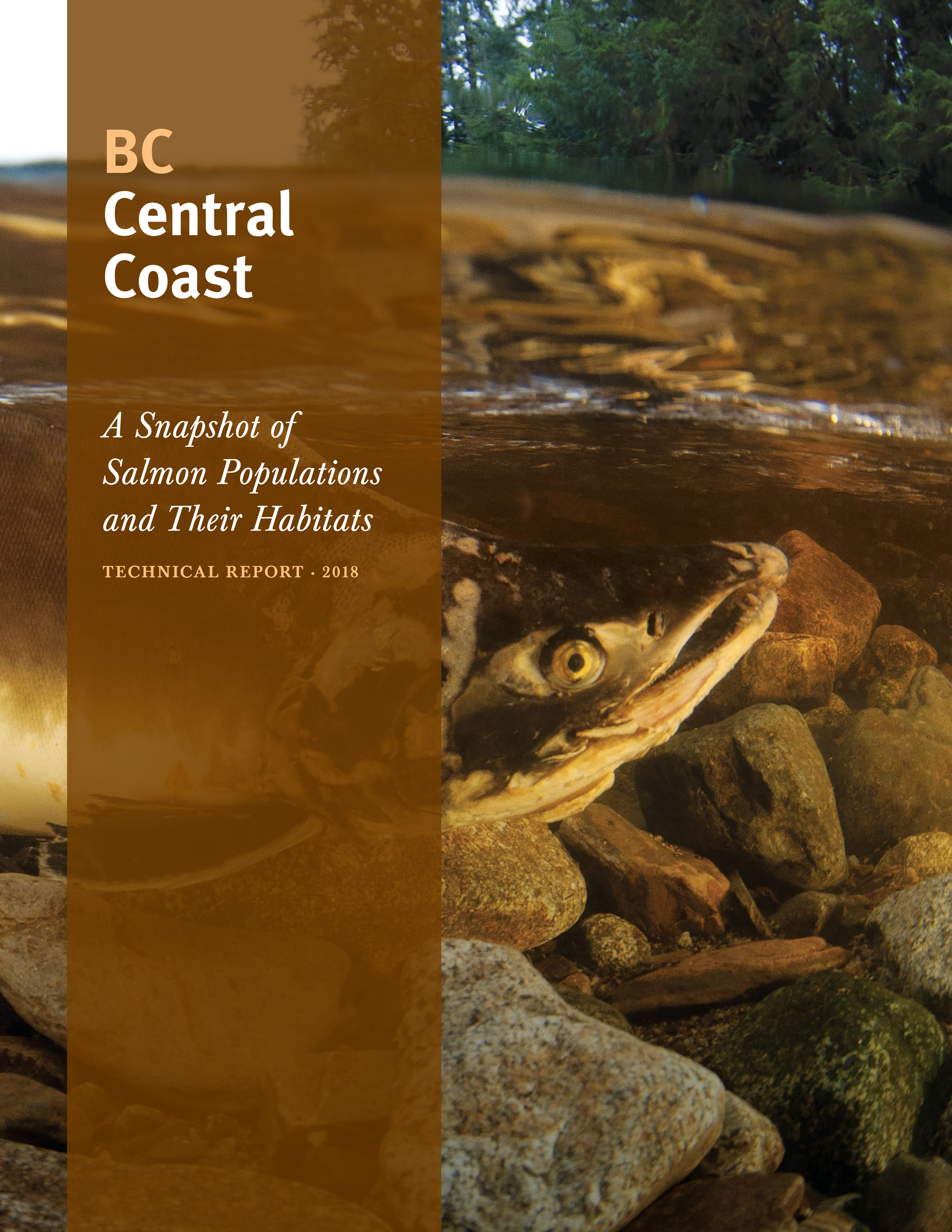

BC
Central Coast

A Snapshot of Salmon Populations and Their Habitats

TECHNICAL REPORT · 2018

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PACIFIC SALMON FOUNDATION
SALMON WATERSHEDS PROGRAM

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Acknowledgements

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Northern Technical Advisory Committee — Bruce Watkinson, Greg McKay, Colin Nelson (Gitxaala Nation); Mike Jacobs (Haisla Nation); Angela Addison, Sarah Jordan (North Coast-Skeena First Nations Stewardship Society); Lana Miller, Sandra Devcic (DFO); Stan Hutchings (Charter Patrol Officer).

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GORDON AND BETTY MOORE FOUNDATION

Canada

Executive Summary

The Central Coast of British Columbia (BC) supports a diversity of wild Pacific salmon.

No less than 114 ecologically, geographically, and genetically unique groups of wild salmon, known as Conservation Units (CUs) under Canada's Wild Salmon Policy, spawn in the region. This represents nearly one-quarter of all salmon CUs in BC and a major source of salmon biodiversity in Canada.

Salmon are an important part of the culture, economy, and ecology of the Central Coast. They provide food, social, and economic benefits to coastal communities and support significant commercial and recreational fisheries. While some salmon populations on the Central Coast are healthy, others are depressed, declining, or of conservation concern. And, for the vast majority, we know very little about their current status or the state of their freshwater habitats.

Our ability to maintain salmon biodiversity depends, in part, on our ability to detect changes in salmon production over time to diagnose the drivers of salmon population dynamics, and to identify where and when conservation and management measures need to be taken to reverse declines. However, our current ability to make salmon-focused and evidence-based decisions in this region is hindered by the lack of timely and broadly available information on the status of salmon on the Central Coast.

In an effort to strengthen the baseline of information for Central Coast salmon populations, the Pacific Salmon Foundation (PSF) collaborated with First Nations, including the Heiltsuk, Nuxalk, Kitasoo/Xai'Xais, Wuikinuxv, Gitxaala, and Haisla, the Central Coast Indigenous Resource Alliance, and Fisheries and Oceans Canada (DFO), to evaluate the status of salmon populations. Working in collaboration with Technical Advisory Committees and local knowledge holders, we compiled the best available data for describing the characteristics, dynamics, and health of all salmon CUs and their freshwater habitats on the Central Coast.

For each salmon CU, we evaluated both ‘biological status’ (the degree of conservation concern and need for management intervention) and ‘habitat status’ (the risk of degradation posed by multiple human and environmental pressures). We were able to assess the biological status of less than half of the 114 salmon CUs on the Central Coast, and 70% of all sockeye CUs were data deficient. Of the 52 CUs with sufficient data to assess status, pink salmon CUs tend to be of the lowest conservation concern and sockeye CUs tend to be of the greatest conservation concern.

To evaluate habitat status, we used 12 different habitat pressure indicators to identify which freshwater salmon habitats are facing a low, moderate, or high risk of degradation as a result of human and environmental pressures. We found that the vast majority of salmon spawning habitats in the region are in good condition with more than two-thirds (67%) rated as low risk, 22% as moderate risk, and 11% as high risk.

Of all the salmon CUs considered in this project, two CUs were identified as being of the utmost conservation concern based on their biological status: South Atnarko Lakes and Curtis Inlet sockeye. In addition, there are four CUs whose habitat status has been identified as high risk, but for which we have no information on their biological status (Kunsoot River sockeye, Mcloughlin sockeye, Bella Coola River-Late chum, and Docee Chinook). These four CUs are in urgent need of monitoring and assessment to determine their current biological status and to identify if management or conservation interventions are required to protect them.

A key output of this project is the development of the first-ever baseline of information on the status of salmon populations and their habitats on BC’s Central Coast. All of the data and assessments developed through the course of this project have been integrated into the Pacific Salmon Explorer (*salmonexplorer.ca*), an online data visualization tool that displays information on salmon populations and their habitats throughout BC, including the Central Coast. We have also made the source datasets broadly and freely available to the public via our Salmon Data Library (*data.salmonwatersheds.ca*). These centralized platforms for storing, distributing, and visualizing salmon-related datasets are critical for providing access to information, increasing the transparency of decision-making, and identifying conservation and management strategies for supporting the recovery of at-risk CUs.

Our hope is that these snapshots of salmon status provide a useful starting point for discussions at local and regional planning tables and enhance the capacity of coastal communities to play a leadership role in the monitoring, assessment, and recovery of Pacific salmon and their habitats.

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1 Introduction

Situated in western Canada, the Central Coast of British Columbia (BC) is characterized by mountainous terrain and thousands of low-relief islands. This region is part of the Great Bear Rainforest – one of the last functioning temperate rainforests in the world. Here, ancient stands of coniferous trees and bog forest dominate the landscape, and terrestrial, freshwater, estuarine, and marine systems are deeply interconnected.

With a diversity of stream, river, lake, and estuary habitats, the Central Coast offers extensive rearing and spawning habitat for hundreds of uniquely adapted Pacific salmon (*Oncorhynchus* spp.) populations (Temple 2005). All five species of eastern Pacific salmon, including coho, Chinook, chum, pink, and sockeye spawn in the region comprising more than 114 ecologically, geographically, and genetically distinct groups of wild salmon known as *Conservation Units* (CUs) under Canada's Wild Salmon Policy (see Box 1).

Within these coastal ecosystems, salmon are a keystone species – shaping the structure of local ecosystems, modulating and stabilizing ecosystem processes, and forging important ecosystem linkages at all levels (Willson and Halupka 1995; Willson et al. 1998). In aquatic systems, salmon are eaten by a variety of aquatic invertebrates and vertebrates and, on land, salmon provide an important food source for many terrestrial invertebrates and a wide array of vertebrates, including large carnivores, small mammals, amphibians, and even birds (Willson and Halupka 1995; Janetski et al. 2009).

Pacific salmon are also important drivers of nutrient and energy flows. The salmon carcasses, eggs, and sperm left behind after spawning deliver a continuous flow of nutrients and energy from the ocean to local streams, rivers, and lakes (Gende et al. 2002). The annual pulse of returning adult salmon provides an important conduit for the input of ocean-derived nutrients (e.g. carbon, nitrogen, phosphorus) to freshwater and terrestrial systems (Willson et al. 1998; Cederholm et al. 1999; Gende et al. 2002). These salmon subsidies not only benefit the next generation of salmon by increasing the productivity of salmon rearing grounds, but also enhance the productivity of entire ecosystems across multiple trophic levels.

Salmon are also closely linked to coastal communities. The high salmon biodiversity found in the Central Coast has supported First Nations cultures and economies for at least 7,000 years (Cannon and Yang 2006; Campbell and Butler 2010). To this day, salmon remain central to the social, cultural, and economic fabric of coastal communities throughout the region.

While many salmon populations on the Central Coast are healthy, others are depressed, declining, or of conservation concern (e.g. Peterman and Dorner 2012), and the status of many other populations is unknown. Declines have been attributed to a variety of human and environmental pressures, including overfishing, mixed-stock fisheries, habitat loss and degradation, and pollution. On top of this, a growing body of evidence suggests that climate change will have a major impact on Pacific salmon through changes in air temperature, precipitation, snowpack, stream flows, and water temperatures, as well as changes in predator and prey assemblages in both marine and freshwater environments (Nelitz et al. 2007; Beamish et al. 2009; Di Lorenzo and

Box 1. Canada's Wild Salmon Policy: A Conservation Blueprint

The Wild Salmon Policy is one of the main regulatory frameworks through which salmon biodiversity can be protected and maintained. The Wild Salmon Policy seeks to maintain salmon biodiversity through the protection of Conservation Units (CUs). A CU is defined as "a group of wild salmon sufficiently isolated from other groups that, if extirpated is very unlikely to recolonize naturally within an acceptable timeframe, such as a human lifetime or a specified number of salmon generations" (Fisheries and Oceans Canada 2005).

More than 400 CUs have been defined for Pacific salmon in BC and the Yukon based on similarities in their ecology, life history, and genetics (Holtby and Ciruna 2007). Under the Wild Salmon Policy, these salmon CUs represent the fundamental unit of biodiversity that is to be maintained over time to ensure the resilience of Pacific salmon on Canada's west coast.

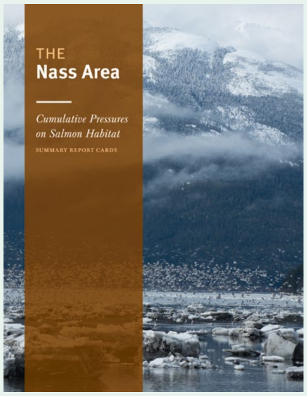
Within the Policy, six strategies have been developed for Fisheries and Oceans Canada (DFO) to apply in its management of wild Pacific salmon. Strategies 1, 2, and 3 focus on improving our current understanding of salmon populations, their habitats, and salmon ecosystems. Strategies 4, 5, and 6 are management-oriented, focused on designing and implementing a process for using the baseline information analyzed in Strategies 1–3, and for informing decisions that directly or indirectly affect salmon.

The PSF's work builds on Strategies 1 and 2, which focus on developing standardized approaches for monitoring and assessing the status of CUs and their habitats. Using the Wild Salmon Policy as a framework, the PSF has completed assessments for more than 190 CUs on BC's North and Central Coast. This work provides a baseline of information that can be used to support evidence-based decision-making and the identification of conservation and management strategies for Pacific salmon.

While our work uses the Wild Salmon Policy as a framework, it is not a formal aspect of Wild Salmon Policy implementation. Implementing the Wild Salmon Policy will require DFO to engage directly with First Nations, stakeholders, and others in the development of strategic plans that outline specific objectives for the management and long-term conservation of salmon on the Pacific Coast.

Learn more at *salmonwatersheds.ca/wsp*.

Box 2. Learn more about our work in other regions.



The Central Coast project is the latest in a series of ongoing initiatives by the PSF's Salmon Watershed Program. Past work focussed on the Skeena and Nass regions, and, as of the writing of this report, we are currently working in the Fraser River watershed, BC's South Coast, and Vancouver Island.

To learn more about our past projects and ongoing initiatives, visit our website *salmonwatersheds.ca*, or see the resources provided below:

SKEENA REGION

Habitat Report Cards (summary report cards): Skeena lake-type sockeye Conservation Units (2013)
salmonwatersheds.ca/projects/skeena-sockeye-habitat-vulnerability-assessment/

Habitat Report Cards (technical report): Skeena lake-type sockeye Conservation Units (2013)
salmonwatersheds.ca/library/lib_277

Habitat Report Cards (summary report cards): Skeena Chinook, coho, pink, chum, and river-type sockeye (2013)
salmonwatersheds.ca/projects/skeena-habitat-assessment-chinook-coho-pink-and-chum-salmon/

Habitat Report Cards (technical report): Skeena Chinook, coho, pink, chum, and river-type sockeye (2013)
salmonwatersheds.ca/library/lib_356

Conservation Unit Snapshots (summary snapshots): Skeena salmon (2013)
salmonwatersheds.ca/projects/cu-snapshots-2/

Conservation Unit Snapshots (technical report): Skeena salmon (2013)
salmonwatersheds.ca/library/lib_420

Skeena River Estuary: A snapshot of current status and condition (2015)
salmonwatersheds.ca/library/lib_432

Skeena River Estuary Assessment (technical report) (2015)
salmonwatersheds.ca/library/lib_433

NASS REGION

The Nass Area: Cumulative Pressures on Salmon Habitat (Technical Report) (2016)
salmonwatersheds.ca/library/lib_437

The Nass Area: Cumulative Pressures on Salmon Habitats (summary report cards) (2016)
salmonwatersheds.ca/library/lib_436

Mantua 2016). Understanding how the cumulative effects of human activities, in combination with changing environmental conditions, may impact the long-term health and productivity of Pacific salmon populations is critical to their conservation and management. Presently, our ability to determine where and when conservation and management actions for Pacific salmon may be required is hindered by a lack of understanding regarding the current status of Central Coast salmon populations and their freshwater habitats. In the absence of a common baseline of information on salmon status, making informed, transparent, and evidenced-based management and conservation decisions remains incredibly difficult.

To address these challenges, the Pacific Salmon Foundation (PSF) partnered with the Central Coast Indigenous Resource Alliance, the Nuxalk, Kitasoo/Xai'Xais, Heiltsuk, Wuikinuxv, Gitxaala and Haisla First Nations, and Fisheries and Oceans Canada (DFO) to strengthen the baseline of information on Central Coast salmon populations, provide a snapshot of their current status, and make this information broadly, and freely, accessible to the public.

This project builds on a decade of similar work undertaken by the PSF's Salmon Watersheds Program in other regions (see Box 2). Since 2008, the PSF has been working with First Nations, provincial and federal governments, local communities, and NGOs on BC's North and Central Coast to bring together existing data on Pacific salmon, evaluate the status of salmon CUs, and quantify pressures on their freshwater habitats. Much of our work has been guided and informed by Canada's Policy for the Conservation of Wild Pacific Salmon, commonly known as the Wild Salmon Policy (Fisheries and Oceans Canada 2005). With its goal of restoring and maintaining heathy and diverse salmon populations and their habitats, the Wild Salmon Policy provides a blueprint for monitoring and assessing the status of wild salmon populations. Over the past decade, our program has worked to advance the implementation of the science-based strategies (Strategies 1 and 2) of the Wild Salmon Policy on BC's North and Central Coast. This project remains consistent with our previous work and our broader goal of maintaining healthy and resilient salmon populations throughout BC and the Yukon.

List of Acronyms

CU	Conservation Unit
DFO	Fisheries and Oceans Canada
FWA	Freshwater Atlas
PSF	Pacific Salmon Foundation
SWP	Salmon Watersheds Program
TAC	Technical Advisory Committee
ZOI	Zone of Influence

● *Work by PSF's Salmon Watersheds Program (SWP) team*

⬟ *SWP and Technical Advisory Committee (TAC) collaboration*

Project Planning & Partner Engagement *September 2016 – April 2017*	● 1	Identify prospective partners and meet to discuss proposed project, formalize partnerships, secure project funding, and establish Technical Advisory Committees (TACs).
Data Gathering – Phase 1 *January – June 2017*	● 2	Compile publicly available data and identify data gaps.
TAC Workshop 1 *May – June 2017*	⬟ 3	Work with TACs to review project methodology, compiled data and data gaps, identify additional data sources, and compile local expert knowledge on salmon spawning locations.
Data Gathering – Phase 2 *June – October 2017*	● 4	Visit communities to share details of the project, compile supplemental information, and elicit additional local expert knowledge on salmon spawning locations.
Run Initial Population & Habitat Assessments *July – September 2017*	● 5	Undertake first draft of habitat and population assessments.
TAC Workshop 2 *November 2017*	⬟ 6	Work with TACs to review draft assessments, elicit feedback, verify draft results, and identify initial key findings to showcase on the Pacific Salmon Explorer.
Finalize Population & Habitat Assessments *September – December 2017*	● 7	Revise habitat and population assessments based on TAC feedback and finalize assessments.
Visualize Results in Pacific Salmon Explorer *September 2017 – April 2018*	● 8	Work with external data visualization experts to add the Central Coast to the Pacific Salmon Explorer and visualize all of the data and assessments in a draft, internal staging site.
TAC Workshop 3 *May 2018*	⬟ 9	Work with TAC to review final assessments in the draft Pacific Salmon Explorer staging site, finalize key findings, and discuss strategy for communicating project results.
Finalize Assessments & Project Communications *May – September 2018*	● 10	Do final quality assurance and quality control testing for the PSE, write technical report describing methodology and project results, and finalize communication documents.
Launch Central Coast Publicly in the Pacific Salmon Explorer *October 2018*	● 11	Secure final approval from TACs for public release, make content publicly available via Pacific Salmon Explorer and Salmon Data Library, distribute technical report, and travel to communities to showcase how Pacific Salmon Explorer can be used to support local-decision making.
Future Work – Updates *Ongoing*	▼	Continue to maintain relationships with TACs and project partners and support them in the ongoing use and application of the Pacific Salmon Explorer, and update the tool as new data become available.

FIGURE 1. Overview of the Central Coast project process and timeline.

2 Project Approach

2.1 Project Overview

The overarching goal of this project was to strengthen baseline scientific information for all salmon CUs on BC's Central Coast and to provide a snapshot of the current status of salmon and their freshwater habitats in the region. Our aim was to establish a legacy of information that can be used to support evidence-based decision-making around salmon conservation and management, and to help identify opportunities for supporting the recovery of at-risk salmon CUs on the Central Coast.

Specifically, our project objectives were to:

- Compile and synthesize the best available data for describing the dynamics and characteristics of salmon CUs;
- Assess the risk of degradation to salmon spawning, rearing, and migratory habitats from individual and cumulative pressures;
- Examine temporal trends in salmon populations and use biological benchmarks to assess their current status;
- Visualize all of the data and assessments on the Pacific Salmon Explorer (*salmonexplorer.ca*); and
- Make all datasets broadly, and freely, available to the public via our Salmon Data Library (*data.salmonwatersheds.ca*).

The project was realized through a two-year process that began in September 2016 (Figure 1). Technical Advisory Committees (TACs) were the primary mechanism through which the PSF engaged with partners and collaborators throughout the duration of the project. Due to the large geographic scope of the project, we established two TACs, one for the northern area of the study region and another for the southern area. The Northern TAC included fisheries staff from Gitxaala and Haisla First Nations, a long-term Charter Patrol Officer for the region, and DFO North Coast Resource Restoration staff. The Southern TAC included staff from the Central Coast Indigenous Resource Alliance, as well as fisheries managers, marine planners, stewardship coordinators, and other technical staff from the Nuxalk, Kitasoo/Xai'Xais, Heiltsuk, and Wuikinuxv First Nations. Together, these two TACs played a critical role in grounding our analyses in local knowledge and expertise, providing guidance on the project's methodology, and ensuring the end results were relevant to local decision-making needs.

In addition to the TACs, the PSF also engaged with project partners in more informal settings. During 2017 and 2018, PSF staff visited the communities of some of our First Nations partners including visits to Wuikinuxv Village, Klemtu, Bella Coola, and Bella Bella. The purpose of these visits was to introduce the project to the broader community and engage with technical staff (who did not already sit on the TAC). We also met with local knowledge holders to gather additional information on salmon spawning locations.

FIGURE 2. Map of the Central Coast region.

2.2 Study Area

We delineated the Central Coast study area based on three criteria. First, we considered the geographic extent of Central Coast salmon CUs (Appendix 1, Appendix 2). The intent was to include the full geographic extent of most CUs within the study area. Second, we considered the adjacency of the region to past and future study areas, with the intent of minimizing the overlap between study areas. Third, we considered major drainage patterns, as represented in BC's Freshwater Atlas (FWA) 1:20K Watershed Groups (MOE 2017a). Where possible, we aligned the boundary of the study area with the boundaries of major drainages.

The resulting study area, termed the Central Coast region, spans a continuous area of 54,813 km² from Douglas Channel and Banks, McCauley, and Pitt Islands in the north, to Rivers Inlet and Smith Inlet in the south (Figure 2). The study area includes 18 major drainages[1] that drain over 132,400 km of streams into Hecate Strait and Queen Charlotte Sound. The study area is home to 114[2] salmon CUs, including eight coho, nine chum, seven Chinook, five pink, and 85 sockeye CUs. To learn more about the geographic scope of the study area, the CUs included in the project, and detailed methods for defining the study area, see Appendices 1–3. It should be noted that the Central Coast region, as defined for the purposes of this project, is inclusive of territories from North Coast First Nations. These Nations (e.g. Haisla, Gitxaala, Gitga'at) were invited to participate in the project with the first two Nations participating on the TAC.

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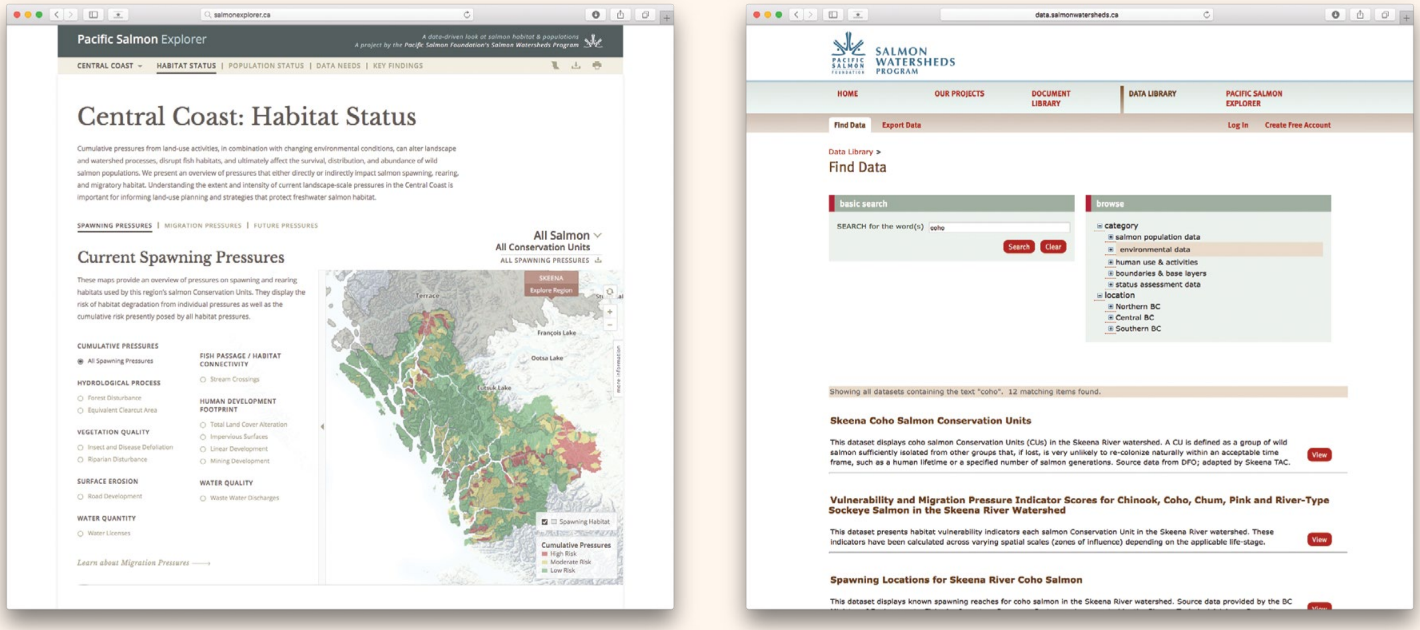
[1] Refers to 1:20K Watershed Groups in British Columbia's Freshwater Atlas (FWA), a standardised dataset for mapping British Columbia's hydrological features created by the Province. Available online at: *https://www2.gov.bc.ca/gov/content/data/geographic-data-services/topographic-data/freshwater*.

[2] We initially considered 116 CUs for the project, but two were removed based on advice from the Technical Advisory Committee and DFO. See Section 3.1 and Appendix 4 for more information.



Central Coast: Habitat Status

Cumulative pressures from land-use activities, in combination with changing environmental conditions, can alter landscape and watershed processes, disrupt fish habitats, and ultimately affect the survival, distribution, and abundance of wild salmon populations. We present an overview of pressures that either directly or indirectly impact salmon spawning, rearing, and migratory habitat. Understanding the extent and intensity of current landscape-scale pressures in the Central Coast is important for informing land-use planning and strategies that protect freshwater salmon habitat.

Current Spawning Pressures

These maps provide an overview of pressures on spawning and rearing habitats used by this region's salmon Conservation Units. They display the risk of habitat degradation from individual pressures as well as the cumulative risk presently posed by all habitat pressures.

Find Data

Showing all datasets containing the text "coho". 12 matching items found.

Skeena Coho Salmon Conservation Units

This dataset displays coho salmon Conservation Units (CUs) in the Skeena River watershed. A CU is defined as a group of wild salmon sufficiently isolated from other groups that, if lost, is very unlikely to re-colonize naturally within an acceptable time frame, such as a human lifetime or a specified number of salmon generations. Source data from DFO; adapted by Skeena TAC.

Vulnerability and Migration Pressure Indicator Scores for Chinook, Coho, Chum, Pink and River-Type Sockeye Salmon in the Skeena River Watershed

This dataset presents habitat vulnerability indicators each salmon Conservation Unit in the Skeena River watershed. These indicators have been calculated across varying spatial scales (zones of influence) depending on the applicable life-stage.

Spawning Locations for Skeena River Coho Salmon

This dataset displays known spawning reaches for coho salmon in the Skeena River watershed. Source data provided by the BC

FIGURE 3. Screenshots of the Pacific Salmon Explorer (left) and the Salmon Data Library (right).

2.3 Project Outputs

We developed two online tools for visualizing the results of this project and providing access to the salmon-related data we compiled: the **Pacific Salmon Explorer** and the **Salmon Data Library**. These tools represent our primary mediums for sharing the results of this project and for providing public access to the source datasets.

The **Pacific Salmon Explorer** (*salmonexplorer.ca*, Figure 3, left) is an interactive online data visualization tool that displays information on salmon populations and their habitats throughout BC, including the Central Coast. This tool helps people interested in salmon conservation and management gain better access to baseline data relevant to Pacific salmon. Users can explore salmon population and habitat assessments using interactive maps and figures, print summary reports for entire CUs, and download source datasets from the links to the Salmon Data Library found throughout the tool.

All of the data and information that has been compiled during the course of this project is stored in the PSF's **Salmon Data Library** (*data.salmonwatersheds.ca*, Figure 3, right). The Salmon Data Library is an integrated data system for storing and disseminating data related to salmon populations and their habitats. The Salmon Data Library allows users to download spatial datasets or time series data, as well as metadata records for each dataset. In instances where we have used an existing publicly available dataset, we provide links to the source data (e.g. to DataBC) so that users can access the most up-to-date authoritative dataset.

The Pacific Salmon Explorer provides a link to the Salmon Data Library, so users can directly access all datasets used in the tool. Alternatively, the public can access the Salmon Data Library independently on our Salmon Watersheds Program website. All non-public datasets available on the Salmon Data Library were shared with the PSF with the permission of project partners and in accordance with relevant data sharing agreements.

3 Salmon Population Assessments

STRATEGY 1 OF the Wild Salmon Policy calls for the standardized monitoring and assessment of wild salmon status (Fisheries and Oceans Canada 2005). We used Strategy 1 as a framework for developing snapshots of salmon status on BC's Central Coast. The first step was to compile and synthesize data for all Central Coast salmon CUs (Section 3.1). This involved sourcing the best available data from public sources, as well as supplementary datasets provided by the TACs. The second step was to summarize six population metrics that can be used to describe the dynamics and characteristics of salmon CUs (Section 3.1.1). The final step involved assessing the biological status for each CU using two different status metrics (Section 3.2).

3.1 Methods: Data Compilation & Synthesis

To quantify trends in abundance, evaluate biological status, and identify data gaps, we compiled data from a number of sources. The primary data inputs include data on spawner abundance, catch, and exploitation rate. For the most part, these data have been sourced from DFO's New Salmon Escapement Database (NuSEDS), the Fisheries Operating System (FOS), and other DFO databases (Figure 4). However, for this project, the PSF primarily accessed these datasets via the North and Central Coast (NCC) Database (English et al. 2016). The NCC Database is a database produced and maintained

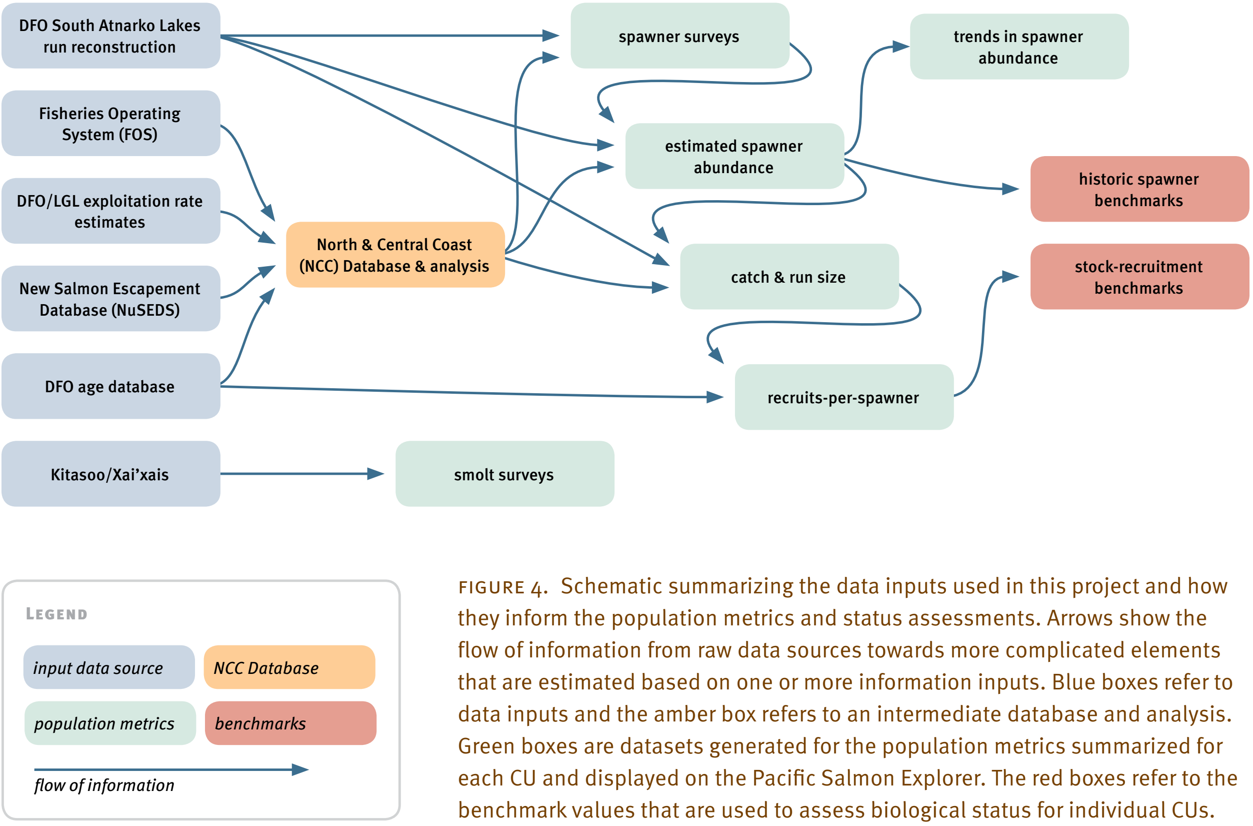


FIGURE 4. Schematic summarizing the data inputs used in this project and how they inform the population metrics and status assessments. Arrows show the flow of information from raw data sources towards more complicated elements that are estimated based on one or more information inputs. Blue boxes refer to data inputs and the amber box refers to an intermediate database and analysis. Green boxes are datasets generated for the population metrics summarized for each CU and displayed on the Pacific Salmon Explorer. The red boxes refer to the benchmark values that are used to assess biological status for individual CUs.

by LGL (an environmental consulting firm) that synthesizes datasets on spawner surveys, catch, exploitation rate, and age structure, and also includes generated datasets for CU-level estimates of spawner abundance, run size, and exploitation rate from 1954–2014 (Figure 4). Since 2008, the PSF has commissioned LGL to work with DFO staff to assemble key datasets from DFO's databases and maintain this information in the NCC Database.

In addition to the NCC Database, we sourced supplementary datasets from DFO for updated spawner abundance and catch data for the South Atnarko Lakes CU (Connors et al. 2016). We also used supplementary data from the Kitasoo/Xai'xais Stewardship Authority for data on smolt abundance for two streams in Kitasoo/Xai'xais territory.

Once we compiled the relevant data, the next step was to review the compiled datasets and the list of CUs included in this project. This largely occurred via the TACs, with the objectives of identifying errors and omissions in the datasets and incorrect assignments of indicator streams to CUs. Through this expert review process, the TACs found notable issues with four of the initial 116 CUs identified in the study area (Appendix 4). As a result of this review process, two CUs were removed from the project (Whalen Lake and Owikeno-Late sockeye (lake-type) CUs).

3.1.1 Summary of Population Metrics

We used six metrics to characterize the dynamics and status of each CU. These metrics provide a detailed snapshot of the best available data on salmon CUs and temporal trends in salmon status over time.

Spawner Surveys / Observed Spawner Counts

Spawner surveys consist of counts or observations of the number of salmon spawning in a specific stream in a given year. Spawner surveys are a fundamental source of information for assessing and tracking the status of salmon populations through time. We used data from NuSEDS (compiled in the NCC Database) to illustrate the spatial and temporal coverage of spawner counts, by stream, for each Central Coast CU. We also calculated average spawner counts using the geometric mean because, unlike the arithmetic mean, it is not inflated by the less frequent, higher abundance years.

All surveyed spawning streams in the Central Coast have been classified as indicator and non-indicator streams. Indicator streams are those streams that have been identified by DFO and LGL as providing more reliable indices of abundance (see English et al. 2006 for details). These indicator streams tend to be more intensively surveyed using methodologies that are considered to provide relatively accurate estimates of annual abundance. Indicator streams are also assumed to be representative of returns to other streams in close proximity. A number of other streams within the CU that are classified as non-indicator may also be surveyed in a given year. Non-indicator streams typically have less consistent survey coverage, variable methods applied, and/or may simply be difficult to survey (e.g. poor water clarity, remote location).

The methods used to survey spawners in both indicator and non-indicator streams vary considerably by species, CU, and stream. Methodology ranges from estimates based on a single visual survey of a stream section on foot, to counts of fish passing through an unbreached counting fence. On the Central Coast, most CUs are enumerated through foot and aerial surveys; however, survey methodology can change through time. For example, some streams that were previously surveyed by visual surveys on foot are now enumerated using a counting fence. Various approaches have been used to score the quality of spawner survey data. English et al. (2016) use three five-point scales to assess the quality of counts, based on three criteria: (1) survey methodology, (2) execution, and (3) coverage, with higher values of each scale corresponding to higher quality estimates of spawner abundance. The data quality scores were not considered in this analysis. In other words, the escapement estimates from a single aerial count are represented in the same way that an unbroken fence count is.

Estimated Spawner Abundance

Estimated spawner abundance represents the estimated total number of spawners that return to spawn each year for a given CU. This CU-level estimate of abundance is based on spawner survey data from NuSEDS, but also accounts for streams that are not surveyed in a given year.

The quality of the spawner abundance estimates in NuSEDS varies by time period, region, and stream. As such, the stream-level data are not always representative of actual changes in abundance through time for a CU. This is because a CU may be comprised of more than one spawning population, and the monitoring coverage of spawning populations has varied greatly over time. Moreover, only very rarely are all of the salmon spawning populations that comprise a CU actually enumerated in a given year (English et al. 2016). As such, an "expansion procedure" is needed so that any changes in abundance through time are not confounded with changes in monitoring effort.

From 2004 to present, the PSF has worked with LGL to generate CU-level estimates of abundance in collaboration with DFO North Coast stock assessment staff (English et al. 2006, 2012, 2016). These expansion procedures, by necessity, make a number of simplifying assumptions. The first expansion factor assumes that the proportion of the overall CU that each indicator stream represents is constant through time. The second expansion factor assumes that indicator and non-indicator streams make up a constant contribution to the overall abundance of a CU. The final expansion factor assumes that observer efficiency is constant between years, CUs, methodologies (except for fences), and hydrological systems. These, and other assumptions, are described in detail in Appendix E of English et al. 2016.

While there are obvious limitations inherent in these simplifying assumptions, in the absence of a complete census for a CU, these expansion procedures are generally recognized as the best practice for generating CU-level estimates of spawner abundance. Similar expansion procedures are part of the Pacific Salmon Treaty through the Northern Boundary Run Reconstruction Model (Alexander et al. 2010) and have been applied to assessments of status in other regions, such as West Coast of Vancouver Island Chum (Holt et al. 2018).

We used the expanded CU-level estimates to illustrate estimated spawner abundance for each Central Coast CU over time. These values were also used as inputs for the Trends in Spawner Abundance, Catch and Run Size, and Recruits-per-Spawner metrics described below, and were used in the assessments of biological status (see Section 3.2).

Smolt Surveys

Smolt abundance is an estimate of the number of outmigrating smolts that are counted in a given system in a given year. For each CU, we plotted smolt abundance data for each stream, where available. We also calculated average smolt counts using the geometric mean because, unlike the arithmetic mean, it is insensitive to less frequent, higher abundance years.

In this project, all smolt abundance data was provided by the Kitasoo/Xai'xais Nation, who have been running a smolt monitoring program in two creeks, Mary Cove Creek and Lagoon Creek, since 1992. This monitoring program uses fyke nets (a type of fish trap) to monitor outmigrating sockeye, coho, pink, and chum smolts. Counts of salmon were taken from the fyke nets at regular intervals throughout the sampling season. Due to differential effort between years, differences in sampling designs through time, and issues with sampling under high-flow events, the smolt abundance estimates shown on the Pacific Salmon Explorer should be considered an index of abundance rather than an estimate of the total number of smolts that migrated to the ocean in a given year.

Catch & Run Size

Catch refers to adult salmon that are caught in commercial (U.S. and Canadian), recreational, and First Nations fisheries. **Run size** refers to the total number of adult salmon returning from the ocean in a given year, including those that reach the spawning grounds (i.e. estimated spawner abundance) and those that are caught. **Exploitation rate** refers to the proportion of the total run that is caught in all fisheries. The large and variable exploitation rates that a CU encounters in various fisheries has a significant influence on the number of fish that return to the spawning streams.

For each CU, annual estimates of catch and exploitation rates were sourced from the NCC Database. The catch data originates primarily from DFO's FOS database. To determine a CU's exploitation rate, a variety of approaches were used depending on the quality and quantity of data available (English et al. 2012, 2016). With the exception of DFO Statistical Area 5, exploitation rates for Central Coast sockeye, pink, and chum are calculated by dividing the total catch in a Statistical Area by the total escapement to that Statistical Area. In Statistical Area 5, the exploitation rate for sockeye, pink, and chum depends on various effort-harvest rate models (see Table 1 in English et al. 2016). In contrast, for Chinook and coho, recoveries of coded-wire tags from a subset of marked CUs are used to derive exploitation rate estimates and CU-specific harvests.

Key sources of uncertainty for catch and run-size estimates include: assumption of no catch for CUs from other Statistical Areas (sockeye, pink and chum); assumption that run-timing estimates are accurate and representative for the effort-harvest rate models (Statistical Area 5 estimates only); and the assumption that the indicator stocks for coho and Chinook are representative of exploitation rates experienced in other (non-indicator) CUs.

Recruits-per-Spawner

Recruits-per-spawner is an estimate of the number of adult salmon produced per spawner in the parental generation. Recruits-per-spawner provides important information on the survival of salmon from a CU over time, which can help to inform questions about drivers of variation in survival within and among CUs. When the total number of recruits produced per spawner is below one, the CU is no longer replacing itself from one generation to the next and will decline in abundance until the recruits-per-spawner exceeds one.

Recruits-per-spawner was calculated as the number of recruits (the sum of all fish that return to spawn from a given brood year) divided by the number of spawners for each brood year (based on CU-level estimates of spawner abundance). The number of recruits is determined from estimates of the total run size for each CU along with estimates of age structure (i.e. the proportions of recruits that returned to spawn for each age at maturity). Data for the age structure of each CU was sourced from the NCC Database, which were based on datasets derived from the Pacific Region Salmon Age Dataset (English et al. 2016). For most CUs, there are no annual estimates of age composition. In some cases, age structure information was borrowed from other CUs of the same species. In cases where some year-specific age composition information exists, but the time series is incomplete, age composition values were imputed with the average value of the years for which there is data. For additional details on the age structure data, see English et al. (2016). The exception was the South Atnarko Lakes CU, which had annual age composition data provided by DFO (Connors et al. 2016).

Assuming a fixed age-structure can lead to uncertainty and bias in estimates of recruits-per-spawner, and corresponding stock-recruitment benchmarks. The assumption of a constant age structure for a CU creates less variation in the time series of recruits, and thus can result in an underestimation of the lower stock-recruitment benchmark, and an overestimation of the upper stock-recruitment benchmark (Zabel and Levin 2002; Korman and English 2013). However, previous studies on salmon CUs in the Skeena River watershed have shown that the overall influence of age structure on estimating stock-recruitment benchmarks is relatively small (Korman and English 2013; Holt et al. 2018).

Trends in Spawner Abundance

Trends in spawner abundance refers to an estimate of the trend in abundance for an individual CU for the full time series of information. These trends highlight long-term shifts in abundance that may otherwise be obscured by the high interannual variability in abundance common in most salmon populations. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) uses trends in abundance over the last three generations (or 10 years, whichever is longer) as an indicator of the risk of extinction. However, consideration of trends in abundance over longer time periods than what is typically considered by COSEWIC has been shown to be more likely to detect true declines in abundance (d'Eon-Eggerston et al. 2015; Porszt et al. 2012).

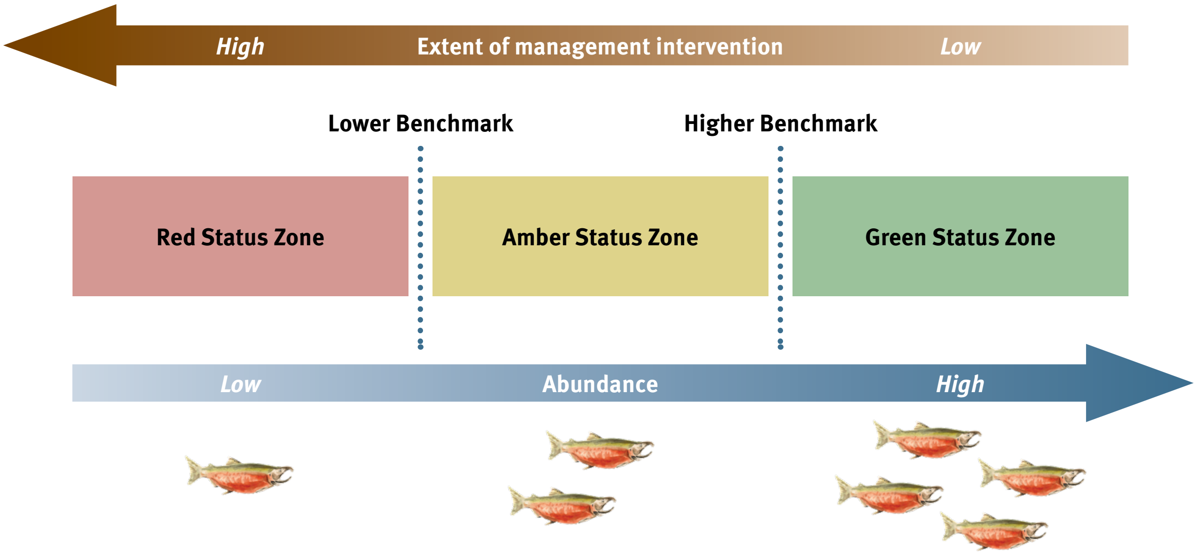


FIGURE 5. Benchmarks and biological status zones to be determined for each Conservation Unit, adapted from the Wild Salmon Policy (Fisheries and Oceans Canada 2005).

For each CU, trends in abundance were based on the geometric mean for each generation as estimated from a running window of the generation length of that CU. For example, pink CUs had a generation length (and thus a sliding window) of two-years, while coho had a four-year generation length. The window was right-aligned so that the data displayed for a given year is for the most recent year in a given time period. For this analysis, the data was natural log-transformed so that a linear relationship could be fit to the data to estimate the rate of change. A back transformation was then completed to permit the calculation of percent change over the time series.

3.2 Methods: Assessing Biological Status

Under Strategy 1 of the Wild Salmon Policy, the status of salmon CUs is to be assessed using standard points of reference (i.e. benchmarks) against which a condition can be compared. These benchmarks can be based on various status metrics in order to quantify the biological status of a CU as falling into one of three status zones: red, amber, or green (Figure 5). As the given status metric declines for a CU, the biological status of the CU moves from green to amber to red, and the extent of management intervention required increases. However, the Wild Salmon Policy is not prescriptive with regards to management actions applied to red and amber CUs; rather, the type and extent of management intervention is determined for CUs on a case-by-case basis.

Holt et al. (2009) proposed candidate benchmarks for evaluating CU status, grouped into four classes of indicators: current spawner abundance, trends in abundance over time, distribution of spawners, and fishing mortality related to stock productivity. For the Central Coast, we used one class of indicator to quantify biological status, spawner abundance,

Box 3. Biological Benchmarks & Management Reference Points

In the management of salmon fisheries, multiple, competing objectives can make it difficult to define reference points for decision-making (Holt and Irvine 2013). Biological benchmarks and management reference points are distinct concepts that help to disentangle the trade-offs between long-term biological and shorter-term socioeconomic considerations.

Biological benchmarks, which are used in this project, delineate zones of biological status (i.e. good/green, fair/amber, or poor/red) based on population dynamics and conservation considerations. They are scientifically derived. In contrast, *management reference points* typically integrate biological information with shorter-term socioeconomic considerations that may be obtained through stakeholder engagement.

In this project, our approach to developing biological benchmarks is consistent with the methodologies put forward by DFO for assessing status under the Wild Salmon Policy (Fisheries and Oceans Canada 2005; Holt et. al 2009). While the biological benchmarks used in this project may not align with management reference points that have been developed for specific CUs, they can provide important inputs for developing management reference points, undertaking integrated status assessments, or supporting other expert-driven processes that integrate socioeconomic information.

and two different metrics within that class: those based on (1) historic spawners and (2) the stock-recruitment relationship. The methods we used to assess biological status for Central Coast CUs build off our work in the Skeena River watershed (Connors et al. 2013; Korman and English 2013) and the Nass River watershed (see Box 2), and recommendations by Holt et al. (2009).

Each of the status metrics we considered have their own advantages and drawbacks. The stock-recruitment approach has the advantage of being more biologically meaningful than the historic spawners approach, as it considers the productivity and carrying capacity of each CU. However, this approach is also more data-intensive, requiring estimates of age structure, exploitation rates, and CU-level spawner abundance. The historic spawners approach requires less data, so is more suited to data-limited situations, but is also less representative of population dynamics. Historic spawner approaches have previously been used to estimate the status of salmon CUs in Canada (Holt et al. 2009, 2018) and Alaska (Clark et al. 2014, 2017). Previous research has found that historic spawner approaches are generally more precautionary for assessing the status of data-limited salmon populations than other approaches (Hilborn et al. 2012; Holt and Folkes 2015).

Neither metric is intended to provide a definitive assessment of biological status. Additionally, these status assessments are not intended to represent management targets, escapement goals, or reference points used in the management of salmon fisheries (Box 3). Rather, the estimates presented in this report are intended to provide a synoptic overview of CU status based on a suite of metrics and an overall indication of the dynamics and characteristics of salmon CUs over the available time series.

Historic Spawners

For the historic spawners metric, we use the 25th and 75th percentile of historic spawner abundance as the lower and upper benchmarks, respectively (Hilborn et al. 2012; Holt et al. 2016). The status of each CU was then determined by comparing the geometric average of spawner abundance over the most recent generation to the upper and lower benchmarks. A CU was assigned a “red” status if the geometric average spawner abundance over the most recent generation (based on the average assumed age at maturity for the CU) was at or below the 25th percentile of historic spawner abundance. An “amber” status was assigned if average spawner abundance over the most recent generation was between the 25th and 75th percentiles of historic abundance, and a “green” status was assigned if it was at or over the 75th percentile.

