this indicator is judged to be "highly effective."

CANADA / CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, TROLL/POLE
CANADA / NORTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA / SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / SOUTH COAST BC, UNASSOCIATED PURSE SEINE

Highly Effective

The management system has implemented some measures to reduce bycatch mortality based on scientific recommendations. For example, all licensed fishing boats must be equipped with revival boxes to improve survival of released salmon. In addition, estimates of bycatch mortality are considered in management. This factor was deemed "highly effective."

CANADA / WEST COAST VANCOUVER ISLAND, TROLL/POLE

Highly Effective

The management system has implemented some measures to reduce bycatch based on scientific recommendations. For example, fisheries are closed from mid-June to late August to avoid encounters with depleted stocks, and all licensed fishing boats must be equipped with revival boxes to improve survival of released salmon (DFO 2014c). In addition, estimates of bycatch mortality are considered in management. This factor was deemed "highly effective."

Subfactor 3.2.5 – Enforcement of Management Regulations

Considerations: Is there a monitoring/enforcement system in place to ensure fishermen follow management regulations and what is the level of fishermen's compliance with regulations? To achieve a Highly Effective rating, there must be consistent enforcement of regulations and verification of compliance.

CANADA, DRIFT GILLNETS (DRIFTNETS)

Moderately Effective

Canadian authorities are responsible for enforcement and monitoring of bycatch in Transboundary rivers within Canada. But the effectiveness of enforcement and monitoring is uncertain because these areas are remote and the cost of accessing these fisheries is high, which limits the amount of enforcement effort. This indicator was judged to be "moderately effective."

CANADA / CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, TROLL/POLE
CANADA / NORTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA / SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / SOUTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA / WEST COAST VANCOUVER ISLAND, TROLL/POLE

Moderately Effective

Some bycatch monitoring and enforcement is in place. Measures are in place for reducing bycatch mortality, including short set times, use of live boxes for live released fish, and other proper fish handling techniques. Although some poor handling of live salmon has been documented, this is not believed to be widespread (Marine Stewardship Council 2014). Enforcement of bycatch regulations is in place, but the level of enforcement effort is often low across the very large fishing area. Therefore, the overall effectiveness of bycatch enforcement is uncertain (e.g., regulations enforced by the industry or by honor system, in addition to some enforcement patrols). Thus, enforcement was rated as "moderately effective."

Criterion 4: Impacts on the habitat and ecosystem

This Criterion assesses the impact of the fishery on seafloor habitats, and increases that base score if there are measures in place to mitigate any impacts. The fishery's overall impact on the ecosystem and food web and the use of ecosystem-based fisheries management (EBFM) principles is also evaluated. Ecosystem Based Fisheries Management aims to consider the interconnections among species and all natural and human stressors on the environment.

The final score is the geometric mean of the impact of fishing gear on habitat score (plus the mitigation of gear impacts score) and the Ecosystem Based Fishery Management score. The Criterion 2 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and ≤3.2=Yellow or Moderate Concern*
- *Score ≤2.2=Red or High Concern*

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

Region / Method	Gear Type and Substrate	Mitigation of Gear Impacts	EBFM	Score
Canada / Drift gillnets (driftnets)	4.00: Very Low Concern	0.25: Minimal Mitigation	4.00: Low Concern	Green (4.123)
Canada / Central Coast BC / Drift gillnets (driftnets)	4.00: Very Low Concern	0.25: Minimal Mitigation	3.00: Moderate Concern	Green (3.571)
Canada / North Coast BC / Drift gillnets (driftnets)	4.00: Very Low Concern	0.25: Minimal Mitigation	3.00: Moderate Concern	Green (3.571)
Canada / North Coast BC / Troll/Pole	5.00: None	0.00: Not Applicable	3.00: Moderate Concern	Green (3.873)
Canada / North Coast BC / Unassociated purse seine	4.00: Very Low Concern	0.25: Minimal Mitigation	3.00: Moderate Concern	Green (3.571)
Canada / South Coast BC / Drift gillnets (driftnets)	4.00: Very Low Concern	0.25: Minimal Mitigation	3.00: Moderate Concern	Green (3.571)
Canada / South Coast BC / Unassociated purse seine	4.00: Very Low Concern	0.25: Minimal Mitigation	3.00: Moderate Concern	Green (3.571)
Canada / West Coast Vancouver Island / Troll/Pole	5.00: None	0.00: Not Applicable	3.00: Moderate Concern	Green (3.873)

Criterion 4 Assessment

SCORING GUIDELINES

Factor 4.1 - Impact of Fishing Gear on the Habitat/Substrate

- *5 (None) - Fishing gear does not contact the bottom*
- *4 (Very Low) - Vertical line gear*
- *3 (Low)—Gears that contacts the bottom, but is not dragged along the bottom (e.g. gillnet, bottom longline, trap) and is not fished on sensitive habitats. Bottom seine on resilient mud/sand habitats. Midwater trawl that is known to contact bottom occasionally*
- *2 (Moderate)—Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Bottom seine except on mud/sand*
- *1 (High)—Hydraulic clam dredge. Dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)*
- *0 (Very High)—Dredge or trawl fished on biogenic habitat, (e.g., deep-sea corals, eelgrass and maerl)*
  Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive, plausible habitat type.

