Skeena Sustainability Assessment Forum's State of the Value Report for Fish & Fish Habitat

Skeena ESI Area

Prepared for Skeena Sustainability (SSAF) of the Skeena Environmental Stewardship Initiative

Final report (February 2021) prepared for the
Skeena ESI Science and Technical Committee (STC)

Citation

Skeena Sustainability Assessment Forum (SSAF). 2021. Skeena Sustainability Assessment Forum's State of the Value Report for Fish & Fish Habitat. Final draft prepared by Carolyn King and Jesse Fraser of Ministry of Forests, Lands, Natural Resource Operations, and Rural Development for the Skeena Environmental Stewardship Initiative Science and Technical Committee (STC). 190 pp.

Acknowledgements

This report was endorsed by the Skeena Sustainability Assessment Forum (SSAF), based on the work conducted through the Skeena ESI Science and Technical Committee (STC) document. STC review and discussions have contributed greatly to this report. Sincere thanks to the Pacific Salmon Foundation's Salmon Watersheds Program for sharing the most updated NuSEDS salmon escapement datasets for monitored streams in the Skeena and Nass River basins.

Document Version History

Date	Version #	Author(s)	Description of Changes Initials are as follows: STC: Scientific and Technical Committee; MP: Marc Porter; SC: Simon Casley, JA: John Arnett; JF: Jesse Fraser; CK: Carolyn King
October 2019	1	MP, SC, JA, JF	First draft prepared by Marc Porter of ESSA Technologies Ltd., Simon Casley and John Arnett of Chartwell Consultants Ltd., and Jesse Fraser of Ministry of Forest, Lands, Natural Resource Operations, and Rural Development
Dec 2019–March 2020	1.1	STC	STC review of prepared draft
March 2020	1.2	MP, SC, JA, JF	Revised draft prepared by Marc Porter of ESSA Technologies Ltd., Simon Casley and John Arnett of Chartwell Consultants Ltd., and Jesse Fraser of Ministry of Forest, Lands, Natural Resource Operations, and Rural Development
November 2020	2	CK, JF	Second draft prepared by Carolyn King and Jesse Fraser of Ministry of Forest, Lands, Natural Resource Operations, and Rural Development. 2015 provincial data updated to 2018 (most recent) for indicators, and revisions made throughout.

November 20, 2020 – January 2021	2.1	STC	Revised draft completed after receiving comments from STC reviewers. Executive summary analysis and interpretation redone, and additions made to policy, current monitoring and future work sections. Reviewers included: Jeff Anderson, Sam Pittman, Mike Ridsdale, David Dewit on behalf of Office of the Wet’suwet’en; Mark Cleveland and Kyla Warran on behalf of Gitanyow Nation, and Eric Smith, and Dave Wilford on behalf of the Ministry of Forests, Lands, Natural Resource Operations and Rural Development.
January 2021	3	CK, JF, MP	Final draft completed by Carolyn King and Jesse Fraser with technical assistance from Marc Porter.
February 2021	3	Project Team	Final draft endorsed by the SSAF Project Team.

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List of Acronyms

AU	Aquatic assessment unit
B.C.	British Columbia
BTM	Baseline Thematic Mapping
CEF	Cumulative Effects Framework
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DDR	Drainage density ruggedness
DFO	Fisheries and Oceans Canada
DRA	Digital Road Atlas
EA	Environmental assessment
ECA	Equivalent Clearcut Area
EFN	Environmental Flow Needs
EPMR	Environmental Protection and Management
ESI	Environmental Stewardship Initiative
EAUBC	Ecological Aquatic Units of British Columbia
FAIB	Forest Analysis and Inventory Branch
FISS	Fish Information Summary System
FOWN	Forest Cover Ownership
FTEN	Forest Tenure
FWA	B.C. Freshwater Atlas
GAR	Government Actions Regulation
ISP	Indigenous Stewardship Project
IWMS	Identified Wildlife Management Strategy
MAD	Mean annual discharge
NuSEDS	New Salmon Escapement Database System
OGC	B.C. Oil and Gas Commission
PODs	Points of diversion
RESULTS	Reporting Silviculture Updates and Land Status Tracking System
SARA	Species at Risk Act
SSAF	Skeena Sustainable Assessment Forum
STC	Skeena ESI Science and Technical Committee
Tantalis	Crown Land Registry (database)
TFL	Tree Farm License
THLB	Timber Harvesting Land Base
TRIM	Terrain Resource Information System
TSA	Timber Supply Area
TSR	Timber Supply Review
VRI	Vegetation Resources Inventory
WSP	Wild Salmon Policy

Executive Summary

Fish have significant food, social, and ceremonial value for many First Nations. Fish populations and fish habitat are influenced by human activities, natural disturbances, natural landscape features, and climate. Fish, and particularly pacific salmon (*Oncorhynchus* spp.), are an important source of food for many Nations, have high value for recreational and commercial fisheries, and are an important food source for grizzly bears. Salmon stocks, and particularly sockeye, have seen significant declines over recent decades which has led many Nations to implement voluntary moratoriums on harvest of sockeye. Sockeye hold significant cultural value for many Skeena Sustainability Assessment Forum (SSAF) Nations, so not being able to harvest sockeye has direct and negative impacts on the ability of Nations to practice culture, and to share oral histories which may be communicated alongside certain activities. This SSAF State of the Value Report for Fish and Fish Habitat provides an overview of the current condition of fish and fish habitat in the SSAF study area and describes some of the key drivers behind these results. Salmon stocks in the SSAF study area have been affected by habitat alterations and Nations have seen significant declines in sockeye salmon populations.

This framework includes pressures, watershed sensitivity, and watershed importance indicators, and are displayed as follows:

- Potential **pressures** that may impact fish and fish habitat reflect anthropogenic and natural disturbances that may change the functioning of a river system, and therefore the habitat for fish. This includes four measures of road density, equivalent clearcut area, young second growth forest (<80 years), riparian disturbance, total land disturbance, dams and impoundments, water licenses, groundwater wells, water allocation restrictions, mines, and point source pollution.
- **Watershed sensitivity** indicators are natural features that influence water flow in an assessment unit (AU), and include low flow sensitivity, drainage density ruggedness, and lakes, wetlands, and man-made waterbodies.
- **Watershed importance** indicators refer to specific characteristics of an AU that are important for salmonid species, and include modeled salmonid habitat extent, observed salmon spawning extent, and salmon escapement. It is important to note that observed salmon habitat does not attempt to quantify historic spawning habitat; the STC recognizes that past industrial activity has likely resulted in current levels that are lower than historic levels.

This state of the value report is informed by 20 indicators, and a selection of these indicators has been chosen for presentation here. Results of this study are displayed as a dashboard for 5 major watersheds (Coastal, Nass, Nechako/Fraser, Skeena East, and Skeena West); data are presented as box plots (large vertical line represents the median, whiskers represent the 5thand 95th percentiles, and dots as outliers). Pressure and watershed sensitivity indicators are displayed across low, medium and high concern rankings. The precautionary principle has been used to identify thresholds that are supported by current knowledge for the values of road density, equivalent clearcut area, and riparian disturbance. The indicators of young second growth forest, point source pollution, total land disturbance, and drainage

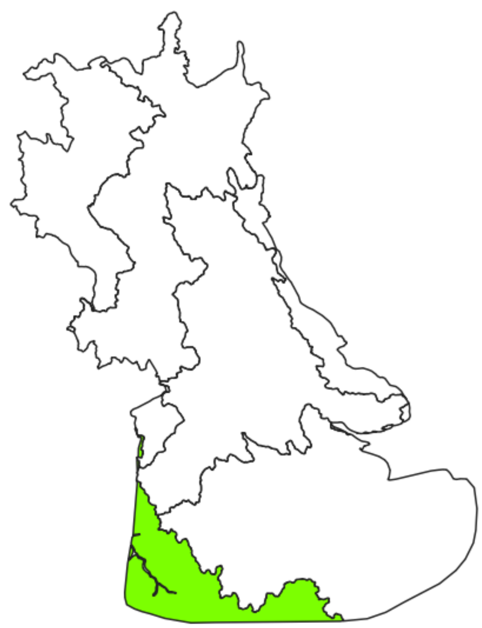
density ruggedness do not have identified benchmarks, breakpoints were identified to provide a relative ranking within the SSAF area to enable communication of the results.

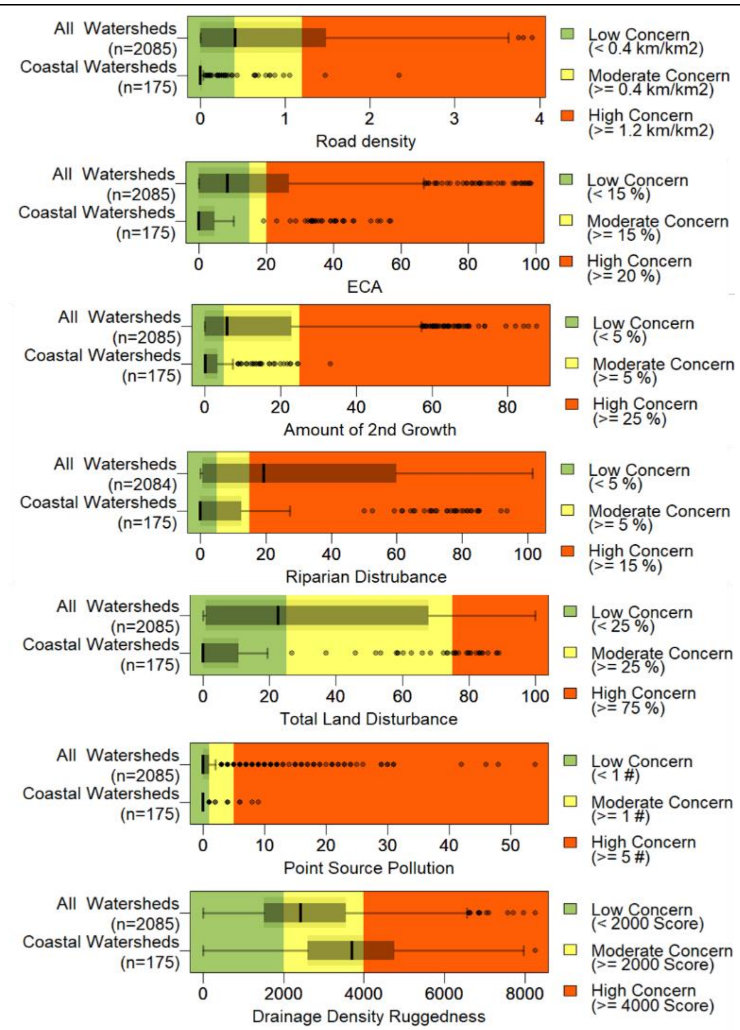
This information is a coarse filter approach at the landscape level, referred to as a Tier 1 approach, that is based on our current knowledge of readily available data (current to 2018) that spans the entire SSAF study area. This report is a single point in time; significant work is being made on updating datasets which will contribute to future versions of this report. This report is one piece of a broader cumulative effects program which is an iterative and multi-scaled approach to cumulative effects assessment in the SSAF area. Complimentary initiatives will enhance our understanding of the state of fish and fish habitat by collecting and analyzing information from direct analysis and observations (Tier 1.5, 2, 3). Tier 1.5 work has not yet started for fish and fish habitat value but will involve refining and updating the various datasets used in the Tier 1 review, watershed monitoring through remote sensing, accompanied by more detailed hydrological characteristics. Tier 2 work involves water and benthic invertebrate sampling from specific streams inside watersheds which have been selected for sampling based on Nation specific metrics (e.g. a Nation may sample a certain stream that has cultural or community importance) and a subset of the Tier 1 assessment data. Tier 3 involves more intensive studies to answer specific management questions or specific research questions, and these learnings will become incorporated into the Tier 1 and 2 assessments over time.

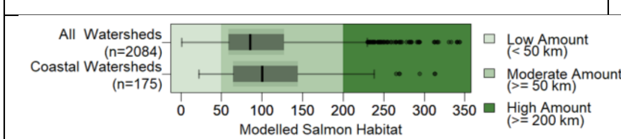
Although this report will not lead to decision making on its own, it can serve as a source of information that can be used to support decision making. Information provided within the report, and the associated database that was developed through the process, can be reframed to support decision makers - contingent on the specified management needs. Sections eight and nine of this document outline future research and monitoring work that can contribute to future analyses and iterations of this report.

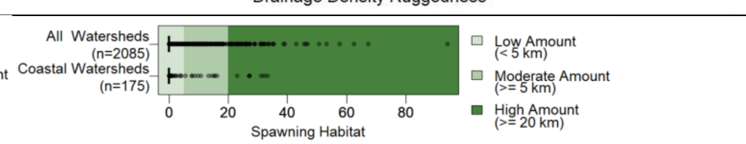
Coastal Unit Summary

The Coastal Unit accounts for the smallest portion of the SSAF Study Area and contains 8.4% of all assessment units (AUs). AUs in the Coastal Unit have relatively less intense pressures and lower watershed sensitivity when compared to the rest of the study area. The watershed pressures of road density, equivalent clearcut area, young second growth forest, riparian disturbance, total land disturbance, and point source pollution all rank as low concern for the Coastal Unit. The Coastal Unit has a higher than average drainage density ruggedness, which can be explained by the steeper topography of the coastal mountains when compared to the inland areas of the SSAF. Drainage density ruggedness is a metric intended to identify how quickly hillslope and stream runoff could be transported downslope or downstream through a watershed, thereby reflecting the potential for flash-floods events. The Coastal Unit has a moderate amount of modelled salmon habitat and low amount of observed spawning habitat, which is comparable to the broader SSAF area. Although the indicators of young second growth forest, point source pollution, total land disturbance, and drainage density ruggedness do not have identified benchmarks, breakpoints were identified to provide a relative ranking within the SSAF area to enable communication of the results.



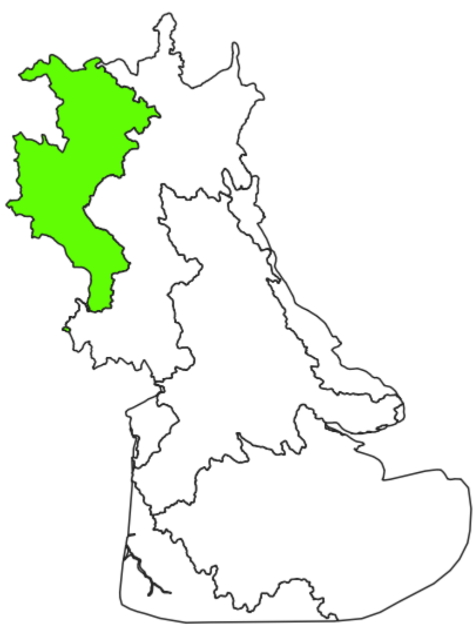


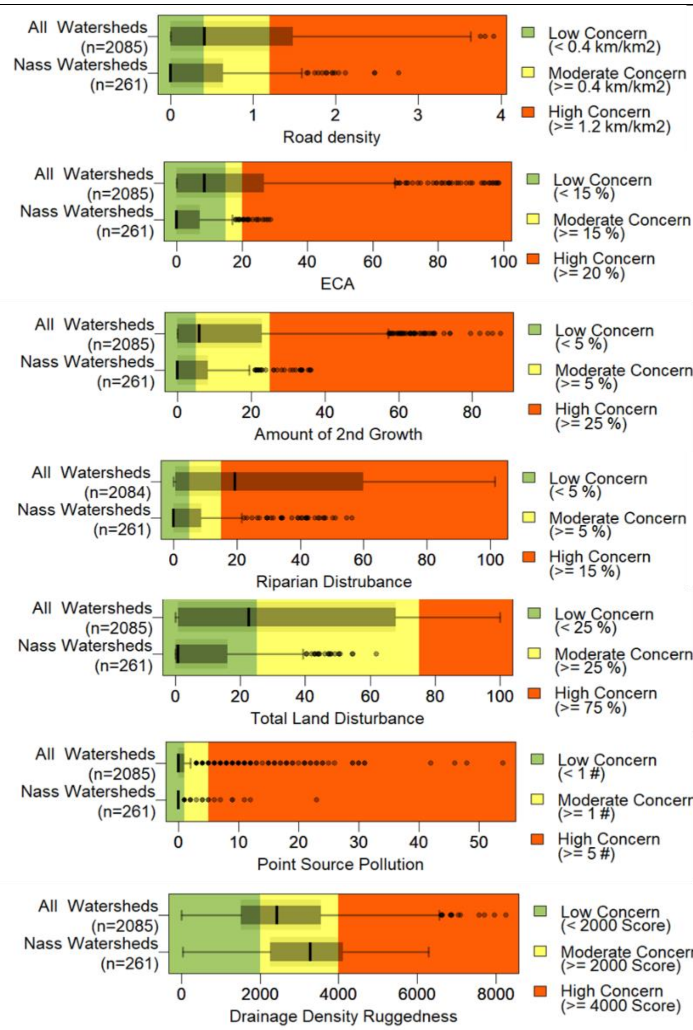


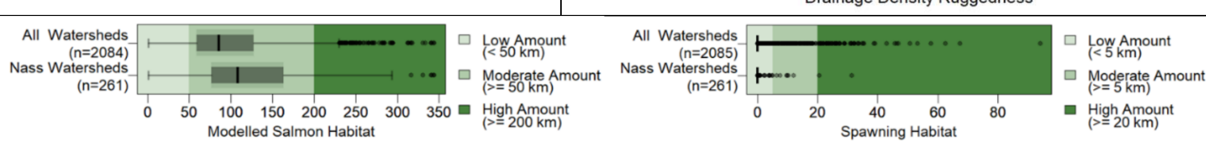


Nass Unit Summary

The Nass Unit accounts for 12.5% of the SSAF Study Area. AUs in the Nass Unit, when compared to the entire area, have relatively less intense pressure and sensitivity indicators. The watershed pressures of road density, equivalent clearcut area, young second growth forest, riparian disturbance, total land disturbance, and point source pollution all rank as low concern for the Nass Unit. The Nass Unit has a higher than average drainage density ruggedness, which can be explained by the steeper topography of the coastal mountains when compared to the inland areas of the SSAF. Drainage density ruggedness is a metric intended to identify how quickly hillslope and stream runoff could be transported downslope or downstream through a watershed, thereby reflecting the potential for flash-floods events. Modelled salmon habitat is moderate overall and is slightly higher when compared to the entire SSAF area. Observed spawning habitat ranks as low yet is comparable to the broader SSAF area. Although the indicators of young second growth forest, point source pollution, total land disturbance, and drainage density ruggedness do not have identified benchmarks, breakpoints were identified to provide a relative ranking within the SSAF area to enable communication of the results.

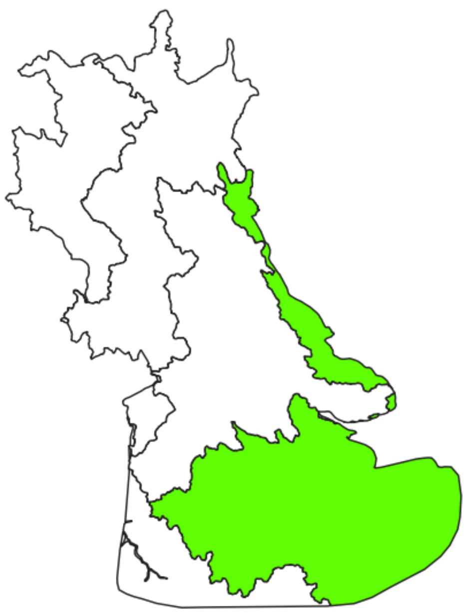


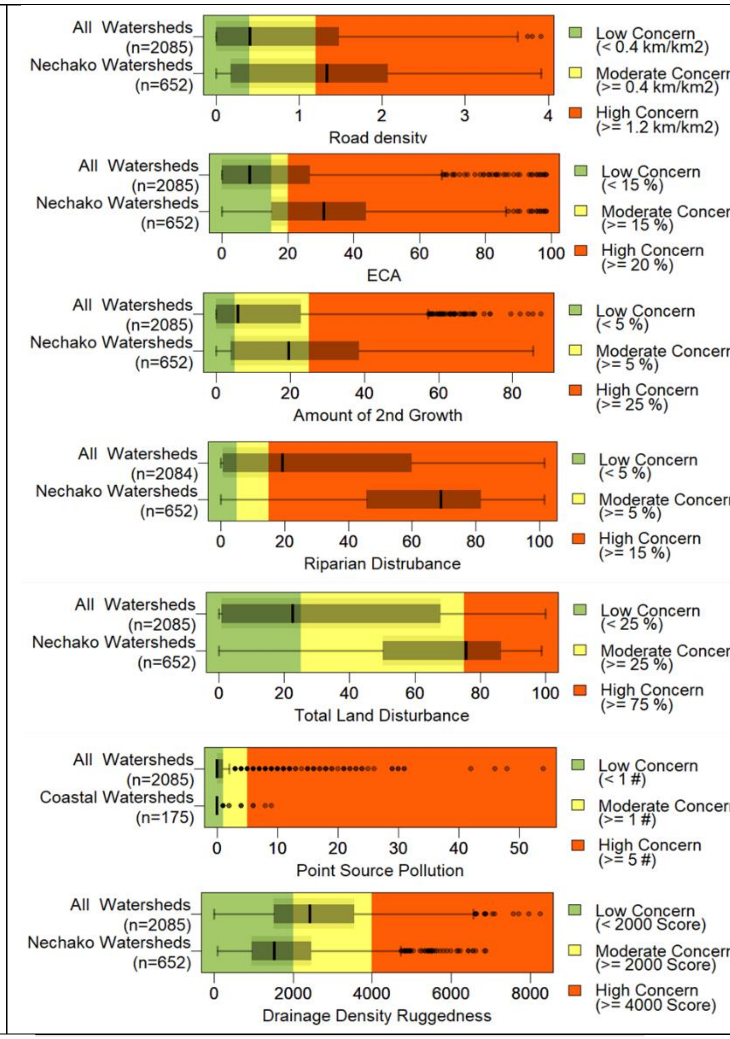


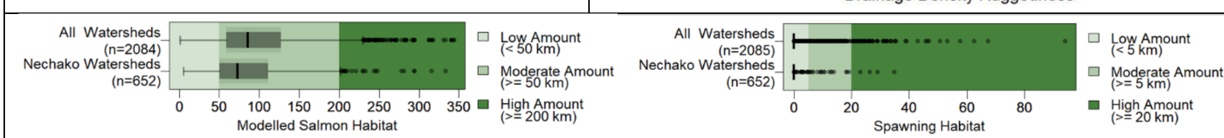


Nechacko/Fraser Unit Summary

The Nechako/Fraser Unit makes up the largest portion of the SSAF area at 31.3% of all AUs. AUs in the Nechako have relatively more pronounced pressures, with high concern rankings for road density, equivalent clearcut area, riparian disturbance, and total land disturbance. These higher risks are related to logging impacts as well as recent and historic fires have which have increased the total land disturbance. The amount of young second growth forest is of moderate concern for this Unit and represents a legacy of past logging in the area. Point source pollution ranks as low concern. Drainage density ruggedness is of low concern in this area and reflects a gentler topography when compared to the western parts of the SSAF. Modelled salmon habitat is moderate overall and is slightly lower when compared to the entire SSAF area. Observed spawning habitat ranks as low yet is comparable to the broader SSAF area. Although the indicators of young second growth forest, point source pollution, total land disturbance, and drainage density ruggedness do not have identified benchmarks, breakpoints were identified to provide a relative ranking within the SSAF area to enable communication of the results.

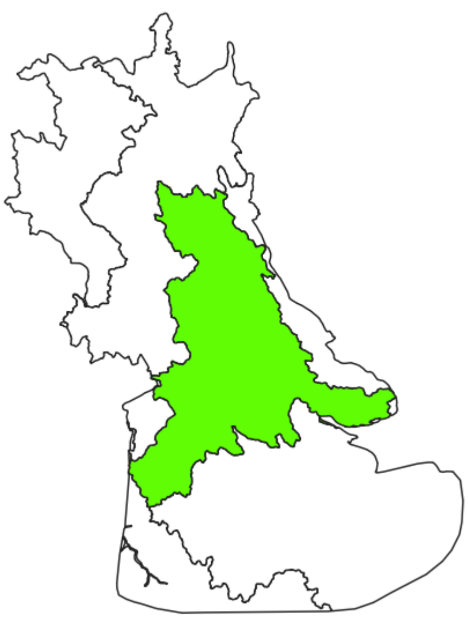


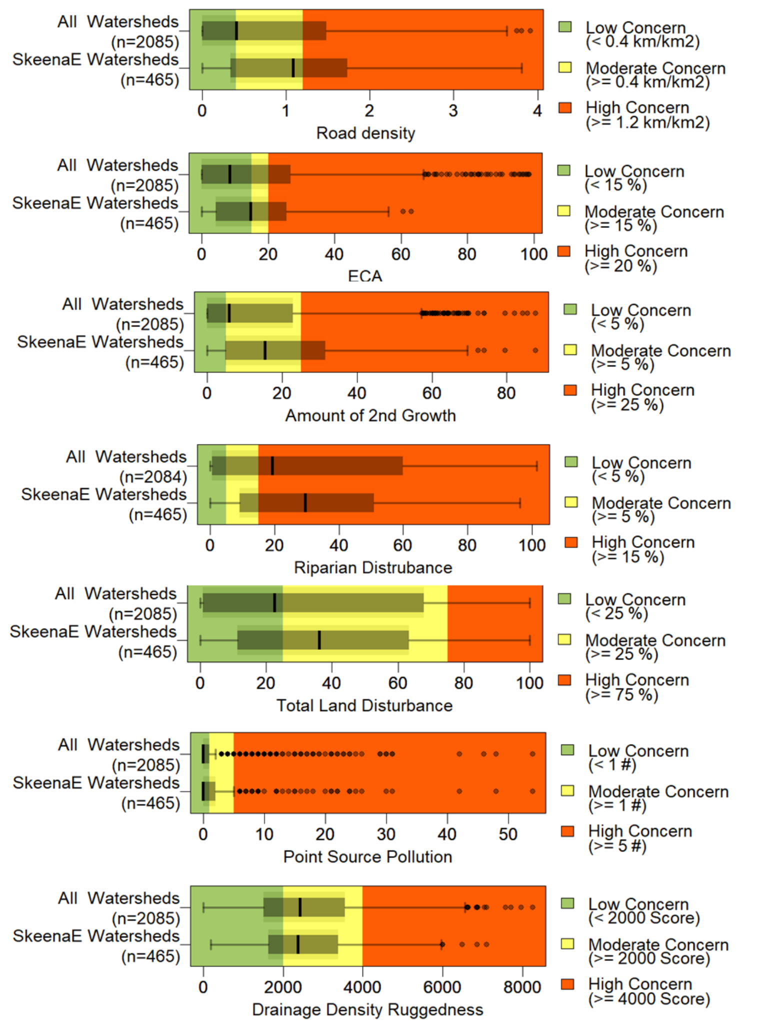


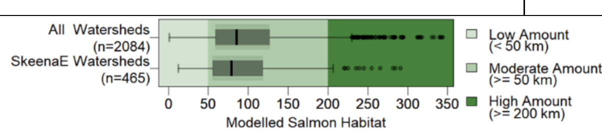


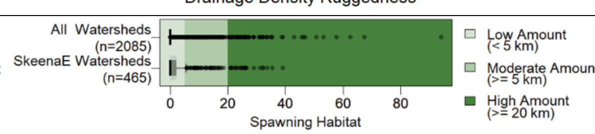
Skeena East Unit Summary

The Skeena East Unit accounts for 22.3% of the SSAF Study Area. AUs in the Skeena East Unit have relatively greater pressures when compared to the larger SSAF area. Riparian disturbance ranks as high concern, with the other pressure indicators of road density, equivalent clearcut area, amount of young second growth, and total land disturbance ranked as being of moderate concern. The moderate concern from the pressure indicators reflects past and current logging, particularly in the central and southern portions of this Unit. The Skeena East Unit has an overall relatively low concern for point source pollution, however there are a number of outlying data points that represent current and historic mines or other industrial sites, and these present a risk to the landbase. Drainage density ruggedness is of moderate concern and reflects the variable terrain seen across this Unit. Modelled salmon habitat is moderate overall and is comparable to the entire SSAF area. Current observed spawning habitat ranks as low yet is comparable to the broader SSAF area. Although the indicators of young second growth forest, point source pollution, total land disturbance, and drainage density ruggedness do not have identified benchmarks, breakpoints were identified to provide a relative ranking within the SSAF area to enable communication of the results.



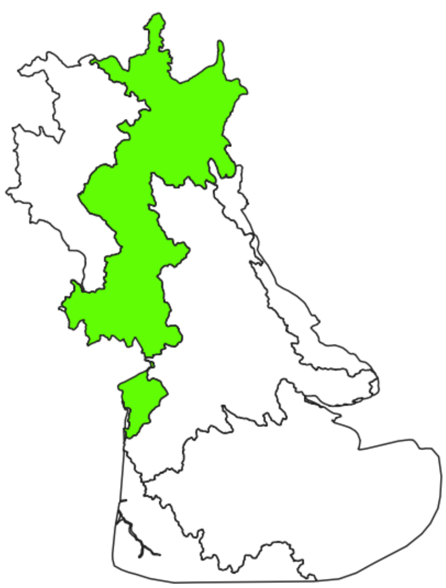


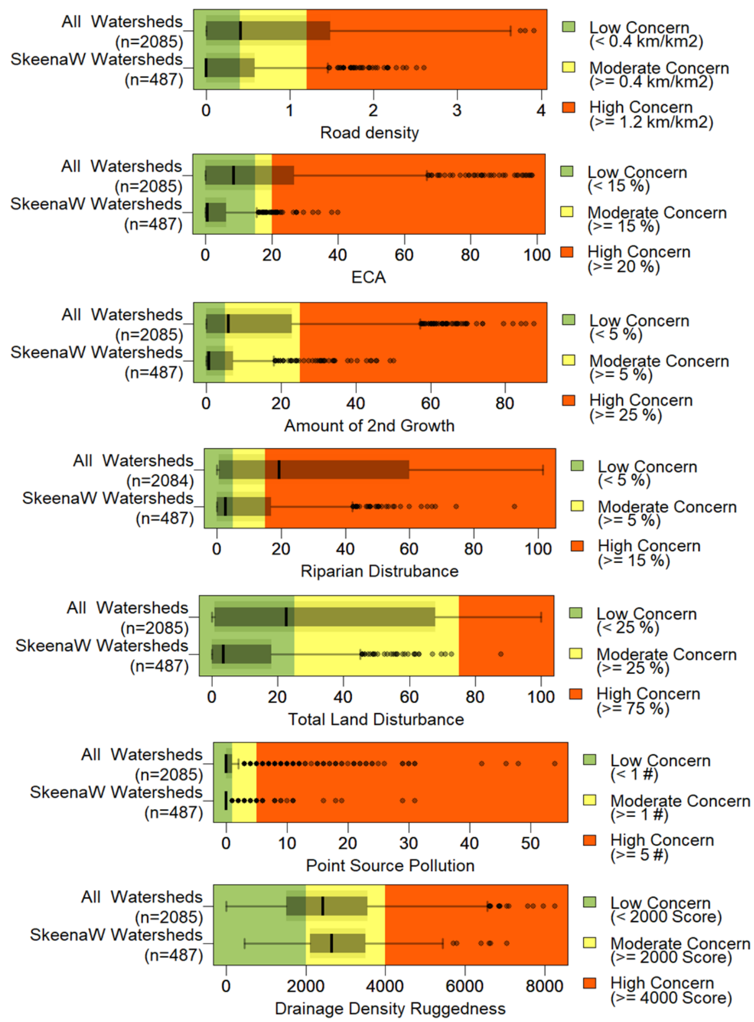


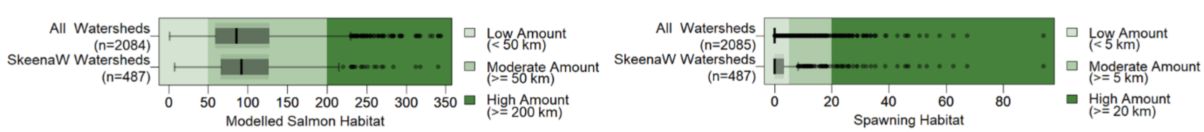


Skeena West Unit Summary

The Skeena West Unit accounts for 23.4% of the SSAF Study Area. AUs in the Skeena West Unit, when compared to the entire area, have relatively less intense pressure and sensitivity indicators. The watershed pressures of road density, equivalent clearcut area, young second growth forest, riparian disturbance, total land disturbance, and point source pollution all rank as low concern for the Skeena West Unit. Drainage density ruggedness is of moderate concern and reflects the variable terrain seem across this Unit. Modelled salmon habitat is moderate overall and is slightly higher when compared to the entire SSAF area. Observed spawning habitat ranks as low yet is comparable to the broader SSAF area. Although the indicators of young second growth forest, point source pollution, total land disturbance, and drainage density ruggedness do not have identified benchmarks, breakpoints were identified to provide a relative ranking within the SSAF area to enable communication of the results.







State of the Value Report - Disclaimer

The Skeena Sustainability Assessment Forum (SSAF) STC State of the Value Report (SOV) for Fish and Fish Habitat is the result of a collaboration between the Province and ten member Nations: Lake Babine Nation, Office of the Wet'suwet'en, Gitxsan Nation, Gitanyow Hereditary Chiefs, Wet'suwet'en First Nation, Witset (Moricetown), Nee-Tahi-Buhn, Skin Tyee, Hagwilget Village, and Gitwangak. This report is one section of a suite of products that assess and monitor the current state of fish and fish habitat in the SSAF Study Area (Figure 2). The other sections of the SSAF's Fish and Fish Habitat program include the Tier 1.5 assessment methods (described in section 1), Tier 3 wetland research, and CABIN and eDNA taxonomic monitoring. Together, these other initiatives contribute to the validation of the indicators as presented in this report. The intention of this report is to broadly assess the pressures, watershed sensitivity and watershed importance of fish and fish habitat across the SSAF Study Area; the other components of the SSAF's fish and fish habitat program are integral pieces to understand what is happening on the ground and at the individual stream level.

The SSAF STC has reviewed the indicators and benchmarks from the Wild Salmon Policy, those used for defining the status of habitat in the Skeena and Nass basins within the Pacific Salmon Foundation's Pacific Salmon Explorer (https://www.salmonexplorer.ca/#!/), and the Aquatic Ecosystems Value for the Provincial Cumulative Effects Framework (Fisheries and Oceans Canada 2005, Porter et al. 2013, Porter et al. 2014, Province of BC 2016, MOE/FLNRORD 2019) among other assessments. For indicators where the use of benchmarks are established, the precautionary principle has been applied and the most conservative benchmarks are used. For indicators where knowledge systems have not identified a benchmark, data are separated into ranges of values which are then displayed. This report is a landscape level assessment of fish and fish habitat, and field-based monitoring of these values should be triggered when assessment units are flagged as being at risk. Conservative benchmarks are therefore implemented to ensure that the associated field monitoring of these values can occur before significant impacts to these values are realized. By conducting field-based monitoring when changes are just being detected, this process endeavours to provide a better understanding of landscape changes over time.

The results presented here are intended to inform the understanding of the pressures, watershed sensitivities and the importance of watershed condition for fish and fish habitat in the SSAF Study Area, and do not constitute specific management direction. Further field-based assessments are needed to validate the indicator results as presented here and to determine next steps for management and conservation of fish and fish habitat (Appendix 7). It is important to emphasize that Aquatic Assessment Units (AUs) flagged as being at higher risk for degraded fish habitats do not necessarily equate to areas of actual adverse impacts to habitat or associated fish populations. Flagging of AUs as being at higher risk or with pressures of generally greater intensity is intended to point regional specialists, First Nation natural resource managers, traditional knowledge holders, and provincial agency decision-makers to areas that may warrant further, more detailed investigation and analysis prior to determining whether or what management (mitigation) response is warranted. While the focus of discussion is directed towards pacific salmon (as the priority fish species of concern to the SSAF Nations) any concerns suggested by the status of habitat indicators would also apply generally to other fish species within the SSAF study area.

Information and data used in the development of this report are current to report initiation (2018) and are of the highest quality that was readily available. The SSAF Scientific and Technical Committee acknowledges the knowledge keepers and the well established First Nations fisheries programs such as the Gitanyow Fisheries Authority, Gitksan Watershed Authorities, Wet'suwet'en Fisheries, Lake Babine Nation Fisheries and the Skeena Fisheries Commission in the study area. It also recognizes that further work is required to reflect the intrinsic, cultural, social and economic importance of fish and fish habitat for the ten member nations involved in this SSAF. A linked project 'Cultural Indicators for the Skeena Environmental Stewardship Initiative' is providing a cultural lens to the SSAF Fish and Fish Habitat program in the hopes of improving future state of the value reports for fish and fish habitat in the SSAF study area.

Fish hold incredible value to the SSAF Nations. This report primarily focuses on fish habitat and watershed integrity and less on fish; there are only three indicators for fish that were added in response to earlier reviews. The STC acknowledges that this is an inadequate presentation of the state of fish in the SSAF area. Future versions of this report, and of associated Tier 1.5 and Tier 2 reports, should more fully explore the current and historic condition of fish in the SSAF study area. The STC would like to note that not all participating Nations were satisfied with the current reporting on the value of fish, and that this should be a significant focus moving forward.

Skeena ESI Values

Values are things that the people care about. Values are seen as important by the people, government of British Columbia, and First Nations for maintaining the integrity and well-being of the communities, economies, and ecological systems within the province. Skeena First Nations and the British Columbia provincial government have collaboratively identified five values of critical importance that provide the foundation of the Skeena Sustainability Assessment Forum (SSAF). These values have been assessed to reflect the state of the values.

The Skeena Region is delivering on the Cumulative Effects Framework through the SSAF. A Current Condition report reflects provincial policy on natural resource reporting through Cumulative Effects. This product is a Current Condition report, however, through the SSAF it has been collaboratively decided between the Provincial and First Nation partners to title SSAF Products as "State of the Value" to reflect the nature of the five chosen values.

The five values of the SSAF are:

Figure 1 Illustrative Summary of the Skeena Sustainability Assessment Forum Five Values Created by Colleen Stevenson from Four Directions Management Services.

1 Introduction

The Environmental Stewardship Initiative (ESI) is a deep collaboration between the Province and First Nations in the northern areas of the Province. The collaborative approach that has been developed through ESI is informed by western science and Indigenous knowledge and is working towards shared principles in environmental monitoring and land management. ESI is intended to facilitate collaboration and trust between the parties in an effort to enhance environmental sustainability, and to address First Nation's long-standing concerns with stewardship of the land and cumulative effects in their traditional territories. The goals of the ESI are to collaboratively establish positive environmental stewardship legacies across the north by investing in four key areas:

1) ecosystem assessment and monitoring;
2) ecosystem restoration and enhancement;
3) ecosystem research and knowledge exchange; and
4) stewardship education and training.

The Province and First Nations have developed and are implementing four Regional Stewardship Forums: Skeena, Omineca, North East, and North Coast. These forums identify and develop projects according to priorities in each area. A fifth working group – the Governance Working Group (GWG) – is responsible for ESI governance principles, decision-making, and a long-term operating structure.

The Skeena Sustainability and Assessment Forum (SSAF) – has a mandate to generate trusted data, co-develop a monitoring and assessment framework, and use the results to inform natural resource management in the Skeena ESI area. The SSAF objectives are to:

1) Design and implement projects that are aligned with the objectives of the ESI;
2) Generate trusted, relevant, accessible information regarding the condition of values to inform the management and stewardship of natural resources;
3) Inform and be informed by Indigenous Stewardship Projects (ISP);
4) Use the results of the SSAF to inform future Provincial and Skeena First Nations' natural resource decisions;
5) Build capacity for Skeena First Nations to lead in natural resource initiatives;
6) Build capacity for Skeena First Nations to participate in natural resource initiatives (Skeena Sustainability Assessment Forum 2017).

SSAF is composed of the Province and ten member Nations: Lake Babine Nation, Office of the Wet'suwet'en, Gitxsan Nation, Gitanyow Hereditary Chiefs, Wet'suwet'en First Nation, Witset (Moricetown), Nee-Tahi-Buhn, Skin Tyee, Hagwilget Village, and Gitwangak. The SSAF is comprised of a Project Team and a Science and Technical Committee (STC) with representation from the participating Nations and the Ministries of Environment and Climate Change Strategy (ENV) and Forests, Lands, and Natural Resource Operations and Rural Development (FLNRORD). The SSAF is also responsible for delivering Indigenous Stewardship Projects (ISPs) that directly support the objectives and elements of the SSAF.

The SSAF Science and Technical Committee (STC) is developing and piloting joint monitoring programs for five key values In the SSAF Study Area – medicinal plants, wetlands, **fish and fish habitat**, moose and grizzly bear. As part of STC activities an assessment was undertaken in 2019 of the current condition of fish and fish habitat in the SSAF Study Area using Tier 1 indicators (i.e., broad pressures and other landscape-level information) that can help illustrate the potential cumulative effects of natural resource activities in the region. In addition to these State of the Value reports, the SSAF has also contracted a study into the potential impact of climate change on the five values under two different future climate scenarios (Price and Daust 2020).

The SSAF uses a multi-scale approach to assessment and monitoring, and refers to these as Tier 1, Tier 1.5, Tier 2, and Tier 3 (Table 1). The coarsest scale is termed a Tier 1 assessment and is the subject of this report. The Tier 1 assessment is a landscape scale approach using GIS layers, such as land cover or point source pollution, to provide an overview of a value under consideration by presenting metrics of pressures (e.g. road density), sensitivity characteristics (e.g. drainage density ruggedness) or importance (e.g. salmon spawning extent). The second key scale is termed Tier 2, which is an assessment through field-based surveys of the condition (e.g. riparian disturbance) or stream-level pressures (e.g. road density, impacts of culverts) on values. Whereas the Tier 1 assessment provides a high-level overview of the entire SSAF area, the Tier 2 assessment provides detailed information at specific sites based on ground monitoring selected through a combination of statistical design and identified importance (e.g. of high cultural or salmon value, see Appendix 6). The intent of Tier 2 monitoring is to better understand the sensitivity, pressures, and impacts at a site level. This Tier 2 data can be used to help interpret information at the landscape level, Tier 1, as well as refine and fill gaps in the Tier 1 data. Between Tier 1 and Tier 2 is the intermediate Tier 1.5; this tier will help to better inform Tier 2 monitoring. Tier 1.5 will provide more detailed desktop assessment of fish and fish habitat. A Tier 1.5 assessment will take watershed selected for Tier 2 monitoring, and evaluated it more closely through remote sensing, as well as provide a more detailed summary of the hydrological characteristics. Finally, Tier 3 is focussed on research. Over time, the learnings from Tier 3 can be incorporated into the Tier 1 and 2 assessments.

Table 1. Examples of how Tiers 1 through 3 are related and how this information may be used

Tier	Data used	How information is reported out
Tier 1	GIS layers e.g. land cover type	State of the Value (SoV) Reports
Tier 1.5	Remotely sensed data, supplementary GIS analysis	Internal reporting to inform Tier 2 site selection
Tier 2	Data collected in the field through standardized methods	Assists interpretation of SoV reports by adding specific context and on-the-ground understanding of the Tier 1 assessment results
Tier 3	Site specific field-based data collection.	Assists interpretation of SoV reports, and may provide insight into underlying causes of Tier 1 and Tier 2 results

The results of the Tier 1 analysis in this report are complementary to the other SSAF fish and fish habitat projects in the Skeena Region. In the future the SSAF fish and fish habitat program will include a Tier 1.5 assessment method to provide more detailed information for specific watersheds that are being considered for field-based monitoring. SSAF also employs a Tier 2 monitoring program based on the Canadian Aquatic Biomonitoring Network assessment protocols (CABIN, Environment Canada 2012). It is not practical to sample all 2085 SSAF watersheds, therefore watersheds are prioritized for Tier 2 monitoring through Tier 1 and Tier 1.5 assessments, after which each Nation uses their own metrics to select streams for Tier 2 monitoring (e.g. Nations might select streams that have importance for fish production, or for protecting their drinking water supply, or those which hold significance to the community for other reasons). One tool to assess some streams is through the Sequencing the Rivers for Environmental Assessment and Monitoring DNA (eDNA) metabarcoding tool in conjunction with the CABIN assessment protocols. The SSAF can use the Tier 1 and Tier 2 methods and results to inform knowledge gaps, to identify further projects, and to better understand and communicate risks to fish and fish habitat from human impacts and climate change.

The assessment and monitoring work done under the SSAF will support the setting of SSAF fish and fish habitat best management practices. This will enable: 1) clear direction to land and resource decision makers regarding appropriate trade-offs among economic and environmental values; 2) simpler assignment of priorities for research, monitoring or direct management intervention; and 3) assignment of local accountability for delivering specific watershed outcomes. Fish and fish habitat objectives may include maintaining the range of habitat characteristics to ensure adequate fish populations for Food, Social, and Ceremonial uses. Ongoing monitoring can be implemented to determine trends in fish and fish habitat and responses to resource management and environmental change.

This State of Value report focuses on the fish and fish habitat value and uses a Tier 1 assessment to examine the risk of fish habitat degradation associated with human activities. Chapters 2 and 3 start with high level overview of fish populations and fish habitats (respectively) in the SSAF study area (Figure 2); specifically, the boundaries of the SSAF First Nations, and the watersheds that intersect their traditional territories (see Appendix 1). Chapter 4 details the relevant current federal and provincial policies and legislation for fish and fish habitat. Chapter 5 introduces the Tier 1 indicators that were developed to further assess pressures, watershed sensitivities, and watershed importance, including any limitations of the assessment methods. Chapter 6 provides a more detailed overview of each indicator and summarizes the results of the analysis, including descriptive maps and interpretation of those maps. Chapter 7 discusses some of the key drivers of the assessment. Chapter 8 describes current monitoring activities that relate to fish and fish habitat in the region. Finally, chapter 9 investigates some potential next steps and summarizes potential opportunities to improve monitoring and to enhance fish habitat in the SSAF Study Area.

Figure 2 SSAF Study Area

1.1 Report Purpose

The primary purpose of this report is to provide an overview of the current condition of fish and fish habitat in the SSAF area. It also provides recommendations for future monitoring of fish and fish habitat. When combined with the further investigations and analyses of the results by the SSAF, this report is intended to help inform the array of resource management decisions that impact the conservation and management of fish and fish habitat in the SSAF Study Area, including but not limited to: research, inventory, and monitoring; wildlife use, role in watershed hydrology; land use including conservation; forest and range planning and practices; major project reviews and conditions; permit authorizations; and public education. This report will inform initial collaborative discussions among First Nations, Government, natural resource industries, and community stakeholders.

1.2 Report Context and Content

Fish and fish habitat monitoring and assessment is carried out to understand the watershed pressures, watershed sensitivities, and watershed importance as they pertain to fish and fish habitat. Ingenious knowledge informs the SSAF assessments through Indigenous Stewardship Projects (ISP) and Indigenous participation and leadership in the Science and Technical Committee.

This SSAF report differs from Provincial Natural Resource Stewardship Monitoring and Assessment Report or Cumulative Effects Framework (CEF) reports in several notable ways. Most importantly, the protocols and indicators driving this assessment were collaboratively modified and developed, reviewed, and agreed-upon by SSAF members. Secondly, this report is an example of how provincial work such as Provincial CEF reports, and the Aquatic Protocol, can be improved through inclusion of local and Indigenous knowledge.

This report provides a current condition report on fish and fish habitat. The report uses an assessment methodology that examines fish and fish habitat using 20 indicators of current conditions. The assessment is based on 2018 data and methodology as outlined in the Skeena ESI Fish Habitat Assessment Procedure 2019 DRAFT 1.1. The focal area of this current condition report is the SSAF area; specifically, the boundaries of the Skeena ESI First Nations.

This report includes:

- an initial high level overview of fish populations in the SSAF Study Area;
- government objectives and legal tools for protecting fish habitat;
- current and future potential threats to fish habitat within the SSAF Study Area;
- an overview of Tier 1 indicators (habitat pressures, sensitivities, and importance) and associated methods used to assess the current condition of fish and fish habitat in the SSAF Study Area, including any limitations of the assessment methods;
- results for each indicator, including descriptive maps and interpretation of those maps;
- a summary of the results and key contributing factors influencing the results; and
- based on the results and other analyses outlined in this report, a summary of potential opportunities to improve monitoring and enhance fish and fish habitat in the SSAF Study Area.

2 Fish Populations in the SSAF Study Area - Overview

All five Pacific salmon species sockeye (*Oncorhynchus nerka*), pink (*O. gorbuscha*), chum (*O. keta*), Chinook (*O. tshawytscha*) and coho (*O. kisutch*)) as well as anadromous steelhead (*O. mykiss*), are present within the boundaries of the SSAF Study Area. This resource feeds 10,000's of people and provides a renewable economic resource worth ten's of millions of dollars annually. Salmon in particular are extremely important to the First Nations that inhabitant the watersheds in question and the stocks have sustained their existence, culture and economies for thousands of years. On average, Skeena and Nass Rivers salmon provide well over 100,000 pieces to First Nations annually, fish that are caught in well developed fisheries throughout the watersheds. The majority of salmon production comes from a smaller subset of watersheds within the SSFA study area. Sockeye, Chinook and coho salmon are the species of choice but sockeye have particular cultural and commercial importance (SSAF First Nations, internal communications).