Stock-Recruitment

The shape of the stock-recruitment relationship can also be used to define benchmarks for evaluating biological status (Korman and English 2013; Holt et al. 2009). For the stock-recruitment approach, the upper benchmark corresponds to S_{MSY} (the spawner abundance predicted to achieve Maximum Sustainable Yield over the long-term), and the lower benchmark corresponds to S_{GEN1} (the spawner abundance predicted to return the population to S_{MSY} in one generation under equilibrium conditions in the absence of fishing). This same approach has previously been used to quantify biological status for Fraser sockeye (Grant et al. 2010) and for CUs from the Skeena River watershed (Korman and English 2013).

Stock-recruitment based benchmarks are estimated in a hierarchical Bayesian framework by species. A hierarchical approach was chosen because estimates of stock-recruitment relationships within a species derived simultaneously are more reliable than those estimated independently. Hierarchical modeling approaches, which borrow information from data-rich populations to potentially improve assessments for data poor ones, are being increasingly applied in stock assessment to share information across populations (see Korman and English 2013; Jiao et al. 2011; Malick et al. 2017).

We generated brood tables for Central Coast CUs based on estimates of age-specific recruitment from the NCC Database (English et al. 2016). For CUs with more than three stock-recruitment pairs we fit a species-specific hierarchical Ricker model:

$$log_e\left(\frac{R_{i,t}}{S_{i,t}}\right) = \alpha_{i,t} - \beta_i S_{i,t} + \varepsilon_{i,t},$$
$$\alpha_i \sim N(\mu_\alpha, \sigma_\alpha),$$
$$\varepsilon_{i,t} \sim N(0, \sigma_{i,t})$$

EQUATION 1.

where R is total recruitment from spawners S from CU i in brood year t, α is intrinsic productivity, β is the strength of within CU density dependence and ε is residual variation. Parameters for each CU within a species were estimated in a hierarchical framework with CU-specific intrinsic productivity values from a normal distribution. For each species, the model in equation 1 was fit to all Central Coast CUs with sufficient stock-recruitment data.

We used uninformative prior distributions for the hyper parameters of α (hyper-priors) and σ_α, and informative priors for CU-specific estimates of β_i based on its reciprocal S_{MAX} with a mean equal to the average spawner abundance for the CU and a coefficient of variation set to an uninformative (10) or minimally informative (1) value if there were problems with convergence.

Posterior probability distributions were generated for the parameters in equation 1 using a Markov chain Monte Carlo procedure in the r2JAGS package in R (Su and Yajima 2012). We ran six chains for 100,000 iterations with a burn-in of 5,000 iterations and thinned every tenth iteration. Convergence was assessed by examining the potential scale reduction factor ($\hat{R}$); convergence was assumed to have occurred if ($\hat{R}$) was less than 1.1 (Gelman and Rubin 1992).

S_{GEN1} was calculated by nonlinear estimation using the 'L-BFGS-B' algorithm from the 'optim' library in R and S_{MSY} was calculated based on the explicit solution proposed by Scheuerell (2016). We then compared the geometric average over the most recent generation to the upper (S_{MSY}) and lower (S_{GEN1}) benchmarks to determine biological status. To account for uncertainty in the benchmarks, we also calculated the probability of current spawner abundance for each CU falling below, between, and above the lower and upper benchmarks.

Data Deficient Conservation Units

Assessments of biological status were contingent on the availability and quality of time series data on spawner abundance. For a number of CUs, limitations in the available data meant that the status of CUs could not be assessed; these CUs were categorized as 'data deficient.'

We considered two types of data deficiencies in this project. The first type includes CUs with *no run reconstruction*. CUs that fall into this category do not have a run reconstruction and have no corresponding CU-level estimates of spawner abundance. This could be for one of two reasons: (1) These CUs do not have any data in NuSEDS. This means that there have been no spawner surveys conducted for these CUs since 1954. (2) These CUs do not have an identified indicator stream. Without an indicator stream, CU-estimates of spawner abundance cannot be generated, which are necessary for estimating biological status.

The second type of data deficient CUs are those for which there is no data on spawner abundance for the *most recent generation*. This means that we cannot generate an estimate of current abundance to compare against the different benchmarks.

3.3 Limitations

There are a number of limitations to population assessments and we outline them in this section. Limitations related to CU-level estimates of spawner abundance and developing benchmarks apply to all species. In addition, species-specific limitations are described. These caveats should be considered when interpreting the results of the biological status assessments, and also when considering future research priorities.

CU-Level Estimates of Spawner Abundance

In the absence of a complete census for a CU, expansion procedures are used to generate CU-level estimates of spawner abundance. These expansion procedures are generally recognized as the best practice for generating CU-level estimates of spawner abundance on BC's North and Central Coast (English et al. 2012). Given that the PSF's objective is to examine the biological status of individual CUs in comparison to different metrics and is not, for example, to determine catch allocation, the assumptions that underpin the expansion procedures should not unduly influence the assessments of biological status. Nonetheless, the PSF and DFO are currently undertaking a simulation analysis to determine the influence of these expansion procedures and other simplifying assumptions on the resulting biological status assessments (Hertz et al. *in prep*).

Refining Benchmarks

The benchmarks that we use to define biological status are based on the best available published literature. However, there are still some areas that would benefit from further consideration. For example, Holt et al. (2018) found that the 25th and 50th percentile benchmark better reflected the stock-recruitment status of chum on Vancouver Island, in contrast with the 25th and 75th percentiles used in this project. In Alaska, Clark et al. (2017) use a tiered approach to define percentile benchmarks based on data quality and exploitation rates. Moving forward, we will continue to apply best practices in the application of benchmarks drawing upon current literature and ongoing discussion with our TACs and experts in the field.

For stock-recruitment-based benchmarks, the influence of the various assumptions that go into the run reconstruction (e.g. expansion factors, age-structure, harvest rate, etc.) is an issue that also requires further consideration. The abovementioned sensitivity analysis (Hertz et al. *in prep*) will also examine the influence of the various run-reconstruction assumptions on our ability to correctly assign status to a CU. Based on this work, we will develop guidelines on when each benchmark is appropriate to use and under what circumstances.

Pink & Chum

CU-level estimates of spawner abundance for pink and chum are generated from the stream-level data sourced from NuSEDS. These data represent different methodologies (e.g. peak count, area-under-the curve estimates), from different observers, in different DFO Statistical Areas. However, the expansion factor for observer efficiency is treated as a constant value across time and space. A more detailed treatment of observer efficiency across time and space could provide more accurate estimates of changes in abundance.

Monitoring coverage, as determined by the number of indicator streams enumerated in a given year, has seen large declines since the 1990's, with even more sharp reductions from 2006 to 2014 (English 2016). The declines in monitoring coverage mean that the magnitude of extrapolation from monitored streams to entire CUs have increased in recent years. Fewer indicator streams are being used to represent CUs within a vast geographic area. This could be problematic if the contribution of various streams within the CU to overall abundance has changed through time.

Coho

Coho data have similar limitations to pink and chum: the assumption of constant observer efficiency and declines in monitoring coverage. However, the quality of coho data are also affected by a large amount of uncertainty in exploitation rate estimates. Exploitation rates for coho on the Central Coast are assumed to be the same as for Skeena coho, or a proportion thereof (English et al. 2016). A coded-wire-tag program for coho on the Central Coast would provide much better exploitation rate estimates.

Chinook

Estimates of abundance and harvest for Bella Coola–Bentinck and Wannock Chinook come from established coded-wire-tag run reconstructions (Velez-Espino et al. 2014; English et al. 2016). Exploitation rates for other Chinook CUs are based on the values for these two CUs. This assumption requires further validation, possibly with DNA data.

Sockeye

Harvest rates for sockeye on the Central Coast are calculated by proportionally partitioning the catch of sockeye within a DFO Statistical Area to the CUs that spawn within that region (with the exception of the South Atnarko Lakes CU). This means that there is an assumption that there is no harvest of these CUs outside of this area, which is highly unlikely. This assumption could be assessed with DNA data.

3.4 Results: Overview

This section provides a high-level overview of the project results for all 114 salmon CUs in the Central Coast region. Full results are available online through the Pacific Salmon Explorer (salmonexplorer.ca), where individual figures, maps, data, and summary statistics are provided for each CU in the region. Please note that the results of this assessment reflect the data in-hand as of September, 2018 and reflect data that are current to 2014 (see Section 3.1). As new data become available, we will update the analyzes and visualize the updated results in the Pacific Salmon Explorer. Consequently, in the future, the results described and summarized in this report will not match the results presented online.

3.5 Results: Biological Status

Of the 114 CUs we examined in this project, we were able to assess biological status for 52 CUs. The remaining 62 salmon CUs had insufficient information for evaluating their biological status (see Section 3.2 for a discussion of the criteria used to define data deficient CUs). Of the CUs for which we were able to assess biological status, the majority are in the green or amber status zones. For the historic spawners metric, 15 CUs are green and 32 CUs are amber, while for the stock-recruitment metric, 32 CUs are green and 15 CUs are amber. This difference highlights the tendency of the historic spawners metric to produce more precautionary results with more CUs in the green or amber zones, especially for data-limited CUs (Holt et al. 2018). Both metrics identified five CUs in the red status zone (Appendix 5).

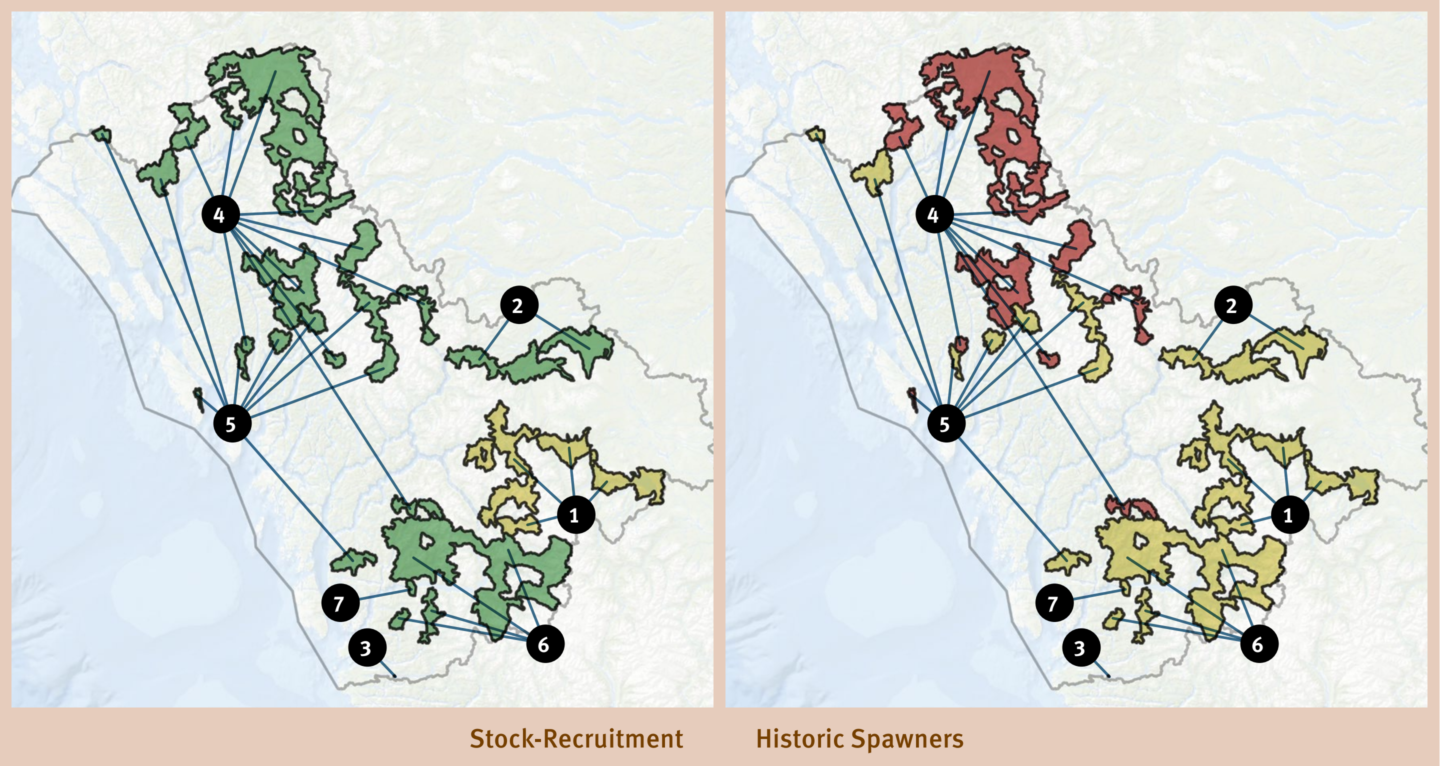
Chinook
Biological Status

🟩 Good

🟨 Fair

🟥 Poor

⬜ Data Deficient



Stock-Recruitment

Historic Spawners

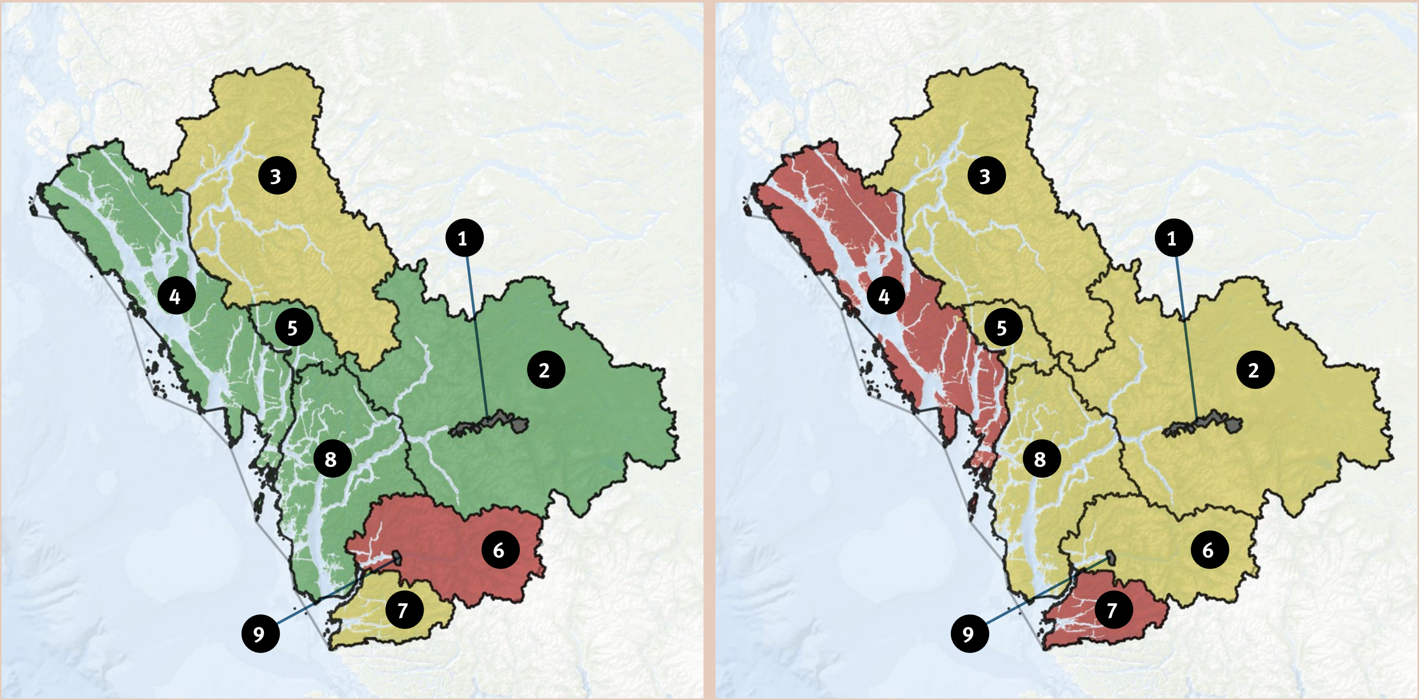
Stock-Recruitment	Historic Spawners		Conservation Unit
🟨	🟨	1	Bella Coola-Bentinck
🟩	🟨	2	Dean River
⬜	⬜	3	Docee
🟩	🟥	4	North & Central Coast-Early
🟩	🟨	5	North & Central Coast-Late
🟩	🟨	6	Rivers Inlet
🟩	🟨	7	Wannock

FIGURE 6. Maps showing the biological status of Central Coast Chinook salmon Conservation Units, using stock-recruitment and historic spawners metrics.

Chum

Biological Status

🟩 Good
🟨 Fair
🟥 Poor
⬜ Data Deficient



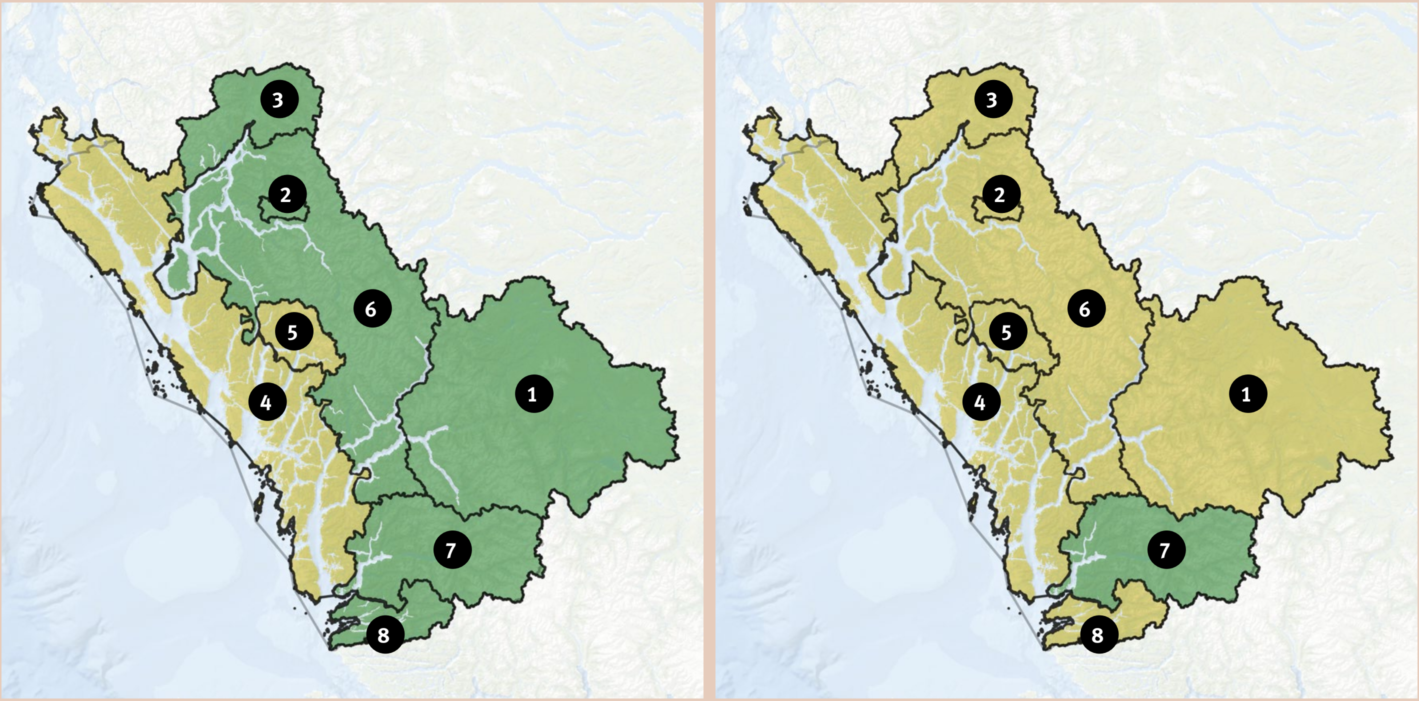
Stock-Recruitment **Historic Spawners**

Stock-Recruitment	Historic Spawners		Conservation Unit
⬜	⬜	1	Bella Coola River-Late
🟩	🟨	2	Bella Coola-Dean Rivers
🟨	🟨	3	Douglas-Gardner
🟩	🟥	4	Hecate Lowlands
🟩	🟨	5	Mussel-Kynoch
🟥	🟨	6	Rivers Inlet
🟨	🟥	7	Smith Inlet
🟩	🟨	8	Spiller-Fitz-Hugh-Burke
⬜	⬜	9	Wannock

FIGURE 7. Maps showing the biological status of Central Coast chum salmon Conservation Units, using stock-recruitment and historic spawners metrics.

Coho
Biological Status

🟩 Good
🟨 Fair
🟥 Poor
⬜ Data Deficient



Stock-Recruitment

Historic Spawners

Stock-Recruitment	Historic Spawners		Conservation Unit
🟩	🟨	1	Bella Coola-Dean Rivers
🟩	🟨	2	Brim-Wahoo
🟩	🟨	3	Douglas Channel-Kitimat Arm
🟨	🟨	4	Hecate Strait Mainland
🟨	🟨	5	Mussel-Kynoch
🟩	🟨	6	Northern Coastal Streams
🟩	🟩	7	Rivers Inlet
🟩	🟨	8	Smith Inlet

FIGURE 8. Maps showing the biological status of Central Coast coho salmon Conservation Units, using stock-recruitment and historic spawners metrics.

Chinook

Most Central Coast Chinook CUs are in the green or amber status zone (Figure 6 and Appendix 5). Four CUs are in the green status zone using the stock-recruitment metric, but are in the amber status zone using the historic spawner approach (Wannock, Dean River, North and Central Coast Late Timing, and Rivers Inlet), again highlighting the tendency of the historic spawners metric to produce more precautionary results. These four CUs are of low to moderate conservation concern, depending on the status metric used.

One CU, Bella Coola-Bentinck, is in the amber status zone for both metrics, indicating that it is of moderate conservation concern. The North and Central Coast Early CU is in the green status zone using the stock-recruitment metric and in the red status zone using the historic spawner approach. The lack of concordance between the two status metrics likely occurs because of a lack of contrast in the available time series (i.e. the difference between the minimum and maximum years is small).

There is no spatial north-south or inland-coastal spatial pattern for the distribution of biological status for Chinook (Figure 6). The most southern Chinook CU, Docee, is data deficient for both status metrics due to a lack of data over the most recent generation. Docee is located in Smith Inlet, and the counting fence that was used to monitor spawning numbers has not been operational for Chinook since 2011.

Chum

The status of chum CUs on the Central Coast is variable, with status ranging from green to red depending on the metric and CU (Figure 7 and Appendix 5). There is very little concordance between the stock-recruitment metric and the historic spawner metric for chum; only the Douglas-Gardner CU is in the same status zone using both metrics (amber). Three CUs show a red status based on either the historic spawners or the stock-recruitment metric: Hecate Lowlands, Smith Inlet, and Rivers Inlet CUs. This suggests that one-third of the chum CUs in the Central Coast may be of conservation concern, suggesting a possible need for conservation or management intervention.

The spatial distribution of biological status is also variable; chum CUs do not show a clear north-south or inland-coastal pattern of biological status (Figure 7). However, the southernmost CUs, Rivers Inlet and Smith Inlet, are doing relatively poorly based on both status metrics (Rivers Inlet is amber/red and Smith Inlet is red/amber using historic spawners/stock-recruitment approaches).

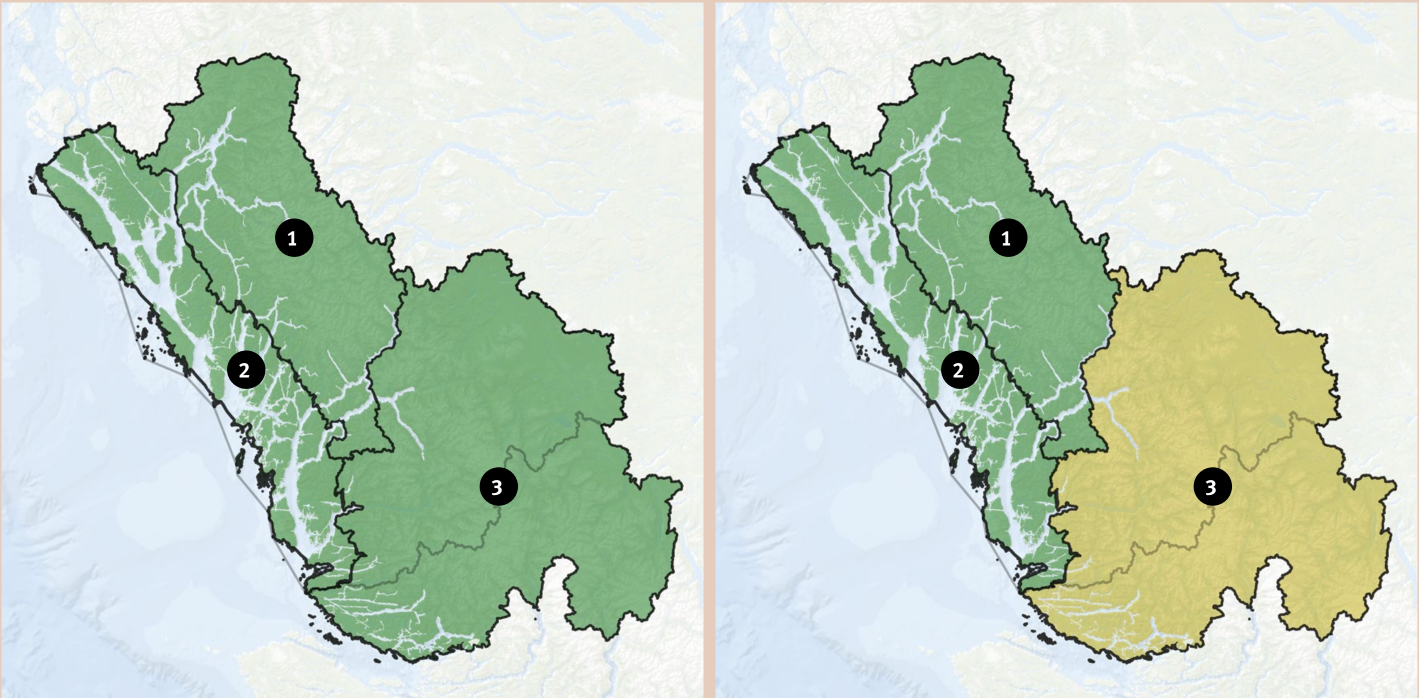
Coho

We were able to examine biological status for all Central Coast coho CUs. All coho CUs are in the green or amber status zones, depending on the metric and CU (Figure 8 and Appendix 5), indicating that coho CUs are of low to moderate conservation concern. Three CUs have concordance for both metrics: Hecate Strait-Mainland and Mussel-Kynoch are both in the amber status zone, and Rivers Inlet is in the green status zone. Five CUs are in the green status zone using the stock-recruitment metric, but are in the amber status zone using the historic spawners approach: Bella Coola-Dean Rivers, Brim-Wahoo, Douglas Channel-Kitimat Arm, Northern Coastal Streams, and Smith Inlet. Coho CUs display a spatial pattern for the stock-recruitment metric only (Figure 8): inland CUs are doing better than coastal CUs (i.e. inland CUs are in the green status zone; coastal CUs are in the amber status zone).

Pink (odd-year)

Biological Status

🟩 Good
🟨 Fair
🟥 Poor
▨ Data Deficient



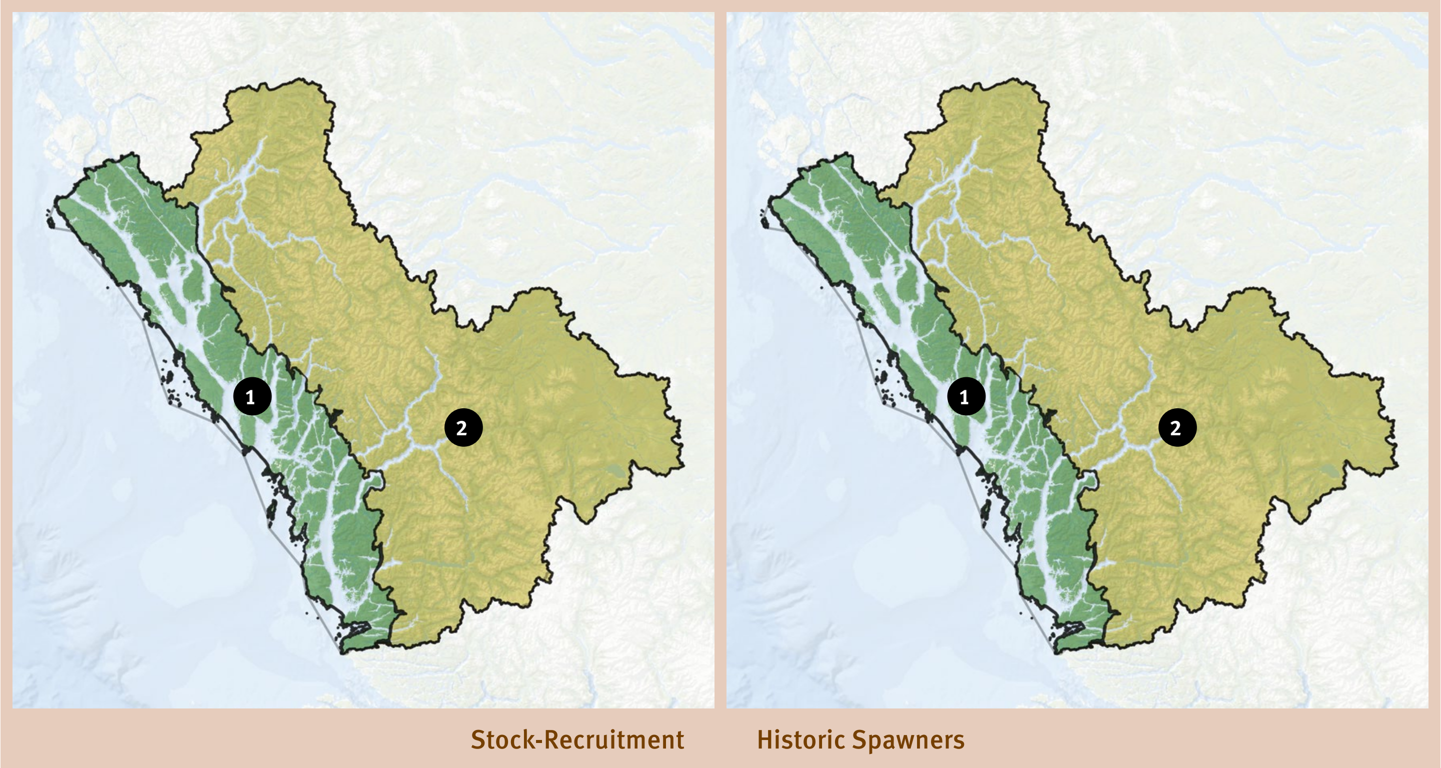
Stock-Recruitment   Historic Spawners

Stock-Recruitment	Historic Spawners		Conservation Unit
🟩	🟩	❶	Hecate Strait-Fjords
🟩	🟩	❷	Hecate Strait-Lowlands
🟩	🟨	❸	Homathko-Klinaklini-Smith-Rivers-Bella Coola-Dean

FIGURE 9. Maps showing the biological status of Central Coast pink (odd-year) salmon Conservation Units, using stock-recruitment and historic spawners metrics.

Pink (even-year)
Biological Status

🟩 **Good**
🟨 **Fair**
🟥 **Poor**
⬜ **Data Deficient**



Stock-Recruitment

Historic Spawners

Stock-Recruitment	Historic Spawners		Conservation Unit
🟩	🟩	1	Hecate Lowlands
🟨	🟨	2	Hecate Strait-Fjords

FIGURE 10. Maps showing the biological status of Central Coast pink (even-year) salmon Conservation Units, using stock-recruitment and historic spawners metrics.

Sockeye (lake-type)

Biological Status

🟩 Good
🟨 Fair
🟥 Poor
⬜ Data Deficient

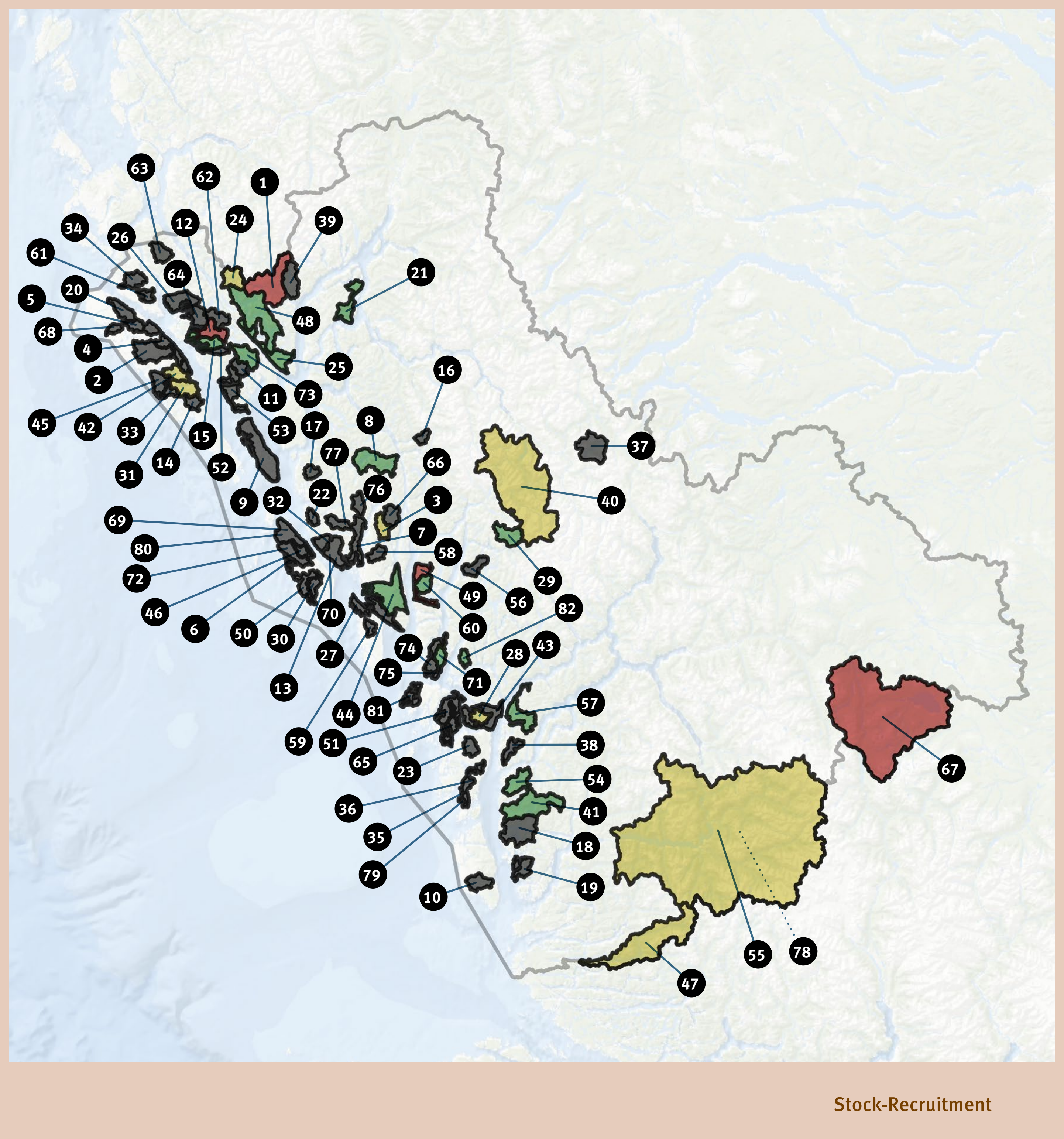


FIGURE 11. Map showing the biological status of Central Coast lake-type sockeye salmon Conservation Units, using stock-recruitment metrics and represented by their spawning zones of influence. (Note that #78 has the same spatial extent as #55, and so is not shown.)

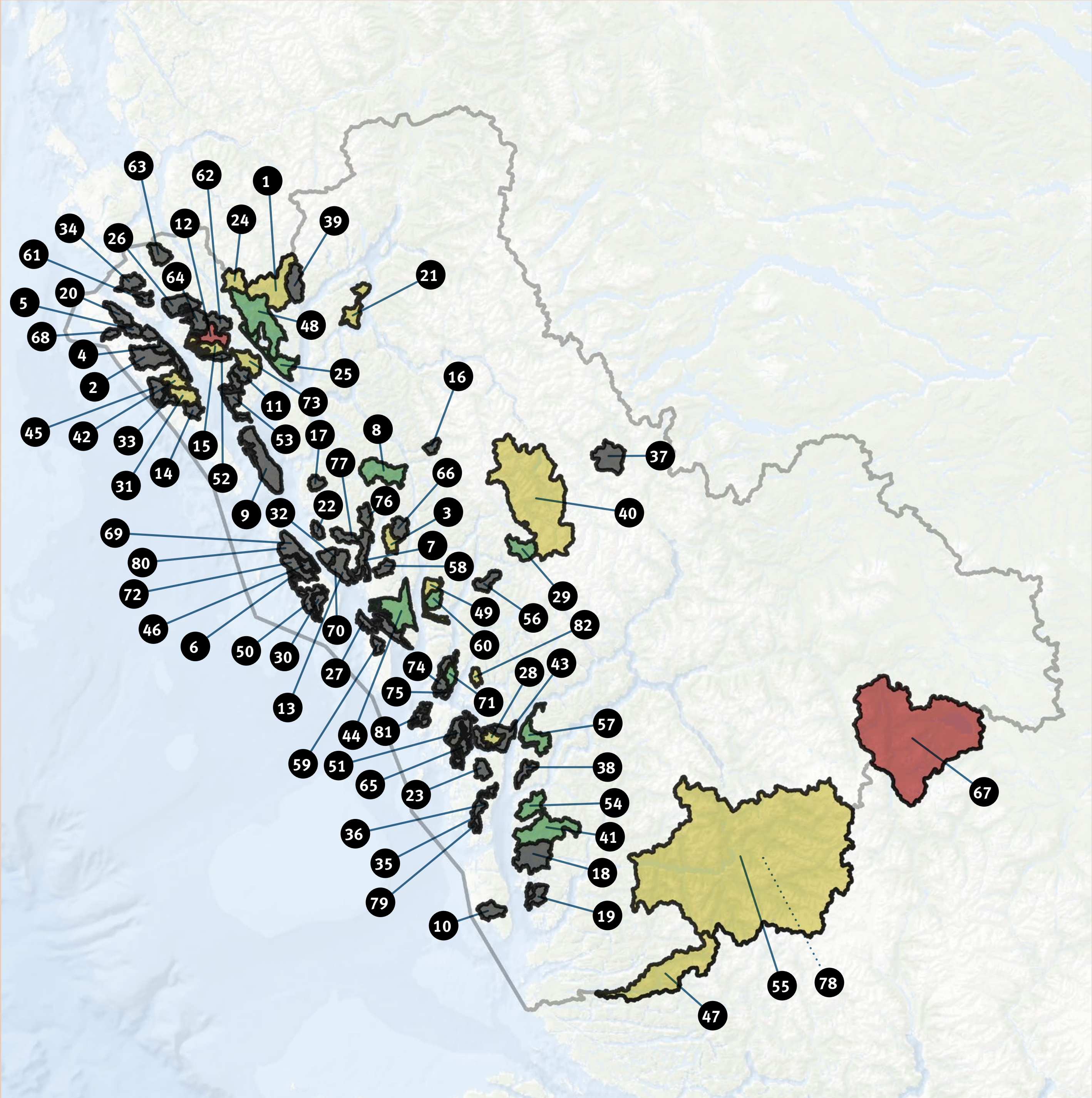
Sockeye (lake-type)
Biological Status

🟩 Good

🟨 Fair

🟥 Poor

⬜ Data Deficient



Historic Spawners

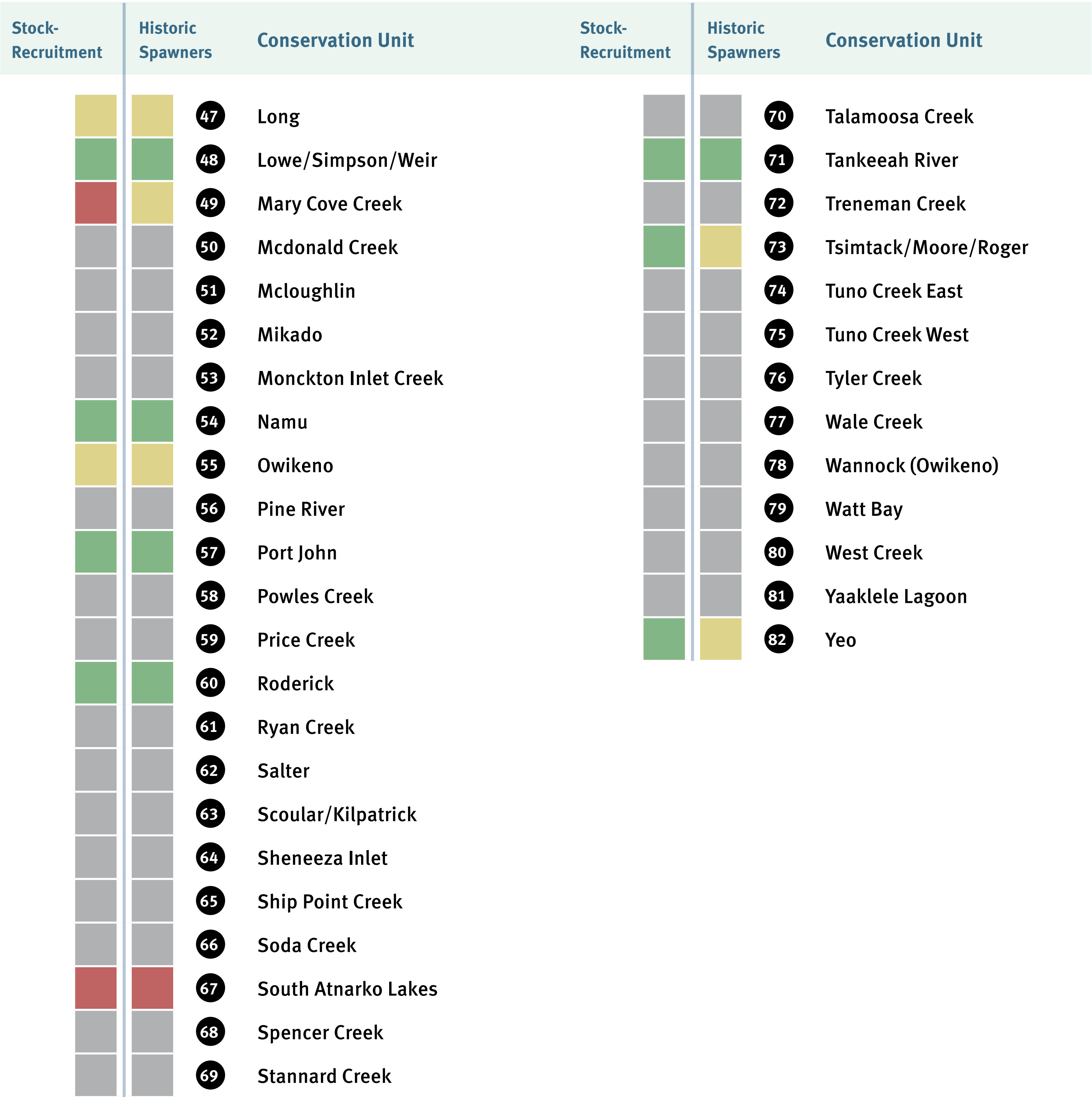
FIGURE 11, continued. Map showing the biological status of Central Coast lake-type sockeye salmon Conservation Units, using historic spawners metrics and represented by their spawning zones of influence. (Note that #78 has the same spatial extent as #55, and so is not shown.)

Sockeye (lake-type)
Biological Status

🟩 Good
🟨 Fair
🟥 Poor
⬜ Data Deficient

Stock-Recruitment	Historic Spawners		Conservation Unit
🟥	🟨	1	Backland
⬜	⬜	2	Banks
🟨	🟨	3	Bloomfield
⬜	⬜	4	Bolton Creek
⬜	⬜	5	Bonilla
⬜	⬜	6	Borrowman Creek
⬜	⬜	7	Busey Creek
🟩	🟩	8	Canoona
⬜	⬜	9	Cartwright Creek
⬜	⬜	10	Chic Chic
⬜	⬜	11	Citeyats
🟥	🟥	12	Curtis Inlet
⬜	⬜	13	Dallain Creek
⬜	⬜	14	Deer
🟩	🟨	15	Devon
⬜	⬜	16	Dome
⬜	⬜	17	Douglas Creek
⬜	⬜	18	Elizabeth
⬜	⬜	19	Elsie/Hoy
⬜	⬜	20	End Hill Creek
🟩	🟨	21	Evelyn
⬜	⬜	22	Evinrude Inlet
⬜	⬜	23	Fannie Cove
🟨	🟨	24	Freeda
🟩	🟩	25	Hartley Bay
⬜	⬜	26	Hevenor Inlet
⬜	⬜	27	Higgins Lagoon
🟨	🟨	28	Kadjusdis River
🟩	🟩	29	Kainet Creek
⬜	⬜	30	Kdelmashan Creek
🟨	🟨	31	Keecha
⬜	⬜	32	Kent Inlet Lagoon Creek
⬜	⬜	33	Kenzuwash Creeks
⬜	⬜	34	Keswar Creek
⬜	⬜	35	Kildidt Creek
⬜	⬜	36	Kildidt Lagoon Creek
⬜	⬜	37	Kimsquit
⬜	⬜	38	Kisameet
⬜	⬜	39	Kitkiata
🟨	🟨	40	Kitlope
🟩	🟩	41	Koeye
🟨	🟨	42	Kooryet
⬜	⬜	43	Kunsoot River
🟩	🟩	44	Kwakwa Creek
⬜	⬜	45	Lewis Creek
⬜	⬜	46	Limestone Creek

FIGURE 11, continued.



Stock-Recruitment	Historic Spawners		Conservation Unit
🟨	🟨	㊼	Long
🟩	🟩	㊽	Lowe/Simpson/Weir
🟥	🟨	㊾	Mary Cove Creek
⬜	⬜	㊿	Mcdonald Creek
⬜	⬜	(51)	Mcloughlin
⬜	⬜	(52)	Mikado
⬜	⬜	(53)	Monckton Inlet Creek
🟩	🟩	(54)	Namu
🟨	🟨	(55)	Owikeno
⬜	⬜	(56)	Pine River
🟩	🟩	(57)	Port John
⬜	⬜	(58)	Powles Creek
⬜	⬜	(59)	Price Creek
🟩	🟩	(60)	Roderick
⬜	⬜	(61)	Ryan Creek
⬜	⬜	(62)	Salter
⬜	⬜	(63)	Scoular/Kilpatrick
⬜	⬜	(64)	Sheneeza Inlet
⬜	⬜	(65)	Ship Point Creek
⬜	⬜	(66)	Soda Creek
🟥	🟥	(67)	South Atnarko Lakes
⬜	⬜	(68)	Spencer Creek
⬜	⬜	(69)	Stannard Creek
⬜	⬜	(70)	Talamoosa Creek
🟩	🟩	(71)	Tankeeah River
⬜	⬜	(72)	Treneman Creek
🟩	🟨	(73)	Tsimtack/Moore/Roger
⬜	⬜	(74)	Tuno Creek East
⬜	⬜	(75)	Tuno Creek West
⬜	⬜	(76)	Tyler Creek
⬜	⬜	(77)	Wale Creek
⬜	⬜	(78)	Wannock (Owikeno)
⬜	⬜	(79)	Watt Bay
⬜	⬜	(80)	West Creek
⬜	⬜	(81)	Yaaklele Lagoon
🟩	🟨	(82)	Yeo

FIGURE 11, continued.

Pink

We were able to examine biological status for all Central Coast pink CUs. All pink CUs are in the green or amber status zones, with odd-year CUs tending to have better status than even-year CUs (Figure 9, Figure 10, and Appendix 5). Three CUs are in the green status zone for both metrics and are of low conservation concern: Hecate Lowlands (even-year), Hecate Strait-Lowlands (odd-year), Hecate Strait-Fjords (odd-year). In contrast, the Hecate Strait Fjords (even-year) CU is in the amber status zone for both metrics, and should be considered of moderate conservation concern. In addition, the Homathko-Klinaklini-Smith-Rivers-Bella Coola-Dean (odd-year) CU is in the green status zone using the stock-recruitment metric and in the amber status zone using the historic spawner approach.

In even-years, there is a clear spatial pattern associated with status: the coastal pink CU (Hecate Lowlands (even-year)) has a better status (green) than the inland CU (Hecate Strait Fjords (odd-year); amber; Figure 10). In odd-years, the spatial distribution of status is less clear: the two northern CUs (Hecate Strait-Lowlands, Hecate Strait-Fjords) are in the green status zone using both metrics, while the southernmost CU (Homathko-Klinaklini-Rivers-Smith-Bella Coola Dean) is the amber status zone using the historic spawner metric and in the green status zone using stock-recruitment approach (Figure 10).

Sockeye

Of the 85 sockeye CUs in the study area, 59 could not be assessed due to data deficiencies, including all three river-type sockeye CUs. In comparison to other species, the status of the 26 lake-type sockeye CUs we were able to assess is more variable than the other species (Figure 11 and Appendix 5). Twenty CUs are in the same status zone using both metrics: 10 CUs are in the green status zone (Canoona, Hartley Bay, Kainet Creek, Koeye, Kwakwa Creek, Lowe/Simpson/Weir, Namu, Port John, Roderick, and Tankeeah River), eight CUs are in the amber status zone (Bloomfield, Freeda, Kadjusdis River, Keecha, Kitlope, Kooryet, Long, and Owikeno), and two CUs are in the red status zone (South Atnarko Lakes and Curtis Inlet) based on both historic spawners and stock-recruitment metrics.

Four CUs (Devon, Tsimtack/Moore/Roger, Evelyn, and Yeo) are in the green status zone using the stock-recruitment approach, but are in the amber status zone using historic spawners metric. Mary Cove Creek and Backland CUs are in the red status zone using the stock-recruitment metric, and in the amber zone using the historic spawner approach.

Large, inland lake-type sockeye CUs tend to be in the amber or red status zones (Figure 11). Coastal lake-type sockeye CUs in the green status zone span nearly the entire study region, from the Lowe/Simpson/Weir CU in the north to Koeye in the south. However, the majority of the small coastal CUs are data deficient. These small sockeye lakes tend to be located in remote regions that are difficult to access and therefore difficult to monitor; however, these smaller sockeye-producing lakes represent 70% of all sockeye CUs found on the Central Coast and are a fundamental source of genetic diversity for sockeye salmon in the region.

Of all the sockeye CUs assessed – and across all of the salmon species we considered – only two CUs are in the red status zone using both metrics: South Atnarko Lakes and Curtis Inlet. On average, fewer than 2,500 fish are returning to Curtis Inlet each year and, for sockeye, from South Atnarko Lakes, the population has been unable to replace itself in seven out of the past 10 years. These two CUs are in critcal need of conservation and management intervention to promote their long-term recovery.