Factor 4.2 - Mitigation of Gear Impacts

- *+1 (Strong Mitigation)—Examples include large proportion of habitat protected from fishing (>50%) with gear, fishing intensity low/limited, gear specifically modified to reduce damage to seafloor and modifications shown to be effective at reducing damage, or an effective combination of 'moderate' mitigation measures.*
- *+0.5 (Moderate Mitigation)—20% of habitat protected from fishing with gear or other measures in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing.*
- *+0.25 (Low Mitigation)—A few measures are in place (e.g., vulnerable habitats protected but other habitats not protected); there are some limits on fishing effort/intensity, but not actively being reduced*

- *0 (No Mitigation)—No effective measures are in place to limit gear impacts on habitats*

Factor 4.3 - Ecosystem-Based Fisheries Management

- *5 (Very Low Concern)—Substantial efforts have been made to protect species' ecological roles and ensure fishing practices do not have negative ecological effects (e.g., large proportion of fishery area is protected with marine reserves, and abundance is maintained at sufficient levels to provide food to predators)*
- *4 (Low Concern)—Studies are underway to assess the ecological role of species and measures are in place to protect the ecological role of any species that plays an exceptionally large role in the ecosystem. Measures are in place to minimize potentially negative ecological effect if hatchery supplementation or fish aggregating devices (FADs) are used.*
- *3 (Moderate Concern)—Fishery does not catch species that play an exceptionally large role in the ecosystem, or if it does, studies are underway to determine how to protect the ecological role of these species, OR negative ecological effects from hatchery supplementation or FADs are possible and management is not place to mitigate these impacts*
- *2 (High Concern)—Fishery catches species that play an exceptionally large role in the ecosystem and no efforts are being made to incorporate their ecological role into management.*
- *1 (Very High Concern)—Use of hatchery supplementation or fish aggregating devices (FADs) in the fishery is having serious negative ecological or genetic consequences, OR fishery has resulted in trophic cascades or other detrimental impacts to the food web.*

Factor 4.1 - Impact of Fishing Gear on the Habitat/Substrate

CANADA, DRIFT GILLNETS (DRIFTNETS)

Very Low Concern

Floating gillnets are used, which are designed not to touch the bottom. Commercial fishers can lose or damage gear entangled on rocks or submerged logs near the bottom. This provides an incentive for avoiding contact with the bottom. Therefore, the impacts on substrate were considered "very low" concern.

CANADA / CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA / SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / SOUTH COAST BC, UNASSOCIATED PURSE SEINE

Very Low Concern

Salmon gillnet and seine gears typically have relatively little contact with the bottom substrate, therefore this was judged to be "very low" concern.

CANADA / NORTH COAST BC, TROLL/POLE
CANADA / WEST COAST VANCOUVER ISLAND, TROLL/POLE

None

Salmon troll fishers may fish near the bottom, especially for Chinook salmon, but they attempt to avoid touching the bottom with gear because it could become lost. Salmon troll gear is judged to have no impact on the substrate.

Factor 4.2 - Mitigation of Gear Impacts

CANADA, DRIFT GILLNETS (DRIFTNETS)

Minimal Mitigation

Mitigation of gear impacts was judged be "minimal" because fishing effort is effectively controlled but not reduced.

CANADA / CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, UNASSOCIATED PURSE SEINE
CANADA / SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / SOUTH COAST BC, UNASSOCIATED PURSE SEINE

Minimal Mitigation

Salmon gillnet and seine gears have minimal contact with the substrate, and mitigation of this effect is "minimal." Fishing effort is controlled but not reduced to limit habitat impacts.

CANADA / NORTH COAST BC, TROLL/POLE
CANADA / WEST COAST VANCOUVER ISLAND, TROLL/POLE

Not Applicable

Troll gear does not contact the seabed and therefore no mitigation mesaures are required to reduce habitat impacts.