Sockeye also represent most of the landed value overall in ocean and freshwater fisheries (the price awarded to fish harvesters for their catch) (Walters et al. 2008) but coho and Chinook are also heavily harvested in ocean sport and economic fisheries, including in Alaska. Both summer-run and winter-run populations of steelhead are found in the Study Area, with the upper Nass watershed supporting one of the larger stocks of summer run steelhead in B.C. (Melymick 2013). There are also about 27 known non-salmonid species of freshwater fish found throughout the major basins (Skeena, Nass and Nechako) that make up the SSAF Study Area (McPhail and Carveth 1993; see Appendix 2). Resident species of particular recreational or conservation note are kokanee (non-anadromous sockeye), rainbow trout (non-anadromous *O. mykiss*), lake trout (*Salvelinus namaycush*), Dolly Varden (*Salvelinus malma*), coastal cutthroat trout (*O. clarkii clarkii*, blue listed), bull trout (*Salvelinus confluentus*, blue listed) and white sturgeon (*Acipenser transmontanus*, red listed). Other freshwater resident fish found in the Study Area include mountain whitefish (*Prosopium williamsoni*), burbot (*Lota lota*), lake chub (*Couesius plumbeus*), peamouth chub (*Mylocheilus caurinus*), pikeminnow (*Ptychocheilus oregonensis*), redside shiner (*Richardsonius balteatus*), three-spine stickleback (*Gasterosteus aculeatus*), largescale sucker (*Catostomus macrocheilus*), longnose sucker (*Catostomus catostomus*), prickly sculpin (*Cottus asper*), and coastrange sculpin (*Cottus aleuticus*).

3 Fish Habitats in the SSAF Study Area - Overview

While extending beyond basin boundaries to some extent, the SSAF Study Area encompasses the middle and upper Skeena and Nass Basins, as well as the Nechako sub-basin of the upper Fraser River. Much of this area has so far avoided the intensive development pressure found in many other large watersheds in the Pacific Northwest. Habitat is generally considered to be in relatively good condition. Linear development and settlement are known to have affected fish habitat in some areas, but generally such disturbance factors such as urbanization, major industrial activities, and agriculture have been relatively minimal to date. The exception to this is parts of the Study Area intersecting the Nechako, a drainage which contains the second largest contiguous agricultural belt in the province, and which has been a center for farming and cattle ranching since the early 20th century (NEWSS 2016). Current pressures on fish habitats in the majority of the Study Area extent are a result principally of effects from logging, roads, mines, and forest health agents driven by climate change, while additional potential future threats[1] include oil and gas and linear development (e.g. pipelines, rail lines) and possible climate change-related affects.

The anticipated effects of climate change on fish and fish habitat (Price and Daust 2020)

Climate change in the SSAF area will likely influence fish habitat via multiple pathways that will affect water quantity and water quality in different ways based on landscape sensitivity, physiography and watershed productivity. Changed precipitation patterns (e.g., more rain falling in shorter periods, less snow and more rapid snowmelt) will influence flow timing, volume and duration.

Summer low flows will likely be more extreme (projected to decrease to less than half of current discharge). Low flows will be of longer duration in most systems (moderated by glacial melt in some watersheds) as warmer air temperature increases evaporative demand. Predation risk increases during low flows as does channel connectivity due to de-watered reaches. Water flow will interact with warmer water temperatures to impact fish habitat. Increased natural disturbance, and consequently decreased forest cover, will also influence hydrology. Disturbance removes forest cover and wildfires change soil hydrophobicity, leading to flashier systems.

Increased water temperature may decrease habitat value for vulnerable species (e.g., temperature sensitive species such as the interior race of sockeye salmon, including Babine stock). Water temperature will increase in some streams and lakes, potentially moving beyond physiological limits for vulnerable fish species.

For more information on the anticipated effects of climate change on regional ecosystems, see Adapting forest and range management to climate change in the Skeena Region: Considerations for practitioners and Government staff (2014) and Climate Change Vulnerability of BC's Fish and Wildlife: First Approximation (2016).
https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/nrs-climate-change/regional-extension-notes/skeenaen151125.pdf

4 Fish Habitat Objectives and Legal Protection

The food, social, and ceremonial (FSC) use of fish by First Nations is legally protected through the Canadian Constitution Act (1982). These rights were affirmed as a result of the 1990 landmark Supreme Court of Canada ruling of R v. Sparrow in which the Supreme Court of Canada found that the Musqueam First Nation has an Aboriginal right to fish for food, social and ceremonial purposes which takes priority, only after conservation and over other uses of the resource. From this landmark decision the Government of

[1] Extensive coal-bed methane fields also exist within the SSAF Study Area that could conceivably be developed at some point in the future, although in 2012 the B.C. government rejected any coal bed methane project development in the Sacred Headwaters area.

Canada established a fisheries program called the Aboriginal Fisheries Strategy (AFS). As a result, many First Nation have AFS agreements with the Department of Fisheries and Oceans Canada (DFO) which includes resources and funding to support First Nations participation in co-management and the delivery of various fisheries related programs. These agreements are typically negotiated annually, and may contain provisions for the amounts that may be fished for FSC needs, licensing, cooperative management arrangements and the delivery of scientific projects and provisions related to communal licenses for obtaining access to commercial fisheries and/or other economic development opportunities (DFO 2003).

Management of fish habitat in the SSAF Study Area is addressed by numerous acts, regulations, and supporting policies across federal and provincial agencies. The federal Department of Fisheries and Oceans (DFO) has committed to a long-term goal of "an overall net gain of the productive capacity of fish habitats... through the active conservation of the current productive capacity of habitats, the restoration of damaged fish habitats and the development of new habitats" (Policy for the Management of Fish Habitat; DFO 2001). DFO has also committed to restore protections for fish and fish habitat, and "strengthen the role of Indigenous peoples in project reviews, monitoring, and policy development while also promoting the recognition of rights, respect, co-operation and partnership" (Fish and Fish Habitat Protection Policy Statement; DFO 2019). Salmon-specific DFO policy aims to "restore and maintain healthy and diverse salmon populations and their habitats … by safeguarding the genetic diversity of wild salmon populations, maintaining habitat and ecosystem integrity, and managing fisheries for sustainable benefits" (Wild Salmon Policy (WSP); DFO 2005). Provincial-scale policy objectives are often complementary to federal objectives because salmon and freshwater fish (including sea-run steelhead) rely on similar habitats. The goal of the BC provincial Freshwater Fisheries Program Plan is to "conserve wild fish and their habitats…and maintain robust wild fish populations, as a key component of healthy watersheds and ecosystems" (MOE 2007). More specific objectives and requirements in the Plan address aquatic organisms (i.e., fish and their habitat), water (quantity, hydrology, and quality), stream channel integrity, and riparian areas. Provincial water management supports fisheries management through the recognition of environmental flows and other protection measures for fish needs as directed under the *Water Sustainability Act*.

Legal objectives[2] expressed through numerous Acts and regulations exist at the federal and provincial levels applicable to the management of fish and their habitats, as well as to water quality and quantity. Relevant **federal legislation** includes the Fisheries Act (1985, amended 2019), Species at Risk Act (2002), Canada Water Act (1985), Canadian Navigable Waters Act (1985, amended 2019), Impact Assessment Act (2019), Canadian Environmental Protection Act (1999) and the Canada National Parks Act (2000). The Fisheries Act is notable in that it contains two key provisions on conservation and protection of fish habitat essential to sustaining freshwater and marine fish species, and also recommends the consideration of cumulative effects. Section 34 of the Act lays out the key provisions for fish and fish habitat protection and pollution prevention, with provisions that allow the minister of DFO to publish orders that enable the free passage of fish where an obstruction has been developed, and that the minister determines to be detrimental to fish or fish habitat. The Fisheries Act also stipulate that no person shall carry on any work,

[2] Legal objectives relating to fish habitat protection and management are formalised in enforceable Acts and Regulations. Legal objectives can apply across the province, regionally or to specific defined areas (e.g., Wildlife Habitat Areas).

undertaking or activity, other than fishing, which results in the death of fish (Section 34) of the harmful alteration, disruption or destruction of fish habitat (Section 25) (Fisheries Act 1985).

Relevant **provincial legislation** that directly relates to fish habitat and watershed integrity includes the Water Sustainability Act (particularly Environmental Flow Needs, 2016), Water Protection Act (1996), Riparian Areas Protection Act (1997), Forest and Range Practices Act (2002), Wildlife Act (1996), Environmental Management Act (2003), Oil and Gas Activities Act (2008), and Park Act (1996), Environmental Assessment Act (2002, amended 2018), and the Environmental Management Act (2003). Of particular note is the goal of the province's new Water Sustainability Act is to protect stream health by (among other things) "ensuring adequate environmental flows…protecting habitat in and adjacent to streams, and… by prohibiting dumping of debris and other material" (WSA 2014). Proposed principles supporting the Water Sustainability Act include Environmental Flow Needs (EFN) (see DFO 2013 review of EFN methodologies), sustainable use, respect for First Nations Food, Social, and Ceremonial use, and science-based decision-making (MOE 2008). Other provincial legislation that more indirectly relates to protection of fish and fish habitat through preservation of general watershed integrity includes the Drinking Water Protection Act (2001), Water Utility Act (1996), Drainage, Ditch and Dike Act (1996), and Dike Maintenance Act (1996),Provincial legal regulations specific to fish apply primarily to defined areas. For example, oil and gas activities must not have a material adverse effect on fish in Fisheries Sensitive Watersheds or in Wildlife Habitat Areas defined for fish.

Recent amendments to the federal and provincial environmental assessment acts create space for the consideration and inclusion of cumulative effects in their assessments of projects. The 2019 amendment to the Impact Assessment Act (Canada) stipulates in sections 6 and 22 that cumulative effects must be considered when conducting a project review, and that Indigenous knowledge should factor into these assessments. Considerations related to Indigenous cultures and Indigenous knowledge raised with respect to designated projects are also to be considered (Impact Assessment Act Canada, 2019, Fisheries Act 1985). At the provincial level, section 25 of the Environmental Assessment Act (2018) states that "positive and negative direct and indirect effects of the reviewable project, including environmental, economic, social, cultural and health effects and adverse cumulative effects" are to be assessed. Although the inclusion of Indigenous Knowledge is not explicitly discussed in the BC Environmental Assessment Act (2018), section 75 details confidentiality of Indigenous Knowledge and when and how this knowledge may be disclosed.

Federal and provincial-scale legal objectives that apply to fish habitat in the SSAF Study Area are presented in Table 4.1.

Table 4.1 Federal/provincial-scale legal objectives/regulations relevant to fisheries and fish habitat management/protection in the SSAF Study Area (adapted from Price and Daust 2017).

Legal Objective	Jurisdiction	Notes
Species at Risk Act (Federal)	Federal	SARA aims to protect endangered and threatened species, to provide an avenue for their recovery, and to encourage the management of other species to prevent them from becoming at risk. SARA is supported by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). SARA allows for protection of listed species and their critical habitats and for the development of recovery strategies
Environmental Assessment Certificate Requirements	Federal / Provincial	Projects meeting certain size criteria or of special concern require an environmental assessment certificate prior to commencing. Assessments consider potential for significant adverse environmental, economic, social, heritage and health effects. Certificates can describe a wide a variety of conditions that must be met by project activities.
Environmental Planning and Management Regulation	Provincial	Enabled by the Oil and Gas Activities Act. Applies province-wide to oil and gas development on provincial crown land. This regulation has provisions allowing the Minister of Environment to define similar categories of species, habitats and watersheds as are defined under the Government Actions Regulation (GAR).
Forest Planning and Practices Regulation	Provincial	Enabled by the Forest and Range Practices Act. Applies province-wide to forestry activities on crown forest (and private land within Tree Farm Licences (TFLs)); activities on woodlot licenses are not included here (see below). Provides objectives for specific species and areas defined under the Government Actions Regulation.
Government Actions Regulation	Provincial	Enabled by the Forest and Range Practices Act. This regulation allows the Minister of Environment to define species at risk, ungulate species, wildlife habitat areas, ungulate winter ranges, and fisheries sensitive watersheds; and related objectives.
Land Act	Provincial	Enables legal orders defining objectives for specific areas. Often used to translate objectives from regional land use plans to more specific legal objectives for the same area.
Range Planning and Practices Regulation	Provincial	Under the Forest and Range Practices Act. Sets province wide objectives and regulations for management of crown land.

Water Sustainability Act	Provincial	Sets province-wide, multi-sector regulations preventing significant adverse pollution and stream damage and controls water extraction/use with a focus on environmental flow needs. Provisions for the establishment of water objectives to maintain water quality, quantity, and aquatic ecosystems. Establishes fish population protection orders in specified streams that the flow of water is or is likely to become so low that the survival of a population of fish in the stream may be or may become threatened.
Wildlife Habitat Area	Provincial	An area, with related habitat management objectives, established to provide for the survival of a species at risk. Areas are selected based on Identified Wildlife Management Strategy (IWMS) policy and legally enabled by GAR and/or EPMR (which determine their scope of applicability).
Woodlot Planning and Practices Regulation	Provincial	Similar to the Forest Planning and Practices Regulation, but applicable on woodlots and with some different objectives.

Regional-scale policy and legal documents add area-specific objectives. At the broadest level, regional land use plans call for the maintenance of aquatic ecosystems that support healthy fish habitats and populations. Municipalities and regional districts may also enact local bylaws or plans for the management and protection of fish habitats under the Local Government Act or under a Community Charter. Examples of these include streamside protection bylaws, rural area tree protection bylaws, invasive species management plans, and application of environmental conditions to development permits.

5 Overview of Fish Habitat Indicators

The SSAF STC developed a conceptual model to illustrate how various processes interact to influence the condition of fish and fish habitat in the SSAF Study Area (Appendix 3). Quantitative information on the state of these processes can be captured through relevant indicators that are measurable at different levels of spatial resolution (i.e., Tier 1 and Tier 2, see Skeena ESI Fish Habitat Assessment Procedure 2019 DRAFT 1.1). The state of the value of fish habitat in the SSAF Study Area was assessed in 2020 using 20 Tier 1 indicators that are considered useful (individually and in composite) for reflecting the potential risk and significance of degradation of fish habitats due to landscape pressures. Many of these indicators have been used to inform similar past habitat assessment exercises both in the Skeena region and more broadly (e.g., MOF 2001; Stalberg et al. 2009; Nelitz et al. 2011; Porter et al. 2013, 2014, 2016; Office of the Wet'suwet'en 2013; Price and Daust 2015; Lewis et al. 2016; FLNRORD 2017) and include the principal indicators being used currently by FLNRORD for provincial-scale assessment of aquatic habitats as part of the province's Cumulative Effects Framework (CEF) (Province of BC 2016; MOE/FLNRORD 2019). These indicators provide information on the potential state of fish habitat but also more generally on ecological functioning, water quality, and other broad environmental processes.

Included in the full suite of Tier 1 indicators evaluated are fourteen watershed-scale "pressure" indicators, three watershed-scale "sensitivity" indicators, and three watershed "importance" indicators, based on known or modeled fish use and production (Table 5.1).

Table 5.1 Tier 1 fish habitat indicators.

Habitat Indicator	Description
WATERSHED PRESSURES	
Road Density	The total length of roads divided by total aquatics assessment unit area (km/km^2).
Road/Stream Crossing Density	Total number of road/stream crossings (i.e., culverts & bridges) divided by total aquatics assessment unit area (km/km^2).
Road Density near Streams	The total length of roads within 100m of streams divided by total aquatics assessment unit area (km/km^2).
Road Density on Steep Slopes	The total length of roads present on steep slopes (>60%) divided by total aquatics assessment unit area (km/km^2).
Equivalent Clearcut Area (ECA)	Percentage of total area of an aquatics assessment unit that is considered comparable to a clearcut forest.
Young Second Growth Forest	Percentage of total area of an aquatics assessment unit that is compromised of regenerating young second growth stands (<80 years old).
Riparian Disturbance	Percentage of a 30m riparian buffer zone around all streams in an aquatics assessment unit that has experienced recent human or natural disturbance (i.e., fire, insects)
Total Land Disturbance	Percentage of aquatics assessment unit that has been disturbed from human activities or natural events (i.e., fire, insects)
Dams and Impoundments	Number of identified large dams and impoundments within an aquatics assessment unit
Water Licenses	Number of water licenses/points of diversion (PODs) within an aquatics assessment unit
Groundwater Wells	Number of groundwater wells within an aquatics assessment unit.
Water Allocation Restrictions	Number of water allocation restrictions within an aquatics assessment unit.
Mines	Number of mines present within an aquatics assessment unit.
Point Source Pollution	Number of pollutant point sources within an aquatics assessment unit.
WATERSHED SENSITIVITIES	
Low Flow Sensitivity	Percentage of streams considered seasonally low flow sensitive (summer sensitive, winter sensitive, or both summer & winter sensitive in an aquatics assessment unit.
Drainage Density Ruggedness	The dimensionless product of drainage density (stream length per aquatics assessment unit area - km/km^2) and total elevation relief (the difference between the highest and lowest points in an aquatics assessment unit - km).
Lakes and Wetlands	Percentage area of mapped lakes and wetlands within an aquatics assessment unit.

WATERSHED IMPORTANCE	
Salmonid Habitat	Total length of known or inferred salmonid habitat within an aquatics assessment unit.
Salmon Spawning	Total length of mapped salmon spawning streams within an aquatics assessment unit (by species and combined).
Salmon Escapement	Recent (2012-2017) average escapement of salmon at SSAF Study Area monitored indicator streams (Skeena & Nass Basins only).

In the next section, the approach to assessing each indicator is explained in more detail to help reviewers of this report interpret the results. For more insights into the Tier 1 fish and fish habitat assessment indicators and data sources also refer to the Skeena ESI Fish Assessment Procedure 2019 (Draft 1.1). Appendix 4 provides a summary of the methodologies used for deriving each of the Tier 1 fish habitat indicators presented in the report, as well as a description of the supporting geodatabase developed for the project.

6 Assessment Results for each Indicator

The following section provides a high-level summary of the state of the value of fish and fish habitats in Aquatic Assessment Units (AUs) within the SSAF Study Area, based on the results for 20 Tier 1-level indicators. Assessment results for each indicator are presented with maps, a brief description of the indicator, a key to interpreting the results, and commentary that describes and elaborates upon the results with a discussion of what the indicator results mean in regard to the current state of fish habitat across the SSAF Study Area and within the territories of the SSAF First Nations. Assessment units are third order watersheds at a scale of 1:50,000.

Watershed Pressure Indicators:

6.1 Road Density

Indicator Description:		This indicator reports the total length of roads (km) in an aquatics assessment unit (AU) divided by the total net area (km^2) of the AU (net AU area excludes large lakes, water, and glaciers/ice in the AU area calculation). Road length information is derived from the province's Consolidated Roads layer which combines DRA, TRIM, FTEN, OGC, and RESULTS in-block roads layers. BC Wildlife Services' Machine and hand line fire guards data are also included. Risk ratings for road densities derives from the Wild Salmon Policy and Pacific Salmon Foundation's cumulative pressures on salmon habitat summary report cards (Fisheries and Oceans Canada 2005, Porter et al. 2013, 2014).
Interpretation Key:	•	Road densities < 0.4 km/km^2 are considered lower risk for fish habitat degradation (green)
	•	Road densities 0.4 – 1.2 km/km^2 are considered moderate risk for fish habitat degradation (yellow)
	•	Road densities > 1.2 km/km^2 are flagged as higher risk for fish habitat degradation (orange)
Assessment Results:	•	See Figure 6.1

Commentary:

Road density can affect both **water quantity** and **water quality** as it can influence peak flow, low flow, and water temperature by increasing surface runoff and modifying subsurface flows (Meehan 1991; MOF 1995a; Smith and Redding 2012). Roads may also increase coarse and fine sediment delivery to streams depending on surficial geology and terrain stability. 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).

The highest densities of roads are found within the central and southeastern portions of the Study Area with many AUs in these areas flagged as being at high risk from roads. Extensive areas with low road densities (i.e., unflagged AUs) are present within the mountainous and more remote northern and southwestern portions of the Study Area. While there are flagged high road density AUs within all SSAF First Nation territories areas with the highest road densities are most concentrated within territories of the Nee-Tahi-Buhn Indian Band, Lake Babine Nation, Witset, Skin Tyee Nation, Wet'suwet'en First Nation, Gitanyow Hereditary Chiefs, and Office of the Wet'suwet'en. Higher road densities are less common in AUs within the territories of the Gitxsan Hereditary Chiefs and the Gitwangak. It should be noted that not all roads are well captured in the provincial roads inventory, as some smaller forest service roads may be missed within the mapping.

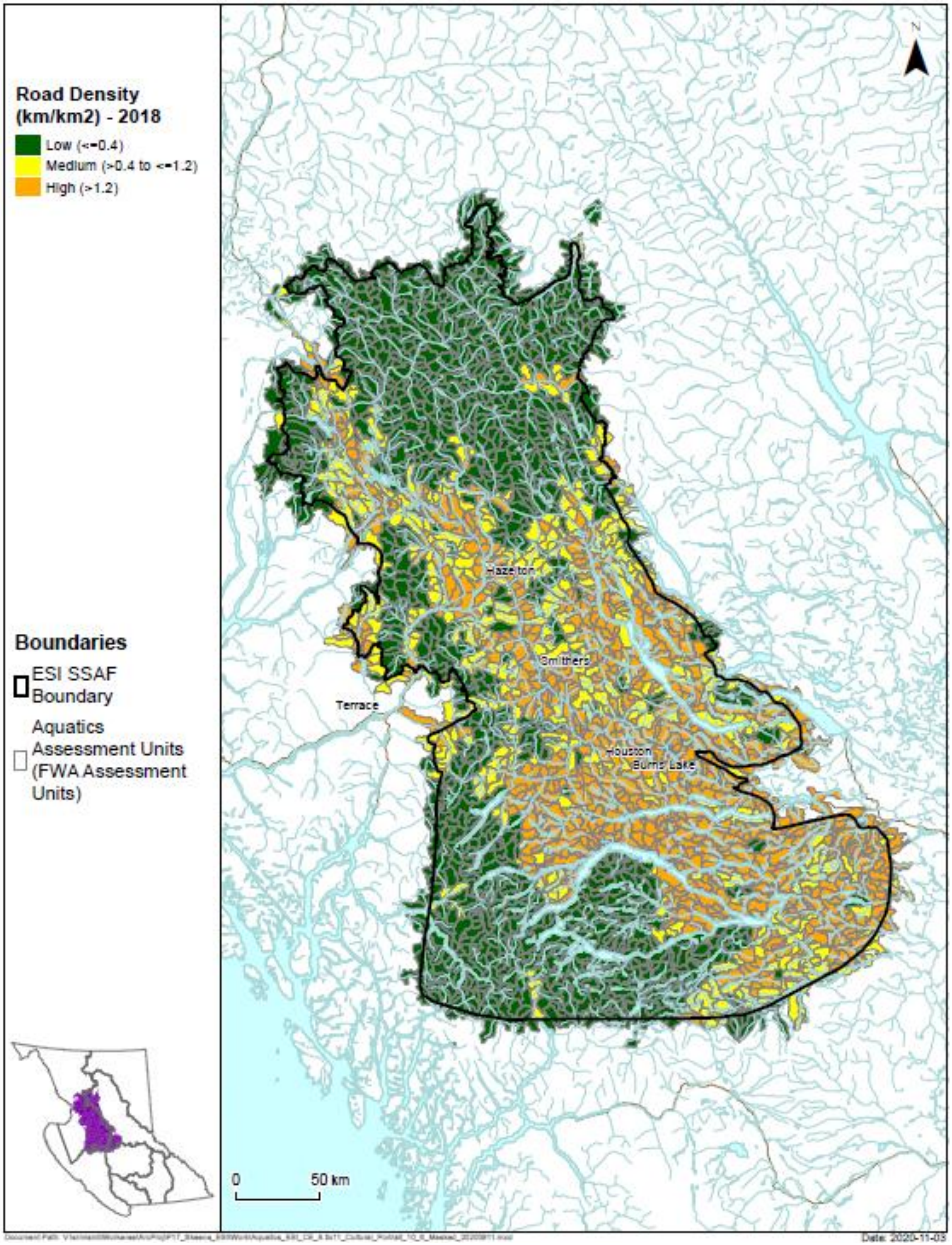


Figure 6.1 Road density ratings – SSAF Study Area

6.2 Road/Stream Crossing Density

Indicator Description: This indicator reports the total number of road/stream crossings (#) in an aquatics assessment unit (AU) divided by the total net area (km^2) of the AU (net AU area excludes large lakes, water, and glaciers/ice in the AU area calculation). Road location information is derived from the province's Consolidated Roads layer which combines DRA, TRIM, FTEN, OGC, and RESULTS in-block roads layers, while the intersecting stream information is derived from the province's 1:20K FWA stream network. All FWA streams are used for analysis, including intermittent and indefinite streams. Risk ratings for stream crossing densities derives from the province's Aquatic Cumulative Effects Assessment Protocol (MOE/FLNRORD 2016). Separation of the SSAF Study Area into distinct "coastal" and "interior" regions for differential risk ratings is based on designations within the province's EAUBC Freshwater Ecoregions layer.

Interpretation Key:

"Coastal" AUs

- Stream crossing densities < 0.4 #/km^2 are considered lower risk for fish habit at degradation (green)
- Stream crossing densities 0.4 – 0.8 #/km^2 are considered moderate risk for fish habitat degradation (yellow)
- Stream crossing densities > 0.8 #/km^2 are flagged as higher risk for fish habitat degradation (orange)

"Interior" AUs

- Stream crossing densities < 0.16 #/km^2 are considered lower risk for fish habitat degradation (green)
- Stream crossing densities 0.16 – 0.32 #/km^2 are considered moderate risk for fish habitat degradation (yellow)
- Stream crossing densities > 0.32 #/km^2 are flagged as higher risk for fish habitat degradation (orange)

Assessment Results:

- See Figure 6.2 (Coastal AUs) and Figure 6.3 (Interior AUs)

Commentary:

Road/stream crossings can affect **water quantity** and **water quality** as they represent a potential focal point for local sediment and intercepted flow delivery, as well as representing a potential physical impediment to connectivity of fish populations (Marshall 1996; Harper and Quigley 2000; BC MOF 2001). A higher density of stream crossings in a watershed is generally indicative of potentially greater risks of excess fine sediment inputs although these risks will be dependent on the construction type (i.e., open box vs. closed box culverts), as well as the condition of stream crossing structures (MOF 1995a, b; Smith and Redding 2012).

The pattern for road/stream crossing density in the Study Area mirrors that for road density in general with the highest road/stream crossing densities found within the central and southeastern portions of the Study Area with many AUs in these areas flagged as being at high risk from road/stream crossings.

Extensive areas with low road/stream crossing densities (i.e., unflagged AUs) are present within the mountainous and more remote northern and southwestern portions of the Study Area. Most areas of the Study Area considered “coastal” are generally considered low risk for road/stream crossing densities (i.e. limited number of flagged AUs). While there are flagged high road/stream crossing density AUs within all Skeena First Nation Territories, areas of highest road/stream crossing densities are most concentrated within territories of the Nee-tahi-Buhn Indian Band, Lake Babine Nation, Witset, Skin Tyee Nation, Gitanyow Hereditary Chiefs, Wet’suwet’en First Nation, and Office of the Wet’suwet’en. Higher road/stream crossing densities are less common across the territories of the Gitxsan Hereditary Chiefs, and Gitwangak.

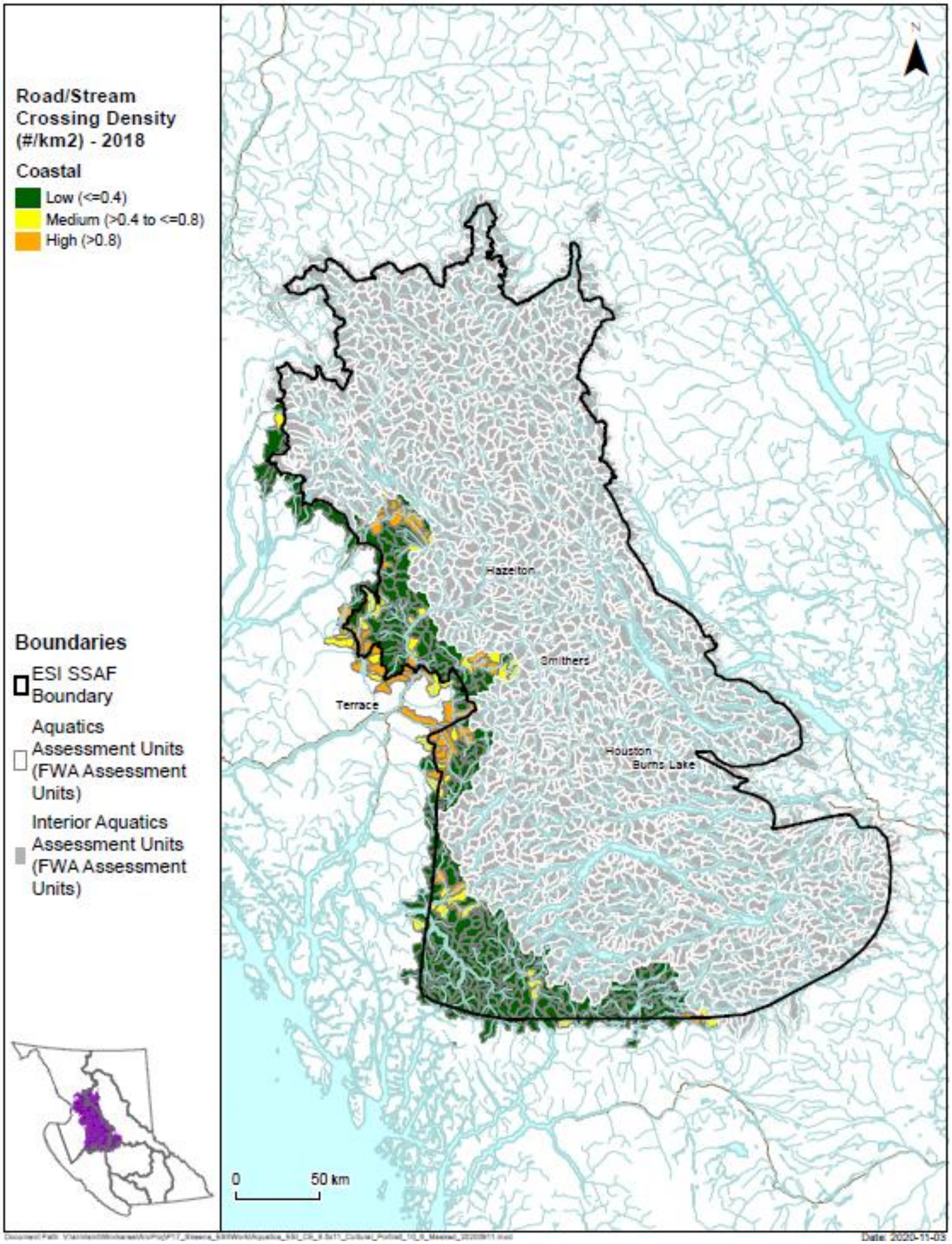


Figure 6.2 Road/stream crossing density ratings (Coastal) – SSAF Study Area.

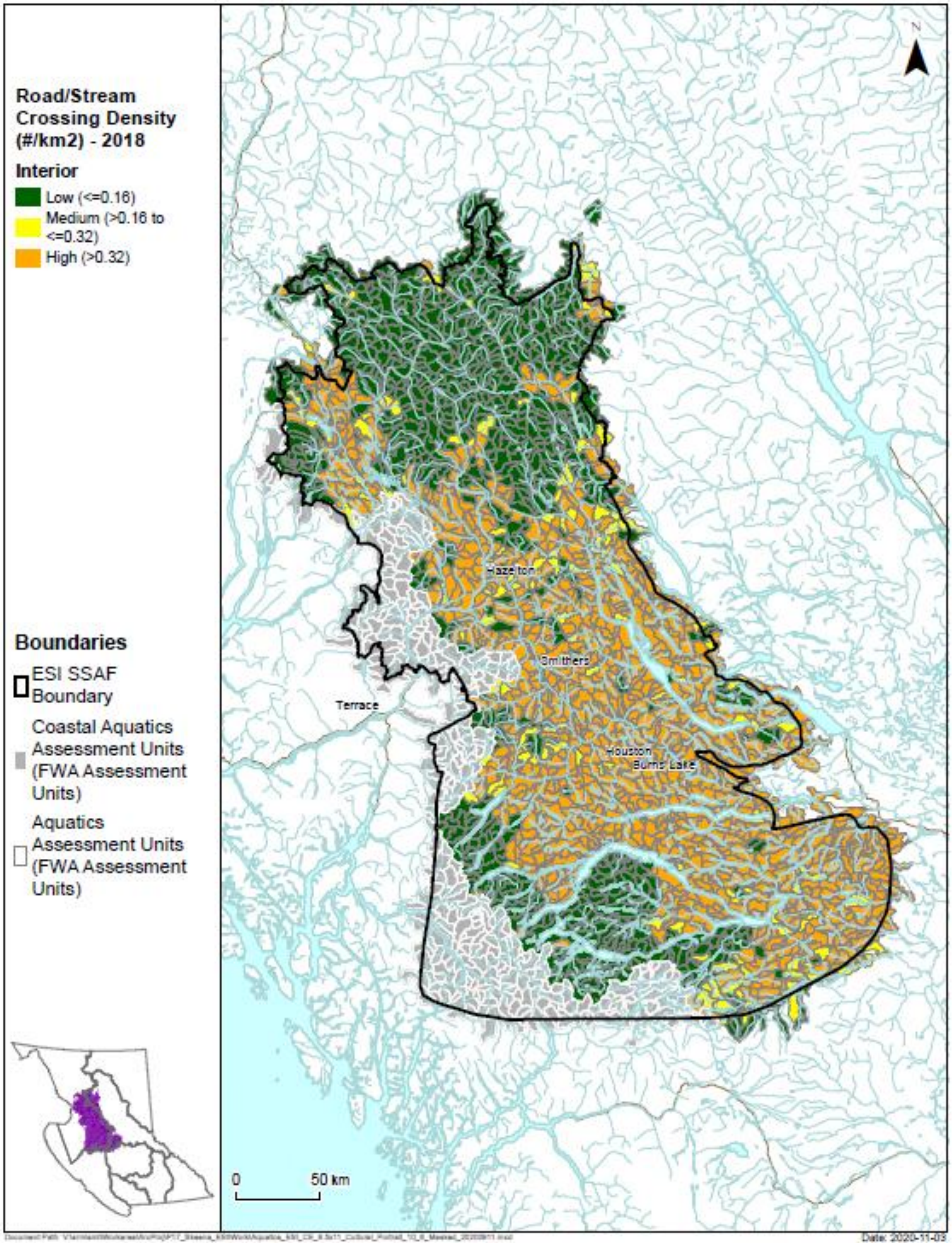


Figure 6.3 Road/stream crossing density ratings (Interior) – SSAF Study Area.

6.3 Road Density near Streams

Indicator Description:	This indicator reports the total length of roads (km) within 100m of streams in an aquatics assessment unit (AU) divided by the total net area (km^2) of the AU (net AU area excludes large lakes, water, and glaciers/ice in the AU area calculation). Road location/length information is derived from the province's Consolidated Roads layer which combines DRA, TRIM, FTEN, OGC, and RESULTS in-block roads layers, while the adjacent stream location information is derived from the province's 1:20K FWA stream network. All FWA streams are used for analysis, including intermittent and indefinite streams. Risk ratings for road densities near streams derives from the province's Aquatic Cumulative Effects Assessment Protocol (MOE/FLNRORD 2016).
Interpretation Key:	• Road densities near streams < 0.08 km/km^2 are considered lower risk for fish habitat degradation (green) • Road densities near streams 0.08 – 0.16 km/km^2 are considered moderate risk for fish habitat degradation (yellow) • Road densities near stream > 0.16 km/km^2 are flagged as higher risk for fish habitat degradation (orange)
Assessment Results:	• See Figure 6.4

Commentary:

Roads near streams may contribute greater amounts of sediment to streams affecting **water quality,** stream bed morphology **(physical surrounding),** and biota **(watershed productivity)** (Carson et al. 2009). The extent of road effects on erosion and sediment transport processes will depend on precipitation, soil texture, road construction and maintenance practices (Gucinski et al. 2001; Carson et al. 2009). Roads adjacent to streams may also directly impact other ecological services and functions provided by riparian areas such as shade or provision of organic material including large wood.

Roads constructed near streams are an issue throughout much of the central and southeastern portions of the Study Area with many AUs in these areas flagged as being at high risk for this indicator. Extensive areas with low road densities near streams (i.e., unflagged AUs) are present within the mountainous and more remote northern and southwestern portions of the Study Area. While there are flagged high road densities near streams for AUs within all Skeena First Nation Territories the areas of highest concern are most concentrated within territories of the Nee-tahi-Buhn Indian Band, Lake Babine Nation, Witset, Skin Tyee Nation, Wet'suwet'en First Nation, Gitanyow Hereditary Chiefs, and Office of the Wet'suwet'en. There are generally lower road densities near streams in AUs within the territories of the Gitxsan Hereditary Chiefs and the Gitwangak.

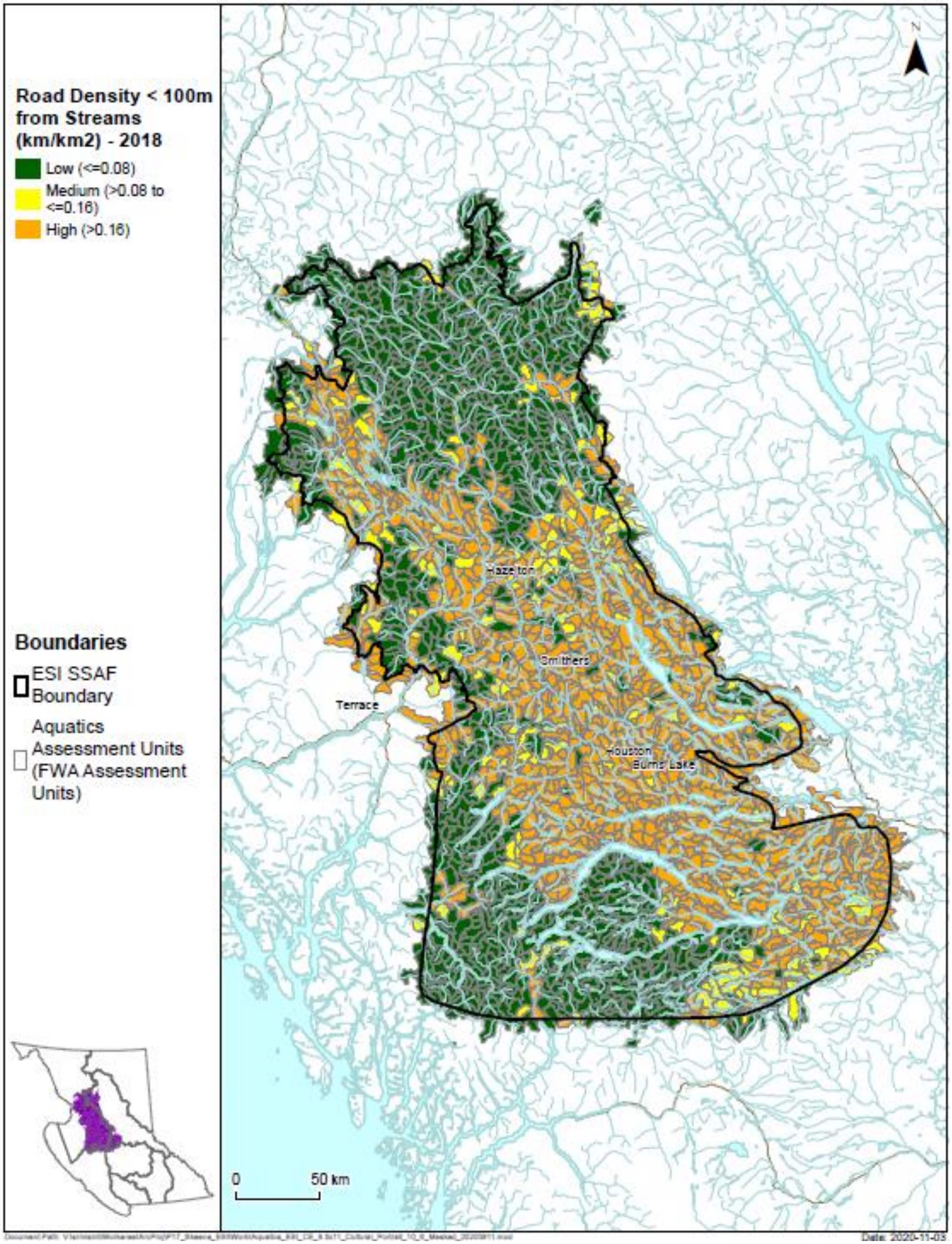


Figure 6.4 Road density near streams ratings – SSAF Study Area.

6.4 Road Density on Steep (Potentially Unstable) Slopes

Indicator Description:	This indicator reports the total length of roads (km) on steep slopes (> 60%) in an aquatics assessment unit (AU) divided by the total net area (km^2) of the AU (net AU area excludes large lakes, water, and glaciers/ice in the AU area calculation). Road location/length information is derived from the province's Consolidated Roads layer which combines DRA, TRIM, FTEN, OGC, and RESULTS in-block roads layers, while terrain slope information is derived from the province's 25m resolution Digital Elevation Model (DEM). Risk ratings for road densities on steep slopes derives from the province's Aquatic Cumulative Effects Assessment Protocol (MOE/FLNRORD 2016). Slope steepness here is used as a surrogate for slope stability as actual mapping of terrain stability is currently available only at local scales for a limited number of watersheds in the province. A presumption of increased instability for slopes >60% slope has traditionally been used in BC (FPB 2017), although with recognition that the potential impacts relative to slope will likely be different on the coast vs. the interior. Until regional-scale scale terrain stability maps become available for broad use road densities on slopes >60% can represent a surrogate criterion in relation to landslide risk on unstable soils in the SSAF Study Area.
Interpretation Key:	• Road densities on steep slopes < 0.06 km/km^2 are considered lower risk for fish habitat degradation (green) • Road densities on steep slopes 0.06 – 0.12 km/km^2 are considered moderate risk for fish habitat degradation (yellow) • Road densities on steep slopes > 0.12 km/km^2 are flagged as higher risk for fish habitat degradation (orange)
Assessment Results:	• See Figure 6.5

Commentary:

Roads on steep (unstable) terrain can affect **water quality** by increasing the likelihood of mass wasting by undermining or loading slopes, by saturating soils, and by reducing soil root networks (Sawyer and Mayhood 1998; Gustavson and Brown 2002; Jordan 2002; Jordan et al. 2010). Roads on steep slopes can alter surface drainage patterns (**physical surrounding**) and divert subsurface flow to the surface increasing the chance of soil saturation and gully erosion (Pike et al. 2007).

Road density on steep slopes does not appear to be an issue anywhere within the Study Area as only one AU is flagged as being at moderate risk for this indicator and none at high risk. The majority of AUs in the Study Area are not flagged, meaning they road densities on steep slopes < 0.12 km/km2 and are therefore not considered a focus for management attention. This situation may be reflective of a number of things in combination: 1) there isn't that much steep slope in highly forested contexts inside the Study Area boundary, 2) licensees may generally avoid steep slopes due to increased costs, and 3) perhaps most importantly, for many of the Timber Supply Areas (TSAs) in the interior (interior plateau in particular) slopes over 40% are removed from the Timber Harvesting Land Base (THLB) in the Timber Supply Review (TSR) process, as licensees don't tend to harvest on these steeper slopes (Nichols 2019.). A combination of economic considerations and good management is likely responsible for the minimal presence of road construction on steep slopes across the Study Area.

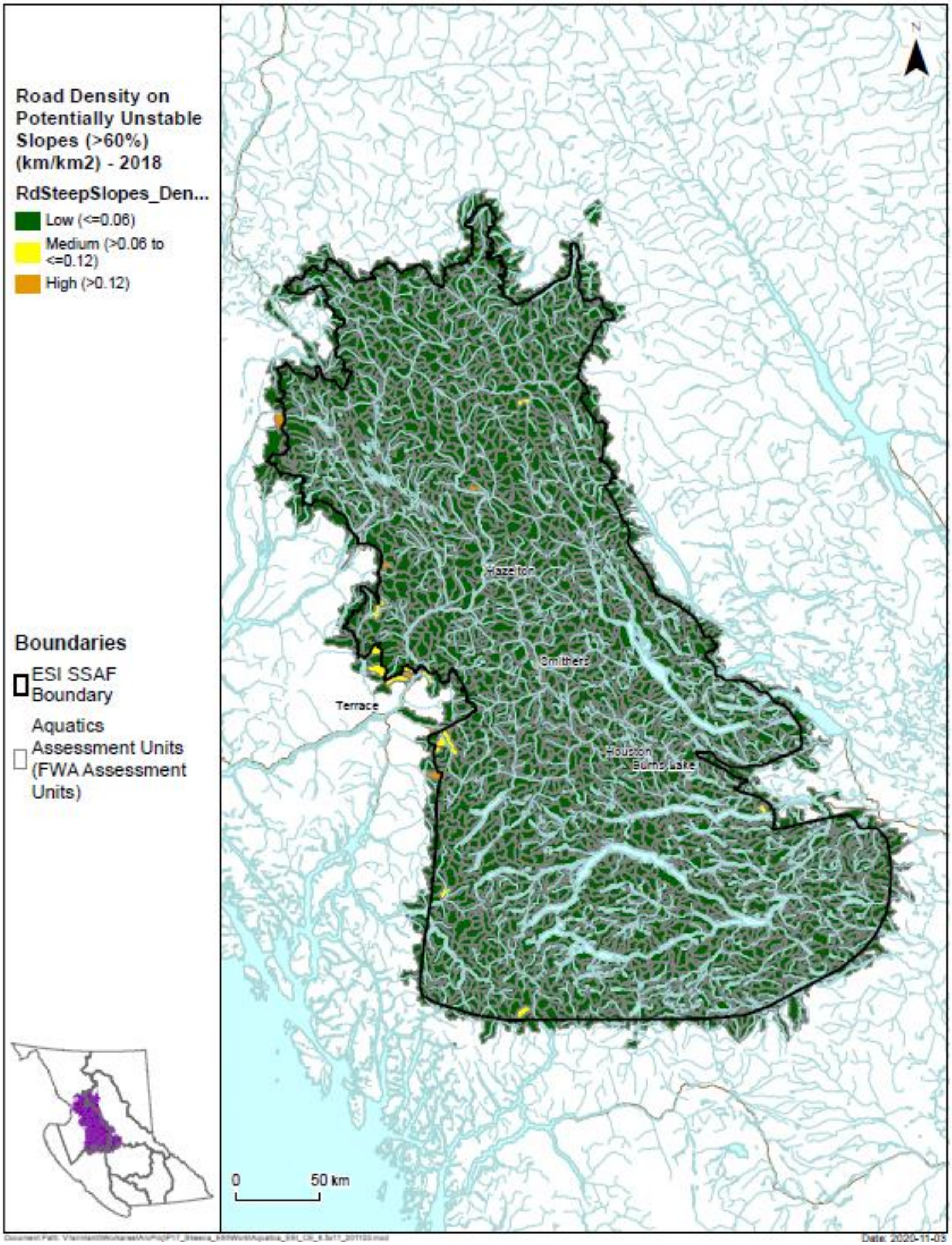


Figure 6.5 Road density on steep slopes ratings – SSAF Study Area.

6.5 Equivalent Clearcut Area (ECA) (peak flow impacts)

Indicator Description:	This indicator reports the percentage of the total area of the aquatic assessment unit (AU) that is considered hydrologically equivalent to a clearcut forest (ECA). Forest harvest information is derived from the province's VRI layer, supplemented with additional harvesting information from the FAIB Consolidated Cutblocks, RESULTs, FOWN and various Human Development layers. Risk ratings for ECA are derived from the Wild Salmon Policy and Pacific Salmon Foundation's cumulative pressures on salmon habitat summary report cards (Fisheries and Oceans Canada 2005, Porter et al. 2013, 2014).Separation of the SSAF Study Area into distinct "coastal" and "interior" regions for application of distinct regional hydrologic recovery curves for derivation of ECA values (as described in MOE/FLNRORD 2019) is based on designations within the province's EAUBC Freshwater Ecoregions layer.
Interpretation Key:	• ECAs < 15% are considered lower risk for fish habitat degradation (green) • ECAs 15 - 20 % are considered moderate risk for fish habitat degradation (yellow) • ECAs > 20% are flagged as higher risk for fish habitat degradation (orange)
Assessment Results:	• See Figure 6.6

Commentary:

ECA is a modeled metric that attempts to define the relative hydrologic impact following major forest disturbance (e.g., clearcutting) compared to a mature intact forest canopy. ECA reflects complex changes in flows (**water quantity**) resulting from changes in canopy precipitation interception, evapotranspiration, snow melt dynamics, and runoff after disturbance (Sawyer and Mayhood 1998; Hudson and Horel 2007; Winkler and Boon 2015). High ECAs can potentially result in increases to peak flows and subsequent disruption of fish habitats (**physical surroundings**) (MOF 2001; Smith and Redding 2012).