3.6 Results: Data Deficient Conservation Units

Biological status could not be assessed for 62 of the 114 CUs, and they were classified as "data deficient" (Appendix 6). Most (95%) of the data deficient CUs do have some spawner survey data, but a CU-level estimate of spawner abundance could not be generated for these CUs because they did not have any identified indicator streams (at least one indicator stream is required in order to generate a CU-level estimate of abundance.) In addition, 19 of these CUs have less than 10 years of spawner survey data, highlighting the gaps in monitoring coverage and the lack of baseline data for many CUs.

The proportion of data deficient CUs varied by species. Most lake-type sockeye CUs are data deficient (70%), while all three river-type sockeye CUs are also data deficient. As mentioned previously, many of these sockeye-producing lakes are relatively small and located in remote coastal areas making them difficult to monitor and reliably collect annual spawner survey data. While the costs to monitor these small salmon populations may be higher, the genetic diversity represented by these CUs is critical for underpinning sockeye salmon resilience on BC's Central Coast.

For the other species, two chum CUs and one Chinook CU are data deficient. Of these, Bella Coola River – Late chum, is expected to be monitored by DFO in 2018. Unfortunately, the other two CUs are likely to remain data deficient.

4 Salmon Habitat Assessments

Strategy 2 of the Wild Salmon Policy calls for the monitoring and assessment of freshwater salmon habitats (Fisheries and Oceans Canada 2005). Monitoring is to be informed by information on **habitat indicators**: characteristics of the environment that, when measured, describe habitat condition, magnitude of stress, degree of exposure to a stressor, or ecological response to exposure. Within the Wild Salmon Policy, indicators are intended to provide quantified information on the current and potential state of freshwater habitats (Stalberg et al. 2009). In the context of evaluating risks to salmon habitat, habitat indicators are selected based on their relevance to salmon where scientific understanding indicates a direct or indirect relationship between the indicators and impacts on salmon.

Stalberg et al. (2009) recommend using a two-tier pressure-state framework for the evaluation of habitat indicators. Under the two-tier pressure-state framework, habitat indicators are classified as either pressure (tier-1) or state (tier-2) indicators. **Pressure indicators** are described as natural processes or human activities that can directly or indirectly induce qualitative or quantitative changes in environmental conditions (Stalberg et al. 2009). **State indicators** are physical, chemical, or biological attributes measured to characterize environmental conditions on the ground (Stalberg et al. 2009). The scale of assessment, the resolution of input data, and cost of assessment and monitoring are distinguishing factors between pressure and state indicators. Pressure indicators are often assessed over broad spatial extents to provide a regional-scale perspective of pressures. They are typically based on remotely-sensed information and require fewer resources to assess, as monitoring is not based on field assessments. Conversely, state indicators are evaluated for smaller geographic areas, often require finer-scale data to evaluate and quantify, and are more resource intensive to assess and monitor, as they often require on-the-ground assessments. The intent of the two-tier framework is that assessing pressure indicators informs decisions around where to conduct the second-tier assessments of state indicators. In this project, we use the first tier of assessment (pressure indicators), which produces a timely and standardized snapshot of habitat status across salmon CUs. This approach allows us to identify high-risk habitats that may be good candidates for targeted state indicator assessment.

Similar to the biological status assessments, we quantify benchmarks for each indicator in order to assess habitat status. As per the Wild Salmon Policy, the purpose of benchmark is to identify a threshold where it is believed necessary to take preventative action to protect or restore habitat before declines in population abundance occur in response to degraded habitat. In this project, **habitat benchmarks** are defined as standard or quantified metrics against which habitat risk or condition can be measured and compared over time and space to determine the risk of adverse effects. These benchmarks enable us to categorize the risk of habitat degradation as low, moderate, or high (green, amber, red zones, respectively).

4.1 Methods: Data Compilation & Synthesis

4.1.1 FRESHWATER ATLAS ASSESSMENT WATERSHEDS

The base reporting unit used in the habitat assessments is the 1:20K Freshwater Atlas (FWA) assessment watersheds dataset (MOE 2017a). The Freshwater Atlas is the most comprehensive standardized source of hydrologic features in BC FWA datasets feature an embedded hierarchically connected coding system which enables the identification of features relative to one another, upstream, or downstream.

The FWA assessment watersheds dataset was selected as the base reporting unit for this analysis as it is a commonly used base dataset for resource managers, researchers, and others interested in evaluating and reporting at a watershed scale. The FWA assessment watersheds were delineated with target sizes between 2,000 hectares and 10,000 hectares, a scale at which hillslope and channel processes are generally well linked (Carver and Gray 2010).

4.1.2 SPAWNING LOCATION DATA

Information about spawning locations is a fundamental input to our methodology for assessing habitat status. We used spawning location data to identify and delineate salmon spawning habitats, identify uplands areas that may impact freshwater salmon habitats, and determine the spatial extent of habitat assessments. We endeavoured to assemble the best available data on spawning locations by using four sources: (1) the Fisheries Information Summary System (FISS) database[1], (2) survey streams in the NCC Database, (3) technical reports, and (4) expert-elicited spawning location data.

(1) Fisheries Information Summary System

The Fisheries Information Summary System (FISS) originated as a jointly funded initiative between the BC Fisheries and DFO. The goal of FISS is to provide fish habitat data for waterbodies throughout BC and the Yukon (MOE 2017b). For this project, we used FISS datasets for “BC Historical Fish Distribution – Zones (50,000)” and “Known BC Fish Observations and BC Fish Distributions”[2], which were downloaded from DataBC (the Province’s data sharing warehouse) and filtered to Pacific salmon species and spawning activity types.[3]

While FISS is a provincial data system, the effort in submitting or maintaining data province-wide is not standardized; therefore, data coverage and data currentness vary across BC. This variability stems from the origins of FISS data and the mechanisms by which the Province maintains this data. Much of the data that is available in FISS is compiled from earlier fisheries information systems, databases, and technical reports, which explains the lack temporal currentness. Since our approach is to use the best available data, we use this data to represent actual spawning locations in the absence of more current or expert-derived information. Ongoing data submissions come from requirements for organizations or individuals to report fisheries data and sampling information when issued a Scientific Fish Collection Permit (an authorization to capture or collect fish specimens for scientific and

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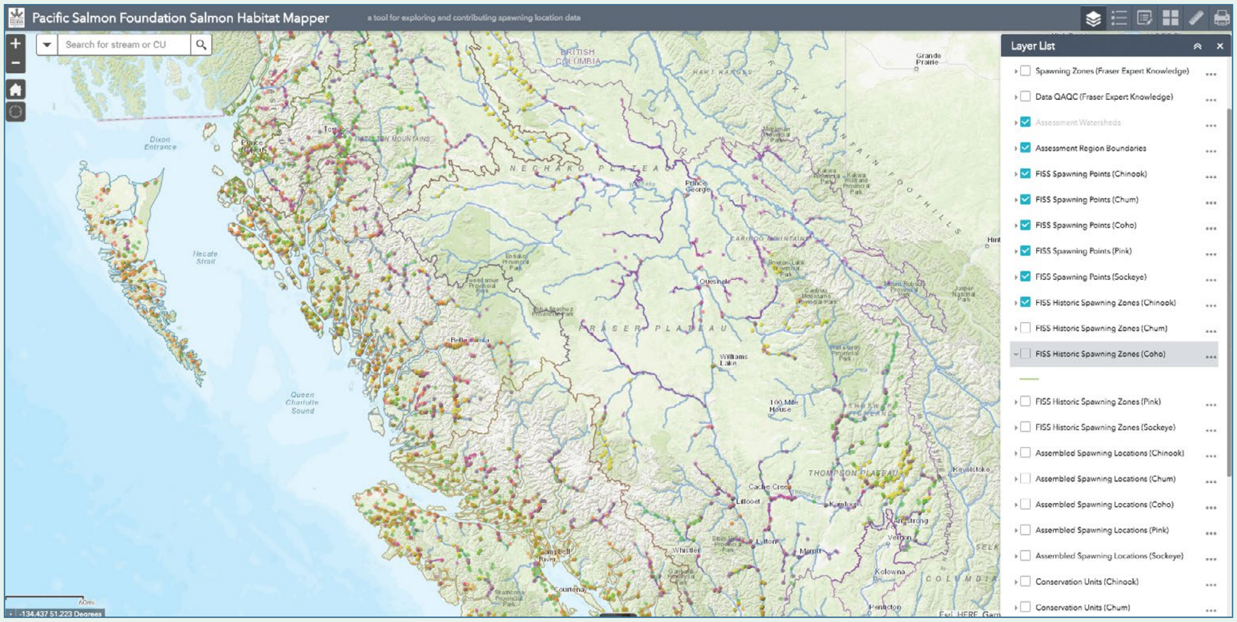
[1] https://catalogue.data.gov.bc.ca/dataset/known-bc-fish-observations-and-bc-fish-distributions

[2] The official description of this dataset on DataBC is “this point location dataset of fish observations is a regularly updated compilation of BC fish distribution information taken from a combination of all the official provincial databases including the BC Fisheries Information Summary System (FISS). Fish occurrences in this dataset represent the most current and comprehensive information source on fish presence for the province.”

[3] See Appendix 10 for detailed methodology on extracting spawning location data from FISS.

Box 4. Salmon Habitat Mapper: A Collaborative Tool for Mapping Salmon Spawning Habitats.



☐ Spawning Zones (Fraser Expert Knowledge)
☐ Data QAQC (Fraser Expert Knowledge)
☑ Assessment Watersheds
☑ Assessment Region Boundaries
☑ FISS Spawning Points (Chinook)
☑ FISS Spawning Points (Chum)
☑ FISS Spawning Points (Coho)
☑ FISS Spawning Points (Pink)
☑ FISS Spawning Points (Sockeye)
☑ FISS Historic Spawning Zones (Chinook)
☐ FISS Historic Spawning Zones (Chum)
☐ FISS Historic Spawning Zones (Coho)
☐ FISS Historic Spawning Zones (Pink)
☐ FISS Historic Spawning Zones (Sockeye)
☐ Assembled Spawning Locations (Chinook)
☐ Assembled Spawning Locations (Chum)
☐ Assembled Spawning Locations (Coho)
☐ Assembled Spawning Locations (Pink)
☐ Assembled Spawning Locations (Sockeye)
☐ Conservation Units (Chinook)
☐ Conservation Units (Chum)

The Salmon Habitat Mapper is a private Geographical Information System (GIS) based tool that enables invited experts to draw salmon spawning location data on online maps and add comments and observations digitally. Navigating through a dynamic and interactive web-interface, users can zoom to and explore areas of interest and different information layers (e.g. CU boundaries, stream layers). They can also view all spawning data gathered during the project including FISS data, expert-elicited data, supplemental data from technical reports, and indicator and non-indicator survey streams.

To contribute a new spawning data observation, users click on the map and complete a data entry form, which includes the user's name, stream name, species, observation date, and a general comment field as applicable. Users can enter data as points or lines, designating either the distribution of known spawning habitat or a specific observation point. Users also have the option to add comments to existing data points. For example, if the user sees a spawning point on the map, but knows the location is upstream of an impassable barrier, the user can add a comment for further review. (Note that the Salmon Habitat Mapper is not a public tool. All users are added by the PSF and data is only shared with project partners.)

The data gathered via the Salmon Habitat Mapper then goes through a quality assurance and control process before being incorporated into our habitat assessments. The manner in which we display user-provided data in the Pacific Salmon Explorer, if at all, is subject to the data sharing agreements we develop with expert contributors. Benefits of the Salmon Habitat Mapper include increased precision in identifying and digitizing local knowledge, and the ability for users to update data remotely – a valuable means for future data collection as habitat conditions change.

other non-recreational purposes) by the Province. The Province also accepts submissions of non-permitted fish and fish habitat information on a voluntary basis.

As of 2001, the Province no longer maintains the spawning zones or linear distribution dataset (BC Historical Fish Distribution – Zones (50,000)[1]). The spawning sites or point observation dataset (Known BC Fish Observations and BC Fish Distributions[2]) continues to be a regularly updated dataset, according to DataBC, though update frequency is not specified. At the time of this project, the most recent spawning point observation in all of BC for Pacific salmon was 2011. Within the Central Coast study area, the spawning zones data ranged from 1955 to 1999, and the spawning point observation data ranged from 1955 to 2008. Despite these limitations, FISS spawning data represents the most comprehensive source of spawning data province-wide and it is a critical data source for our habitat assessments.

(2) Survey Streams in the North Central Coast Database

We supplemented the FISS data with information on survey streams sourced from the NCC Database. The NCC Database stores coordinate location data for all monitored streams by CU. Spatial coordinates for the locations of survey streams for individual CUs were extracted from the NCC Database and included in our spawning location dataset. In some cases, the coordinates for survey streams were located outside of a CU's boundary and these survey stream locations were not used.

(3) Technical Reports

We also sourced spawning location data from technical reports. Specifically, we used information from the Small Streams Survey Technical Report prepared by Raincoast Conservation Foundation for the Heiltsuk First Nation (Raincoast Conservation Foundation 2007). Coordinates for spawning observations by species were extracted from this report and digitized.

(4) Expert-Elicited Habitat Data & Data Review

To ensure that we were using the best available data on spawning locations for this project, we worked with the TACs and local knowledge holders to review and supplement the compiled datasets. To assist in this process, we (1) created large-format maps of our spawning location dataset for the study area and (2) developed the Salmon Habitat Mapper – a private online tool for exploring and contributing spawning data in BC (Box 4). Using a combination of these two mediums, we asked TAC members to review the data and identify additional sites of known spawning locations. We also met with community members and fisheries staff during our community visits to review the data and document local knowledge of salmon spawning locations. We then digitized the data collected on hard copy maps and integrated it, along with data collected in the Salmon Habitat Mapper, into our spawning location dataset.

Working with the TACs and local knowledge holders, we were able to expand upon the publicly available datasets and create a more comprehensive dataset for salmon spawning locations in the Central Coast. The dataset of salmon spawning locations compiled through the course of this project reflects decades of on-the-ground experience and observations, which allowed us to more accurately identify areas

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[1] https://catalogue.data.gov.bc.ca/dataset/bc-historical-fish-distribution-zones-50-000

[2] https://catalogue.data.gov.bc.ca/dataset/known-bc-fish-observations-and-bc-fish-distributions

of spawning habitat. In fact, 30% of all salmon spawning habitats assessed were either in part or exclusively identified based on expert local knowledge. This data remains a private resource for the project partners. This means that no data provided by First Nations and local knowledge holders in any of our projects will be shared without their permission.

Assigning Spawning Locations to Conservation Units

For all spawning location data, we assigned spawning locations to individual CUs. For all species except lake-type sockeye, CU assignments were made by determining which CU a spawning location was located in. This process to assign spawning locations to CUs was done on a species-by-species basis – coho spawning locations were matched to coho CUs, chum spawning locations were matched to chum CUs, and Chinook spawning locations were matched to Chinook CUs. For pink CUs, there was an additional step: where spawning data sources did not differentiate between pink (even-year) or pink (odd-year), and where a pink spawning location occurred inside the boundaries of both a pink (even-year) and pink (odd-year) CU, that spawning location was attributed to both pink (even-year) and pink (odd-year) CUs.

A different method was used for lake-type sockeye because the CU boundaries are constrained to the rearing lake. In order to capture the side channels that are used for spawning, we instead used the rearing lake *zone of influence* (described in the next section). Spawning locations that occurred inside the boundaries of the rearing zone of influence were assigned to that lake-type sockeye CU. Where sockeye spawning locations occurred outside of lake-type sockeye spawning zones of influence, the spawning locations were assigned to the river-type sockeye CU whose boundary they were located within.

4.1.3 ZONES OF INFLUENCE

Our assessment methodology uses the concept of a **zone of influence (ZOI)**, a watershed-boundary-delineated area of land that is considered to influence salmon habitat. Using ZOIs to assess salmon habitats is aligned with assertions from Strategy 2 of the Wild Salmon Policy that (1) the identification of habitats that support or limit salmon production is necessary to inform assessment, monitoring, and protection priorities; and (2) that habitat requirements vary by species, life history characteristics and phase, and geography (Fisheries and Oceans Canada 2005). We define three classes of ZOIs[1] related to specific life-stages (rearing, spawning, migration) for each salmon CU:

- A **spawning ZOI** represents the area of land that drains into the spawning habitat of a specific salmon CU.
- A **migration ZOI** represents the area of land that drains into the migration route (between spawning habitat and the ocean) of a specific salmon CU.
- A **rearing ZOI** represents the area of land that drains into the rearing habitat of a specific salmon CU.

We use these geographic extents (i.e. the ZOIs) to assess and quantify habitat pressures by CU and by life-stage. The specific rules for defining

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[1] In the Pacific Salmon Explorer and other public communications, we use the terms “spawning habitat” and “migratory habitat” in place of “zones of influence.” Although some nuance is lost when we use these terms, the intent is to present less-technical language that can be understood by a general audience.

ZOIs, which vary by species and life-stage, were initially developed by the PSF's Skeena Technical Advisory Committee (see Porter et al. 2013a, 2014); however, we modified the methods for defining Chinook migration ZOIs to make them relevant for the landscape of the Central Coast. The rules used to define ZOIs for the Central Coast are described in Appendix 7, along with information about spatial processing.

4.1.4 HABITAT PRESSURE INDICATORS

In addition to delineating salmon habitats, the other component of the habitat assessments involves defining habitat pressure indicators of significance in the region. We selected 12 habitat pressure indicators to assess the status of freshwater salmon habitats on the Central Coast. Table 1 summarizes the indicators, including a definition of each indicator and a description of its relevance to salmon habitat. More information can be found in Appendix 8.

The core set of habitat pressure indicators (total land cover alteration, road development, water licenses, riparian disturbance, and permitted wastewater management discharges) were recommended for monitoring and evaluation of salmon habitats under the Wild Salmon Policy (Stalberg et al. 2009). These were supplemented with additional indicators (mining development, impervious surfaces, linear development, forest disturbance, Equivalent Clearcut Area, insect and disease defoliation, and stream crossing density) from a broader suite of proposed habitat indicators identified in Nelitz et al. (2007). These are the same indicators used in similar habitat assessments in the Skeena River watershed, Nass River watershed, and the Fraser River watershed (Nelitz et al. 2011; Porter et al. 2013a, 2013b, 2014, 2016).

All data used to inform the 12 habitat pressure indicators was sourced from publicly available BC government or federal agency databases. Most indicator data were sourced from DataBC. Additional datasets were sourced from the BC Ministry of Environment and Climate Change Strategy, BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development, BC Ministry of Energy, Mines and Petroleum Resources, and Geogratis (a Natural Resources Canada web portal for accessing spatial data across Canada). Publication years for indicator datasets ranged from 1992 to 2017.[1] Refer to Appendix 9 for a complete listing of datasets, publication years, and data sources used to assess the habitat pressure indicators.

To ensure our methodology is standardized and extensible to other regions across BC, we established specific criteria when sourcing data for the habitat pressure indicators. The following criteria were considered when selecting datasets to support the quantification of habitat indicators:

- Publicly available and readily accessible;
- Created with consistent and documented data collection protocols;
- In formats that allow easy integration into data systems;

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[1] The publication year for a dataset is the year that the data was last updated (e.g. the Base Thematic Mapping data product was last updated in 1992 and, at the time of this analysis, the Harvested Areas of BC dataset contained data current to 2015). Refer to Appendix 10 for details on the date ranges of data applied to the habitat assessments (date ranges of data within the study area and within each indicator dataset where date ranges were applied). For example, within the Central Coast study area, the Harvested Areas of BC dataset contained cut block data with harvest dates ranging from 1930 to 2015. However, the assessment methodology only considers forest disturbances occurring within the last 60 years from the date of analysis, so the range of harvest dates considered in the analysis was 1957 to 2015.

TABLE 1. Habitat indicator definitions and relevance to salmon habitat.
(Note that *watershed* refers to the Province of British Columbia's 1:20,000 Freshwater Atlas (FWA) Assessment Watersheds.)

Impact Category	Indicator	Units	Definition	Relevance
Hydrologic Processes	Forest disturbance	% of watershed	The percentage of total watershed area that, in the last 60 years, has been clear cut, selectively logged, or burned.	Disturbances to the forest canopy due to logging or burning can change the hydrology of a watershed by altering interception, transpiration, and snowmelt processes. Changes over time can affect salmon habitat through altered peak stream flows, low flows, and annual water yields.
	Equivalent Clearcut Area (ECA)	% of watershed	The percentage of total watershed area that is considered functionally and hydrologically equivalent to a clear cut forest. Landscapes that have been altered by urban, road, rail, and forestry development, as well as crown tenure were considered.	Equivalent Clearcut Area (ECA) reflects pressure on salmon habitats principally from potential increase to peak flow.
Surface Erosion	Road development	km/km²	The average density of all roads in each watershed.	Extensive road development can interfere with natural patterns of overland flow through a watershed, interrupt subsurface flow, and increase peak flows. Roads are a significant cause of increased erosion and fine sediment generation, impacting downstream spawning and rearing habitats.
Fish Passage / Habitat Connectivity	Stream crossing density	# crossings/ km of salmon accessible stream	The number of stream crossings per kilometer of defined fish habitat in each watershed.	Obstructions at stream crossings can hinder migration of fish or block access to useable habitats. Stream crossings can also influence the efficiency of water delivery to the stream network, such that high densities of stream crossings can increase peak flows and also become a chronic source of fine sediments.
Vegetation Quality	Insect and disease defoliation	% forest stands killed	The percentage of pine forest stands in each watershed that have been killed by recent insect invasion or disease.	While different than forest disturbances caused by logging or fire (as insect damaged forests retain standing timber and understory vegetation), forest defoliation from insects or disease can impact salmon habitats through changes to peak flows and groundwater supplies from altered precipitation interception and reduced transpiration.
	Riparian disturbance	% of riparian zone	The percentage of the riparian zone in each watershed that has been altered by land use activities.	The riparian zone is defined as a 30m buffer around all streams, lakes, and wetlands. Disturbance to the riparian zone can affect salmon habitat by increasing stream temperatures through altered stream shading, destabilizing stream banks, and increasing organic matter inputs.

TABLE 1, continued.

Impact Category	Indicator	Units	Definition	Relevance
Water Quantity	Licensed water use permits	# of water licenses	The total number of provincially permitted water licenses for withdrawal of water from streams for a variety of uses (i.e. industrial, agriculture, power, and storage).	Heavy allocation of both surface and hydraulically connected groundwater for human purposes can affect salmon habitat at critical times of the year by reducing instream flows thereby limiting fish access to or use of habitats.
Water Quality	Permitted wastewater discharges	# of discharges	The total number of permitted wastewater management discharge sites within each watershed.	High levels of wastewater discharge from municipal and industrial sources have the potential to impact water quality. Some waste products can directly injure or kill aquatic life while excessive nutrient levels (eutrophication) can result in depletion if dissolved oxygen in streams and lakes, starving salmon and other aquatic life.
Human Development Footprint	Total land cover alteration	% of watershed	The percentage of total watershed area that has been altered from the natural landscape by human activities.	Total land cover alteration is a synthesis of the indicators for forest disturbance, urban land use, agricultural/rural land use, mining development, and other smaller types of development. Total land cover alteration reflects a suite of potential changes to hydrological processes and sedimentation, with potential impacts on salmon habitats.
	Linear development	km/km²	The density of all linear development (e.g. roads, utility corridors, pipelines, power lines, right of ways, railways, etc.) within each watershed.	Linear development is a general indicator of potential human impacts on fish habitats.
	Mining development	# of mines	The total number of mines (total of coal, mineral, and aggregate mines, as well as placer tenures) within each watershed.	The general footprint of a mine and mining processes can change geomorphology and the hydrological processes of nearby water bodies. Mining can also contribute to the deposition of fine sediments which can affect salmon survival and prey densities.
	Impervious surface (urban and agricultural/rural development)	% of watershed	The total watershed area represented by hard impervious surfaces (e.g. sidewalk, paved roads, buildings, etc.).	Extensive impervious surfaces from urban and rural development can impact rainwater infiltration and groundwater recharge, and lead to stream habitat degradation through changes in geomorphology and hydrology. Impervious surfaces are also associated with increased loading of nutrients and contaminants in developed areas.

- Cost-effective for long-term data collection;
- Reflective of both short- and long-term response and trends in the indicator;
- Appropriate to geographic scale of analyses;
- Supported by quality assurance/quality control and an established data update process.

Each indicator was quantified for each 1:20K watershed, based on specific units relevant to that indicator (see Table 1 for details). Spatial processing of habitat pressure indicator datasets was conducted using ArcGIS Desktop 10.5 and an ArcGIS Model Builder toolbox developed by the PSF's Salmon Watersheds Program. Data processing followed a general pattern of selecting out features of interest from the indicator datasets and then intersecting these with the FWA assessment watersheds to identify and quantify habitat pressures by watershed. While conceptually simple, in practice, the complete processing routine (as programmed in the Model Builder toolbox) to calculate habitat pressures for all indicators across the study area involved over 300 processing steps. Refer to Appendix 10 for a description of processing methods applied for each habitat pressure indicator.

To facilitate calculation of a cumulative risk rating (later described in Section 4.2.2), we grouped individual habitat pressure indicators into seven impact categories, as shown in Table 1. Impact categories represent relatively independent processes that drive changes in on-the-ground environmental conditions. Impact categories are also used within the Province's traditional Watershed Assessment Procedures to categorize pressure indicators (MOF 1995a,b). The impact categories we used for the Central Coast were initially developed in collaboration with the PSF's Skeena Technical Advisory Committee (see Porter et al. 2013a, Porter et al. 2014).

4.1.5 FUTURE RESOURCE DEVELOPMENT PRESSURES

In addition to quantifying habitat pressures and assessing risks to freshwater salmon habitats (see Section 4.2), we also mapped known future pressures for the region. Risks associated with proposed resource development projects were not explicitly integrated into the habitat assessments (described in Section 4.2). However, we did compile and map data on proposed resource development projects alongside current development projects in recognition of the potential impacts these activities may have on freshwater salmon habitats on the Central Coast, and to allow for the consideration of habitat status in the citing and planning of proposed development projects. While the specific impacts of future development pressures on salmon habitats is unknown, research has shown that activities related to the construction and operation of industrial infrastructure can alter the physical and chemical nature of streams and upland habitat, leading to potential degradation, fragmentation and loss of rearing, spawning and migration habitats (National Research Council 1996). Salmon are sensitive to disturbances that lead to altered stream temperatures and flow, increased turbidity, changes in stream sediments, decreased levels of dissolved oxygen, and water contamination. In addition, salmon are dependent on the complex habitat provided by naturally vegetated banks and may be affected by the physical alteration of shorelines or stream banks.

Current and proposed resource development data was categorized into six types of projects and infrastructure:

1. **Oil and Gas Pipelines** — This category refers to infrastructure that either currently exists or is proposed for transporting natural gas or oil across the study area to marine terminals on the Central Coast. Oil and gas pipelines can

potentially impact salmon habitat adjacent to stream crossings and along right-of-ways during construction due to increases in total suspended solids from trench excavation, disposal of fill, erosion, and run-off from adjacent upland worksites. In the event of pipeline leaks or spills, petroleum contaminants can have detrimental impacts on fish in terms of mortality, growth reductions, and harmful reproductive effects.

2 **Mining Development** — This category includes the locations of existing (and in some cases, decommissioned) aggregate, coal, and mineral mines, as well as current placer tenures. Alternately, *Proposed Mining Development* displays locations where mining exploration has identified the potential for future development. Mining development can cause the loss of salmon habitat directly through the footprint of mine sites, tailings ponds and other associated infrastructure, or indirectly through increased soil erosion, run-off, and sedimentation from cleared sites and roads. In some cases, acid-generating mining sites can introduce heavy metals and other contaminants that may have lethal or sub-lethal effects on salmon, other fishes, and prey.

3 **Water Licenses** — This category displays the locations of existing or proposed "Points of Diversion", which are defined as "the place on the natural channel of a stream where an applicant proposes, or a licensee is authorized, to divert water from the stream," as licensed under the BC *Water Sustainability Act*. Water Licenses directly divert water from streams and, during periods of high water usage or low natural flow (such as in the late summer months), instream flows can be reduced to levels that constrain access to salmon spawning and rearing habitats or even cause spawning redds to dry out. In addition, the reduction of both surface water and groundwater can increase instream water temperatures, with impacts on salmon physiology and survival.

4 **Hydroelectric Power Lines** — This category displays the locations of existing or proposed major power lines constructed by BC Hydro. Hydroelectric Power Lines can impact salmon habitat at stream crossings or through the clearing of forests for right-of-ways and the construction of associated roads. Disturbances to the forest canopy and riparian zones can affect salmon habitats by destabilizing stream banks, increasing soil erosion and sedimentation, reducing inputs of nutrients and woody debris, and increasing stream temperatures through reduced streamside shading. Where power lines and access roads cross streams, extensive bank armouring with rip rap can reduce channel complexity and expose banks to erosion. In addition, streambanks with rip rap often have fewer undercut banks, less low-overhead cover, and fewer inputs of large woody debris to the stream, all important factors in creating suitable salmon habitat.

5 **Hydroelectric Power Tenures** — This category displays the locations of existing or proposed water power tenures issued under the BC *Land Act*. Hydroelectric Power Tenures represent the potential for diversion of water from streams for the production of hydroelectricity. This type of industrial infrastructure can have similar impacts to the *water licenses* and *hydroelectric power lines*. These tenures represent a subset of crown land dispositions that are issued for specific purposes and periods of time under an agreement between an individual or company and the provincial government for an interest in crown land. Leases, Licenses, and Reserves are included, but Crown Grants and Acquisitions are not. Historical records (e.g. expired, replaced, or completed) are not included.

6 **Wind Power Tenures** — This category displays the locations of existing or proposed wind power tenures issued under the BC *Land Act*. Wind Power Tenures represent areas where wind power facilities may be constructed. The construction of wind power facilities requires the clearing of land for turbines, associated facilities, and access roads. The land-use impact of wind power facilities varies substantially depending on the size of the operation and the unique characteristics of the site. Reduction of forest cover, loss of riparian habitat, and modification of natural drainage for access roads may impact juvenile and adult salmon. These tenures represent a subset of crown land dispositions that are issued for specific purposes and periods of time under an agreement between an individual or company and the provincial government for an interest in crown land. Leases, Licenses, and Reserves are included, but Crown Grants and Acquisitions are not. Historical records (e.g. expired, replaced, or completed) are not included in this dataset.

Specific data processing steps related to the compilation and mapping of resource development data is presented in Appendix 11 (Spatial Data Processing for Future Pressures).

TABLE 2. Benchmark values and type for individual habitat pressure indicators.

Impact Category	Indicator	Units	Benchmark Type	Benchmarks			Benchmark Reference
				Low Risk (green)	**Moderate Risk (amber)**	**High Risk (red)**	
Hydrologic Processes	Forest disturbance	% of watershed	relative ranking (Type 2)	0	> 0	≥ 7.6	n/a
	Equivalent Clearcut Area (ECA)	% of watershed	green/amber - science- and expert-based; amber/red - science-based	< 15	≥ 15 to < 20	≥ 20	green/amber - NOAA 1996, MOF 2001; amber/red - Summit/MOE 2006, FPB 2011
Surface Erosion	Road development	km/km²	green/amber - science- and expert-based; amber/red - science-based	< 0.4	≥ 0.4 to < 1.2	≥ 1.2	green/amber - Stalberg et al. 2009; amber/red – MOF 1995a,b and Porter et al. 2012

TABLE 2, continued.

Impact Category	Indicator	Units	Benchmark Type	Benchmarks			Benchmark Reference
				Low Risk (green)	Moderate Risk (amber)	High Risk (red)	
Fish Passage/ Habitat Connectivity	Stream crossing density	# crossings/ km of salmon accessible stream	relative ranking (Type 2, binary)	0	n/a	> 0	n/a
Vegetation Quality	Insect and disease defoliation	% forest stands killed	relative ranking (Type 2, binary)	0	n/a	> 0	n/a
	Riparian disturbance	% of riparian zone	green/amber - science- and expert-based; amber/red - science-based	< 5	≥ 5 to < 15	≥ 15	green/amber - Stalberg et al. 2009; amber/ red - Tripp and Bird 2004
Water Quantity	Licensed water use permits	# of water licenses	relative ranking (Type 2, binary)	0	n/a	> 0	n/a
Water Quality	Permitted wastewater discharges	# of discharges	relative ranking (Type 2, binary)	0	n/a	> 0	n/a
Human Development Footprint	Total land cover alteration	% of watershed	relative ranking (Type 2)	0	> 0	≥ 12.9	n/a
	Linear development	km/km²	relative ranking (Type 2)	0	> 0	≥ 0.72	n/a
	Mining development	# of mines	relative ranking (Type 2, binary)	0	n/a	> 0	n/a
	Impervious surface (urban and agricultural/ rural development)	% of watershed	science- and expert-based	< 3	≥ 3 to < 10	≥ 10	Paul and Meyer 2001; Smith 2005

4.2 Methods: Assessing Habitat Status

4.2.1 ASSESSING INDIVIDUAL HABITAT PRESSURE INDICATORS

We assessed the risk of habitat degradation for each 1:20K FWA assessment watershed in the study area posed by the 12 habitat pressure indicators. We first quantified the extent and intensity of each indicator for each 1:20K FWA assessment watershed, as described in Section 4.1.4 and based on the units shown in Table 1. For example, forest disturbance was quantified as the percentage of each 1:20K FWA assessment watershed that has recently (in the last 60 years) been logged, selectively logged, or burned. Risk scores were then determined based on the value of an indicator in a 1:20K FWA assessment watershed in relation to the benchmark values set for that indicator.

The benchmark values used for each indicator are shown in Table 2. Where possible, empirical benchmarks for habitat pressure indicators were developed based on existing science (e.g. Stalberg et al. 2009, other literature, or expert sources). For habitat pressure indicators where scientifically defensible empirical benchmarks do not exist or could not be explicitly defined for the Central Coast, benchmarks were developed based on relative rankings from distribution curves developed for indicator values across the full spatial extent of all FWA assessment watersheds in the Central Coast study area (*n*= 1132 1:20K FWA assessment watersheds). This approach is consistent with recommendations in Stalberg et al. 2009 and is considered an interim approach for developing benchmarks until regional science or expert-based indicator benchmarks can be developed. (See Section 4.3 for a discussion of the limitations of this approach.)

For benchmarks based on relative rankings, two approaches are defined for developing benchmarks, depending on the statistical spread of the habitat indicator data. These approaches were initially developed in collaboration with the PSF's Skeena Technical Advisory Committee (see Porter et al. 2013a, Porter et al. 2014) and have been adapted to be more suitable for highly skewed indicators (see Porter et al. 2016).

Type 1: indicator values have symmetric or moderately skewed distributions

Using the distribution of indicator values across all FWA assessment watersheds, the lower benchmark was set at the 50th percentile and the upper benchmark was set at the 75th percentile. In other words, the "best" 50% of watersheds were considered low risk (green), the "worst" 25% of watersheds were considered high risk (red), and all other watersheds were considered moderate risk (amber). In the Central Coast, no indicators had symmetric or moderately skewed distributions and this approach was not used.

Type 2: indicator values have a highly skewed distribution (e.g. many 0 values)

For area-based indicators with a highly skewed distribution, the lower benchmark was set at 0 and the upper benchmark was set at the threshold for outlier values. In other words, watersheds with a 0 value were considered low risk (green), watersheds with outlier values were considered high risk (red) and all other watersheds were considered moderate risk (amber). For several indicators, indicator values are so highly skewed that the outlier threshold evaluates to zero. In these cases, the indicator is classified in a binary manner (presence or absence): watersheds with a 0 value were considered low risk (green) and watersheds with a value above zero were considered high risk (red). See Section 4.3 for further discussion of the limitations with using benchmarks based on relative rankings.

4.2.2 ASSESSING CUMULATIVE PRESSURES

To reflect interactions and spatial and temporal overlap among individual habitat indicators, and to understand the risk of habitat degradation posed by cumulative pressures, we developed cumulative pressure scores for each FWA assessment watershed in the Central Coast region. The cumulative scores allow us to communicate results succinctly and visualize which CUs face the greatest cumulative pressures. Cumulative scores are also useful for providing a baseline to compare future risks and identify areas where it may be prudent to avoid introducing additional pressures. A summary index of this type also allows pressures on salmon habitat to be considered in tandem with the biological status of CUs, and this information can assist in prioritizing conservation efforts, mitigation strategies, and identifying locations for on-the-ground monitoring (i.e. targeting candidate areas for state indicator monitoring at a local scale).

Aggregating indicators into a single, composite risk or condition score is an approach taken by a variety of programs that currently monitor watersheds in Canada and the U.S. Pacific Northwest (e.g. FLRNO's Forest and Range Evaluation Program, USEPA's Environmental Monitoring and Assessment Program, USDA Forest Service's Aquatic and Riparian Effectiveness Monitoring Program). These programs use a variety of methods (ranging widely in complexity) to aggregate their habitat data and each approach has strengths and weaknesses (Pickard et al. 2008). Recent habitat indicator analyses for BC salmon CUs (e.g. Cohen Commission analyses of Fraser sockeye CUs (Nelitz et al. 2011)) and an indicator mapping project for the Lower Thompson coho CU (Beauchamp 2008) generated cumulative habitat stressor or impact scores based on a simple summation of all the individually scored indicators (i.e. a higher total score equates to higher risk). Habitat assessments undertaken in Porter et al. (2013b) employed an alternative approach for rating relative risk in watersheds for Southern Chinook CUs: cumulative risk scoring was based on an indicator "roll-up" rule set based on the proportion of the indicators that were rated low, moderate, or high risk.

For the Central Coast, we used an approach piloted in the Skeena River watershed (Porter et al. 2013a; 2014), and subsequently applied in the Nass River watershed (Porter et al. 2016). In this approach, both a simple risk score summation and an application of roll-up rule sets were used to assign cumulative pressure scores. These cumulative pressure scores were calculated for individual 1:20K FWA assessment watersheds within the ZOIs for all CUs, and different methods were used depending on the life-stage assessed.

Cumulative pressure scores for each FWA assessment watershed were calculated using a two-step roll-up rule set. For the 1st-level roll-up, the 12 habitat pressure indicators were aggregated into seven high-level landscape processes, called impact categories (described in Section 4.1.4). Using the rule sets described in Appendix 13, risk was assigned as low, moderate, or high (green, amber, or red) for each of the impact categories. We then used a 2nd-level roll-up rule set to combine the impact categories into a single cumulative pressure score.

Two different 2nd-level roll-up rule sets, methods A and B, were used to roll-up scores across impact categories and determine a cumulative habitat pressure score. Different methods were used to better represent how cumulative pressures may impact different species and life-stages. Method A was applied to watersheds in (1) lake-type sockeye rearing lakes and tributary spawning ZOIs and (2) spawning ZOIs for all other species. Method B was applied to watersheds within (1) the migration ZOI for lake-type sockeye CUs and (2) the rearing/migration ZOI for all other species. For method A, the cumulative pressure risk score was determined based on the number of impact categories that were scored as low, moderate, or high risk. If three or more impact categories were scored as high risk as determined by the 1st-level roll-up rule set, then the cumulative habitat pressure score was high risk. If five or more impact categories were rated low risk, then the cumulative habitat pressure score was low risk. For all other cases (less than five impact categories were low risk or less than three impact categories were high risk) then the cumulative habitat pressure score was moderate risk. For method B, we followed similar methods used in Nelitz et al. (2011) and Beauchamp (2008) whereby each high risk (red) impact category in a watershed was given a score of two, each moderate risk (amber) impact category was given a score of one, and each low risk (green) impact category was given a score of 0. For impact categories with binary ratings, a score of two (high risk) or zero (low risk) was used. The impact category scores were summed and the resulting cumulative pressure scores for each watershed ranged from 0 to 14. The individual watershed scores were then summed across all the watersheds comprising the CU's ZOI to determine the total cumulative pressure score for a particular CU's migration ZOI. Using this alternative approach to score the cumulative risks along the migration ZOI provides a better spatial representation of the changing intensities of habitat pressures along the migration route. This approach also better accounts for the more diffuse nature of the impacts along the migration corridor; migrating salmon may not actually be using all of the watersheds in the migration ZOI, but these watersheds drain into the CU's migration route. As such, pressures impacting upstream watersheds may accumulate downstream and influence conditions along a CU's migration route. Refer to Appendix 13 for additional details on the roll-up rule sets used to develop cumulative habitat pressure scores.

4.2.3 AREA-WEIGHTED CUMULATIVE PRESSURE SCORES

In the previous section, we described methods to produce a cumulative pressure score for each spawning and each migration watershed in a CU's ZOI. To facilitate comparisons of habitat status and population status, we also aggregated these watershed-scale results to assign spawning and migration habitat status risk ratings to each CU. For migration habitat, this is calculated as an area-weighted cumulative pressure score for each Central Coast salmon CU's migration ZOI. These area-weighted cumulative pressure scores were calculated using the following equation:

$$\bar{x}_w = \frac{\sum_{i=1}^{n}(w_i x_i)}{\sum_{i=1}^{n}(w_i)}$$

EQUATION 2.

where w_i is the watershed area, x_i is the indicator value for the watershed, n is the number of watersheds in the migration ZOI for the CU, and $\bar{x}_w$ is the CU-level area-weighted cumulative pressure score.

In other words, the process was to

1. multiply individual watershed cumulative migration pressure scores by watershed area,
2. sum the watershed area-weighted cumulative migration pressure scores in the CU, and
3. divide the sum of watershed area-weighted cumulative migration pressure score by total CU migration ZOI area.

TABLE 3. 3rd-level rollup rule set to develop a Conservation Unit-level cumulative pressure score for spawning Zones of Influence.

Conservation Unit Level Roll-Up Rule		
Rating	**Percentage of Spawning Watersheds Rated Green**	**Percentage of Spawning Watersheds Rated Red**
Green	100%	-
Red	-	≥ 25%
Amber	‹100%	‹ 25%

Calculating area-weighted cumulative pressure scores for each Central Coast salmon CU's spawning ZOI is challenging due to indicators that are evaluated with binary benchmarks. Given that such indicators use benchmarks based on presence/absence of the indicator, including them in an area-weighted approach for spawning ZOIs – scaled up to the CU-level – would over-represent the impact these indicators may have for the CU. In other words, if a single watershed in a CU contained a mine, the entire CU would be scored as high risk for the mining development indicator, which likely would overstate the impact that the mine has on the entire CU, especially for those species whose CUs tend to cover a large geographic area such as chum or pink. Further work is required to refine the methods for quantifying cumulative spawning pressures at the CU-level. However, in the absence of a more refined method, we applied a 3rd-level roll-up rule set to categorize cumulative spawning pressures as high, moderate, or low risk at the CU-level based on the percentage of spawning watersheds in the CU which were rated low, moderate, or high risk (Table 3). If 25% or more of spawning watersheds in a CU are rated high risk, the CU was identified as high risk. If 100% of the spawning watersheds in the CU are rated green, the CU was identified as low risk. All other CUs were rated moderate risk.

4.3 Limitations

Limitations related to habitat assessments are outlined in this section. Limitations, which apply to all species, related to outdated and incomplete datasets, developing benchmarks, and methods for calculating cumulative pressure scores. These caveats should be considered when interpreting the results of the habitat assessments, and also when considering future research priorities.

Data Needs

A number of the datasets we used to assess the risks to freshwater habitats are outdated or incomplete. For example, the Total Land Cover Alteration indicator uses land cover classification data dated between 1996 and 2005 and the National Topographic System dataset from 1998. In both cases, more current datasets certainly exist, but are either not publicly available or do not conform to several of the data selection criteria outlined in Section 4.1.4. Another example is road development: publicly available data on road development in the Central Coast is sparse. According to the BC government[1], existing road databases are missing an estimated 150,000 kilometers of resource roads, and more than half of the existing data is out-of-date. As such, our assessment of road development pressure on the Central Coast likely underrepresents the threat that this pressure poses to freshwater salmon habitats.

Temporal and spatial data gaps limit our ability to accurately quantify and assess risks to freshwater salmon habitats. There is an urgent need for better spatial data to support a more accurate and timely assessment of current pressures on freshwater salmon habitats on the Central Coast.

Refining Benchmarks

As described in Section 4.2.1, for some habitat indicators we used benchmarks based on relative rankings. While acceptable as an interim approach for developing benchmarks until regional science- or expert-based indicator benchmarks can be developed, the weakness of a relative ranking approach is that all of the watersheds could, in reality, be quite pristine or they could all be at risk in an absolute sense, regardless of their relative ranking. However, this approach at least serves to identify the potential worst-case habitats and informs selection of priority watersheds for further local-scale investigation to determine the actual impact of the perceived pressure on habitat status.

While this relative benchmarking approach allows the assessment of indicators that lack scientific benchmarks, it presents data interpretation challenges and limits our ability to compare assessments across regions. For example, we assessed the stream crossing density indicator using a relative binary benchmark approach in the Central Coast. Greater than 75% of watersheds in the Central Coast do not contain stream crossings (as represented in the modelled potential culverts source data). As such, the relative benchmarking methods resulted in a binary classification whereby watersheds that contain one or more stream crossings are categorized as high risk and watersheds with no stream crossings are categorized as low risk. This binary classification, while precautionary, does not reflect a difference in potential stream crossing impacts in watersheds that have one stream crossing versus watersheds that contain hundreds of stream crossings.

Additional research is needed at the landscape scale to better understand the impacts that stream crossing density, forest disturbance, total land cover alteration, insect and disease defoliation, and linear development have on salmon habitat. Until such a time when defensible research exists to support science-based benchmarks for all evaluated habitat indicators, we must consider the relative nature of benchmarks for certain indicators when interpreting habitat assessment results.

Cumulative Pressure Scores

Determining how best to aggregate and "roll up" individual indicators to facilitate calculation of an overall cumulative habitat status score within a salmon CU is challenging and was identified as a remaining and unresolved challenge in Stalberg et al. (2009). Combining information into a single overall "index" score can make interpretation easier, but information can be lost, and there may be multiple approaches to aggregating indicators without certainty about which is best. The approach we used (described in Section 4.2.2) is relatively simplistic: it uses a combination of simple risk score summations in combination with roll-up rule sets.

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[1] https://www2.gov.bc.ca/gov/content/data/geographic-data-services/topographic-data/roads/resource-roads

This means that, within impact categories, each indicator is given the same weight. In addition, each impact category is given the same weight when calculating the final cumulative pressure score. As a result, there is no ability to weight certain indicators as having more or less impact on salmon habitat than other indicators. However, this approach offers transparency and produces a cumulative pressure score that can be more easily understood by a range of audiences.

4.4 Results: Overview

We completed habitat assessments for 114 salmon CUs on the Central Coast of BC. The habitat assessments produced three levels of outputs: (1) a risk rating for each FWA assessment watershed in the study area for each individual habitat pressure indicator; (2) a cumulative pressure score for each FWA assessment watershed in the study area which represents the risk to a watershed from all habitat pressures combined; and (3) a cumulative pressure score for each CU. The first two levels of outputs, risk ratings for individual pressures by watershed and cumulative pressures by watershed, were produced for spawning ZOIs. The third level of output, the cumulative pressure score for each CU, was produced for both spawning and migration ZOIs. At both the watershed- and CU-levels, cumulative pressure scores allow us to communicate results succinctly and visualize which CUs face the greatest cumulative pressures.

Full results are available online through the Pacific Salmon Explorer (*salmonexplorer.ca*). For each CU, the results can be download directly from the Pacific Salmon Explorer and the datasets compiled for the analysis are also available for download via the Salmon Data Library (*data.salmonwatersheds.ca*). However, as new data become available, we will update the analyses and visualize the results in the Pacific Salmon Explorer. Consequently, in the future, the results described and summarized in this report will not match the results presented online. As such, this report should be considered a snapshot of the best data available as of September 2018.

4.5 Results: Habitat Status at the Regional Scale

Quantifying both individual and cumulative pressures at the scale of the study area can provide a snapshot of habitat pressures across the entire Central Coast. Specifically, an overview of habitat pressures emerges from identifying:

1. the percentage of watersheds within the combined spawning ZOI for all species that are rated high, moderate, or low risk (i.e. red, amber, green) for cumulative habitat pressures; and

2. the percentage of watersheds within the combined spawning zone of influence for all species that are rated high, moderate, or low risk (i.e. red, amber, green) for each of the evaluated individual habitat pressure indicators.

Of the 1,493 1:20K FWA assessment watersheds assessed in the study area[1], 46% (n=692) were designated as spawning habitat based on compiled spawning location data. These 692 watersheds represent the combined spawning ZOI for all species. Of these 692 spawning habitat watersheds, 11% are rated high risk (red), 22% are rated moderate risk (amber), and 67% are rated low risk (green) for cumulative habitat pressures.

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[1] Refer to Appendix 3 for a distinction between (1) the number of watersheds assessed in this project (n=1493) and (2) the number of watersheds (n=1132) used to calculate relative benchmarks (as described in Section 4.2.1).

TABLE 4. The percentage of watersheds (n = 692) within the combined spawning ZOI for all species that are rated high, moderate, or low risk (i.e. red, amber, green) for each of the evaluated individual habitat pressure indicators. The number of CUs which spatially overlap the impacted watersheds are presented in parentheses.

	Number of High Risk Watersheds	Number of Moderate Risk Watersheds	Number of Low Risk Watersheds	(%) High Risk	(%) Moderate Risk	(%) Low Risk
Total Landcover Alteration	74 (30 CUs)	333 (74 CUs)	285 (78 CUs)	11%	48%	41%
Forest Disturbance	97 (33 CUs)	234 (59 CUs)	361 (89 CUs)	14%	34%	52%
Impervious Surfaces	0 (0 CUs)	16 (17 CUs)	676 (114 CUs)	0%	2%	98%
Mines	22 (25 CUs)	NA	670 (114 CUs)	3%	NA	97%
Linear Development	77 (33 CUs)	266 (62 CUs)	349 (90 CUs)	11%	39%	50%
Road Development	30 (21 CUs)	105 (36 CUs)	557 (113 CUs)	4%	15%	81%
Stream Crossing Density	188 (46 CUs)	NA	504 (106 CUs)	27%	NA	73%
Riparian Disturbance	59 (29 CUs)	107 (36 CUs)	526 (113 CUs)	9%	15%	76%
Water Licenses	30 (26 CUs)	NA	662 (110 CUs)	4%	NA	96%
Wastewater Discharges	11 (20 CUs)	NA	681 (114 CUs)	2%	NA	98%
Equivalent Clearcut Area	1 (1 CU)	3 (3 CUs)	688 (114 CUs)	0%	1%	99%
Insect and Disease Defoliation	80 (21 CUs)	NA	612 (114 CUs)	12%	NA	88%

Looking to individual pressures, Table 4 presents the percentage of watersheds by risk rating (high, moderate, low) for each habitat indicator across the combined spawning ZOI for all species (see also Figures in Appendix 14). Indicators where greater than 10% of the combined spawning zone of influence for all species is rated high risk include stream crossing density, forest disturbance, insect and disease defoliation, linear development, and total land cover alteration. Indicators where greater than 90% of the combined spawning zone of influence for all species is rated low risk include impervious surfaces, mines, water licenses, wastewater discharges, and equivalent clearcut area.