Factor 4.3 - Ecosystem-Based Fisheries Management

CANADA, DRIFT GILLNETS (DRIFTNETS)

Low Concern

Salmon are considered species of exceptional importance because they are keystone species in freshwater systems, providing an annual pulse of marine-derived nutrients and food for predators (Helfield and Naiman 2006). Research on ecosystem and food web impacts of salmon harvest is being conducted, although fishery management does not have explicit policies for protecting ecosystem function. A recent study analyzed fisheries management in relation to bear populations and identified the need to equally balance fishery harvests with the needs of the ecosystem (Levi et al. 2012). Although the needs of the ecosystem are not explicitly considered in fisheries management, escapement goals are based on the number of salmon that make it to the spawning stream (regardless of whether they spawn or are preyed upon). Thus, ecosystem needs are implicitly considered in the spawning goals. There are no Chinook and coho hatcheries located on the Transboundary rivers. Therefore this factor is scored as a “low” concern.

CANADA / CENTRAL COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / NORTH COAST BC, UNASSOCIATED PURSE SEINE

Moderate Concern

Salmon are considered species of exceptional importance because they are keystone species in freshwater systems, providing an annual pulse of marine-derived nutrients and food for predators (Helfield and Naiman 2006). Research on ecosystem and food web impacts of salmon harvest is being conducted, although fishery management does not have explicit policies for protecting ecosystem function. (Levi et al. 2012) analyzed fisheries management in relation to bear populations and identified the need to equally balance fishery harvests with the needs of the ecosystem.

Hatchery practices can have negative genetic and ecological impacts on wild salmon (e.g., (Naish et al. 2007)). There is some hatchery production of Chinook and coho salmon in North/Central Coast BC, though it is limited compared to production in South Coast BC. DFO is aware of the potential negative impacts that hatchery fish can have on wild stocks and has developed risk mitigation procedures and guidelines (DFO 2014b). Canada’s Wild Salmon Policy states that hatchery salmon are used to rebuild natural populations by encouraging enhanced fish to spawn in the wild. The enhancement program attempts to minimize genetic impacts to natural salmon by using natural origin fish as broodstock in hatcheries (MacKinlay et al. 2004).

The ecosystem conservation concern was judged to be "moderate" because there is some evidence that the ecosystem is not fully considered when developing spawning escapement goals or setting exploitation rates. Also, hatcheries are used to rebuild depleted stocks.

CANADA / NORTH COAST BC, TROLL/POLE

Moderate Concern

Salmon are considered species of exceptional importance because they are keystone species in freshwater systems, providing an annual pulse of marine-derived nutrients and food for predators (Helfield and Naiman 2006). Research on ecosystem and food web impacts of salmon harvest is being conducted, although fishery management does not have explicit policies for protecting ecosystem function. (Levi et al. 2012) analyzed fisheries management in relation to bear populations and identified the need to equally balance fishery harvests with the needs of the ecosystem.

Hatchery practices can have negative genetic and ecological impacts on wild salmon (e.g., (Naish et al. 2007)). There is some hatchery production of Chinook and coho salmon in North Coast BC, with releases of about 3 million Chinook and 300,000 coho juveniles produced from 2012 brood year adults (DFO SEP 2014). Nevertheless, production is limited compared to production in South Coast BC. Contributions of hatchery fish to spawning escapements are not consistently monitored but are likely low; the proportion of hatchery-produced fish was less than 5% for one BC North Coast indicator stock (PSC 2014a). DFO is aware of the potential negative impacts that hatchery fish can have on wild stocks and has developed risk mitigation procedures, including guidelines for integrating wild and hatchery-produced stocks (DFO 2014b) (MacKinlay et al. 2004). Because explicit policies for protecting ecosystem functioning are lacking, conservation concern was deemed "moderate."

Rationale:

The Salmonid Enhancement Program (SEP) in BC includes nearly 300 projects, ranging from hatcheries and spawning channels to small classroom incubators. SEP facilities are subject to the Pacific Aquaculture Regulations described under the Fisheries Act (DFO 2014b). Production planning meetings involve most DFO sectors as well as external consultation. Annual production plans establish the maximum number of eggs to be collected and number of juveniles to be released, taking into account information on adult production, average fecundities, average incubation to release survival rates, average marine survival rates, and average exploitation rate (Hilborn et al. 2013).

A proportion of hatchery-produced salmon are marked with coded wire tags, and data from marked fish are used to estimate contributions of hatchery-produced fish to harvest and escapements. The BC North Coast indicator stock (Kitsumkalum River in the Skeena system) has a low proportion of hatchery-origin fish (mean of 3.4% for return years from 1985 to 2012) (PSC 2014a). The proportion of hatchery-origin fish in the BC Central Coast indicator stock (Wannock River) has not been estimated.