The highest ECAs are found within the southeastern portions of the Study Area with many AUs in these areas flagged as being at moderate or high risk from logging impacts on peak flows. Extensive areas with low ECAs (i.e., unflagged AUs) are present within the mountainous and more remote northern and southwestern portions of the Study Area. AUs with higher ECAs are found principally within the territories of the Skin Tyee Nation, Witset, Nee-Tahi-Buhn Indian Band, Wet'suwet'en First Nation, Office of the Wet'suwet'en, and Lake Babine Nation. ECAs are generally lower across AUs within the territories of the Gitwangak, Gitanyow Hereditary Chiefs, and Gitxsan Hereditary Chiefs.

There are a number of AUs indicated as having insufficient data, due to lack of supporting VRI data for calculating ECA (i.e., >50% of AU has VRI unreported). ECA condition is therefore unknown for AUs in these areas, which are found within the territories of the Wet'suwet'en First Nation and the Skin Tyee Nation in the south, and the Gitwangak and Gitxsan in the west.

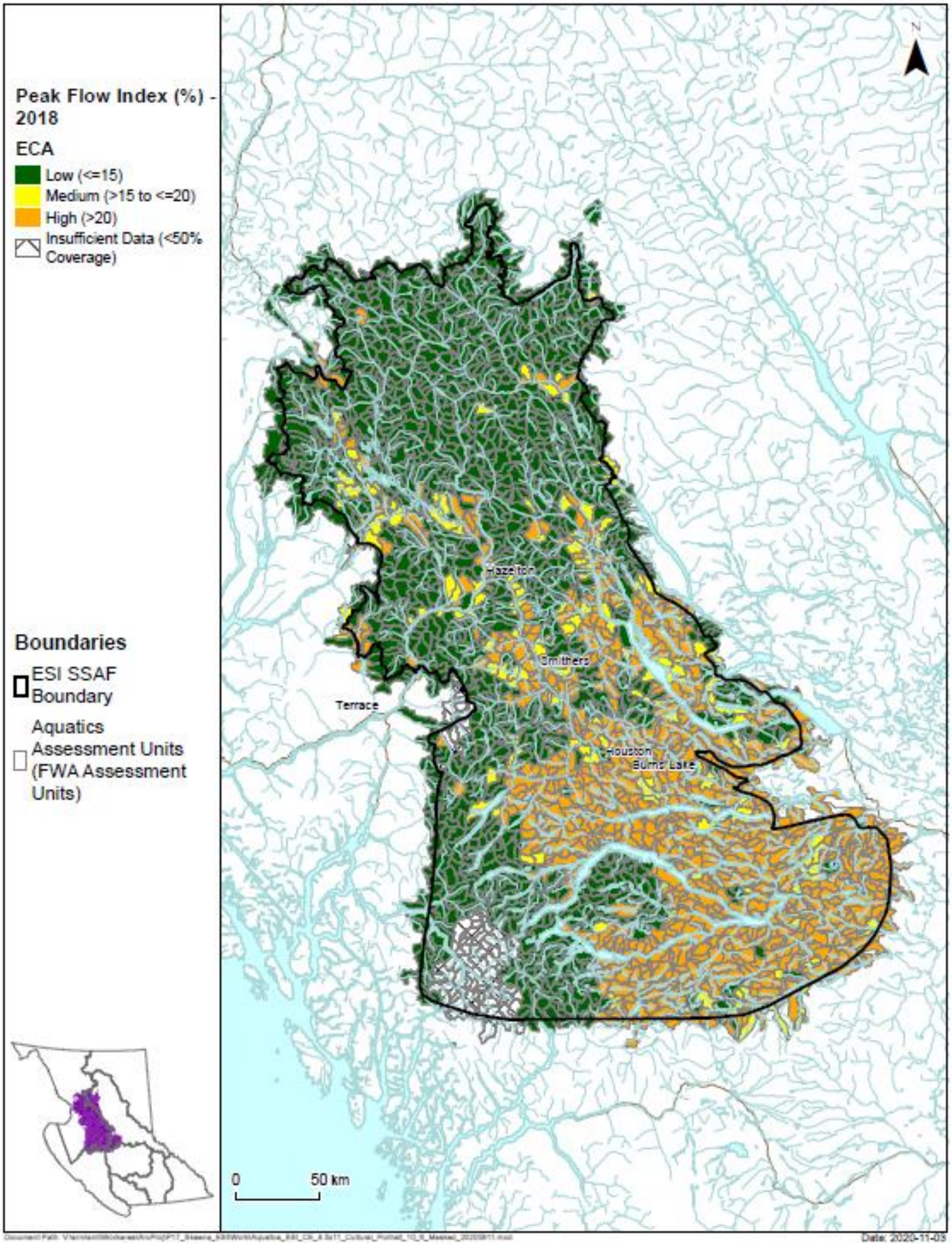


Figure 6.6 Equivalent Clearcut Area (ECA) ratings – SSAF Study Area.

6.6 Young Second Growth Forest (low flow impacts)

Indicator Description:	This indicator reports the percentage of the total net area of the aquatic assessment unit (AU) that is represented by young second growth forest (< 80 years old) (net AU area excludes large lakes, water, and glaciers/ice in the AU area calculation). Forest age information is derived from the province's VRI layer.
Interpretation Key:	No risk classifications have been developed for mapping of this indicator as the science/understanding around the degree of potential low flow impacts from regenerating forests is still uncertain. Instead the percentage of young second growth (<80 years) within SSAF Study Areas AUs is simply mapped as a changing relative intensity colour ramp ranging from dark green (lower % of young second growth) to red (higher % of young second growth) with an assumption that a greater percentage of young second growth represents a potentially greater risk to fish habitats.
Assessment Results:	• See Figure 6.7

Commentary:

Evidence from the US Pacific Northwest indicates that rigorously regenerating forest plantations can reduce summer stream flows (**water quantity**) relative to mature and old growth forest (Hicks et al. 1991; Jones and Post 2004; Perry et al. 2017; Grosdahl et al. 2019). Widespread transformation of mature and old-growth forests through past and ongoing logging practices may contribute to summer water yield declines (**water quantity**) over large basins and regions, reducing stream habitats, and exacerbating stream warming (Post and Jones 2016; Gronsdahl et al. 2019). Data are limited but may suggest the beginning of a significant second growth effect on low flows beginning at around 25 years, a maximum effect at 50 years, and cessation at approximately 75-80 years (D. Tripp, pers. comm.). For evaluation within the SSAF Study Area we have identified the extent of forest within an AU aged < 80 years to reflect the general extent of this potential forest regrowth effect on summertime low flows. Further research is required at both stand and catchment levels to more accurately clarify the time scales and specific conditions under which reductions in low flows would occur (Grosdahl et al. 2019). Low flow response will conceivably vary with climate, elevation, and the physiology of the dominant tree species (Grosdahl et al. 2019).

AUs with the greatest extents of young regenerating second growth forest (<80 years old) are found within the central and southeastern portions of the Study Area. Young second growth is less prevalent within the mountainous and more remote northern and southwestern portions of the Study Area. While there are areas of extensive young second growth found within all Skeena First Nation territories AUs with higher percentages of young second growth are most concentrated within territories of the Lake Babine Nation, Office of the Wet'suwet'en, Wet'suwet'en First Nation, Nee-tahi-Buhn Indian Band, Skin Tyee Nation, and Witset representing a past legacy of extensive recent logging in a large proportion of the Study Area. AUs with extensive stands of young second growth are less common across the territories of the Gitxsan Hereditary Chiefs, the Gitanyow Hereditary Chiefs, and the Gitwangak.

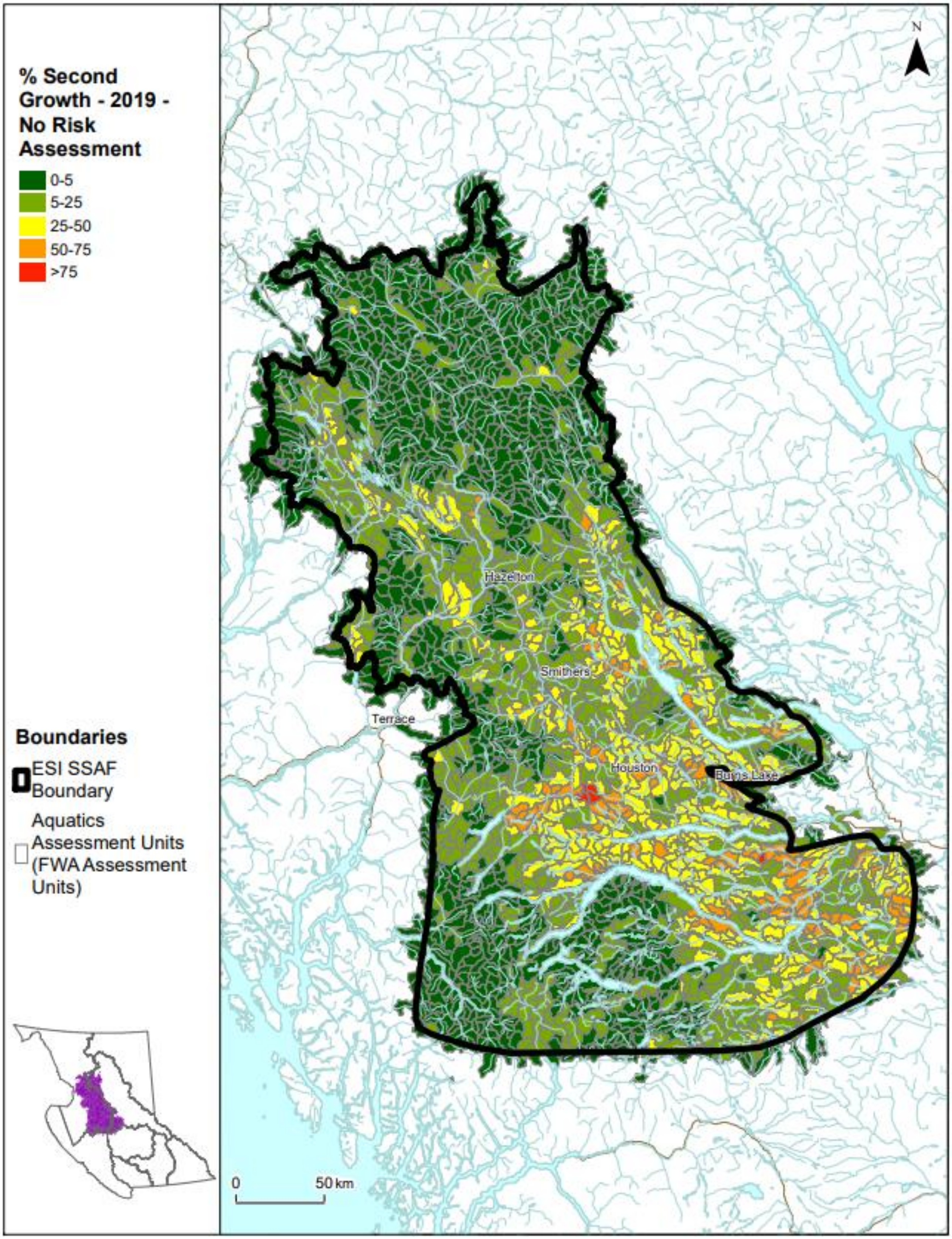


Figure 6.7 Young second growth forest percentage – SSAF Study Area.

6.7 Riparian Disturbance

Indicator Description:	This indicator reports the percentage of the total stream length within an aquatic assessment unit (AU) that has been disturbed (by natural causes or human actions). The extent of disturbance is derived from an intersection of stream lines with the province's custom 'Development' layer which incorporates current (within last 20 years) and historic disturbance data from various sources (Current and Historic Fire Perimeters), Tantalis, OGC, BTM, FAIB Consolidated Cutblocks, and VRI (insect disturbance) layers) while the intersecting stream location information is derived from the province's 1:20K FWA stream network. All FWA streams are used for analysis, including intermittent and indefinite streams. For double line rivers, if either bank has disturbance within 30m, the river main flow centerline length (approx.) is counted as disturbed. Disturbance is reported in hierarchical order: if there are multiple overlapping disturbance types, current human disturbance is reported first, then historical human disturbance, then any natural disturbance. Risk ratings for riparian disturbances (preliminary categorizations) derive from the derives from the Wild Salmon Policy and Pacific Salmon Foundation's cumulative pressures on salmon habitat summary report cards (Fisheries and Oceans Canada 2005, Porter et al. 2013, 2014). Note that for the province's current derivation of Riparian Disturbance that all fire, and pine beetle disturbance is included in the assessment, which means that the disturbance is probably over-predicted, as riparian disturbance is only considered an issue when the trunk of the tree is removed, which is not the case in many fires and non-harvested pine beetle forest. Furthermore, this disturbance dataset uses harvest boundaries, and does not consider riparian reserves inside harvest boundaries. The new provincial CE assessment, running in 2020, will exclude fire, insect disturbance, and riparian reserves. This will likely change the future representation of riparian disturbances in the Study Area considerably.
Interpretation Key:	• Riparian disturbance < 5% is considered lower risk for fish habitat degradation (green) • Riparian disturbance 5 - 15% is considered moderate risk for fish habitat degradation (yellow) • Riparian disturbance > 15% is flagged as higher risk for fish habitat degradation (orange)
Assessment Results:	• See Figure 6.8

Commentary:

Riparian areas are important as they can affect channel morphology (**physical surroundings**) and aquatic habitats (**watershed productivity**) through the provision of large wood. Riparian areas also influence **water quality**, provide shade, and are sources of food and nutrients to aquatic ecosystems. The maintenance of these functions and services depends upon intact riparian areas (Meehan 1991; Gustavson and Brown 2002). Multiple factors contribute to riparian condition including watershed area, distribution and types of vegetation, regulatory compliance, vegetation disturbance, form and structure (Stalberg et al. 2009). As the portion of streams that are disturbed (by various factors) increases, so does the risk of surface erosion and mass-transport of sediment during heavy precipitation events (MOF 1995a, 1995b). When riparian vegetation is lost, stream channels are weakened due to the lack of root structures, and intensified surface erosion and mass-wasting are common outcomes.

Areas of high riparian disturbance are present throughout the entire south-central and southeastern portions of the Study Area (i.e., almost all AUs in these areas are flagged as high risk, indicating that >15% of defined riparian areas within an AU may have been disturbed). Conversely, riparian disturbance is rated as primarily low risk (i.e., <5% disturbed) in AUs in the northern and western portions of the Study Area. All SSAF First Nations have AUs with extensive amounts of riparian disturbance, but the greatest proportion of high risk flagged AUs are found within the territories of the Lake Babine Nation, Office of the Wet'suwet'en, Wet'suwet'en First Nation, Nee-tahi-Buhn Indian Band, Witset, and Skin Tyee Nation. While still having many highly impacted AUs there are a greater proportion of AUs that are not flagged for risk for this indicator (i.e., <5% riparian disturbance) within the territories of the Gitxsan Hereditary Chiefs, the Gitanyow Hereditary Chiefs Office, and the Gitwangak.

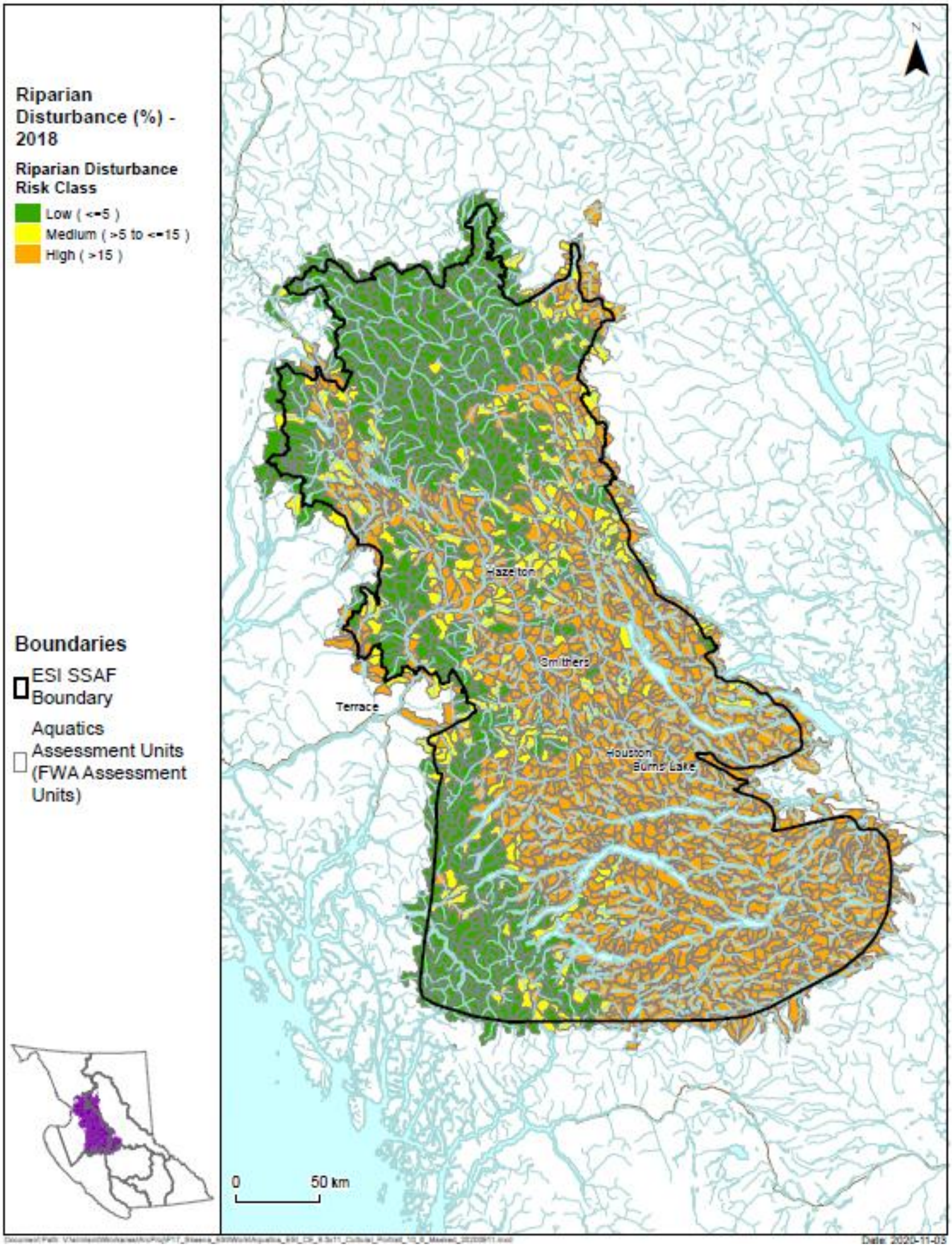


Figure 6.8 Riparian disturbance ratings – SSAF Study Area.

6.8 Total Land Disturbance

Indicator Description:	This indicator reports the percentage of the total area of the aquatic assessment unit (AU) that has been disturbed (by natural causes or human actions). The extent of disturbance is derived from the province's custom 'Development' layer which incorporates current (within last 20 years) and historic disturbance data from various sources (Current and Historic Fire Perimeters), Tantalis, OGC, BTM, FAIB Consolidated Cutblocks, and VRI (insect disturbance) layers). Disturbance is reported in hierarchical order: if there are multiple overlapping disturbance types, current human disturbance is reported first, then historical human disturbance, then any natural disturbance.
Interpretation Key:	No risk classifications have been developed for mapping of this indicator as the science/understanding around the degree of impacts to fish habitats from different levels of general land disturbance is still uncertain. Instead the percentage of total land disturbance within SSAF Study Areas AUs is simply mapped as a changing relative intensity colour ramp ranging from dark green (relatively lower % of disturbance) to orange (relatively higher % of disturbance) with an assumption that a greater percentage of total land disturbance represents a potentially greater risk to fish habitats.
Assessment Results:	• See Figure 6.9

Commentary:

Land development and natural disturbances within a watershed influence aquatic ecosystems via multiple pathways. Large scale disturbances can result in changes to forest canopy, rainfall interception, run-off, and stream flow (**water quality and quantity**) and generate cumulative impacts through sediment generation, and introduction of contaminants that can affect aquatic habitats (**watershed productivity**) (Poff et al. 2006; Stalberg et al. 2009). Multiple elements of land disturbance (changes in land cover composition, configuration, and connectivity of impervious areas) will have interacting and often unpredictable effects on the biophysical environment (Alberti et al. 2007).

The areas of greatest total land disturbance are within the central-eastern and southeastern portions of the Study Area with many AUs in these areas showing overall disturbance from past human and/or natural factors as being >75%. Extensive areas of the northern and western sections of the Study Area are, however, relatively undisturbed (i.e., <25% disturbance). Skeena First Nation territories with the highest levels of total land disturbance include the Lake Babine Nation, the Office of the Wet'suwet'en, Wet'suwet'en First Nation, Nee-tahi-Buhn Indian Band, and Skin Tyee Nation. A greater proportion of relatively undisturbed AUs is found within the territories of the Witset, Gitanyow Hereditary Chiefs Office, Gitxsan Hereditary Chiefs, and the Gitwangak.

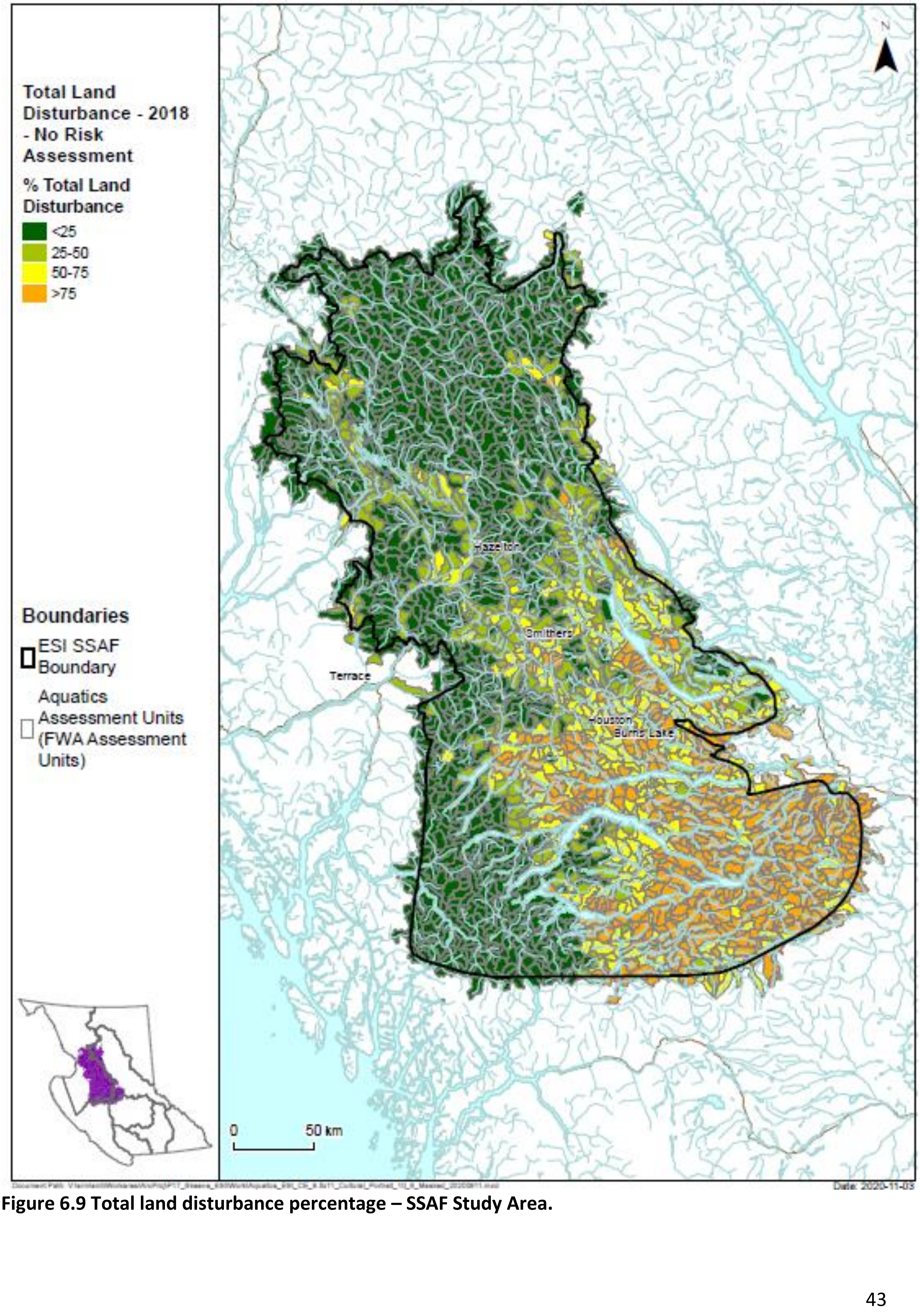


Figure 6.9 Total land disturbance percentage – SSAF Study Area.

6.9 Dams and Impoundments

Indicator Description:	This indicator reports the total number of human caused dams in the aquatic assessment unit (AU). Locations of dams are derived from the province's WHSE_WATER_MANAGEMENT.WRIS_DAMS_PUBLIC_SVW layer and does not include natural dams, such as those created by beavers.
Interpretation Key:	No risk classifications have been developed for mapping of this indicator as the degree of potential impacts to fish habitats from dams may be highly variable (depending on the size/type/operations of the dam as well as its location in the watershed) and difficult to predict. No attempt in this report has been made to weight the risk of particular dams. Instead the number of dams within SSAF Study Areas AUs is simply mapped as a changing relative intensity colour ramp ranging from dark green (no dams present) to orange (relatively higher number of dams present) with an assumption that a greater number of dams represents a potentially greater risk to fish habitats.
Assessment Results:	• See Figure 6.10

Commentary:

Dams can impact aquatic ecosystems by altering and fragmenting fish habitats. Man-made) and their impoundments can affect volume and timing of downstream flows (**water quantity**), alter **water quality**, simplify channel morphology (**physical surroundings**), and create barriers or impediments to fish movement (Meehan 1991). Restricted access to spawning streams and/or lakes can have consequent impacts to fish survival and productivity (Stantec 2007) and impact overall population connectivity.

Only a small number of dams (large enough to be identified within the province's dams GIS layer) are present within the Study Area. The majority of AUs in the Study Area are undammed. Dams have been constructed most commonly within the central areas of the Study Area, including concentrations near the major communities of Hazelton, Smithers, Houston and Burns Lake. While the total number of dams in the Study Area is small there are dams present within the territories of most SSAF First Nations, including the Gitxsan Hereditary Chiefs, Witset, Skin Tyee Nation, Lake Babine Nation, Nee-tahi-Buhn Indian Band, Wet'suwet'en First Nation, Office of the Wet'suwet'en, and Gitwangak. No dams are present in the territory of the Gitanyow Hereditary Chiefs.

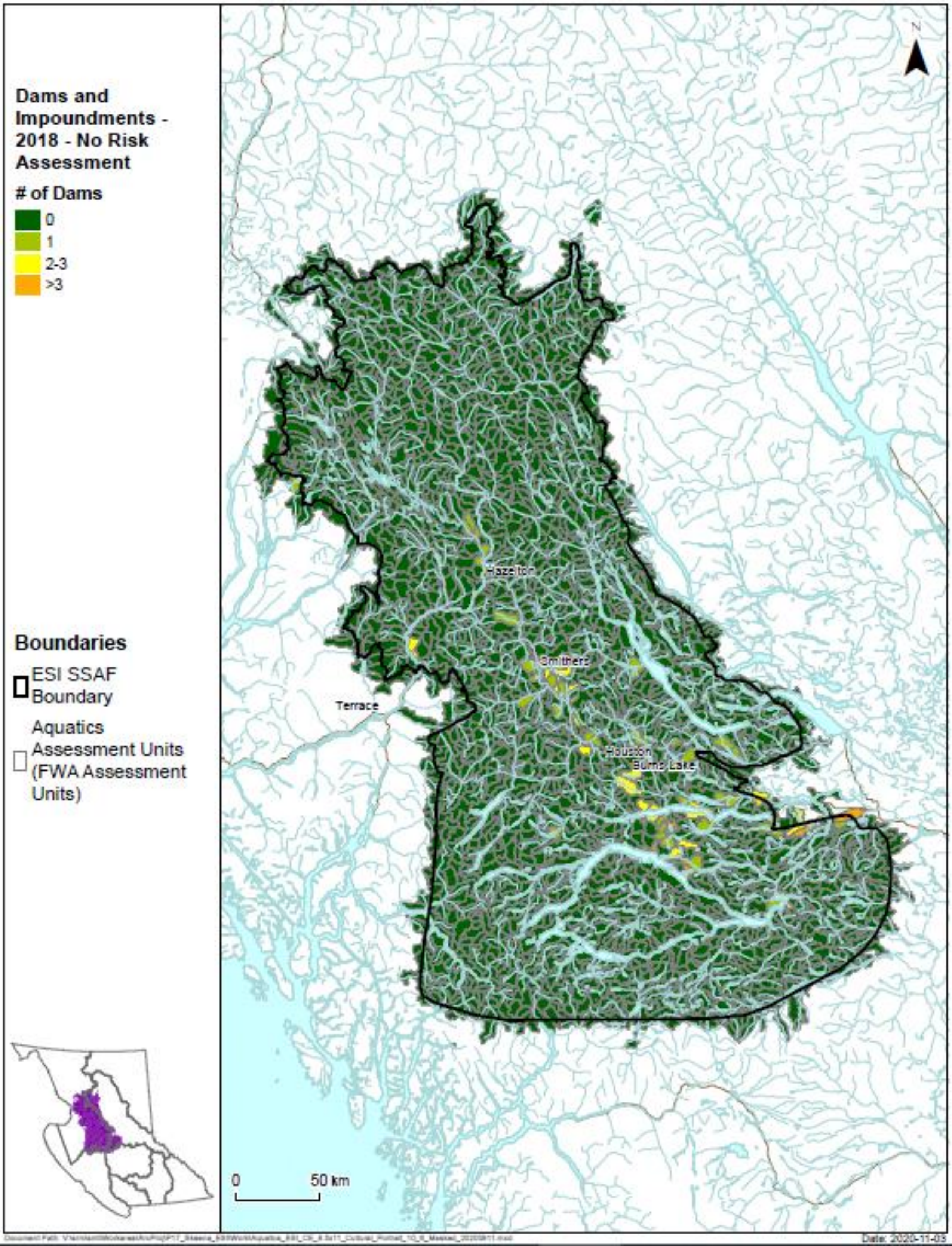


Figure 6.10 Number of dams – SSAF Study Area.

6.10 Water Licenses

Indicator Description:	This indicator reports the total number of water licenses in the aquatic assessment unit (AU). Locations of water license points of diversion (PODs) are derived from the province's WHSE_WATER_MANAGEMENT.WLS_POD_LICENCE_SP layer.
Interpretation Key:	No risk classifications have been developed for mapping of this indicator as the degree of potential impacts to fish habitats from licensed surface water volume allocations is difficult to determine as there may be mismatches between licensed allocations and actual water use. Seasonal water use is also a more critical pressure than overall licensed annual use and this is generally difficult to ascertain. Recognizing the weakness in the available information the number of water licenses represents a coarse surrogate measure of potential water use. The number of water licenses within SSAF Study Areas AUs is simply mapped as a changing relative intensity colour ramp ranging from dark green (no water licenses present) to red (relatively higher number of water licenses present) with an assumption that a greater number of water licenses represents a potentially greater risk to fish habitats. However, a single large industrial license may pose a greater hazard and this should be investigated at the Tier 1.5 level, which can be investigated with the Northwest Water Tool (https://nwwt.bcwatertool.ca/). No attempt is made to weight the potential pressures from individual water licenses based on allocated volumes. More detailed examination of the quantity and timing of actual water removals will need to be carried out to better determine the impacts of licensed allocations on aquatic values.
Assessment Results:	• See Figure 6.11

Commentary:

Water withdrawal includes data on points of diversion (PODs) which is an indicator of human caused water removal. Heavy allocation (and presumed use) of both surface and hydraulically connected subsurface water for human purposes for a variety of consumptive and non-consumptive uses (e.g., domestic, industrial, agriculture, power, and storage) from PODs within a watershed can affect fish habitats at critical times of year by reducing instream flows (**water quantity**) to levels that could constrain physical access to spawning and rearing habitats or potentially dewater fish redds. Reductions in both surface water and ground water supplies can also increase water temperatures with resultant impacts on all fish life stages (**water quality**, Richter et al. 2003; Hatfield et al. 2003; Douglas 2006).

The highest number of water licenses are concentrated in the central area of the Study Area, particularly around Smithers and to a lesser extent around the communities of Hazelton, Houston and Burns Lake, as well as in some agricultural areas in the southern portion of the Study Area. Most of the Study Area is considered relatively water abundant at present and license withdrawals likely do not currently represent a significant factor in the Study Area, save in select watersheds such as the Bulkley Valley. However, with climate implications, this may change. For example, new initiatives to produce alfalfa near Vanderhoof represent a potential new user in the Study Area as temperatures may become increasingly favourable for agriculture. Across SSAF First Nations a greater number of current water licenses are present in the territories of the Office of the Wet'suwet'en, Wet'suwet'en First Nation, Nee-tahi-Buhn Indian Band, Skin

Tyee Nation, and Witset while fewer water licenses are found within the territories of the Gitanyow Hereditary Chiefs, Lake Babine Nation, Gitxsan Hereditary Chiefs, and Gitwangak.

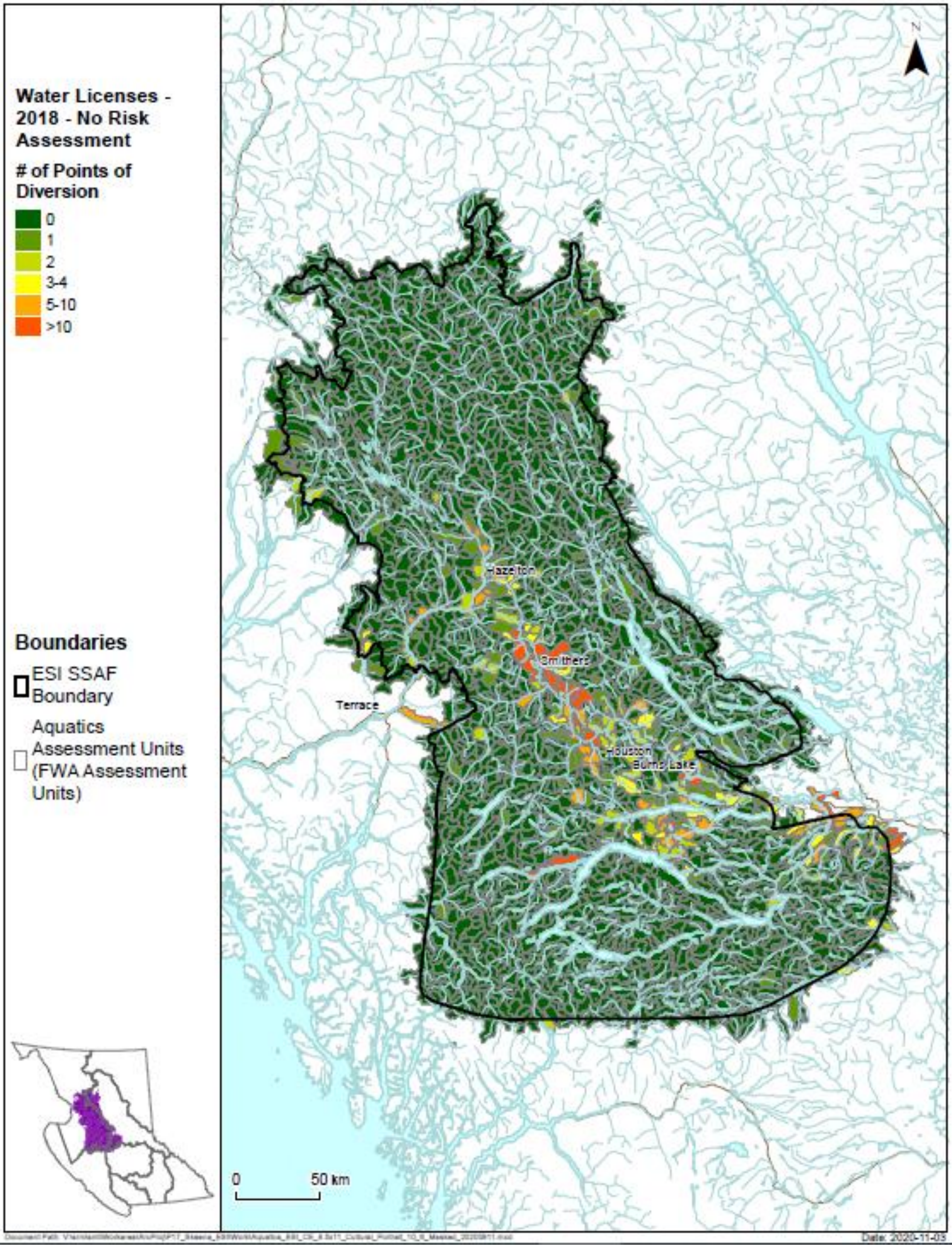


Figure 6.11 Number of water licenses (PODs) – SSAF Study Area.

6.11 Groundwater Wells

Indicator Description:	This indicator reports the total number of groundwater wells in the aquatic assessment unit (AU). Locations of ground water wells derives from the province's WHSE_WATER_MANAGEMENT.GW_WATER_WELLS_WRBC_SVW layer.
Interpretation Key:	No risk classifications have been developed for mapping of this indicator as the degree of potential impacts to fish habitats from licensed groundwater volume allocations is difficult to determine as there may be mismatches between licensed allocations and actual water use. Seasonal water use is also a more critical pressure than overall licensed annual use and this is generally difficult to ascertain. Recognizing the weakness in the available information the number of groundwater wells represents a coarse surrogate measure of potential water use. The number of groundwater wells within SSAF Study Areas AUs is simply mapped as a changing relative intensity colour ramp ranging from dark green (no groundwater wells present) to red (relatively higher number of groundwater present) with an assumption that a greater number of groundwater wells represents a potentially greater risk to fish habitats. No attempt is made to weight the potential pressures from individual groundwater wells based on allocated volumes.
Assessment Results:	• See Figure 6.12

Commentary:

Released groundwater provides much of the base flow for many streams during periods of low precipitation, or during winter when precipitation is locked up as snow or ice; groundwater inputs also ameliorate extreme surface water temperature (**water quantity and quality**, AEWG 2016). Many species of stream and lake-dwelling fish use groundwater upwelling areas as thermal refugia in summer, spawning habitat, or holding habitat during migrations (Baxter and McPhail, 1999; Torgersen et al., 1999; Austin et al. 2008 as cited in AEWG 2016). Pressures on groundwater comes from industry, municipalities, farms and homeowners that need access to groundwater from regional aquifers to meet domestic and non-domestic water needs. Groundwater allocations/use cannot be determined in detail. Regardless, water extraction metrics should include some measure of potential groundwater withdrawal, even if only a simple measure like the number of wells.

The greatest number of groundwater wells are concentrated in the central area of the Study Area, particularly around the communities of Smithers and Houston and to a lesser extent around the Hazelton and Burns Lake. Groundwater wells have not been drilled within the majority of the Study Area. Groundwater wells are present within the territories of all the SSAF First Nations.

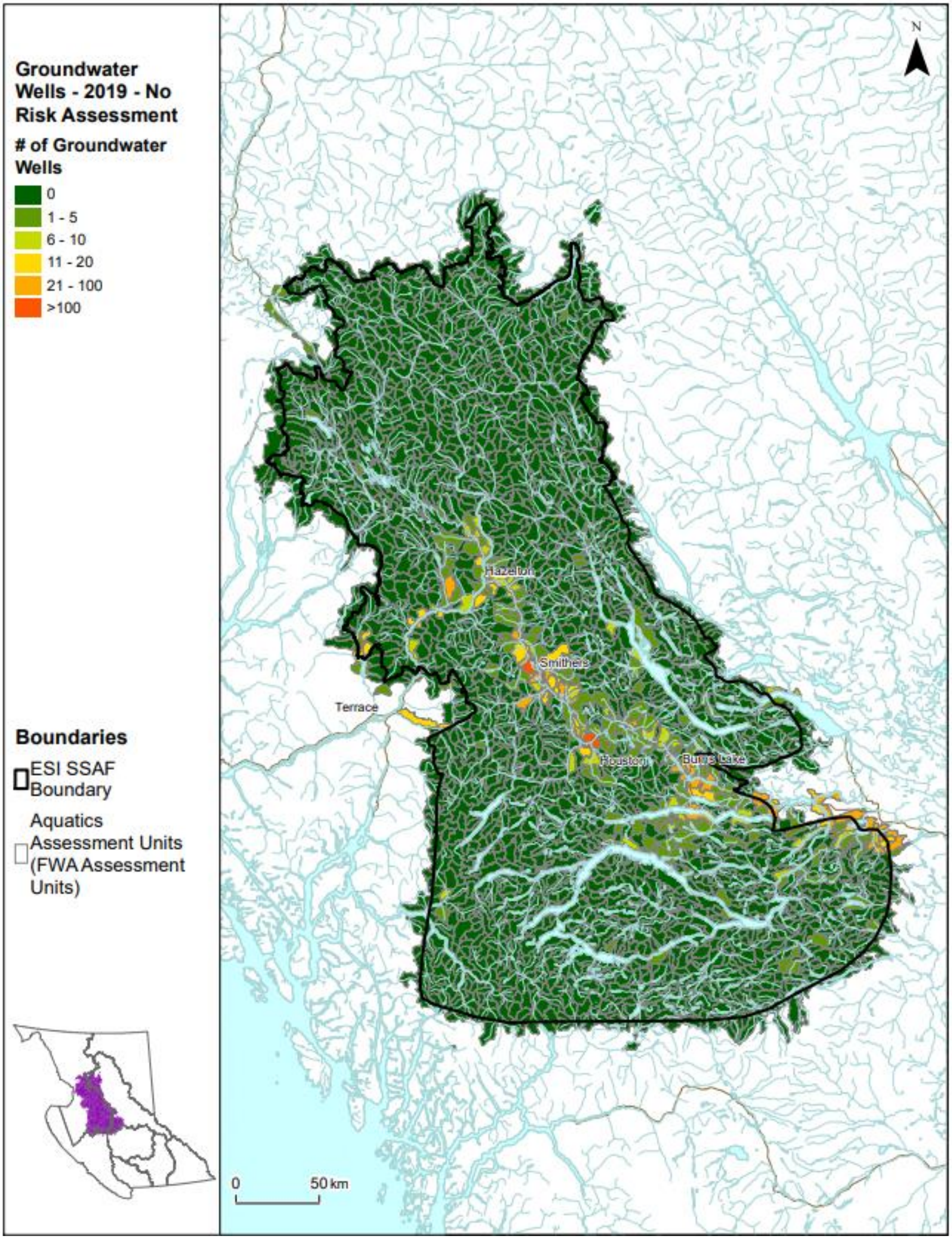


Figure 6.12 Number of groundwater wells – SSAF Study Area.

6.12 Water Allocation Restrictions

Indicator Description:	This indicator reports the total number of water allocation restrictions in the aquatic assessment unit (AU). Locations of water allocation restriction points derives from the province's WHSE_WATER_MANAGEMENT.WLS_WATER_RESTRICTION_LOC_SVW layer.
Interpretation Key:	No risk classifications have been developed for mapping of this indicator as the degree of potential impacts to fish habitats from individual water allocation restrictions is difficult to determine. Recognizing the weakness in the available information the number of water allocation restrictions represents a coarse surrogate measure of potential water use issues; local knowledge and a Tier 1.5 assessment may help to complete this data layer. The number of water allocation restrictions within SSAF Study Areas AUs is simply mapped as a changing relative intensity colour ramp ranging from dark green (no water allocation restrictions present) to red (relatively higher number of water allocation restrictions present) with an assumption that a greater number of water allocation restrictions represents a potentially greater risk to fish habitats.
Assessment Results:	• See Figure 6.13

Commentary:

Many small streams in BC are fully recorded or fully allocated meaning water supply (**water quantity**) is now severely limited, and naturally some streams go completely dry in the summer (Ptolemy 2015). A Water Allocation Restriction set by the province is a supply state that indicates nearly or always full allocation of water from a stream for human use. FLNRORD staff will put water allocation restrictions on a stream or an aquifer to alert other staff to current or potential water allocation concerns, ranging from a possible water shortage to water fully recorded with suggested limitations on further water permit licensing.

The greatest number of formal Water Allocation Restrictions that have been applied by the province are within AUs in the central portion of the Study Area, particularly around the communities of Smithers and Houston. There are no Water Allocation Restrictions in place for the majority of AUs in the Study Area. Water Allocation Restrictions have been placed for AUs within the territories of all the SSAF First Nations, although the total number of restrictions is very small within the territories of the Lake Babine Nation and the Gitanyow Hereditary Chiefs Office.

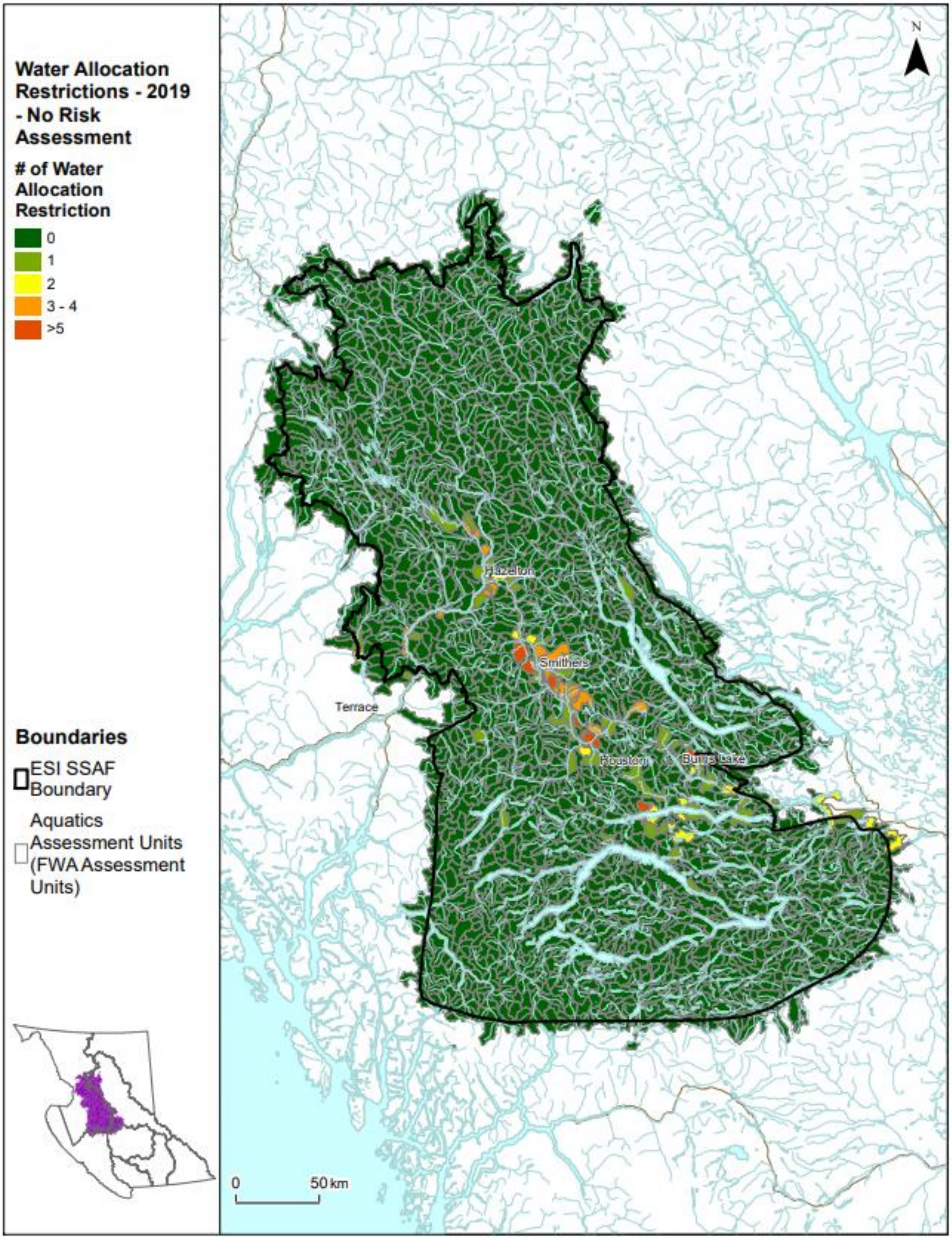


Figure 6.13 Number of water allocation restriction points – SSAF Study Area.