These region-wide results provide a high-level overview of which indicators are impacting spawning areas to a greater or lesser extent across the region and may be useful when seeking to compare results to other regions. However, caution is warranted when examining results at this broader spatial scale. For example, while only 4% of the combined spawning zone of influence for all species is rated high risk due to water licenses, 18 different CUs[1] spawn in this 4% of watersheds. Examining the spatial distribution of pressures on the landscape in relation to CU locations is critical. Appendix 14 presents maps of cumulative and individual habitat pressures for the Central Coast region. More useful still, the Pacific Salmon Explorer allows a user to interactively highlight an individual watershed, for example a watershed that is high risk due to water licenses, and simultaneously identify which CUs spawn in that watershed.

4.6 Results: Habitat Status for Individual Conservation Units

We can also create a snapshot of habitat pressures at the CU-level by quantifying individual and cumulative pressures for each CU. Specifically, this overview of habitat pressures emerges from identifying:

1. the percentage of watersheds within each CU's spawning ZOI that are rated high, moderate, or low risk (i.e. red, amber, green) for each of the *individual* habitat pressure indicators (Appendix 15);
2. the percentage of watersheds within each CU's spawning ZOI that are rated high, moderate, or low risk (i.e. red, amber, green) for *cumulative* habitat pressures (Appendix 16);
3. the cumulative habitat pressure score for each CU's spawning ZOI (Appendix 17); and
4. the area-weighted cumulative habitat pressure score for each CU's migration ZOI (Appendix 18).

We examined the percentage of watersheds within each CU's spawning ZOI that are rated high, moderate, or low risk (i.e. red, amber, green) for each habitat pressure indicator. Examining results in this way highlights which indicators are impacting a higher number of CUs than others (for example, there are 22 CUs where 50% or more of the CU spawning ZOI is at high risk due to stream crossings[2]), and also which CUs are facing high risk from multiple pressures (for example, five pressures are present at high risk in the Yeo sockeye (lake-type) spawning ZOI). Appendix 15 presents

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[1] Bella Coola-Bentinck (Chinook), North and Central Coast-Early (Chinook), Bella Coola-Dean Rivers (coho), Douglas Channel-Kitimat Arm (coho), Hecate Strait Mainland (coho), Northern Coastal Streams (coho), Bella Coola River-Late (chum), Bella Coola-Dean Rivers (chum), Douglas-Gardner (chum), Hecate Lowlands (chum), Smith Inlet (chum), Spiller-Fitz-Hugh-Burke (chum), Hartley Bay (lake-type sockeye), Kunsoot River (lake-type sockeye), Kwakwa Creek (lake-type sockeye), Mcloughlin (lake-type sockeye), Port John (lake-type sockeye), South Atnarko Lakes (lake-type sockeye).

[2] Refer back to Section 4.1.5 for an important description of the binary benchmark approach used for stream crossings.

TABLE 5. Conservation Units with 50% or more of the spawning habitat (or ZOI) designated as high risk for one or more individual pressure indicators.

Species	**Conservation Unit**	**Equivalent Clearcut Area**	**Forest Disturbance**	**Insect & Disease Defoliation**	**Impervious Surfaces**	**Linear Development**	**Mining Development**	**Riparian Disturbance**	**Road Development**	**Stream Crossings**	**Total Landcover Alteration**	**Wastewater Discharges**	**Water Licenses**
Chinook	Bella Coola-Bentinck	0%	28%	60%	0%	38%	5%	35%	13%	58%	33%	3%	23%
	Dean River	0%	4%	100%	0%	12%	0%	12%	8%	24%	24%	0%	0%
	Wannock	0%	0%	0%	0%	50%	50%	0%	0%	50%	0%	0%	0%
Chum	Bella Coola River-Late	0%	0%	75%	0%	25%	50%	0%	25%	100%	0%	25%	100%
	Bella Coola-Dean Rivers	0%	20%	44%	0%	29%	7%	12%	5%	59%	15%	2%	29%
	Rivers Inlet	0%	57%	0%	0%	14%	0%	14%	0%	48%	24%	0%	0%
	Smith Inlet	0%	38%	0%	0%	6%	0%	19%	6%	50%	19%	0%	6%
	Wannock	0%	0%	0%	0%	50%	50%	0%	0%	50%	0%	0%	0%
Coho	Bella Coola-Dean Rivers	0%	27%	50%	0%	32%	9%	14%	9%	77%	18%	5%	41%
	Douglas Channel-Kitimat Arm	0%	29%	5%	0%	43%	7%	21%	29%	60%	29%	10%	5%
	Smith Inlet	0%	42%	0%	0%	8%	0%	25%	0%	50%	25%	0%	0%
Pink (odd-year)	Homathko-Klinaklini-Smith-Rivers-Bella Coola-Dean	0%	38%	21%	0%	26%	5%	20%	7%	62%	25%	1%	17%
Sockeye (lake-type)	Banks	0%	0%	0%	0%	0%	0%	0%	0%	50%	0%	0%	0%
	Chic Chic	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
	Elsie/Hoy	0%	0%	0%	0%	100%	100%	0%	0%	100%	0%	0%	0%
	Evelyn	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%

TABLE 5, continued.

Species	Conservation Unit	Equivalent Clearcut Area	Forest Disturbance	Insect & Disease Defoliation	Impervious Surfaces	Linear Development	Mining Development	Riparian Disturbance	Road Development	Stream Crossings	Total Landcover Alteration	Wastewater Discharges	Water Licenses
Sockeye (lake-type)	Hartley Bay	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	100%
	Kitkiata	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
	Koeye	0%	0%	0%	0%	0%	25%	0%	0%	50%	0%	0%	0%
	Kunsoot River	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	100%	100%
	Limestone Creek	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
	Mcloughlin	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	100%	100%
	Monckton Inlet Creek	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Port John	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%
	South Atnarko Lakes	4%	15%	92%	0%	15%	0%	42%	15%	27%	46%	0%	4%
	Yaaklele Lagoon	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%
	Yeo	0%	100%	0%	0%	100%	0%	0%	100%	100%	100%	0%	0%
Sockeye (river-type)	Rivers-Smith Inlets	0%	40%	0%	0%	10%	10%	10%	0%	60%	10%	0%	0%

the percentage of watersheds within each CU's spawning ZOI that are rated high, moderate, or low risk (i.e. red, amber, green) for each habitat pressure indicator. A subset of Appendix 15 is presented in Table 5 for CUs with 50% or greater of their spawning habitat at high risk due to one or more individual pressure indicators.

Appendix 16 presents the results for each CU, the percentage of watersheds within each CU's spawning zone of influence that are rated high, moderate, or low risk (i.e. red, amber, green) for cumulative habitat pressures. There are 70 CUs with 100% of the spawning habitat designated as low risk. Conversely, there are 11 CUs with 25% or more of the spawning habitat designated as high risk

TABLE 6. Conservation Units assessed as high risk of habitat degradation for cumulative spawning pressures based on the CU-level rollup of watershed percentages by risk rating.

Species	Total # of CUs	% of CUs at High Risk	Conservation Units at High Risk
Chinook	7	29%	Bella Coola-Bentinck, Docee
Chum	9	22%	Bella Coola River-Late, Bella Coola-Dean Rivers
Coho	8	38%	Bella Coola-Dean Rivers, Douglas Channel-Kitimat Arm, Smith Inlet
Pink	5	20%	Homathko-Klinaklini-Smith-Rivers-Bella Coola-Dean (odd-year)
Sockeye	85	4%	Kunsoot River (lake-type), Mcloughlin (lake-type), Yeo (lake-type)

(Appendix 19). These 11 CUs are concentrated in four distinct areas: five are near Bella Coola, two are near Rivers Inlet and Smith Inlet, three are near Bella Bella, and one is near Kitimat.

At the CU-level, Appendix 17 presents the cumulative pressure risk ratings for each CU based on percentages of spawning ZOI watersheds that are rated high, moderate or low risk. Table 6 presents an overview of the CU-level cumulative spawning pressure risk ratings by species. Notable is that so few sockeye CUs are at high risk. The majority, 77 of the 85 sockeye CU spawning ZOIs, are made up of four or fewer watersheds. In contrast, spawning ZOIs for Chinook, chum, coho, and pink are comprised of an average of 64 watersheds. This difference in spawning ZOI size is due to the small and isolated nature of the majority of sockeye CUs on the Central Coast. Conditions in these watersheds are relatively un-impacted in comparison to larger CUs which overlap with areas of higher human population density.

Appendix 18 presents area-weighted cumulative pressure risk ratings for each CU's migration ZOI. The CUs assessed in the top 75th percentile for cumulative migration pressures are presented in Table 7. Comparing spawning and migration results, there are specific differences for Chinook: Docee is high risk for spawning, but not migration, and Dean River is high risk for migration, but not for spawning. In the case of Docee, there are watersheds upstream of the CU that are part of the migration ZOI, but not the spawning ZOI, which are at a lower risk for migration pressures and thus bring down the area-weighted migration pressure for the CU. The opposite is true for Dean River in that the additional watersheds upstream of the CU that are part of the migration ZOI but not the spawning ZOI are at a higher risk for migration pressures. For other

TABLE 7. Conservation Units in the top 75th percentile for cumulative migration pressures based on the area-weighted cumulative habitat pressure risk rating for each CU's migration ZOI. CUs in bold are also high risk for cumulative spawning pressures.

Species	Total # of CUs	% of CUs in the 75th percentile	Conservation Units in the 75th Percentile
Chinook	7	29%	**Bella Coola-Bentinck**, Dean River
Chum	9	44%	**Bella Coola River-Late**, **Bella Coola-Dean Rivers**, Smith Inlet, Spiller-Fitz-Hugh-Burke
Coho	8	39%	**Bella Coola-Dean Rivers**, **Douglas Channel-Kitimat Arm**, **Smith Inlet**
Pink	5	40%	Hecate Strait-Fjords (even-year), **Homathko-Klinaklini-Smith-Rivers-Bella Coola-Dean (odd-year)**
Sockeye	85	20%	Banks (lake-type), Elsie/Hoy (lake-type), Evelyn (lake-type), Hartley Bay (lake-type), Kadjusdis River (lake-type), Kimsquit (lake-type), Kitkiata (lake-type), Koeye (lake-type), **Kunsoot River (lake-type)**, Kwakwa Creek (lake-type), Long (lake-type), **Mcloughlin (lake-type)**, Northern Coastal Fjords (river-type), Port John (lake-type), Ship Point Creek (lake-type), South Atnarko Lakes (lake-type), **Yeo (lake-type)**

species, the same CUs are at high risk for spawning pressures are at high risk for migration pressures. There are more CUs at risk for migration pressures than for spawning pressures, because the migration ZOIs account for pressures in areas along the route that fish travel to and from the ocean.[1]

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[1] Chinook migration zones of influence (ZOIs) are delineated as all watersheds upstream of the CU and the area impacting the migration route between the ocean and the CU. Chinook spawning ZOIs are delineated as all watersheds within the CU. Refer to Appendix 7 for a detailed description of spawning and migration ZOI delineation methods.

5 Discussion

5.1 Concordance Between Habitat & Biological Status

The Wild Salmon Policy calls for the consideration of information on biological status in conjunction with information on habitat, ecology, and socioeconomic status when making decisions that directly or indirectly affect Pacific salmon (Fisheries and Oceans Canada 2005). This project brings together important information on biological and habitat status that can be used to identify which CUs are in greater need of conservation and management intervention.

Table 8 presents a summary of: (1) biological status, based on both stock-recruitment and historic spawner metrics, and (2) spawning habitat status, based the percentage of spawning watersheds in the CU that were rated low, moderate, or high risk. For biological status, the red, amber, and green colours indicate the status zones assigned to each CU (poor, fair, good status, respectively). For spawning habitat status, red, amber, and green colours indicate a high, moderate, or low risk, respectively, of habitat degradation due to cumulative pressures on a CU's spawning habitat.

On the Central Coast, there appears to be little concordance between habitat and biological status. The relationship between population and habitat status for any CU is complex, and the lack of alignment between the two metrics could be reflective of any number of factors, including marine or climate conditions experienced by the CU. However, in comparing habitat and biological status, there was one trend that emerged: most of the sockeye populations that are data deficient for biological status have a green cumulative habitat pressure score. Many of these CUs are located in unpopulated, remote locations, which may explain why they are at lower risk of habitat degradation as they would be subjected to fewer human-induced pressures.

TABLE 8. Biological and spawning habitat status for each CU on the Central Coast. Biological status is based on two metrics, stock-recruitment and historic spawners.

Species	Conservation Unit	Biological Status		Habitat Status
		Stock-Recruitment	Historic Spawners	
Chinook	Bella Coola-Bentinck	🟨	🟨	🟥
	Dean River	🟩	🟨	🟨
	Docee	⬜	⬜	🟥
	North and Central Coast-Early	🟩	🟥	🟨
	North and Central Coast-Late	🟩	🟨	🟨
	Rivers Inlet	🟩	🟨	🟨
	Wannock	🟩	🟨	🟨

TABLE 8, continued.

Species	Conservation Unit	Biological Status		Habitat Status
		Stock-Recruitment	Historic Spawners	
Chum	Bella Coola River-Late	⬜	⬜	🟥
	Bella Coola-Dean Rivers	🟩	🟨	🟥
	Douglas-Gardner	🟨	🟨	🟨
	Hecate Lowlands	🟩	🟥	🟨
	Mussel-Kynoch	🟩	🟨	🟩
	Rivers Inlet	🟥	🟨	🟨
	Smith Inlet	🟨	🟥	🟨
	Spiller-Fitz-Hugh-Burke	🟩	🟨	🟨
	Wannock	⬜	⬜	🟨
Coho	Bella Coola-Dean Rivers	🟩	🟨	🟥
	Brim-Wahoo	🟩	🟨	🟩
	Douglas Channel-Kitimat Arm	🟩	🟨	🟥
	Hecate Strait Mainland	🟨	🟨	🟨
	Mussel-Kynoch	🟨	🟨	🟨
	Northern Coastal Streams	🟩	🟨	🟨
	Rivers Inlet	🟩	🟩	🟨
	Smith Inlet	🟩	🟨	🟥
Pink (even-year)	Hecate Lowlands	🟩	🟩	🟨
	Hecate Strait-Fjords	🟨	🟨	🟨
Pink (odd-year)	Hecate Strait-Fjords	🟩	🟩	🟨
	Hecate Strait-Lowlands	🟩	🟩	🟨
	Homathko-Klinaklini-Smith-Rivers-Bella Coola-Dean	🟩	🟨	🟥
Sockeye (river-type)	Northern Coastal Fjords	⬜	⬜	🟨
	Northern Coastal Streams	⬜	⬜	🟨
	Rivers-Smith Inlets	⬜	⬜	🟨
Sockeye (lake-type)	Backland	🟥	🟨	🟨
	Banks	⬜	⬜	🟩
	Bloomfield	🟨	🟨	🟩
	Bolton Creek	⬜	⬜	🟩
	Bonilla	⬜	⬜	🟩
	Borrowman Creek	⬜	⬜	🟩
	Busey Creek	⬜	⬜	🟩
	Canoona	🟩	🟩	🟩
	Cartwright Creek	⬜	⬜	🟩
	Chic Chic	⬜	⬜	🟩

TABLE 8, continued.

Species	Conservation Unit	Biological Status		Habitat Status
		Stock-Recruitment	Historic Spawners	
Sockeye (lake-type)	Citeyats	⬜	⬜	🟩
	Curtis Inlet	🟥	🟥	🟩
	Dallain Creek	⬜	⬜	🟩
	Deer	⬜	⬜	🟩
	Devon	🟩	🟨	🟩
	Dome	⬜	⬜	🟩
	Douglas Creek	⬜	⬜	🟩
	Elizabeth	⬜	⬜	🟩
	Elsie/Hoy	⬜	⬜	🟨
	End Hill Creek	⬜	⬜	🟩
	Evelyn	🟩	🟨	🟨
	Evinrude Inlet	⬜	⬜	🟩
	Fannie Cove	⬜	⬜	🟩
	Freeda	🟨	🟨	🟩
	Hartley Bay	🟩	🟩	🟨
	Hevenor Inlet	⬜	⬜	🟩
	Higgins Lagoon	⬜	⬜	🟩
	Kadjusdis River	🟨	🟨	🟩
	Kainet Creek	🟩	🟩	🟩
	Kdelmashan Creek	⬜	⬜	🟩
	Keecha	🟨	🟨	🟩
	Kent Inlet Lagoon Creek	⬜	⬜	🟩
	Kenzuwash Creeks	⬜	⬜	🟩
	Keswar Creek	⬜	⬜	🟩
	Kildidt Creek	⬜	⬜	🟩
	Kildidt Lagoon Creek	⬜	⬜	🟩
	Kimsquit	⬜	⬜	🟩
	Kisameet	⬜	⬜	🟩
	Kitkiata	⬜	⬜	🟨
	Kitlope	🟨	🟨	🟩
	Koeye	🟩	🟩	🟨
	Kooryet	🟨	🟨	🟩
	Kunsoot River	⬜	⬜	🟥
	Kwakwa Creek	🟩	🟩	🟩
	Lewis Creek	⬜	⬜	🟩
	Limestone Creek	⬜	⬜	🟩

TABLE 8, continued.

Species	Conservation Unit	Biological Status		Habitat Status
		Stock-Recruitment	Historic Spawners	
Sockeye (lake-type)	Long	🟨	🟨	🟨
	Lowe/Simpson/Weir	🟩	🟩	🟩
	Mary Cove Creek	🟥	🟨	🟨
	Mcdonald Creek	⬜	⬜	🟩
	Mcloughlin	⬜	⬜	🟥
	Mikado	⬜	⬜	🟩
	Monckton Inlet Creek	⬜	⬜	🟩
	Namu	🟩	🟩	🟩
	Owikeno	🟨	🟨	🟨
	Pine River	⬜	⬜	🟩
	Port John	🟩	🟩	🟩
	Powles Creek	⬜	⬜	🟩
	Price Creek	⬜	⬜	🟩
	Roderick	🟩	🟩	🟩
	Ryan Creek	⬜	⬜	🟩
	Salter	⬜	⬜	🟩
	Scoular/Kilpatrick	⬜	⬜	🟩
	Sheneeza Inlet	⬜	⬜	🟩
	Ship Point Creek	⬜	⬜	🟩
	Soda Creek	⬜	⬜	🟩
	South Atnarko Lakes	🟥	🟥	🟨
	Spencer Creek	⬜	⬜	🟩
	Stannard Creek	⬜	⬜	🟩
	Talamoosa Creek	⬜	⬜	🟩
	Tankeeah River	🟩	🟩	🟩
	Treneman Creek	⬜	⬜	🟩
	Tsimtack/Moore/Roger	🟩	🟨	🟩
	Tuno Creek East	⬜	⬜	🟩
	Tuno Creek West	⬜	⬜	🟩
	Tyler Creek	⬜	⬜	🟩
	Wale Creek	⬜	⬜	🟩
	Wannock (Owikeno)	⬜	⬜	🟨
	Watt Bay	⬜	⬜	🟩
	West Creek	⬜	⬜	🟩
	Yaaklele Lagoon	⬜	⬜	🟩
	Yeo	🟩	🟨	🟥

TABLE 9. CUs with notable results for both biological and habitat status. The colour shown in biological status indicates that the score is the same for both metrics.

Biological Status	Habitat Status	Conservation Units
🟥	🟨	**Sockeye (lake-type):** South Atnarko Lakes
🟥	🟩	**Sockeye (lake-type):** Curtis Inlet
⬜	🟥	**Sockeye (lake-type):** Kunsoot River, Mcloughlin **Chum:** Bella Coola River-Late **Chinook:** Docee

Notable categories of results from the comparison of biological status and habitat status are cases where: (1) biological status is red for both metrics and habitat status is amber (there were no instances of CUs with red biological status and red habitat status); (2) biological status is red for both metrics and habitat status is green; and (3) biological status is data deficient and habitat status is red (Table 9).

Out of all 114 CUs examined in this project, South Atnarko Lakes CU is considered to be a high priority candidate for conservation and management intervention, as its biological status is in the red zone for both metrics and it is at moderate risk of degradation due to cumulative habitat pressures. The conservation concerns related to South Atnarko Lakes are widely recognized and there is a recovery plan in place (Connors et al. 2016). The South Atnarko Lakes recovery plan suggests that while there may be no single factor to blame for the current biological status of this CU, further research on current impacts from fisheries could help to determine their likelihood of recovery. A number of other steps, including research on life-history and undertaking detailed assessments of freshwater habitats were also suggested as beneficial (Connors et al. 2016). At a minimum, tier-two *state indicator* monitoring[1] should be undertaken in this CU to confirm the results of these tier-one pressure status assessments and to support on-the-ground assessments of habitat condition.

Curtis Lake CU was the only CU that had red biological status for both metrics, but green habitat status. These results suggest that pressures on freshwater habitats may not be a driving factor for Curtis Lake's biological status and that further investigation into alternative factors (e.g. ocean conditions, harvest rates) affecting this CU are warranted. Alternatively, more detailed state indicator monitoring could be initiated for this CU to determine whether finer-scale habitat factors,

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[1] See Section 4.0 for a description of tier-one and tier-two monitoring in the context of Stalberg et al.'s (2009) pressure-state monitoring framework.

not reflected in the coarse-scale assessment undertaken in this project, are driving factors affecting the biological status of this CU.

The four CUs that are data deficient for both biological status metrics, but red for habitat status, are also high priorities for further investigation (Kunsoot River and Mcloughlin sockeye (lake-type), Bella Coola River-Late chum, and Docee Chinook). The significant pressures on their freshwater habitats combined with their unknown biological status should be cause for concern. In these cases, increasing monitoring efforts for these CUs will help to establish a much-needed baseline of information that can be used to determine changes in future abundance over time.

5.2 Data-Limited Conservation Units

By employing a systematic approach to compiling and synthesizing the best available data by CU, this project highlights where determinations of the current status of individual CUs is hampered by gaps in the available information. Overall, we found that the biological status of 54% of CUs could not be determined due to lack of data. The number of data-limited CUs in the Central Coast suggests an urgent need to increase monitoring in this region. The identification and focused monitoring of at least one indicator stream per CU should be considered both a priority and a minimum monitoring requirement moving forward. Without this information, it will be difficult to meaningfully assess CU status in the future and to determine when a CU is falling below its lower benchmark.

The prominence of data-limited CUs on the Central Coast is part of a larger trend in BC: monitoring coverage of CUs on the North and Central Coast of BC is at an all-time low, with only 51% of the identified indicator streams monitored in 2014 (English et al. 2016). The lack of monitoring undermines the ability of fisheries managers to make informed decisions about the management of data deficient CUs on the Central Coast. Moreover, without adequate baseline scientific information, there is no way of knowing how data-deficient CUs are faring in the face of changing human and environmental pressures, how their status may be changing over time, and (in instances where their survival may be declining) when management and conservation intervention may be required.

5.3 Taking a Holistic Approach: Strategic Frameworks & Recovery Planning

By reporting on standardized indicators of salmon abundance and habitat status across the Central Coast, and visualizing the results in the Pacific Salmon Explorer, this project facilitates the comparison of salmon status at a regional scale and helps to identify where conservation and management intervention may be required to support the recovery of at-risk populations. This synoptic overview of wild salmon status also helps to identify which CUs or groups of CUs merit more detailed on-the-ground investigations of habitat status in order to properly attribute causes of decline in salmon CUs.

A good starting place for identifying which CUs are high priorities for recovery planning would be to focus attention on (1) those CUs whose biological status is in the red status zone based on both metrics (South Antarko Lakes and Curtis Inlet sockeye), and (2) those CUs where biological status is deemed data deficient and habitat status is red (Kunsoot River and Mcloughlin sockeye, Bella Coola River-Late chum, and Docee Chinook; see Table 9). While this is a defensible starting point for thinking about recovery planning options, decisions about where to invest limited financial resources for conservation are influenced by a number of other factors including societal values, likelihood of recovery, the feasibility of management and conservation actions, and the costs of recovery. Deciding which salmon populations merit recovery planning efforts is inherently challenging as limited financial resources require trade-offs to be made amongst salmon populations to ensure that the funds available for recovery planning are used effectively (Martin et al. 2018). Therefore we recommend that the outputs of this project be considered within a broader strategic planning framework to ensure that the funds available for recovery planning are used the best possible manner.

One example of how the outputs of this project can be applied in a strategic planning context is work that the PSF is currently doing in partnership with the Central Coast Indigenous Resource Alliance, the Nuxalk, Kitasoo/Xai'Xais, Heiltsuk, and Wuikinuxv First Nations, and researchers from Simon Fraser University, the University of Victoria, and the University of BC. This work uses Priority Threat Management methods (Martin et al. 2018; Carwardine et al. 2012; Chades et al. 2015) to identify which recovery actions would cost-effectively increase the probability of persistence for salmon CUs. This expert-based approach uses the information developed in this project combined with expert knowledge, to identify cost-effective conservation recovery strategies. Ultimately, the outputs of this work will help to inform strategic decisions about where and how to focus efforts and limited resources for salmon management in the future, to achieve the greatest return on investment.

6 Conclusion

The goal of this project was to provide an overview of the status of salmon CUs and their freshwater habitats on BC's Central Coast.

Using Canada's Wild Salmon Policy as a framework, and working in partnership with the Central Coast Indigenous Resource Alliance, the Nuxalk, Kitasoo/Xai'Xais, Heiltsuk, Wuikinuxv, Gitxaala and Haisla First Nations, and DFO, we compiled and synthesized the best available salmon data for describing the characteristics, dynamics, and health of individual salmon populations and their freshwater habitats in the region.

Compiling information on salmon populations can be a complex and daunting task due to the sheer number of agencies and organizations involved in the collection of salmon-related data and the large number of salmon populations in BC. This project has greatly enhanced the baseline of information available for wild salmon and ensures that the best available information is accessible to decision-makers. All of the data and assessments developed through the course of this project have been integrated into the Pacific Salmon Explorer (*salmonexplorer.ca*), an online data visualisation tool that displays information on salmon populations and their habitats in BC, including the Central Coast. We have also made the source datasets broadly and freely available to the public via our Salmon Data Library (*data.salmonwatersheds.ca*). These centralized platforms for storing, distributing, and visualizing salmon-related datasets are critical for providing access to information, increasing the transparency of decision-making, and helping to identify conservation and management strategies for at-risk CUs. Our hope is that these snapshots of salmon status provide a useful starting point for supporting discussions at local and regional planning tables and enhance the capacity of First Nations to play a leadership role in the monitoring, assessment, and recovery of Pacific salmon and their habitats.

Examples of how the outputs of this project can be applied to support local planning, fisheries management, and conservation initiatives include:

- identifying data gaps and where monitoring efforts are lacking or non-existent;
- establishing a baseline of current status that can be used to track future changes in status;
- identifying which CUs may be good candidates for recovery planning exercises, and management and conservation intervention; and
- providing insights into the factors that may be affecting the survival of salmon CUs (e.g. are habitat pressures a driving factor of current biological status?).

Providing timely public access to salmon-related information is critical to promoting open and transparent decision-making, one of the four guiding principles of the Wild Salmon Policy. In recent years, the capacity of First Nations communities to assess threats to coastal salmon habitats has been impeded by outdated information, a limited understanding of the cumulative effects of land-use activities on salmon habitats, and the absence of a standardized assessment approach for assessing salmon populations and their habitats across watersheds and jurisdictional boundaries. By establishing a common baseline of information on salmon populations and their habitats, the outputs of this project will support First Nations in playing a more prominent role in the management of salmon fisheries, and in identifying and implementing coastal restoration projects that can help to restore the structure and function of salmon ecosystems within their traditional lands.

Over the long-term, the PSF intends to continue working with the Central Coast Indigenous Resource Alliance, the Nuxalk, Kitasoo/Xai'Xais, Heiltsuk, and Wuikinuxv First Nations, DFO and TAC members to regularly update the population and habitat assessments and ensure that data on the Pacific Salmon Explorer remains a trusted and comprehensive resource for the Central Coast.

Glossary

FWA assessment watershed: The watersheds represented in the Province of BC's Freshwater Atlas (FWA) Assessment Watersheds dataset, defined at a 1:20,000 watershed scale. FWA assessment watersheds were delineated with target sizes between 2,000 hectares and 10,000 hectares.

Benchmark: A standard point of reference against which a condition can be compared.

Freshwater Atlas (FWA): A standardised dataset for mapping British Columbia's hydrological features, created by the Province of British Columbia. *https://www2.gov.bc.ca/gov/content/data/geographic-data-services/topographic-data/freshwater*

Brood year: The year that a cohort of salmon spawned.

Carrying capacity: The maximum population size that can be sustained indefinitely in the absence of harvest. Carrying capacity can refer to specific habitats (e.g. a sockeye nursery lake) or over the life of a species (e.g. integrated across all life-stages).

Catch: The number of adult salmon that are caught in commercial, recreational, and First Nations fisheries.

Conservation Unit (CU): A geographically, ecologically and genetically distinct population of wild Pacific salmon. A CU can contain one or more *populations*. The unit created under Canada's Wild Salmon Policy to enable DFO to identify and manage for the maintenance of salmon diversity. *https://salmonwatersheds.ca/wsp*

DFO or **Fisheries and Oceans Canada**: Formerly, the Department of Fisheries and Oceans, and still widely referred to as DFO, Fisheries and Oceans Canada is the federal government branch responsible for fisheries and oceans in Canada.

Escapement: The number of mature salmon that pass through (or escape) fisheries and return to fresh water to spawn.

Exploitation rate: The proportion of the total run that is caught in all fisheries.

Habitat Indicator: Characteristics of the environment that, when measured, describe habitat condition, magnitude of stress, degree of exposure to a stressor, or ecological response to exposure.

Indicator stream / non-indicator streams: All surveyed spawning streams in the Central Coast have been classified as indicator and non-indicator streams. Indicator streams are those streams that have been identified as providing more reliable indices of abundance. These indicator streams tend to be more intensively surveyed using methodologies that are considered to provide relatively accurate estimates of annual abundance. Indicator streams are also assumed to be representative of returns to other streams in close proximity. A number of other streams within the CU that are classified as non-indicator may also be surveyed in a given year. Non-indicator streams typically have less consistent survey coverage, variable methods applied, and/or may simply be difficult to survey (e.g. poor water clarity, remote location).

Life history stage: An arbitrary age classification of salmon into categories related to body morphology, behaviour and reproductive potential, such as migration, spawning, egg incubation, fry, and juvenile rearing.

Pacific Salmon Explorer: An online data visualization tool, created by the Pacific Salmon Foundation, that displays information on salmon populations and their habitats in British Columbia.

Population: A group of interbreeding salmon that is sufficiently isolated (i.e. reduced genetic exchange) from other populations such that persistent adaptations to the local habitat can develop over time.

Pressure indicator: Measurable extent or intensity of natural processes or human activities that can directly or indirectly induce qualitative or quantitative changes in habitat condition or state.

Recruitment: The process where juvenile organisms survive and are added to a population of interest. In salmon management, recruitment usually refers to the pre-fishery abundance of adults. Recruitment is typically calculated based on the sum of all catches, estimates of pre-spawn mortality and post-release mortality (if fish are captured and then released), and the escapement.

Riparian zone: The area of vegetation near streams and other bodies of water that is influenced by proximity to water. For management purposes, DFO guidelines generally recognize a defined riparian zone of 30 meters adjacent to waterbodies.

Risk: For analyses in this report, risk is defined as the risk of adverse effects to salmon habitats within a defined *zone of influence*. Levels of increasing risk are defined based on the extent or intensity of impacts relative to defined *benchmarks* of concern.

Run size: The total number of adult salmon returning from the ocean in a given year, including those that reach the spawning grounds (i.e. estimated spawner abundance) and those that are caught.

Salmon Habitat Mapper: An online spatial data visualisation tool for exploring and contributing spawning data in BC. The tool was created by the PSF during the Central Coast project to simplify the process of engaging with local experts. The tool allows approved users to navigate interactive maps and comment on existing spawning data or add new locations. This data is then used to enhance the PSF's population and habitat assessments.

Smolt: A juvenile salmon that has completed rearing in freshwater and is ready to migrate to the marine environment.

Sockeye (lake-type/river-type): Sockeye belonging to one of the two distinct life history types found among sockeye Conservation Units. After hatching, fry from lake-type sockeye Conservation Units migrate to a rearing lake where they spend a year feeding and maturing into smolts. In contrast, juveniles from river-type sockeye CUs rear in flowing water and may smolt soon after emergence.

State indicator: Physical, chemical, or biological attributes measured to characterize environmental conditions.

Status: Condition relative to a defined indicator benchmark.

Watershed: The area of land that drains water, sediment, and dissolved materials into a stream, river, lake, or ocean. Watersheds can be defined at various spatial scales (e.g. ranging from a watershed boundary delineated for a tributary stream to the watershed boundary delineated for an entire mainstem river).

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

Zone of influence (ZOI): Areas upstream or adjacent to habitats used by salmon during the various life-stages (e.g. migration or spawning). ZOIs represent the geographic extent for measurement of habitat pressure indicators.

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Appendices

APPENDIX 1

Conservation Unit Reference List

TABLE A.1. List of Central Coast Conservation Units by species. Overview of the number of CUs by species: seven Chinook, nine chum, eight coho, two pink (even-year), three pink (odd-year), three sockeye (river-type), and 82 sockeye (lake-type) for a total of 114 CUs. The CUs Names and Index are based on Holtby and Ciruna (2007).

Species	Conservation Unit	CUID	CU Index
Chinook	Bella Coola-Bentinck	512	39
	Dean River	513	40
	Docee	509	36
	North & Central Coast-Early	515	42
	North & Central Coast-Late	514	41
	Rivers Inlet	510	37
	Wannock	511	38
Chum	Bella Coola River-Late	505	17
	Bella Coola-Dean Rivers	504	16
	Douglas-Gardner	508	20
	Hecate Lowlands	506	18
	Mussel-Kynoch	507	19
	Rivers Inlet	501	13
	Smith Inlet	500	12
	Spiller-Fitz-Hugh-Burke	503	15
	Wannock	502	14
Coho	Bella Coola-Dean Rivers	518	22
	Brim-Wahoo	521	28
	Douglas Channel-Kitimat Arm	522	29
	Hecate Strait Mainland	520	27
	Mussel-Kynoch	519	26
	Northern Coastal Streams	523	30
	Rivers Inlet	517	21
	Smith Inlet	516	20
Pink (even-year)	Hecate Lowlands	608	5
	Hecate Strait-Fjords	609	6
Pink (odd-year)	Hecate Strait-Fjords	612	13
	Hecate Strait-Lowlands	611	12
	Homathko-Klinaklini-Smith-Rivers-Bella Coola-Dean	610	8

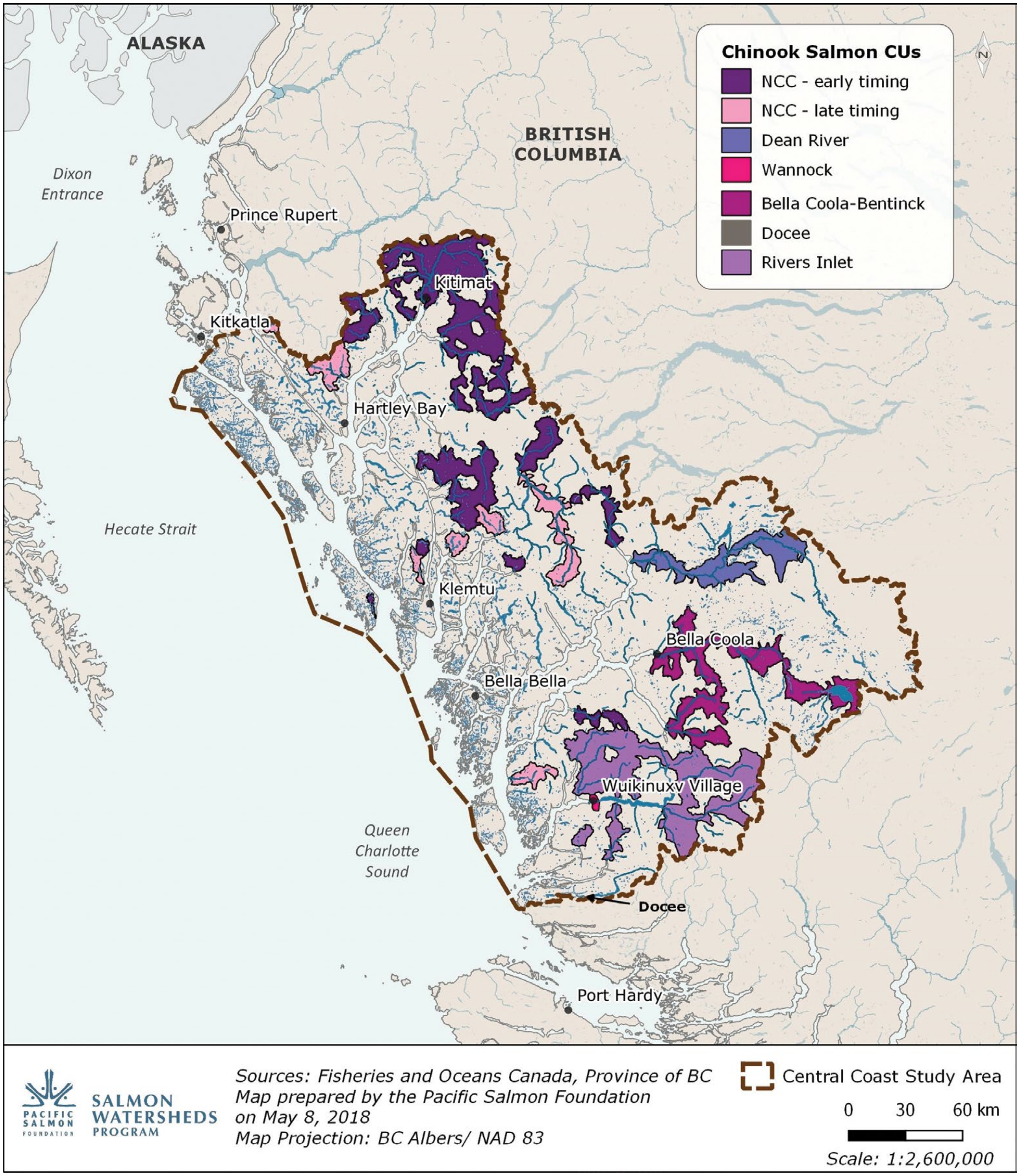
Species	Conservation Unit	CUID	CU Index
Sockeye (river-type)	Northern Coastal Fjords	614	R16
	Northern Coastal Streams	615	R17
	Rivers-Smith Inlets	613	R12
Sockeye (lake-type)	Backland	529	L_18_01
	Banks	540	L_19_01
	Bloomfield	541	L_19_02
	Bolton Creek	542	L_19_03
	Bonilla	543	L_19_04
	Borrowman Creek	544	L_19_05
	Busey Creek	545	L_19_06
	Canoona	532	L_18_02
	Cartwright Creek	546	L_19_07
	Chic Chic	547	L_19_08
	Citeyats	548	L_19_09
	Curtis Inlet	550	L_19_11
	Dallain Creek	551	L_19_12
	Deer	552	L_19_13
	Devon	553	L_19_14
	Dome	533	L_18_03
	Douglas Creek	554	L_19_15
	Elizabeth	555	L_19_16
	Elsie/Hoy	556	L_19_17
	End Hill Creek	557	L_19_18
	Evelyn	534	L_18_04
	Evinrude Inlet	558	L_19_19
	Fannie Cove	549	L_19_10
	Freeda	559	L_19_20
	Hartley Bay	560	L_19_21
	Hevenor Inlet	561	L_19_22
	Higgins Lagoon	562	L_19_23
	Kadjusdis River	563	L_19_24
	Kainet Creek	535	L_18_05
	Kdelmashan Creek	564	L_19_25
	Keecha	565	L_19_26
	Kent Inlet Lagoon Creek	566	L_19_27
	Kenzuwash Creeks	567	L_19_28

Species	Conservation Unit	CUID	CU Index
Sockeye (lake-type)	Keswar Creek	568	L_19_29
	Kildidt Creek	569	L_19_30
	Kildidt Lagoon Creek	570	L_19_31
	Kimsquit	536	L_18_06
	Kisameet	571	L_19_32
	Kitkiata	537	L_18_07
	Kitlope	538	L_18_08
	Koeye	572	L_19_33
	Kooryet	573	L_19_34
	Kunsoot River	574	L_19_35
	Kwakwa Creek	575	L_19_36
	Lewis Creek	576	L_19_37
	Limestone Creek	577	L_19_38
	Long	524	L_15_01
	Lowe/Simpson/Weir	578	L_19_39
	Mary Cove Creek	579	L_19_40
	Mcdonald Creek	580	L_19_41
	Mcloughlin	581	L_19_42
	Mikado	582	L_19_43
	Monckton Inlet Creek	583	L_19_44
	Namu	584	L_19_45
	Owikeno	525	L_15_02
	Pine River	539	L_18_09
	Port John	585	L_19_46
	Powles Creek	586	L_19_47
	Price Creek	587	L_19_48
	Roderick	588	L_19_50
	Ryan Creek	589	L_19_51
	Salter	590	L_19_52
	Scoular/Kilpatrick	591	L_19_53
	Sheneeza Inlet	592	L_19_55
	Ship Point Creek	593	L_19_56
	Soda Creek	530	L_18_10
	South Atnarko Lakes	528	L_16_01
	Spencer Creek	594	L_19_57
	Stannard Creek	595	L_19_58

Species	Conservation Unit	CUID	CU Index
Sockeye (lake-type)	Talamoosa Creek	596	L_19_59
	Tankeeah River	597	L_19_60
	Treneman Creek	598	L_19_61
	Tsimtack/Moore/Roger	599	L_19_62
	Tuno Creek East	600	L_19_63
	Tuno Creek West	601	L_19_64
	Tyler Creek	602	L_19_65
	Wale Creek	603	L_19_66
	Wannock (Owikeno)	527	L_15_04
	Watt Bay	604	L_19_67
	West Creek	605	L_19_68
	Yaaklele Lagoon	606	L_19_69
	Yeo	607	L_19_70

APPENDIX 2

Conservation Unit Maps by Species



Sources: Fisheries and Oceans Canada, Province of BC
Map prepared by the Pacific Salmon Foundation
on May 8, 2018
Map Projection: BC Albers/ NAD 83

FIGURE A.1. This map shows the seven Chinook Conservation Units (CUs), as defined by Holtby and Ciruna (2007), in the Central Coast region.

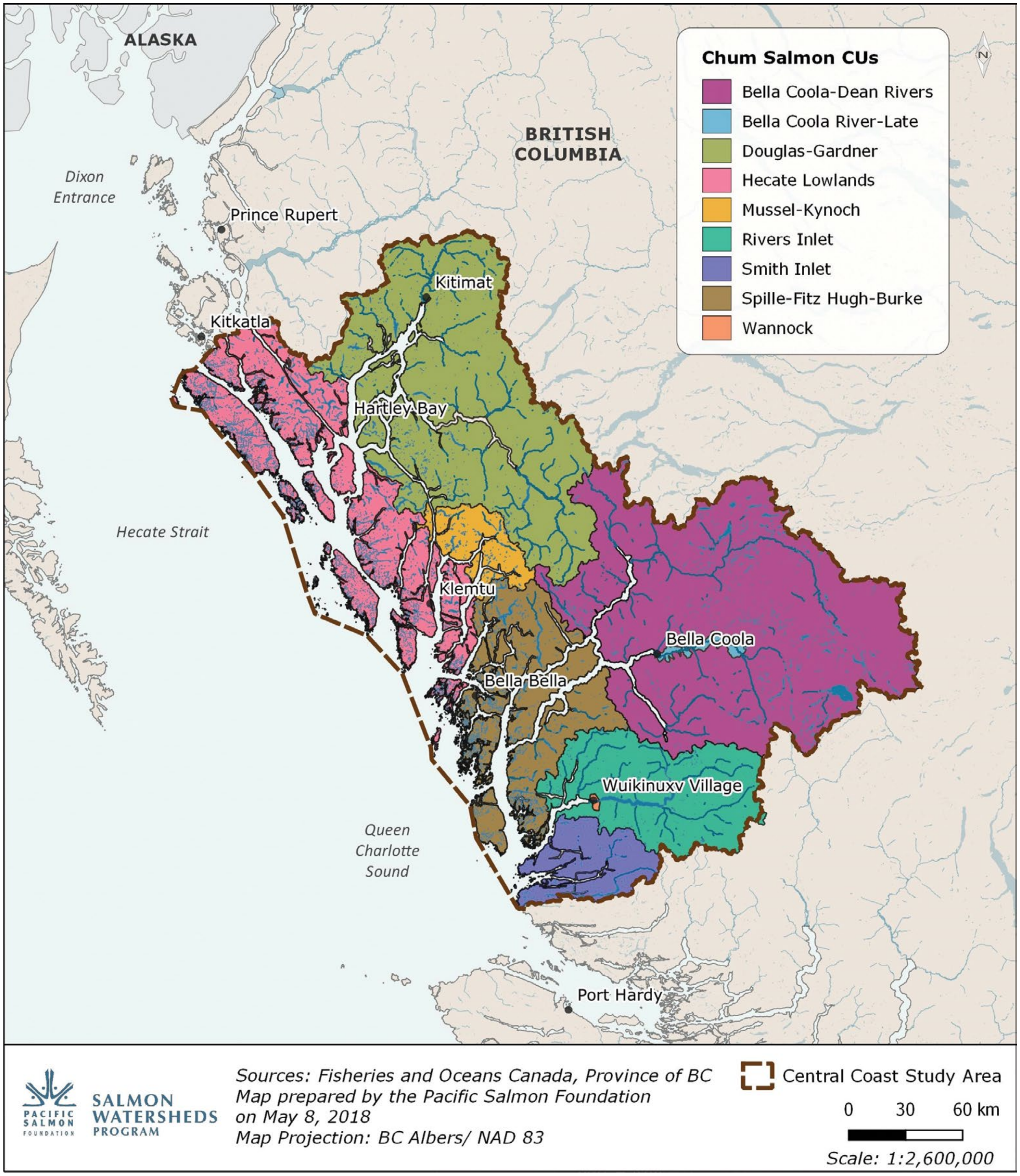
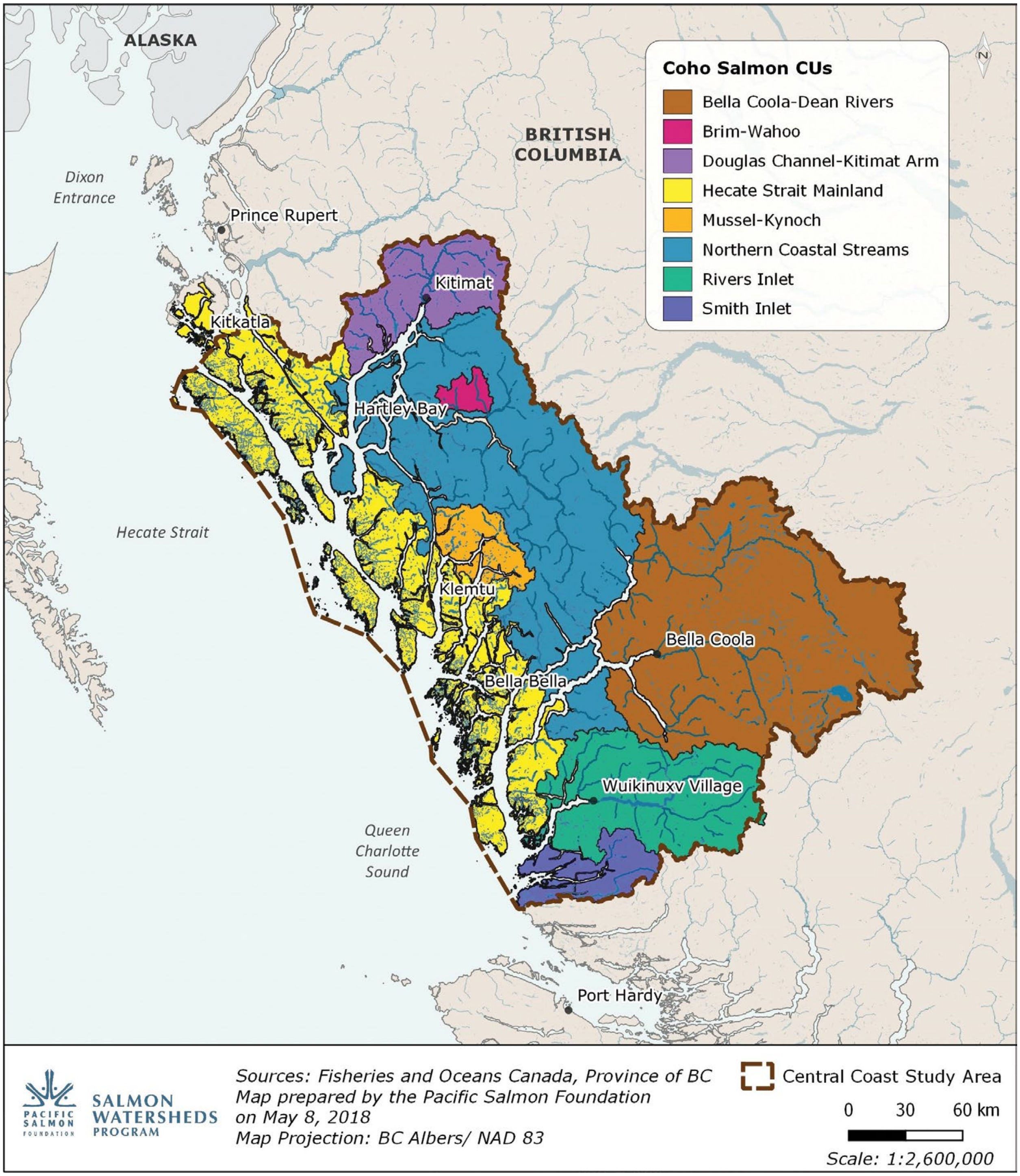
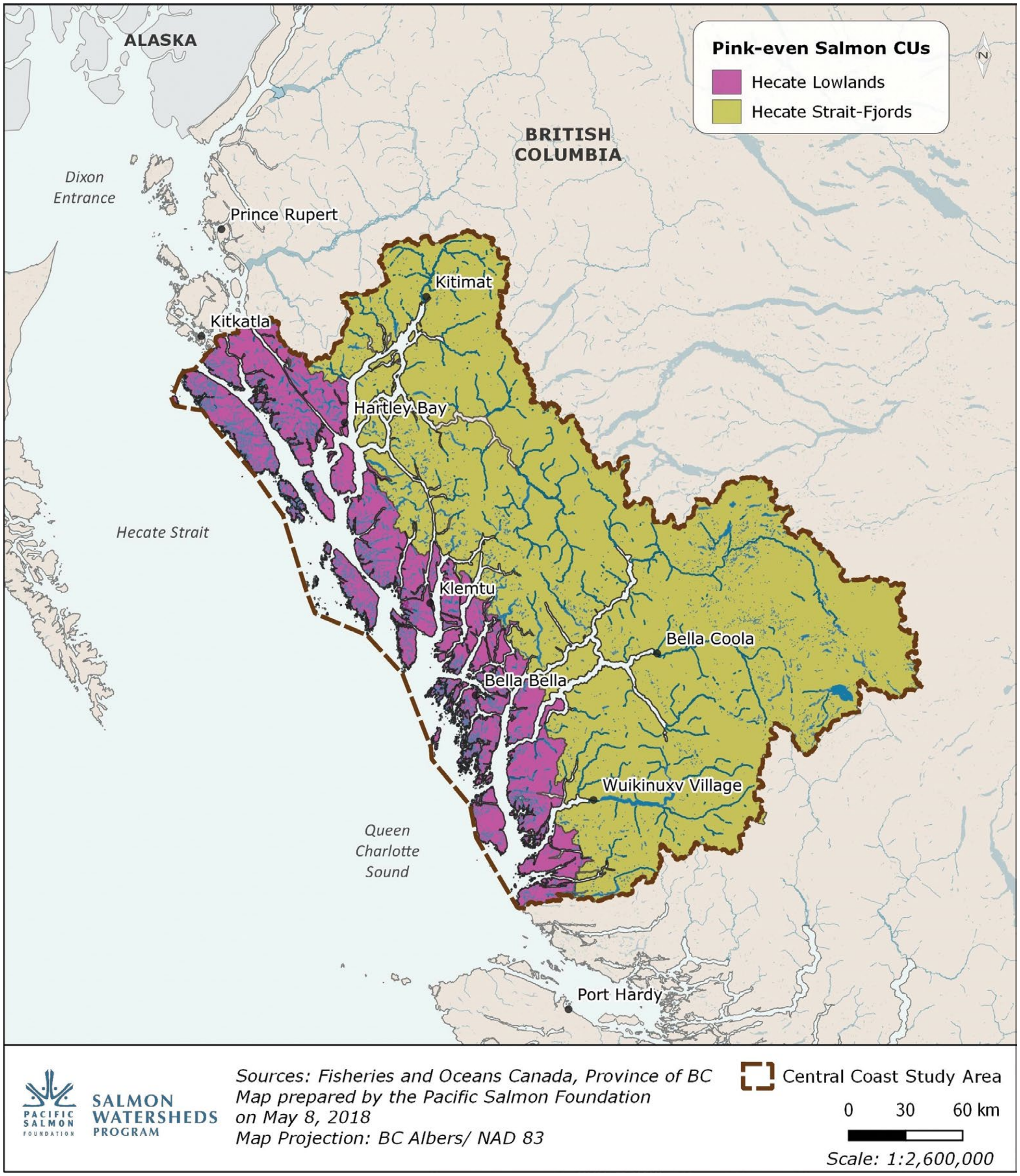


FIGURE A.2. This map shows the nine chum Conservation Units (CUs), as defined by Holtby and Ciruna (2007), in the Central Coast region.