CANADA / SOUTH COAST BC, DRIFT GILLNETS (DRIFTNETS)
CANADA / SOUTH COAST BC, UNASSOCIATED PURSE SEINE

Moderate Concern

Salmon are considered species of exceptional importance because they are keystone species in freshwater systems, providing an annual pulse of marine-derived nutrients and food for predators (Helfield and Naiman 2006). Research on ecosystem and food web impacts of salmon harvest is being conducted, although fishery management does not have explicit policies for protecting ecosystem function. (Levi et al. 2012) analyzed fisheries management in relation to bear populations and identified the need to equally balance fishery harvests with the needs of the ecosystem.

Hatchery practices can have negative genetic and ecological impacts on wild salmon (e.g., (Naish et al. 2007)). There is considerable hatchery production of Chinook and coho salmon in in South Coast BC. DFO is aware of the potential negative impacts that hatchery fish can have on wild stocks and has developed risk mitigation procedures and guidelines (DFO 2014b). Canada's Wild Salmon Policy states that hatchery salmon are used to rebuild natural populations by encouraging enhanced fish to spawn in the wild, leading to a high percentage of hatchery fish in some watersheds (Riddell 2013). The enhancement program attempts to minimize genetic impacts to natural salmon by using natural origin fish as broodstock in hatcheries (MacKinlay et al. 2004).

The ecosystem conservation concern was judged to be "moderate" because there is some evidence that the ecosystem is not fully considered when developing spawning escapement goals or setting exploitation rates. Also, hatchery production is significant, many fish stray to the spawning areas and potentially confound stock status, and hatcheries are used to rebuild depleted stocks. There is a greater level of integration in the BC hatchery system than is seen in the U.S. West Coast watersheds, so there is a lower level of concern regarding the impact of hatchery production.

CANADA / WEST COAST VANCOUVER ISLAND, TROLL/POLE

Moderate Concern

Salmon are considered species of exceptional importance because they are keystone species in freshwater systems, providing an annual pulse of marine-derived nutrients and food for predators (Helfield and Naiman 2006). Research on ecosystem and food web impacts of salmon harvest is being conducted, although fishery management does not have explicit policies for protecting ecosystem function. (Levi et al. 2012) analyzed fisheries management in relation to bear populations and identified the need to equally balance fishery harvests with the needs of the ecosystem.

Hatchery practices can have negative genetic and ecological impacts on wild salmon (e.g., (Naish et al. 2007)). There is substantial hatchery production of Chinook and coho salmon in the BC South Coast regional area (which includes WCVI), with target releases of about 37 million Chinook and 4.7 million coho juveniles produced from 2012 brood year adults (DFO SEP 2014). DFO is aware of the potential negative impacts that hatchery fish can have on wild stocks and has developed risk mitigation procedures, including guidelines for integrating wild and hatchery-produced stocks (DFO 2014c) (MacKinlay et al. 2004). The contribution of hatchery Chinook to the spawning estimates is often unknown but has been exceptionally high for some monitored BC South Coast populations, e.g., ~65% for Big Qualicum, ~30% for Cowichan fall, and 70% for Robertson Creek (Riddell et al. 2013). Because explicit policies for protecting ecosystem functioning are lacking, and hatcheries may impact wild populations, conservation concern was deemed "moderate."

Rationale:

The Salmonid Enhancement Program (SEP) in BC includes nearly 300 projects, ranging from hatcheries and spawning channels to small classroom incubators. SEP facilities are subject to the Pacific Aquaculture Regulations described under the Fisheries Act (DFO 2014b). Production planning meetings involve most DFO sectors as well as external consultation. Annual production plans establish the maximum number of eggs to be collected and number of juveniles to be released, taking into account information on adult production, average fecundities, average incubation to release survival rates, average marine survival rates, and average exploitation rate (Hilborn et al. 2013).

Canada's Wild Salmon Policy states that hatchery salmon are used to rebuild natural populations by encouraging enhanced fish to spawn in the wild. The enhancement program attempts to minimize genetic impacts to natural-origin salmon by using spawning channels and by using local natural-origin fish as broodstock in hatcheries (MacKinlay et al. 2004) (Ward 2011). A proportion of hatchery-produced salmon are marked with coded wire tags, and data from marked fish are used to estimate contributions of hatchery-produced fish to harvest and escapements. In addition, some South Coast commercial fisheries are mark-selective for coho salmon, where unmarked (natural-origin) fish are released when caught (PSC 2013b).

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Appendix A: Review Schedule

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is currently reviewing the status of North and Central Coast Chinook populations and Interior Fraser River coho populations. Seafood Watch will update this report with the results of these assessments where applicable once the assessments have been made publicly available.