6.13 Mines

Indicator Description:	This indicator reports the presence of mines in the aquatic assessment unit (AU). Locations of mines derives from the province's WHSE_MINERAL_TENURE.MINFIL_MINERAL_FILE layer.
Interpretation Key:	No risk classifications have been developed for mapping of this indicator as the degree of potential impacts to fish and fish habitats from individual mines can be difficult to determine as this can be highly variable based on mine size, type, operations and mitigation efforts. Recognizing the weakness in the available information the presence or absence of mines within the SSAF Study Area AUs is mapped. This is a coarse surrogate measure of potential mine impacts, and the assumption is that the presence of any mine represents a potential risk to fish and fish habitats. Further data on the number of mines in an AU are available in the spatial data features. No attempt is made to weight the potential pressures from individual mines based on mine characteristics.
Assessment Results:	• See Figure 6.14

Commentary:

Mines can pose a potentially significant threat to aquatic ecosystems (Meehan 1991; Nelson et al. 1991; Kondolf 1997). Depending on the type and size of mining activity and the mitigation measures employed mines can potentially have a significant impact to **water quality** or direct footprint impacts to aquatic habitat. Fuel and oil spills are a risk at all mine sites where equipment is used. Runoff from mines, quarries, well sites, and mine wastes have potential to contribute sediment, metals, acids, oils, organic contaminants and salts to water bodies (Quigley et al. 1996). Metal mines have the potential to generate acid rock drainage (ARD) based on the type of bedrock the mine site is located on (Cooper 2011). Tailings pond failure poses a low probability, but high consequence, risk. Toxic chemicals affect water quality and can kill fish and their invertebrate food supply (Nelson et al. 1991; Kondolf 1997). This indicator is meant to alert decision makers and professionals of the potential for impact and the need for further investigation into the type, extent and mitigation measures of mining activity that have been undertaken within an assessment watershed.

Mining activity is not generally intense within the Study Area with mines distributed fairly widely across the landscape but there are denser concentrations of mines in a few AUs, particularly in the area around Smithers. Mines are present in the territories of all SSAF First Nations with the exception of the territory of the Gitanyow Hereditary Chiefs (although a number of mines are present in two watersheds at the edge of Gitanyow territory). The densest concentrations of mines are in the territories of the Office of the Wet'suwet'en and the Witset.

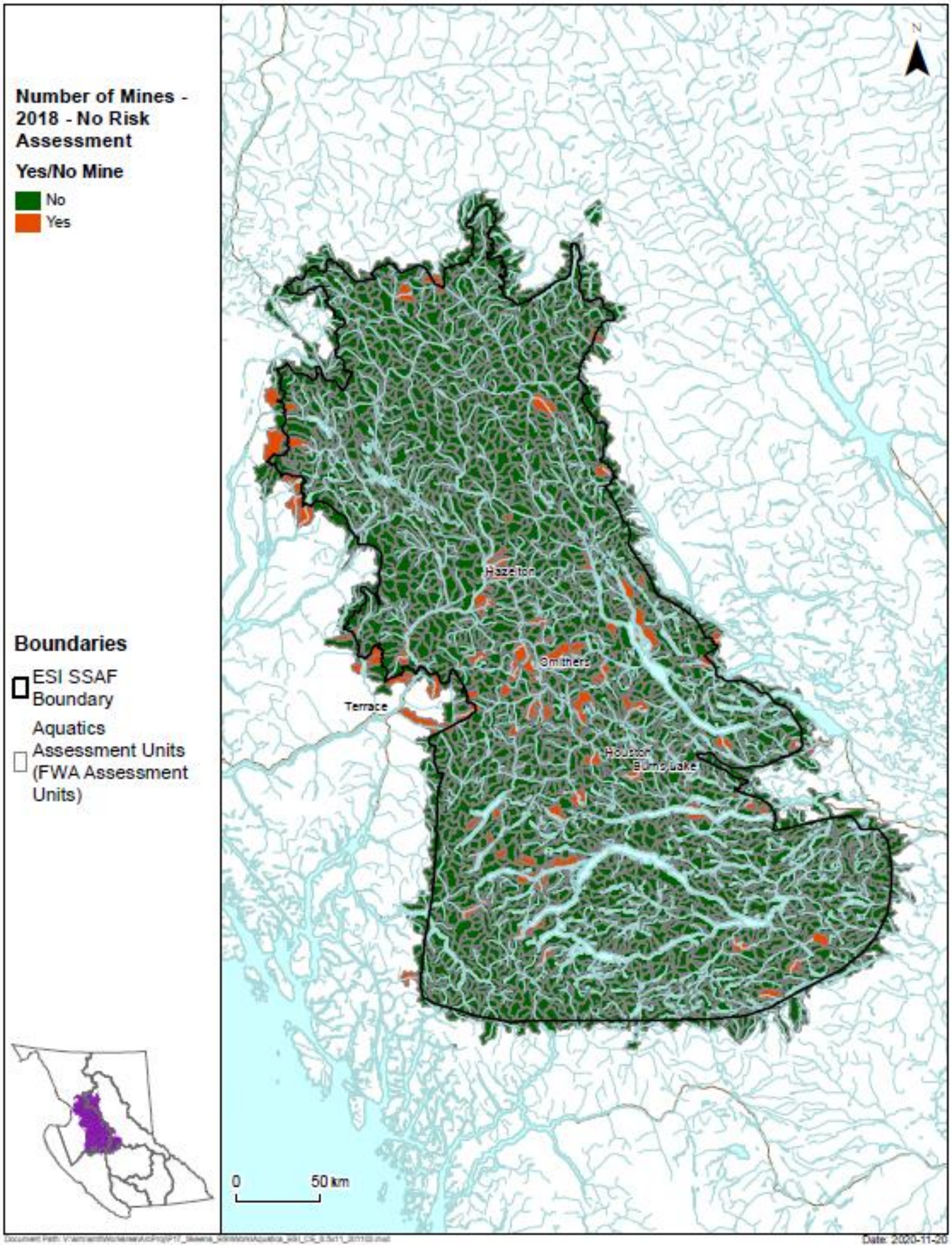


Figure 6.14 Presence or Absence of mines – SSAF Study Area.

6.14 Point Source Pollution

Indicator Description:	This indicator reports the total number of pollutant point sources (i.e., wastewater discharges, Notice of Work mine sites, remediation sites, and placer mine tenure intersection with streams) in the aquatic assessment unit (AU). Locations of pollutant points sources are derived from a combination of the province's MOE Authorizations Database and WHSE_MINERAL_TENURE.MMS_NOTICE_OF_WORK (2018-11-29), WHSE_WASTE.SITE_ENV_RMDTN_SITES_SVW (2019-04-12), and WHSE_MINERAL_TENURE.MTA_ACQUIRED_TENURE_GOV_SVW (2018-11-29) layers.
Interpretation Key:	No risk classifications have been developed for mapping of this indicator as the degree of potential impacts to fish habitats from individual pollutant point sources can be difficult to determine as this can be highly variable based on type of pollutant, volume, frequency of exposure, and mitigation efforts. Recognizing the weakness in the available information the number of pollutant point sources represents a coarse surrogate measure of potential pollution impacts. The number of pollutant point sources within SSAF Study Areas AUs is simply mapped as a changing relative intensity colour ramp ranging from dark green (no point source pollution sites present) to red (relatively higher number of point source pollution sites present) with an assumption that a greater number of pollutant point sources represents a potentially greater risk to fish habitats. No attempt is made to weight the potential pressures from individual pollution sources based on source characteristics.
Assessment Results:	• See Figure 6.15

Commentary:

High levels of pollutant discharges from municipal and industrial sources could impact the **water quality** of fish habitats either through excessive nutrient enrichment or chemical contamination. Some industrial waste products can directly injure or kill aquatic life even at low concentration (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).

There are numerous sources of point source pollution throughout the Study Area, with concentrations of release points in the central and southeastern portions of the Study Area. These pollutants can come from a variety of sources in the Study Area, with concentrations near the major communities of Smithers, Hazelton, Houston, and Burns Lake, while also common within other areas of the Study Area where there may be more intensive agriculture, mining or other polluting activities. AUs with high numbers of pollutant point sources are present in all SSAF First Nations territories.

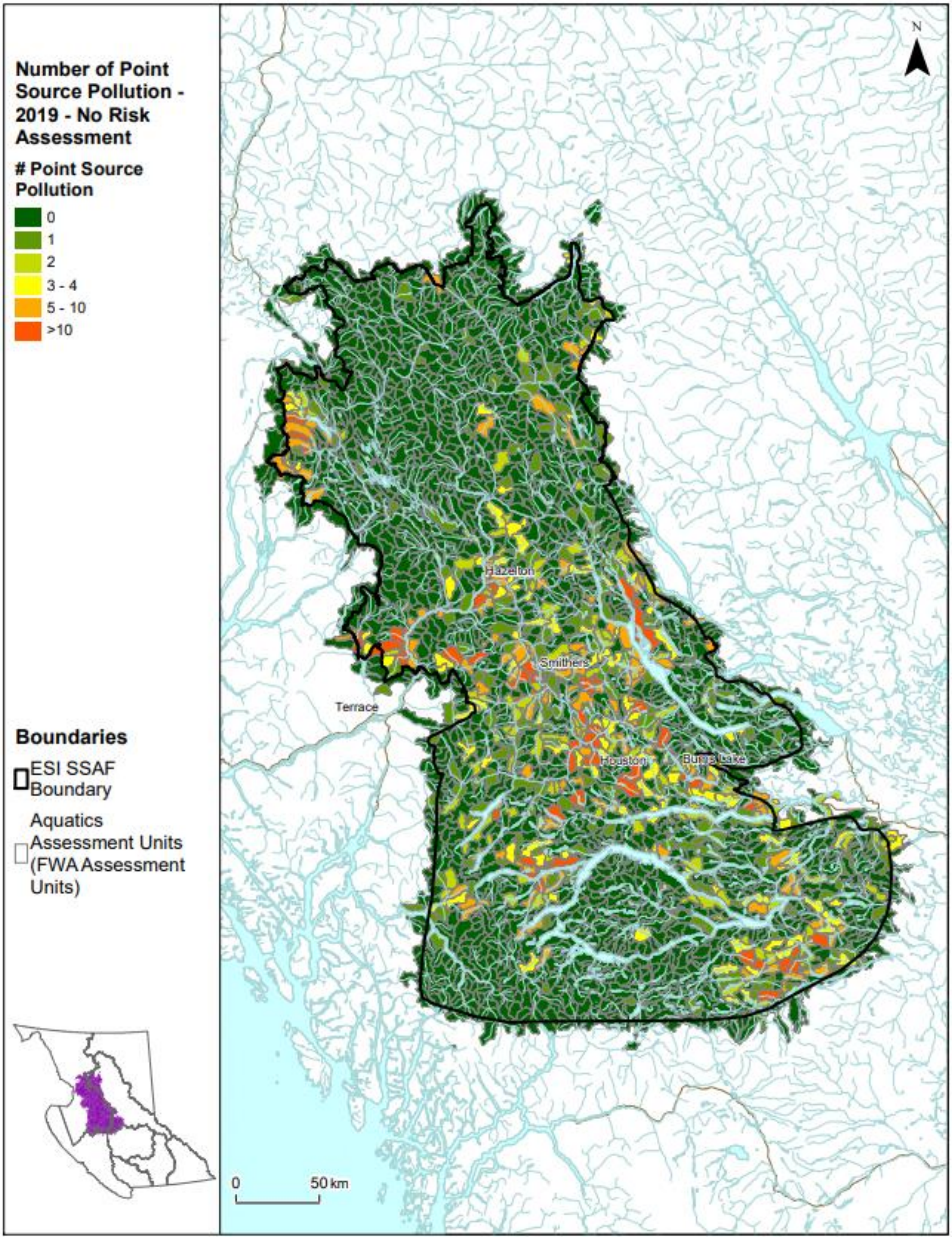


Figure 6.15 Number of pollutant point sources - SSAF Study Area.

Watershed Sensitivity Indicators:

6.15 Low Flow Sensitivity

Indicator Description:	This indicator reports the percentage of streams in the aquatic assessment unit (AU) that are considered seasonally low flow sensitive (summer sensitive, and/or winter sensitive). Information on stream flow sensitivities is derived from the province's Ecoregional Flow Sensitivity map layer. Flow sensitivity in the province's low flow model used to develop this flow sensitivity layer is characterized by streams with 30-day baseflows in 1-or 2-year frequencies that are $\leq$20% long term mean annual discharge (MAD) (R. Ptolemy, unpublished).
Interpretation Key:	No sensitivity classifications have been developed for mapping of this indicator as the science/understanding as to the degree of concern around low flow sensitivity is still uncertain. Instead the percentage of low flow sensitive streams within SSAF Study Areas AUs is simply mapped as a changing relative intensity colour ramp ranging from dark green (lower % of sensitive streams) to red (higher % of sensitive streams) with an assumption that a greater percentage of flow sensitive streams represents a potentially greater risk to fish habitats.
Assessment Results:	• See Figures 6.16 (summer low flow sensitivity) and 6.17 (winter low flow sensitivity)

Commentary:

High water temperatures, low levels of dissolved oxygen, and deleterious levels of toxins can all be exacerbated by low stream flows (**water quality**, Nelitz et al. 2011). Moreover, the quantity, quality and connectivity of aquatic habitats are also influenced by the amount of flow. Watersheds with a greater proportion of seasonally flow sensitive streams would therefore be considered relatively more vulnerable to additional habitat pressures that can affect flows than watersheds considered less flow sensitive.

The majority of AUs across the SSAF Study Area have streams that are considered winter low flow sensitive while streams for many AUs in the central and southeastern portions of the Study Area are also considered summer low flow sensitive (based on provincial flow models (Ptolemy 2015)). While concerns about effects of winter low flows in their territories will be generally common across all SSAF First Nations the impacts from potentially more significant summer low flow issues will be predominantly felt within the territories of the Office of the Wet'suwet'en, Wet'suwet'en First Nation, Nee-tahi-Buhn Indian Band, Skin Tyee Nation, and Witset. Summer low flow issues should theoretically be less of a concern within territories of the Gitanyow Hereditary Chiefs, Lake Babine Nation, Gitxsan Hereditary Chiefs, and Gitwangak. Recent summer low flow issues noted for stream systems within Gitanyow, GItxan, and LBN territories (J. Anderson, pers. comm.) however indicates that local climate change related-effects are impacting flows even in creeks within the study area not rated low flow sensitive through these broad previous provincial flow modeling exercises.

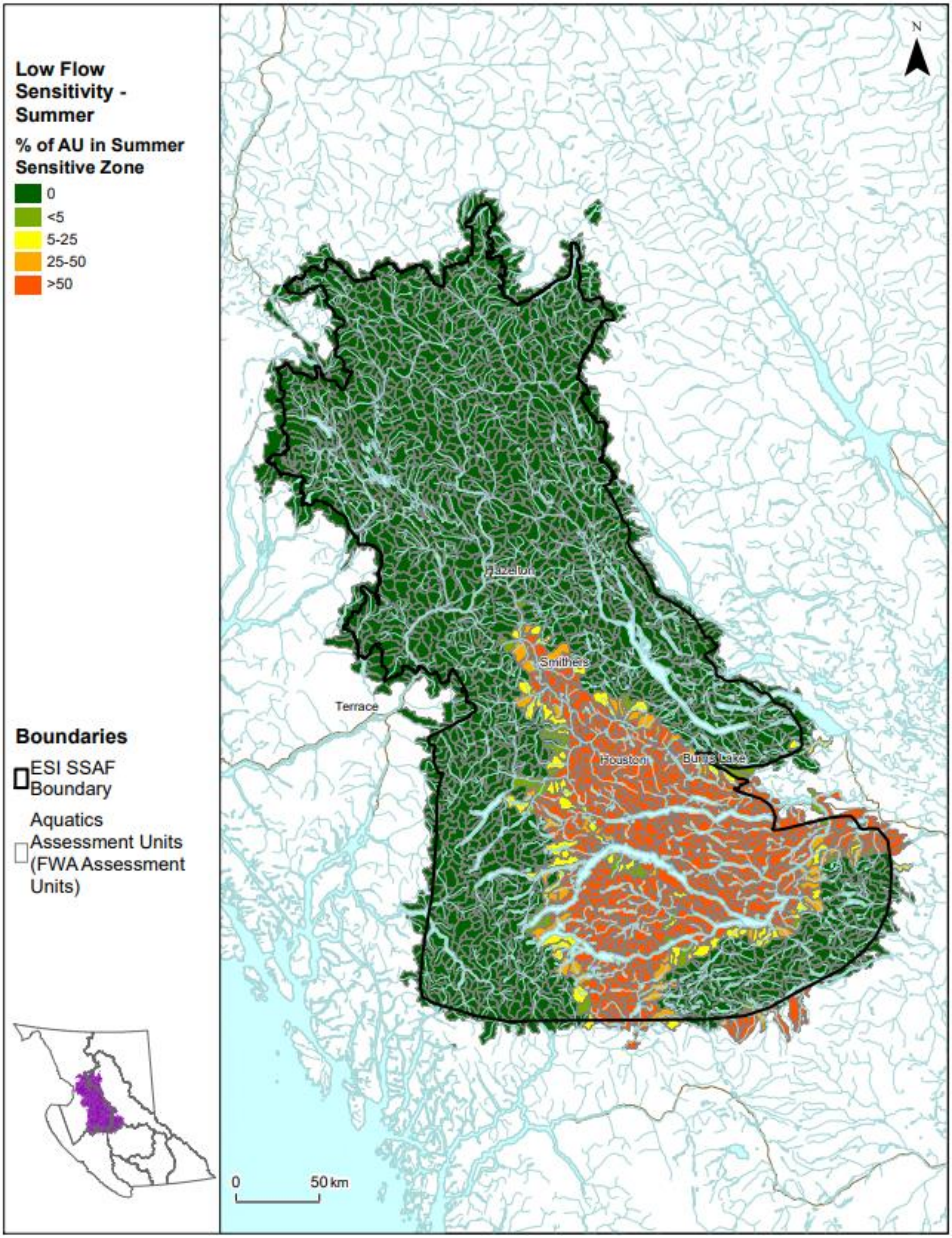


Figure 6.16 Percentage of AU summer low flow sensitive - SSAF Study Area.

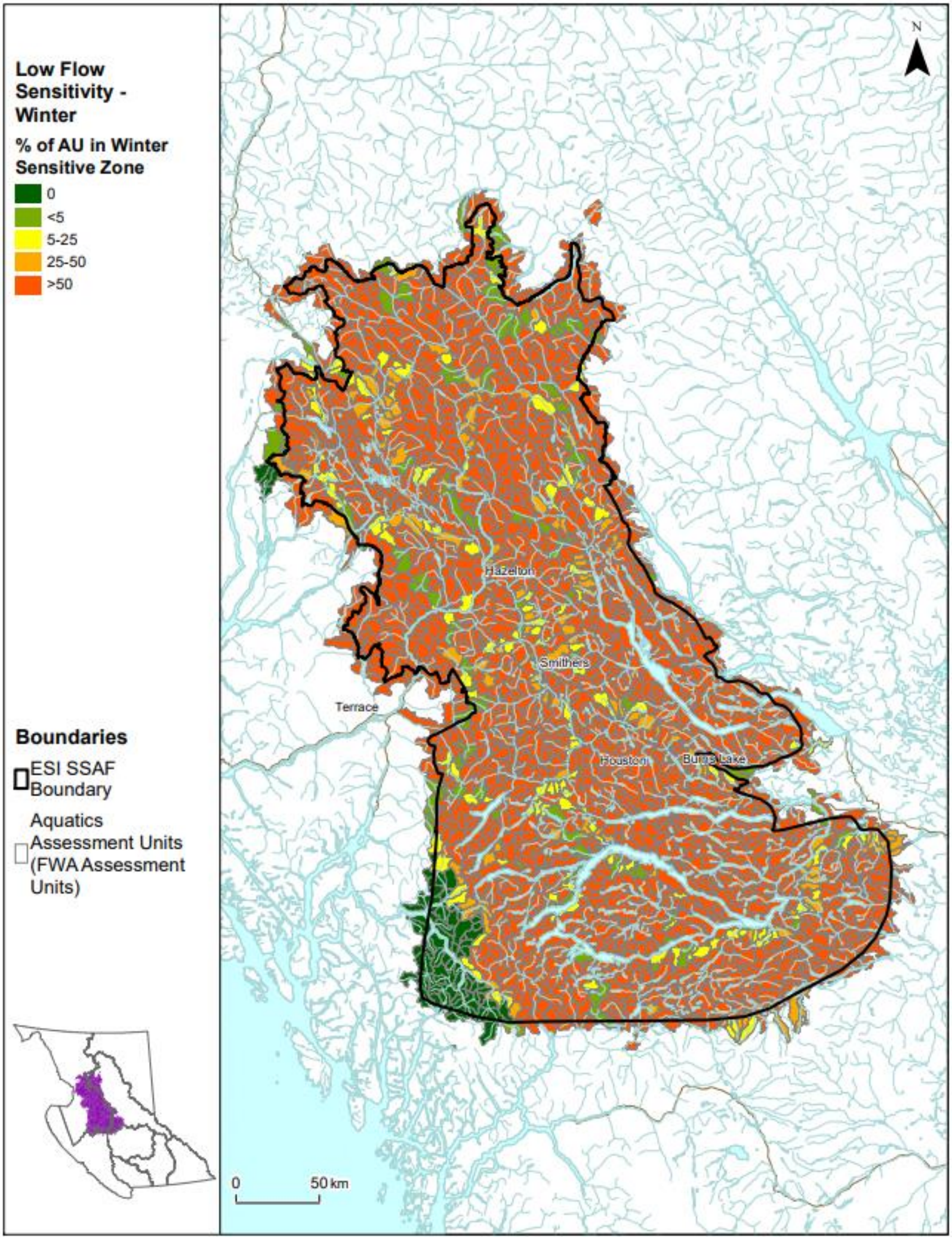


Figure 6.17 Percentage of AU winter low flow sensitive - SSAF Study Area.

6.16 Drainage Density Ruggedness

Indicator Description:	This indicator reports the drainage density ruggedness (DDR) in the aquatic assessment unit (AU). DDR is measured as the dimensionless product of drainage density (stream length per unit area (km/km^2)) and total elevation relief (the difference in meters between the highest and lowest points in the AU). Drainage Density Ruggedness is derived from the province's DDR Score layer (based on minimum elevation, maximum elevation, elevation relief, and stream density within the AU).
Interpretation Key:	No sensitivity classifications have been developed for mapping of this indicator as the science/understanding as to the degree of increased peak flow sensitivity in relation to drainage density ruggedness is still uncertain. The drainage density ruggedness within SSAF Study Areas AUs is simply broken into three discrete classes and mapped as a changing relative intensity colour ramp ranging from dark green (lower DDR class) to red (higher DDR class) with an assumption that a higher DDR represents a potentially greater risk to fish habitats.
Assessment Results:	• See Figure 6.18

Commentary:

Drainage density ruggedness (DDR) is a metric intended to identify how quickly hillslope and stream runoff could be transported downslope or downstream through a watershed, thereby reflecting the potential for flash-floods events (**physical surrounding,** Patton and Baker 1976 as cited in Lewis et al. 2013). The greater the stream density in a catchment, the less distance there will be for hillslope runoff to travel before reaching a stream. Likewise, the greater the elevation relief in a basin the greater the average stream gradient and streamflow velocity. Both these factors reduce the time of concentration for precipitation to reach lower channel reaches such that higher drainage density ruggedness increases the sensitivity of the basin to elevated peak flows (Lewis et al. 2013).

DDR is greatest in the mountainous AUs of the western portions of the Study Area with many AUs in this region categorized as Class 3, suggesting an intrinsically high sensitivity to elevated peak flows in these AUs. DDR is also of relatively high value across the northern portions of the Study Area with AUs commonly categorized here as Class 2. DDR is lowest across the southeastern portion of the Study Area with most AUs categorized as Class 1 (i.e., low intrinsic peak flow sensitivity). Most SSAF First Nations territories have large numbers of AUs potentially at increased risk from elevated peak flows due to high DDR. The territory of the Lake Babine Nation has the highest proportion of low DDR AUs (i.e., Class 1), while the AUs in the flatter areas of the eastern portions of the territories of the Nee-tahi-Buhn Indian Band, Office of the Wet'suwet'en, Skin Tyee, and Wet'suwet'en First Nation are also predominantly Class 1 (low DDR) and would be considered less prone to damaging elevated peak flow events.

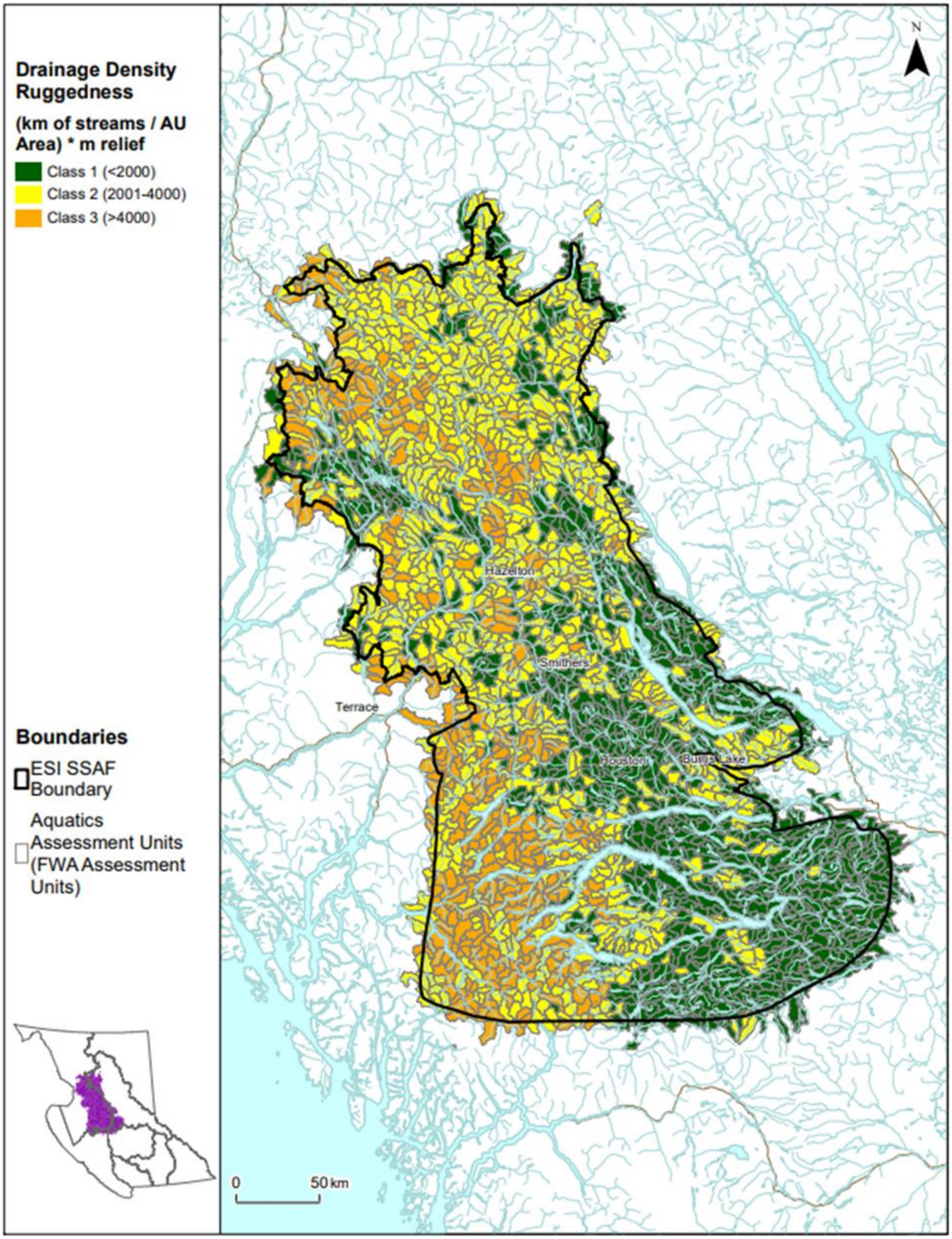


Figure 6.18 Drainage density ruggedness (DDR) - SSAF Study Area.

6.17 Lakes and Wetlands (and Man-made Waterbodies)

Indicator Description:	This indicator reports the percentage of the total area of the aquatic assessment unit (AU) that is represented by lakes, wetlands and man-made water bodies (i.e., reservoirs and canals). The combined area of wetlands, lakes and other waterbodies is derived from the province's WHSE_BASEMAPPING.FWA_LAKES_POLY and WHSE_BASEMAPPING.FWA_MANMADE_WATERBODIES_POLY GIS layers, as well as the newly developed Skeena ESI Consolidated Wetlands layer (which is derived from combined provincial VRI and FWA Wetlands GIS layers).
Interpretation Key:	No sensitivity classifications have been developed for mapping of this indicator as the science/understanding as to the peak flow buffering capacity of waterbodies within a watershed is still uncertain, and both size of a waterbody and its position within a watershed could be important. Instead the percentage of wetlands, lakes, and manmade water bodies within SSAF Study Areas AUs is simply mapped as a (reversed) changing relative intensity colour ramp ranging from dark green (higher % of AU represented by wetlands, lakes and/or man-made waterbodies) to red (lower % of AU represented by wetlands, lakes and/or man-made waterbodies) with an assumption that a lower percentage of wetlands, lakes and/or waterbodies represents a potentially greater risk to fish habitats. Note that this translates into a map legend that is represented in the reverse of other sensitivity maps in the report (i.e., in the case of this indicator more is better and less is worse).
Assessment Results:	• See Figure 6.19

Commentary:

Within the constraints of local climate and geology watershed hydrology (**physical surroundings**) may react differently to the same intensities of land-use disturbance, at least partly because of differences in watershed storage capacity. Watersheds with large storage capacity, defined as the percentage of watershed area covered by wetlands, lakes and/or man-made water bodies, can better buffer against increased water runoff from land clearing (Sauer et al. 1983; Johnston et al. 1990). Storage capacity, as well as watershed area, channel slope, and soil permeability determine sensitivity of watersheds to stressors associated with land-use activities that impact hydrologic regimes (Detenbeck et al. 2000). Specifically there is strong support as to the concept that a greater storage capacity in a watershed will increase buffering of high peak flow events that could be potentially damaging to fish habitats (Utzig and Carver 2013 – note also that position of waterbodies within the watershed can also be an important factor affecting buffering). While past evaluations around potential thresholds of concern are variable, peak flows and systems flashiness appear to increase rapidly as watershed storage drops below 5 to 10% of total watershed area (Detenbeck et al. 2000; Detenbeck et al. 2005; Hey and Wickenkamp 1996; Krug et al. 1992; Jacques and Lorenz 1988). This indicator reflects the hydrological importance of lakes and wetlands and does not reflect the biological importance of individual lakes and wetlands.

Most AUs in the central eastern and southeastern portions of the Study Area have considerable existing extents of lakes, wetlands and other waterbodies that could help in buffering the effects of land disturbances on peak flows (i.e., often making up >10% of the total area of an AU). Conversely AUs within the western and northern portions of the Study Area are generally mountainous with often very small proportions (i.e., <2%) of AU area consisting of lakes, wetlands or other waterbodies. Intrinsic hydrological buffering would be considered generally very poor throughout these latter areas due to the limited watershed storage capacities. First Nations territories possessing a high proportion of low storage capacity AUs that would be considered more sensitive to peak flow events include those of the Witset, Gitanyow Hereditary Chiefs, Gitwangak, Gitxsan Hereditary Chiefs, Wet'suwet'en First Nation, and Office of the Wet'suwet'en. Less sensitive, high storage capacity AUs predominant in the territories of the Lake Babine Nation and the Nee-tahi-Buhn Indian Band, as well as in the central and eastern portions of the Skin Tyee Nation territory.

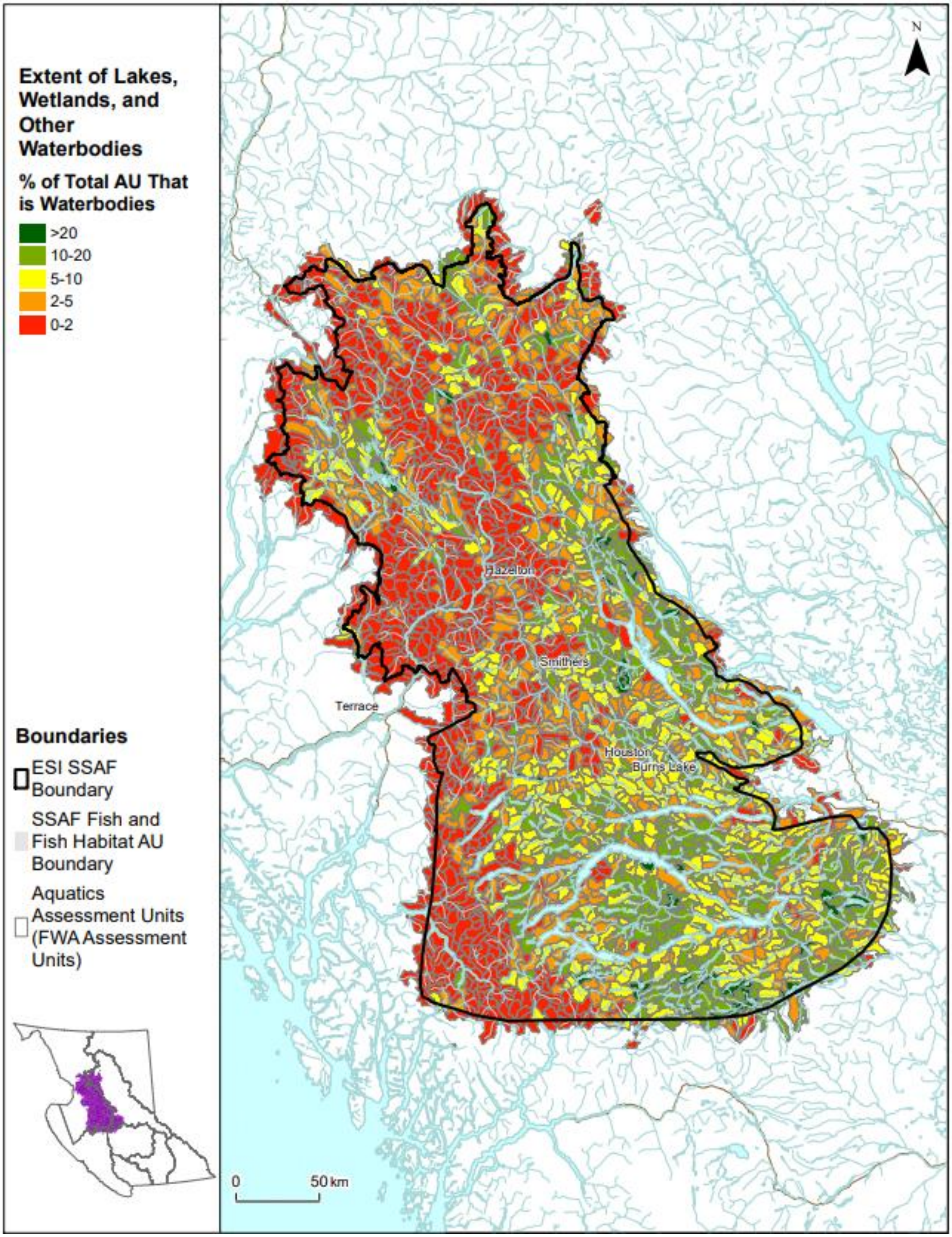


Figure 6.19 Lakes, wetlands, and other waterbodies (combined) percentage - SSAF Study Area.

Watershed Importance Indicators:

6.18 Salmonid Habitat Extent

Indicator Description:	This indicator reports the total length of habitat that is either known to be or presumed to be accessible to salmonids (i.e., inclusive of both Observed and Inferred (modeled) fish habitat classifications for 1:20K FWA stream reaches) within an aquatic assessment unit (AU). Information on accessible stream reaches is derived from the province's Fish Passage/Habitat Model (Version 2 as in use as of 2019-06-20). Within the province's habitat model (Norris and Mount 2011) information on known fish observations is derived from the province's WHSE_FISH.FISS_FISH_OBSRVTN_PNT_SP GIS layer, while stream reach (steep) gradient criteria and known presence of passage obstructions (as identified in the province's WHSE_BASEMAPPING.CWB_OBSTRUCTIONS_SP and WHSE_FISH.FISS_OBSTACLES_PNT_SP GIS layers) are used to identify the presumed maximum upstream limits of salmonid distribution (i.e., areas above these limits are defined as NON-FISH HABITAT). Default stream gradient thresholds used in the model are intended to be conservative and are based on the presumed passage abilities of bull trout and Dolly Varden which can ascend the steepest gradients of any salmonid. Therefore, the default habitat model outputs as mapped here over represent the extent of potential habitat that could be accessed by other trout and salmon species as the extent of possible access varies across individual species. Non-salmonid fish species are presumed to also be constrained to within these access distribution limits as they are assumed to have lesser passage capabilities than salmonids.
Interpretation Key:	No specific importance classifications have been developed for mapping of this indicator as there is no clear science around any particular amount of potentially accessible habitat that would be considered critical. Also, the mapped extent of known and modelled salmonid habitat does not provide any associated information on habitat quality (such that a short length of accessible high-quality habitat may be able potentially to support salmonids more successfully than a longer accessible reach that is of lower habitat quality). Determining relative habitat quality requires supporting field analysis. Instead the length of known/modelled accessible habitat within SSAF Study Areas AUs is simply mapped as a changing relative intensity colour ramp ranging from light green (small length of known & inferred accessible habitat within an AU) to dark green (greater length of known & inferred accessible habitat within an AU) with an assumption that AUs with a greater amount of accessible salmonid habitat are more important.
Assessment Results:	• See Figure 6.20

Commentary:

The total length of salmonid accessible streams (observed and model inferred combined) (Norris and Mount 2011) within a watershed is used to define the total amount of useable habitat that fish could (theoretically) access for spawning and rearing needs and thus support larger, more interconnected populations/sub-populations. AUs with greater extents of accessible habitat could be considered more important (all else being equal) for supporting robust salmonid populations. It could also be considered that fish populations in AUs with limited accessible habitat would (all else being equal) may be at relatively greater risk from localized impacts arising from development pressures than AUs with greater lengths of accessible habitat.

The province's fish habitat model suggests that, while variable, the majority of AUs across the Study Area have the potential to provide considerable amounts of accessible habitat for use by salmonids (salmon and trout). While accessible habitat is widely distributed across the Study Area the AUs rating highest for potential accessible habitat extent are more common in the western and northern portions of the Study Area, while the extent of accessible salmonid habitat is generally less across AUs in the central eastern and southeastern portions of the Study Area. SSAF First Nations with generally lower relative amounts of accessible salmonid habitat include the territory of the Lake Babine Nation and the central and eastern portions of the Skin Tyee Nation territory.

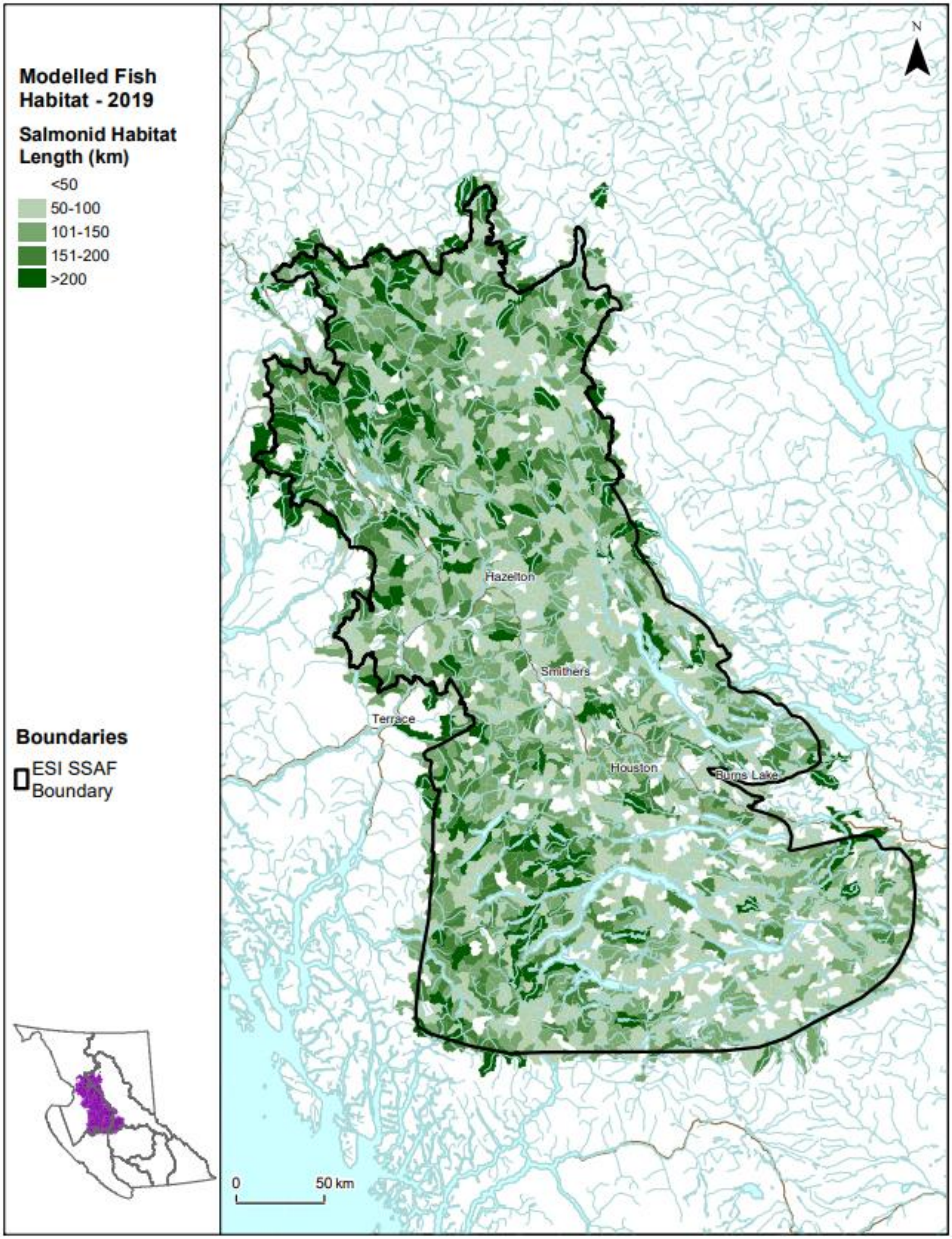


Figure 6.20 Length of modeled salmonid habitat - SSAF Study Area.

6.19 Salmon Spawning Extent

Indicator Description:	This indicator reports the total summed length of identified historical spawning habitat (by individual salmon species and all species combined) within an aquatic assessment unit (AU). Information on known salmon spawning locations within the boundaries of the Skeena Basin itself was downloaded from salmon spawning layers available on the Pacific Salmon Foundation's Salmon Watersheds Program Data Library available at https://data.salmonwatersheds.ca/data-library/,, while information on known salmon spawning locations for other drainages within the SSAF Study Area was determined from the Fish Information Summary System (FISS) Historical Fish Distribution Zones available within the province's WHSE_FISH.FISS_HIST_FISH_DST_LIN_PUB_SVW GIS layer. PSF's mapping of salmon spawning reaches within the Skeena Basin is considered more comprehensive (i.e., FISS supplemented) than for other areas of the SSAF Study Area (particularly for Sockeye) as it includes additional local information compiled by EcoTrust during their 2008-11 engagement with Skeena stakeholders, First Nations, and regulatory agencies for the Skeena Watershed Initiative. Note that FISS historical spawn mapping is known to be incomplete for many streams. FISS summaries should not be considered as fully reflective of salmon spawning distributions within and across watersheds.
Interpretation Key:	No specific importance classifications have been developed for mapping of this indicator as there is no clear science around any particular extent of spawning habitat that would be considered critical. Also, the mapped extent of historical spawning habitats does not provide any associated information on habitat quality (such that a short length of high-quality habitat may be able to support more successful spawning than a longer identified spawning reach that is of lower habitat quality). Determining relative habitat quality requires supporting field-based analysis. Instead the length of identified spawning habitat within SSAF Study Areas AUs is simply mapped as a changing relative intensity colour ramp ranging from light green (small length of identified spawning reaches within an AU) to dark green (greater length of identified spawning reaches within an AU) with an assumption that AUs with more extensive known salmon spawning habitats are more important.
Assessment Results:	• See Figures 6.21, (Chinook) 6.22 (Sockeye), 6.23 (Chum), 6.24 (Pink), 16.25 (Coho), and 16.26 (all Pacific salmon species combined). Note that spawning lengths summarized within the "all Pacific salmon species combined "category represent the summed spawning lengths across all the individual species in an AU and that there is no adjustment for species overlaps (i.e., where multiple species use the same stream reach for spawning the length of this stream will be counted multiple times).

Commentary:

The total extent of known salmon spawning streams (for individual species and across all salmon species) in a watershed indicates the scope of opportunities for successful spawning within a watershed and is intended to reflect the watershed's relative current importance in supporting salmon production (all else being equal). As noted in the Interpretation Key above no measure of spawning habitat "quality" has been integrated into the mapping of spawning extents and this represents a significant information gap. Note also that there are potentially significant issues in the completeness of spawn mapping that is available, particularly for the southern portion of the Study Area.

Available spawning zone mapping shows **Chinook** spawning habitat to be broadly distributed across the Study Area but with the most extensive Chinook habitat present in the northern portions of the Study Area overlapping with the territories of the Gitanyow Hereditary Chiefs and the Gitxsan Hereditary Chiefs. While not as extensive as in the north, considerable Chinook spawning habitat exists in the central portion of the Study Area, overlapping with the territories of the Office of the Wet'suwet'en, Witset, Wet'suwet'en First Nation, and Gitwangak. Lesser amounts of Chinook spawning habitat have been documented within the territories of the Lake Babine Nation, the Skin Tyee Nation, and the Nee-Tahi-Buhn Indian Band.

Available spawning zone mapping shows the most extensive **sockeye** spawning habitat (lake and river sockeye combined, within-lake spawning areas excluded) present in the central eastern and northeastern portions of the Study Area, overlapping with the territories of the Lake Babine Nation and the Gitxsan Hereditary Chiefs. Although present to lesser extents all other SSAF First Nations have some amount of known sockeye spawning habitat within their territories.

Available spawning zone mapping shows the most extensive **chum** spawning habitat present in the western portions of the Study Area, overlapping with the territories of the Gitwangak, Gitanyow Hereditary Chiefs Office, and Gitxsan Hereditary Chiefs. There are also areas of extensive chum spawning identified for the southwestern portion of the Skin Tyee Nation territory. Although present to lesser extents all other SSAF First Nations have some amount of known chum spawning habitat within their territories. Note however that the existing mapping of spawning habitat for chum is likely very incomplete, as very little is known as to the areas where chum spawn (M. Cleveland, pers. comm.).

Available spawning zone mapping shows the most extensive **pink salmon** (odd and even years combined) spawning habitat present in the central portions of the Study Area (predominantly more to the central-west), overlapping to some extent with the territories of all the SSAF First Nations. A concentration of pink salmon spawning habitat is also documented further south, in the southwestern portion of the Skin Tyee Nation territory.

Available spawning zone mapping shows **coho** spawning habitat to be broadly distributed across the Study Area but with the most extensive coho habitat present in the central portions of the Study Area overlapping to some extent with the territories of all the SSAF First Nations. Known coho spawning habitat is most concentrated, however, within the territories of the Office of the Wet'suwet'en, Witset, Wet'suwet'en First Nation, Gitwangak, Gitxsan Hereditary Chiefs, and Gitanyow Hereditary Chiefs Office.

When looking at spawning habitat for **all salmon species combined** the documented key spawning areas are concentrated in the central and northeastern portions of the Study Area. Much less spawning habitat (all species combined) has been reported in the southern sections of the Study Area (but this may be an artifact of incomplete reporting). AUs providing extensive reaches of spawning habitat that may be used across multiple species are found in the territories of all SSAF First Nations. The First Nations territories providing the greatest length of salmon spawning habitat (based on available reporting) across species includes those of the Wet’suwet’en First Nations, Gitanyow Hereditary Chiefs Office, Witset, Office of the Wet’suwet’en, Gitxsan Hereditary Chiefs, Gitwangak, Lake Babine Nation. Salmon spawning habitats appear to less extensive and more sparsely distributed in the territories of the Skin Tyee Nation and Nee-Tahi-Buhn Indian Band (but these may be underrepresented in the supporting provincial datasets/GIS spawning layers).