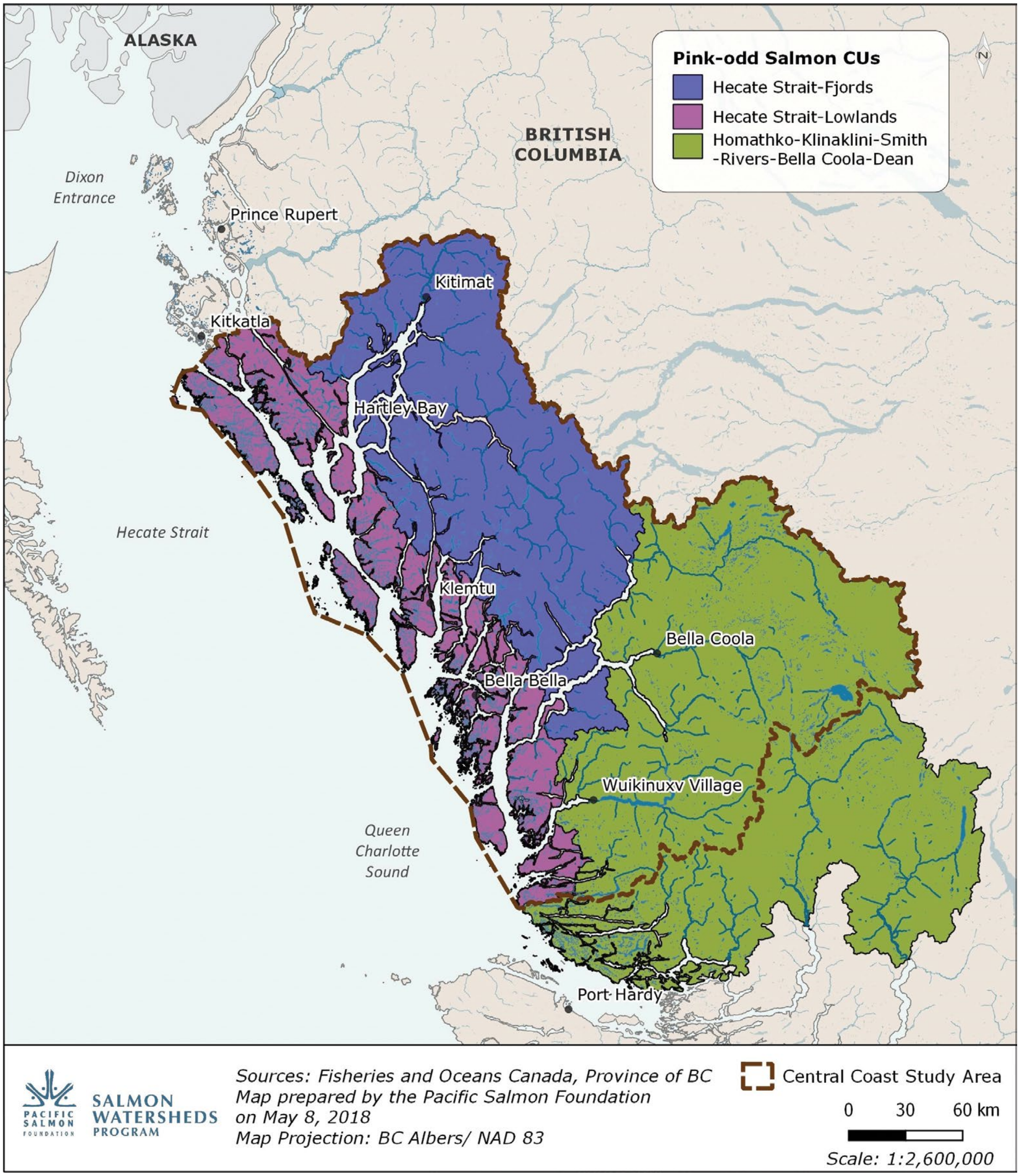
Sources: Fisheries and Oceans Canada, Province of BC
Map prepared by the Pacific Salmon Foundation
on May 8, 2018
Map Projection: BC Albers/ NAD 83

FIGURE A.3. This map shows the eight coho Conservation Units (CUs), as defined by Holtby and Ciruna (2007), in the Central Coast region.



Sources: Fisheries and Oceans Canada, Province of BC
Map prepared by the Pacific Salmon Foundation
on May 8, 2018
Map Projection: BC Albers/ NAD 83

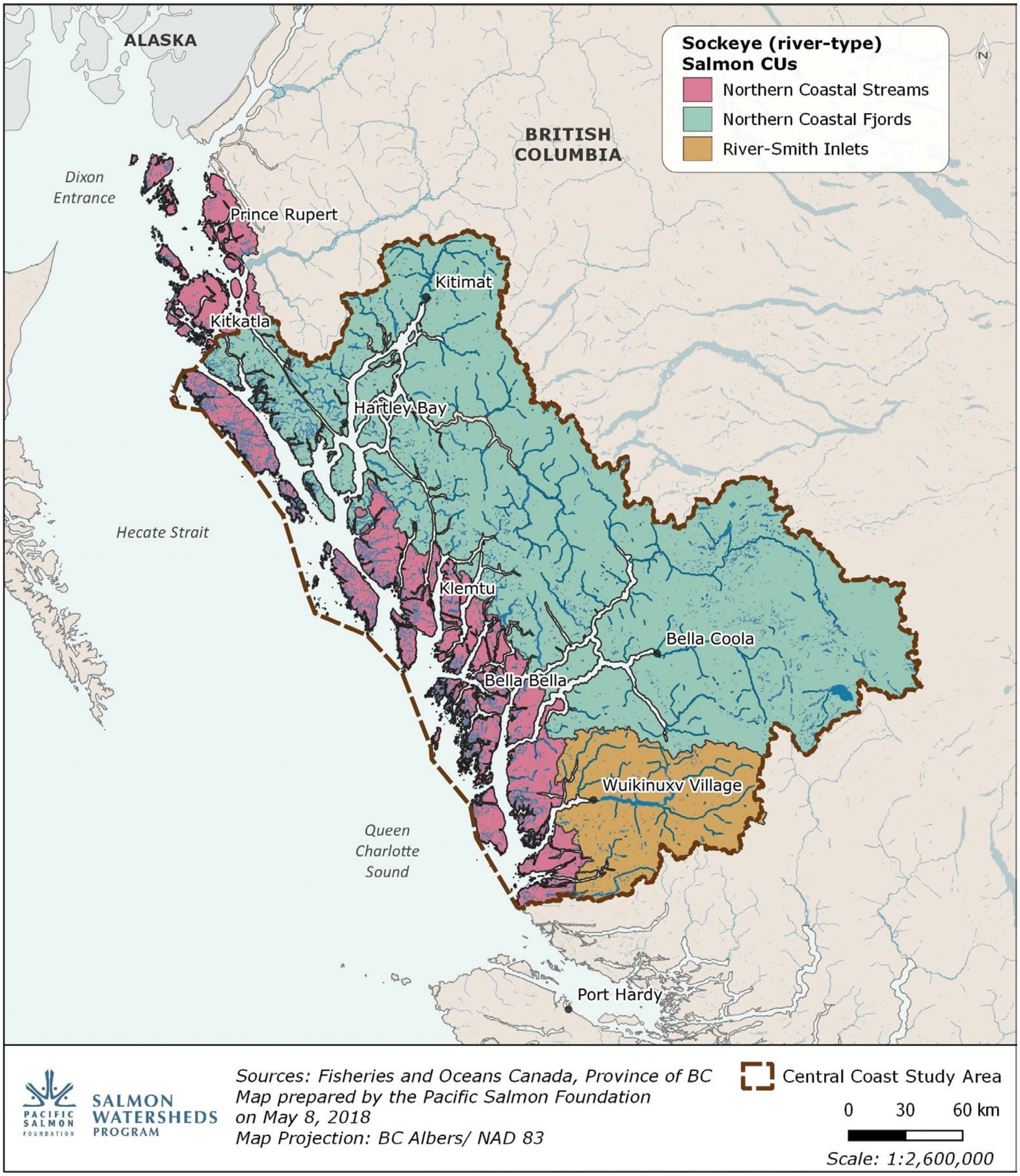
FIGURE A.4. This map shows two pink (even-year) Conservation Units (CUs), as defined by Holtby and Ciruna (2007), in the Central Coast region.



Sources: Fisheries and Oceans Canada, Province of BC
Map prepared by the Pacific Salmon Foundation
on May 8, 2018
Map Projection: BC Albers/ NAD 83

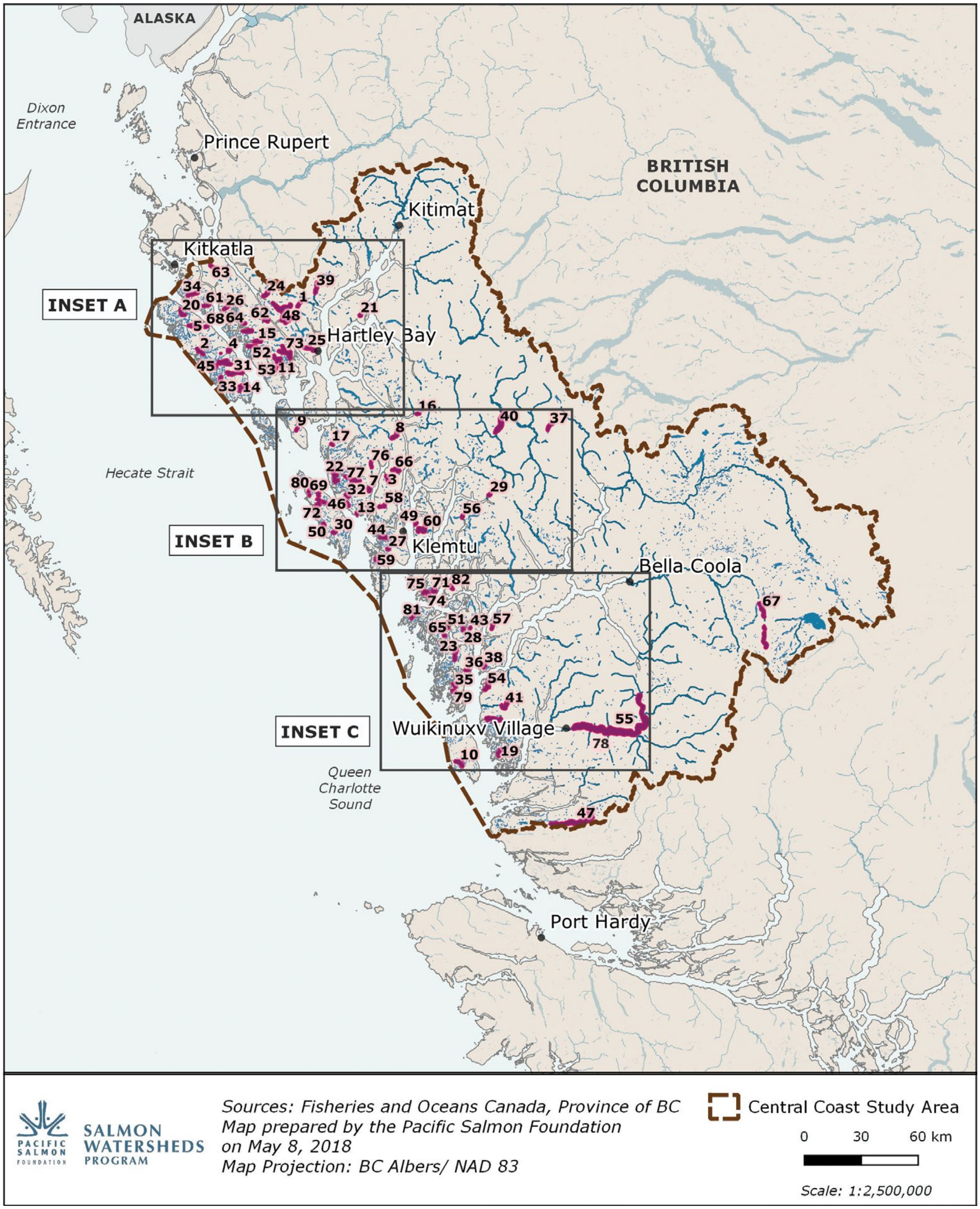
Scale: 1:2,600,000

FIGURE A.5. This map shows the three pink (odd-year) Conservation Units (CUs), as defined by Holtby and Ciruna (2007), in the Central Coast region.



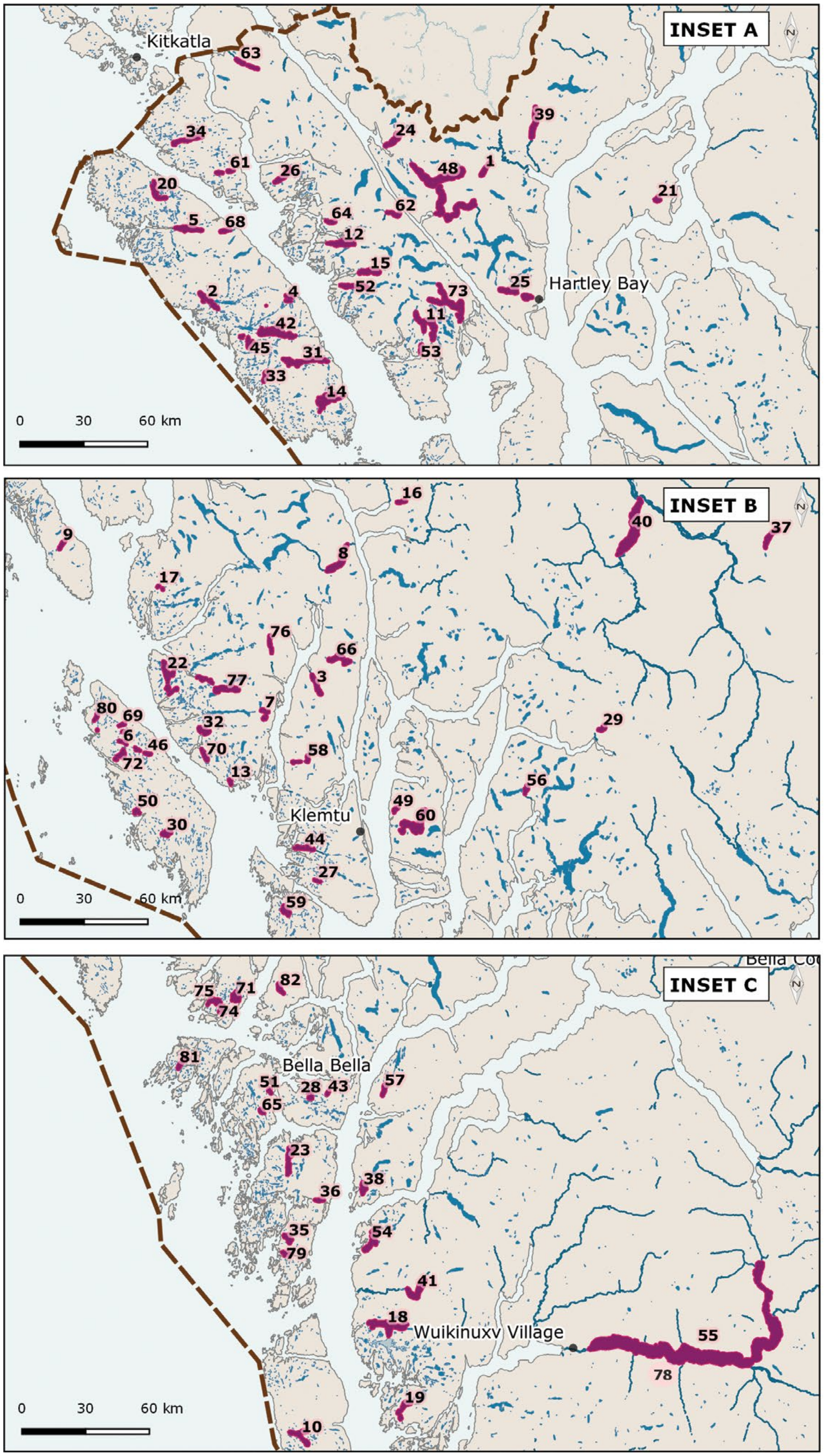
Sources: Fisheries and Oceans Canada, Province of BC
Map prepared by the Pacific Salmon Foundation
on May 8, 2018
Map Projection: BC Albers/ NAD 83

FIGURE A.6. This map shows the three river-type sockeye Conservation Units (CUs), as defined by Holtby and Ciruna (2007), in the Central Coast region.



Sources: Fisheries and Oceans Canada, Province of BC
Map prepared by the Pacific Salmon Foundation
on May 8, 2018
Map Projection: BC Albers/ NAD 83

FIGURE A.7. This map shows the 82 lake-type sockeye Conservation Units (CUs), as defined by Holtby and Ciruna (2007), in the Central Coast region. See Figure A.8 for inset maps to view the lake-type sockeye CU locations in more detail.



Sockeye (lake-type) Conservation Units

1	Backland
2	Banks
3	Bloomfield
4	Bolton Creek
5	Bonilla
6	Borrowman Creek
7	Busey Creek
8	Canoona
9	Cartwright Creek
10	Chic Chic
11	Citeyats
12	Curtis Inlet
13	Dallain Creek
14	Deer
15	Devon
16	Dome
17	Douglas Creek
18	Elizabeth
19	Elsie/Hoy
20	End Hill Creek
21	Evelyn
22	Evinrude Inlet
23	Fannie Cove
24	Freeda
25	Hartley Bay
26	Hevenor Inlet
27	Higgins Lagoon
28	Kadjusdis River
29	Kainet Creek
30	Kdelmashan Creek
31	Keecha
32	Kent Inlet Lagoon Creek
33	Kenzuwash Creeks
34	Keswar Creek
35	Kildidt Creek
36	Kildidt Lagoon Creek
37	Kimsquit
38	Kisameet
39	Kitkiata
40	Kitlope
41	Koeye
42	Kooryet
43	Kunsoot River
44	Kwakwa Creek
45	Lewis Creek
46	Limestone Creek
47	Long
48	Lowe/Simpson/Weir
49	Mary Cove Creek
50	Mcdonald Creek
51	Mcloughlin
52	Mikado
53	Monckton Inlet Creek
54	Namu
55	Owikeno
56	Pine River
57	Port John
58	Powles Creek
59	Price Creek
60	Roderick
61	Ryan Creek
62	Salter
63	Scoular/Kilpatrick
64	Sheneeza Inlet
65	Ship Point Creek
66	Soda Creek
67	South Atnarko Lakes
68	Spencer Creek
69	Stannard Creek
70	Talamoosa Creek
71	Tankeeah River
72	Treneman Creek
73	Tsimtack/Moore/Roger
74	Tuno Creek East
75	Tuno Creek West
76	Tyler Creek
77	Wale Creek
78	Wannock (Owikeno)
79	Watt Bay
80	West Creek
81	Yaaklele Lagoon
82	Yeo

FIGURE A.8. These inset maps (extents defined in Figure A.7) show the location of the 82 lake-type sockeye CUs in the Central Coast region.

APPENDIX 3

Region Delineation Process

As previously described in Section 2.2, for this assessment, we defined the spatial scope of the Central Coast region according to three criteria:

1 the geographic extent of salmon CUs in the region,

2 the region's adjacency to past and future assessment regions (with an aim to minimize overlap between regions), and

3 alignment to major drainage patterns (as represented in BC's Freshwater Atlas 1:20K Watershed Groups).

Following the first criteria, our starting point for potential conservation units to assess was Holtby and Ciruna's (2007) list of 425 Conservation Units in all of BC, the spatial boundaries for which were delineated and provided by Fisheries and Oceans Canada in 2008. We overlaid the spatial boundaries for all CUs identified by Holtby and Ciruna (2007) with a map of BC and selected CUs that overlapped areas commonly identified as BC's "Central Coast." The boundary to the east was apparent from the natural divide of the Coast Mountains and to the west — the Pacific Ocean. We then looked to establish the northern and southern boundaries for the region based on boundaries that were shared by multiple CUs. A common boundary at the north was determined based on the northern extents of chum, pink (even-year), pink (odd-year) and Chinook CUs. To the south, chum, coho, pink (even-year), Chinook, and sockeye (river-type) CUs shared a common boundary. There were three CUs included in this project that extended beyond these northern and southern boundaries shared by the majority of CUs (Homathko-Klinaklini-Smith-Rivers-Bella-Coola-Dean pink (odd-year), Northern Coastal Streams sockeye (river-type), and Hecate Strait Mainland coho). The decision not to define the Central Coast region based on the full northern and southern extents of these 3 CUs was based on the second delineation criteria, where we aimed to minimize spatial overlap with past or planned assessment regions.

Looking to the second region delineation criteria, a northern boundary was apparent based on several coastal CUs that were already assessed in the Skeena. This decision to bound the northern end of the Central Coast region by the previously assessed Skeena region meant that portions of the Northern Coastal Streams river-type sockeye CU and Hecate Strait Mainlaind coho CU fell outside the study area. To the south, we had to decide whether or not to define the southern edge of the study area to include the full extent of the Homathko-Klinaklini-Smith-Rivers-Bella-Coola-Dean pink (odd-year) CU. If the full extent of this CU were included in the Central Coast study area, this would introduce a conflict where in multiple CUs on the South Coast (a region planned for assessment in the future) would cover the same spatial area as the southern half of the Homathko-Klinaklini-Smith-Rivers-Bella-Coola-Dean pink (odd-year) CU. Therefore, we looked to our third delineation criteria to solidify a decision for the region's southern boundary.

In the third delineation criteria, we aimed to align the region boundary with major drainage patterns. We decided to align the southern boundary of the study area with the southern edges of the Owikeno

Lake, Bella Coola River, Atnarko and Upper Dean River watershed groups, which in turn meant that the study area would not include the full extent of the Homathko-Klinaklini-Smith-Rivers-Bella-Coola-Dean pink (odd-year) CU.

In summary, the northern and southern boundaries of the Central Coast region study area aligned with multiple Central Coast CU boundaries, avoided overlap with areas that were assessed in the Skeena and that will be assessed on the South Coast, and aligned to watershed group boundaries (rather than bisecting them as would have been the case for the Knight Inlet, Klinaklini River and Homathko River watershed groups if the full extent of the Homathko-Klinaklini-Smith-Rivers-Bella-Coola-Dean pink (odd-year) CU were included in the study area). Note that while the northern and southern boundaries of the Central Coast region do not fully contain the 3 "extension" CUs named previously, these "extension" CUs were assessed in their entirety for both the population and habitat assessment work.[1]

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[1] For the habitat assessments, these "extension" CUs did require a distinction be made between (1) the number of watersheds assessed (*n*=1493), which covers the entire geographic extent of the 114 CUs considered in this project, and (2) the number of watersheds in the study area (*n*=1132) (mapped in Figure 2 and described in Section 4.2.1) as the number of watersheds used to calculate relative benchmarks.

APPENDIX 4

Review of Conservation Units

Through the expert review process, the Technical Advisory Committees identified issues with four of the initial 116 Conservation Units (CUs) in the study area. These issues are outlined below, along with explanations of how we have addressed these issues for each CU. As a result of this review process, two CUs were removed from the project (Whalen Lake and Owikeno-Late sockeye (lake-type) CUs).

South Atnarko Lakes CU

The South Atnarko Lakes sockeye CU is enumerated in the Bella Coola River. In nuSEDS, the Bella Coola River was attributed to the Northern Coastal Fjords river-type sockeye CU. This occurred because a significant, but unknown, proportion of the sockeye in the Bella Coola River are river-type fish. This meant that this indicator stream was erroneously attributed to the Northern Coastal Fjords CU, rather than the South Atnarko Lakes CU. Working with DFO, we determined that the best data source for South Atnarko Lakes CU is a dataset compiled after the publication of the recovery plan for South Atnarko Lakes sockeye (Connors et al. 2016; Brendan Connors, *unpublished data*). Consequently, we reassigned the Bella Coola River indicator stream (and associated data) from the Northern Coastal Fjords CU to the South Atnarko Lakes CU.

Bella Coola-Late Chum CU

Charter Patrolman Stan Hutchings identified an issue in nuSEDS for the Bella Coola-Late chum CU. In nuSEDS, the stream-level estimates for the Bella Coola River chum indicator stream were combined for both the relatively small Bella Coola-Late chum CU and the much larger Bella Coola-Dean chum CU. We worked with DFO to distinguish the stream-level estimates from these two different Bella Coola River chum CUs, which have different run timings. We updated the data for both CUs to reflect this.

Whalen Lake Sockeye CU

The Whalen Lake sockeye CU is included in Holtby and Ciruna (2007), but long-time Charter Patrolman Stan Hutchings recommended that it be removed from the list of CUs. There is an impassable waterfall that prevents sockeye from accessing Whalen Lake, which is the spawning and rearing lake for this CU. As such, we removed this CU from the project.

Owikeno-Late Sockeye CU

The Owikeno-Late sockeye CU is not listed in Holtby and Ciruna (2007), but was provisionally designated as a CU by Blair Holtby in 2008. However, a TAC member from Wuikinuxv advised us that this CU is not distinguishable from other sockeye CUs in the lake. Furthermore, this CU was not included on the most recent list of CUs published on the Government of Canada's OpenData portal[1]. Given that it was not in the most recent list of CUs, it lacks any baseline data, and we could not find any documentation about its creation, we removed this CU from the project.

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[1] https://open.canada.ca/data/en/dataset/c48669a3-045b-400d-b730-48aafe8c5ee6

APPENDIX 5

Biological Status Details for Central Coast Conservation Units

TABLE A.2. Summary statistics, biological status designation, and benchmark values for 114 Central Coast Conservation Units. Current abundance is expressed as the average over the most recent generation, shown in parentheses. Years of Data shows the number of years with a CU-level estimate of spawner abundance. For the stock-recruitment metric, the percentage in each column is the probability (%) of a given status based on the benchmarks (S_{GEN1} and S_{MSY} values) estimated from a Hierarchical Bayesian Model. For the stock–recruitment benchmark values, 95% credible intervals (CI) are shown in parentheses.

Conservation Unit	Current Abundance	Years of Data	Biological Status				Status Metrics			
			Historic Spawners	Stock–Recruitment			Historic Spawners		Stock–Recruitment	
				% Chance of Red Status	% Chance of Amber Status	% Chance of Green Status	Lower Benchmark: 25th percentile	Upper Benchmark: 75th percentile	Lower Benchmark: S_{GEN1} (95% CI)	Upper Benchmark: S_{MSY} (95% CI)
Chinook										
Bella Coola-Bentinck	14,773 (2010–2014)	30	🟨	3%	52%	45%	14,569	25,000	5,033 (1,972–15,015)	15,188 (10,946–30,030)
Dean River	2,081 (2010–2014)	30	🟨	0%	0%	100%	1,300	3,290	350 (184–662)	1,083 (913–1,400)
Docee	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
North & Central Coast-Early	444 (2010–2014)	30	🟥	0%	36%	64%	602	957	161 (104–248)	428 (355–536)
North & Central Coast-Late	1,201 (2010–2014)	29	🟨	7%	40%	53%	1,030	2,574	329 (75–1,964)	1,154 (510–5,612)
Rivers Inlet	1,179 (2010–2014)	30	🟨	1%	36%	64%	800	2,394	464 (272–845)	1,118 (848–1,656)
Wannock	6,097 (2010–2014)	30	🟨	0%	0%	100%	5,827	8,594	818 (458–1,550)	3,830 (3,226–4,910)
Chum										
Bella Coola River-Late	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bella Coola-Dean Rivers	185,854 (2011–2014)	61	🟨	0%	5%	95%	107,112	271,837	72,046 (58,510–100,779)	144,091 (117,020–201,558)
Douglas-Gardner	131,956 (2011–2014)	61	🟨	2%	98%	0%	84,009	344,398	91,703 (72,683–129,796)	183,406 (145,367–259,592)

Conservation Unit	Current Abundance	Years of Data	Biological Status				Status Metrics			
			Historic Spawners	Stock–Recruitment			Historic Spawners		Stock–Recruitment	
				% Chance of Red Status	% Chance of Amber Status	% Chance of Green Status	Lower Benchmark: 25th percentile	Upper Benchmark: 75th percentile	Lower Benchmark: S_{GEN1} (95% CI)	Upper Benchmark: S_{MSY} (95% CI)
Hecate Lowlands	83,633 (2011–2014)	61	🟥	0%	46%	54%	83,960	128,606	41,482 (34,824–54,157)	82,964 (69,648–108,313)
Mussel-Kynoch	127,181 (2011–2014)	61	🟨	0%	0%	100%	60,943	144,468	32,396 (28,067–39,429)	64,791 (56,134–78,858)
Rivers Inlet	9,874 (2011–2014)	61	🟨	85%	15%	0%	8,610	39,200	13,744 (6,215–19,174)	28,022 (21,741–38,358)
Smith Inlet	23,122 (2011–2014)	61	🟥	1%	99%	0%	25,775	75,356	16,077 (6,683–21,021)	32,255 (26,679–42,041)
Spiller-Fitz-Hugh-Burke	285,700 (2011–2014)	61	🟨	0%	1%	99%	173,374	302,066	88,408 (72,874–121,701)	176,815 (145,748–243,401)
Wannock	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Coho										
Bella Coola-Dean Rivers	39,775 (2011–2014)	61	🟨	0%	1%	99%	20,228	50,571	13,338 (6,339–18,285)	26,747 (21,789–36,570)
Brim-Wahoo	7,061 (2011–2014)	61	🟨	1%	3%	96%	2,818	8,145	1,373 (722–3,436)	4,465 (3,368–7,781)
Douglas Channel-Kitimat Arm	96,590 (2011–2014)	61	🟨	0%	0%	100%	32,832	139,175	22,123 (47,49–30,294)	45,371 (37,537–60,588)
Hecate Strait Mainland	103,454 (2011–2014)	61	🟨	4%	93%	3%	82,456	209,861	67,715 (51,290–115,571)	135,503 (102,843–234,091)
Mussel-Kynoch	4,586 (2011–2014)	61	🟨	12%	84%	4%	2,880	8,600	3,112 (1,885–7,667)	6,154 (4,398–13,882)
Northern Coastal Streams	135,017 (2011–2014)	61	🟨	0%	1%	99%	73,955	146,816	43,411 (35,524–61,144)	86,838 (71,090–122,587)
Rivers Inlet	144,618 (2011–2014)	57	🟩	6%	5%	89%	15,705	68,425	23,916 (0–3,076,644)	49,060 (28,737–1.78 × 10^9)
Smith Inlet	10,467 (2011–2014)	41	🟨	21%	16%	63%	1,967	14,485	4,185 (0–2.25 × 10^7)	8,008 (3,635–2.73 × 10^{10})

Conservation Unit	Current Abundance	Years of Data	Biological Status				Status Metrics			
			Historic Spawners	Stock–Recruitment			Historic Spawners		Stock–Recruitment	
				% Chance of Red Status	% Chance of Amber Status	% Chance of Green Status	Lower Benchmark: 25th percentile	Upper Benchmark: 75th percentile	Lower Benchmark: S_{GEN1} (95% CI)	Upper Benchmark: S_{MSY} (95% CI)
Pink (even-year)										
Hecate Lowlands	1,357,185 (2014)	31	🟩	22%	29%	49%	536,868	1,156,006	409,621 (0–2.72 × 10^{13})	1,449,367 (508,087–5.44 × 10^{13})
Hecate Strait-Fjords	3,260,914 (2014)	31	🟨	25%	50%	25%	1,825,621	4,931,321	1,710,253 (0–7.61 × 10^{13})	5,595,447 (2,178,435–1.52 × 10^{14})
Pink (odd-year)										
Hecate Strait-Fjords	6,751,025 (2013)	30	🟩	12%	21%	67%	820,952	2,378,371	949,715 (0–2.42 × 10^{13})	2,582,148 (1,179,970–8.33 × 10^{12})
Hecate Strait-Lowlands	1,375,172 (2013)	30	🟩	1%	1%	98%	449,425	918,263	246,283 (185,076–525,848)	494,166 (377,095–1,310,036)
Homathko-Klinaklini-Rivers-Smith-Bella Coola Dean	1,250,848 (2013)	30	🟨	2%	16%	82%	469,935	1,794,086	492,354 (334,789–1,130,348)	989,185 (693,273–3,075,539)
Sockeye (river-type)										
Northern Coastal Fjords	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Northern Coastal Streams	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rivers-Smith Inlets	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sockeye (lake-type)										
Backland	55 (2010–2014)	53	🟨	93%	6%	1%	41	175	249 (35–1,884)	513 (75–4,026)
Banks	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bloomfield	780 (2010–2014)	55	🟨	13%	87%	1%	395	1,425	542 (327–1,162)	1,248 (869–2,294)
Bolton Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bonilla	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Borrowman Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Busey Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Canoona	5,362 (2010–2014)	47	🟩	0%	0%	100%	1,400	5,150	544 (324–1,021)	2,439 (1,998–3,308)
Cartwright Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

			Biological Status				Status Metrics			
				Stock–Recruitment			Historic Spawners		Stock–Recruitment	
Conservation Unit	Current Abundance	Years of Data	Historic Spawners	% Chance of Red Status	% Chance of Amber Status	% Chance of Green Status	Lower Benchmark: 25th percentile	Upper Benchmark: 75th percentile	Lower Benchmark: S_{GEN1} (95% CI)	Upper Benchmark: S_{MSY} (95% CI)
Chic Chic	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Citeyats	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Curtis Inlet	2,150 (2010–2014)	55	🟥	99%	1%	0%	3,050	15,000	4,260 (2,379–13,327)	8,798 (5,787–31,564)
Dallain Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Deer	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Devon	7,300 (2010–2014)	55	🟨	0%	0%	100%	3,000	8,000	1,791 (1,246–2,634)	4,283 (3,589–5,341)
Dome	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Douglas Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Elizabeth	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Elsie/Hoy	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
End Hill Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Evelyn	2,074 (2010–2014)	55	🟨	6%	26%	69%	578	2,300	690 (340–7,414)	1,793 (1,216–96,329)
Evinrude Inlet	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fannie Cove	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Freeda	420 (2010–2014)	41	🟨	6%	90%	4%	400	900	241 (128–523)	603 (401–1,104)
Hartley Bay	2,290 (2010–2014)	54	🟩	19%	21%	60%	800	1,700	692 (0–5,075,389)	1,921 (1,060–4.43 × 10^9)
Hevenor Inlet	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Higgins Lagoon	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Kadjusdis River	1,400 (2010–2014)	52	🟨	46%	54%	0%	800	4,000	1,329 (567–4,549)	4,872 (3,018–12,378)
Kainet Creek	4,310 (2010–2014)	55	🟩	0%	0%	99%	800	3,000	228 (113–606)	1,439 (1,105–2,437)
Kdelmashan Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Keecha	2,200 (2010–2014)	53	🟨	37%	62%	0%	2,000	7,000	1,990 (1,086–6,049)	4,200 (3,018–12,378)

Conservation Unit	Current Abundance	Years of Data	Biological Status				Status Metrics			
			Historic Spawners	Stock–Recruitment			Historic Spawners		Stock–Recruitment	
				% Chance of Red Status	% Chance of Amber Status	% Chance of Green Status	Lower Benchmark: 25th percentile	Upper Benchmark: 75th percentile	Lower Benchmark: S_{GEN1} (95% CI)	Upper Benchmark: S_{MSY} (95% CI)
Kent Inlet Lagoon Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Kenzuwash Creeks	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Keswar Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Kildidt Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Kildidt Lagoon Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Kimsquit	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Kisameet	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Kitkiata	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Kitlope	25,540 (2010–2014)	55	🟨	33%	67%	0%	16,600	40,000	23,257 (16,600–42,940)	46,542 (33,264–86,485)
Koeye	9,600 (2010–2014)	55	🟩	3%	20%	77%	1,625	5,000	2,549 (1,032–10,349)	6,925 (3,852–20,824)
Kooryet	3,510 (2010–2014)	55	🟨	10%	70%	20%	1,420	7,000	2,022 (1,097–8,855)	4,238 (2,771–29,094)
Kunsoot River	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Kwakwa Creek	4,200 (2010–2014)	55	🟩	1%	19%	80%	1,500	3,700	1,360 (819–2,913)	3,511 (2,536–6,166)
Lewis Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Limestone Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Long	75,471 (2010–2014)	55	🟨	3%	65%	32%	29,430	158,059	41,413 (29,849–76,693)	82,826 (59,698–153,387)
Lowe/Simpson/Weir	24,250 (2010–2014)	53	🟩	0	0	100%	4,850	14,250	3,674 (2,561–5,675)	7,221 (5,040–10,739)
Mary Cove Creek	493 (2010–2014)	55	🟨	95%	5%	0%	300	1,600	3,794 (0–4,843,116)	9,024 (4,643–4.96 $\times 10^9$)
Mcdonald Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mcloughlin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mikado	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Conservation Unit	Current Abundance	Years of Data	Biological Status				Status Metrics			
			Historic Spawners	Stock–Recruitment			Historic Spawners		Stock–Recruitment	
				% Chance of Red Status	% Chance of Amber Status	% Chance of Green Status	Lower Benchmark: 25th percentile	Upper Benchmark: 75th percentile	Lower Benchmark: S_{GEN1} (95% CI)	Upper Benchmark: S_{MSY} (95% CI)
Monckton Inlet Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Namu	5,550 (2010–2014)	55	🟩	13%	14%	73%	1,400	3,500	1,480 (0–4,001,069)	3,799 (2,300–2.44 × 10^9)
Owikeno	337,628 (2010–2014)	55	🟨	33%	64%	2%	181,800	688,265	275,614 (0–3.75 × 10^7)	589,009 (340,623–2.29 × 10^{10})
Pine River	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Port John	1,075	51	🟩	4%	37%	59%	200	950	413 (185–1,249)	993 (564–2,605)
Powles Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Price Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Roderick	1,169 (2010–2014)	49	🟩	10%	31%	59%	400	800	605 (344–20,577)	1,094 (679–439,263)
Ryan Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Salter	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Scoular/Kilpatrick	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sheneeza Inlet	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ship Point Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Soda Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
South Atnarko Lakes	2,160 (2010–2014)	41	🟥	100%	0%	0%	6,000	30,000	3,798 (2,540–4,399)	14,572 (8,209–24,584)
Spencer Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Stannard Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Talamoosa Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tankeeah River	7,933 (2010–2014)	55	🟩	10%	11%	78%	2,000	6,000	1457 (0–2,230,647)	4,845 (3,078–8.24 × 10^8)
Treneman Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tsimtack/Moore/Roger	6,016 (2010–2014)	53	🟨	1%	1%	98%	1,500	7,000	977 (493–2,593)	2,165 (1,427–4,949)
Tuno Creek East	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tuno Creek West	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tyler Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Conservation Unit	Current Abundance	Years of Data	Biological Status				Status Metrics			
			Historic Spawners	Stock–Recruitment			Historic Spawners		Stock–Recruitment	
				% Chance of Red Status	% Chance of Amber Status	% Chance of Green Status	Lower Benchmark: 25th percentile	Upper Benchmark: 75th percentile	Lower Benchmark: S_{GEN1} (95% CI)	Upper Benchmark: S_{MSY} (95% CI)
Wale Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wannock (Owikeno)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Watt Bay	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
West Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Yaaklele Lagoon	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Yeo	1,442 (2010–2014)	49	🟨	0%	7%	93%	268	1,600	315 (164–688)	1,026 (760–1,683)

APPENDIX 6

Data Deficient Conservation Units on the Central Coast

TABLE A.3. Data deficient Conservation Units. CUs marked with an asterisk (*) have less than ten years of spawner survey data.

Reason for Data Deficiency	Number of CUs	Conservation Units (by Species)
No run reconstruction	60	**Chum:** Bella Coola River–Late*, Wannock **Sockeye (river-type):** Northern Coastal Fjords, Northern Coastal Stream, Rivers–Smith Inlet* **Sockeye (lake-type):** Banks, Bolton Creek, Bonilla, Borrowman Creek, Busey Creek*, Cartwright Creek*, Chic Chic*, Citeyats, Dallain Creek, Deer, Dome*, Douglas Creek*, Elizabeth*, Elsie/Hoy*, End Hill Creek, Evinrude Inlet, Fannie Cove, Hevenor Inlet, Higgins Lagoon*, Kdelmashan Creek, Kent Inlet Lagoon Creek, Kenzuwash Creeks*, Keswar Kreek, Kildidt Creek*, Kildidt Lagoon Creek*, Kimsquit, Kisameet, Kitkiata, Kunsoot River*, Lewis Creek, Limestone Creek, McDonald Creek, McLoughlin, Monckton Inlet Creek, , Pine River, Powles Creek, Price Creek, , Ryan Creek, Salter*, Scoular/Kilpatrick, Sheneeza Inlet, Ship Point Creek, Soda Creek, Spencer Creek Stannard Creek, Talamoosa Creek, Treneman Creek*, Tuno Creek East, Tuno Creek West, Tyler Creek*, Wale Creek, Wannock (Owikeno), Watt Bay*, West Creek, Yaaklele Lagoon
No data on spawner abundance for the most recent generation	2	**Chinook:** Docee **Sockeye (lake-type):** Mikado

APPENDIX 7

Rules for Defining Zones of Influence

We define three classes of zones of influence (ZOIs) related to specific life stages (rearing, spawning, migration) for each salmon Conservation Unit (CU):

- A **spawning ZOI** represents the area of land that drains into the spawning habitat of a specific salmon CU. Spawning habitat is determined based on known spawning locations.
- A **migration ZOI** represents the area of land that drains into the migration route (the path salmon travel from the Conservation Unit back to the ocean) of a specific salmon CU.
- A **rearing ZOI** represents the area of land that drains into the rearing habitat of a specific salmon CU.

To delineate the ZOIs, we used the Province of British Columbia's 1:20,000 Freshwater Atlas (FWA) Assessment Watersheds dataset (hereinafter called 1:20K FWA assessment watersheds). This geospatial dataset is freely available online through DataBC.[1] The specific rules for defining ZOIs, which vary by species and life-stage, were initially developed by the Skeena Technical Advisory Committee (see Porter et al. 2013a, 2014); however we modified the methods for defining Chinook migration ZOIs to make them relevant for the landscape of the Central Coast. The rules are described below.

Spatial processing to delineate species- and life-history-specific ZOIs was conducted in ArcGIS Desktop 10.5 in combination with Python scripts. The scripts allowed automation of the querying of the FWA hierarchical coding system to identify areas upstream of lake-type sockeye rearing lakes as well as downstream migration routes for lake-type sockeye and Chinook CUs. In some cases, particularly in areas along the coast and on smaller islands, the automated querying method would select some watersheds that did not drain into a lake-type sockeye CU's rearing lake. For this reason, ZOIs for all species were manually reviewed and verified or corrected as needed.

Lake-type Sockeye CU Zones of Influence

Rearing Lake ZOI: For each CU, we identified the principal nursery lake and defined an upstream ZOI by delineating the areas of all 1:20K FWA assessment watersheds present upstream of the lake outlet.

Spawning ZOI: Areas of land influencing mainstem or lake outlet, lake spawning, and tributary or lake inlet spawning sites identified for a lake-type sockeye CU are embedded within the broader area of each CU's rearing lake ZOI. Therefore, we did not delineate a more precisely defined ZOI for the lake-type sockeye spawning life-stage.

Migration ZOI: The migration route for each lake-type sockeye CU was determined by using a connected hydrology network to trace a path from the outlet of each CU's nursery lake to the ocean. All 1:20K FWA assessment watersheds that intersect each CU's migration route within a 1km buffer along the migration route defined a variable-width migration ZOI for each CU. The width of the ZOI (while variable) is substantially larger than the distances typically used by agencies

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[1] https://catalogue.data.gov.bc.ca/dataset/freshwater-atlas-assessment-watersheds

to directly protect stream or river riparian zones. This larger ZOI helped to ensure that we captured the potential effect of upstream watershed activities along the migration corridor, which may have broader, more diffuse impacts than those immediately adjacent to the migration path.

River-type Sockeye CU Zones of Influence

Spawning ZOI: The spawning ZOI for each river-type sockeye CU was delineated by capturing the extent of all 1:20K FWA assessment watersheds that directly intersect with known spawning locations for river sockeye.

Rearing/Migration ZOI: Little is known about the freshwater ecology of river-type sockeye. As such, rearing areas and migration routes for river-type sockeye were not explicitly delineated or differentiated. Rather, a combined rearing/migration ZOI for each river-type sockeye CU was delineated based on the boundaries of the suite of subdrainages[1] in which CU spawning was identified, plus any subdrainages that intersected the migration route from the CU-specific spawning areas downstream to the ocean. Rearing of river-type sockeye CUs may be expected to occur in adjoining watersheds at any point along the migratory route. All 1:20K FWA assessment watersheds embedded with the subdrainage-defined boundary were considered part of the rearing/migration ZOI for our analyses.[2]

Chum CU Zones of Influence

Spawning ZOI: The localized spawning ZOI for each chum CU was delineated by capturing the extent of all 1:20K FWA assessment watersheds that directly intersect with known spawning locations for chum.

Rearing/Migration ZOI: As chum spend limited time post-hatch rearing in freshwater, their rearing and migration areas can be considered essentially the same. We therefore defined a combined rearing/migration ZOI for each chum CU, based on the boundaries of the subdrainage or suite of subdrainages in which chum spawning was identified, plus any subdrainages intersecting the migration route from the CU-specific spawning areas downstream into the ocean. All 1:20K FWA assessment watersheds embedded within the subdrainage-defined boundary are considered part of the rearing/migration ZOI for our analyses.

Chinook CU Zones of Influence

Spawning ZOI: The localized spawning ZOI for each Chinook CU was delineated by capturing the extent of all 1:20K FWA assessment watersheds that directly intersect with the Chinook CU boundaries, irrespective of whether or not spawning location data were present in an assessment watershed.

Rearing/Migration ZOI: The localized rearing/migration ZOI for each Chinook CU was defined based on areas upstream of each CU's outlet(s), plus areas along the migration route from the CU's outlet(s) to the ocean. We defined an upstream ZOI by delineating the areas of all 1:20K FWA assessment watersheds present upstream of the CU outlet. The migration route for each Chinook CU was determined by using a connected hydrology network to trace a path from the outlet(s) of each CU to the ocean. All 1:20K FWA assessment watersheds that intersect each CU's migration route within a 1km buffer along the migration route defined a variable-width migration ZOI for each CU. The width of the ZOI (while variable) is substantially larger than the distances typically used by agencies to directly protect stream or river riparian zones. The significantly larger ZOI

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[1] "Subdrainage" refers to Watershed Atlas 1:50,000 Major Watersheds. This 1:50K Watershed Atlas dataset was used based on its representation of distinct drainage networks known to be relevant for management purposes (pers. comm. Porter 2017). No such equivalent (in these respects) data product exists at the 1:20,000 scale.

[2] The maximum extent of a CU's rearing/migration ZOI was bounded by the extent of the CU (i.e. if a subdrainage extended beyond the boundary of a CU, the subdrainage area outside of the CU boundary was not included in the CU's rearing/migration ZOI).

helped to ensure that we captured the potential effect of upstream watershed activities along the migration corridor that may have broader, more diffuse impacts than those immediately adjacent to the migration path.

This rearing/migration ZOI delineation method differs from the subdrainage-based method used for river-type sockeye, chum, coho and pink. Chinook CUs, like lake-type sockeye CUs, are have a more spatially restricted definition than other species. Using the maximum extent of these CUs would not capture upstream areas of land which may be influencing the CU. Thus, we delineated the Chinook rearing/migration ZOIs following the same method as was used for lake-type sockeye CUs.

Coho CU Zones of Influence

Spawning ZOI: The localized spawning ZOI for each coho CU was delineated by capturing the extent of all 1:20K FWA assessment watersheds that directly intersect with known spawning locations for coho.

Rearing/Migration ZOI: Rearing areas and migration routes for coho are diverse and widespread and were not explicitly delineated or differentiated. Therefore, a combined rearing/migration ZOI for each coho CU was delineated based on the boundaries of the subdrainage or suite of subdrainages in which CU spawning was identified, plus any subdrainages intersecting the migration route from the CU-specific spawning areas downstream into the ocean. Rearing of upriver coho CUs may be expected to occur at any point along this route. All 1:20K FWA assessment watersheds embedded within the subdrainage-defined boundary were considered part of the rearing/migration ZOI for our analyses.[1]

Pink CU Zones of Influence

Spawning ZOI: The localized spawning ZOI for each pink CU was delineated by capturing the extent of all 1:20K FWA assessment watersheds that directly intersect with known spawning locations for pinks.

Rearing/Migration ZOI: As pink salmon spend limited time post-hatch rearing in freshwater, their rearing and migration areas can be considered essentially the same. We therefore defined a combined rearing/migration ZOI for each pink salmon CU based on the boundaries of the subdrainage or suite of subdrainages in which CU spawning was identified, plus any subdrainages intersecting the migration route from the CU-specific spawning areas downstream into the ocean. All 1:20K FWA assessment watersheds embedded within the subdrainage-defined boundary were considered part of the rearing/migration ZOI for our analyses.

Additional Note: Life-Stage-Specific Vulnerabilities

For all species, egg incubation occurs in the same locations as adult spawning (although at a different time of year); therefore, habitat within the spawning ZOIs corresponds to both the spawning and incubation life history stages (i.e. this can be considered as a "spawning/incubation ZOI" although for brevity it is labeled simply as "spawning ZOI"). While the habitats used within a CU's spawning ZOI are identical for these two life-history stages, there may be life-history-stage specific differences in vulnerability to the associated habitat pressures. Conversely, while various rearing and migration habitats are used throughout a CU's broad combined rearing/migration ZOI (for all species excluding lake-type sockeye), the exact locations used by either life-history stage (and the degree of overlap between the two) cannot be determined, therefore associated vulnerabilities to habitat pressures cannot be differentiated between these two life-history stages.

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[1] The maximum extent of a CU's rearing/migration ZOI was bounded by the extent of the CU (i.e. if a subdrainage extended beyond the boundary of a CU, the subdrainage area outside of the CU boundary was not included in the CU's rearing/migration ZOI).

APPENDIX 8

Description of Habitat Pressures Indicators & Their Relevance to Salmon

The following is a description for each indicator, the metric by which it was measured, a rationale for its relevance to salmon habitat, and any limitations associated with the indicator.

Indicator	**Total Land Cover Alteration**
Metric	% watershed area
Description	The percentage of the total watershed area that has been altered from the natural landscape by human activities (a sum of the indicators for forest disturbance, urban land use, agricultural/rural land use, mining development and other smaller types of development).
Rationale	Total land cover alteration captures potential changes in cumulative watershed processes, such as peak hydrologic flows and sediment generation, which can affect downstream spawning and rearing habitats (Poff et al. 2006 as cited in Stalberg et al. 2009).
Limitations	Development of the total land cover alteration dataset requires compiling datasets from several data sources that vary in date and completeness. Most notably, the base input to this indicator is land cover classification data ranging from 1996 to 2005.

Indicator	**Mining Development**
Metric	# of mines
Description	The number of current (active and past producing) coal, mineral or aggregate mine sites within a watershed.
Rationale	Mining development can potentially cause loss of salmon habitat directly through the footprint of the mine site, tailings ponds and other infrastructure, or more indirectly through disruption of stream beds and inputs of fine sediment or other contaminants (Meehan 1991; Nelson et al. 1991; Kondolf 1997).
Limitations	Available data on aggregate mining locations was last updated in 2004. Data on footprints of mine sites (all types) and other detailed information on infrastructure and mining activity is not readily available at the scale of this assessment. Therefore, impacts from mine sites are considered in a simplistic, binary (presence/absence) manner.

Indicator	**Impervious Surfaces**
Metric	% watershed area
Description	the percentage of total watershed area represented by hard, impervious development.

Rationale	Impervious surface is a calculated term that reflects the amount of man-made structures (e.g. paved roads, sidewalks, driveways, buildings, etc.) that are covered by impervious materials (e.g. concrete, asphalt, concrete, brick, etc.). Extensive hard impervious surfaces from urban/rural development in a watershed can alter natural flow patterns and lead to stream degradation, through changes in geomorphology and hydrology, and are also associated with increased loading of nutrients and contaminants in developed areas (Rosenau and Angelo 2009). Although the size of the urban/rural footprint may be smaller relative to other activities (e.g. forestry), the intensity of disturbance is generally regarded as higher; in part, due to the concentration of activities and irreversibility of disturbance associated with the built environment (Schendel et al. 2004; Schindler et al. 2006; Smith et al. 2007; Jokinen et al. 2010 and Paul and Meyer 2001 as cited in Nelitz et al. 2011).
Limitations	Impervious Surface Coefficients (ISCs) for land types used for this analysis were not specific to the Central Coast study area and were instead based on ISCs determined for watersheds in Connecticut (Prisloe et al. 2003), which had higher population densities (>500 but <1800 people per square mile). Therefore, patterns of urban/rural development may be overestimated when applied to the Central Coast.

Indicator	**Linear Development**
Metric	km/km²
Description	The density of all linear developments (roads, utility corridors, pipelines, railways, power lines, telecom infrastructure, right of ways, etc.) within a watershed.
Rationale	Linear development represents a general indicator of level of overall development from a variety of resource activities with associated potential impacts to salmon habitats (WCEL 2011; FLNRO et al. 2012).
Limitations	See Road Development limitations.

Indicator	**Forest Disturbance**
Metric	% watershed area
Description	The percentage of total watershed area that, in the last 60 years, forest has been disturbed. Includes logged areas (clearcut, selectively logged) and recently burned areas.
Rationale	Disturbances to the forest canopy due to logging or other processes can change the hydrology of a watershed by altering interception, transpiration, and snowmelt processes, resulting in potential impacts to salmon habitat through altered peak flows, low flows, and annual water yields (MOF 1995a; Smith and Redding 2012).
Limitations	n/a.

Indicator	**Equivalent Clearcut Area (ECA)**
Metric	% watershed area
Description	The percentage of total watershed area that is considered comparable to a clearcut forest. ECA is a calculated term that reflects the cumulative effect of harvesting and second-growth forest regeneration in terms of its hydrological equivalent as a clearcut.
Rationale	A derived measure of forest disturbance, ECA reflects pressure on salmon habitat principally from potential increases to peak flow (MOF 2001; Smith and Redding 2012).
Limitations	ECA calculation relies on projected tree height data that is not available in all sources of forestry data. Where no tree height data is available, we assume a tree height of 0. Limitations of the Total Land Cover Alteration (TLCA) indicator also apply here, as several TLCA inputs inform the ECA calculation.

Indicator	**Riparian Disturbance**
Metric	% watershed area
Description	The same disturbance sub-components (i.e. urban, mining, agricultural/rural, forest) as used for Total Land Cover Alteration as described above, but captured only within a 30m riparian buffer zone defined around all streams, lakes and wetlands.
Rationale	Disturbances to riparian zones (i.e. land adjacent to the normal high water line in a stream, river, lake, or pond) can affect salmon habitats by destabilizing stream banks, increasing surface erosion and sedimentation, reducing inputs of nutrients and woody debris, and increasing stream temperatures through reduced streamside shading (Meehan 1991; MOF 1995a). These changes have the potential to affect the growth and survival of salmon eggs and juveniles.
Limitations	See Total Land Cover Alteration limitations.

Indicator	**Insect and Disease Defoliation**
Metric	% watershed area
Description	The percentage of pine stands within a watershed that have been killed by insects or disease.
Rationale	While different than forest disturbances caused by logging or fire (as insect damaged forests retain standing timber and understory vegetation), forest defoliation from insects or disease can similarly decrease canopy interception of precipitation and reduce transpiration, resulting in increased soil moisture. This in turn can affect salmon habitats through potential changes to peak flows and groundwater supplies (Uunila et al. 2006; EDI 2008 as cited in Nelitz et al. 2011). Hydrological processes within insect/disease-affected stands are considered to be somewhere between a mature forest and clearcut, with hydrologic recovery taking between 20-60 years (FPB 2007). In addition, salvage harvest of affected

	forests can have the same watershed effects as clear cut logging.
Limitations	The data that informs this indicator is derived from modeled data and 2010 aerial overview surveys.

Indicator	**Road Development**
Metric	km/km²
Description	The average density of all roads within a watershed.
Rationale	Road development can interfere with natural patterns of overland flow through a watershed, interrupt subsurface flow, and increase peak flows (Smith and Redding 2012). Roads are also one of the most significant causes of increased erosion, as road construction exposes large areas of soil to potential erosion by rainwater and snowmelt, while the roads themselves intercept and concentrate surface runoff so that it has more energy to erode even stable soils (MOF 1995a). The eroded fine sediments can be easily delivered to water courses during wet periods, where they can cover salmonid spawning redds, reduce oxygenation of incubating eggs and increase turbidity, which reduces foraging success for juveniles (Meehan 1991).
Limitations	Roads data is sourced from the Digital Road Atlas (DRA) and supplemented with Forest Tenure Road segments that occur outside a 30m buffer on DRA roads. This is a reasonable but imperfect process to create an amalgamated/comprehensive roads dataset to inform this indicator.

Indicator	**Stream Crossing Density**
Metric	#/km
Description	The number of stream crossings per km of the total length of modeled salmon habitat in a watershed (salmon habitat defined based on a gradient criteria filtering of the Fish Passage Model developed by Mount et al. 2011).
Rationale	Stream crossings at roads can (dependent on the type and condition of the crossing structure) create fish passage problems by interfering with or blocking access to upstream habitats that include spawning or rearing areas and reduce the total amount of available salmonid habitat in a watershed (Harper and Quigley 2000; FLNRO et al. 2012). Stream crossings can also influence the efficiency of water delivery to the stream network so that high densities can increase peak flows and become a chronic source of fine sediment delivery to streams (MOF 1995a; Smith and Redding 2012).
Limitations	This indicator is based on modeled data for determining salmon habitat (gradient-based) and presence of stream crossings (modeled at the intersections of roads and streams). Stream crossings have not been confirmed to exist, nor assessed for fish passage.

Indicator	**Permitted Water Licenses**
Metric	# of permitted water licenses
Description	The total number of water licenses permitted for withdrawal of water for a variety of consumptive and non-consumptive uses (e.g. domestic,

	industrial, agriculture, power, and storage) from points of diversion within a watershed. Status of this indicator is evaluated at the scale of within-watersheds for all salmon CUs, while for lake-type sockeye (only) the number of water licenses is also summed across the full extent of all watersheds in the CU migration ZOI (i.e.to capture the possible composite effect of water extraction pressures on mainstem water levels along the mainstem river routes of lake-type sockeye migration).
Rationale	Heavy allocation (and presumed use) of both surface and hydraulically connected subsurface water for human purposes can affect salmonid habitats at critical times of year by reducing instream flows to levels that could constrain physical access to spawning and rearing habitats or potentially dewater redds, while reductions in both surface water and groundwater supplies can increase water temperatures with resultant impacts on all salmonid life stages (Richter et al. 2003 and Hatfield et al. 2003 as cited in Stalberg et al. 2009; Douglas 2006).
Limitations	Water licenses represent only the amount of water allocated through provincial permitting processes, not actual use (i.e.monitoring of water use and compliance with water license conditions does not generally occur). Additionally, information describing water licenses (long term use) does not account for water allocated through temporary water permits (short term use), which is a regulatory tool used in the oil and gas sector and is currently difficult to track.

Indicator	**Permitted Wastewater Discharges**
Metric	# of permitted wastewater discharges
Description	The number of permitted wastewater management discharge sites within a watershed.
Rationale	High levels of wastewater discharge from municipal and industrial sources can impact the water quality of salmonid habitats either through excessive nutrient enrichment or chemical contamination. Some industrial waste products can directly injure or kill aquatic life even at low concentrations (US EPA 2008). While excessive nutrient levels (eutrophication) can result in depletion of the dissolved oxygen in streams and lakes, starving fish and other aquatic life (Zheng and Paul 2007).
Limitations	The provincial dataset available to support this indicator only identifies the number of permitted discharge sites. However, the actual risks and impacts to salmon habitat are determined by the respective volumes and nature of the actual discharges, not simply the number of discharge points, and those supporting elements are not captured within this analysis.

APPENDIX 9

Habitat Pressure Datasets & Data Sources

TABLE A.4. Habitat pressure datasets, data sources and dataset publication years.

Dataset Name	Source	Publication Year
Harvested Areas of BC (consolidated cutblocks)	DataBC	2015
Digital Road Atlas (DRA)	DataBC	2017
Forest Tenure Road Segments (FTEN)	DataBC	2017
BC MOE Fish Passage Habitat Model	BC MOECCS	2017
BC Freshwater Atlas Stream Network	DataBC	2016
BC Freshwater Atlas River Polygons	DataBC	2016
Vegetation Resources Inventory (VRI)	DataBC	2016
BC Freshwater Atlas Lake Polygons	DataBC	2016
BC Freshwater Atlas Wetland Polygons	DataBC	2016
BC Freshwater Atlas Assessment Watershed Polygons	DataBC	2016
BC Freshwater Atlas Watershed Groups Polygons	DataBC	2016
BC Watershed Atlas Major Watershed Polygons	DataBC	2011
BC Points of Diversion (POD) with Water License Information	DataBC	2017
MOE Wastewater Discharge and Permits Database	BC MOECCS	2016
Landcover circa 2000 (agriculture, urban)	Geogratis	2000
Forest Tenure Cutblocks	DataBC	2016
Reporting Silviculture Updates and Land Status Tracking System (RESULTS)	DataBC	2017
Crown Tenures (Utility Corridors and Rights of Ways)	DataBC	2017
Historical Fire Perimeters	DataBC	2017
Current Fire Perimeters	DataBC	2017
Base Thematic Mapping (mining polygons)	DataBC	1992

Dataset Name	Source	Publication Year
CanVec Railways	Geogratis	1998
CanVec Power Lines	Geogratis	1998
CanVec Trails	Geogratis	1998
OGC Pipeline Rights-of-Way	DataBC	2017
Pipelines: Prince Rupert Gas Transmission Project (proposed)	Chartwell Consultants Ltd.	2016
Pipelines: Pacific Northern Gas Looping Project (proposed)	Johanna Pfalz (Eclipse GIS)	2014
Pipelines: Pacific Trails Pipeline (proposed)	Johanna Pfalz (Eclipse GIS)	2014
Pipelines: West Coast Connector Gas Transmission Project (proposed)	Chartwell Consultants Ltd.	2016
Pipelines: Coastal GasLink Pipeline (proposed)	Johanna Pfalz (Eclipse GIS)	2014
Pipelines: Pacific Northern Gas (existing)	Johanna Pfalz (Eclipse GIS)	2014
Aggregate mining inventory	BC EMPR	2004
Coal and Mineral Mines (Minifile)	BC EMPR	2017
Placer Tenures	DataBC	2016
Historical Fish Distribution Zones (FISS)	DataBC	2001
Spawning Distribution (local experts)	Central Coast Technical Advisory Committee	2016
Spawning Distribution (stream survey reports)	Raincoast Conservation Foundation for the Heiltsuk Nation	2016
Stream Survey Locations (NuSEDs)	DFO	2014
Timber Harvesting Land Base	BC FLNRORD	2017
Crown Tenures (Wind and Water Power)	DataBC	2017
Proposed Transmission Lines	BC Hydro	2014
Known BC Fish Observations and BC Fish Distributions (FISS)	DataBC	2016
Conservation Unit Boundaries	DFO	2008

APPENDIX 10

Spatial Data Processing for Habitat Pressure Indicators

Impact Category: Hydrologic Processes

Indicator	**Forest disturbance**
Units	% of watershed
Definition	The percentage of total watershed area that, in the last 60 years, has been clearcut, selectively logged, or burned.
Data Source	DataBC
Dataset(s)	▸ Harvested Areas of BC (Consolidated Cutblocks)
Processing	Forestry polygons were overlaid with the watersheds layer, and total forested area per watershed was calculated.
Notes	Forestry polygons were prepared as part of the total landcover alteration indicator. See total landcover alteration indicator for processing details.

Indicator	**Equivalent Clearcut Area (ECA)**
Units	% of watershed
Definition	The percentage of total watershed area that is considered functionally and hydrologically equivalent to a clearcut forest.
Data Source	BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development
Dataset(s)	▸ Parameters for the ECA calculation (proportion of opening covered by functional regeneration and recovery factor determined by projected canopy height)

Data Source See total land cover alteration indicator for data sources.

Dataset(s)

- Urban, road, rail, utility and forestry polygons

Processing All urban, road, rail and utility polygons were merged and dissolved into one single ‘alienated’ layer and overlaid with the watersheds layer. Forestry polygons were combined (union process) with the alienated layer.

The growth recovery of each forested/alienated polygon was calculated using the following equation:

$$ECA = A \times C (1 - R/100)$$

where A is the original polygon area, C is the proportion of the opening covered by functional regeneration (determined from Table A2.1, MOF 2001), and R is the recovery factor determined by the VRI projected height (PROJ_HEIGHT_1) and Table A2.2 (MOF 2001). For developed polygons, there is no functional regeneration or recovery factor, so for these polygons C will be equal to 1 and R will be equal to 0. Forestry polygons with no tree height information were assumed to have a height of 0 m.

All ECA values were summed for each watershed and divided by the total watershed area to give an ECA percentage.

Notes This indicator is partially derived from the total land cover alteration dataset. See total landcover alteration indicator for processing details to prepare the urban, road, rail, utility and forestry polygons.

An update to MOF’s ECA protocol is currently in draft, but was not applied to the Central Coast analysis.

Impact Category: Surface Erosion

Indicator **Road development**

Units km/km^2

Definition The average density of all roads in each watershed.

Data Source DataBC

Dataset(s)

- Digital Road Atlas (DRA) – Master Partially-Attributed Roads
- Forest Tenure Road Segments (FTEN)

Processing	Roads were clipped using the watershed layer. FTEN road segments that do not appear in the DRA were extracted from FTEN by applying a 30 m buffer to DRA roads and selecting all FTEN roads outside of this buffer. The extracted FTEN roads were merged with the original DRA roads to produce a single comprehensive road layer. The road data was overlaid (identity process) with the watersheds. Road length was summarized by watershed and divided by watershed area to calculate road density per watershed (km/km²).
Notes	DRA and FTEN roads contain representations of the same roads but do not have identical geometries. The process of buffering the DRA to identify additional FTEN roads that do not appear in the DRA was a solution to produce a single road layer with minimal duplication of roads. However, the resulting road layer is not a topologically correct road network and should not be used as one.

Impact Category: Fish Passage/ Habitat Connectivity

Indicator	**Stream crossing density**
Units	# crossings/ km of salmon accessible stream
Definition	The number of stream crossings per kilometer of defined fish habitat in each watershed.
Data Source	BC Ministry of Environment and Climate Change Strategy
Dataset(s)	▸ BC MOE Fish Habitat Model *fish_habitat IN ('FISH HABITAT - INFERRED - 000-100PCT', 'FISH HABITAT - INFERRED - 100-150PCT', 'FISH HABITAT - OBSERVED - 000-100PCT', 'FISH HABITAT - OBSERVED - 100-150PCT')*
Processing	Fish habitat arcs and stream crossing points classified as 15% or less gradient were overlaid with the watersheds layer. Inferred and observed fish habitat was merged into a single ‘fish habitat’ group. A total number of fish habitat crossings per total length of fish habitat was calculated for each watershed.
Notes	Note the fish habitat and stream crossings are based on modeled data. For more information on the accessible stream length input data contact Craig Mount at the BC Ministry of Environment and Climate Change Strategy.

Impact Category: Vegetation Quality

Indicator	**Insect and disease defoliation**
Units	% forest stands killed
Definition	The percentage of pine forest stands in each watershed that have been killed by recent insect invasion or disease.
Data Source	DataBC
Dataset(s)	▸ Vegetation Resources Inventory (VRI): *DEAD_STAND_VOLUME_125, DEAD_STAND_VOLUME_175, DEAD_STAND_VOLUME_225, LIVE_STAND_VOLUME_125, LIVE_STAND_VOLUME_175, LIVE_STAND_VOLUME_225*
Processing	VRI were overlaid (identity process) with the watersheds layer. VRI polygons' dead and live stand volumes were summarized by watershed, using the maximum value in the 3 dead/live volume utility levels for each stand. Percentage of stand killed was calculated as (sum of dead stand volume) / (sum of dead stand volume + sum of live stand volume).
Notes	Conversion of live standing volume to dead volume in the VRI follow predictions made using the provincial MPB model and the 2010 aerial overview surveys.

Indicator	**Riparian disturbance**
Units	% of riparian zone
Definition	The percentage of the riparian zone in each watershed that has been altered by land use activities.
Data Source	DataBC
Dataset(s)	▸ Freshwater Atlas: stream network, lakes, wetlands: Streams – *FEATURE_CODE IN ('GA24850000', 'GA24850140','GA24850150)* Stream ditches & canals – *FEATURE_CODE IN ('GA08800110','GA0395000')* Rivers – *FEATURE_CODE = 'GA24850000'* Lakes – *"WATERBODY_TYPE" = 'L'* Wetlands – *"WATERBODY_TYPE" = 'W'* ▸ Total Land Cover Alteration restricted to riparian zone

Processing A layer representing the riparian zone (30 m buffer around streams and water bodies) for the study area was created.

Stream Features were buffered by 30 m (only ditch and canal features that intersected the streams were buffered (i.e. isolated ditches and canals were not buffered)). An overlay (identity process) was performed using the buffered stream features and the watershed layer. The resulting layer was dissolved by watershed ID.

Lake and wetland features were merged into one layer and buffered by 30 m (lakes and wetlands isolated from the stream network were not buffered). Buffer features resulting from 'islands' or 'donuts' in the water bodies were removed.

Prior to buffering lakes and wetlands, all features in those layers coincident with stream arcs FTRCD WA24111170 (isolated water bodies) were selected and extracted. The extracted isolated water bodies were overlaid with the stream network. Those features intersecting the streams were selected and added to the water body layer for buffering (this was done in case a water body had erroneously been tagged as 'isolated').

An overlay (identity process) was performed using the buffered water body features and the watershed layer. The resulting layer was dissolved by watershed ID.

River features were buffered by 30 m. As with water bodies, buffer features created around 'islands' or 'donuts' in the river polygon layer were removed. An overlay (identity process) was performed using the buffered river features and the watershed layer. The resulting layer was dissolved by watershed ID.

The buffer layers for streams, water bodies and rivers were merged into one layer and dissolved by watershed ID.

The resulting layer was overlaid (identity process) with the total land cover alteration layer.

Riparian disturbance was summarized by area (hectares) and percentage of total riparian area per watershed.

Notes This indicator is derived from the total land cover alteration indicator/dataset. See total landcover alteration for processing details.

Impact Category: Water Quantity

Indicator **Licensed water use permits**

Units # of water licenses

Definition The total number of provincially permitted water licenses for withdrawal of water from streams for a variety of non-consumptive uses (i.e. industrial, agriculture, power, and storage).

Data Source DataBC

Dataset(s)
- BC Points of Diversion with Water License Information

  LIC_STATUS = 'CURRENT'

Processing POD features were clipped using watersheds. Only current licenses were used. The clipped point data were overlaid with watersheds (identity process). The total number of POD locations was summarized by watershed. Licenses were also categorized into the following classes: power, domestic, agriculture, industrial, or storage using the PURPOSE attribute.

Impact Category: Water Quality

Indicator **Permitted wastewater discharges**

Units # of discharges

Definition The total number of permitted wastewater management discharge sites within each watershed.

Data Source BC Ministry of Environment and Climate Change Strategy

Dataset(s)
- Wastewater Discharge and Permits database

  STATUS = 'Active' and DischargeT = 'effluent'

Processing Active effluent wastewater discharge locations (converted to spatial point features) were overlaid with the watersheds layer. The total number of discharge locations was summarized by watershed.

Notes Type of discharge and amount are not currently tracked or incorporated into the analysis.

Impact Category: Human Development Footprint

Indicator **Total land cover alteration**

Units % of watershed

Definition The percentage of total watershed area that has been altered from the natural landscape by human activities.

Data Source DataBC

Dataset(s)

- Harvested Areas of BC (Consolidated Cutblocks)

  "DSTRBSTDT" >= '19570101000000'

- Vegetation Resources Inventory (VRI)

  Urban – *BCLCS_LEVEL_5 IN ('RZ', 'RN', 'UR', 'AP')*

  Fire – *BCLCS_LEVEL_5 IN ('BU') OR EARLIEST_NONLOGGING_DIST_TYPE = 'B'*

  Mining – *BCLCS_LEVEL_5 IN ('GP', 'TZ', 'MI')*

- Digital Road Atlas (DRA)

  Highways – *TRANSPORT_LINE_TYPE_CODE IN ('RH1','RH2', 'RF')*

  Non-highways – *TRANSPORT_LINE_TYPE_CODE NOT IN ('RH1' ,'RH2', 'RF')*

- Forest Tenure Road Segments (FTEN)
- Crown Tenures (Utility Corridors and Rights of Ways)

  "TNRPRPS" = 'UTILITY'

- Historical Fire Perimeters

  "FIRE_YEAR" >=1993

- Current Fire Perimeters
- Base Thematic Mapping

  "PLU_LABEL" = 'Mining'

Data Source Geogratis

Dataset(s)

- Landcover Circa 2000

  Agriculture – *COVTYPE IN (120,121,122)*

  Urban – *COVTYPE = 34*

- CanVec

  Railway – *track_segment_1*

Processing Agriculture land cover was extracted from the LCC2000-V.

Urban land cover was extracted from the LCC2000-V and merged with urban polygons extracted from the VRI.

Forestry polygons were extracted from the Consolidated Cutblocks layer. Areas where logging had occurred greater than 60 years ago were not considered.

The linear road features from the road development indicator were buffered by their corresponding road width, calculated as (number of lanes) × (8 m for freeways/highways or 5 m for everything else). Where the number of lanes attribute was not known (i.e. FTEN roads), the road was assumed to be 1 lane.

Rail linear features were buffered by 4 m per track.

Agriculture, urban, forestry, road, and rail polygons were merged with the crown tenure utility corridor/ROW polygons, fire polygons (areas burnt within the last 25 years), and mining area polygons. The resulting land cover layer was planarized; where different land cover class polygons overlapped, the following priority order was used to determine the land cover class of the overlapping area (highest priority first): road, rail, utility, forestry, urban, mine, fire, agriculture.

The final land cover class layer was overlaid with the watersheds. Total altered land area for any watershed is a sum of all land cover polygons in that watershed.

Notes Road datasets may have incomplete coverage in the study area.

Some of the datasets that are used to produce the total land cover alteration indicator/dataset are outdated: mining polygons from the base thematic mapping product (early 1990s), agriculture and urban polygons from Landcover circa 2000, railways from CanVec (1998).

Indicator **Linear development**

Units km/km²

Definition The density of all linear development (e.g. roads, pipelines, power lines, trails, railways) within each watershed.

Data Source DataBC

Dataset(s)
- Digital Road Atlas (DRA)
- Forest Tenure Road Segments (FTEN)

Data Source Geogratis

Dataset(s)
- ▸ CanVec

  Track_segment_1, trail_1, power_line_1

Data Source Eclipse GIS

Dataset(s)
- ▸ Pacific Northern Gas Existing Line

Processing Roads, pipelines, power lines, trails and railway lines were combined into one linear feature layer. The linear features were overlaid with the watersheds layer and the sum of line length was calculated for each watershed. This length was then divided by the total watershed area to give a linear feature density (km/km²) for each watershed.

Notes Road datasets may have incomplete coverage in the study area.

The power line, trail and railway data from the CanVec dataset is outdated (1998) and may not represent the best available data.

Indicator **Mining development**

Units # of mines

Definition The total number of mines (total of coal, mineral, and aggregate mines, as well as placer tenures) within each watershed.

Data Source BC Ministry of Energy, Mines and Petroleum Resources

Dataset(s)
- ▸ Aggregate Inventory
- ▸ MINFILE

  “STATUS_D” IN (‘Producer’, ‘Past Producer’)

Data Source DataBC

Dataset(s)
- ▸ Placer tenures

  "TNRTPDSCRP" = 'Placer'

Processing Past producing and producing mineral and coal mines were extracted from MINFILE and combined with aggregate mines. Placer mine tenure polygons were converted to point features (center point), with one point per unique placer mine. These mine point locations were then overlaid with the watersheds layer and the total number of mines calculated for each watershed.

Notes Aggregate mining data is outdated (2004) and may not represent the best available data.

Indicator **Impervious surface (urban & agricultural/ rural development)**

Units % of watershed

Definition The total watershed area represented by hard impervious surfaces (e.g. sidewalk, paved roads, buildings etc.).

Data Source DataBC

Dataset(s)
- Vegetation Resources Inventory (VRI)
- Digital Road Atlas (DRA)
- Forest Tenure Road Segments (FTEN)

Data Source Geogratis

Dataset(s)
- CanVec
- Landcover Circa 2000 (agriculture, urban)

Processing Urban, road, rail, and agriculture polygons were combined (union process) and overlaid with the watersheds layer.

An impervious surface coefficient (ISC) attribute was added to each polygon, representing the proportional area of that land cover that can be considered impervious. ISC values were calculated using the average ISC for land cover categories defined by Prisloe et al. 2003, for medium population density areas (>= 500 but < 1800 people per square mile).

The following ISC values were applied to the area of each polygon: urban 0.19878, agriculture 0.0719, roads 1.0, rail 1.0.

All ISC adjusted polygon areas were then summed to give the total impervious surface area for each watershed.

Notes The railway data from the CanVec dataset (1998) and the agriculture and urban polygons from Landcover circa 2000 are outdated and may not represent the best available data.

APPENDIX 11

Spatial Data Processing for Future Pressures

Existing Oil and Gas Pipelines – Pipeline routes were provided by Johanna Pfalz at Eclipse GIS (see Pfalz 2014). Routes were updated in 2016 based on project descriptions and maps accessed through the BC Environmental Assessment Office. Digitized data can be inaccurate and the locations of digitized features should be viewed as more illustrative than definitive.

Existing Mining Development – Coal and mineral mine locations were obtained from the BC Ministry of Energy and Mines MINFILE shapefile. All "producer" and "past producer" mines were selected from the source dataset. The locations of aggregate mines were obtained from the BC Ministry of Energy, Mines and Petroleum Resources aggregate file; coordinates in the file were used to generate spatial point data. Information on placer mine tenures was obtained from the BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (via DataBC); polygons were converted to point features with one point per unique placer tenure.

Existing Water Licenses – Information on water licenses was obtained from the BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (via DataBC). All "current" licenses were selected from the source dataset and categorized into the following class types: power, agriculture, industrial, storage, or residential. Residential licenses were removed from the dataset and, for the remaining classes, the names of individual licensees were changed to a generic descriptor.

Existing Hydroelectric Power Lines – No existing hydroelectric power lines from the National Topographic System 1:250,000 scale transmission line data that intersected the Central Coast study area.

Existing Hydroelectric Power Tenures – The locations of Crown land water power tenures were obtained from the BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (via DataBC). The source dataset was filtered to include only "waterpower" projects in the "tenure" rather than "application" stage.

Existing Wind Power Tenures – The locations of Crown land wind power tenures were obtained from the BC Ministry of Forests, Lands, Natural Resources Operations and Rural Development (via DataBC). The source dataset was filtered to include only "windpower" projects in the "tenure" rather than "application" stage.

Proposed Oil and Gas Pipelines – The spatial data in this category was obtained from three sources. The proposed routes for the Coastal GasLink Pipeline, the Pacific Northern Gas Looping project, and the Pacific Trails pipeline were provided by Johanna Pfalz at Eclipse GIS (see Pfalz 2014). The routes were updated in 2016 based on information and maps accessed through the BC Environmental Assessment Office (BC EAO). Because digitized data can be inaccurate, the digitized pipelines are meant to be illustrative and do not represent the exact locations of this infrastructure.

Proposed Mining Development – Coal and mineral mine locations were obtained from the BC Ministry of Energy, Mines and Petroleum Resources MINFILE shapefile. Only mineral occurrences listed as “developed prospect” are shown.

Proposed Water Licenses – Information on water licenses was obtained from the BC Ministry of Forests, Lands, Natural Resources Operations and Rural Development (via DataBC). All “active” and “pending” applications for licenses were selected from the source dataset. Licenses were categorized into the following class types: power, agriculture, industrial, storage or residential. Residential licenses were then removed from the dataset and, for the remaining classes, the names of individual licensees were changed to a generic descriptor.

Proposed Hydroelectric Power Lines – Only one major transmission line is proposed in BC: BC Hydro’s Terrace to Kitimat Transmission Project (TKTP). The route was digitized from a PDF map available on BC Hydro’s website.[1] Digitized data can be inaccurate and the locations of digitized features should be viewed as more illustrative than definitive.

Proposed Wind Power Tenures – The locations of proposed Crown land wind power tenures were obtained from the BC Ministry of Forests, Lands, Natural Resources Operations and Rural Development (via DataBC). The source dataset was filtered to include only "windpower" projects in the "application" rather than “tenure” stage.

Timber Harvesting Landbase – The Timber Harvesting Landbase (THLB) dataset was obtained from the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD). This dataset includes only timber supply area (TSA) lands. Some Tree Farm License (TFL) THLB data may exist but is not considered current (the most up to date data for TFLs can only be obtained with licensee permission).

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[1] https://www.bchydro.com/energy-in-bc/operations/transmission/transmission-system/maps.html

APPENDIX 12

Identifying Outliers for Habitat Assessment Indicator Values

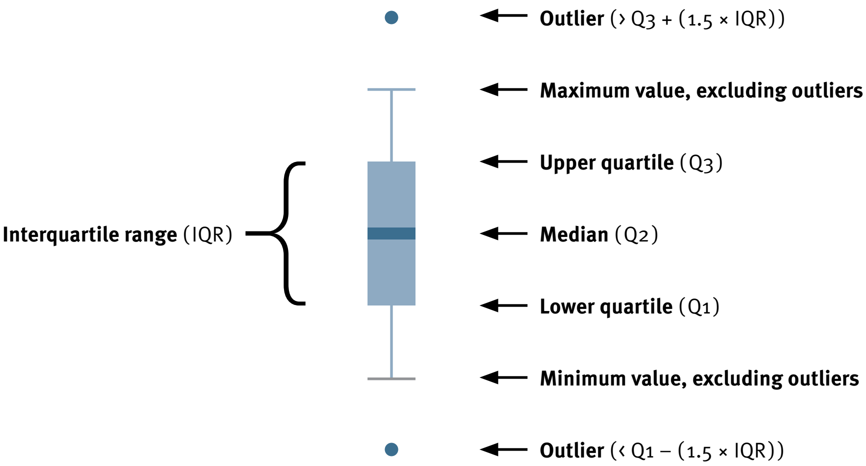


FIGURE A.9. Key to interpreting a "box plot" used for assigning a relative risk score to a habitat pressure indicator value. The plot includes a box indicating the inner 50th percentile of the data, whiskers showing the robust data range, outliers, and median. The top and bottom of the box are the 25th (Q1) and 75th (Q3) percentiles. The size of the box is called the interquartile range (IQR) and is defined as IQR = Q3 – Q1. The whiskers extend to the most extreme data points which are not considered outliers. The horizontal line inside the box represents the median (50th percentile, Q2). Data that fall outside the IQR box by a specific amount are considered "outliers." Outliers are values greater than 1.5 × IQR outside of the IQR. (Modified from Porter et al. 2016)

APPENDIX 13

Roll-up Rules for Salmon Habitat Assessments

TABLE A.5. 1st level roll-up rule set (within impact categories) and Method A 2nd level roll-up rule set (across impact categories) for developing cumulative habitat risk ratings for watersheds within Central Coast salmon Conservation Unit zones of influence (ZOIs) (rearing lake ZOIs for lake-type sockeye CUs and spawning ZOIs for all other salmon species CUs).

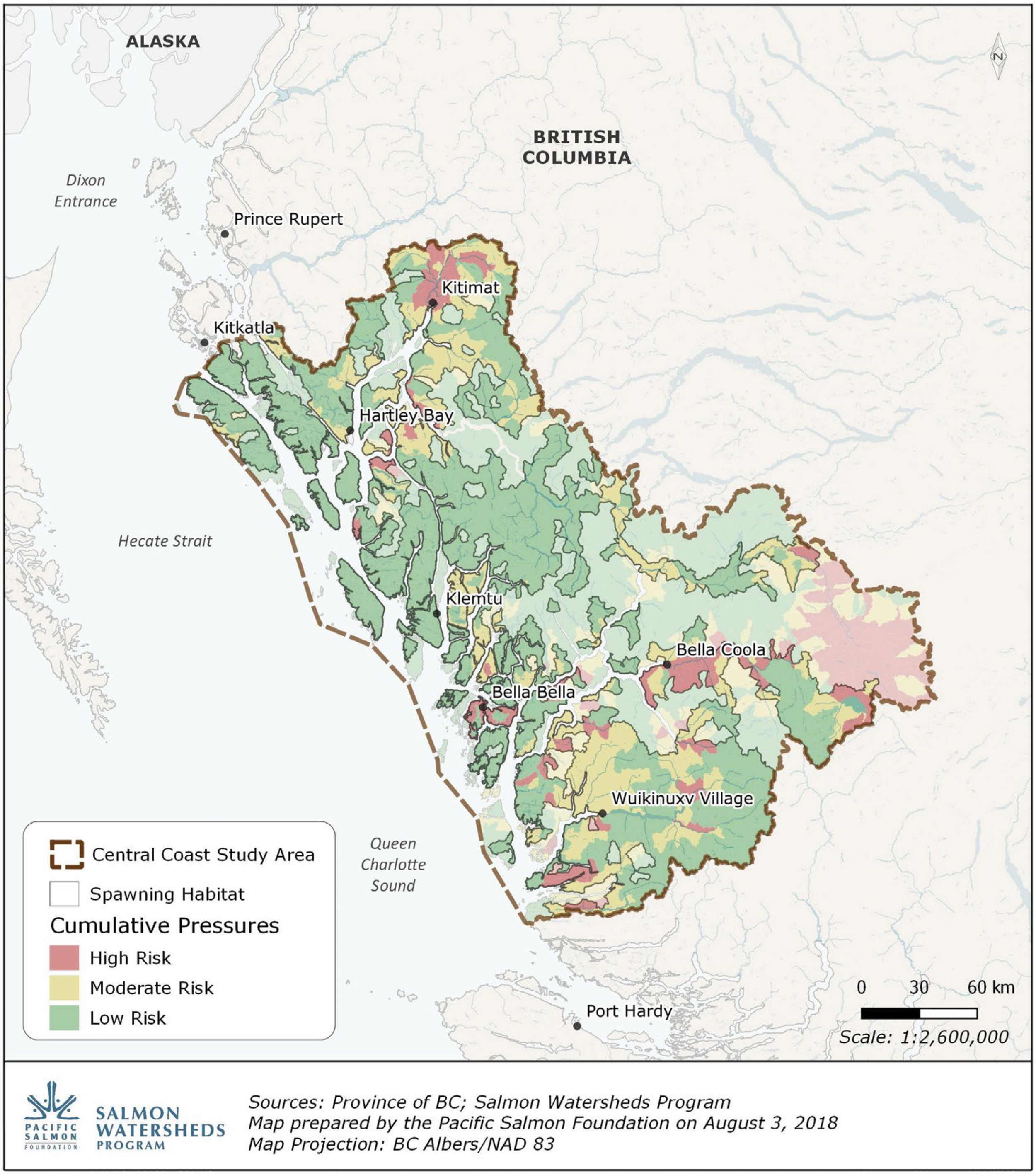
Impact Category	Indicator	1st Level Roll-Up Rule	2nd Level Roll-Up Rule (Method A)
hydrologic processes	Equivalent Clearcut Area	if ≥ 1 indicator rated red then impact category rated red, if 2 indicators rated green then impact category rated green, else impact category rated amber	If ≥ 3 impact categories are rated red then the cumulative risk rating is **red (high risk)**. If ≥ 5 impact categories are rated green then the cumulative risk rating is **green (low risk)**. For all other cases (< 5 impact categories are green or < 3 impact categories are red) the cumulative risk rating is **amber (moderate risk)**.
	forest disturbance		
surface erosion	road density	if the indicator rated green then impact category rated green, if the indicator rated amber then impact category rated amber, if the indicator rated red then impact category rated red	
fish passage and habitat connectivity	stream crossing density in fish habitat	if the indicator rated green then impact category rated green, if the indicator rated amber then impact category rated amber, if the indicator rated red then impact category rated red	
vegetation quality	riparian disturbance	if ≥ 1 indicator rated red then impact category rated red, if 2 indicators rated green then impact category rated green, else impact category rated amber	
	insect defoliation		
water quantity	water licenses	if the indicator rated red then impact category rated red, else impact category rated green	
water quality	permitted wastewater discharges	if the indicator rated red then impact category rated red, else impact category rated green	
human development footprint	total land cover alteration	if ≥ 2 indicators rated red then impact category rated red, if ≥ 3 indicators rated green then impact category rated green, else impact category rated amber	
	impervious surfaces		
	linear development		
	mines (general)		

TABLE A.6. Method B 2nd level roll-up rule set (across impact categories) for developing cumulative habitat risk ratings for watersheds within Central Coast salmon Conservation Unit zones of influence (ZOIs) (the migration ZOI for lake-type sockeye CUs and the rearing/migration ZOI for all other species).

Impact Category	Indicator	1st Level Roll-Up Rule	2nd Level Roll-Up Rule (Method B)
hydrologic processes	Equivalent Clearcut Area	🟥	2
	forest disturbance		
surface erosion	road density	🟥	2
fish passage and habitat connectivity	stream crossing density in fish habitat	🟥	2
vegetation quality	riparian disturbance	🟨	1
	insect defoliation		
water quantity	water licenses	🟩	0
water quality	permitted wastewater discharges	🟩	0
human development footprint	total land cover alteration	🟨	1
	impervious surfaces		
	linear development		
	mines (general)		
Final cumulative habitat pressure score for this example:			**8**

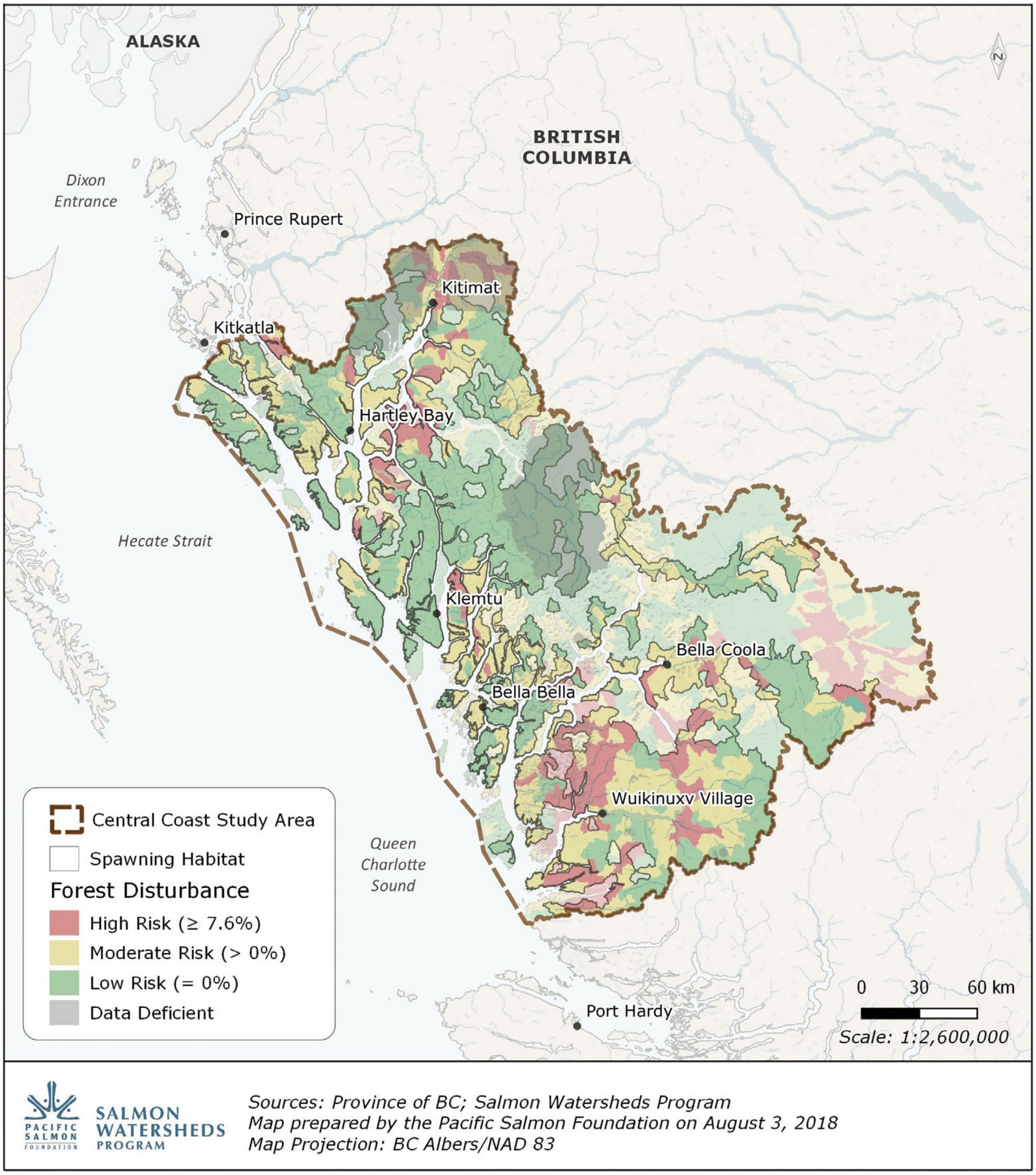
APPENDIX 14

Region Maps for Each Habitat Indicator



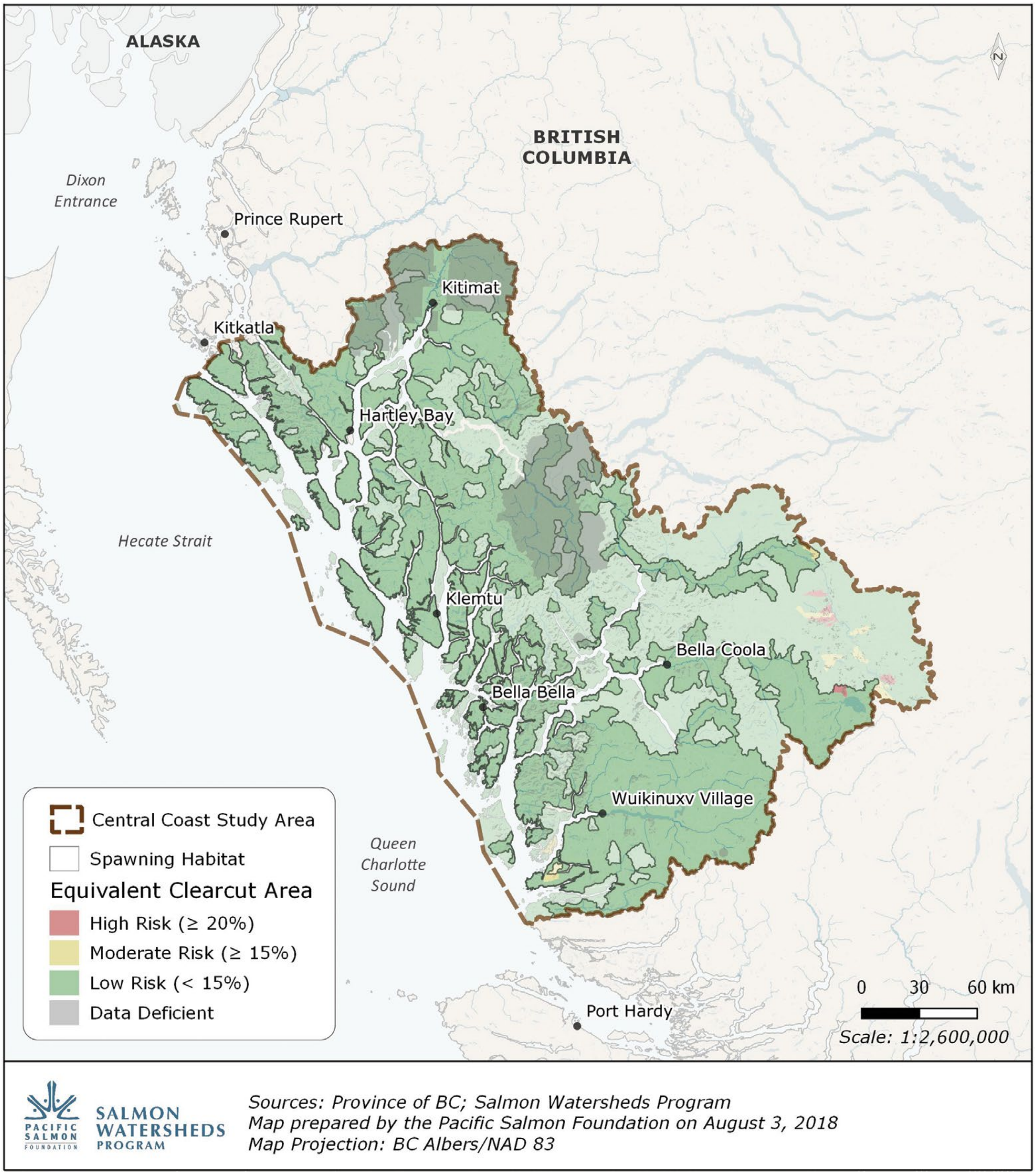
Sources: Province of BC; Salmon Watersheds Program
Map prepared by the Pacific Salmon Foundation on August 3, 2018
Map Projection: BC Albers/NAD 83

FIGURE A.10. **Cumulative Pressures** — This map shows the cumulative risk of degradation posed to salmon spawning habitats from both human and environmental pressures in the Central Coast region. These pressures are the human activities and natural factors that have the potential to cause physical and ecological changes to salmon habitats by altering hydrological processes, water quality and quantity, surface erosion, fish passage, and habitat availability.