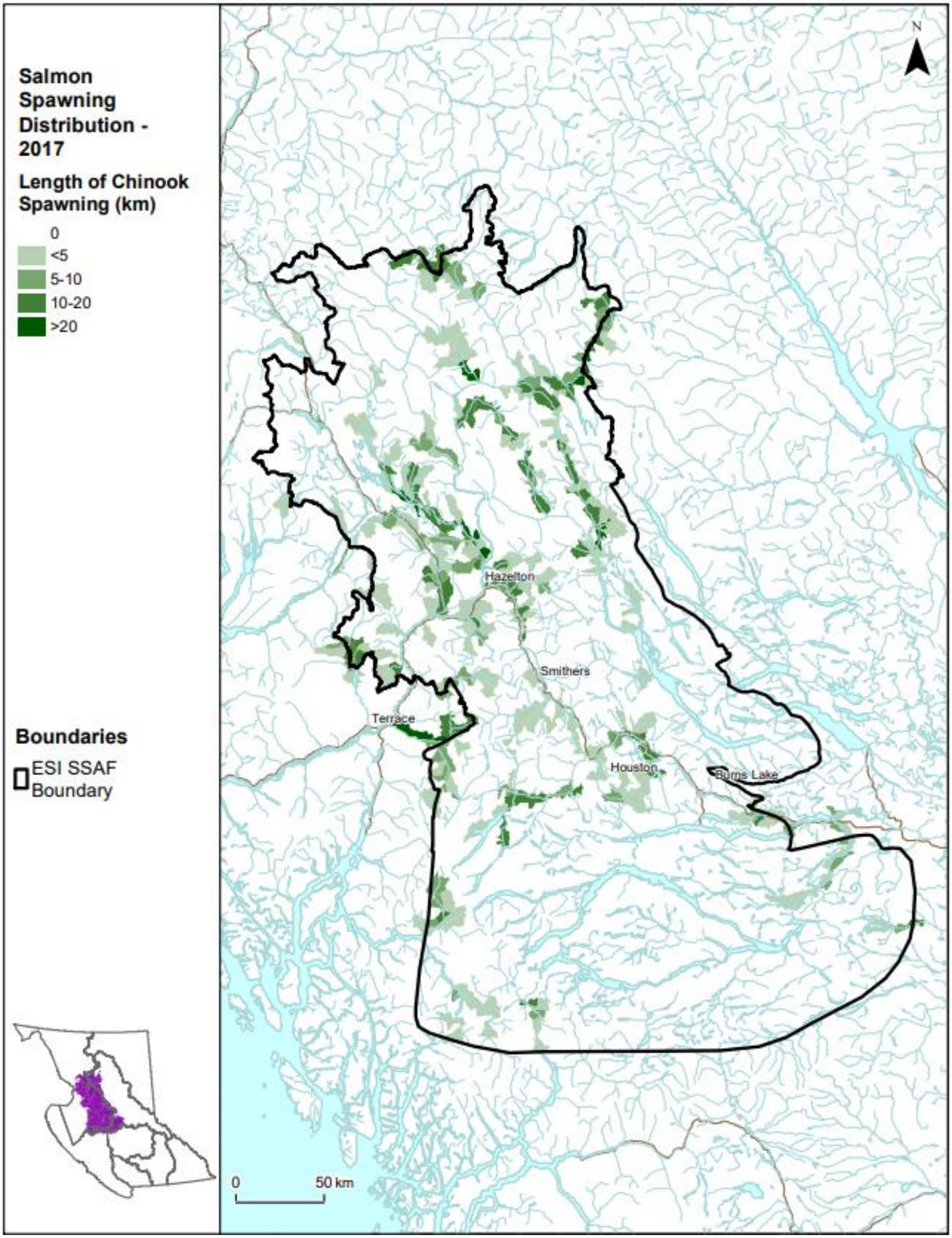


Figure 6.21 Length of identified Chinook spawning habitat - SSAF Study Area.

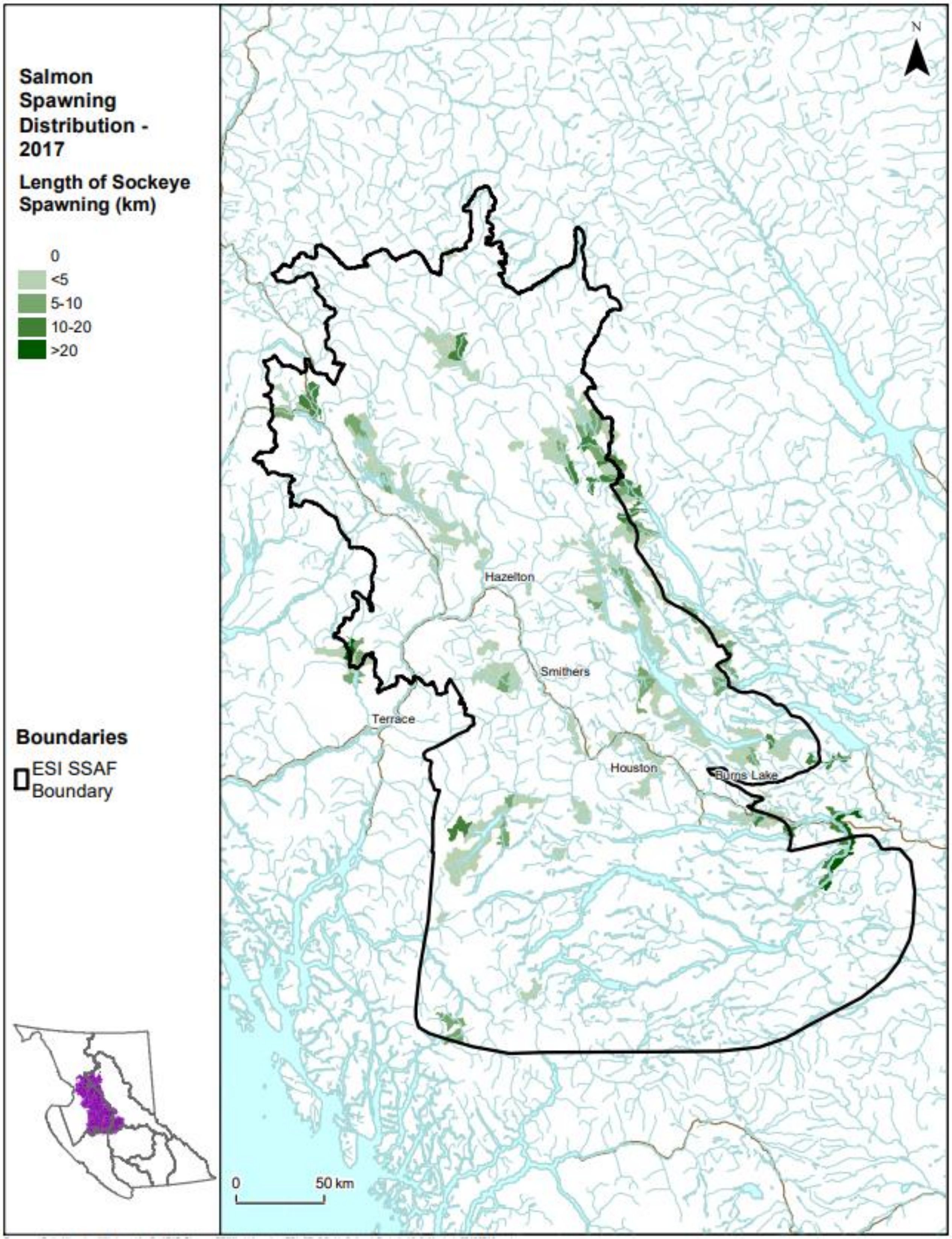


Figure 6.22 Length of identified Sockeye spawning habitat - SSAF Study Area.

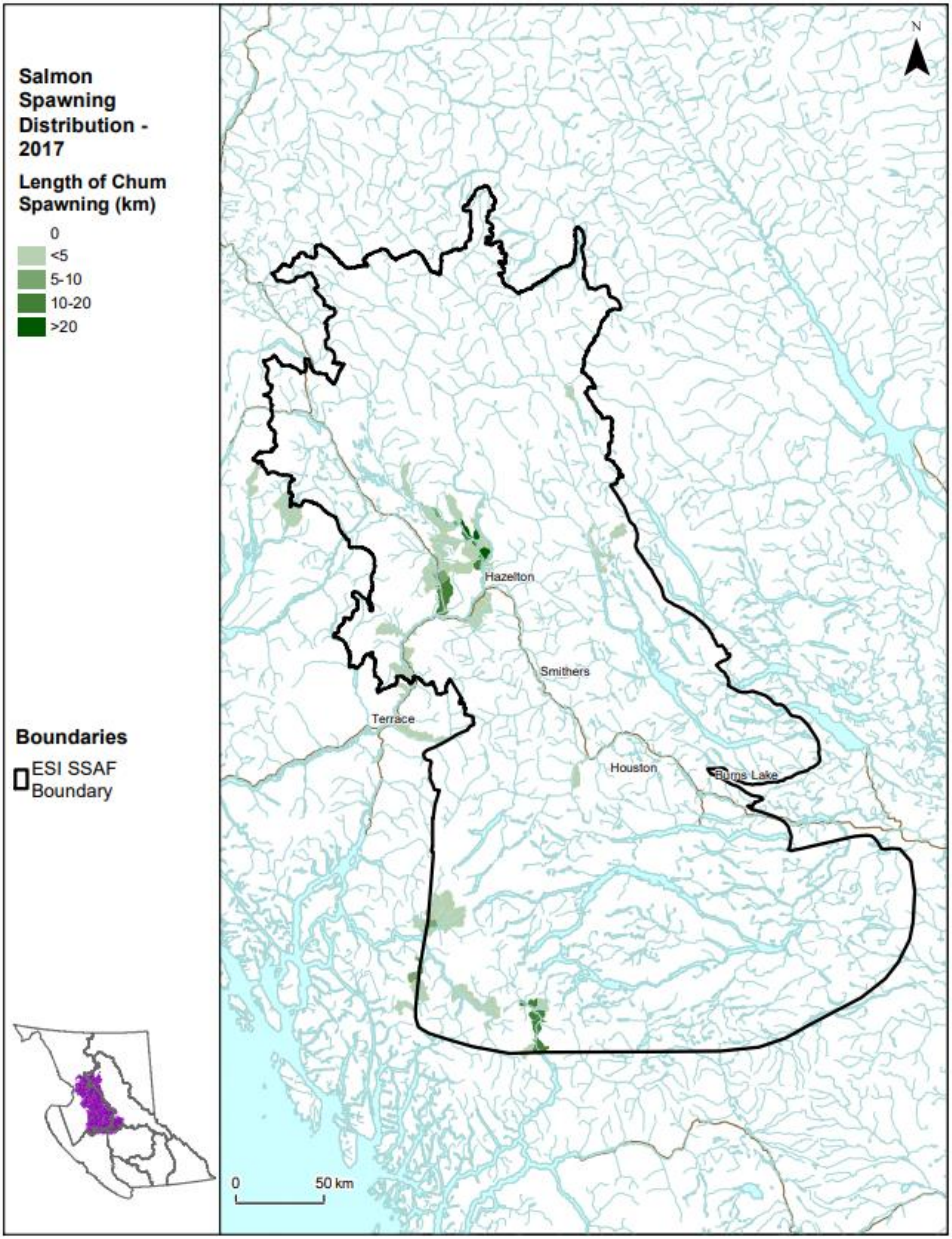


Figure 6.23 Length of identified Chum spawning habitat- SSAF Study Area.

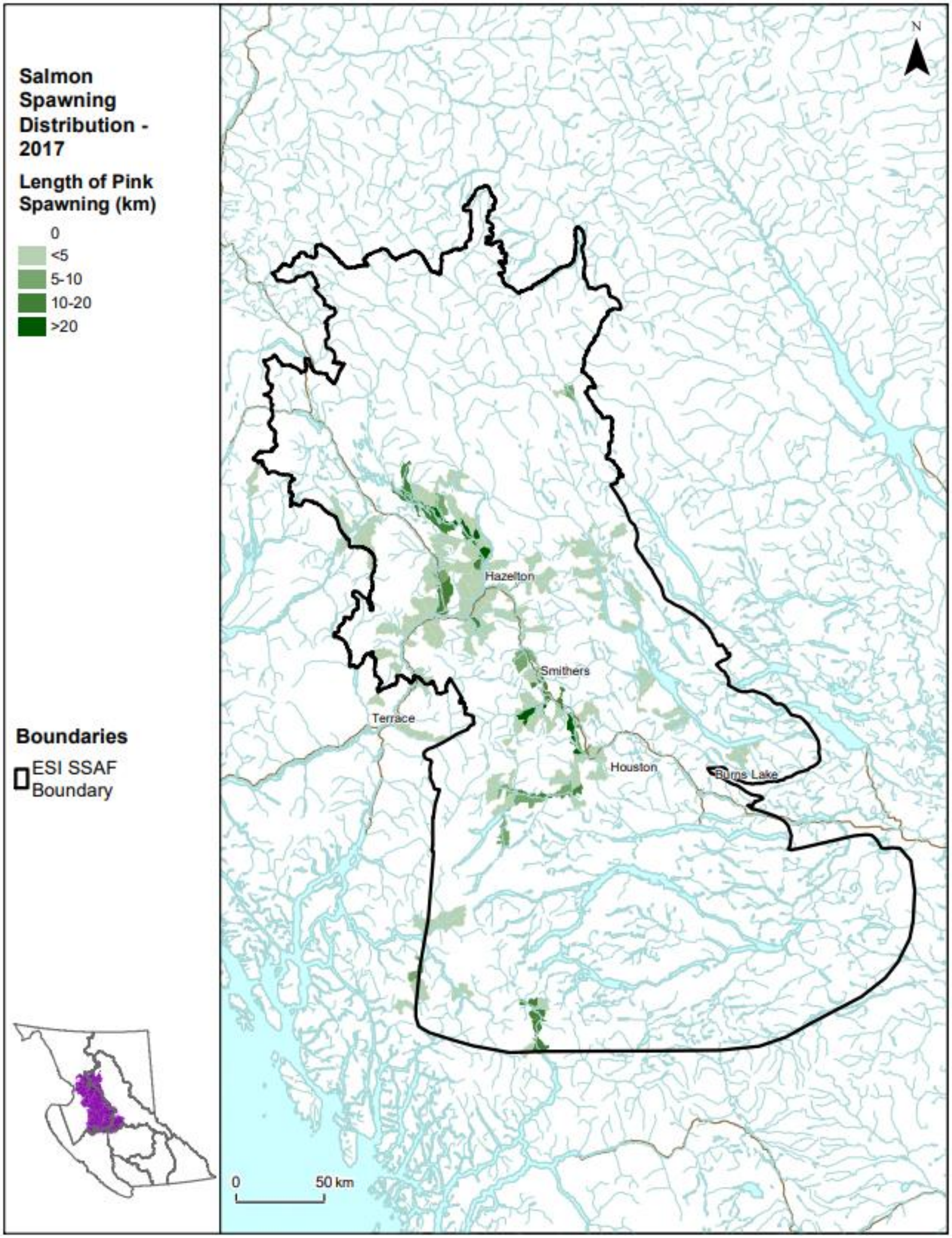


Figure 6.24 Length of identified Pink spawning habitat - SSAF Study Area.

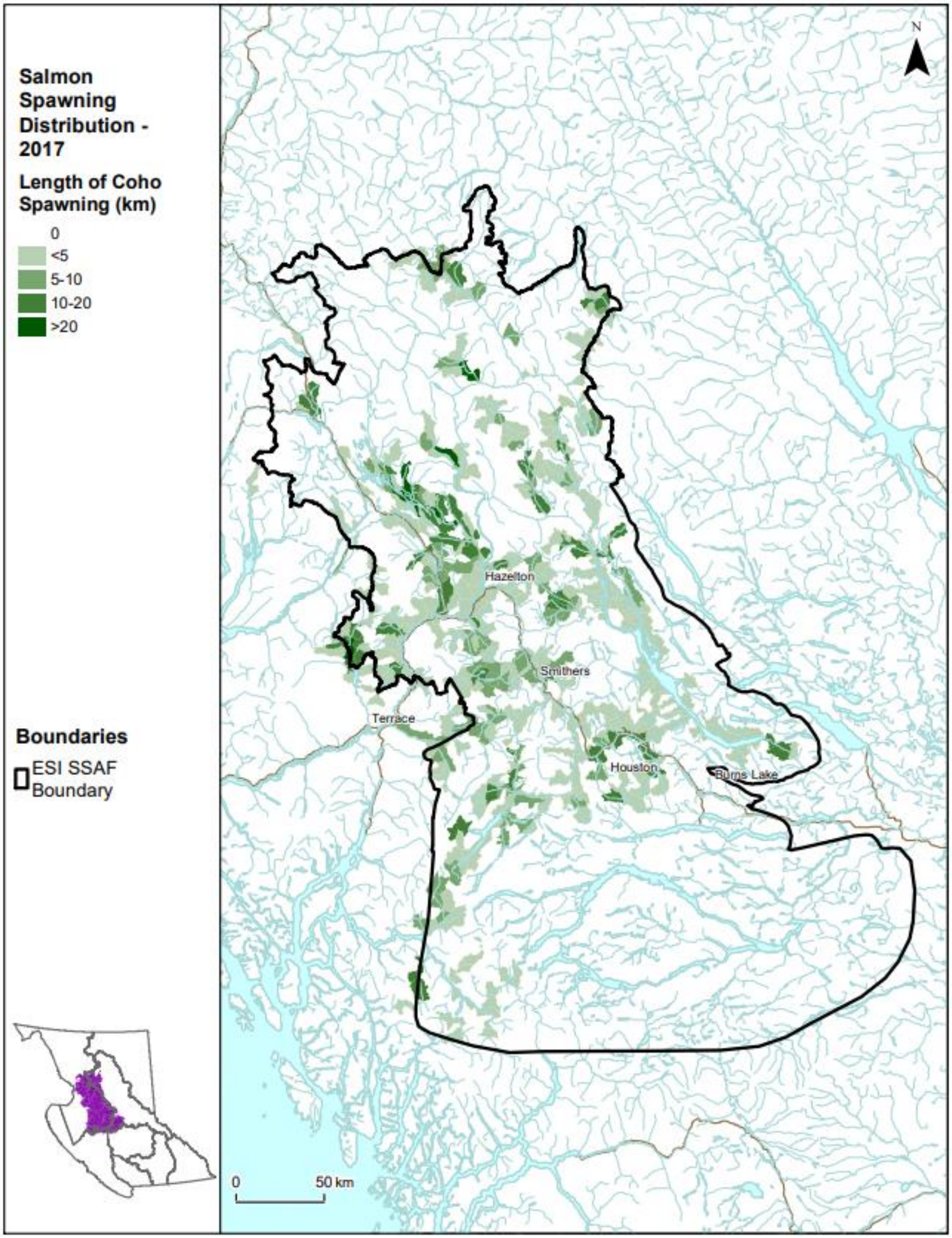


Figure 6.25 Length of identified Coho spawning habitat - SSAF Study Area.

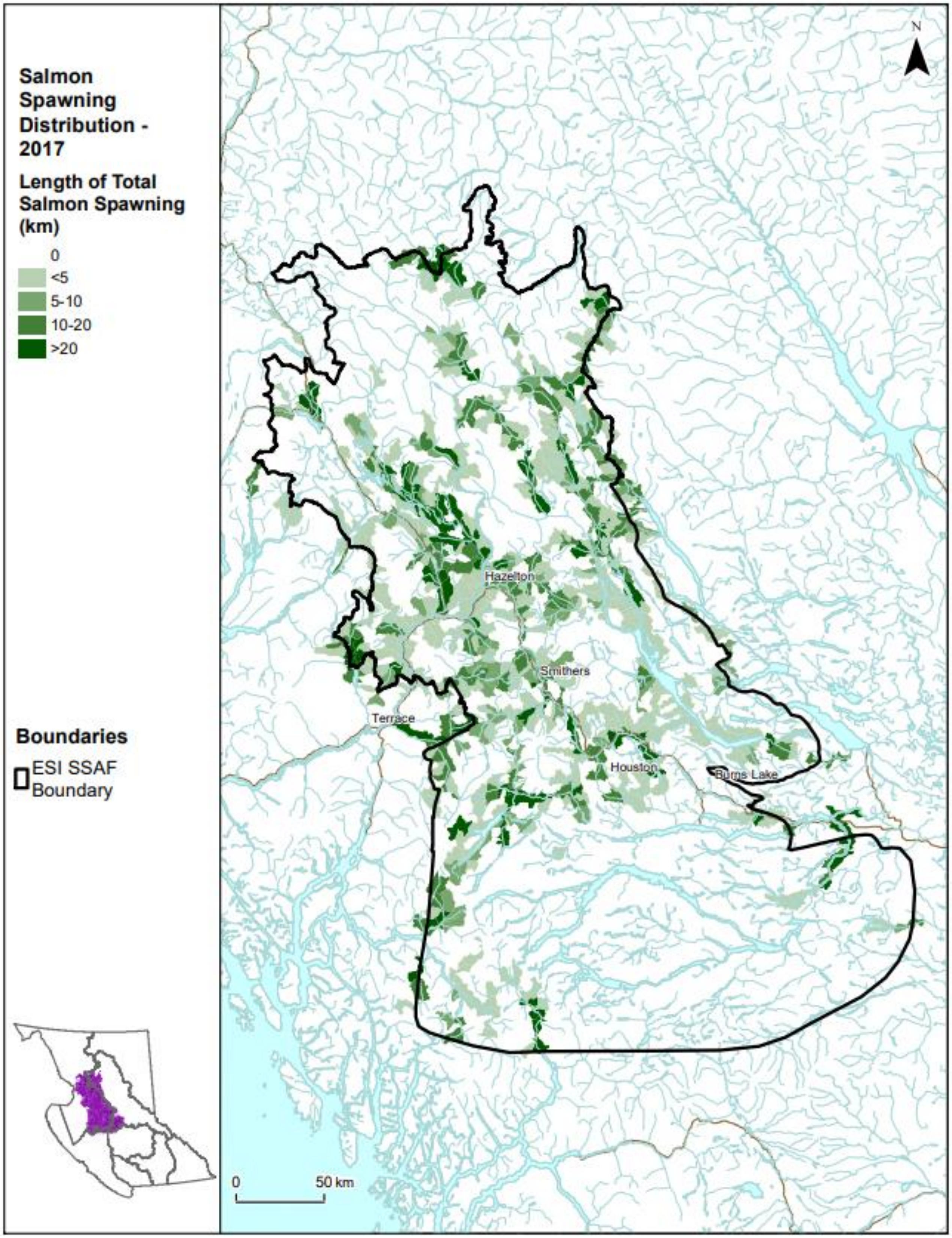


Figure 6.26 Length of total salmon spawning habitat (all species combined) - SSAF Study Area.

6.20 Salmon Escapement

Indicator Description:

This indicator reports 1) most recent average escapements (by individual salmon species) at monitored indicator streams within the Nass and Skeena Basin portions of the SSAF Study Area, and 2) change in average escapement at indicator streams between the earliest average recorded escapements and the most recent average recorded escapements (where sufficient observations to calculate change). Information is presented here only to illustrate general patterns and trends across SSAF salmon species and is not intended to represent detailed stock assessment of salmon population or stock status. Average escapements for this representation of current status and change are based on the first 10 years of observations at an indicator stream (may not be consecutive years) vs. the most recent 10 years of observations at the indicator stream (may not be consecutive years). For indicator streams with less than 11 years of data all available information was averaged (but not used for historical change comparisons). If only one data point for escapement was available for an indicator stream that single entry was presented (without any historical comparison).

Indicator streams within this analysis are those for which information has been compiled into DFO's NuSEDS database. Historical escapement numbers for these Skeena and Nass indicator streams (compiled for analyses in English et al. 2018) were extracted from the Pacific Salmon Foundation's Salmon Watersheds Program Data Library available at https://data.salmonwatersheds.ca/data-library/. All NuSEDS surveyed streams in the Study Area are described in this report as indicator streams, although this actually represents a mix of streams including some of which would formally be classified as non-indicator streams (see English et al. 2006 for details). Indicator streams are those streams that have been identified by regional experts as providing more reliable indices of abundance. These indicator streams tend to be more intensively surveyed using methodologies that provide relatively accurate estimates of annual abundance (English et al. 2018). A number of other streams that are classified as non-indicator may also have been surveyed in a given year. These streams typically have less consistent survey coverage, variable methods applied, or may simply be more difficult to survey (e.g. poor water clarity, remote location) (Connors et al. 2019). For our mapping of escapement averages no separation of indicator and non-indicator streams is presented.

Escapement data for sites within the SSAF Study Area that are outside the boundaries of the Skeena and Nass basins are not represented here as no recent, thorough regional compilation and associated QA/QC analysis comparable to that of English et al. (2018) has yet been undertaken (to our knowledge) for these indicator streams. Expanding the current representation of escapement information to additional regions of the Study Area (i.e., Nechako) should be a focus of next stage analyses within the ESI program.

An effort has been made here to illustrate all available historical escapement data for salmon species in the Skeena and Nass basins (as synthesized by English et al. 2018). Please note however that the quality of escapement data may vary across indicator streams and across years. See English et al. (2018) for relative survey quality ratings that can be applied for escapement data from different indicator streams in the Skeena and Nass basins. Historical escapement numbers for indicators streams that are based on a different methodology that does not match well, in some cases, with modern methodology are not considered reliable for formal stock assessment evaluations (see English et al. 2018 for guidance in this regard).

Interpretation Key: No specific importance classifications have been developed for mapping of this indicator as there is no clear science around escapement for any particular indicator stream that would be considered critical. Instead the recent average annual escapement at each indicator stream location is simply mapped as increasing sized grey circle based on escapement size with an assumption that indicators streams (and their underlying AUs) with greater escapements are potentially more important for sustaining salmon production. Each indicator stream location is also tagged with an internal, smaller circle of different colours denoting (as defined in the map legend) whether the average escapement has increased, decreased, or stayed the same over time. Indicator streams for which there are not enough annual observations over time to evaluate change in escapement are denoted by an "Insufficient Data" coloured circle.

Assessment Results:

- See Figures 6.27 (Chinook), 6.28 (Lake Sockeye), 6.29 (River Sockeye), 6.30 (Chum), 6.31 (Pink-even), 6.32 (Pink-odd), and 6.33 (Coho). See Appendix 5 for more details of historical escapements for each mapped indicator stream.

Commentary:

Knowledge of escapement (i.e., the number of salmon spawners) is necessary to develop spawner-recruit relationships and forecast future salmon production, including the number of salmon potentially available to harvest from within the SSAF Study Area. Annual estimates of returns of each salmon species to each Statistical Area and Conservation Unit on the North and Central Coast (NCC) of British Columbia are derived from data collected during spawning escapement surveys. A set of streams referred to as "indicator streams" across the province have been more consistently monitored for escapement over the years to provide for evaluations of trends in salmon population stock groups. Knowledge of total run-size for a population (escapement plus catch) is required to compute the survival and productivity of the previous salmon generation and to fully monitor trends in abundance and/or productivity. Average escapement numbers also provide a relative indication of the amounts of marine-derived nutrients inputs that are being introduced to the system from the carcasses of returning salmon spawners. Marine-derived nutrients deposited by salmon carcasses are retained in streams, lakes and rivers and can be important for enhancing nutrient levels present in naturally low productivity coastal systems (Schmidt et al. 1998; Schindler et al. 2003). Note that recent genetics-based analyses by Price et al. (2019) suggest that centuries-long declines of salmon in the Skeena River are much greater than those based on documented modern-day salmon abundance data (i.e., catch + escapement). They suggest a deeper historical perspective is required to fully understand the past abundances that were present in the Skeena basin prior to the initiation of monitoring and before salmon began to incur significant losses from fishing.

Chinook spawning occurs widely across the Skeena and Nass basins with high concentrations of spawning (based on monitored indicator stream escapements) at a number of distinct locations, with recent escapement averages exceeding 11,000 Chinook spawners at some indicator streams. Chinook spawning is known to occur in the territories of all the SSAF First Nations. While the representation of Chinook escapement in this report does not fully cover the territories of the Skin Tyee Nation, Nee-Tahi-Buhn Indian Band, Lake Babine Nation, Gitxsan Hereditary Chiefs, Office of the Wet'suwet'en, Witset, or Wet'suwet'en First Nation the compiled recent escapement averages show that high numbers of Chinook spawners (i.e., > 2000) have been reported at particular indicator streams within the boundaries of each SSAF First Nation, with the exception of the Lake Babine Nation territory where the highest recent Chinook escapement average at an indicator stream was estimated at 1226 spawners. Evaluation of trend in Chinook spawners based on observed differences between the most recent average escapements vs. earliest average escapements in the monitoring records (where there is sufficient data to evaluate, n =26) suggests a mix of changes across indicator streams with 50% of the indicator streams showing an increase in average escapement (greatest increase at a site = +578%) and 50% of indicator streams showing a decrease in escapement (greatest decrease at a site = -86%). On average the change in Chinook escapement across the 26 indicator streams was +33% (although noting that the time frames for recent vs. earlier escapement comparisons are not consistent across indicator streams).

Lake sockeye spawning occurs widely across the Skeena and Nass basins with high concentrations of spawning (based on indicator stream escapements) at a number of distinct locations, with higher numbers of spawners at indicator streams along the Babine River. These are representative of returns from enhanced Babine sockeye, which typically exceed spawner requirements as these enhanced runs cannot be harvested fully in mixed-stock fisheries without over-harvesting less productive populations (DFO 1999). While the representation of lake sockeye escapement in this report does not fully cover the territories of the Skin Tyee Nation, Nee-Tahi-Buhn Indian Band, Lake Babine Nation, Gitxsan Hereditary Chiefs, Office of the Wet'suwet'en, Witset, or Wet'suwet'en First Nation the compiled recent escapement averages show that lake sockeye spawning occurs in high numbers (i.e., > 5000 spawners) at particular indicator streams within the territories of each of the SSAF First Nations, most predominantly within the territory of the Lake Babine Nation and also of the Gitanyow Hereditary Chiefs Office and the Gitxsan Hereditary Chiefs. Evaluation of trend in lake sockeye spawners based on observed differences between the most recent average escapements vs. earliest average escapements in the monitoring records (where there is sufficient data to evaluate, n = 44) suggests a general decline across indicator streams with 66% of the indicator streams showing a decrease in escapement (greatest decrease at a site = -86%) and 34% of indicator streams showing an increase (greatest increase at a site = +3245%). On average the change in lake sockeye escapement across the 44 indicator streams was +72% (although noting that the time frames for recent vs. earlier escapement comparisons are not consistent across indicator stream, and also noting that the overall average change is skewed by the development of enhanced Babine sockeye stocks and the extremely high escapements at Babine associated indicator streams as discussed earlier).

River sockeye spawning is low within the Skeena and Nass basins with recent average escapements at indicator sites generally below 1000 spawners and in some cases below 100 spawners. The distribution of river sockeye spawning also appears to be quite limited, being observed at only a small number of indicator streams. While the representation of river sockeye escapement in this report does not fully cover the territories of the Skin Tyee Nation, Nee-Tahi-Buhn Indian Band, Lake Babine Nation, Gitxsan

Hereditary Chiefs, Office of the Wet'suwet'en, Witset, or Wet'suwet'en First Nation the compiled recent escapement data show river sockeye spawning occurring in the territories of all the SSAF First Nations with the exception of the Lake Babine Nation. Evaluation of trend in river sockeye spawners based on observed differences between the most recent average escapements vs. earliest average escapements in the monitoring records is very limited as there are only three indicator streams with sufficient data to evaluate. Average river sockeye escapement increased at two of those indicator streams (greatest increase = +54%), while decreasing at the third (decrease = -42%). On average the change in river sockeye escapement across the three indicator streams was +9.5% (although noting that the time frames for recent vs. earlier escapement comparisons are not consistent across indicator streams).

Chum spawning is low within the Skeena and Nass basins with recent average escapements at indicator sites generally below 1000 spawners and in some cases below 100 spawners. Chum spawning has been observed at only a fairly limited number of indicator streams within the central portion of the Study Area. While the representation of chum escapement in this report does not fully cover the territories of the Skin Tyee Nation, Nee-Tahi-Buhn Indian Band, Lake Babine Nation, Gitxsan Hereditary Chiefs, Office of the Wet'suwet'en, Witset, or Wet'suwet'en First Nation the compiled recent escapement data show chum spawning occurring only in the territories of the Gitxsan Hereditary Chiefs, Office of the Wet'suwet'en, Witset, Lake Babine Nation, Gitanyow, and Gitwangak. Evaluation of trend in chum spawners based on observed differences between the most recent average escapements vs. earliest average escapements in the monitoring records is very limited as there are only six indicator streams with sufficient data to evaluate. However, average chum escapement decreased at all six of these indicator streams (greatest decrease = -85%). On average the change in chum escapement across the six indicator streams was -68% (although noting that the time frames for recent vs. earlier escapement comparisons are not consistent across indicator streams).

Pink salmon (even) spawning is quite widespread within the Skeena and Nass basins with high recent average escapements at multiple indicator streams across the basins. Spawning is concentrated however in the central western portion of the Study Area. While the representation of Pink (odd) escapement in this report does not fully cover the territories of the Skin Tyee Nation, Nee-Tahi-Buhn Indian Band, Lake Babine Nation, Gitxsan Hereditary Chiefs, Office of the Wet'suwet'en, Witset, or Wet'suwet'en First Nation the compiled recent escapement averages show that pink (odd) spawning occurs at indicator streams within the territories of each of the SSAF First Nations, with particularly high concentrations of spawning occurring within the territories of Gitxsan Hereditary Chiefs, the Gitanyow, and the Gitwangak. Evaluation of trend in pink (even) spawners based on observed differences between the most recent average escapements vs. earliest average escapements in the monitoring records (where there is sufficient data to evaluate, n = 15) suggests a mix of change across indicator streams with 60% of the indicator streams showing an increase in escapement (greatest increase at a site = +830%) and 40% of indicator streams showing a decrease (greatest decrease at a site = -92%). On average the change in pink (even) escapement across the 15 indicator streams was +122% (although noting that the time frames for recent vs. earlier escapement comparisons are not consistent across indicator streams).

Pink salmon (odd) spawning is quite widespread within the Skeena and Nass basins with high recent average escapements at multiple indicator streams across the basins. Similar to the pattern for pink (even) spawning for pink (odd) is concentrated in the central western portion of the Study Area, however, overall numbers of spawners are much greater for pink (odd) than for pink (even). Recent average escapements totals across all indicators streams in the Skeena and Nass totalled about 300,000 pink (even) spawners whereas there were close to 800,000 pink (odd) spawners. While the representation of Pink (odd) escapement in this report does not fully cover the territories of the Skin Tyee Nation, Nee-Tahi-Buhn Indian Band, Lake Babine Nation, Gitxsan Hereditary Chiefs, Office of the Wet'suwet'en, Witset, or Wet'suwet'en First Nation the compiled recent escapement averages show that pink (odd) spawning occurs at indicator streams within the territories of each of the SSAF First Nations, with particularly high concentrations of spawning occurring within the territories of Gitxsan Hereditary Chiefs, Gitanyow, and the Gitwangak. Evaluation of trend in pink (odd) spawners based on observed differences between the most recent average escapements vs. earliest average escapements in the monitoring records (where there is sufficient data to evaluate, n = 15) suggests a general increase in number of pink (odd) spawners across indicator streams with 87% of the indicator streams showing an increase in escapement (greatest increase at a site = +789%) and 13% of indicator streams showing a decrease (greatest decrease at a site = -42%). On average the change in pink (odd) escapement across the 15 indicator streams was +347% (although noting that the time frames for recent vs. earlier escapement comparisons are not consistent across indicator streams).

Coho spawning occurs very widely across streams in the Skeena and Nass basins with fairly high recent average escapements at multiple indicator streams across the basins. Spawning is most concentrated in the central western portion of the Study Area. While the representation of coho escapement in this report does not fully cover the territories of the Skin Tyee Nation, Nee-Tahi-Buhn Indian Band, Lake Babine Nation, Gitxsan Hereditary Chiefs, Office of the Wet'suwet'en, Witset, or Wet'suwet'en First Nation the compiled recent escapement averages show that coho spawning occurs in high numbers at indicator streams within the territories of each of the SSAF First Nations. Evaluation of trend in coho spawners based on observed differences between the most recent average escapements vs. earliest average escapements in the monitoring records (where there is sufficient data to evaluate, n = 69) suggests a general decrease in number of coho spawners across indicator streams with 64% of the indicator streams showing a decrease in escapement (greatest decrease at a site = 85%) and 36% of indicator streams showing an increase (greatest increase at a site = +1217%). On average the change in coho escapement across the 69 indicator streams was +49% (although noting that the time frames for recent vs. earlier escapement comparisons are not consistent across indicator streams).

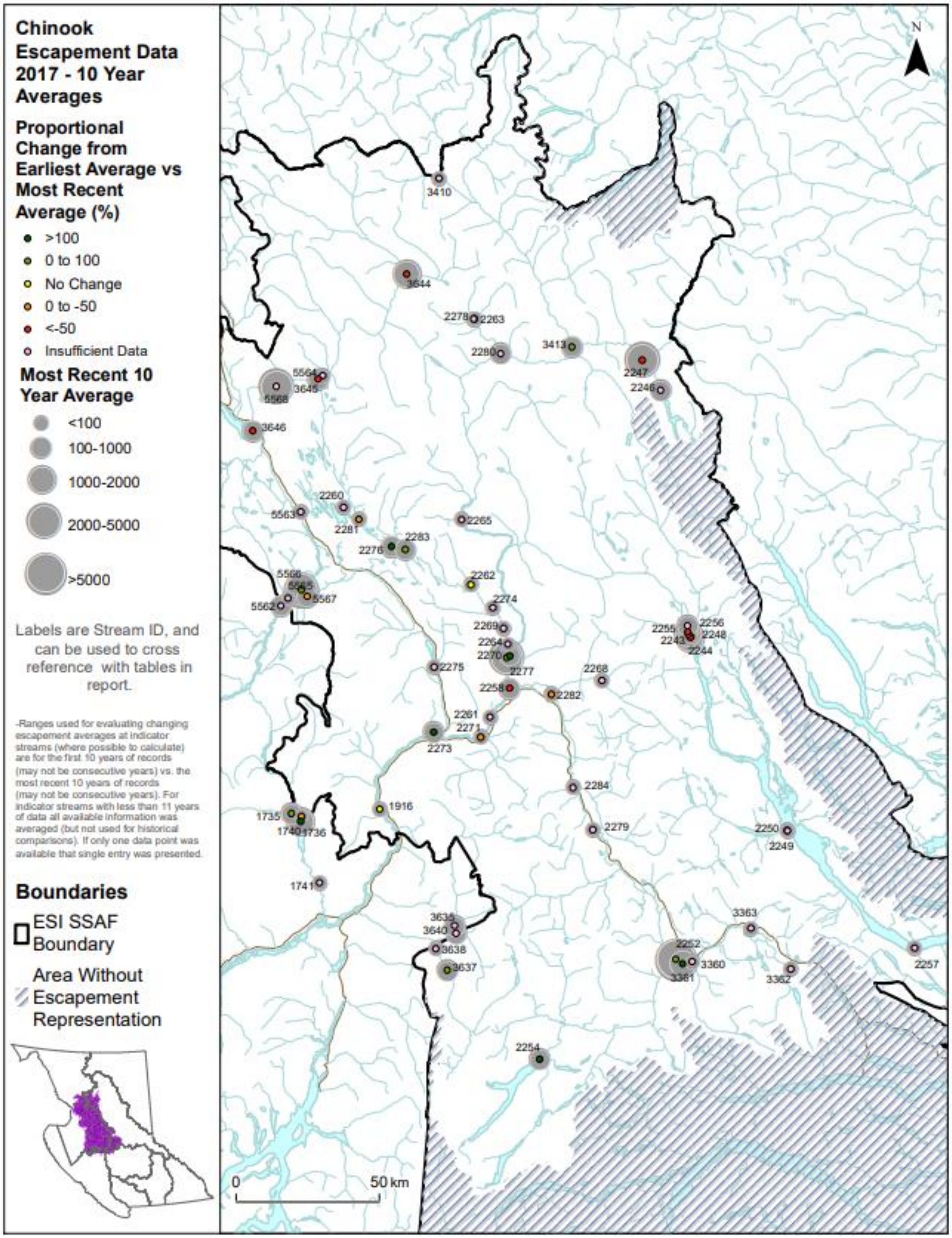


Figure 6.27 Chinook escapement (at monitored indicator streams) for Nass and Skeena watersheds in the SSAF Study Area.

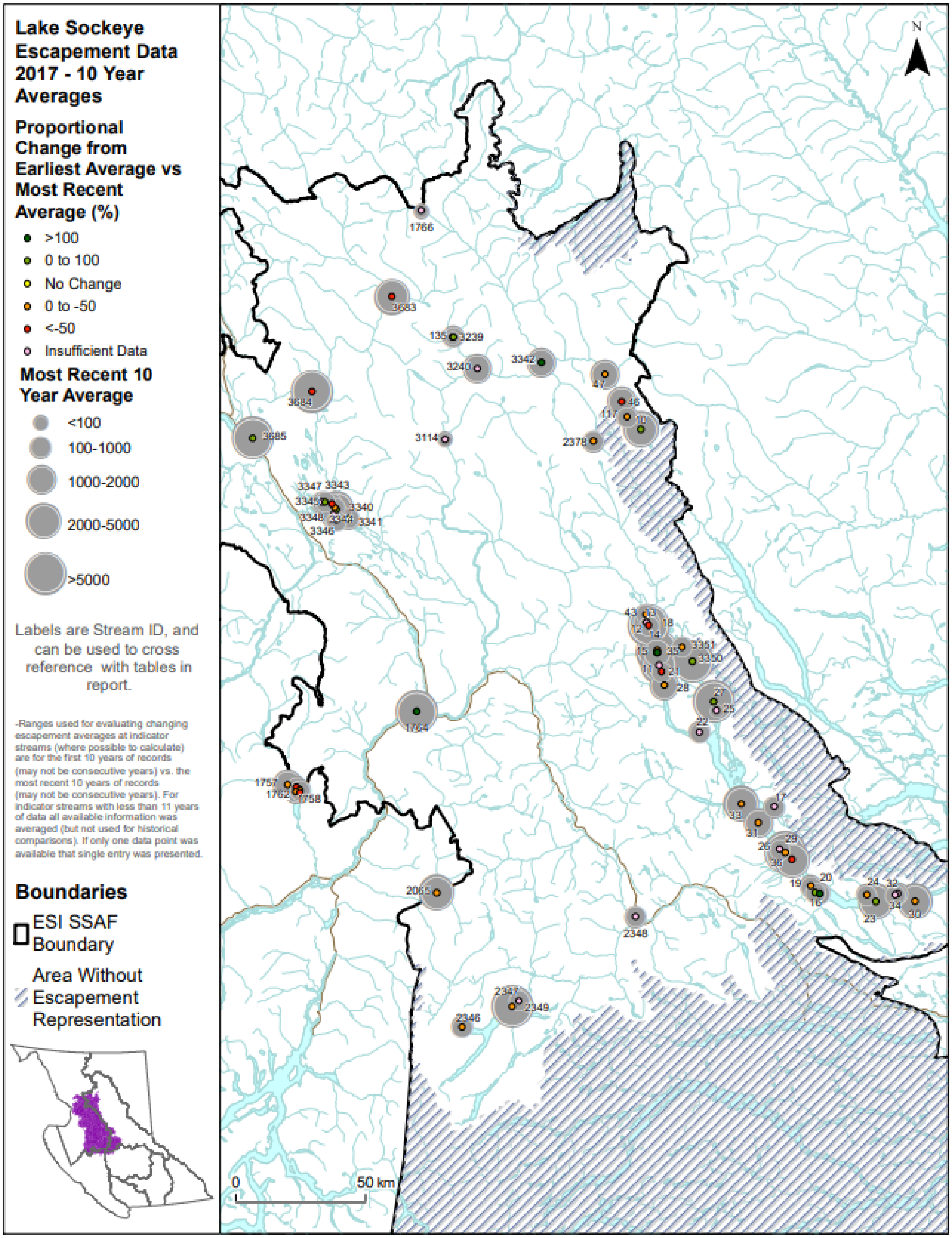


Figure 6.28 Lake Sockeye escapement (at monitored indicator streams) for Nass and Skeena watersheds in the SSAF Study Area.

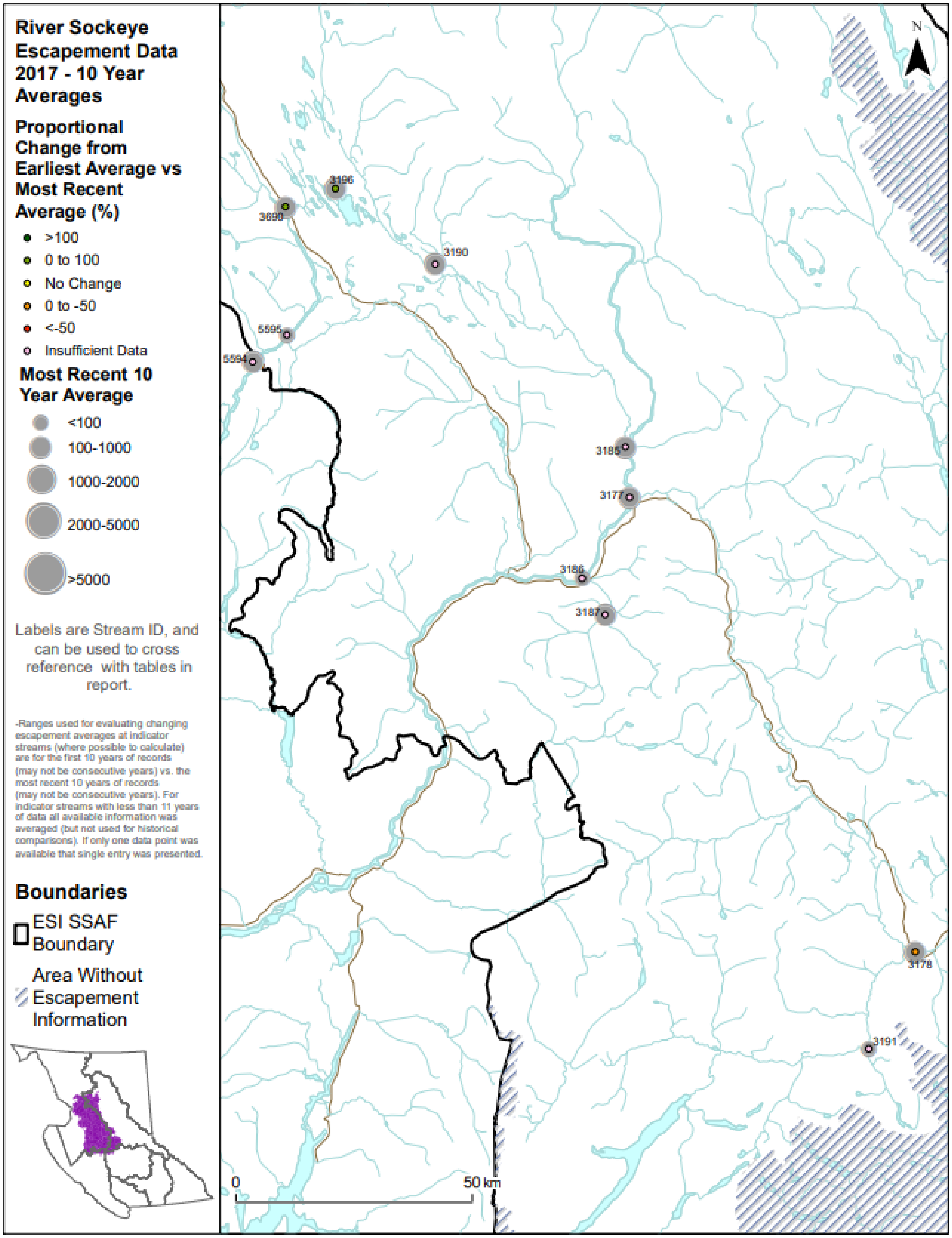


Figure 6.29 River Sockeye escapement (at monitored indicator streams) for Nass and Skeena watersheds in the SSAF Study Area.