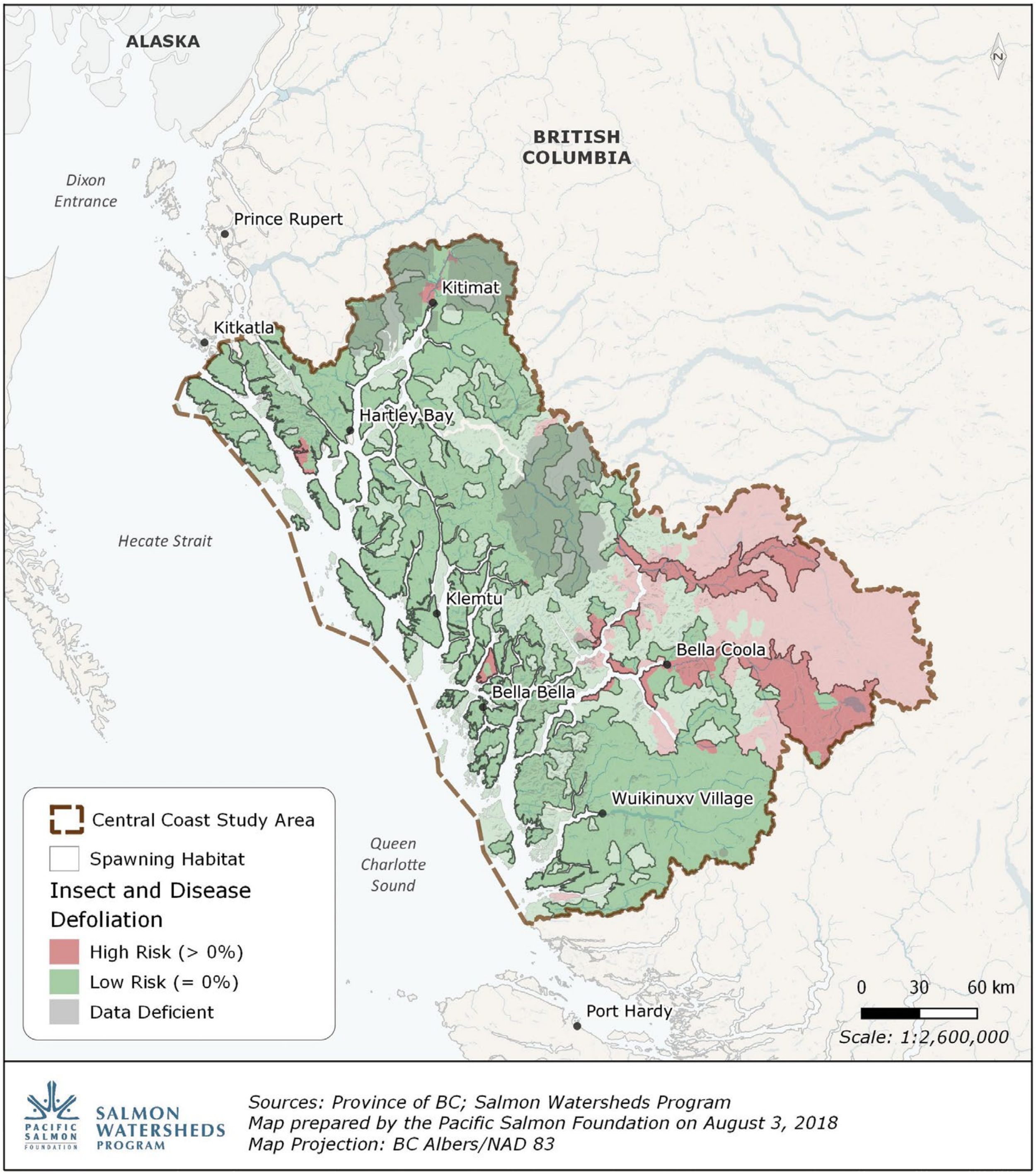
Sources: Province of BC; Salmon Watersheds Program
Map prepared by the Pacific Salmon Foundation on August 3, 2018
Map Projection: BC Albers/NAD 83

FIGURE A.11. **Forest Disturbance** — This map shows risk to Central Coast salmon spawning habitat from forest disturbance, measured as the percentage of each 1:20,000 Freshwater Atlas (FWA) Assessment Watershed that has been recently logged, selectively logged, or recently burned. Disturbances to the forest canopy due to logging or burning can change the hydrology of a watershed by altering interception, transpiration, and snowmelt processes. Changes over time can affect salmon habitat through altered peak flows, low flows, and annual water yields.



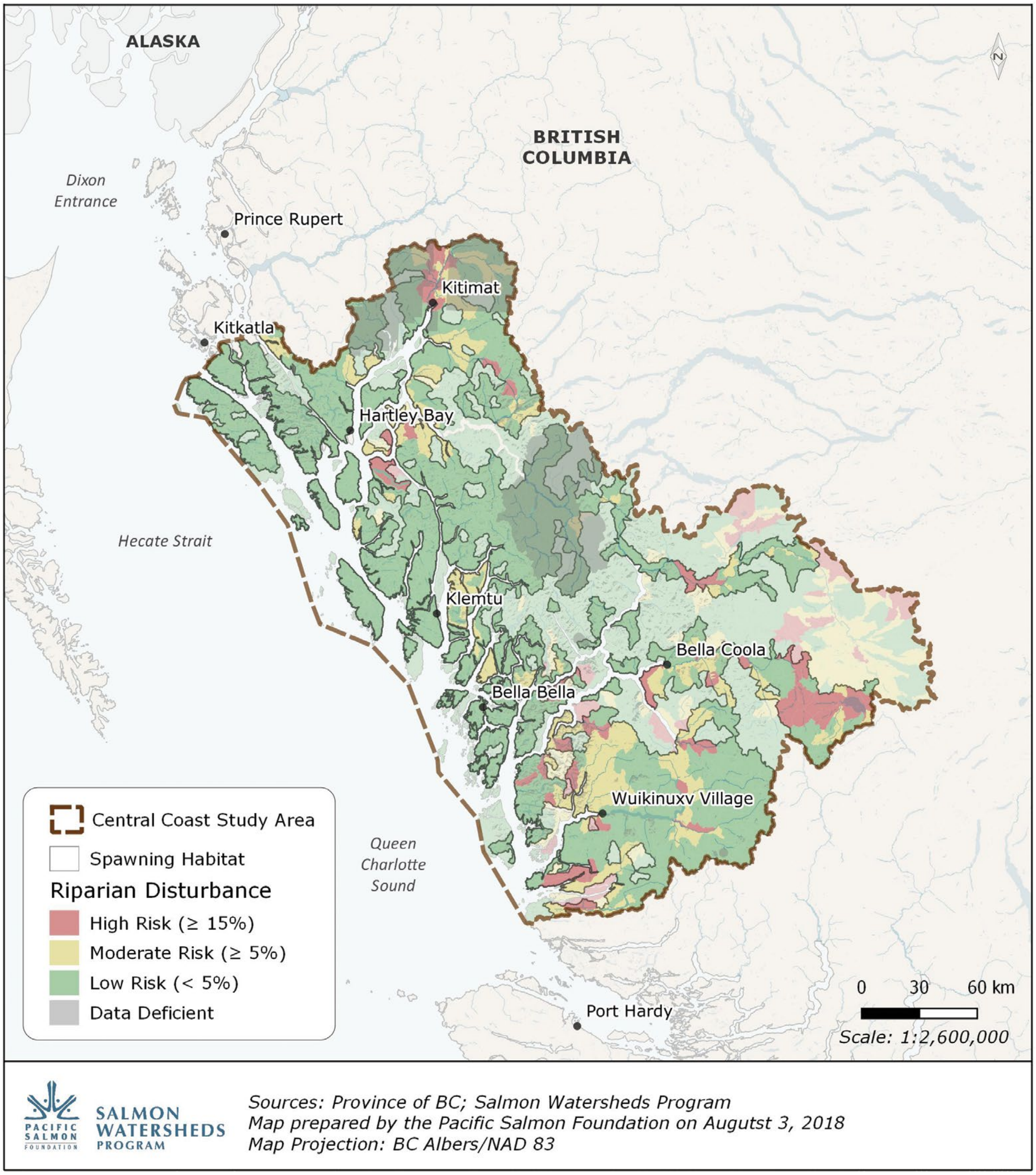
Sources: Province of BC; Salmon Watersheds Program
Map prepared by the Pacific Salmon Foundation on August 3, 2018
Map Projection: BC Albers/NAD 83

FIGURE A.12. **Equivalent Clearcut Area** — This map shows risk to Central Coast salmon spawning habitat from cleared land or land alteration that mimics the functional and hydrological impacts of a clearcut forest. Equivalent clearcut area (ECA) is measured as the percentage of each 1:20,000 Freshwater Atlas (FWA) Assessment Watershed that is considered functionally and hydrologically equivalent to a clearcut forest. ECA reflects the potential cumulative impact on fish habitats of harvesting and second-growth forest regeneration effects on peak flow.



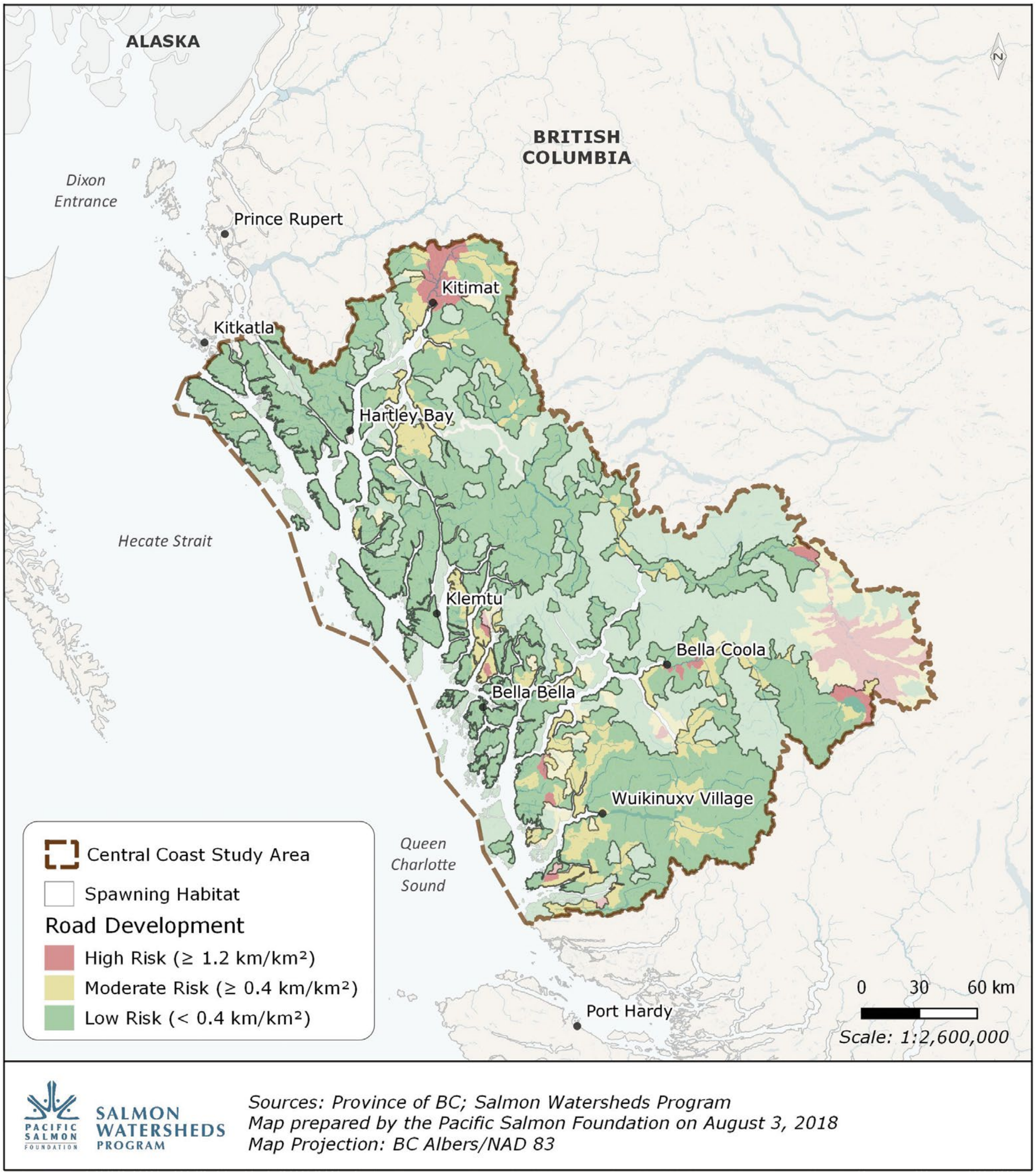
Sources: Province of BC; Salmon Watersheds Program
Map prepared by the Pacific Salmon Foundation on August 3, 2018
Map Projection: BC Albers/NAD 83

FIGURE A.13. **Insect and Disease Defoliation** — This map shows risk to Central Coast salmon spawning habitat from insect and disease defoliation. Insect and disease defoliation is measured as the percentage of pine forest stands in each 1:20,000 Freshwater Atlas (FWA) Assessment Watershed that has been killed by recent insect invasion or disease. While different than forest disturbances caused by logging or fire (as insect damaged forests retain standing timber and understory vegetation), forest defoliation from insects or disease can similarly impact salmon habitats through changes to flows and groundwater supplies due to altered precipitation interception and reduced transpiration.



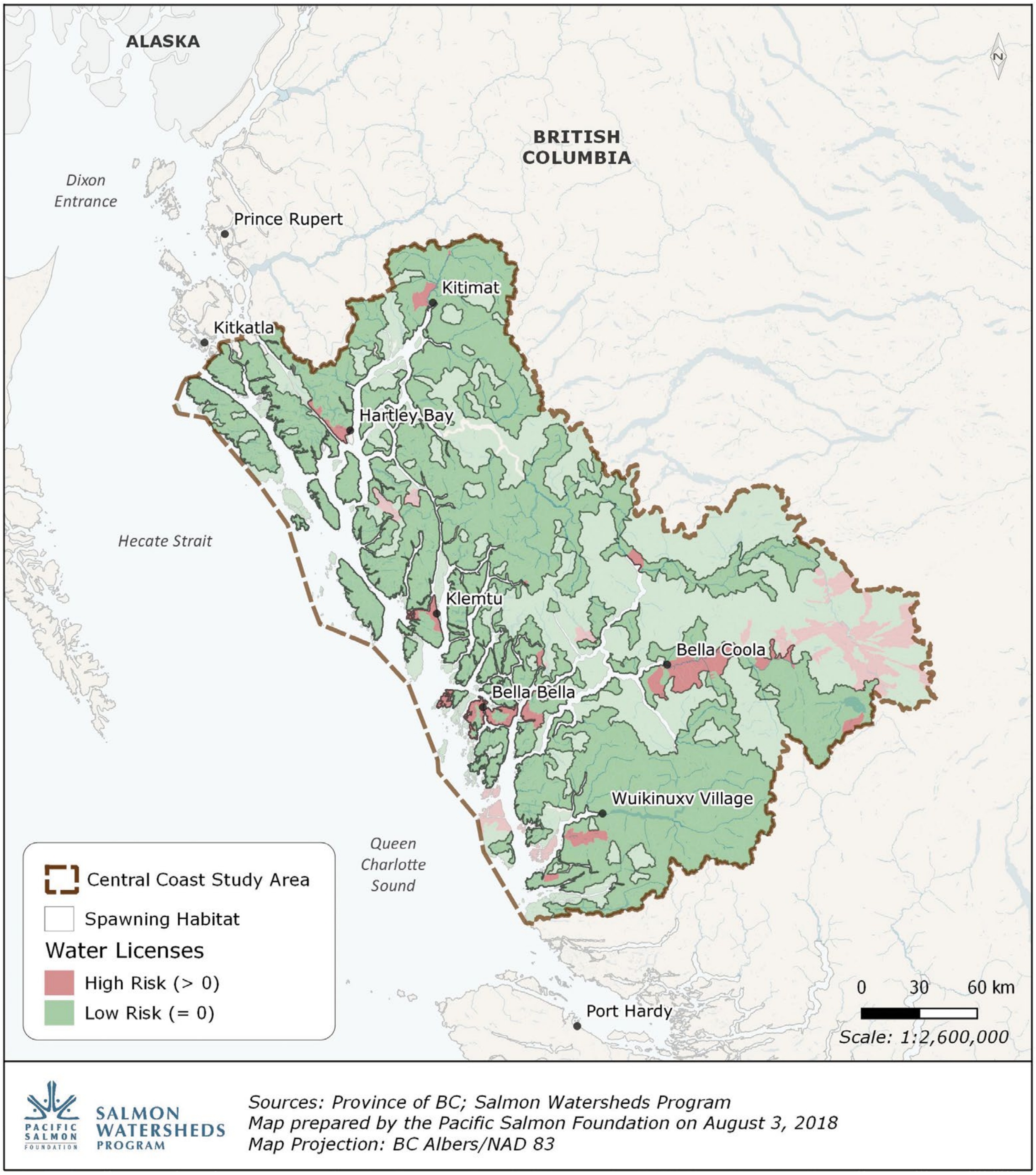
Sources: Province of BC; Salmon Watersheds Program
Map prepared by the Pacific Salmon Foundation on Augutst 3, 2018
Map Projection: BC Albers/NAD 83

FIGURE A.14. **Riparian Disturbance** — This map shows risk to Central Coast salmon spawning habitat from riparian disturbance, measured as the percentage of the riparian zone in each 1:20,000 Freshwater Atlas (FWA) Assessment Watershed that has been altered by land use activities. The riparian zone is defined as a 30m buffer around all water bodies. Disturbance to the riparian zone can alter stream shading, water temperature, organic matter inputs, and bank stability.



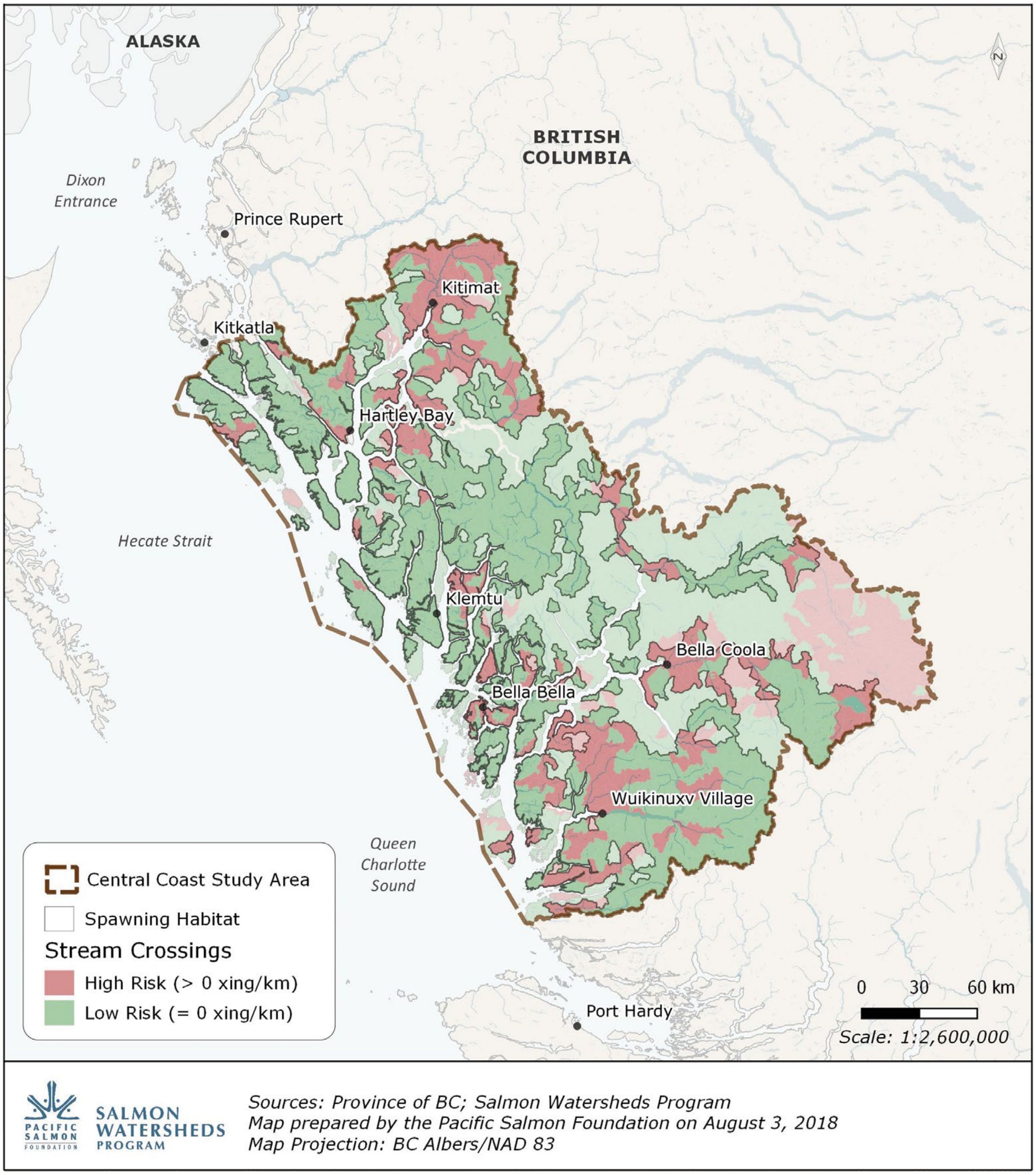
Sources: Province of BC; Salmon Watersheds Program
Map prepared by the Pacific Salmon Foundation on August 3, 2018
Map Projection: BC Albers/NAD 83

FIGURE A.15. **Road Development** — This map shows risk to Central Coast salmon spawning habitat from road development, measured as the density of all roads in each 1:20,000 Freshwater Atlas (FWA) Assessment Watershed. Extensive road development can interrupt overland flow and increase fine sediment generation, impacting downstream spawning and rearing habitats.



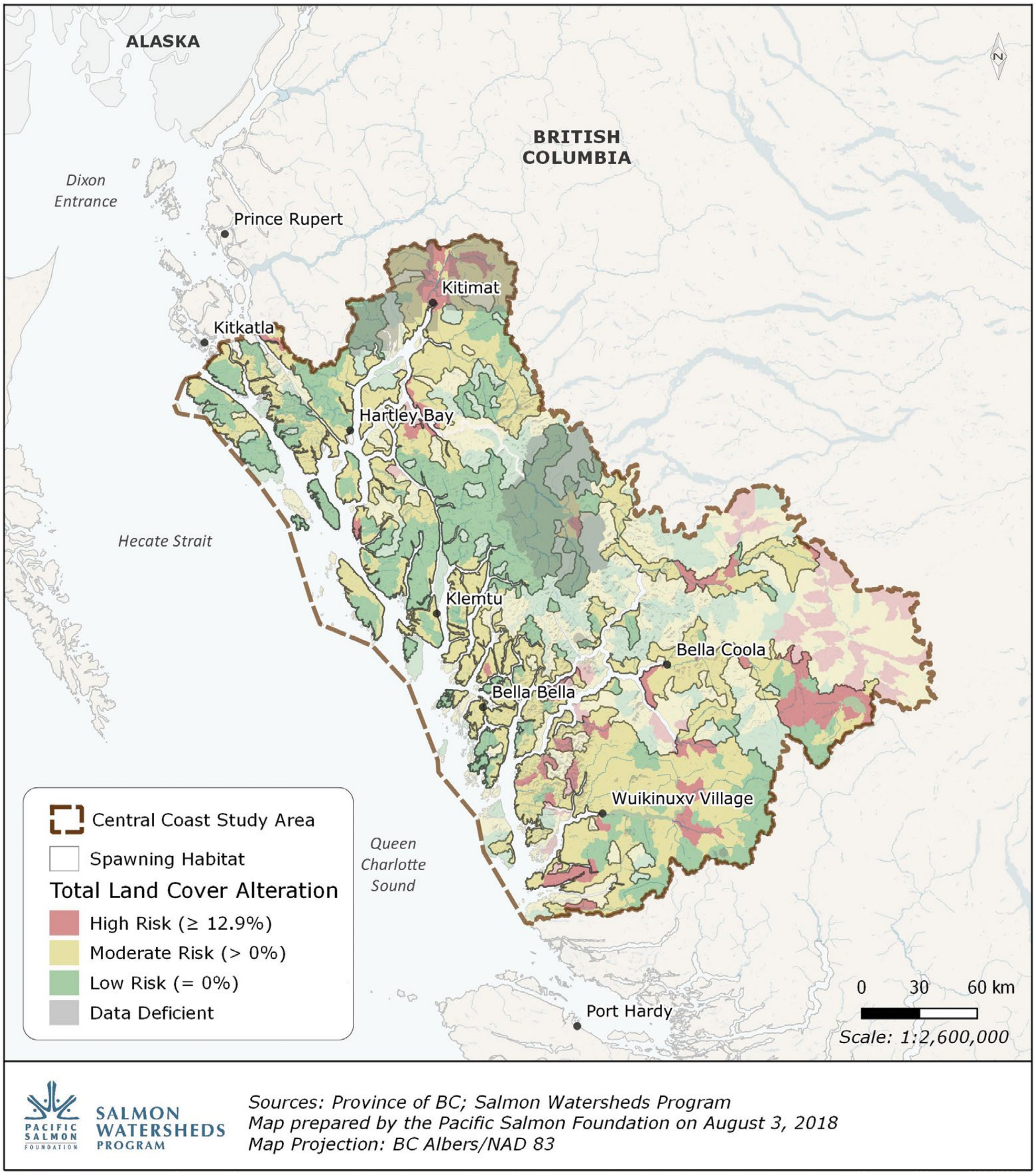
Sources: Province of BC; Salmon Watersheds Program
Map prepared by the Pacific Salmon Foundation on August 3, 2018
Map Projection: BC Albers/NAD 83

FIGURE A.16. **Water Licenses** — This map shows risk to Central Coast salmon spawning habitat from diversion of water, measured as the total number of provincially permitted water licenses for points of diversion in each 1:20,000 Freshwater Atlas (FWA) Assessment Watershed. Diverted water can potentially reduce flows in streams, thereby limiting fish access to or use of habitats as well as change hydrological processes.



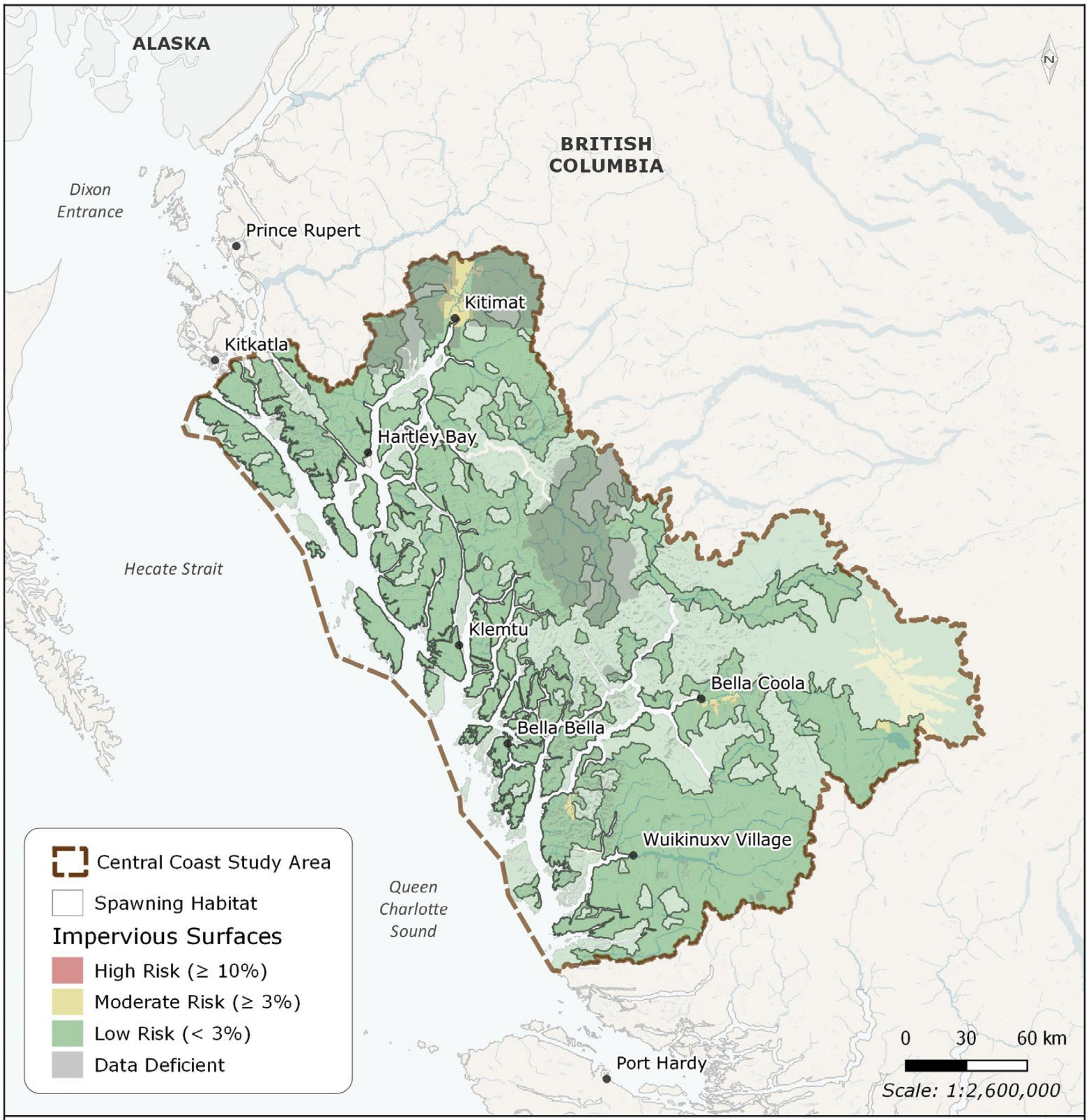
Sources: Province of BC; Salmon Watersheds Program
Map prepared by the Pacific Salmon Foundation on August 3, 2018
Map Projection: BC Albers/NAD 83

FIGURE A.17. **Stream Crossings** — This map shows risk to Central Coast salmon spawning habitat associated with stream crossings, measured as the number of crossings per kilometer of defined fish habitat in each 1:20,000 Freshwater Atlas (FWA) Assessment Watershed. Obstructions at stream crossings can hinder migration of fish or block access to useable habitats. Stream crossings can also influence the efficiency of water delivery to the stream network, such that high densities of stream crossings can increase peak flows and also become a chronic source of fine sediments. Note that these results are based on modelled data which assumes the presence of stream crossings where streams and roads intersect. Modelled stream crossings in the high risk watersheds have not been surveyed or confirmed to exist or assessed for fish passability.



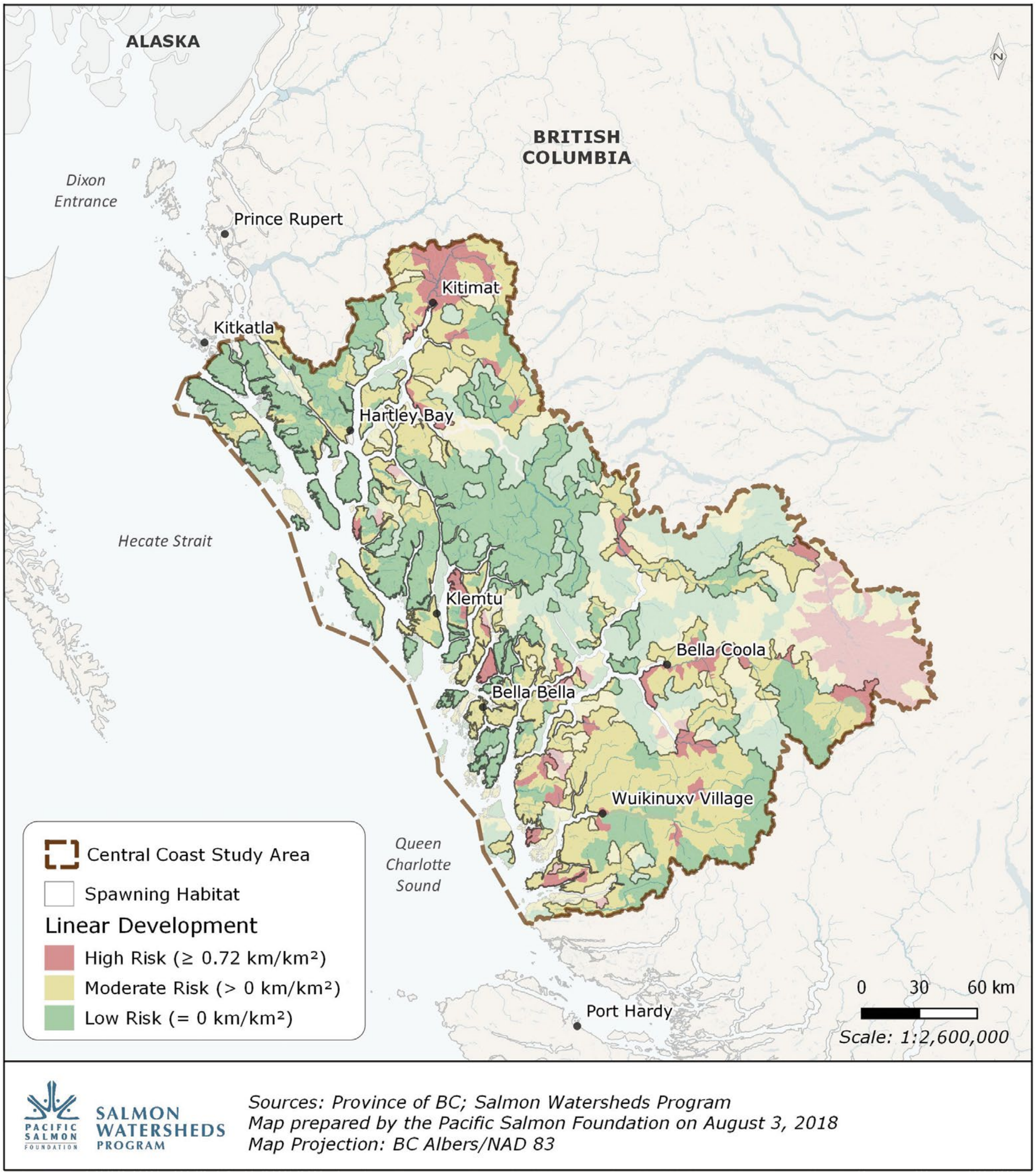
Sources: Province of BC; Salmon Watersheds Program
Map prepared by the Pacific Salmon Foundation on August 3, 2018
Map Projection: BC Albers/NAD 83

FIGURE A.18. **Total Land Cover Alteration** — This map shows risk to Central Coast salmon spawning habitat from land cover alteration, measured as the percentage of each 1:20,000 Freshwater Atlas (FWA) Assessment Watershed that has been altered from the natural landscape by human activities. Total land cover alteration is a synthesis of the indicators for forest disturbance, urban land use, agricultural/rural land use, mining development, and other smaller types of development). Total Land cover alteration reflects a suite of potential changes to hydrological processes and sedimentation, with potential impacts on salmon habitats.



Sources: Province of BC; Salmon Watersheds Program
Map prepared by the Pacific Salmon Foundation on August 3, 2018
Map Projection: BC Albers/NAD 83

FIGURE A.19. **Impervious Surfaces** — This map shows risk to Central Coast salmon spawning habitat from impervious surfaces, based on the percentage of each 1:20,000 Freshwater Atlas (FWA) Assessment Watershed that is considered impervious (e.g. asphalt, concrete). Extensive impervious surfaces from urban and rural development can impact rainwater infiltration and groundwater recharge, and can lead to stream habitat degradation through changes in geomorphology and hydrology. Impervious surfaces are also associated with increased loading of nutrients and contaminants in developed areas.

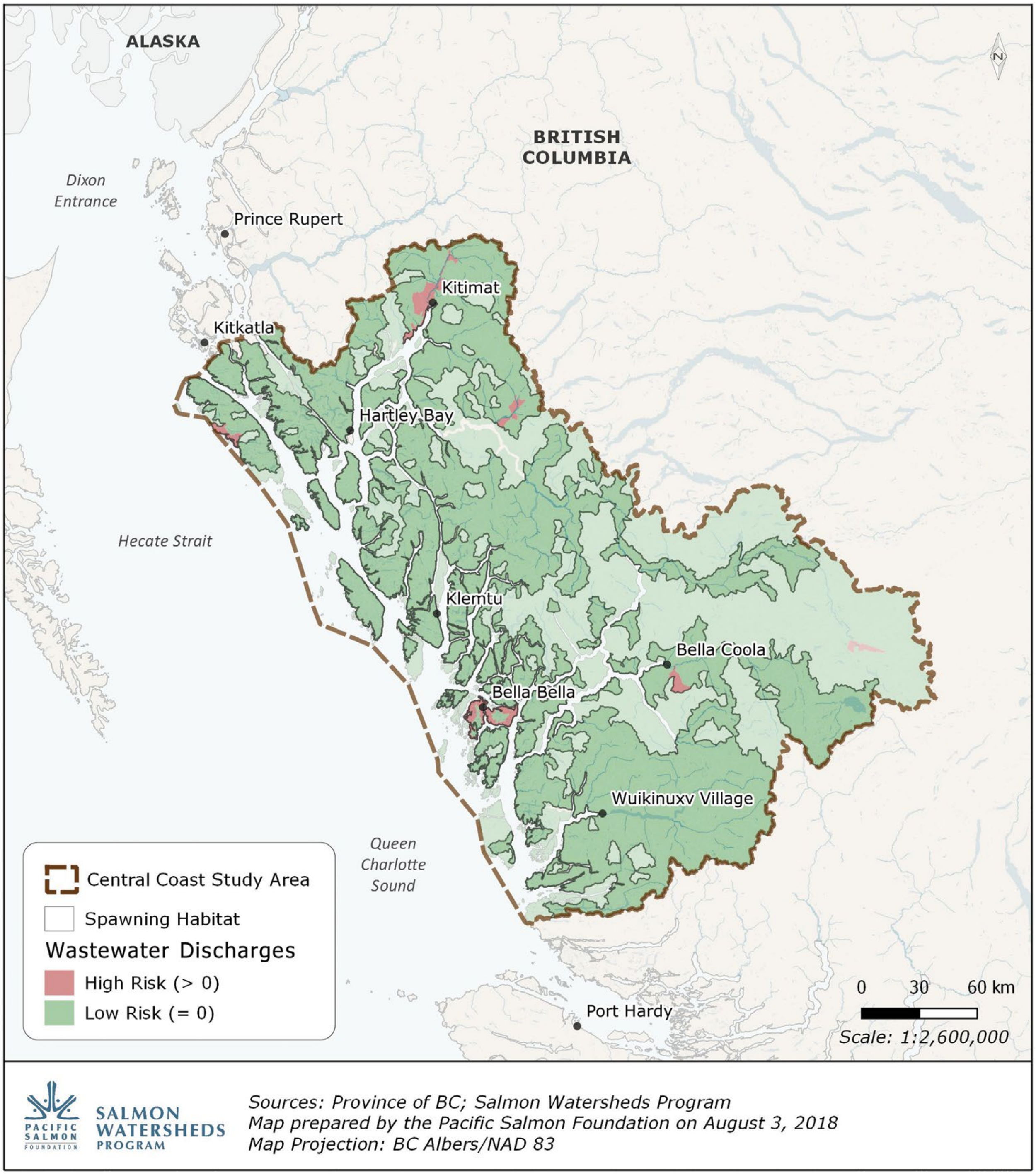


Sources: Province of BC; Salmon Watersheds Program
Map prepared by the Pacific Salmon Foundation on August 3, 2018
Map Projection: BC Albers/NAD 83

FIGURE A.20. **Linear Development** — This map shows risk to Central Coast salmon spawning habitat from linear development, measured as the density of all linear construction (e.g. roads, utility corridors, pipelines, powerlines, right of ways, railways, etc.) in each small-scale watershed. Linear development is a general indicator of potential human impacts on fish habitats.

Sources: Province of BC; Salmon Watersheds Program
Map prepared by the Pacific Salmon Foundation on August 3, 2018
Map Projection: BC Albers/NAD 83

FIGURE A.21. **Mining Development** — This map shows risk to Central Coast salmon spawning habitat from mining development, measured by the total number of mines in each 1:20,000 Freshwater Atlas (FWA) Assessment Watershed. The general footprint of a mine and mining processes can change geomorphology and the hydrological processes of nearby water bodies. Mining can also contribute to the deposition of fine sediments, which can affect salmon survival and prey densities.



Sources: Province of BC; Salmon Watersheds Program
Map prepared by the Pacific Salmon Foundation on August 3, 2018
Map Projection: BC Albers/NAD 83

FIGURE A.22. **Wastewater discharge** — This map shows risk to Central Coast salmon spawning habitat from wastewater discharge, measured as the total number of permitted wastewater discharge sites in each small-scale watershed. High levels of wastewater discharge have the potential to impact water quality through excessive nutrient enrichment or chemical contamination.

APPENDIX 15

Individual Habitat Pressure Indicator Results by Conservation Unit for Spawning Zone of Influence Watersheds

TABLE A.7. The percentage of watersheds within each CU's spawning zone of influence that are rated high risk (i.e. red) for each of the evaluated individual habitat pressure indicators. Darker red cells indicate a higher percentage of watersheds in the spawning ZOI are rated high risk.

Species	CU ID	Conservation Unit	Watersheds in ZOI (#)	Equivalent Clearcut Area	Forest Disturbance	Insect & Disease Defoliation	Impervious Surfaces	Linear Development	Mining Development	Riparian Disturbance	Road Development	Stream Crossings	Total Landcover Alteration	Wastewater Discharges	Water Licenses
Chinook	512	Bella Coola-Bentinck	**40**	0%	28%	60%	0%	38%	5%	35%	13%	58%	33%	3%	23%
	513	Dean River	**25**	0%	4%	100%	0%	12%	0%	12%	8%	24%	24%	0%	0%
	509	Docee	**4**	0%	25%	0%	0%	0%	0%	25%	0%	25%	25%	0%	0%
	515	North & Central Coast-Early	**102**	0%	16%	3%	0%	23%	6%	12%	13%	39%	14%	4%	1%
	514	North & Central Coast-Late	**32**	0%	3%	0%	0%	0%	3%	0%	0%	13%	0%	0%	0%
	510	Rivers Inlet	**51**	0%	24%	0%	0%	4%	0%	2%	0%	29%	8%	0%	0%
	511	Wannock	**2**	0%	0%	0%	0%	50%	50%	0%	0%	50%	0%	0%	0%
Chum	505	Bella Coola River-Late	**4**	0%	0%	75%	0%	25%	50%	0%	25%	100%	0%	25%	100%
	504	Bella Coola-Dean Rivers	**41**	0%	20%	44%	0%	29%	7%	12%	5%	59%	15%	2%	29%
	508	Douglas-Gardner	**117**	0%	19%	2%	0%	19%	5%	11%	9%	42%	12%	4%	1%
	506	Hecate Lowlands	**122**	0%	4%	1%	0%	2%	2%	0%	0%	7%	1%	1%	2%
	507	Mussel-Kynoch	**19**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	501	Rivers Inlet	**21**	0%	57%	0%	0%	14%	0%	14%	0%	48%	24%	0%	0%
	500	Smith Inlet	**16**	0%	38%	0%	0%	6%	0%	19%	6%	50%	19%	0%	6%
	503	Spiller-Fitz-Hugh-Burke	**56**	0%	13%	4%	0%	16%	7%	11%	5%	30%	13%	4%	7%
	502	Wannock	**2**	0%	0%	0%	0%	50%	50%	0%	0%	50%	0%	0%	0%

Species	CU ID	Conservation Unit	Watersheds in ZOI (#)	Equivalent Clearcut Area	Forest Disturbance	Insect & Disease Defoliation	Impervious Surfaces	Linear Development	Mining Development	Riparian Disturbance	Road Development	Stream Crossings	Total Landcover Alteration	Wastewater Discharges	Water Licenses
Coho	518	Bella Coola-Dean Rivers	**22**	0%	27%	50%	0%	32%	9%	14%	9%	77%	18%	5%	41%
	521	Brim-Wahoo	**4**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	522	Douglas Channel-Kitimat Arm	**42**	0%	29%	5%	0%	43%	7%	21%	29%	60%	29%	10%	5%
	520	Hecate Strait Mainland	**164**	0%	7%	1%	0%	5%	5%	1%	2%	16%	4%	2%	4%
	519	Mussel-Kynoch	**13**	0%	0%	0%	0%	0%	0%	0%	0%	8%	0%	0%	0%
	523	Northern Coastal Streams	**109**	0%	10%	3%	0%	8%	3%	8%	0%	28%	6%	2%	1%
	517	Rivers Inlet	**38**	0%	42%	0%	0%	13%	3%	11%	3%	39%	16%	0%	0%
	516	Smith Inlet	**12**	0%	42%	0%	0%	8%	0%	25%	0%	50%	25%	0%	0%
Pink (even-year)	608	Hecate Lowlands	**157**	0%	6%	1%	0%	6%	5%	1%	2%	16%	4%	2%	4%
	609	Hecate Strait-Fjords	**238**	0%	22%	10%	0%	16%	5%	12%	6%	42%	14%	3%	6%
Pink (odd-year)	612	Hecate Strait-Fjords	**174**	0%	17%	4%	0%	15%	5%	10%	7%	36%	11%	3%	2%
	611	Hecate Strait-Lowlands	**158**	0%	7%	1%	0%	6%	5%	2%	2%	16%	4%	2%	3%
	610	Homathko-Klinaklini-Smith-Rivers-Bella Coola-Dean	**84**	0%	38%	21%	0%	26%	5%	20%	7%	62%	25%	1%	17%
Sockeye (river-type)	614	Northern Coastal Fjords	**84**	0%	18%	7%	0%	14%	4%	10%	4%	35%	12%	4%	5%
	615	Northern Coastal Streams	**35**	0%	6%	3%	0%	9%	9%	3%	6%	20%	3%	3%	6%
	613	Rivers-Smith Inlets	**10**	0%	40%	0%	0%	10%	10%	10%	0%	60%	10%	0%	0%
Sockeye (lake-type)	529	Backland	**3**	0%	0%	0%	0%	0%	0%	0%	0%	33%	0%	0%	0%
	540	Banks	**2**	0%	0%	0%	0%	0%	0%	0%	0%	50%	0%	0%	0%
	541	Bloomfield	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	542	Bolton Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	543	Bonilla	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	544	Borrowman Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Species	CU ID	Conservation Unit	Watersheds in ZOI (#)	Equivalent Clearcut Area	Forest Disturbance	Insect & Disease Defoliation	Impervious Surfaces	Linear Development	Mining Development	Riparian Disturbance	Road Development	Stream Crossings	Total Landcover Alteration	Wastewater Discharges	Water Licenses
Sockeye (lake-type)	545	Busey Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	532	Canoona	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	546	Cartwright Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	547	Chic Chic	**1**	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
	548	Citeyats	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	550	Curtis Inlet	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	551	Dallain Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	552	Deer	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	553	Devon	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	533	Dome	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	554	Douglas Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	555	Elizabeth	**2**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	556	Elsie/Hoy	**1**	0%	0%	0%	0%	100%	100%	0%	0%	100%	0%	0%	0%
	557	End Hill Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	534	Evelyn	**1**	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
	558	Evinrude Inlet	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	549	Fannie Cove	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	559	Freeda	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	560	Hartley Bay	**1**	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	100%
	561	Hevenor Inlet	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	562	Higgins Lagoon	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	563	Kadjusdis River	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	535	Kainet Creek	**2**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	564	Kdelmashan Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	565	Keecha	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	566	Kent Inlet Lagoon Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	567	Kenzuwash Creeks	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	568	Keswar Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	569	Kildidt Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	570	Kildidt Lagoon Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Species	CU ID	Conservation Unit	Watersheds in ZOI (#)	Equivalent Clearcut Area	Forest Disturbance	Insect & Disease Defoliation	Impervious Surfaces	Linear Development	Mining Development	Riparian Disturbance	Road Development	Stream Crossings	Total Landcover Alteration	Wastewater Discharges	Water Licenses
Sockeye (lake-type)	536	Kimsquit	**2**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	571	Kisameet	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	537	Kitkiata	**1**	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
	538	Kitlope	**18**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	572	Koeye	**4**	0%	0%	0%	0%	0%	25%	0%	0%	50%	0%	0%	0%
	573	Kooryet	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	574	Kunsoot River	**1**	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	100%	100%
	575	Kwakwa Creek	**3**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	33%
	576	Lewis Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	577	Limestone Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
	524	Long	**10**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	578	Lowe/Simpson/Weir	**3**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	579	Mary Cove Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	580	Mcdonald Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	581	Mcloughlin	**1**	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	100%	100%
	582	Mikado	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	583	Monckton Inlet Creek	**1**	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	584	Namu	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	525	Owikeno	**75**	0%	11%	0%	0%	3%	0%	3%	0%	9%	8%	0%	0%
	539	Pine River	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	585	Port John	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%
	586	Powles Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	587	Price Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	588	Roderick	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	589	Ryan Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	590	Salter	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	591	Scoular/Kilpatrick	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	592	Sheneeza Inlet	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	593	Ship Point Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	530	Soda Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Species	CU ID	Conservation Unit	Watersheds in ZOI (#)	Equivalent Clearcut Area	Forest Disturbance	Insect & Disease Defoliation	Impervious Surfaces	Linear Development	Mining Development	Riparian Disturbance	Road Development	Stream Crossings	Total Landcover Alteration	Wastewater Discharges	Water Licenses
Sockeye (lake-type)	528	South Atnarko Lakes	**26**	4%	15%	92%	0%	15%	0%	42%	15%	27%	46%	0%	4%
	594	Spencer Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	595	Stannard Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	596	Talamoosa Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	597	Tankeeah River	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	598	Treneman Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	599	Tsimtack/ Moore/Roger	**2**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	600	Tuno Creek East	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	601	Tuno Creek West	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	602	Tyler Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	603	Wale Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	527	Wannock (Owikeno)	**75**	0%	11%	0%	0%	3%	0%	3%	0%	9%	8%	0%	0%
	604	Watt Bay	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	605	West Creek	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	606	Yaaklele Lagoon	**1**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%
	607	Yeo	**1**	0%	100%	0%	0%	100%	0%	0%	100%	100%	100%	0%	0%

TABLE A.8. The percentage of watersheds within each CU's spawning zone of influence that are rated moderate risk (i.e. amber) for each of the evaluated individual habitat pressure indicators. Darker amber cells indicate a higher percentage of watersheds in the spawning ZOI are rated moderate risk. Indicators that were evaluated with binary relative benchmarks are not reported in the moderate risk category.