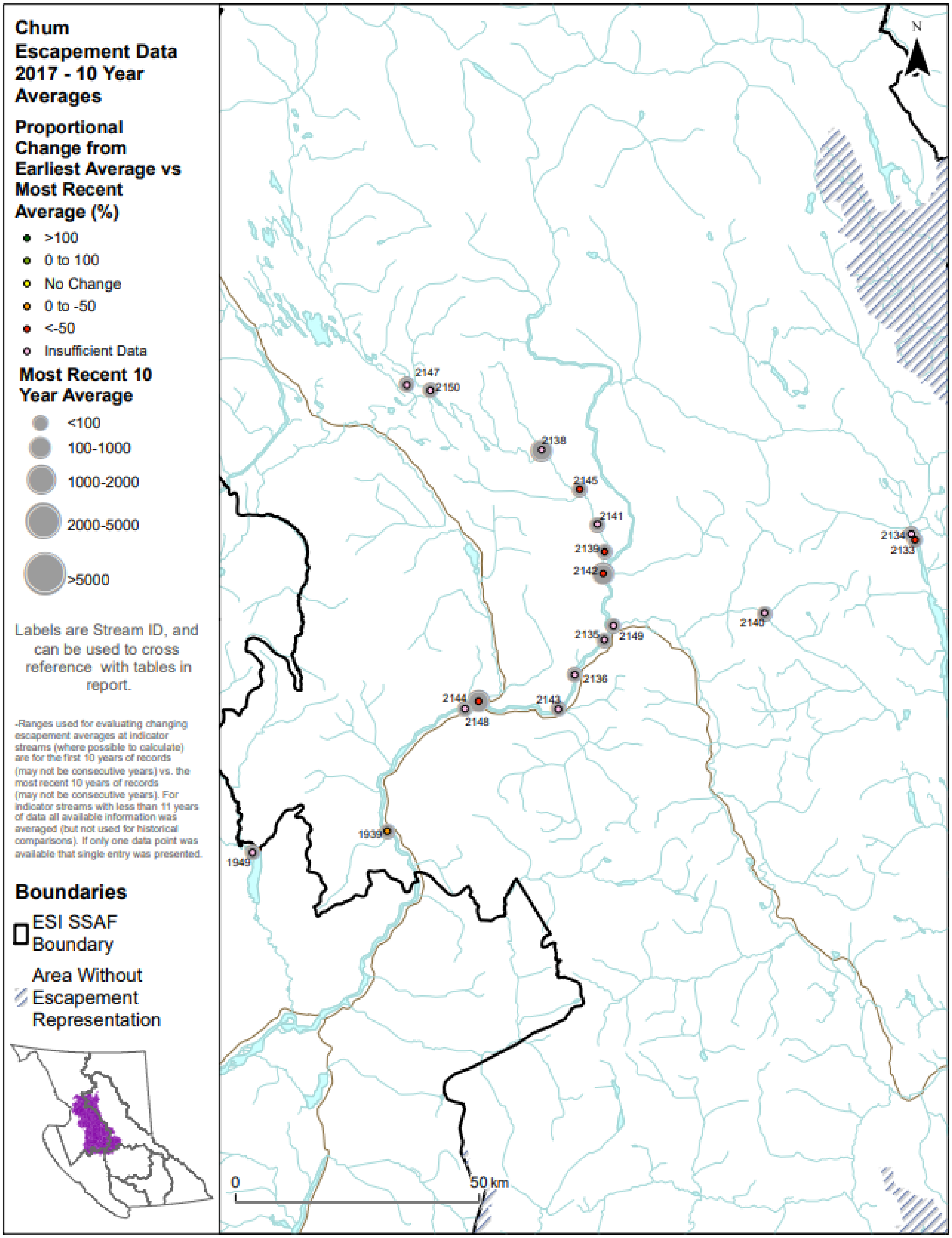


Figure 6.30 Chum escapement (at monitored indicator streams) for Nass and Skeena watersheds in the SSAF Study Area.

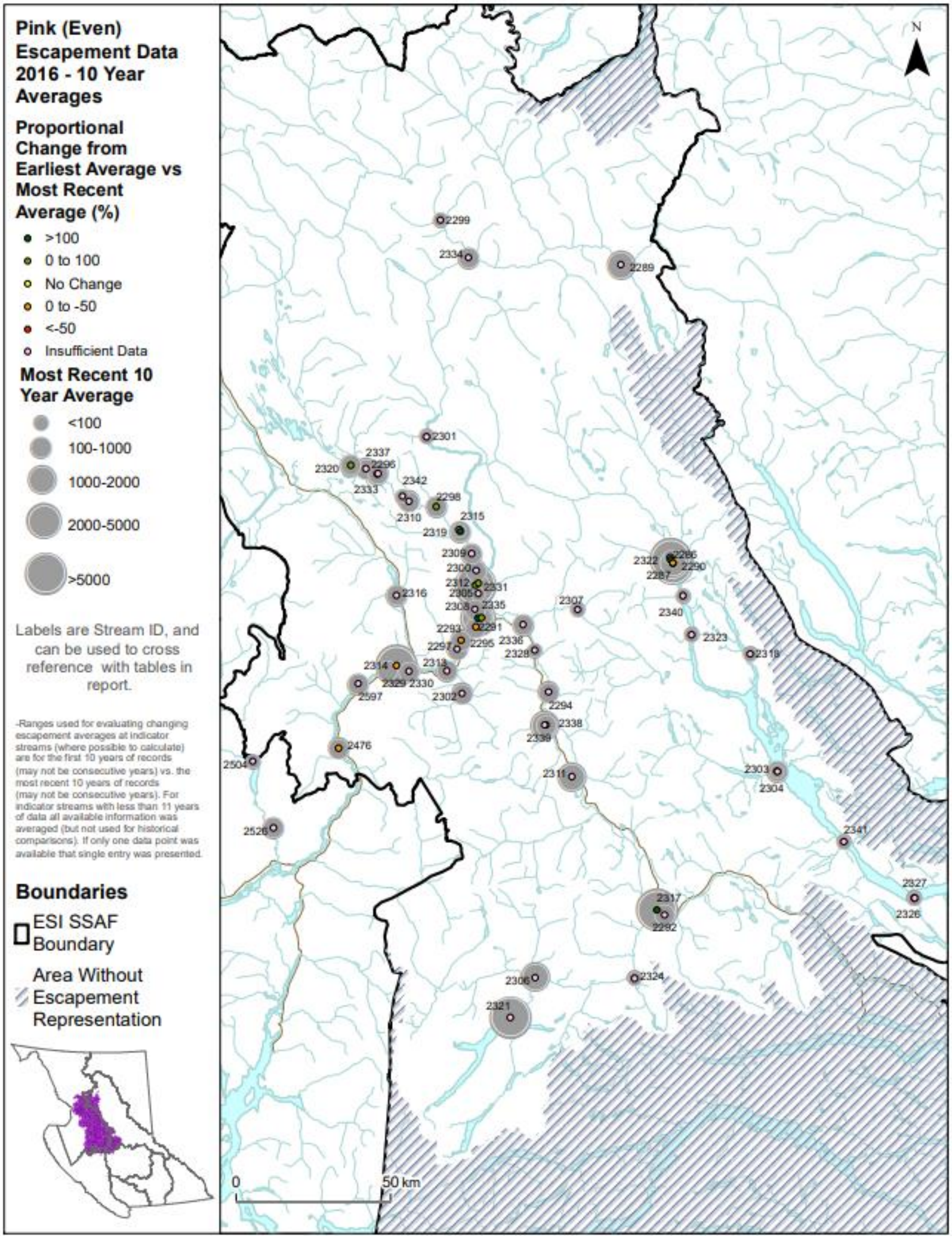


Figure 6.31 Pink(even) escapement (at monitored indicator streams) for Nass and Skeena watersheds in the SSAF Study Area.

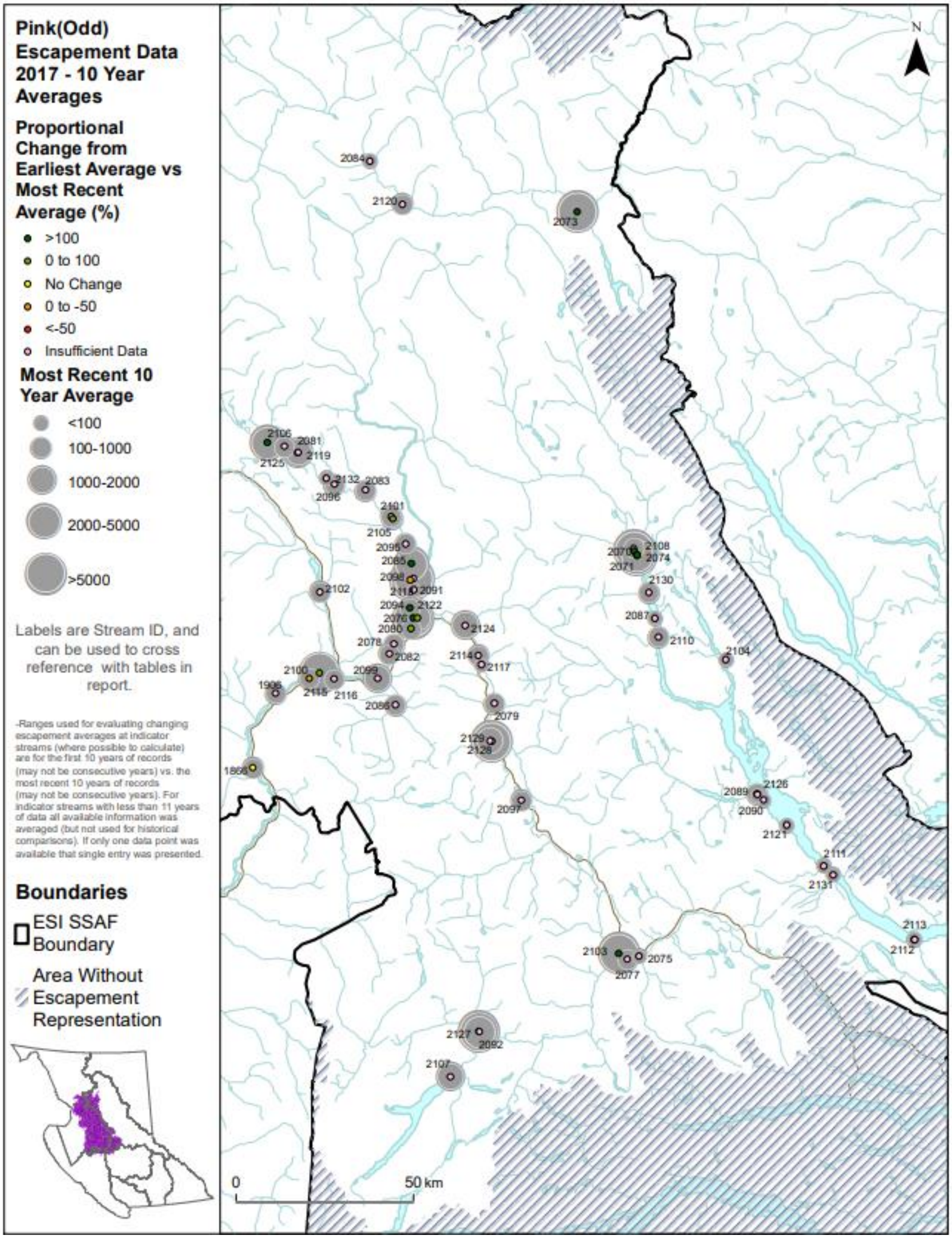


Figure 6.32 Pink(odd) escapement (at monitored indicator streams) for Nass and Skeena watersheds in the SSAF Study Area.

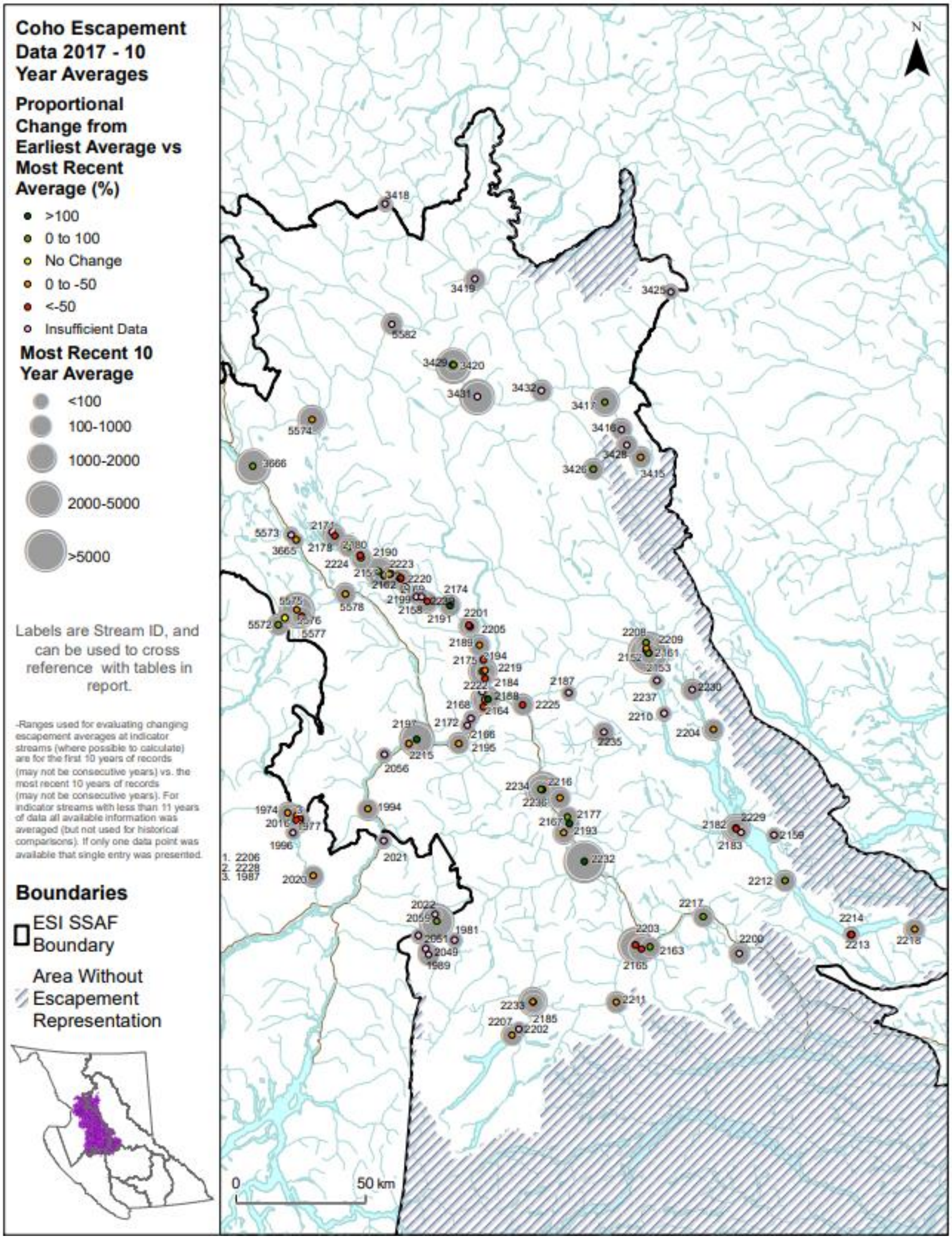


Figure 6.33 Coho escapement (at monitored indicator streams) for Nass and Skeena watersheds in the SSAF Study Area.

7 Interpretation and Key Drivers of Tier 1 Results

The following section provides a concise summary of the Tier 1 assessment results for the indicators separated into three categories of landscape-scale indicators: 1) pressures, 2) watershed sensitivity, and 3) watershed importance, as described in section 5. There is regional commentary to identify where attention is needed to improve assessment results and future management efforts within the SSAF Study Area.

Based on results for the 20 watershed pressure, sensitivity, and importance indicators assessed in this state of the value report it is recommended that resource managers in or adjacent to the SSAF Study Area focus attention on AUs in the Study Area where there are multiple pressure indicator types identified as high risk (i.e., flagged) or high intensity and could be individually or cumulatively impacting fish and fish habitats.

7.1 Watershed Pressures

While the basins of the SSAF Study Area are relatively undeveloped compared to watersheds in more southern areas of the province, there is still a legacy of industrial activities that have likely had significant impacts on key fish habitat and fish species in various parts of the Study Area. The indicators can be grouped into: **roads** (high road density, high stream/road crossing density and/or high road density near streams), **flows** (high ECA, high young second growth, high number of water licenses, high number of groundwater wells and/or high number of water allocation restrictions), **disturbance** (high riparian disturbance and/or high total land disturbance), and **pollution** (presence of mines and/or high number of pollutant point sources). Overlapping high risk/high intensity pressures predominate in the central and southeastern portions of the Study Area, with a lesser degree of landscape-scale pressures in AUs in the northern and southwestern sections of the Study Area.

7.2 Watershed Sensitivity

The distribution of more extensive development pressures in the central and southwestern portions of the Study Area also overlaps considerably with the identified areas of general summer low flow sensitivity in the Study Area. This is a concern, especially as any effects of development on flows will likely be exacerbated in the future given increased climate variability due to climate change. Winter low flow sensitivity is common across most AUs in the Study Area. Areas that may be more susceptible to increased, potentially damaging peak flow events due to a combination of high drainage density ruggedness (DDR) and low water storage capacity buffering are found primarily in the western and northern sections of the Study Area; these are areas that show the least amounts of local development pressures that could affect normal peak events.

7.3 Watershed Importance

Accessible (modeled) salmonid habitat is present throughout the Study Area but does seem to be present in higher amounts within the north and western sections of the Study Area; areas that show the lowest relative development pressure. Known salmon spawning habitat is distributed widely within the Study Area, including areas through the central portions of the Study Area where development pressures are more intense and spawning habitats could be more strongly impacted. Salmon spawning zones in the southeastern portion of the Study Area are not well represented in the province's underlying Fish Information Summary System database and as such it is uncertain where spawning habitats may be at risk from the relatively heavy land use activities occurring here. This is a data deficiency that should be rectified through continued discussion with SSAF Nations and additional spawning surveys/mapping where needed.

Noting that there is no evaluation of salmon escapement in this report for the southern section of the Study Area (i.e. outside the boundaries of the Nass and Skeena Basins – a data deficiency that should be rectified[3]) the known spawning sites for chum and river sockeye (while limited in total number) occur primarily in the relatively undeveloped central western portions of the Study Area while spawning streams for the other salmon species are more numerous and are distributed more broadly across both relatively pristine and relatively disturbed portions of the Study Area. There are a variety of indicator streams within the Study Area that have shown particularly high average escapements in recent years across the species, especially for lake Sockeye, Pink salmon (odd and even), Coho, and Chinook. Such high escapement sites are distributed broadly across the Study Area but there are very high concentrations for many salmon species at mid-Skeena River sites and at Babine Lake for lake sockeye. Evaluation of species escapement changes (recent averages vs earliest recorded averages) at monitored indicator streams (where data was sufficient to evaluate) indicated increased average escapements at indicator streams for Chinook, lake Sockeye, river Sockeye, Pink salmon, (both odd and even) and Coho, and decreased average escapements for Chum. While this information is useful for assessing spatial patterns in escapement and trends at individual indicator streams it should be recognized that a high proportion of salmon production within the study area is driven by production from a relatively small number of streams, so that escapement trends at individual indicator streams may not reflect broader population trends (which will be driven by status of the historically more productive stocks). For detailed evaluations we refer the reader to English et al. 2018 and Price et al. 2019 for analyses of historical changes in abundances of north coast salmon populations.

8 Monitoring

This State of the Value Report on fish and fish habitat primarily focuses on Provincial and Regionally available data sets with office-based GIS analysis as part of a Tier 1 process. The following set of monitoring projects provide additional information about the region.

8.1 Summary of Existing Tier 1 and 2 monitoring

Monitoring and assessment information for fish and fish habitats within the SSAF Study Area is available from a variety of past projects at varying spatial scales. This variety includes assessments of fish and fish

[3] Note also that Office of Wet'suwet'en has salmon escapement data from 2017 and 2018 from their ISP. Further analysis is needed to determine how to incorporate this information into the broader historical comparisons of escapement patterns across indicator streams in the Study Area.

habitat that were value driven as well as assessments associated with the review of proposed major development projects in the region (i.e., environmental assessments). This distinction is particularly important. The spatial and temporal scale of value-driven assessments tend to be broader than for project-driven assessments. Table 8.1 and Table 8.2 provide summaries of fish habitat information that may be available in the SSAF Study Area from "value"-driven assessments and major project-driven assessments respectively. Table 8.3 identifies past synthesis reports that have evaluated monitoring efforts undertaken within the SSAF Study Area. Detailed habitat datasets that have been collected from past projects within the SSAF Study Area can also be located and downloaded from the Skeena Salmon Data Centre at https://data.skeenasalmon.info/tr/dataset?groups=habitat.

Table 8.1 Fish habitat focused monitoring/assessment undertaken within the SSAF Study Area.

Report	Description
Canadian Aquatic Biomonitoring Network *(Environment Canada)*	Stream health condition assessment
Hanna, Tintina and Strohn Creeks Habitat Restoration Initiative *(Koch, 2016; Koch and Anderson 2017; Koch and Anderson 2019)*	fish population inventory; fish habitat condition assessment
Office of the Wet'suwet'en ISP (2018-2019)	Salmon and steelhead tagging (mark and recapture), CABIN data, water quality and water quantity
Gitksan Watershed Authority fish and fish habitat monitoring and assessment	water quality and water quantity assessment
Lake Babine Nation Fisheries Program	fish population inventory; fish habitat condition assessment
Morice Cumulative Effects Assessment *(Daust and Morgan 2014)*	fish habitat risk assessment
Morice Water Monitoring Trust *(M.R. Gordan & Associates 2009)*	water quality assessment
Morice Fish and Aquatic Habitat Review *(SkeenaWild 2013)*	GIS-based assessment of fish and aquatic habitat
Owen and Lamprey Watershed Status Assessments *(Bulkley Valley Research Centre/FLNRO – in finalization)*	watershed assessment (pressure and condition)
Upper Bulkley Fish and Aquatic Review. *(Office of the Wet'suwet'en 2017)*	watershed assessment of fish and aquatic habitat
Skeena and Nass Salmon Habitat Report Cards *(Porter et al. 2013, Porter et al. 2014, Porter et al. 2016)*	GIS-based assessment of freshwater salmon habitat

Fish Passage Assessment of Highway 16 and CN Rail in the Bulkley Watershed. *(Wilson and Rabnett 2007)*	field assessment of fish habitat connectivity / access
Forest and Range Evaluation Program assessments Conducted by FLNRORD staff at the Nadina and Skeena Stikine Natural Resource District offices	Field assessment for riparian and water quality
Gitanyow Huwilp Society DBA Gitanyow Fisheries Authority and District of Skeena Stikine collaborative FREP and ESI monitoring project	Pilot project field assessment to rebuild Kitwanga River / Gitanyow Lake fish stocks towards levels that will serve Food, Social, and Ceremonial and Commercial / Economic fishing needs

Table 8.2 Fish habitat assessments undertaken as part of major project reviews within the SSAF Study Area.

Report	Description
Enbridge Northern Gateway Project (2015)	freshwater ecosystem assessment (water quantity, water quality, and stream/riparian areas)
Prince Rupert Gas Transmission Project *(2014)*	fish and fish habitat baseline assessment
Pacific Trails Pipeline Project *(Applied Aquatic Research Ltd. 2007*)	fish and fish habitat baseline assessment
Pacific Trails Pipeline Project *(Hydrologic Consulting Inc. 2012-2014)*	water quality and fish habitat assessment
Pacific Trails Pipeline Project *(Hydrologic Consulting Inc. 2012-2014)*	aquatic ecosystem components: water quality, groundwater, and wetlands.

Table 8.3 Synthesis reports that include evaluation of monitoring and assessment efforts within the SSAF Study Area.

Report	Description
Comparison of watershed assessment methodologies *(Daust, 2015)*	A comprehensive comparison of the strengths and weaknesses of the Tier 1 aspects of four watershed assessment procedures.
Skeena Natural Resource Region Strategic Stewardship Monitoring Plan *(FLNRO, 2015)*	A summary of the existing monitoring and gaps in the Skeena region for a number of values including: 13 species of fish (notably excluding Pacific salmon), aquatic

	ecosystems (water quality and water quantity), and riparian/wetlands/floodplains/alluvial fan ecosystems.
Skeena ESI Review of Fish and Fish Habitat Assessment and Monitoring Practices *(Parsamanesh and Kurtz 2016)*	A broad review of literature and protocols from the Pacific Northwest and a focused review of applications in the inland Skeena River watershed.

8.2 Overview of First Nations Fisheries monitoring programs

In addition to the monitoring and assessment work conducted for this state of the values report, many of the SSAF First Nations run their own fisheries monitoring programs. Wet'suwet'en First Nation and Witset do not have fisheries programs however, the SSAF First Nations have received training on Meso-Habitat mapping. This monitoring protocol is the Tier 2 ground truthing of spawning habitat extent (section 6.19).

8.2.1 Gitanyow Fisheries Authority[4]

The Gitanyow Fisheries Authority (GFA) is the technical arm of the Gitanyow Hereditary Chiefs, and provides fisheries, wildlife and overall environmental expertise and services. GFA has been operating since 1997 and conducts salmonid stock assessment, watershed restoration, environmental monitoring, fish and wildlife habitat assessment, environmental impact assessment, research, and planning, primarily within the Gitanyow Territory. Starting with the protection of the Kitwanga River sockeye salmon, the GFA has grown into a well-established fisheries management team, that now conducts stock assessment work in the Nass River Watershed (Cranberry River, Brown Bear Creek, Meziadin Watershed), as well as a variety of work throughout the Gitanyow Traditional Territory.

Some of the GFA's larger and longer-term projects include the operation of a temporary adult salmon counting weir (2000-2002) and permanent adult facilities on the Kitwanga River (2003-2020); Kitwanga River Smolt Enumeration Facility (2008-2020); Implementation of a Kitwanga sockeye recovery plan (2006-2020), Brown Bear Creek Sockeye and Coho Enumeration and Monitoring (2003-2020) and the joint operation of the Meziadin Fishway (2001-2020). In the last decade GFA has also undertaken a multitude of spawning ground and lake trophic status studies to monitor habitat conditions in the Meziadin Watershed as they relate to sockeye salmon.

The GFA also provides services relating to aquatic habitat assessment; habitat restoration and enhancement; fish population monitoring, enumeration, assessment, and enhancement; hydrological monitoring; environmental monitoring; environmental impact assessment review; and land use planning.

The Gitanyow Traditional Territory lies in the heart of wild salmon country, and salmon has been a staple of their diet for thousands of years. Today, Gitanyow people still rely heavily on salmon, and during summertime each year, the Gitanyow Village smokehouses are fired up, and people are very busy

[4] All information on Gitanyow Fisheries Authority is from: http://www.gitanyowfisheries.com/

processing fish. Fishing occurs mostly on the Nass River mainstem and on the Meziadin River at well established Century old fishing sites. Gitanyow FSC. Fish are also caught on the Skeena River mainstem through special arrangements with the Gitksan Watershed Authority who manage the middle and Upper Skeena First Nation FSC fisheries. Historically, FSC fishing also took place on the Kitwanga River and Upper Kispiox River, but for the most part these fishing sites are no longer used because of conservation concerns for many of these terminal stocks.

The Gitanyow also take part in economic sockeye and coho salmon fisheries on the Nass through special permits with DFO. These fisheries first started in 1995 and 1999 whereby Estimated Surplus to Spawner Requirements (ESSR) licence were granted to harvest sockeye on the Meziadin river, all through selective dipnet fisheries. No ESSR's have taken place since that time but other commercial licences have been awarded to the Gitanyow. These Gitanyow economic demonstration fisheries have been ongoing since 2009 and are implemented in some years when returns warrant commercial harvest. In recent years Gitanyow's share of the total allowable Harvest on the Nass has been the catch equivalent of 37 Area C (Gillnet licences) and 8 Area A (Seine net licences). The target species is sockeye, but coho may be retained and sold as a bycatch when other commercial sectors are allowed to do so in any given fishing year. It should be noted that all Gitanyow commercial fisheries are implemented on the Nass River mainstem and the Meziadin River and only through selective means, which have included the use of dipnets and fishwheels (only on Nass mainstem).

8.2.2 Gitksan Watershed Authorities[5]

The mandate for the Gitksan Watershed Authorities (GWA) arises from Gitksan law, ownership and jurisdiction over Gitksan territory. Hereditary Chiefs created the GWA as the agency responsible for re-invigorating jurisdiction and enforcing Gitksan law for activities involving lands and resources of the Gitksan territories. The Gitksan Watershed Authorities (GWA) was founded in 1992 to complement the Gitksan aboriginal title research work initiated in the 1970's.

GWA core programs include an extensive and well-respected Catch Monitoring Program, Salmon Stock Assessment Programs, Water Quality and Quantity assessments, and Habitat Restoration Initiatives, all of which work within the Gitksan laws to uphold and sustain fisheries resources within the Gitksan territories and beyond. Beyond core programming, the GWA applies for external pots of funding each year to address additional needs beyond the scope of their core funding, explore research questions, and conduct shorter-term or exploratory projects specific to outstanding or community-identified needs. One of the main objectives under this umbrella of work is to expand and update our collective understanding of salmon stocks within our territories and monitor their status as well as the environments that support them. Continually re-assessing the status of wild salmon populations, habitats and systems through time as environments change is a key role the GWA fills in order to re-prioritize restoration and protection efforts as pressures to wild salmon also adapt to changing environments and climates. For more information on core programs or specific projects and initiatives please visit their website www.gitksanwatershed.com

[5] All information on Gitksan Watershed Authorities is from: http://gitksanwatershed.com/

8.2.3 Lake Babine Nation Fisheries Program[6]

The Traditional Lake Babine Nation (LBN) diet consisted of plants, animals, and fish as supplements to sockeye salmon which was the major staple. The LBN used weirs to harvest the sockeye salmon that returned to Babine Lake to spawn. The LBN people harvested and preserved vast quantities for food and a commodity for trade with neighboring people. The LBN people were known to catch and preserve approximately 750,000 sockeye in one season. This gave the LBN people the opportunity not only to sell/trade with neighboring nations but, also with the Hudson's Bay Company (HBC) and miners. The historical weir site has become the location of a permanent fish counting structure, the Babine River counting fence.

Lake Babine Nation Fisheries Program has a mandate to *protect and conserve the fisheries resources and habitats within the Lake Babine Nation Territory for the benefit of all members, present and future.* The suite of LBNF projects include:

- Babine River fish counting fence – to enumerate sockeye, pink, chinook and coho salmon. This is also the main location for Food, Social and Ceremonial harvest of sockeye salmon.
- Stream enumerations in tributaries of Babine River and Babine Lake that support wild sockeye stocks
- Habitat monitoring and small-scale restoration – includes water quality and quantity monitoring, limnology and improvements to spawning habitats as funding comes available
- Sockeye smolt enumeration project (when funding is available) – to enumerate both early timing and late timing out-migrating sockeye smolts.
- Salmon education and awareness in LBN schools and at a variety of public events (Smithers Fall Fair, Farmer's Markets, BC Rivers Day, LBN Annual General Assembly, youth camps)
- Creel surveys during recreational sockeye fishery (when funding is available)
- Participation in sockeye management processes in partnership with Resource Management Branch of DFO and other First Nations
- Recovery Plan for Wild Babine Sockeye
- Liaise with other LBN departments, government agencies, industry representatives and other stakeholders to ensure protection of salmon and their habitat in the traditional territory

The suite of LBNF programs aim to work towards identifying limiting factors to salmonid survival, monitor stock strength over time and take appropriate actions to ensure that LBN people have salmon in perpetuity.

[6] All information on Lake Babine Nation Fisheries Program is from: https://www.lakebabine.com/programs-services/fisheries/

8.2.4 **Wet'suwet'en Fisheries Program**[7]

The Wet'suwet'en Fisheries Program (WFP) team of the Office of the Wet'suwet'en is dedicated to the stewardship and sustainable management of the fisheries resources within the Wet'suwet'en territory. The salmon fishery is and always has been a central focus of the Wet'suwet'en sustenance and trading economies. The large-scale utilization of the abundant and predictable salmon stocks formed the foundation of the economy. Arrangements for management of the fishery are deeply interconnected and woven into the fabric of Wet'suwet'en culture.

The WFP's strategic goals are to: manage salmon stocks so that conservations needs for Chinook, Coho, pink, sockeye and steelhead are met; to ensure the stocks are sufficient to meet food and cultural needs; and to gain economic benefits from stocks that can support a commercial fishery. To achieve these goals, the WFP gather data to inform responsible decisions regarding fish management for salmon (Chinook, Coho, pink, sockeye and steelhead), as well as other species such as trout, char and lamprey eels.

Active and planned WFP projects include identifying stocks within each salmon species through DNA collection; determining the impact of other user groups on fish stocks by obtaining catch data from other groups such as commercial and recreational fisheries; estimation of spawning escapement and the development of harvest plans. The WFP also endeavours to enforce regulations for First Nation food and commercial fisheries; to protect fish habitat, to participate in processes that may impact fish stocks, and to ensure that fisheries resources are allocated fairly and equitably among the Wet'suwet'en communities, especially for food fish and employment.

Sockeye is the most desirable fish for the Wet'suwet'en owing to a fat content that facilitates smoke-drying. They are fished heavily until sockeye needs are met, which typically signal the beginning of berry picking and high country hunting. Major sockeye harvest and processing locations include Hagwilget Canyon, Moricetown Canyon, Morice Lake outlet, Nanika River outlet, Bulkley Falls, Maxan and Bulkley lake outlets, Nadina River, and at the outlet of Endako River downstream of Burns Lake. Following the disastrous Fraser Canyon slide in 1913, harvesting effort of the Endako and Nadina rivers sockeye was transferred to Bulkley sockeye stocks. Precontact sockeye catch abundance is speculative as to exact numbers; however, Wet'suwet'en oral histories clearly note that salmon were abundant and runs were annually reliable.

For conservation reasons, the Wet'suwet'en have voluntarily stopped fishing sockeye in the Wetzin'kwa.

8.3 Gaps in existing Tier 1 & 2 monitoring

Although other Tier 1 analyses for fish and fish habitat related values have been undertaken in the SSAF area in the past, this report supplements that past work with more recent data and assessments that extend into more areas of the SSAF study area (i.e. the Nechako drainage) that have not been previously included in these assessments. Previous Tier 1 assessments of natural and anthropogenic pressures have been completed for the majority of the SSAF Study Area drainages (i.e., Skeena and Nass) (Porter et al.

[7] Information on Wet'suwet'en Fisheries Program is from:http://www.wetsuweten.com/departments/fisheries-and-wildlife/ and http://www.wetsuweten.com/images/uploads/Wetsuweten_Written_Submission_revised.pdf

2013, Skeena Wild 2013, Porter et al. 2014, Daust and Morgan 2014, Porter et al. 2016, , OW 2017). Past issues related to previous Tier I analyses within the SSAF Study Area have included:

- differences in the particular GIS data layers used and different algorithms developed for deriving the specific habitat indicators used for analyses across projects;
- differences in the specific metrics used for quantifying indicator values for analytical comparisons (e.g., road density within 30m of a stream vs. road density within 100m of a stream, etc.);
- differences in the thresholds used for defining zones of concern for Tier 1 indicator values;
- a lack of any real time series information for tracking habitat disturbance information at broader scales.

While these remain issues, integration of SSAF Tier 1 indicators into the province's aquatic CE analytical framework (AEWG 2016) as has been initiated for this state of the value report will ensure a consistent approach for undertaking these habitat assessments and the beginning of a consistent, reliable time series for future trend evaluations.

While there have been many detailed field assessments of fish habitat condition in specific locations across the SSAF Study Area, there has been little consistency across these Tier 2 assessments and the spatial and temporal scope of evaluations is often limited. The fieldwork undertaken in 2020 was consistent and well organized, laying the groundwork for future Tier 2 monitoring for the SSAF Study area. There is a need for continued rigorous integrated regional-scale approach to monitoring fish habitat condition. A recent review of fish habitat assessment approaches within the SSAF Study Area (Pickard and Porter 2017) as well as discussions within the Skeena STC have identified six general Tier 2 monitoring themes that need improvement. These are: cultural and spiritual, water quantity, water quality, climate change, lakes and wetlands, fish populations, and models. These are described in section 9 of this report.

9 Potential next steps

9.1 Improvements to this assessment

This Tier 1 assessment of the fish and fish habitat value represents an iterative process whereby the SSAF has collaboratively developed a list of indicators and benchmarks to assess the value. Future work assessing the state of the value for fish and fish habitat may use different indicators as Tier 1.5, 2, and 3 assessments may indicate that certain indicators should be added or removed, or that default thresholds of concern initially applied should be adjusted. Through this process, the SSAF has identified six key areas for the focus of future research and monitoring efforts. By identifying these areas of focus, the SSAF hopes to ensure that future Tier 1 reports can better reflect these areas.

9.1.1 Cultural and Spiritual

This report details the current western scientific understanding of the state of the value for fish and fish habitat. Work is underway to develop a set of cultural indicators that can inform future state of the value reports for the SSAF. This work is being led by the SSAF Project Team and will reflect cultural practices from the SSAF Nations. It is anticipated that the development of cultural indicators will greatly shift the focus of the current suite of indicators for this value.

This report broadly focuses on salmon species; however, it is anticipated that monitoring of fish habitat generally will be broad enough to capture the habitats of non-salmonid species. Future work is needed to better capture the impact of pressure, watershed sensitivity, and watershed importance indicators on other important fish species such as pacific lamprey eel (*Entosphenus tridentatus).*

FSC use of fish to support economic and cultural needs warrant greater understanding and greater importance in this report. A better understanding of the alignment between the location of no longer used historical fishing areas and areas of higher development pressure needs more study. These data can be informed by a detailed understanding of the Indigenous Knowledge in the area, and may be able to inform a better understanding of the shift in available resources for First Nations over time; e.g. many SSAF Nations have a self-imposed moratorium on sockeye harvesting, where sockeye used to be one of the primary foods for these Nations.

The FSC use of salmon is informed by the historic and modern Indigenous knowledge and is supported by the current monitoring of fish and fish habitat by SSAF Nations. To inform the FSC use of salmon by the SSAF nations, additional work is needed to better understand how fish quality has changed over time. In this context, fish quality refers to the health metrics of the fish, such as the percentage of fish that rejected when caught.

Additionally, understanding the social impact of declining fish stocks is critical. Conversations amongst the SSAF STC have pointed out that the number of youths who actively participate in FSC fisheries is declining, and that the number of people who know how to fish according to traditional ways is also on the decline. The intergenerational knowledge transfer that happens during fish harvesting and fish processing may also be declining as fish populations decline. It is important to understanding this impact.

Spatial data could support this information by communicating the change over time of the location of culturally important fishing areas.

9.1.2 Water quantity

There is insufficient information on the timing and quantity of water as it moves through the aquatic ecosystems that support fish. There is limited long term information on stream discharge available in the SSAF Study Area. While some water gauges are maintained through the Government of Canada (https://wateroffice.ec.gc.ca) these need to be supplemented to provide a more complete network to inform local Environmental Flow Needs (EFN) assessments and local decisions around climate change adaptation or restoration. There are a few recent projects that are helping to address this gap within the SSAF Study Area (Daust and Morgan 2014; Koch 2016; Koch and Anderson 2017). The Northwest water tool provides some of this information, but further work on integrating it into assessments is needed.

Ground water. There is limited information related to groundwater and there is a need to improve understanding of the role ground water plays in maintaining fish habitats within the SSAF Study Area.

9.1.3 Water quality

There is a need to establish a more extensive network of long term **water temperature** monitoring stations throughout the SSAF Study Area to track and predict changing water temperatures so as to better inform management and mitigation decisions around extreme flow and water temperature events, which may become exacerbated under potential climate change scenarios.

There is a need to build upon existing efforts by the Federal and Provincial governments to collect and store data on **benthic macroinvertebrates**. The CABIN protocol provides a standardized, relatively simple field protocol for data collection and an associated database is available and maintained by the CABIN program.

9.1.4 Climate change

Climate change issues are not yet adequately addressed within SSAF Study Area monitoring. Expanding focused climate change-related monitoring will be important in several ways:

- **Monitoring and modeling climate change:** Long term data on **glacier extent** and **snowpack** will provide calibration of climate models.
- **Sensitivity:** Climate change indicators or predictive models will provide important insight into the relative sensitivity or resilience of different habitats within the Study Area to local land use impacts.
- **Climate change adaptation:** Uncertainties associated with climate change affect how communities in the Study Area will manage their resources (e.g., decisions around where to put restoration effort for maximum benefit).

9.1.5 Lakes and wetlands

While lakes and wetlands are an important component of fish habitat in the region, monitoring of their status in the SSAF Study Area has been limited and principally tied to localized EA project impact assessment. There is a need for a broad program of small lakes and wetlands monitoring to be developed so as to better understand the current and potential future risks to and status of wetlands and lakes in the Study Area. A suite of wetland-focused analyses that have been completed by the SSAF Scientific and Technical Committee in 2019 and 2020 and provide a strong foundation for improved future wetland delineation and monitoring across the Study Area.

9.1.6 Fish populations

Continued engagement with SSAF Nations and potential new approaches (e.g. radio tagging, eDNA) could help to improve understanding of spawning areas used by salmon populations across the SSAF study area. There are some long-term population datasets in the SSAF Study Area; most of these are spawner counts, although some juvenile datasets are available as well. Analyses by Connors et al. (2013), English et al. (2018), and Connors et al. (2019) have illustrated major gaps in population data for salmon across the Skeena and Nass Basins. New gaps are being added where cuts in DFO funding have resulted in some indicator streams being dropped. First Nation communities are now supplementing DFO’s efforts or developing their own population monitoring programs, and further integration of this data into. Population assessments for fish (anadromous and resident) are fundamental data needs within the SSAF Study Area. Detailed stock assessment analyses of status of regional salmon populations (beyond the very general patterns and trends identified in this report) should be a key focus of future steps (across 1.5, 2, and 3 Tiers) within the SSAF process.

It is important to note that the data used for Indicator 6.20 – Salmon Escapement are incomplete. Data in this section are presented only to illustrate generalized patterns and trends across SSAF salmon species and are not intended to represent detailed stock assessment of salmon population or stock status. The STC acknowledges that there are significant data gaps, and that the table for this section (Appendix 5) requires significant revisions in future versions of this report. Moving forward, it is recommended that Tier 1.5, Tier 2, and Tier 3 assessments iteratively feed into this work, and that these numbers are further refined. Detailed stock assessments should involve collaboration between federal, provincial, and First Nation governments, and should ensure that relevant local, traditional, and place-based knowledge is used to refine the understanding of escapement data and trends in salmon populations.

9.1.7 **Models**

A wide range of tools have been developed to assess, monitor and model aspects of the productive capacity of fish habitat in aquatic environments. Modelling techniques can simulate fish habitats to evaluate the quality of habitat for different fish species under different local anthropogenic or broader climate change impacts. These techniques are increasingly being used to assess the potential impacts of development or the success of habitat remediation projects (de Kerckhove et al. 2008), and for providing science advice for management programs, Environmental Impact Assessments and for guiding further research. Models allow for both the representation of complex ecological systems in quantifiable terms and for predictions of the consequences of management actions.

Examples of recent use of such modeling in the SSAF Study Area include hydraulic modeling within the Nass Basin's Hanna and Tintina Creeks for determining environmental flow needs (EFN) (see Hatfield et al. 2003; Linnansaari et al. 2013) for range of possible EFN modeling approaches) for spawning sockeye based on modeled habitat suitability criteria (Koch and Anderson 2017), and modeling of the potential impacts individually and cumulatively across fish habitat components in the Skeena Basin's Morice watershed from future local development scenarios and/or potential climate change impacts (Morgan and Daust 2014). It would be useful to expand environmental flows and species habitat models like these across the SSAF Study Area.

Other types of models that would be useful to develop broadly within the Study Area include water quality related models such as stream temperature models (e.g., Nelitz et al. 2010, Porter et al. 2018) that can be used to evaluate current/predict future thermal conditions for temperature sensitive fish species in the region, and models describing and predicting fine sediment delivery processes to streams. Models of potential seasonal flow changes (low flows and peak flows) under future climate change scenarios may be critical for predicting impacts to fish habitat and developing appropriate management responses.

Monitoring data will be critical for informing, calibrating, and improving such models for the SSAF Study Area. For example, robust basin-scale stream temperature and flow models can only be developed if supported by a well-designed arrangement of continuously monitoring temperature and flow gauges throughout the hydrology network. Meaningful, detailed habitat suitability models based on field-based approaches such as meso-habitat mapping will need to be informed and improved by further research into the differential use of habitat components by the varied fish species in the region. Such field-based modeling of habitat quality can link to and refine the broader depictions of fish habitat quantity captured by coarser Tier 1-scale modeling.

9.1.8 Remote Sensing

Future work should consider improving on remote sensing where:

- Datasets are found lacking or non-existent, glaciation extent and change for example.
- There is a huge cost to collecting and creating input data (roads, ECA etc.).
- Lags in data currency is considerable (input datasets including VRI and disturbance)

Remote sensing technology through free satellite data (Landsat among others), as well as through drone work have vastly improved over the last ten years. Work on automating assessments through remote sensing for topics such as ECA, human disturbance, and riparian disturbance hold a great deal of promise. Furthermore, remote sensing, and especially drone data, offers the opportunity to create a more accurate and precise inventories that could greatly improve the sensitivity indicators, among others. The use of remote sensing could make future fish and fish habitat datasets and the accompanying report more responsive and better suited to answering what are the impacts on fish and fish habitat.

9.2 Management actions

Based on the combined results outlined in this report, resource specialists and decision-makers may wish to consider the following opportunities to enhance fish habitats and improve monitoring in the SSAF Study Area:

- Undertake the following actions to reduce risks to fish populations in AUs with potentially degraded habitat:
  - Deactivate roads in areas of high road density that overlap with known areas of salmon spawning
  - Adjust forest planning and practices (including forest thinning and prescribed fire or other innovative forest management approaches) in key salmon areas to reduce potential impacts to fish habitats from either elevated peak flows or decreased summer low flows (especially as both these risks will conceivably become magnified across the Study Area under varied climate change scenarios)
  - Establish fish species Wildlife Habitat Areas (WHAs) under provisions of the *Forest and Range Practices Act in* locations considered important for salmon but where populations are threatened by the combined effects of multiple high intensity pressures;
  - Consider development of an expert network of river/stream restoration practitioners for the Study Area that can be called upon for advice in designing future fish habitat restoration projects
- Expand on existing research, inventory, and monitoring initiatives to refine the understanding of fish habitat and fish population interactions in the Study Area, particularly in more highly impacted areas and important fish producing systems. As highlighted at the 2017 ESI Fish Habitat Workshop in Smithers improved, integrated monitoring across both Tier 1 and Tier 2 scales of resolution would help to:

- Assess development proposals for forestry tenures, linear development, etc.;
- Improve stewardship planning, including protection, enhancement and restoration of degraded fish habitats;
- Inform decisions around special areas, and protection of key spawning areas.
- Inform decisions related to water allocation;
- Help determine the "significance of impact" in EIA decisions;
- Set objectives under the "Water Sustainability Act";
- Define instream flow needs in terms of amount and timing of flow for proper functioning;
- Set objectives for Timber Supply Reviews;
- Set objectives under the Land Act;
- Inform Regional District decisions around land use;
- Provide input for decision-making around salmon escapement and harvesting levels.

Future regional environmental and industrial trends will be important to consider when determining next steps for managing fish habitats and monitoring impacts in the SSAF Study Area. For example:

- Liquified Natural Gas (LNG) pipeline construction and post-construction;
- Continued industrial and urban expansion that could further impact fish habitats; and,
- Effects of climate change on water flows (timing and extent) and water temperatures for fish.

9.3 Targeted future Tier 1 and Tier 2 work

The following steps should be considered to improve monitoring and assessment of fish habitats in the SSAF Study Area:

- Continue development and refinement of defensible risk benchmarks that could be applied to the suite of priority Tier 1 indicators. For example further analyses could suggest how to modify default road density thresholds of concern based on such modifying factors as underlying geology or soil conditions, DDR, road surface type, etc. Improving the analyses around threshold derivation and threshold setting specific to unique elements of the SSAF landscape is expected to be a collaborative effort within next steps. Improving Tier 1 threshold analysis/algorithms/data layers and regionally specific threshold setting are also currently part of ongoing efforts within various entities (provincial CE framework, PSF) that will also be able to help inform SSAF analyses in the future.
- Develop additional Tier 1 indicators as needed to better understand and track regional risks and sensitivities, particularly in regard to climate change related impacts (e.g. glacier extent)
- Consider potential indicator aggregation approaches that could be used for summarizing cumulative impacts from human development pressures.
- Finalize a core set of Tier 2 indicators that are important across the Nations. Develop standardized sampling design and field protocols to provide a consistent regional dataset for these core indicators. Improved ability to compare and contrast information across broad spatial extents will be critical for improved regional planning
- Design Tier 2 monitoring in such a way to allow individual communities to supplement their monitoring efforts (e.g., additional indicators or additional sampling sites) to address local priorities while still being coordinated with the regional program (e.g., consider use of a Master Sample Draw for coordinating regional monitoring efforts).