Species	CU ID	Conservation Unit	Watersheds in ZOI (#)	Equivalent Clearcut Area	Forest Disturbance	Impervious Surfaces	Linear Development	Riparian Disturbance	Road Development	Total Landcover Alteration
Chinook	512	Bella Coola-Bentinck	**40**	0%	40%	5%	45%	23%	35%	58%
	513	Dean River	**25**	4%	40%	0%	48%	20%	8%	68%
	509	Docee	**4**	0%	75%	0%	75%	50%	25%	75%
	515	North & Central Coast-Early	**102**	0%	25%	10%	25%	16%	16%	35%
	514	North & Central Coast-Late	**32**	0%	13%	0%	16%	3%	3%	25%
	510	Rivers Inlet	**51**	0%	33%	0%	51%	29%	16%	51%
	511	Wannock	**2**	0%	0%	0%	0%	0%	50%	50%
Chum	505	Bella Coola River-Late	**4**	0%	100%	25%	75%	25%	0%	100%
	504	Bella Coola-Dean Rivers	**41**	0%	66%	5%	54%	27%	29%	78%
	508	Douglas-Gardner	**117**	0%	35%	8%	43%	20%	19%	56%
	506	Hecate Lowlands	**122**	0%	30%	0%	24%	6%	5%	42%
	507	Mussel-Kynoch	**19**	0%	11%	0%	0%	0%	0%	11%
	501	Rivers Inlet	**21**	0%	43%	0%	76%	52%	52%	76%
	500	Smith Inlet	**16**	6%	50%	0%	69%	31%	44%	69%
	503	Spiller-Fitz-Hugh-Burke	**56**	0%	46%	2%	50%	11%	23%	61%
	502	Wannock	**2**	0%	0%	0%	0%	0%	50%	50%
Coho	518	Bella Coola-Dean Rivers	**22**	0%	64%	9%	59%	45%	27%	82%
	521	Brim-Wahoo	**4**	0%	0%	0%	0%	0%	0%	0%
	522	Douglas Channel-Kitimat Arm	**42**	0%	38%	24%	40%	21%	26%	55%
	520	Hecate Strait Mainland	**164**	0%	34%	1%	33%	9%	10%	48%
	519	Mussel-Kynoch	**13**	0%	23%	0%	8%	8%	0%	23%

Species	CU ID	Conservation Unit	Watersheds in ZOI (#)	Equivalent Clearcut Area	Forest Disturbance	Impervious Surfaces	Linear Development	Riparian Disturbance	Road Development	Total Landcover Alteration
Coho	523	Northern Coastal Streams	**109**	0%	29%	0%	35%	13%	14%	47%
	517	Rivers Inlet	**38**	0%	39%	0%	68%	39%	34%	71%
	516	Smith Inlet	**12**	0%	42%	0%	67%	33%	50%	58%
Pink (even-year)	608	Hecate Lowlands	**157**	0%	36%	1%	32%	10%	11%	50%
	609	Hecate Strait-Fjords	**238**	0%	36%	5%	47%	21%	23%	56%
Pink (odd-year)	612	Hecate Strait-Fjords	**174**	0%	32%	6%	41%	17%	18%	50%
	611	Hecate Strait-Lowlands	**158**	0%	37%	1%	32%	10%	11%	49%
	610	Homathko-Klinaklini-Smith-Rivers-Bella Coola-Dean	**84**	1%	49%	5%	60%	35%	39%	69%
Sockeye (river-type)	614	Northern Coastal Fjords	**84**	0%	32%	4%	32%	14%	19%	48%
	615	Northern Coastal Streams	**35**	0%	37%	3%	34%	14%	14%	49%
	613	Rivers-Smith Inlets	**10**	0%	30%	0%	60%	50%	40%	70%
Sockeye (lake-type)	529	Backland	**3**	0%	33%	0%	33%	0%	0%	33%
	540	Banks	**2**	0%	0%	0%	50%	0%	0%	50%
	541	Bloomfield	**1**	0%	0%	0%	0%	0%	0%	0%
	542	Bolton Creek	**1**	0%	100%	0%	100%	0%	0%	100%
	543	Bonilla	**1**	0%	0%	0%	0%	0%	0%	0%
	544	Borrowman Creek	**1**	0%	100%	0%	0%	0%	0%	100%
	545	Busey Creek	**1**	0%	100%	0%	0%	0%	0%	100%
	532	Canoona	**1**	0%	0%	0%	100%	0%	0%	100%
	546	Cartwright Creek	**1**	0%	0%	0%	0%	0%	0%	0%
	547	Chic Chic	**1**	0%	0%	0%	100%	0%	0%	100%
	548	Citeyats	**1**	0%	100%	0%	0%	0%	0%	100%
	550	Curtis Inlet	**1**	0%	0%	0%	0%	0%	0%	0%
	551	Dallain Creek	**1**	0%	0%	0%	0%	0%	0%	0%

Species	CU ID	Conservation Unit	Watersheds in ZOI (#)	Equivalent Clearcut Area	Forest Disturbance	Impervious Surfaces	Linear Development	Riparian Disturbance	Road Development	Total Landcover Alteration
Sockeye (lake-type)	552	Deer	**1**	0%	0%	0%	0%	0%	0%	0%
	553	Devon	**1**	0%	100%	0%	100%	0%	0%	100%
	533	Dome	**1**	0%	0%	0%	0%	0%	0%	0%
	554	Douglas Creek	**1**	0%	0%	0%	0%	0%	0%	0%
	555	Elizabeth	**2**	0%	50%	0%	50%	0%	0%	50%
	556	Elsie/Hoy	**1**	0%	100%	0%	0%	0%	100%	100%
	557	End Hill Creek	**1**	0%	0%	0%	0%	0%	0%	0%
	534	Evelyn	**1**	0%	100%	0%	100%	0%	100%	100%
	558	Evinrude Inlet	**1**	0%	0%	0%	0%	0%	0%	0%
	549	Fannie Cove	**1**	0%	0%	0%	0%	0%	0%	0%
	559	Freeda	**1**	0%	0%	0%	0%	0%	0%	0%
	560	Hartley Bay	**1**	0%	0%	0%	100%	0%	0%	100%
	561	Hevenor Inlet	**1**	0%	100%	0%	0%	0%	0%	100%
	562	Higgins Lagoon	**1**	0%	0%	0%	100%	0%	0%	100%
	563	Kadjusdis River	**1**	0%	0%	0%	100%	0%	0%	100%
	535	Kainet Creek	**2**	0%	0%	0%	0%	0%	0%	0%
	564	Kdelmashan Creek	**1**	0%	0%	0%	0%	0%	0%	0%
	565	Keecha	**1**	0%	0%	0%	0%	0%	0%	0%
	566	Kent Inlet Lagoon Creek	**1**	0%	0%	0%	0%	0%	0%	0%
	567	Kenzuwash Creeks	**1**	0%	0%	0%	0%	0%	0%	0%
	568	Keswar Creek	**1**	0%	0%	0%	0%	0%	0%	0%
	569	Kildidt Creek	**1**	0%	0%	0%	0%	0%	0%	0%
	570	Kildidt Lagoon Creek	**1**	0%	0%	0%	0%	0%	0%	0%
	536	Kimsquit	**2**	0%	0%	0%	0%	0%	0%	0%
	571	Kisameet	**1**	0%	0%	0%	100%	0%	0%	100%
	537	Kitkiata	**1**	0%	0%	0%	100%	100%	0%	100%
	538	Kitlope	**18**	0%	0%	0%	0%	0%	0%	0%
	572	Koeye	**4**	0%	50%	0%	50%	0%	25%	75%
	573	Kooryet	**1**	0%	0%	0%	0%	0%	0%	0%
	574	Kunsoot River	**1**	0%	0%	0%	100%	0%	0%	100%

Species	CU ID	Conservation Unit	Watersheds in ZOI (#)	Equivalent Clearcut Area	Forest Disturbance	Impervious Surfaces	Linear Development	Riparian Disturbance	Road Development	Total Landcover Alteration
Sockeye (lake-type)	575	Kwakwa Creek	3	0%	0%	0%	67%	0%	0%	33%
	576	Lewis Creek	1	0%	0%	0%	0%	0%	0%	0%
	577	Limestone Creek	1	0%	0%	0%	100%	0%	0%	100%
	524	Long	10	0%	40%	0%	30%	20%	10%	40%
	578	Lowe/Simpson/ Weir	3	0%	0%	0%	0%	0%	0%	0%
	579	Mary Cove Creek	1	0%	100%	0%	100%	100%	0%	100%
	580	Mcdonald Creek	1	0%	0%	0%	0%	0%	0%	0%
	581	Mcloughlin	1	0%	100%	0%	100%	0%	0%	100%
	582	Mikado	1	0%	0%	0%	0%	0%	0%	0%
	583	Monckton Inlet Creek	1	0%	100%	0%	0%	0%	0%	100%
	584	Namu	1	0%	100%	0%	100%	0%	0%	100%
	525	Owikeno	75	0%	39%	0%	41%	11%	9%	43%
	539	Pine River	1	0%	100%	0%	100%	0%	0%	100%
	585	Port John	1	0%	0%	0%	100%	0%	0%	100%
	586	Powles Creek	1	0%	0%	0%	0%	0%	0%	0%
	587	Price Creek	1	0%	0%	0%	0%	0%	0%	0%
	588	Roderick	1	0%	0%	0%	0%	0%	0%	0%
	589	Ryan Creek	1	0%	0%	0%	0%	0%	0%	0%
	590	Salter	1	0%	0%	0%	0%	0%	0%	0%
	591	Scoular/ Kilpatrick	1	0%	0%	0%	0%	0%	0%	0%
	592	Sheneeza Inlet	1	0%	100%	0%	0%	0%	0%	100%
	593	Ship Point Creek	1	0%	100%	0%	100%	0%	0%	100%
	530	Soda Creek	1	0%	0%	0%	0%	0%	0%	0%
	528	South Atnarko Lakes	26	0%	15%	4%	27%	15%	4%	15%
	594	Spencer Creek	1	0%	0%	0%	0%	0%	0%	0%
	595	Stannard Creek	1	0%	100%	0%	100%	0%	0%	100%
	596	Talamoosa Creek	1	0%	0%	0%	0%	0%	0%	0%
	597	Tankeeah River	1	0%	0%	0%	100%	0%	0%	100%
	598	Treneman Creek	1	0%	100%	0%	0%	0%	0%	100%
	599	Tsimtack/ Moore/Roger	2	0%	100%	0%	0%	0%	0%	100%

Species	CU ID	Conservation Unit	Watersheds in ZOI (#)	Equivalent Clearcut Area	Forest Disturbance	Impervious Surfaces	Linear Development	Riparian Disturbance	Road Development	Total Landcover Alteration
Sockeye (lake-type)	600	Tuno Creek East	**1**	0%	100%	0%	100%	0%	0%	100%
	601	Tuno Creek West	**1**	0%	100%	0%	100%	0%	0%	100%
	602	Tyler Creek	**1**	0%	0%	0%	0%	0%	0%	0%
	603	Wale Creek	**1**	0%	0%	0%	0%	0%	0%	0%
	527	Wannock (Owikeno)	**75**	0%	39%	0%	41%	11%	9%	43%
	604	Watt Bay	**1**	0%	0%	0%	0%	0%	0%	0%
	605	West Creek	**1**	0%	100%	0%	100%	0%	0%	100%
	606	Yaaklele Lagoon	**1**	0%	0%	0%	0%	0%	0%	0%
	607	Yeo	**1**	0%	0%	0%	0%	100%	0%	0%

TABLE A.9. The percentage of watersheds within each CU's spawning zone of influence that are rated low risk (i.e. green) for each of the evaluated individual habitat pressure indicators. Darker green cells indicate a higher percentage of watersheds in the spawning ZOI are rated low risk

Species	CU ID	Conservation Unit	Watersheds in ZOI (#)	Equivalent Clearcut Area	Forest Disturbance	Insect & Disease Defoliation	Impervious Surfaces	Linear Development	Mining Development	Riparian Disturbance	Road Development	Stream Crossings	Total Landcover Alteration	Wastewater Discharges	Water Licenses
Chinook	512	Bella Coola-Bentinck	**40**	100%	33%	40%	95%	18%	95%	43%	53%	43%	10%	98%	78%
	513	Dean River	**25**	96%	56%	0%	100%	40%	100%	68%	84%	76%	8%	100%	100%
	509	Docee	**4**	100%	0%	100%	100%	25%	100%	25%	75%	75%	0%	100%	100%
	515	North & Central Coast-Early	**102**	100%	59%	97%	90%	53%	94%	73%	72%	61%	51%	96%	99%
	514	North & Central Coast-Late	**32**	100%	84%	100%	100%	84%	97%	97%	97%	88%	75%	100%	100%
	510	Rivers Inlet	**51**	100%	43%	100%	100%	45%	100%	69%	84%	71%	41%	100%	100%
	511	Wannock	**2**	100%	100%	100%	100%	50%	50%	100%	50%	50%	50%	100%	100%
Chum	505	Bella Coola River-Late	**4**	100%	0%	25%	75%	0%	50%	75%	75%	0%	0%	75%	0%
	504	Bella Coola-Dean Rivers	**41**	100%	15%	56%	95%	17%	93%	61%	66%	41%	7%	98%	71%
	508	Douglas-Gardner	**117**	100%	46%	98%	92%	38%	95%	69%	72%	58%	32%	96%	99%
	506	Hecate Lowlands	**122**	100%	66%	99%	100%	75%	98%	94%	95%	93%	57%	99%	98%
	507	Mussel-Kynoch	**19**	100%	89%	100%	100%	100%	100%	100%	100%	100%	89%	100%	100%
	501	Rivers Inlet	**21**	100%	0%	100%	100%	10%	100%	33%	48%	52%	0%	100%	100%
	500	Smith Inlet	**16**	94%	13%	100%	100%	25%	100%	50%	50%	50%	13%	100%	94%
	503	Spiller-Fitz-Hugh-Burke	**56**	100%	41%	96%	98%	34%	93%	79%	71%	70%	27%	96%	93%
	502	Wannock	**2**	100%	100%	100%	100%	50%	50%	100%	50%	50%	50%	100%	100%
Coho	518	Bella Coola-Dean Rivers	**22**	100%	9%	50%	91%	9%	91%	41%	64%	23%	0%	95%	59%
	521	Brim-Wahoo	**4**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	522	Douglas Channel-Kitimat Arm	**42**	100%	33%	95%	76%	17%	93%	57%	45%	40%	17%	90%	95%
	520	Hecate Strait Mainland	**164**	100%	60%	99%	99%	62%	95%	90%	88%	84%	48%	98%	96%
	519	Mussel-Kynoch	**13**	100%	77%	100%	100%	92%	100%	92%	100%	92%	77%	100%	100%
	523	Northern Coastal Streams	**109**	100%	61%	97%	100%	57%	97%	79%	86%	72%	47%	98%	99%
	517	Rivers Inlet	**38**	100%	18%	100%	100%	18%	97%	50%	63%	61%	13%	100%	100%
	516	Smith Inlet	**12**	100%	17%	100%	100%	25%	100%	42%	50%	50%	17%	100%	100%

Species	CU ID	Conservation Unit	Watersheds in ZOI (#)	Equivalent Clearcut Area	Forest Disturbance	Insect & Disease Defoliation	Impervious Surfaces	Linear Development	Mining Development	Riparian Disturbance	Road Development	Stream Crossings	Total Landcover Alteration	Wastewater Discharges	Water Licenses
Pink (even-year)	608	Hecate Lowlands	**157**	100%	57%	99%	99%	62%	95%	89%	87%	84%	46%	98%	96%
	609	Hecate Strait-Fjords	**238**	100%	42%	90%	95%	37%	95%	66%	71%	58%	30%	97%	94%
Pink (odd-year)	612	Hecate Strait-Fjords	**174**	100%	51%	96%	94%	44%	95%	73%	75%	64%	39%	97%	98%
	611	Hecate Strait-Lowlands	**158**	100%	56%	99%	99%	62%	95%	88%	87%	84%	46%	98%	97%
	610	Homathko-Klinaklini-Smith-Rivers-Bella Coola-Dean	**84**	99%	13%	79%	95%	14%	95%	45%	54%	38%	6%	99%	83%
Sockeye (river-type)	614	Northern Coastal Fjords	**84**	100%	50%	93%	96%	54%	96%	76%	77%	65%	40%	96%	95%
	615	Northern Coastal Streams	**35**	100%	57%	97%	97%	57%	91%	83%	80%	80%	49%	97%	94%
	613	Rivers-Smith Inlets	**10**	100%	30%	100%	100%	30%	90%	40%	60%	40%	20%	100%	100%
Sockeye (lake-type)	529	Backland	**3**	100%	67%	100%	100%	67%	100%	100%	100%	67%	67%	100%	100%
	540	Banks	**2**	100%	100%	100%	100%	50%	100%	100%	100%	50%	50%	100%	100%
	541	Bloomfield	**1**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	542	Bolton Creek	**1**	100%	0%	100%	100%	0%	100%	100%	100%	100%	0%	100%	100%
	543	Bonilla	**1**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	544	Borrowman Creek	**1**	100%	0%	100%	100%	100%	100%	100%	100%	100%	0%	100%	100%
	545	Busey Creek	**1**	100%	0%	100%	100%	100%	100%	100%	100%	100%	0%	100%	100%
	532	Canoona	**1**	100%	100%	100%	100%	0%	100%	100%	100%	100%	0%	100%	100%
	546	Cartwright Creek	**1**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	547	Chic Chic	**1**	100%	100%	100%	100%	0%	100%	100%	100%	0%	0%	100%	100%
	548	Citeyats	**1**	100%	0%	100%	100%	100%	100%	100%	100%	100%	0%	100%	100%
	550	Curtis Inlet	**1**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	551	Dallain Creek	**1**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	552	Deer	**1**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	553	Devon	**1**	100%	0%	100%	100%	0%	100%	100%	100%	100%	0%	100%	100%
	533	Dome	**1**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	554	Douglas Creek	**1**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	555	Elizabeth	**2**	100%	50%	100%	100%	50%	100%	100%	100%	100%	50%	100%	100%
	556	Elsie/Hoy	**1**	100%	0%	100%	100%	0%	0%	100%	0%	0%	0%	100%	100%

Species	CU ID	Conservation Unit	Watersheds in ZOI (#)	Equivalent Clearcut Area	Forest Disturbance	Insect & Disease Defoliation	Impervious Surfaces	Linear Development	Mining Development	Riparian Disturbance	Road Development	Stream Crossings	Total Landcover Alteration	Wastewater Discharges	Water Licenses
Sockeye (lake-type)	557	End Hill Creek	**1**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	534	Evelyn	**1**	100%	0%	100%	100%	0%	100%	100%	0%	0%	0%	100%	100%
	558	Evinrude Inlet	**1**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	549	Fannie Cove	**1**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	559	Freeda	**1**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	560	Hartley Bay	**1**	100%	100%	100%	100%	0%	100%	100%	100%	0%	0%	100%	0%
	561	Hevenor Inlet	**1**	100%	0%	100%	100%	100%	100%	100%	100%	100%	0%	100%	100%
	562	Higgins Lagoon	**1**	100%	100%	100%	100%	0%	100%	100%	100%	100%	0%	100%	100%
	563	Kadjusdis River	**1**	100%	100%	100%	100%	0%	100%	100%	100%	100%	0%	100%	100%
	535	Kainet Creek	**2**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	564	Kdelmashan Creek	**1**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	565	Keecha	**1**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	566	Kent Inlet Lagoon Creek	**1**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	567	Kenzuwash Creeks	**1**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	568	Keswar Creek	**1**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	569	Kildidt Creek	**1**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	570	Kildidt Lagoon Creek	**1**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	536	Kimsquit	**2**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	571	Kisameet	**1**	100%	100%	100%	100%	0%	100%	100%	100%	100%	0%	100%	100%
	537	Kitkiata	**1**	100%	0%	100%	100%	0%	100%	0%	100%	0%	0%	100%	100%
	538	Kitlope	**18**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	572	Koeye	**4**	100%	50%	100%	100%	50%	75%	100%	75%	50%	25%	100%	100%
	573	Kooryet	**1**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	574	Kunsoot River	**1**	100%	100%	100%	100%	0%	100%	100%	100%	0%	0%	0%	0%
	575	Kwakwa Creek	**3**	100%	100%	100%	100%	33%	100%	100%	100%	100%	67%	100%	67%
	576	Lewis Creek	**1**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	577	Limestone Creek	**1**	100%	100%	100%	100%	0%	100%	100%	100%	0%	0%	100%	100%
	524	Long	**10**	100%	60%	100%	100%	70%	100%	80%	90%	100%	60%	100%	100%
	578	Lowe/Simpson/Weir	**3**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	579	Mary Cove Creek	**1**	100%	0%	100%	100%	0%	100%	0%	100%	100%	0%	100%	100%
	580	Mcdonald Creek	**1**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Species	CU ID	Conservation Unit	Watersheds in ZOI (#)	Equivalent Clearcut Area	Forest Disturbance	Insect & Disease Defoliation	Impervious Surfaces	Linear Development	Mining Development	Riparian Disturbance	Road Development	Stream Crossings	Total Landcover Alteration	Wastewater Discharges	Water Licenses
Sockeye (lake-type)	581	Mcloughlin	1	100%	0%	100%	100%	0%	100%	100%	100%	0%	0%	0%	0%
	582	Mikado	1	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	583	Monckton Inlet Creek	1	100%	0%	0%	100%	100%	100%	100%	100%	100%	0%	100%	100%
	584	Namu	1	100%	0%	100%	100%	0%	100%	100%	100%	100%	0%	100%	100%
	525	Owikeno	**75**	100%	51%	100%	100%	56%	100%	87%	91%	91%	49%	100%	100%
	539	Pine River	1	100%	0%	100%	100%	0%	100%	100%	100%	100%	0%	100%	100%
	585	Port John	1	100%	100%	100%	100%	0%	100%	100%	100%	100%	0%	100%	0%
	586	Powles Creek	1	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	587	Price Creek	1	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	588	Roderick	1	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	589	Ryan Creek	1	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	590	Salter	1	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	591	Scoular/ Kilpatrick	1	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	592	Sheneeza Inlet	1	100%	0%	100%	100%	100%	100%	100%	100%	100%	0%	100%	100%
	593	Ship Point Creek	1	100%	0%	100%	100%	0%	100%	100%	100%	100%	0%	100%	100%
	530	Soda Creek	1	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	528	South Atnarko Lakes	**26**	96%	69%	8%	96%	58%	100%	42%	81%	73%	38%	100%	96%
	594	Spencer Creek	1	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	595	Stannard Creek	1	100%	0%	100%	100%	0%	100%	100%	100%	100%	0%	100%	100%
	596	Talamoosa Creek	1	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	597	Tankeeah River	1	100%	100%	100%	100%	0%	100%	100%	100%	100%	0%	100%	100%
	598	Treneman Creek	1	100%	0%	100%	100%	100%	100%	100%	100%	100%	0%	100%	100%
	599	Tsimtack/ Moore/Roger	2	100%	0%	100%	100%	100%	100%	100%	100%	100%	0%	100%	100%
	600	Tuno Creek East	1	100%	0%	100%	100%	0%	100%	100%	100%	100%	0%	100%	100%
	601	Tuno Creek West	1	100%	0%	100%	100%	0%	100%	100%	100%	100%	0%	100%	100%
	602	Tyler Creek	1	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	603	Wale Creek	1	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	527	Wannock (Owikeno)	**75**	100%	51%	100%	100%	56%	100%	87%	91%	91%	49%	100%	100%
	604	Watt Bay	1	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	605	West Creek	1	100%	0%	100%	100%	0%	100%	100%	100%	100%	0%	100%	100%
	606	Yaaklele Lagoon	1	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	0%
	607	Yeo	1	100%	0%	100%	100%	0%	100%	0%	0%	0%	0%	100%	100%

APPENDIX 16

Cumulative Spawning Pressure Results by Conservation Unit

TABLE A.10. The percentage of watersheds within each CU's spawning zone of influence that are rated high, moderate, or low risk (i.e. red, amber, green) for cumulative habitat pressures.

Species	**CU ID**	**Conservation Unit**	**Number of Watersheds in Spawning ZOI**				**Percentage (%)**		
			High Risk	Moderate Risk	Low Risk	**Total**	High Risk	Moderate Risk	Low Risk
Chinook	512	Bella Coola-Bentinck	17	9	14	**40**	43%	23%	35%
	513	Dean River	2	9	14	**25**	8%	36%	56%
	509	Docee	1	2	1	**4**	25%	50%	25%
	515	North & Central Coast-Early	15	24	63	**102**	15%	24%	62%
	514	North & Central Coast-Late	0	3	29	**32**	0%	9%	91%
	510	Rivers Inlet	2	18	31	**51**	4%	35%	61%
	511	Wannock	0	1	1	**2**	0%	50%	50%
Chum	505	Bella Coola River-Late	4	0	0	**4**	100%	0%	0%
	504	Bella Coola-Dean Rivers	13	17	11	**41**	32%	41%	27%
	508	Douglas-Gardner	15	38	64	**117**	13%	32%	55%
	506	Hecate Lowlands	1	10	111	**122**	1%	8%	91%
	507	Mussel-Kynoch	0	0	19	**19**	0%	0%	100%
	501	Rivers Inlet	2	15	4	**21**	10%	71%	19%
	500	Smith Inlet	3	6	7	**16**	19%	38%	44%
	503	Spiller-Fitz-Hugh-Burke	9	11	36	**56**	16%	20%	64%
	502	Wannock	0	1	1	**2**	0%	50%	50%
Coho	518	Bella Coola-Dean Rivers	11	9	2	**22**	50%	41%	9%
	521	Brim-Wahoo	0	0	4	**4**	0%	0%	100%
	522	Douglas Channel-Kitimat Arm	14	12	16	**42**	33%	29%	38%

Species	CU ID	Conservation Unit	Number of Watersheds in Spawning ZOI				Percentage (%)		
			High Risk	Moderate Risk	Low Risk	Total	High Risk	Moderate Risk	Low Risk
Coho	520	Hecate Strait Mainland	8	23	133	**164**	5%	14%	81%
	519	Mussel-Kynoch	0	1	12	**13**	0%	8%	92%
	523	Northern Coastal Streams	7	25	77	**109**	6%	23%	71%
	517	Rivers Inlet	3	21	14	**38**	8%	55%	37%
	516	Smith Inlet	3	4	5	**12**	25%	33%	42%
Pink (even-year)	608	Hecate Lowlands	7	22	128	**157**	4%	14%	82%
	609	Hecate Strait-Fjords	38	78	122	**238**	16%	33%	51%
Pink (odd-year)	612	Hecate Strait-Fjords	22	47	105	**174**	13%	27%	60%
	611	Hecate Strait-Lowlands	8	22	128	**158**	5%	14%	81%
	610	Homathko-Klinaklini-Smith-Rivers-Bella Coola-Dean	24	39	21	**84**	29%	46%	25%
Sockeye (river-type)	614	Northern Coastal Fjords	13	18	53	**84**	15%	21%	63%
	615	Northern Coastal Streams	1	10	24	**35**	3%	29%	69%
	613	Rivers-Smith Inlets	0	7	3	**10**	0%	70%	30%
Sockeye (lake-type)	529	Backland	0	1	2	**3**	0%	33%	67%
	540	Banks	0	0	2	**2**	0%	0%	100%
	541	Bloomfield	0	0	1	**1**	0%	0%	100%
	542	Bolton Creek	0	0	1	**1**	0%	0%	100%
	543	Bonilla	0	0	1	**1**	0%	0%	100%
	544	Borrowman Creek	0	0	1	**1**	0%	0%	100%
	545	Busey Creek	0	0	1	**1**	0%	0%	100%
	532	Canoona	0	0	1	**1**	0%	0%	100%
	546	Cartwright Creek	0	0	1	**1**	0%	0%	100%
	547	Chic Chic	0	0	1	**1**	0%	0%	100%
	548	Citeyats	0	0	1	**1**	0%	0%	100%
	550	Curtis Inlet	0	0	1	**1**	0%	0%	100%
	551	Dallain Creek	0	0	1	**1**	0%	0%	100%
	552	Deer	0	0	1	**1**	0%	0%	100%
	553	Devon	0	0	1	**1**	0%	0%	100%

Species	CU ID	Conservation Unit	Number of Watersheds in Spawning ZOI				Percentage (%)		
			High Risk	Moderate Risk	Low Risk	Total	High Risk	Moderate Risk	Low Risk
Sockeye (lake-type)	533	Dome	0	0	1	**1**	0%	0%	100%
	554	Douglas Creek	0	0	1	**1**	0%	0%	100%
	555	Elizabeth	0	0	2	**2**	0%	0%	100%
	556	Elsie/Hoy	0	1	0	**1**	0%	100%	0%
	557	End Hill Creek	0	0	1	**1**	0%	0%	100%
	534	Evelyn	0	1	0	**1**	0%	100%	0%
	558	Evinrude Inlet	0	0	1	**1**	0%	0%	100%
	549	Fannie Cove	0	0	1	**1**	0%	0%	100%
	559	Freeda	0	0	1	**1**	0%	0%	100%
	560	Hartley Bay	0	1	0	**1**	0%	100%	0%
	561	Hevenor Inlet	0	0	1	**1**	0%	0%	100%
	562	Higgins Lagoon	0	0	1	**1**	0%	0%	100%
	563	Kadjusdis River	0	0	1	**1**	0%	0%	100%
	535	Kainet Creek	0	0	2	**2**	0%	0%	100%
	564	Kdelmashan Creek	0	0	1	**1**	0%	0%	100%
	565	Keecha	0	0	1	**1**	0%	0%	100%
	566	Kent Inlet Lagoon Creek	0	0	1	**1**	0%	0%	100%
	567	Kenzuwash Creeks	0	0	1	**1**	0%	0%	100%
	568	Keswar Creek	0	0	1	**1**	0%	0%	100%
	569	Kildidt Creek	0	0	1	**1**	0%	0%	100%
	570	Kildidt Lagoon Creek	0	0	1	**1**	0%	0%	100%
	536	Kimsquit	0	0	2	**2**	0%	0%	100%
	571	Kisameet	0	0	1	**1**	0%	0%	100%
	537	Kitkiata	0	1	0	**1**	0%	100%	0%
	538	Kitlope	0	0	18	**18**	0%	0%	100%
	572	Koeye	0	1	3	**4**	0%	25%	75%
	573	Kooryet	0	0	1	**1**	0%	0%	100%
	574	Kunsoot River	1	0	0	**1**	100%	0%	0%
	575	Kwakwa Creek	0	0	3	**3**	0%	0%	100%
	576	Lewis Creek	0	0	1	**1**	0%	0%	100%
	577	Limestone Creek	0	0	1	**1**	0%	0%	100%
	524	Long	0	3	7	**10**	0%	30%	70%
	578	Lowe/Simpson/ Weir	0	0	3	**3**	0%	0%	100%
	579	Mary Cove Creek	0	1	0	**1**	0%	100%	0%

Species	CU ID	Conservation Unit	Number of Watersheds in Spawning ZOI				Percentage (%)		
			High Risk	Moderate Risk	Low Risk	Total	High Risk	Moderate Risk	Low Risk
Sockeye (lake-type)	580	Mcdonald Creek	0	0	1	**1**	0%	0%	100%
	581	Mcloughlin	1	0	0	**1**	100%	0%	0%
	582	Mikado	0	0	1	**1**	0%	0%	100%
	583	Monckton Inlet Creek	0	0	1	**1**	0%	0%	100%
	584	Namu	0	0	1	**1**	0%	0%	100%
	525	Owikeno	3	10	62	**75**	4%	13%	83%
	539	Pine River	0	0	1	**1**	0%	0%	100%
	585	Port John	0	0	1	**1**	0%	0%	100%
	586	Powles Creek	0	0	1	**1**	0%	0%	100%
	587	Price Creek	0	0	1	**1**	0%	0%	100%
	588	Roderick	0	0	1	**1**	0%	0%	100%
	589	Ryan Creek	0	0	1	**1**	0%	0%	100%
	590	Salter	0	0	1	**1**	0%	0%	100%
	591	Scoular/ Kilpatrick	0	0	1	**1**	0%	0%	100%
	592	Sheneeza Inlet	0	0	1	**1**	0%	0%	100%
	593	Ship Point Creek	0	0	1	**1**	0%	0%	100%
	530	Soda Creek	0	0	1	**1**	0%	0%	100%
	528	South Atnarko Lakes	5	4	17	**26**	19%	15%	65%
	594	Spencer Creek	0	0	1	**1**	0%	0%	100%
	595	Stannard Creek	0	0	1	**1**	0%	0%	100%
	596	Talamoosa Creek	0	0	1	**1**	0%	0%	100%
	597	Tankeeah River	0	0	1	**1**	0%	0%	100%
	598	Treneman Creek	0	0	1	**1**	0%	0%	100%
	599	Tsimtack/ Moore/Roger	0	0	2	**2**	0%	0%	100%
	600	Tuno Creek East	0	0	1	**1**	0%	0%	100%
	601	Tuno Creek West	0	0	1	**1**	0%	0%	100%
	602	Tyler Creek	0	0	1	**1**	0%	0%	100%
	603	Wale Creek	0	0	1	**1**	0%	0%	100%
	527	Wannock (Owikeno)	3	10	62	**75**	4%	13%	83%
	604	Watt Bay	0	0	1	**1**	0%	0%	100%
	605	West Creek	0	0	1	**1**	0%	0%	100%
	606	Yaaklele Lagoon	0	0	1	**1**	0%	0%	100%
	607	Yeo	1	0	0	**1**	100%	0%	0%

APPENDIX 17

Cumulative Pressure Risk Ratings for Each CU Based on Risk Rating Percentages of Spawning ZOI Watersheds

TABLE A.11. This table presents the CU-scale spawning habitat status based on the percentage of watersheds within each CU's spawning zone of influence that are rated high, moderate, or low risk (i.e. red, amber, green) for cumulative habitat pressures. CUs with ≥25% of their spawning watersheds rated as high risk are rated high risk at the CU scale. CUs with 100% of their spawning watersheds rated as low risk are rated low risk at the CU scale. All other CUs are rated moderate risk at the CU scale.

Species	CU ID	Conservation Unit	Total Number of Watersheds in Spawning ZOI	Percentage (%)			CU-scale Spawning Habitat Status
				High Risk	Moderate Risk	Low Risk	
Chinook	512	Bella Coola-Bentinck	**40**	43%	23%	35%	🟥
	513	Dean River	**25**	8%	36%	56%	🟨
	509	Docee	**4**	25%	50%	25%	🟥
	515	North & Central Coast-Early	**102**	15%	24%	62%	🟨
	514	North & Central Coast-Late	**32**	0%	9%	91%	🟨
	510	Rivers Inlet	**51**	4%	35%	61%	🟨
	511	Wannock	**2**	0%	50%	50%	🟨
Chum	505	Bella Coola River-Late	**4**	100%	0%	0%	🟥
	504	Bella Coola-Dean Rivers	**41**	32%	41%	27%	🟥
	508	Douglas-Gardner	**117**	13%	32%	55%	🟨
	506	Hecate Lowlands	**122**	1%	8%	91%	🟨
	507	Mussel-Kynoch	**19**	0%	0%	100%	🟩
	501	Rivers Inlet	**21**	10%	71%	19%	🟨
	500	Smith Inlet	**16**	19%	38%	44%	🟨
	503	Spiller-Fitz-Hugh-Burke	**56**	16%	20%	64%	🟨
	502	Wannock	**2**	0%	50%	50%	🟨

Species	CU ID	Conservation Unit	Total Number of Watersheds in Spawning ZOI	Percentage (%)			CU-scale Spawning Habitat Status
				High Risk	Moderate Risk	Low Risk	
Coho	518	Bella Coola-Dean Rivers	**22**	50%	41%	9%	🟥
	521	Brim-Wahoo	**4**	0%	0%	100%	🟩
	522	Douglas Channel-Kitimat Arm	**42**	33%	29%	38%	🟥
	520	Hecate Strait Mainland	**164**	5%	14%	81%	🟨
	519	Mussel-Kynoch	**13**	0%	8%	92%	🟨
	523	Northern Coastal Streams	**109**	6%	23%	71%	🟨
	517	Rivers Inlet	**38**	8%	55%	37%	🟨
	516	Smith Inlet	**12**	25%	33%	42%	🟥
Pink (even-year)	608	Hecate Lowlands	**157**	4%	14%	82%	🟨
	609	Hecate Strait-Fjords	**238**	16%	33%	51%	🟨
Pink (odd-year)	612	Hecate Strait-Fjords	**174**	13%	27%	60%	🟨
	611	Hecate Strait-Lowlands	**158**	5%	14%	81%	🟨
	610	Homathko-Klinaklini-Smith-Rivers-Bella Coola-Dean	**84**	29%	46%	25%	🟥
Sockeye (river-type)	614	Northern Coastal Fjords	**84**	15%	21%	63%	🟨
	615	Northern Coastal Streams	**35**	3%	29%	69%	🟨
	613	Rivers-Smith Inlets	**10**	0%	70%	30%	🟨
Sockeye (lake-type)	529	Backland	**3**	0%	33%	67%	🟨
	540	Banks	**2**	0%	0%	100%	🟩
	541	Bloomfield	**1**	0%	0%	100%	🟩
	542	Bolton Creek	**1**	0%	0%	100%	🟩
	543	Bonilla	**1**	0%	0%	100%	🟩
	544	Borrowman Creek	**1**	0%	0%	100%	🟩
	545	Busey Creek	**1**	0%	0%	100%	🟩

Species	CU ID	Conservation Unit	Total Number of Watersheds in Spawning ZOI	Percentage (%)			CU-scale Spawning Habitat Status
				High Risk	Moderate Risk	Low Risk	
Sockeye (lake-type)	532	Canoona	1	0%	0%	100%	🟩
	546	Cartwright Creek	1	0%	0%	100%	🟩
	547	Chic Chic	1	0%	0%	100%	🟩
	548	Citeyats	1	0%	0%	100%	🟩
	550	Curtis Inlet	1	0%	0%	100%	🟩
	551	Dallain Creek	1	0%	0%	100%	🟩
	552	Deer	1	0%	0%	100%	🟩
	553	Devon	1	0%	0%	100%	🟩
	533	Dome	1	0%	0%	100%	🟩
	554	Douglas Creek	1	0%	0%	100%	🟩
	555	Elizabeth	2	0%	0%	100%	🟩
	556	Elsie/Hoy	1	0%	100%	0%	🟨
	557	End Hill Creek	1	0%	0%	100%	🟩
	534	Evelyn	1	0%	100%	0%	🟨
	558	Evinrude Inlet	1	0%	0%	100%	🟩
	549	Fannie Cove	1	0%	0%	100%	🟩
	559	Freeda	1	0%	0%	100%	🟩
	560	Hartley Bay	1	0%	100%	0%	🟨
	561	Hevenor Inlet	1	0%	0%	100%	🟩
	562	Higgins Lagoon	1	0%	0%	100%	🟩
	563	Kadjusdis River	1	0%	0%	100%	🟩
	535	Kainet Creek	2	0%	0%	100%	🟩
	564	Kdelmashan Creek	1	0%	0%	100%	🟩
	565	Keecha	1	0%	0%	100%	🟩
	566	Kent Inlet Lagoon Creek	1	0%	0%	100%	🟩
	567	Kenzuwash Creeks	1	0%	0%	100%	🟩
	568	Keswar Creek	1	0%	0%	100%	🟩
	569	Kildidt Creek	1	0%	0%	100%	🟩
	570	Kildidt Lagoon Creek	1	0%	0%	100%	🟩
	536	Kimsquit	2	0%	0%	100%	🟩
	571	Kisameet	1	0%	0%	100%	🟩
	537	Kitkiata	1	0%	100%	0%	🟨

Species	CU ID	Conservation Unit	Total Number of Watersheds in Spawning ZOI	Percentage (%)			CU-scale Spawning Habitat Status
				High Risk	Moderate Risk	Low Risk	
Sockeye (lake-type)	538	Kitlope	**18**	0%	0%	100%	🟩
	572	Koeye	**4**	0%	25%	75%	🟨
	573	Kooryet	**1**	0%	0%	100%	🟩
	574	Kunsoot River	**1**	100%	0%	0%	🟥
	575	Kwakwa Creek	**3**	0%	0%	100%	🟩
	576	Lewis Creek	**1**	0%	0%	100%	🟩
	577	Limestone Creek	**1**	0%	0%	100%	🟩
	524	Long	**10**	0%	30%	70%	🟨
	578	Lowe/Simpson/ Weir	**3**	0%	0%	100%	🟩
	579	Mary Cove Creek	**1**	0%	100%	0%	🟨
	580	Mcdonald Creek	**1**	0%	0%	100%	🟩
	581	Mcloughlin	**1**	100%	0%	0%	🟥
	582	Mikado	**1**	0%	0%	100%	🟩
	583	Monckton Inlet Creek	**1**	0%	0%	100%	🟩
	584	Namu	**1**	0%	0%	100%	🟩
	525	Owikeno	**75**	4%	13%	83%	🟨
	539	Pine River	**1**	0%	0%	100%	🟩
	585	Port John	**1**	0%	0%	100%	🟩
	586	Powles Creek	**1**	0%	0%	100%	🟩
	587	Price Creek	**1**	0%	0%	100%	🟩
	588	Roderick	**1**	0%	0%	100%	🟩
	589	Ryan Creek	**1**	0%	0%	100%	🟩
	590	Salter	**1**	0%	0%	100%	🟩
	591	Scoular/ Kilpatrick	**1**	0%	0%	100%	🟩
	592	Sheneeza Inlet	**1**	0%	0%	100%	🟩
	593	Ship Point Creek	**1**	0%	0%	100%	🟩
	530	Soda Creek	**1**	0%	0%	100%	🟩
	528	South Atnarko Lakes	**26**	19%	15%	65%	🟨
	594	Spencer Creek	**1**	0%	0%	100%	🟩
	595	Stannard Creek	**1**	0%	0%	100%	🟩
	596	Talamoosa Creek	**1**	0%	0%	100%	🟩
	597	Tankeeah River	**1**	0%	0%	100%	🟩

Species	CU ID	Conservation Unit	Total Number of Watersheds in Spawning ZOI	Percentage (%)			CU-scale Spawning Habitat Status
				High Risk	Moderate Risk	Low Risk	
Sockeye (lake-type)	598	Treneman Creek	**1**	0%	0%	100%	🟩
	599	Tsimtack/ Moore/Roger	**2**	0%	0%	100%	🟩
	600	Tuno Creek East	**1**	0%	0%	100%	🟩
	601	Tuno Creek West	**1**	0%	0%	100%	🟩
	602	Tyler Creek	**1**	0%	0%	100%	🟩
	603	Wale Creek	**1**	0%	0%	100%	🟩
	527	Wannock (Owikeno)	**75**	4%	13%	83%	🟨
	604	Watt Bay	**1**	0%	0%	100%	🟩
	605	West Creek	**1**	0%	0%	100%	🟩
	606	Yaaklele Lagoon	**1**	0%	0%	100%	🟩
	607	Yeo	**1**	100%	0%	0%	🟥

APPENDIX 18

Area-weighted Cumulative Pressure Risk Ratings for Each CU's Migration ZOI

TABLE A.12. Area-weighted cumulative pressure risk ratings for each CU's migration zone of influence. Darker cells indicate relatively higher risk of habitat degradation. Lighter cells indicate relatively lower risk of habitat degradation.

Species	CU ID	Conservation Unit	ZOI Area (km²)	Number of Watersheds in ZOI	Total Cumulative Risk Score (sum across ZOI watersheds)	Area-Weighted Mean Cumulative Risk
Chinook	513	Dean River	7893.14	164	829	5.06
	512	Bella Coola-Bentinck	6527.43	126	539	4.29
	510	Rivers Inlet	5532.24	101	216	2.64
	509	Docee	508.62	12	23	2.24
	515	North & Central Coast-Early	12460.28	257	447	1.88
	511	Wannock	4015.01	79	129	1.87
	514	North & Central Coast-Late	4284.79	91	41	0.53
Chum	505	Bella Coola River-Late	293.13	6	54	9.10
	504	Bella Coola-Dean Rivers	18149.54	370	1467	4.01
	500	Smith Inlet	2100.26	41	139	3.64
	503	Spiller-Fitz-Hugh-Burke	5726.71	122	362	3.11
	501	Rivers Inlet	5388.92	102	243	2.71
	502	Wannock	34.43	2	5	2.25
	508	Douglas-Gardner	13681.43	280	515	2.03
	506	Hecate Lowlands	7482.15	160	150	1.13
	507	Mussel-Kynoch	1418.48	32	4	0.14
Coho	518	Bella Coola-Dean Rivers	16180.26	327	1433	4.38
	522	Douglas Channel-Kitimat Arm	3385.63	65	245	3.81
	516	Smith Inlet	1650.58	35	120	3.69
	517	Rivers Inlet	5905.60	111	274	2.78

Species	CU ID	Conservation Unit	ZOI Area (km²)	Number of Watersheds in ZOI	Total Cumulative Risk Score (sum across ZOI watersheds)	Area-Weighted Mean Cumulative Risk
Coho	523	Northern Coastal Streams	14694.35	316	521	1.83
	520	Hecate Strait Mainland	11045.20	229	361	1.78
	519	Mussel-Kynoch	1372.55	31	4	0.15
	521	Brim-Wahoo	464.08	11	0	0.00
Pink (even-year)	609	Hecate Strait-Fjords	43031.66	884	2515	3.01
	608	Hecate Lowlands	11281.50	232	430	2.02
Pink (odd-year)	610	Homathko-Klinaklini-Smith-Rivers-Bella Coola-Dean	39915.93	767	2928	3.98
	612	Hecate Strait-Fjords	20262.89	431	796	2.03
	611	Hecate Strait-Lowlands	11281.50	232	430	2.02
Sockeye (river-type)	614	Northern Coastal Fjords	39539.18	823	2291	2.92
	615	Northern Coastal Streams	9942.93	203	516	2.75
	613	Rivers-Smith Inlets	6588.51	126	286	2.64
Sockeye (lake-type)	607	Yeo	95.26	2	16	7.43
	581	Mcloughlin	133.72	2	10	6.13
	593	Ship Point Creek	133.72	2	10	6.13
	528	South Atnarko Lakes	1922.56	37	211	5.69
	534	Evelyn	70.24	1	5	5.00
	556	Elsie/Hoy	187.21	3	15	4.91
	524	Long	224.22	5	20	4.74
	563	Kadjusdis River	161.54	3	10	4.66
	574	Kunsoot River	161.54	3	10	4.66
	537	Kitkiata	197.05	3	13	4.43
	540	Banks	137.79	2	8	3.91
	560	Hartley Bay	119.83	2	5	3.74
	536	Kimsquit	998.24	19	60	3.11
	575	Kwakwa Creek	90.39	1	3	3.00
	585	Port John	85.77	1	3	3.00

Species	CU ID	Conservation Unit	ZOI Area (km²)	Number of Watersheds in ZOI	Total Cumulative Risk Score (sum across ZOI watersheds)	Area-Weighted Mean Cumulative Risk
Sockeye (lake-type)	572	Koeye	204.25	4	13	2.98
	529	Backland	349.89	5	14	2.75
	525	Owikeno	352.21	9	24	2.69
	527	Wannock (Owikeno)	352.21	9	24	2.69
	584	Namu	227.18	4	10	2.60
	555	Elizabeth	234.29	3	8	2.59
	539	Pine River	82.97	2	5	2.48
	583	Monckton Inlet Creek	133.25	2	4	2.27
	597	Tankeeah River	171.36	3	6	2.26
	547	Chic Chic	199.17	4	7	2.10
	554	Douglas Creek	160.51	5	9	2.05
	548	Citeyats	222.49	4	7	2.01
	553	Devon	62.40	1	2	2.00
	600	Tuno Creek East	105.74	2	4	2.00
	601	Tuno Creek West	105.74	2	4	2.00
	606	Yaaklele Lagoon	78.96	2	4	2.00
	578	Lowe/Simpson/ Weir	285.48	4	7	1.84
	576	Lewis Creek	236.78	5	7	1.79
	579	Mary Cove Creek	92.97	2	3	1.76
	588	Roderick	92.97	2	3	1.76
	605	West Creek	113.30	2	3	1.68
	604	Watt Bay	197.02	3	5	1.56
	558	Evinrude Inlet	88.45	2	2	1.52
	544	Borrowman Creek	150.33	2	3	1.51
	577	Limestone Creek	278.37	5	8	1.45
	595	Stannard Creek	186.54	3	4	1.41
	599	Tsimtack/ Moore/Roger	179.95	4	5	1.31
	535	Kainet Creek	257.28	5	6	1.23
	571	Kisameet	158.45	4	5	1.23
	550	Curtis Inlet	191.40	3	3	1.00
	532	Canoona	166.80	2	2	1.00
	561	Hevenor Inlet	74.13	1	1	1.00
	562	Higgins Lagoon	131.39	2	2	1.00

Species	CU ID	Conservation Unit	ZOI Area (km²)	Number of Watersheds in ZOI	Total Cumulative Risk Score (sum across ZOI watersheds)	Area-Weighted Mean Cumulative Risk
Sockeye (lake-type)	592	Sheneeza Inlet	66.86	1	1	1.00
	598	Treneman Creek	109.45	2	2	1.00
	542	Bolton Creek	97.57	3	2	0.98
	552	Deer	124.44	3	2	0.89
	559	Freeda	148.00	3	3	0.84
	582	Mikado	159.93	3	2	0.78
	589	Ryan Creek	110.06	2	1	0.77
	565	Keecha	152.05	3	2	0.73
	549	Fannie Cove	307.63	4	2	0.72
	603	Wale Creek	204.58	4	2	0.66
	590	Salter	119.45	3	2	0.65
	557	End Hill Creek	105.64	3	2	0.54
	545	Busey Creek	142.59	3	1	0.53
	602	Tyler Creek	142.76	3	1	0.53
	546	Cartwright Creek	223.36	2	2	0.50
	567	Kenzuwash Creeks	242.23	5	2	0.46
	569	Kildidt Creek	205.42	3	3	0.42
	580	Mcdonald Creek	127.22	3	1	0.28
	570	Kildidt Lagoon Creek	137.17	3	1	0.26
	587	Price Creek	151.86	4	1	0.24
	530	Soda Creek	162.52	4	1	0.23
	564	Kdelmashan Creek	166.38	4	1	0.22
	543	Bonilla	176.36	6	1	0.06
	541	Bloomfield	125.66	2	0	0.00
	551	Dallain Creek	112.77	2	0	0.00
	533	Dome	149.45	3	0	0.00
	566	Kent Inlet Lagoon Creek	112.77	2	0	0.00
	568	Keswar Creek	124.55	2	0	0.00
	538	Kitlope	450.17	11	0	0.00
	573	Kooryet	151.90	3	0	0.00
	586	Powles Creek	166.90	4	0	0.00
	591	Scoular/ Kilpatrick	46.24	1	0	0.00
	594	Spencer Creek	44.22	1	0	0.00
	596	Talamoosa Creek	112.77	2	0	0.00

APPENDIX 19

Conservation Units at High Risk of Habitat Degradation

TABLE A.13. Conservation Units with 25% or more of the spawning habitat (or zone of influence) designated as high risk.

Species	CU ID	Conservation Unit	Number of High Risk Watersheds	Total Number of Watersheds in Spawning ZOI	High Risk	Location
Chinook	512	Bella Coola-Bentinck	17	**40**	**43%**	Bella Coola
	509	Docee	1	**4**	**25%**	Rivers Inlet, Smith Inlet
Chum	505	Bella Coola River-Late	4	**4**	**100%**	Bella Coola
	504	Bella Coola-Dean Rivers	13	**41**	**32%**	Bella Coola
Coho	518	Bella Coola-Dean Rivers	11	**22**	**50%**	Bella Coola
	522	Douglas Channel-Kitimat Arm	14	**42**	**33%**	Kitimat
	516	Smith Inlet	3	**12**	**25%**	Rivers Inlet, Smith Inlet
Pink (odd-year)	610	Homathko-Klinaklini-Smith-Rivers-Bella Coola-Dean	24	**84**	**29%**	Bella Coola, Rivers Inlet, Smith Inlet
Sockeye (lake-type)	574	Kunsoot River	1	**1**	**100%**	Bella Bella
	581	Mcloughlin	1	**1**	**100%**	Bella Bella
	607	Yeo	1	**1**	**100%**	Bella Bella

October 25, 2018

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