- Use Tier 2 monitoring information to verify and improve interpretations from Tier 1 assessments (i.e., how well do Tier 1 risk assessments translate into status of fish habitat condition as measured by Tier 2 indicators?)
- Use Tier 2 monitoring to update and improve underlying GIS data sets by adding information, such as deactivated or missing roads, removing ephemeral or non-existent streams, etc.
- Data needs or decisions should drive the development of the Skeena monitoring program. The US EPA (2006) has developed a decision driven monitoring approach called the Data Quality Objectives approach where key decisions or questions are identified first, and the data needs are assessed with respect to the priority decisions. This has proven to be a very effective framework on which to build a comprehensive field monitoring program and the approach has been adopted, for example, by the BC Coastal First Nations' Regional Monitoring System.
- Indigenous knowledge indicators for fish habitats should also be developed in the Study Area and used alongside western science-based indicators for cross validation. Tier 2 monitoring represents a key opportunity to have indigenous ecological knowledge and western science equally inform the selection of monitoring locations, monitoring protocols, and decisions to be supported
- Consistent with the November 2019 recommendations from the Chief Forester's Timber Supply Area rationale for the Lakes, the following recommendations would assist in the delivery of SSAF products, and would strengthen the ties between the various SSAF SOVs and decision making:
    - Develop a comprehensive stream classification, that examines on-the-ground retention levels for all stream classes, for use in future TSRs
    - Complete a comprehensive watershed assessment for the Lakes TSA
    - Inventory existing roads according to risk to values and prepare management guidelines that manage the risk to aquatic ecosystems and grizzly bear and wherever possible

In addition to federal and provincial government objectives for fish habitat identified in Section 4 the following regional-based plans[8] and objectives should be considered when making decisions regarding future monitoring, management and conservation of fish habitats within the SSAF Study Area:

- Bulkley Land and Resource Management Plan (1998)
- Bulkley Valley Sustainable Resource Management Plan (2005)
- Bulkley Higher Level Plan (2006)
- Bulkley Objectives Set by Government (2006)
- Cranberry Sustainable Resource Management Plan (2012)
- Cranberry Land Use Objectives (2016)
- Kalum Land and Resource Management Plan (2002)
- Kalum Sustainable Resource Management Plan (2006)
- Kispiox Land and Resource Management Plan (1996)
- Lakes District Land and Resource Management Plan (2000)
- Lakes North Sustainable Resource Management Plan (2009)
- Lakes South Sustainable Resource Management Plan (2003)
- Xsu gwin lik'l'inswx: West Babine Sustainable Resource Management Plan (2012)

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[8] Land-use plans that are signed by the provincial government (e.g., Land and Resource Management Plans, or Sustainable Resource Management Plans) are considered policy unless their objectives have been legalised via a Land Use Objectives order.

- Morice Land and Resource Management Plan (2007)
- Morice Land Use Objectives (2016)
- Gitanyow Land-use Plan (2012)
- Future regional Water Sustainability Plans (WSPs)
- Other plans at appropriate scales

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Appendix 1—Boundaries of Skeena Sustainable Assessment Forum (SSAF) Nations within the SSAF Study Area

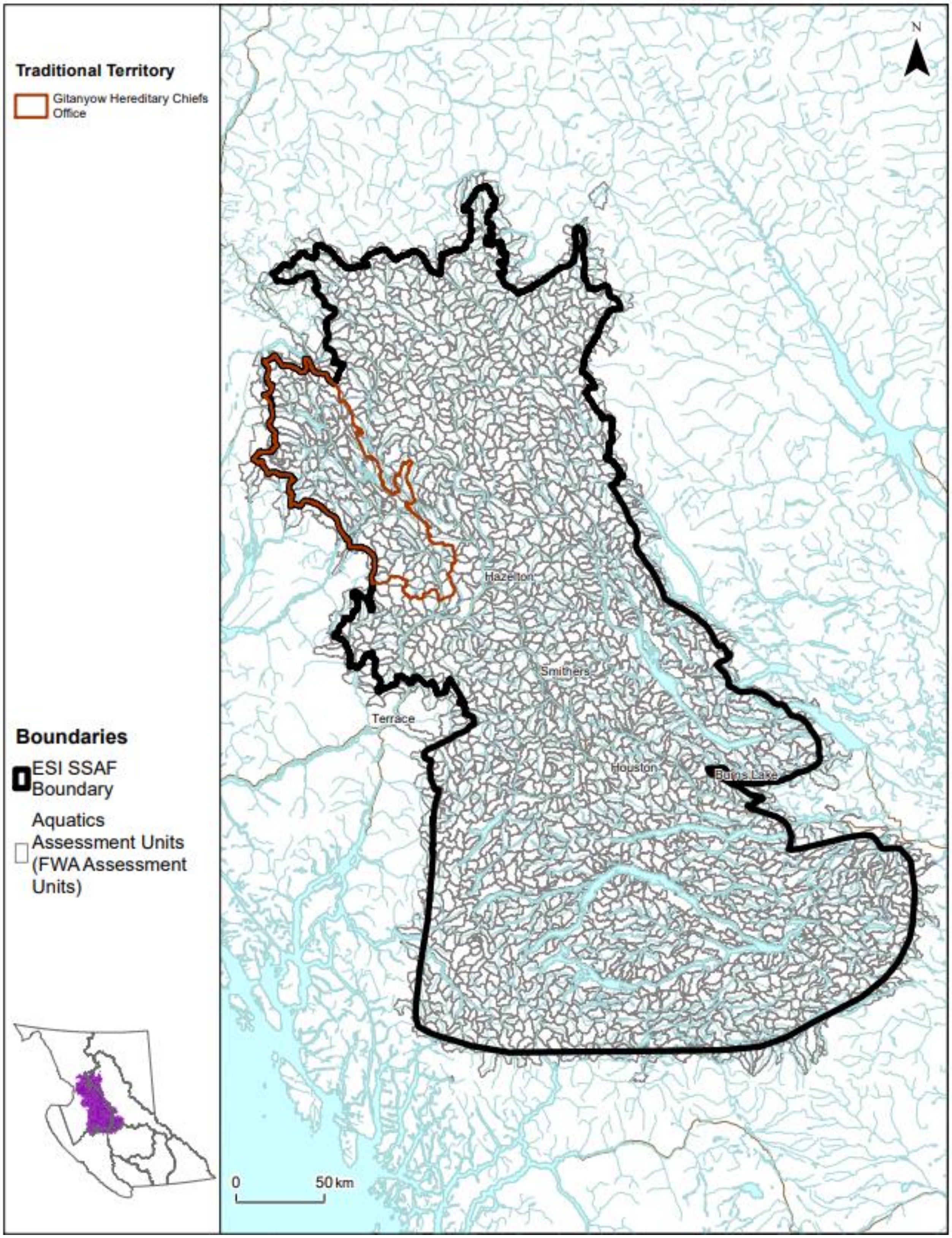


Figure A2-1. Gitanyow Traditional Territory (Gitanyow Hereditary Chiefs Office) within the Skeena Environmental Sustainability Initiative (ESI) Study Area.

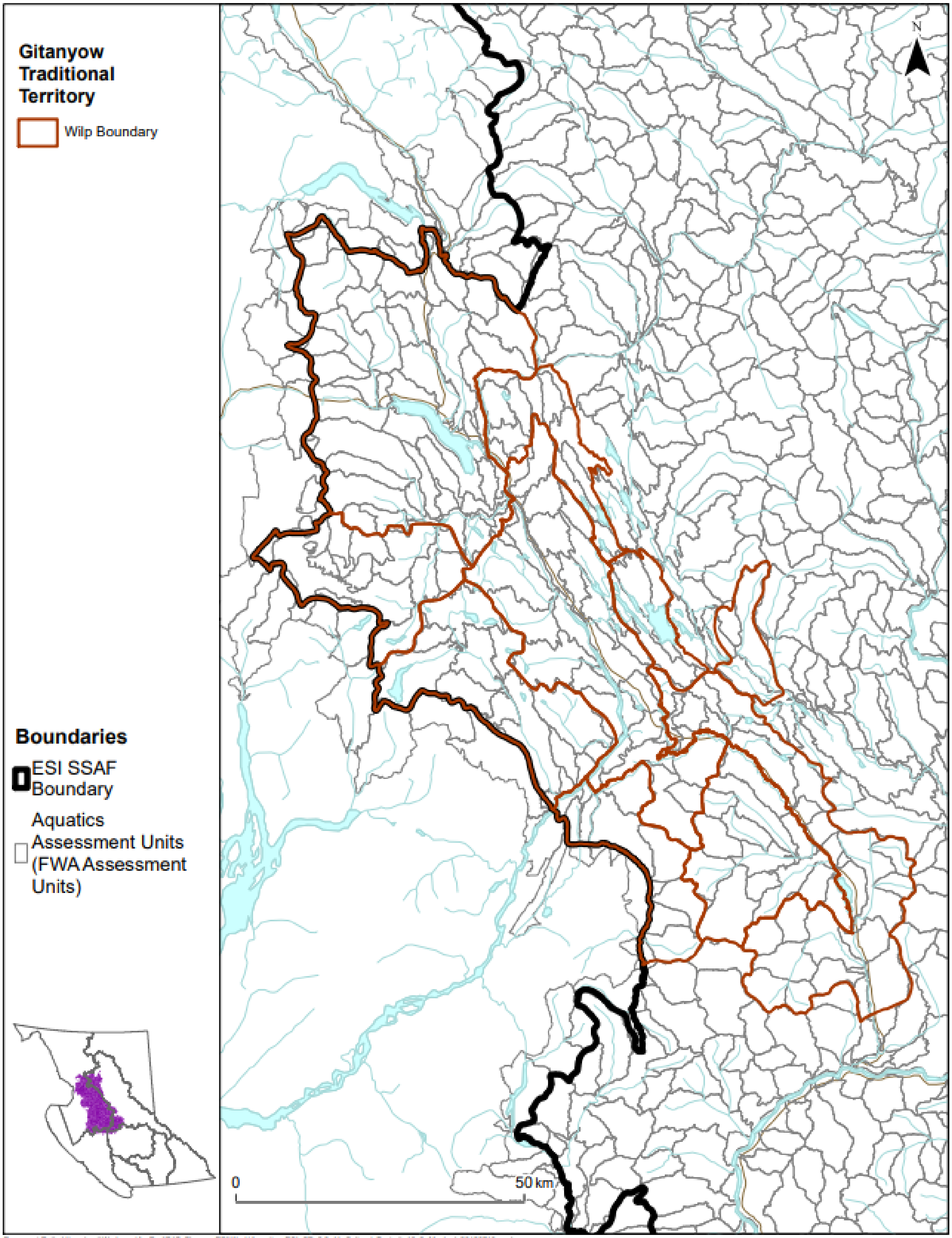


Figure A2-2. Gitanyou Traditional Territory (Wilp boundaries) within the Skeena Environmental Sustainability Initiative (ESI) Study Area.

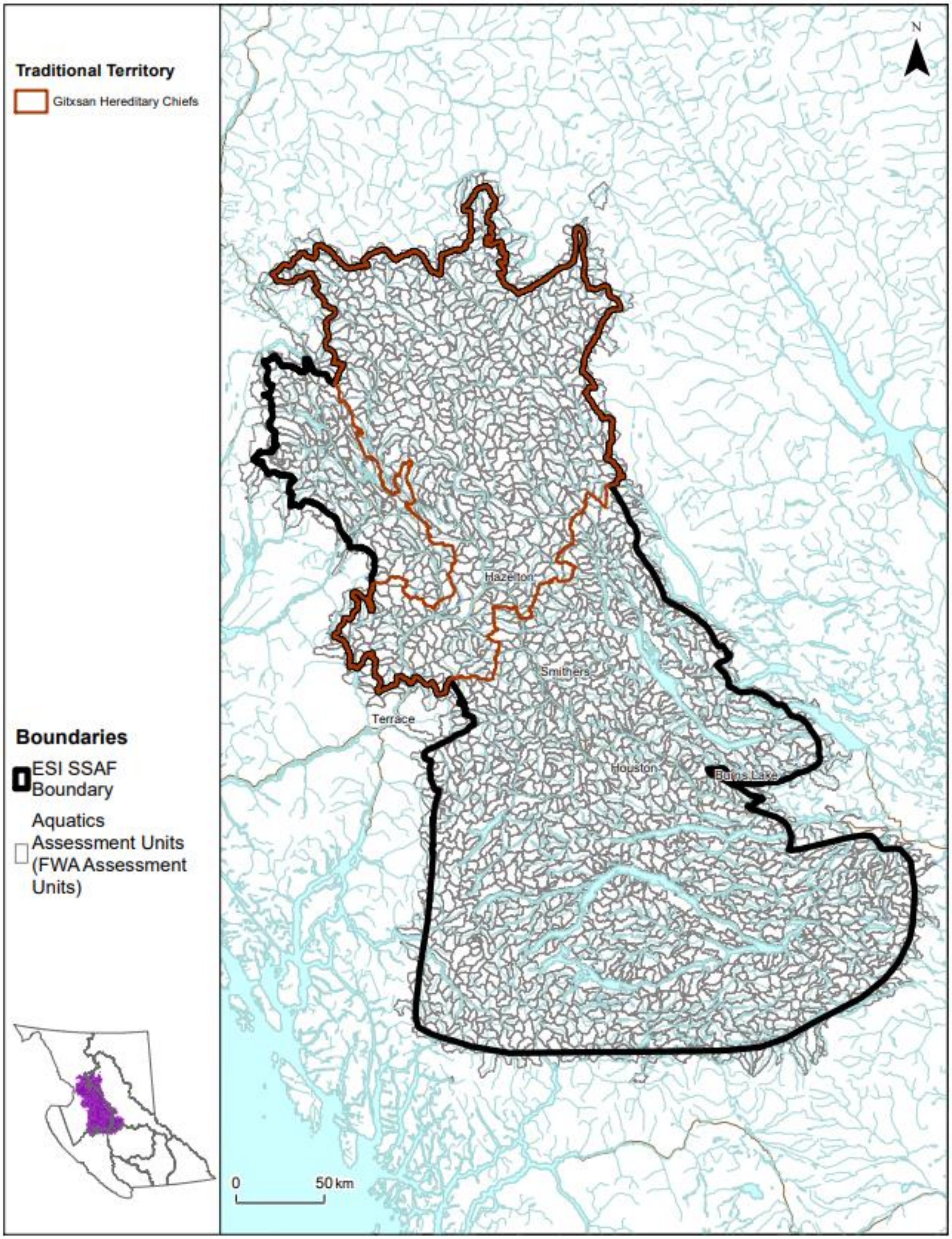


Figure A2-3. Gitxsan Traditional Territory (Gitxsan Hereditary Chiefs) within the Skeena Environmental Sustainability Initiative (ESI) Study Area.

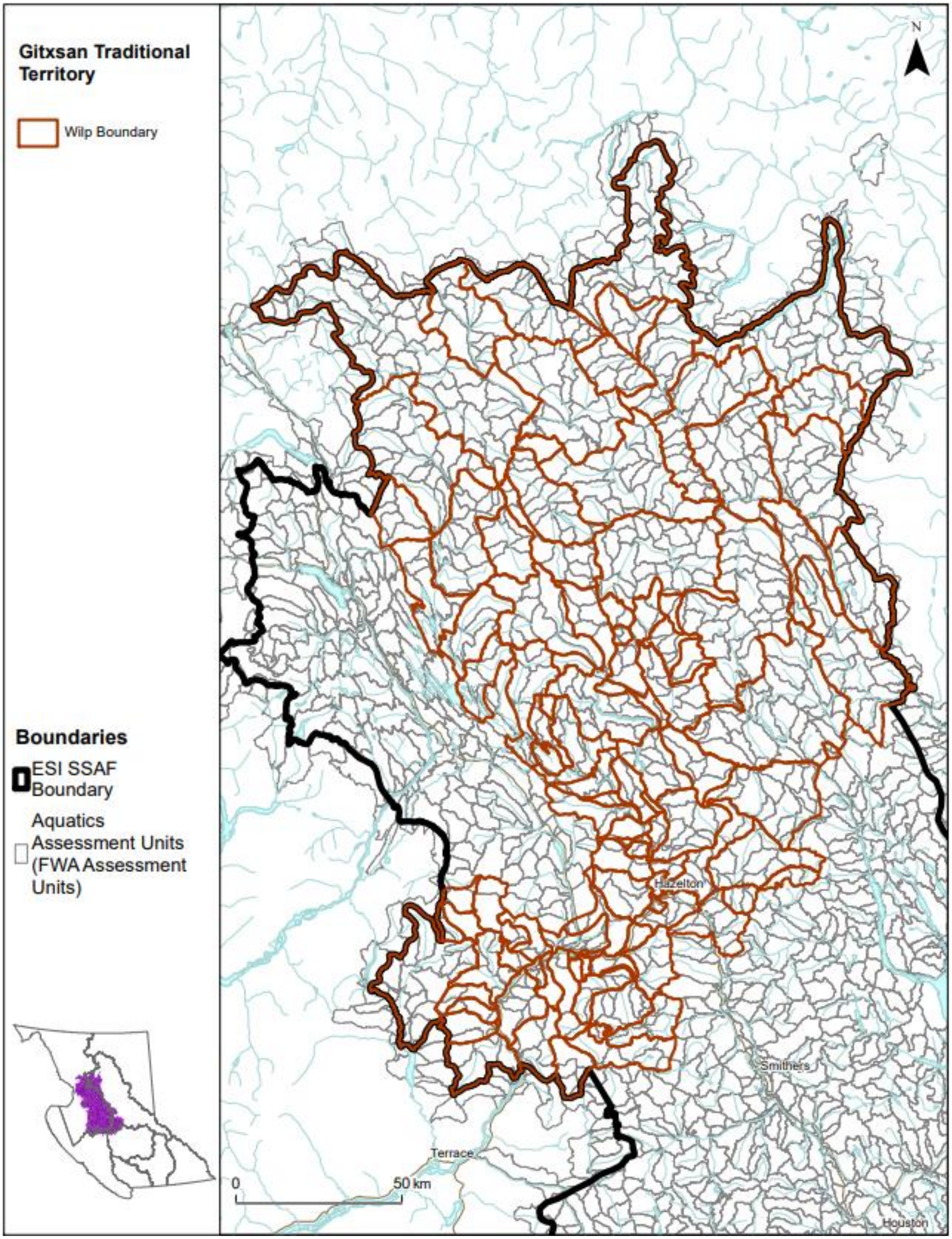


Figure A2-4. Gitxsan Traditional Territory (Wilp boundaries) within the Skeena Environmental Sustainability Initiative (ESI) Study Area.

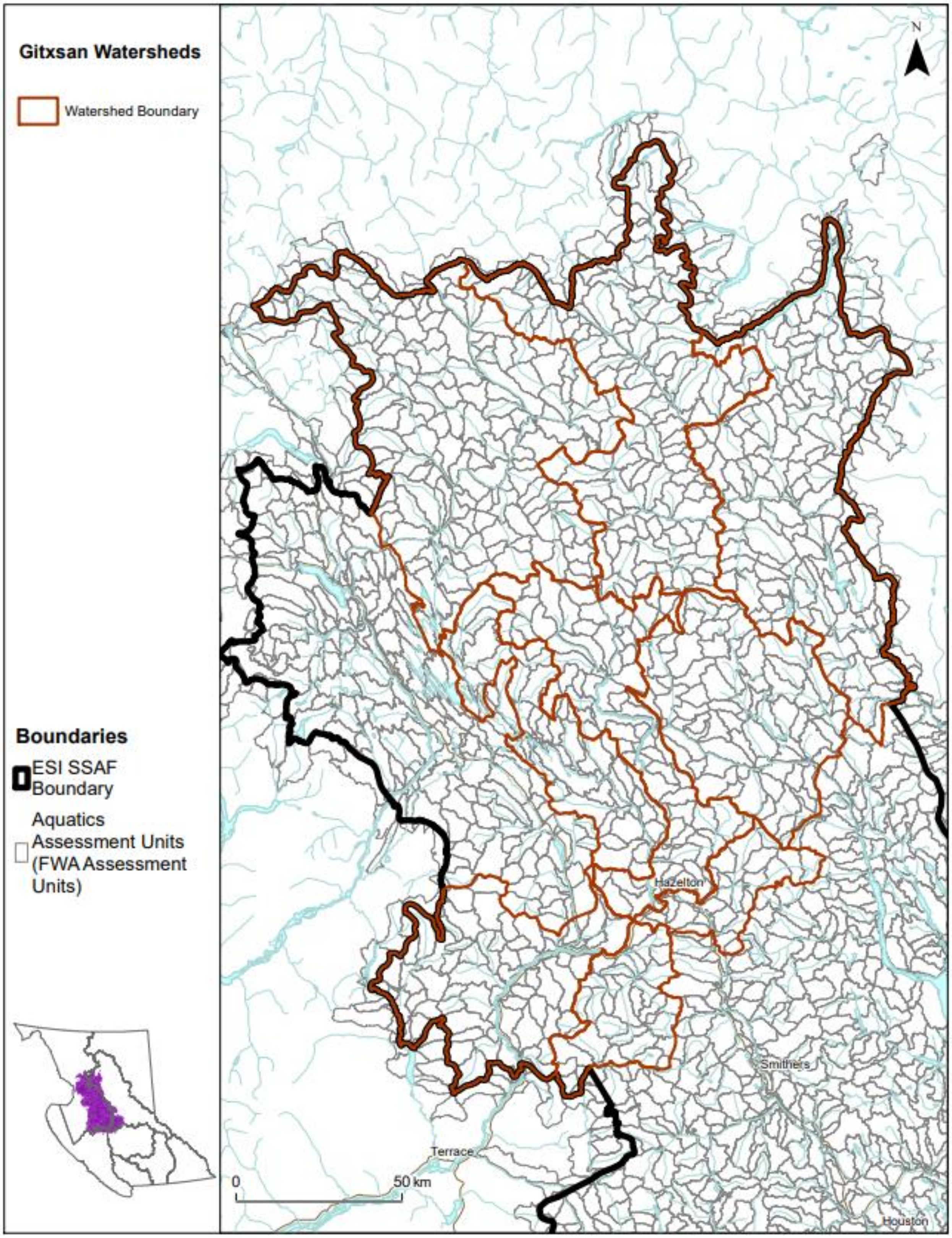


Figure A2-5. Gitxsan Traditional Territory (Gitxsan watershed boundaries) within the Skeena Environmental Sustainability Initiative (ESI) Study Area.

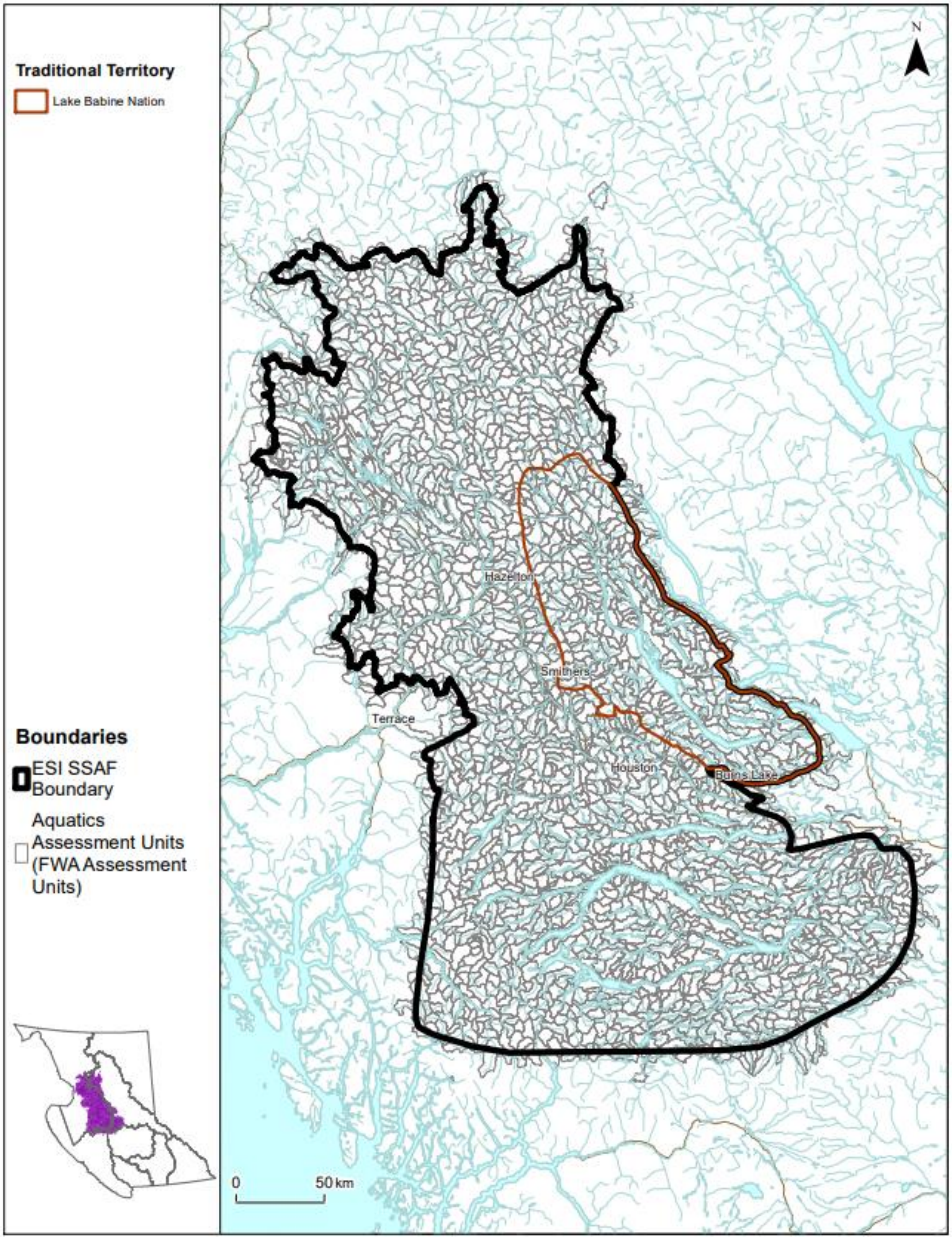


Figure A2-6. Lake Babine Traditional Territory (Lake Babine Nation) within the Skeena Environmental Sustainability Initiative (ESI) Study Area.

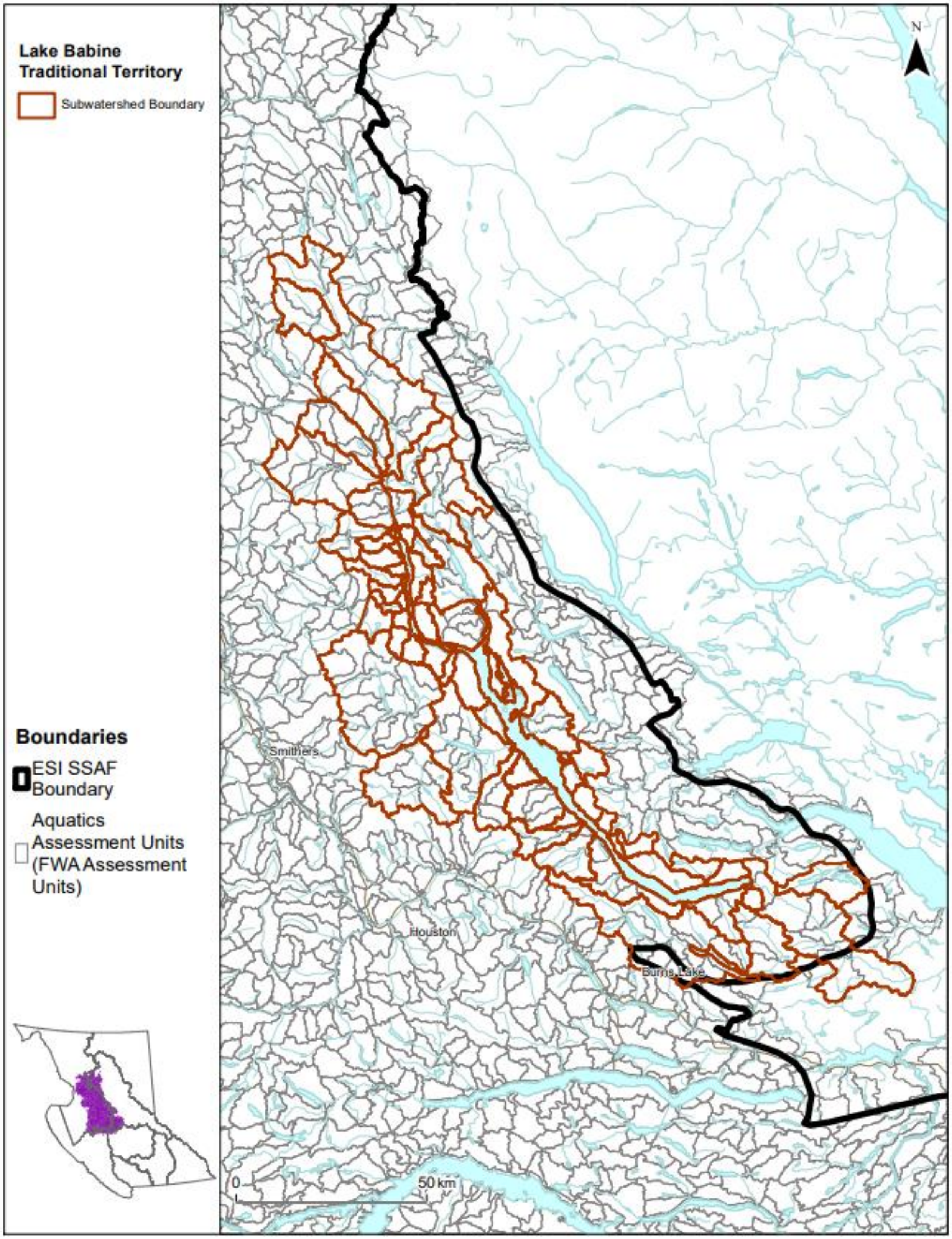


Figure A2-7. Lake Babine Traditional Territory (Lake Babine subwatershed boundaries) within the Skeena Environmental Sustainability Initiative (ESI) Study Area.

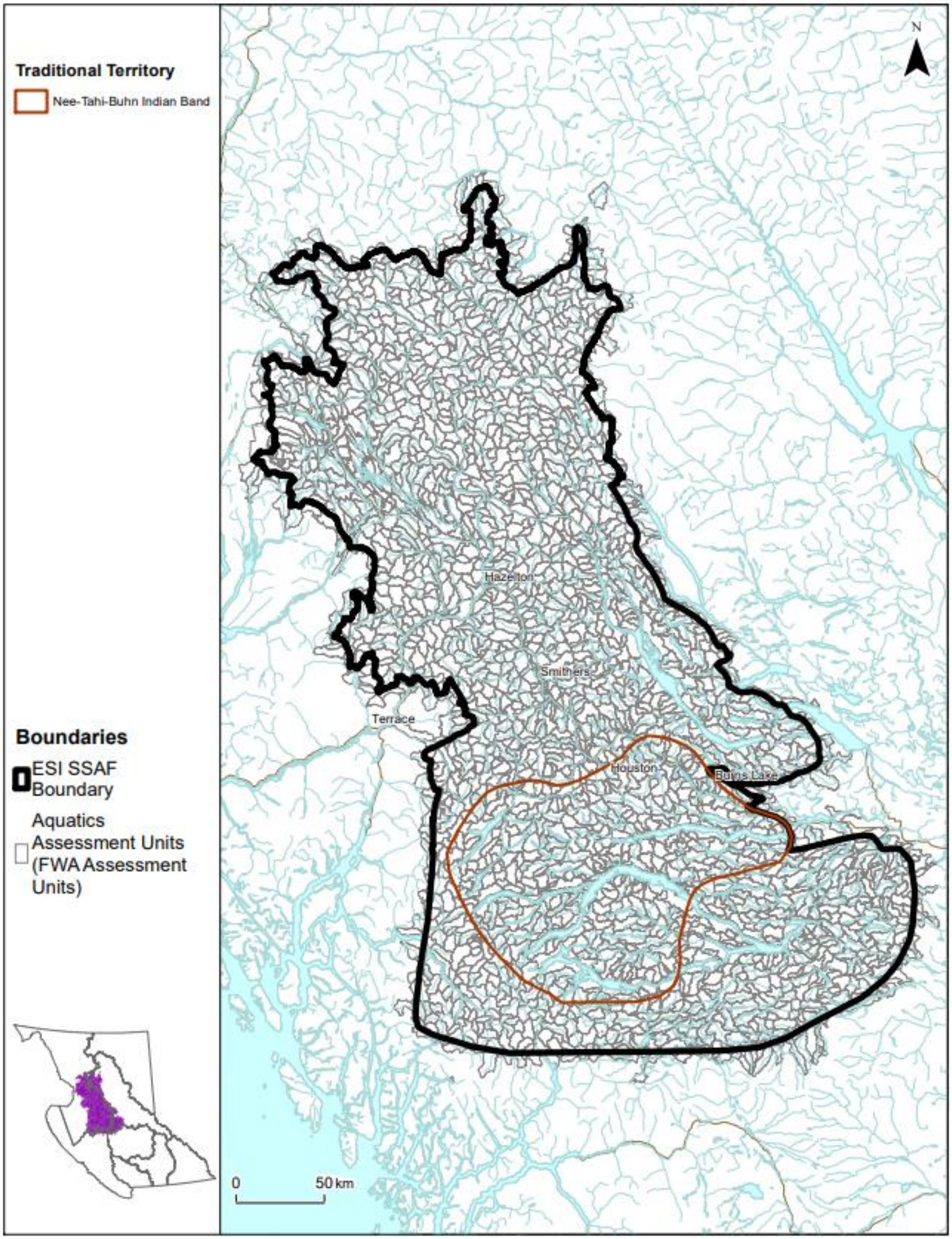


Figure A2-8. Nee-Tahi-Buhn Traditional Territory (Nee-Tahi-Buhn Indian Band) within the Skeena Environmental Sustainability Initiative (ESI) Study Area.

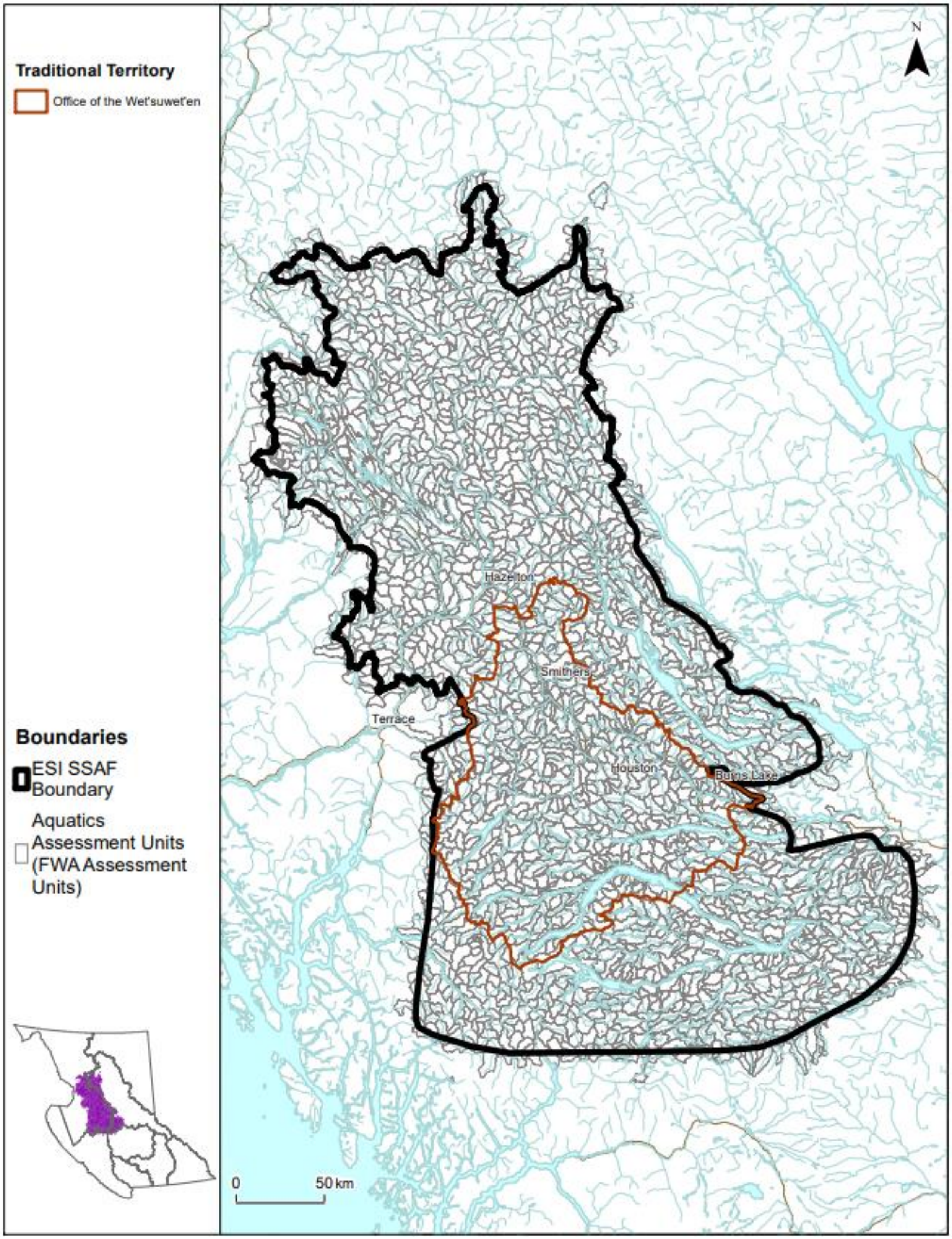


Figure A2-9. Wet'suwet'en Traditional Territory (Office of the Wet'suwet'en) within the Skeena Environmental Sustainability Initiative (ESI) Study Area.

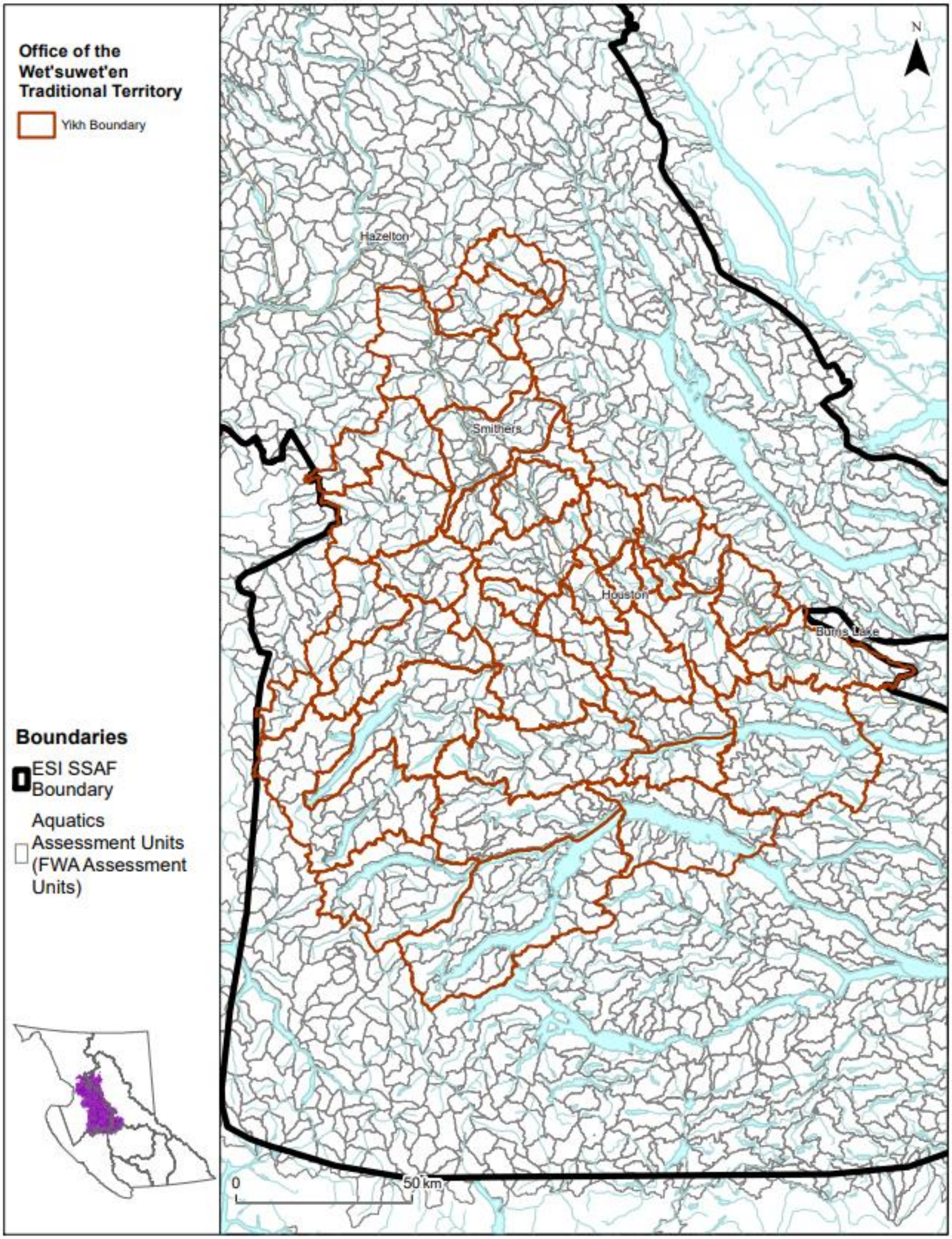


Figure A2-10. Wet'suwet'en Traditional Territory (Yikh boundaries) within the Skeena Environmental Sustainability Initiative (ESI) Study Area.

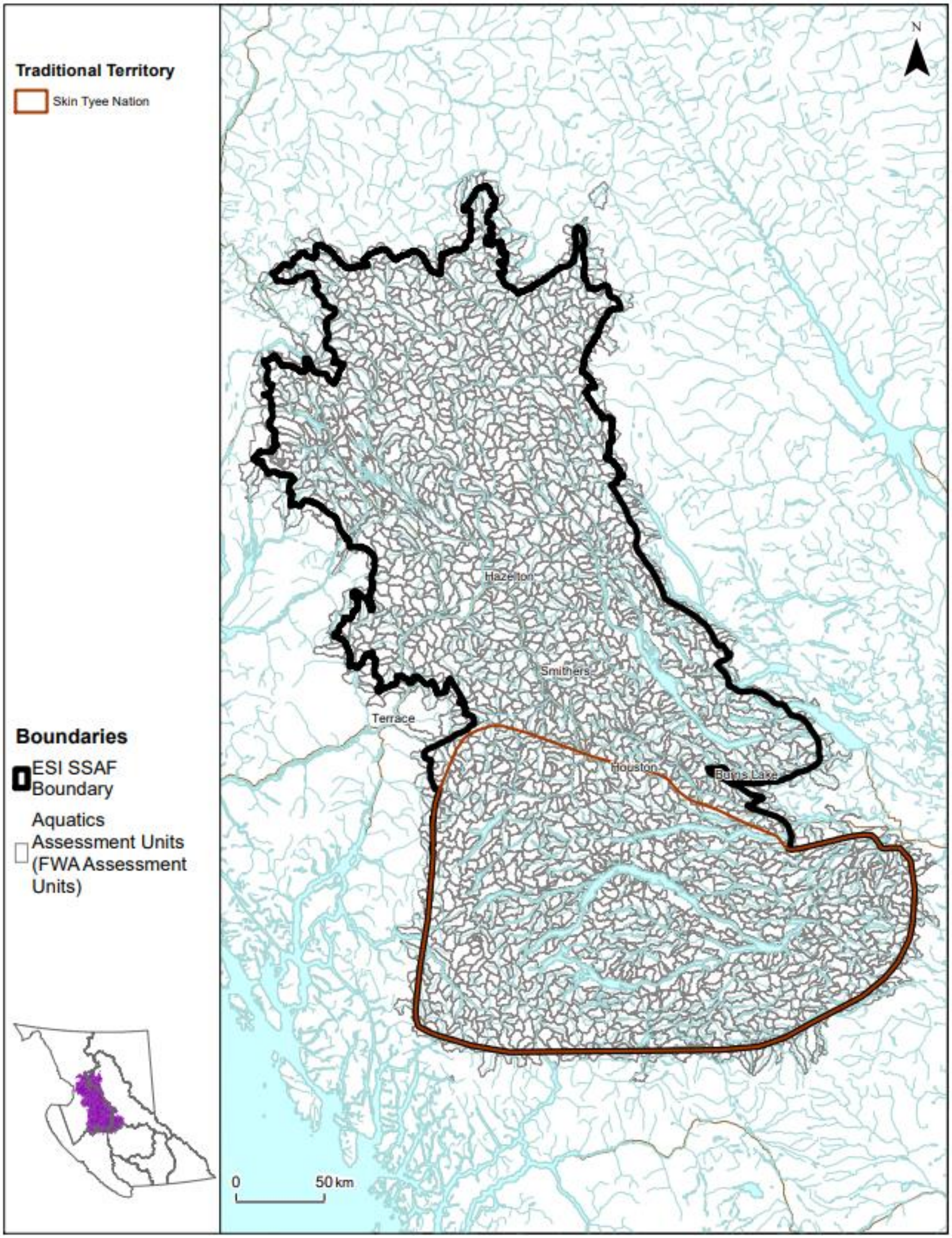


Figure A2-11. Skin Tyee Traditional Territory (Skin Tyee Nation) within the Skeena Environmental Sustainability Initiative (ESI) Study Area.

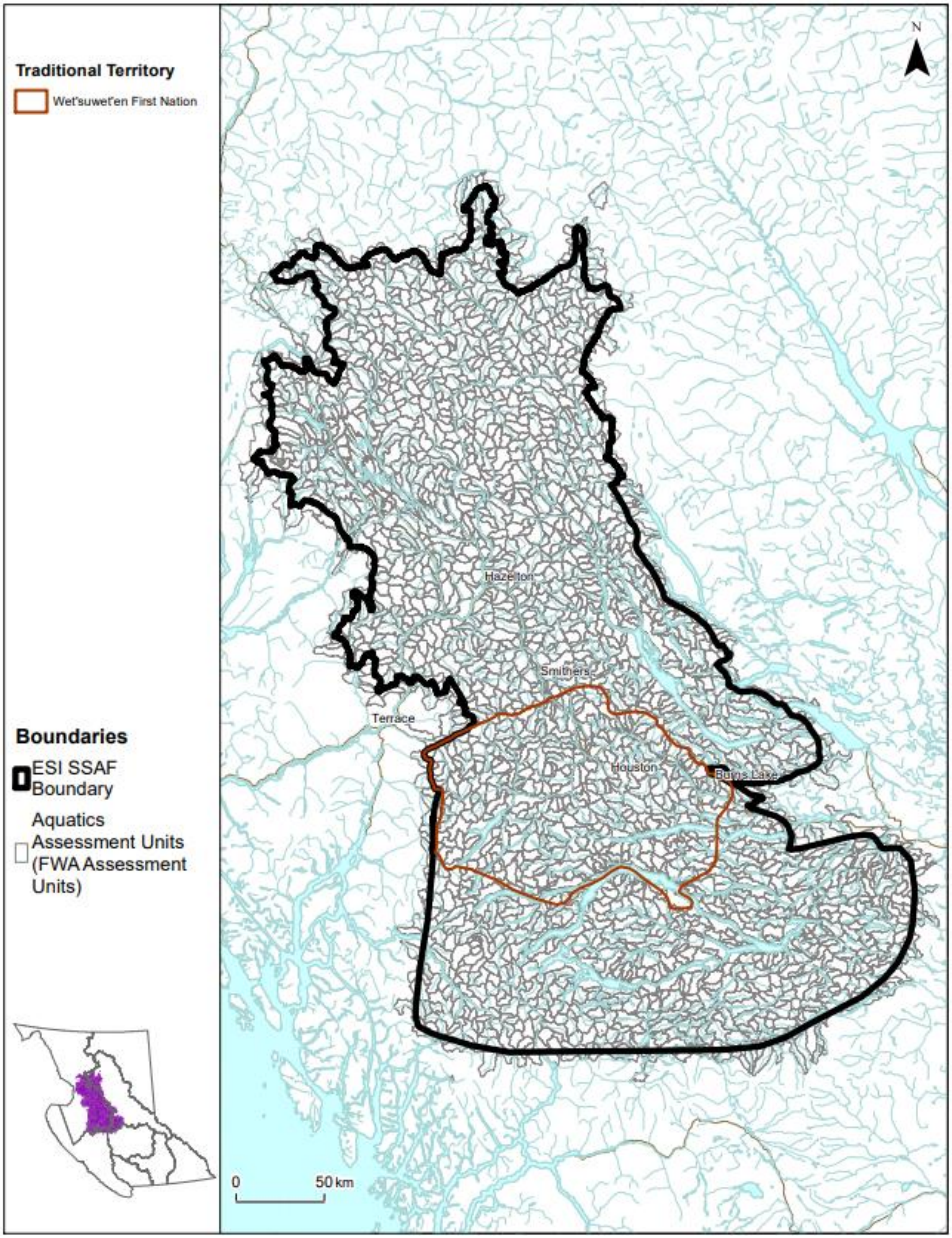


Figure A2-12. Wet'suwet'en Traditional Territory (Wet'suwet'en First Nation) within the Skeena Environmental Sustainability Initiative (ESI) Study Area.

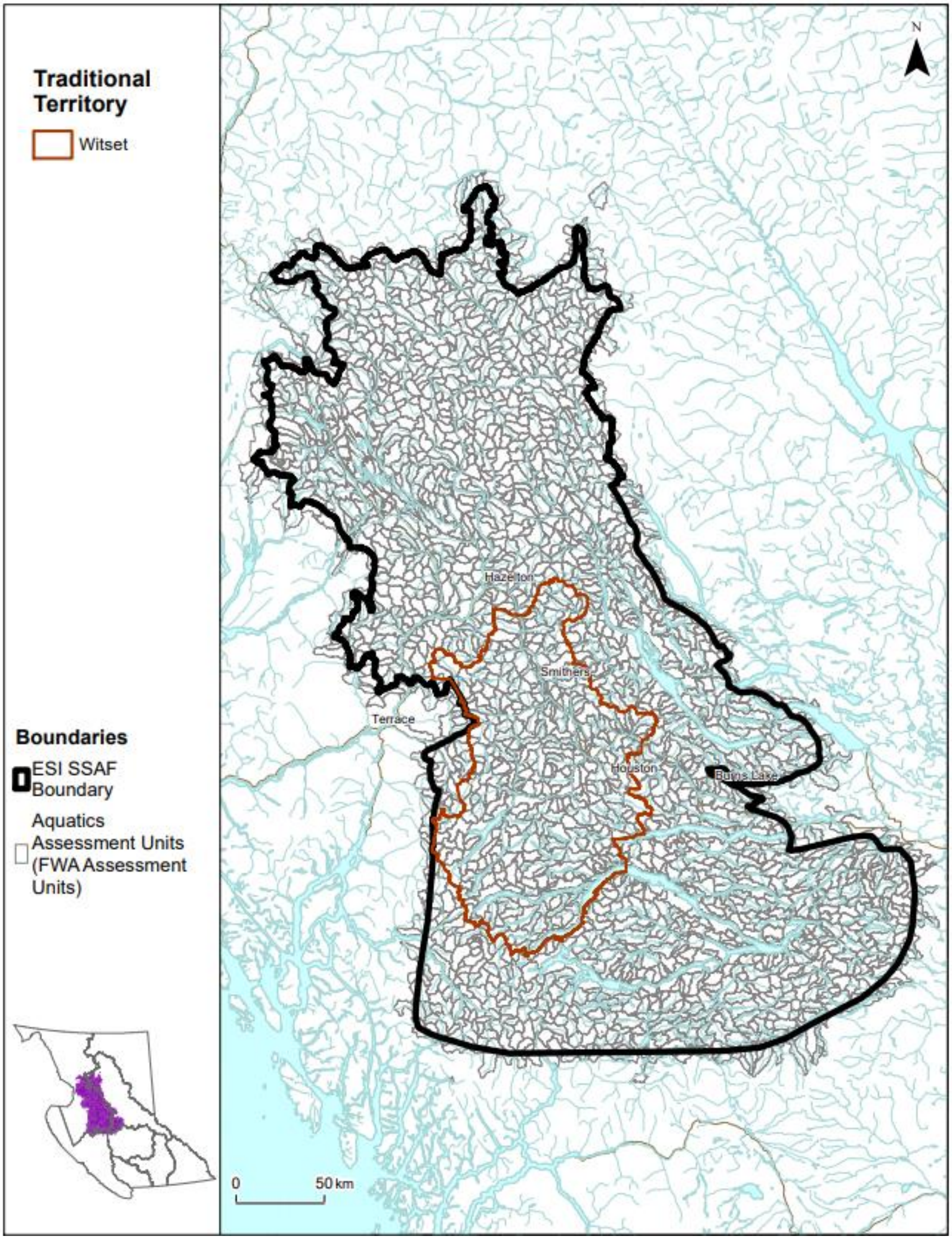


Figure A2-13. Witset Traditional Territory (Witset) within the Skeena Environmental Sustainability Initiative (ESI) Study Area.

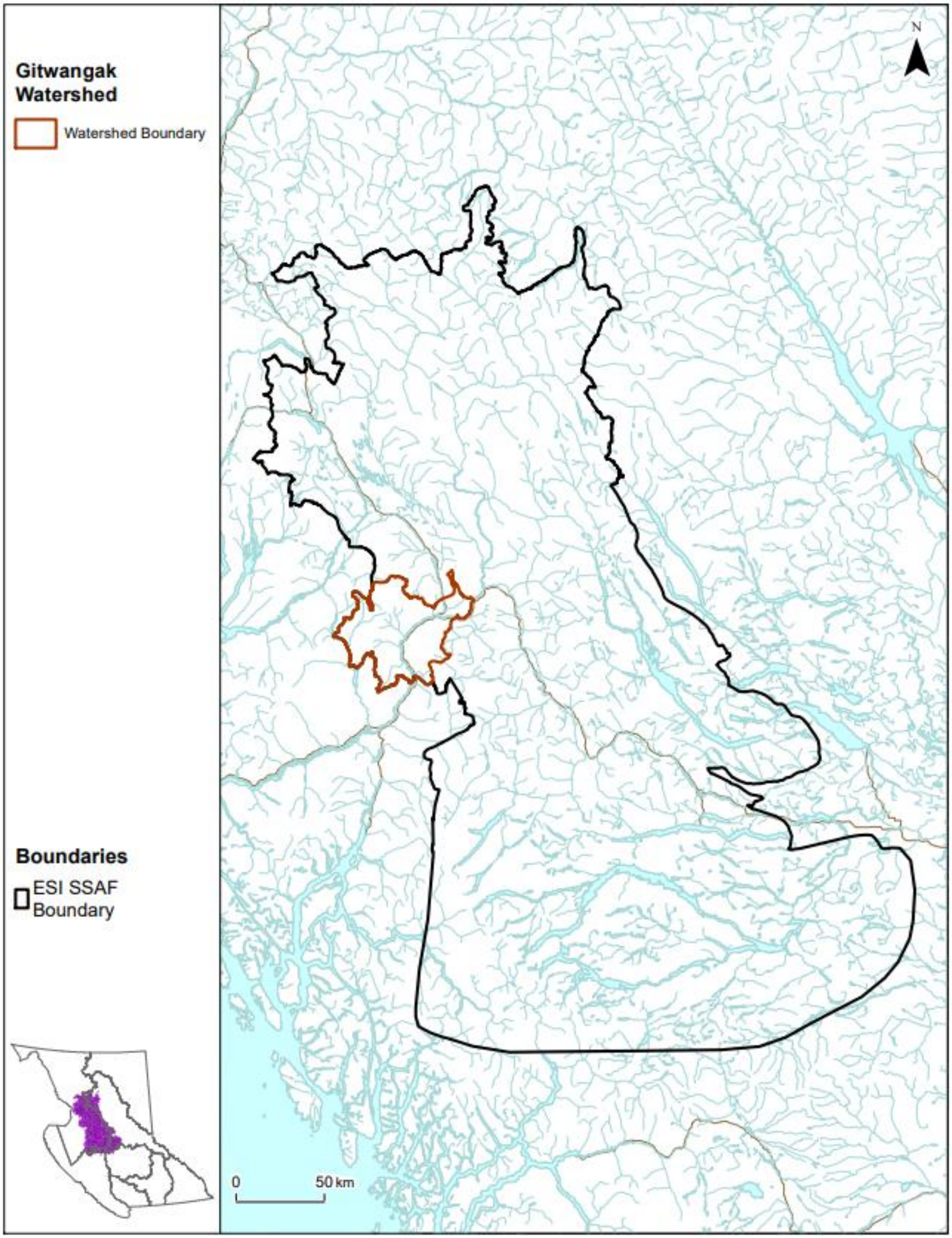


Figure A2-14. Gitwangak Traditional Territory (Gitwangak watershed boundary) within the Skeena Environmental Sustainability Initiative (ESI) Study Area.

Appendix 2—Freshwater fish species present in the major drainages of the SSAF Study Area.

Fish species designations/occurrences are from McPhail and Carveth 1993. Blue/red designations with species names indicate fish species that are designated by the B.C. Conservation Data Centre (CDC) as being Endangered (Red) or of Special Concern (Blue).

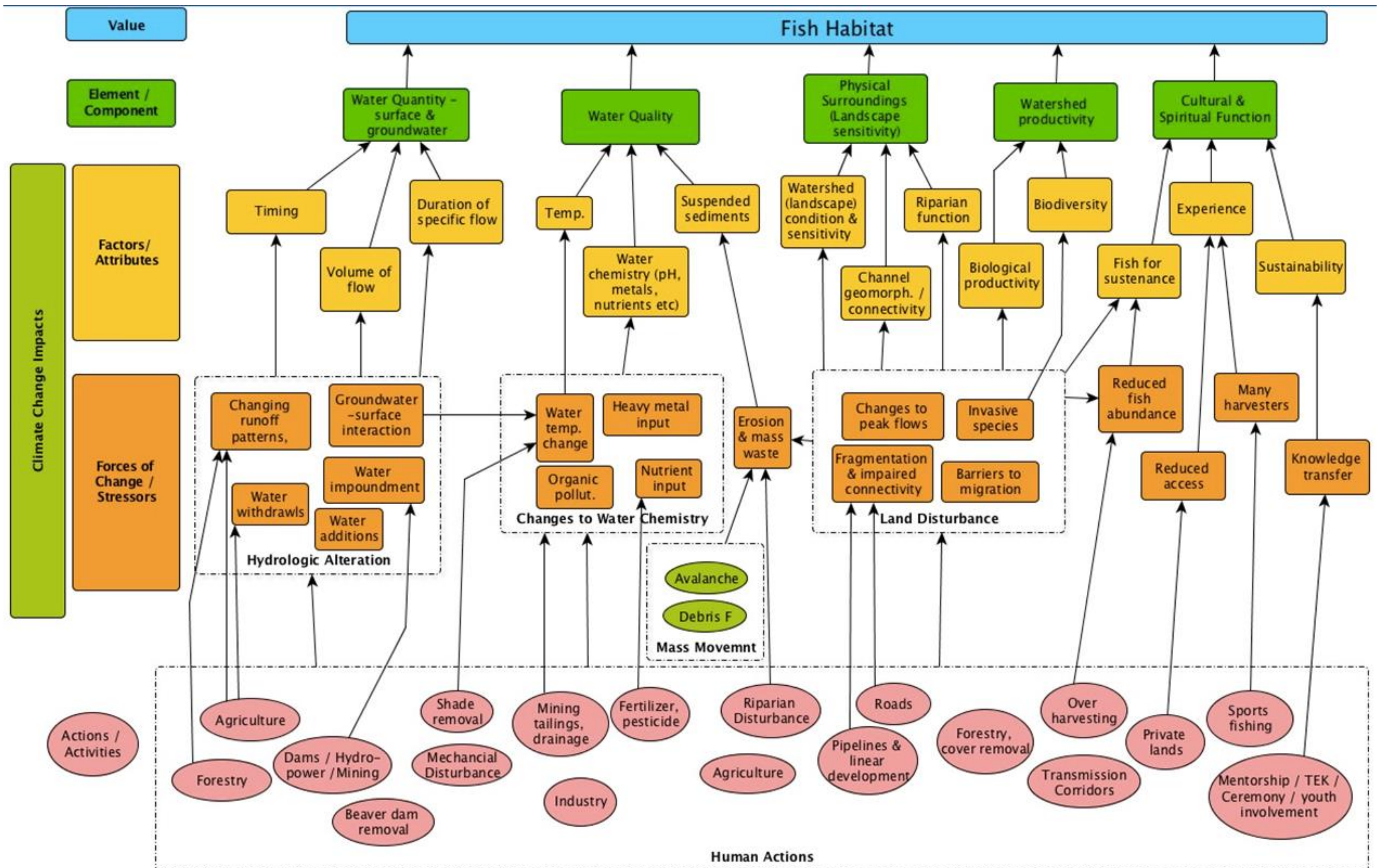
Fish Species	Common Name	Skeena	Nass	Nechako (upper Fraser)
Lampetra ayresi	River lamprey	+	?	-
L. richardsoni	Brook lamprey	+	?	-
L. tridentata	Pacific lamprey	+	+	-
*Acipenser medirostris*Red	Green sturgeon	+	+	-
*A. transmontanus*Red	White sturgeon	?	?	+
Alosa sapidissima	American shad	I	I	-
Couesius plumbeus	Lake chub	+	+	+
Mylocheilus caurinus	Peamouth chub	+	+	+
Ptychocheilus oregonesis	Northern pike-minnow	+	+	+
Rhinichthys cataractae	Longnose dace	+	-	+
Richardsonius balteatus	Redside shiner	+	+	+
Catostomus catostomus	Longnose sucker	+	+	+
C. commersoni	White sucker	+	-	-
C. macrocheilus	Largescale sucker	+	+	+
Osmerus dentex	Pacific rainbow smelt	?	?	-
Spirinchus thaleichthys	Longfin smelt	+	?	-
*Thaleichthys pacificus*Blue	Eulachon	+	+	-
O. gorbuscha	Pink salmon	+	+	-
O. keta	Chum salmon	+	+	-

O. kisutch	Coho salmon	+	+	-
O. nerka	Sockeye salmon	+	+	+
O. tshawytscha	Chinook salmon	+	+	+
Oncorhynchus clarki clarki[Blue]	Cuthroat trout	+	+	+
O. mykiss	Rainbow trout	+	+	+
Salvelinus confluentus[Blue]	Bull trout	+	+	-
S. malma	Dolly Varden	+	+	-
S. namaycush	Lake trout	+	-	+
Coregonus clupeaformis	Lake whitefish	+	-	+
Prosopium coulteri	Pygmy whitefish	+	-	+
P. williamsoni	Mountain whitefish	+	+	+
Lota lota	Burbot	+	+	+
Gastersteus aculeatus	Threespine stickleback	+	+	-
Cottus aleuticus	Coastrange sculpin	+	+	-
C. asper	Prickly sculpin	+	+	-
C. cognathus	Slimy sculpin	-	-	+

+ = present; - = absent; **I** = introduced; **?** = uncertain record

Appendix 3—Conceptual Model for Assessing Fish Habitat

Skeena Environmental Stewardship Initiative (ESI) conceptual model for the Fish Habitat value (Figure source: SSAF Scientific and Technical Committee (STC)). This diagram illustrates the various interlinked functions and processes that ultimately affect the condition of fish habitats in the SSAF Study Area



Appendix 4 – Data Dictionary and GIS Appendices

4.1 - Indicator Summary

Indicator	Formula	Threshold	Data Source	Measurement	Methodology	Watershed Site Selection	Notes_References
Road density	Total length of roads (km) / total (or net) watershed area (km2)	***0.4, 1.2 (PSF)***	Best available road network. BC Cumulative Effects Aquatic Ecosystems Current Condition Assessment. From BC Consolidated Roads: DRA, FTEN, OGC, RESULTS in-block roads BC Wildfire Service: Machine and hand line fire guards.	Total length of roads / total watershed area. Fire guards may be included where available. Weighted road length is used for the Water Quality component. See tab 'meta Road Guard Weighting'. Additional measures: Total road length Total length of roads / net watershed area (excluding large lakes, water, glaciers/ice.)	road length / watershed area -> Rd_Density (Rd_Density_net)	Risk Number Associated with Rd Dens thresholds) w/ 0 = Low Risk, 1 = Moderate, and 2 = High When totalled with all three features a risk class between 0-6 is created. Watersheds with a score of 0 are considered pristine. With scores of 6 are considered very high risk. Both these watersheds are put into the random draw.	Aquatic_Protocol_Appendix_GIS_Indicators_Inputs_DataDict_2018_20200810_DRAFT

ECA	ECA / total watershed area (%) Revised Hydrologic Recovery Curves: Interior 100*(1-EXP(-0.24*(Tree Height-2)))^2.909 with 100% recovery at > 19m Coastal 100*(1-EXP(-0.1*(Tree Height-2.1)))^1.45 with 100% recovery at > 36m Note that Interior/Coastal classificatio	***15, 20 (PSF)***	VRI updated with additional harvesting from FAIB Consolidated cutblocks and RESULTS (including height info if available) Private Land (FOWN) Human Development layers (various) Ecological Aquatic Units of BC (EAUBC) Watershed Classification (Interior vs Coastal)	ECA / total watershed (%) ECA is based on forest stand height and additional disturbance assumptions for harvest, fire, MPB, and human disturbance. ie. Human development considered as 100% ECA. See Feature Criteria column for details. ECA Criteria Updated June 2017: •Restricted ECA calculation to harvested or 'disturbed' areas only (see 'feature criteria' column). • Revised hydrologic recovery curve formulas for interior vs coastal areas.	ECA_Final_PCNT	Risk Number Associated with ECA thresholds) w/ 0 = Low Risk, 1 = Moderate, and 2 = High When totalled with all three features a risk class between 0-6 is created. Watersheds with a score of 0 are considered pristine. With scores of 6 are considered very high risk. Both these watersheds are put into the random draw.	Aquatic_Protocol_Appendix_GIS_Indicators_Inputs_DataDict_2018_20200810_DRAFT

	n is based on EAUBC watershed class. Proportion of ECA in Watershed: km2/total watershed (%) Where >50% of watershed has VRI Unreported (e.g. TFL), ECA is recorded as 9999 (insufficien t data)			May 2020: • incorporated Fire Severity and fire impacts. For fires without Severity, and where there is no updated VRI information, height is estimated based on Site Tools. Site Tools inputs are: estimated age since disturbance, leading species, and site index. This estimated height is then plugged in to the recovery curve formula to calculate ECA. For fires with severity a general ECA factor is used, see 'feature criteria' column. • For recent cutblocks not yet in VRI, Site Tools is also used to estimate height and ECA recovery, as per fires above. • For fires or harvest			

				areas where the regen understory may not yet be represented in VRI, this may appear in VRI as old scattered trees with low canopy cover, but where there is more recent disturbance. These areas are treated similarly to fires and harvest above - i.e. it is assumed the regen is not fully inventoried in VRI yet and Site Tools is used to estimate height for the recovery curve. • For firest, harvest, or scattered vets where there is no species or site index, a general age since disturbance factor is used to calculate ECA. • For Mountain Pine Beetle effected areas, an additional ECA factor is calculated			

				based on time since attack, proportion of stand dead, and BEC moisture class. This MPB factor is additive with the height or age based ECA, where there is no salvage/harvest or fire post MPB attack. See 'feature criteria' column for more details.			
Dams and impoundments	# / assessment watershed	No, Yes	Dam Lines WHSE_WATER_MANAGEMENT.WRIS_DAMS_PUBLIC_SVW		Dam_Lines_Count		Aquatic_Protocol_Appendix_GIS_Indicators_Inputs_DataDict_2018_20200810_DRAFT
# of water licenses	# / assessment watershed	No, Yes	Points of Diversion WHSE_WATER_MANAGEMENT.WLS_POD_LICENCE_SP		POD_Count		Aquatic_Protocol_Appendix_GIS_Indicators_Inputs_DataDict_2018_20200810_DRAFT
Road/stream crossing density	Total number of road/stream crossings	***Interior: 0.16, 0.32 Coastal: 0.4, 0.8***	BC Consolidated Roads (as above) FWA stream network Ecological Aquatic	Total number of road/stream crossings divided by watershed area.	RdsStrmXing_Density		Aquatic_Protocol_Appendix_GIS_Indicators_Inputs_DataDict_

	divided by total (or net) watershed area	***(CEF 2015)***	Units of BC (EAUBC) Ecoregions used for delineation of coastal vs interior.	Also reported per net watershed area (excluding large lakes, water, glaciers/ice.)	(RdsStrmXing_ Density_net)		2018_20200810_DR AFT
Riparian disturbance	% of total stream length within 30m of total human (current and historical) and natural (fire and insect) disturbance (km)	***5, 15 (PSF)***	BC Cumulative Effects Aquatic Ecosystems Current Condition Assessment + Riparian Disturbance Insect and Fire Data Add in. Human Disturbance Current (within 20yrs): Rail, transmission, major rights of way, harvesting, mining, oil&gas, seismic, agriculture, and urban activity. Historic Harvesting (pre 1995): FAIB Consolidated cutblocks and BTM RESULTS Reserves >90 yrs: does not include	Total Disturbance includes: Human disturbance within 20 years (rail, transmission, major rights of way, harvesting, mining, oil&gas, seismic, agriculture, and urban activity) Historical Logging (pre 20 years). Road and Fire Guard Buffers. Fire < 60 years old Insect Disturbance Reserves < 90 years old Additional measures: Total Stream Length. Disturbances may overlap, so stream	Rip_Tot_All_D strb_PCNT	Risk Number Associated with Riparian Disturbance thresholds) w/ 0 = Low Risk, 1 = Moderate, and 2 = High When totalled with all three features a risk class between 0-6 is created. Watersheds with a score of 0 are considered pristine. With scores of 6 are considered very high risk. Both these watersheds	Rip Dist - Add Fire and Insect for more.

			Dispersed (D) reserves or Non reserves (SILV_RESERVE_CODE = 'D' or 'N'). Includes natural areas of lake, meadow,rock or swamp (STOCKING_STATUS_CODE in ('L', 'M', 'R', 'S'). Select for Age >90, either in RESULTs age, or VRI age (if age not in RESULTS).	lengths were also reported separately by: Current (within 20yrs) disturbance Historic harvesting		are put into the random draw.	
Road density near streams	Total length of roads within 100 m of a stream (each side), divided by the total (or net) watershed area.	***0.08, 0.16 (CEF 2015)***	BC Consolidated Roads (as above) FWA stream network Ecological Aquatic Units of BC (EAUBC) Ecoregions used for delineation of coastal vs interior.	Total length of roads within 100 m of a stream (each side), divided by the total watershed area. Weighted road length is used for the Water Quality component. See tab 'meta Road Guard Weighting'. Additional measure: Total length of roads	RdsStrmBuff100_Density (RdsStrmBuff100_Density_net)		Aquatic_Protocol_Appendix_GIS_Indicators_Inputs_DataDict_2018_20200810_DRAFT

				within 100m of stream / net watershed area (excluding large lakes, water, glaciers/ice.)			
Roads on unstable slope	Total length of roads found on steep slopes, divided by the total (or net) watershed area.	***0.06, 0.12 (CEF 2015)***	BC Consolidated Roads (as above) DEM	Total length of roads found on steep slopes, divided by the total watershed area. Steep Slope = >60%	RdSteepSlopes_Density (RdSteepSlopes_Density_net)		Aquatic_Protocol_Appendix_GIS_Indicators_Inputs_DataDict_2018_20200810_DRAFT
# mines	# / assessment watershed	No, Yes	MinFile Points WHSE_MINERAL_TENURE.MINFIL_MINERAL_FILE		Mine_Points_Count		Aquatic_Protocol_Appendix_GIS_Indicators_Inputs_DataDict_2018_20200810_DRAFT

# of point source pollution	# / assessment watershed	Binning Rather than threshold (No scientific research) 0,1,2,3-4,5-10,>10	BC Cumulative Effects Aquatic Ecosystems Current Condition Assessment; WHSE_MINERAL_TENURE.MMS_NOTICE_OF_WORK (2018-11-29); WHSE_WASTE.SITE_ENV_RMDTN_SITES_SVW (2019-04-12); WHSE_MINERAL_TENURE.MTA_ACQUIRED_TENURE_GOV_SVW (2018-11-29); WHSE_BASEMAPPING.FWA_STREAM_NETWORKS_SP		WWDischarge_Count + (Count of NoticeOfWork Mines) + (Count of Remediation Sites) + (Count of (MineralTenures_181129 WHERE TENURE_TYPE_DESCRIPTION = 'Placer') intersected with (FWA Streams WHERE EDGE_TYPE IN (1000, 1050, 1100, 1150, 1250, 2000, 2300)))		Aquatic_Protocol_Appendix_GIS_Indicators_Inputs_DataDict_2018_20200810_DRAFT; https://catalogue.data.gov.bc.ca/dataset/notice-of-work-now-spatial-locations; https://catalogue.data.gov.bc.ca/dataset/environmental-remediation-sites; https://catalogue.data.gov.bc.ca/dataset/mta-mineral-placer-and-coal-tenure-gov-svw; https://catalogue.data.gov.bc.ca/dataset/freshwater-atlas-stream-network

Total land disturbance	Footprint of the disturbed area or land type / total watershed area (%).	Binning rather than thresholds (No scientific research) 25, 75	Custom 'Development' data from various sources, including Tantalis, OGC, and BTM (Baseline Thematic Mapping), FAIB Consolidated Cutblocks Fire perimeters - current and historic (Wildfire Management Branch) VRI (for insect disturbance)	footprint of the disturbed area or land type / total watershed. Disturbance types are reported separately, as well as grouped into disturbance categories. Human disturbance/land use/land cover is reported for 100% of the watershed assessment unit (ie. with no overlaps.) Where there are overlapping activities, a hierarchy is applied where certain activities take precedence. See 'Feature criteria' column. Reporting by: Unique disturbance/Land cover type	AU_TOT_Disturb_all_PCNT		Aquatic_Protocol_Appendix_GIS_Indicators_Inputs_DataDict_2018_20200810_DRAFT

				Current Human Disturbance (within 20 yrs) Historic Harvesting (pre 20 years) Total human disturbed (current and historic) Total Fire Total Insect Total Fire and Insect (no double accounting) Net Fire and Insect (not covered by human disturbance) Total Non-Disturbed (not effected by human or natural disturbance)			
Drainage Density Ruggednes s	Stream density as a function of relief (km of streams / km2 of reporting unit) *(reporting	2000, 4000	WHSE_BASEMAPPING. FWA_STREAM_NETWO RKS_SP Relief (max elevation - min elevation in the unit) derived from TRIM DEM (25m)		DDR_Score		Aquatic_Protocol_Ap pendix_GIS_Indicato rs_Inputs_DataDict_ 2018_20200810_DR AFT

	unit relief m)						
Extent of lakes and wetlands	Total area of lakes, wetlands, and man-made reservoirs and canals (ha) / assessment watershed	Binning rather than thresholds (No scientific research)	WHSE_BASEMAPPING.FWA_LAKES_POLY; WHSE_BASEMAPPING.FWA_MANMADE_WATERBODIES_POLY; Skeena ESI Consolidated Wetlands (2019-06-25)		Area of FWA Lakes + Area of FWA Manmade waterbodies WHERE FEATURE_CODE LIKE 'GB%' OR FEATURE_CODE LIKE 'GA%' + Area of Wetlands		https://catalogue.data.gov.bc.ca/dataset/freshwater-atlas-lakes; https://catalogue.data.gov.bc.ca/dataset/freshwater-atlas-manmade-waterbodies; Skeena ESI Consolidated Wetlands generated from VRI and FWA Wetlands.
Low flow sensitivity	% of watershed area in summer sensitive region	Binning Rather than threshold (No scientific research) 0,0-5,5-25,25-50,>50	BC MOE ecoregional flow sensitivity (2012-02-08)		Intersect assessment watershed with ecoregional flow sensitivity polygons to calculate percent of watershed area within		

					summer sensitive regions.		
	% of watershed area in winter sensitive region	Binning Rather than threshold (No scientific research) 0,0-5,5-25,25-50,>50	BC MOE ecoregional flow sensitivity (2012-02-08)		Intersect assessment watershed with ecoregional flow sensitivity polygons to calculate percent of watershed area within winter sensitive regions.		
Salmonid habitat extent	Total length of modelled potential fish habitat (km) / assessment watershed	Binning Rather than threshold (No scientific research) <50, 50-100, 100-150, 150-200, >200	WHSE_BASEMAPPING.FWA_STREAM_NETWORKS_SP Relief (max elevation - min elevation in the unit) derived from TRIM DEM (25m)	fa	Sum length of modelled_habitat_potential WHERE fish_habitat <> 'NON FISH HABITAT' for each assessment watershed		

Extent of known salmon spawning habitat	Total length of spawning zones by salmon species (km) / assessment watershed	Binning Rather than threshold (No scientific research) 0,<5,5-10,10-20,>20	Skeena spawning layers from PSF data library (downloaded 2019-07-21); WHSE_FISH.FISS_HIST_FISH_DST_LIN_PUB_SVW		PSF spawning data doesn't cover the whole ESI area so we need to supplement with FISS (which is already represented in the PSF data); to avoid double counting we needed to exclude FISS data in the watersheds already covered by the PSF data, i.e. any watershed codes beginning with 400-. Skeena spawning layers from PSF data		Lake Sockeye: https://data.salmonwatersheds.ca/data-library/ResultDetails.aspx?id=57 https://data.salmonwatersheds.ca/data-library/ResultDetails.aspx?id=56 (mainstem) https://data.salmonwatersheds.ca/data-library/ResultDetails.aspx?id=58 (tribs) River Sockeye: https://data.salmonwatersheds.ca/data-library/ResultDetails.aspx?id=55 Chinook: https://data.salmonwatersheds.ca/data-library/ResultDetails.aspx?id=50 Coho: https://data.salmonwatersheds.ca/data-library/ResultDetails.aspx?id=52 Chum:

					library combined with spawning from FISS Historical Fish Distribution Zones outside the Skeena basin: FISS WHERE ACTIVITY IN ('Major spawning location', 'Spawning in estuary', 'Spawning location') AND SPECIES_NAME IN ('Chinook Salmon', 'Chum Salmon', 'Coho Salmon', 'Pink Salmon', 'Sockeye Salmon') AND NEW_WATERSHED_CODE NOT LIKE '4%'		https://data.salmonwatersheds.ca/data-library/ResultDetails.aspx?id=51 Pink (even): https://data.salmonwatersheds.ca/data-library/ResultDetails.aspx?id=53 Pink (odd): https://data.salmonwatersheds.ca/data-library/ResultDetails.aspx?id=54 https://catalogue.data.gov.bc.ca/dataset/bc-historical-fish-distribution-zones-50-000

					Sum length (km) of spawning for each species (Coho, Chinook, Chum, Sockeye, Pink) within each FWA watershed.		
	Total length of all spawning zones for all salmon species (km) / assessment watershed	Binning Rather than threshold (No scientific research) 0,<5,5-10,10-20,>20	Skeena spawning layers from PSF data library; WHSE_FISH.FISS_HIST_FISH_DST_LIN_PUB_SVW		As above, sum length of spawning for each species within each assessment watershed.		Where multiple species use the same stream reach for spawning, the length of this stream will be counted multiple times.
Water allocation restrictions	Proportion of streams in assessment watershed under	Binning Rather than threshold (No	WHSE_WATER_MANAGEMENT.WLS_STREAM_RESTRICTIONS_SP; WHSE_BASEMAPPING.FWA_STREAM_NETWORKS_SP		Sum length of water allocation restriction streams divided by		https://catalogue.data.gov.bc.ca/dataset/streams-with-water-allocation-restrictions; https://catalogue.da

	water allocation restrictions (%)	scientific research)			sum of total length of FWA Streams		ta.gov.bc.ca/dataset/freshwater-atlas-stream-network
	# / assessment watershed	No, Yes	WHSE_WATER_MANAGEMENT.WLS_WATER_RESTRICTION_LOC_SVW		Count of water allocation restriction points within each assessment watershed.		https://catalogue.data.gov.bc.ca/dataset/water-allocation-restrictions-view
# of groundwater wells	# / assessment watershed	No, Yes	WHSE_WATER_MANAGEMENT.GW_WATER_WELLS_WRBC_SVW		Count of groundwater wells within each assessment watershed.		https://catalogue.data.gov.bc.ca/dataset/ground-water-wells
% of second growth	Total area of second growth forest / total (or net) watershed area (%)	15, 20 Taking from ECA not sure if that's appropriate	WHSE_FOREST_VEGETATION.VEG_COMP_LYR_R1_POLY		Sum VRI area WHERE PROJ_AGE_1 < 80 divided by total (or net - excluding BTM water/glacier/snow)		https://catalogue.data.gov.bc.ca/dataset/vri-forest-vegetation-composite-polygons-and-rank-1-layer

					watershed area.		
Salmon Escapement by Species (Both Indicators captured in a Single Map)	Proportional Change Over time (Earliest Average vs Most Recent Average) Stream ID linked to Assessment Watershed	Binning Rather than threshold (No scientific research) Insufficient, <-50, 0 to -50, 0 to 100, >100	NuSEDS Escapement Data - skeena_streamsurveydata_20191024 and nass_streamsurveydata_20190927.xlsx		Port_Chg Field (The proportional change from the first ten year average to most recent ten year average(Difference/Fst_10_Avg)*100)		Survey Stream Spatial Data: https://data.salmonwatersheds.ca/data-library/ResultDetails.aspx?id=114 NUSEDs Escapement Stream Data from PSF
	Most Recent Ten Year Avg Stream ID linked to Assessment Watershed	Binning Rather than threshold (No scientific research) <100, 100-1000, 1000-2000, 2000-	NuSEDS Escapement Data - skeena_streamsurveydata_20191024 and nass_streamsurveydata_20190927.xlsx **See Salmon Escapement Script and the python script**		Lst_10_Avg (The average of the most recent 10 years of assessments)		Survey Stream Spatial Data: https://data.salmonwatersheds.ca/data-library/ResultDetails.aspx?id=114 NUSEDs Escapement Stream Data from PSF

		5000, >5000					

4.2 - Citations

Threshold reference	Full citation for inclusion in report
CEF 2015	Interim Assessment Protocol for Aquatic Ecosystems in British Columbia. Version 1.1 (Oct 2016). Prepared by the Provincial Aquatic Ecosystems Technical Working Group – Ministries of Environment and Forests, Lands and Natural Resource Operations – for the Value Foundation Steering Committee. 19 p.
PSF	Porter, M., D. Pickard, S. Casley, N. Ochoski, K. Bryan and S. Huang. 2013. Skeena lake sockeye Conservation Units: habitat report cards. Report prepared by ESSA Technologies Ltd. for the Pacific Salmon Foundation. Porter, M., D. Pickard, S. Casley, and N. Ochoski. 2014. Skeena Salmon Conservation Units Habitat Report Cards: Chinook, coho, pink, chum, and river sockeye. Report prepared by ESSA Technologies Ltd. for the Pacific Salmon Foundation.
Wild Salmon Policy	Fisheries and Oceans Canada (DFO). 2005. Canada's Policy for Conservation of Wild Pacific Salmon. Fisheries and Oceans Canada, Vancouver, BC.

4.3 – Output Field Descriptions

Geodatabase	Dataset Name	Field Name	Description	Relevant Indicator
SSAF_ESI_T1_FFH.gdb	SSAF_CEF_FFH_2018_200428_200903	WATERSHED_FEATURE_ID	FWA Assessment Watershed Unique ID. Used as the Cumulative Effects Assessment Unit identifier.	
		ASSESSMENT_TARGET_YEAR	The year or vintage when the assessment analysis was initiated and for which the results represent.	
		ASSESSMENT_UNIT_PROCESSED_DATE	The date when the assessment analysis was run for this assessment unit.	
		Coastal_Interior	Classification of AU into Coastal vs Interior. Based on max overlap with Ecological Aquatic Units of British Columbia (EAU BC) Freshwater Ecoregion	
		AU_Area_ha	Assessment Unit Total Area ha	
		AU_Area_ha_noIceWater	AU Area ha - excluding BTM Fresh Water, Salt Water, Glaciers and Snow	
		Rd_Density	Road Density per total AU - km/km2	Road density
		Dam_Lines_Count	count of Dam Inventory Lines by Dam File Number	Dams and impoundments

		POD_Count	count of all Points of Diversion by TPOD_TAG	# of water licenses
		RdsStrmXing_Density	Density of road-stream intersections (#/total AU km2)	Road/stream crossing density
		RdsStrmBuff100_Density	Density of roads within 100m of streams (km/total AU km2)	Road density near streams
		RdSteepSlopes_Density	Density of roads on steep slopes (km/total AU km2). Steep is defined as >50% for Haida Gwaii, and >60% for the remainder of the province.	Roads on unstable slope
		Mine_Points_Count	count of MinFile points by Mineral File Number	# mines
		AU_TOT_Disturb_all_PCNT	% of AU that has been effectected by human, fire, or insect disturbance (hectares)	Total land disturbance
		NoW_Mines_Count	Count of Notice of Work mine points. Component of final	# of point source pollution
		Placer_Stream_Count	Count of intersection points between placer mineral tenures and FWA streams.	# of point source pollution
		WWDischarge_Count	count of Waste Water Discharge points by Authorization Number	# of point source pollution
		Rd_Density_net	Road Density per net AU (excluding BTM water/glacier/snow) - km/km2	Road density

		RdsStrmXing_Density_net	Density of road-stream intersections (#/net AU km2)	Road/stream crossing density
		RdsStrmBuff100_Density_net	Density of roads within 100m of streams (km/net AU km2)	Road density near streams
		RdSteepSlopes_Density_net	Density of roads on steep slopes (km/net AU km2). Steep is defined as >50% for Haida Gwaii, and >60% for the remainder of the province.	Roads on unstable slope
		ECA_Final_PCNT	ECA Percent of AU, but indicated as 9999 where >50% of AU has VRI unreported.	ECA
		Rip_Tot_Human_Dstrb_StrmKM_PCNT	% of total stream length within 30m of total human (current and historical)	Riparian disturbance - See other Fire and Insect dataset for included Rip Dist
		MinElev	Minimum Watershed Elevation	
		MaxElev	Maximum Watershed Elevation	
		Elev_Relief	Difference between Min and Max Elevation	
		DDR_Score	Drainage Density Ruggedness - stream density as a function of relief (km of streams / km2 of reporting unit) *(reporting unit relief m)	Drainage Density Ruggedness

	SSAF_ESI_T1_FFH _NoCEF_wEscpmt _Link_TerrOvlp_C ABIN_20200507	WATERSHED_FEATURE_ID	FWA Assessment Watershed Unique ID. Used as the Cumulative Effects Assessment Unit identifier.	
		NoW_Mines_Count	Count of Notice of Work mine points. Component of final	# of point source pollution
		Placer_Stream_Count	Count of intersection points between placer mineral tenures and FWA streams.	# of point source pollution
		AddRemediation_Sites_Count	Count of additional remediation sites.	# of point source pollution
		WWDischarge_Count	count of Waste Water Discharge points by Authorization Number	# of point source pollution
		Pnt_Src_Plltn_Final_Count	Total count of all contributing point source pollution counts	# of point source pollution
		Lakes_Wetlands_HA	Total area of lakes, wetlands, and man-made reservoirs and canals (hectares).	Extent of lakes and wetlands
		Lakes_Wetlands_PCNT	Proportion of lakes, wetlands, and man-made reservoirs and canals in the AU.	Extent of lakes and wetlands
		Summer_Sens_PCNT	Proportion of AU in summer low flow sensitive region.	Low flow sensitivity
		Winter_Sens_PCNT	Proportion of AU in winter low flow sensitive region.	Low flow sensitivity
		Salmonid_hab_KM	Total length (km) of modelled potential fish habitat.	Salmonid habitat extent

		Spawning_CK_KM	Length (km) of Chinook salmon spawning habitat.	Extent of known salmon spawning habitat
		Spawning_CH_KM	Length (km) of Chum salmon spawning habitat.	Extent of known salmon spawning habitat
		Spawning_CO_KM	Length (km) of Coho salmon spawning habitat.	Extent of known salmon spawning habitat
		Spawning_PK_KM	Length (km) of Pink salmon spawning habitat.	Extent of known salmon spawning habitat
		Spawning_SE_KM	Length (km) of Sockeye salmon spawning habitat.	Extent of known salmon spawning habitat
		Spawning_Total_KM	Total combined length (km) of all salmon spawning habitat across all species.	Extent of known salmon spawning habitat
		Wtr_Allctn_Rstrctns_KM	Length (km) of streams that have water licence restrictions.	Water allocation restrictions
		Wtr_Allctn_Rstrctns_PCNT	Proportion of streams in the AU that have water licence restrictions.	Water allocation restrictions
		Wtr_Allctn_Rstrctns_Count	Count of water allocation restrictions in the AU	Water allocation restrictions
		GW_Wells_Count	Count of groundwater wells.	# of groundwater wells
		Second_Growth_HA	Area (ha) of second growth forest (< 80 yrs old) in AU	% of second growth

		Second_Growth_PCNT	Proportion of AU that is second growth forest (< 80 yrs old).	% of second growth
		Second_Growth_PCNT_net	Proportion of net AU (excluding BTM water/glacier/snow) that is second growth forest (< 80 yrs old).	% of second growth
		sys_nm	System Name - Name of the River System	Salmon Escapement
		CUID	System Name ID	Salmon Escapement
		geofeatid	Specific Feature ID	Salmon Escapement
		streamid	Specific Stream ID	Salmon Escapement
		Species	Salmon Species	Salmon Escapement
		Total_Avg	Average of all the Assessment Years	Salmon Escapement
		Fst_10_Avg	The average of the earliest 10 years of assessments	Salmon Escapement
		Lst_10_Avg	The average of the most recent 10 years of assessments	Salmon Escapement
		Std_Dev	Standard Deviation of all assessments	Salmon Escapement
		Difference	The difference between the two averages (Lst_10_Avg - Fst_10_Avg)	Salmon Escapement

		Port_Chg	The proportional change from the first ten year average to most recent ten year average(Difference/Fst_10_Avg)*100	Salmon Escapement
		First_Yr	First Year of Assessment	Salmon Escapement
		Fst_Yr_Rt	First Year escapement numbers	Salmon Escapement
		Last_Yr	Most Current Year of Assessment	Salmon Escapement
		Lst_Yr_Rt	Most Current Year escapement numbers	Salmon Escapement
		Num_Assess	Number of Year Assessed	Salmon Escapement
		ECA_WSP_Flag	Risk Number Associated with ECA PSF thresholds) w/ 0 = Low Risk, 1 = Moderate, and 2 = High	Tier 1/2 Linkages
		RdDens_WSP_Flag	Risk Number Associated with Road Density (PSF thresholds) same scoring as ECA	Tier 1/2 Linkages
		RipDist_WSP_Flag	Risk Number Associated with Riparian Disturbance (PSF thresholds) same scoring as ECA	Tier 1/2 Linkages
		Linkage_Score	Sum of Three Flag Scores	Tier 1/2 Linkages
		LAXWIIYIP_Over	Name of Gitxsan House that overlaps the watershed	Tier 1/2 Linkages

		WILPNAMES_Over	Name of Gitanyow House that overlaps the watershed	Tier 1/2 Linkages
		TTY_NAME_Over	Name of Wetsuweten House that overlaps the watershed	Tier 1/2 Linkages
		Witset_YesNo	Does Witset Overlap?	Tier 1/2 Linkages
		Wet_suwet_en_First_Nation_YesNo	Does Wetsuweten First Nation Overlap?	Tier 1/2 Linkages
		Gitxsan_Hereditary_Chiefs_YesNo	Does Gitxsan Overlap?	Tier 1/2 Linkages
		Lake_Babine_Nation_YesNo	Lake Babine Nation Overlap?	Tier 1/2 Linkages
		Nee_Tahi_Buhn_Indian_Band_YesNo	Nee Tahi Buhn Overlap?	Tier 1/2 Linkages
		Skin_Tyee_Nation_YesNo	Skin Tyee Nation Overlap?	Tier 1/2 Linkages
		Office_of_the_Wet_suwet_en_YesNo	Office of the Wetsuweten Overlap?	Tier 1/2 Linkages
		Gitanyow_Hereditary_Chiefs_Office_YesNo	Gitanyow Overlap?	Tier 1/2 Linkages
		CABIN Watershed	Has CABIN been carried out in the watershed?	Tier 1/2 Linkages
		Gitwangak_YesNo	Gitwangak Overlap	Tier 1/2 Linkages

		AU_TOT_strLngth_km	Total length (km) of stream in the Assessment Unit	Riparian disturbance
		Rip_Human_Dstrb_Curr_KM	Total length (km) of stream disturbed by current human disturbance	Riparian disturbance
		Rip_Human_Dstrb_Hist_KM	Total length (km) of stream disturbed by historical human disturbance	Riparian disturbance
		Rip_Tot_Human_Dstrb_KM	Total length (km) of stream disturbed by ALL human disturbance	Riparian disturbance
		Rip_Tot_NonDstrb_StrmKM	Total length (km) of stream undisturbed by ALL human disturbance	Riparian disturbance
	SSAF_RipDist_Analysis_200924	Rip_Human_Dstrb_Curr_StrmKM_PCNT	Percent of stream disturbed by current human disturbance	Riparian disturbance
		Rip_Human_Dstrb_Hist_StrmKM_PCNT	Percent of stream disturbed by historical human disturbance	Riparian disturbance
		Rip_Tot_Human_Dstrb_StrmKM_PCNT	Percent of stream disturbed by ALL human disturbance	Riparian disturbance
		Rip_Tot_NonDstrb_StrmKM_PCNT	Percent of stream undisturbed by ALL human disturbance	Riparian disturbance
		Rip_Fire_Dstrb_KM	Total length (km) of stream disturbed by Fire	Riparian disturbance
		Rip_Insect_Dstrb_KM	Total length (km) of stream disturbed by Insect	Riparian disturbance

		Rip_Fire_Dstrb_PCNT	Percent of stream disturbed by Fire	Riparian disturbance
		Rip_Insect_Dstrb_PCNT	Percent of stream disturbed by Insect	Riparian disturbance
		Rip_Tot_All_Dstrb_KM	Total length (km) of stream disturbed by ALL input	Riparian disturbance
		Rip_Tot_All_Dstrb_PCNT	Percent of stream disturbed by ALL input	Riparian disturbance
		Rip_Tot_All_Dstrb_CLS	Riparian Disturbance Risk Class	Riparian disturbance
		Rip_Tot_All_Dstrb_NUM	Riparian Disturbance Risk Class Number	Riparian disturbance
	SSAF_Disturbance Type_2018_2020 1015	ASSESSMENT_UNIT_SOURCE_ID	FWA Assessment Watershed Unique ID. Used as the Cumulative Effects Assessment Unit identifier.	
		WATERSHED_GROUP_ID	Watershed Group Unique ID	
		ASSESSMENT_UNIT_GROUP	Four Letter Classification of Watershed Group	
		ASSESSMENT_UNIT_AREA_HA	Area in Ha of Assessment Watershed	
		ASSESSMENT_TARGET_YEAR	The year or vintage when the assessment analysis was initiated and for which the results represent.	

		COASTAL_INTERIOR	Classification of AU into Coastal vs Interior. Based on max overlap with Ecological Aquatic Units of British Columbia (EAU BC) Freshwater Ecoregion	
		FOWN_CROWN_HA	See meta Disturbance tab	
		FOWN_FEDERAL_HA		
		FOWN_PRIVATE_HA		
		FOWN_PROTECTED_HA		
		FOWN_UNKNOWN_HA		
		FOWN_CROWN_PCNT		
		FOWN_FEDERAL_PCNT		
		FOWN_PRIVATE_PCNT		
		FOWN_PRTCTD_PCNT		
		FOWN_UNKNOWN_PCNT		
		ROAD_BUFFERS_HA		
		FIRE_GUARD_BUFFERS_HA		
		MINING_AND_EXTRACTION_HA		
		RAIL_AND_INFRASTRUCTURE_HA		

		OGC_INFRASTRUCTURE_HA		
		POWER_HA		
		ROW_HA		
		URBAN_HA		
		RECREATION_HA		
		OGC_GEOPHYSICAL_HA		
		CUTBLOCKS_HA		
		AGRICULTURE_AND_CLEARING_HA		
		RESULTS_RESERVES_HA		
		RANGE_LANDS_HA		
		FOREST_LAND_HA		
		SHRUBS_HA		
		WETLANDS_ESTUARIES_HA		
		FRESH_WATER_HA		
		SALT_WATER_HA		
		ALPINE_SUBALPINE_BARREN_HA		
		GLACIERS_AND_SNOW_HA		

		ROAD_BUFFERS_PCNT		
		FIRE_GUARD_BUFFERS_PCNT		
		MINING_AND_EXTRACTION_PCNT		
		RAIL_AND_INFRASTRUCTURE_PCNT		
		OGC_INFRASTRUCTURE_PCNT		
		POWER_PCNT		
		ROW_PCNT		
		URBAN_PCNT		
		RECREATION_PCNT		
		OGC_GEOPHYSICAL_PCNT		
		CUTBLOCKS_PCNT		
		AGRICULTURE_AND_CLEARING_PCNT		
		RESULTS_RESERVES_PCNT		
		RANGE_LANDS_PCNT		
		FOREST_LAND_PCNT		
		SHRUBS_PCNT		

		WETLANDS_ESTUARIES_PCNT		
		FRESH_WATER_PCNT		
		SALT_WATER_PCNT		
		ALPINE_SUBALPINE_BARREN_PCNT		
		GLACIERS_AND_SNOW_PCNT		
		DISTRB_HUMAN_CRNT_20YR_HA		
		DISTRB_HUMAN_HIST_HA		
		NATURAL_LANDBASE_HA		
		DISTRB_HUMAN_CRNT_20YR_PCNT		
		DISTRB_HUMAN_HIST_PCNT		
		NATURAL_LANDBASE_PCNT		
		DISTRB_FIRE_HA		
		DISTRB_INSECT_HA		
		DISTRB_FIRE_INSECT_TOT_HA		
		DISTRB_FIRE_PCNT		
		DISTRB_INSECT_PCNT		

		DISTRB_FIRE_INSECT_TOT_PCNT		
		DISTRB_FIRE_NET_HA		
		DISTRB_INSECT_NET_HA		
		DISTRB_FIRE_INSECT_NET_HA		
		DISTRB_FIRE_NET_PCNT		
		DISTRB_INSECT_NET_PCNT		
		DISTRB_FIRE_INSECT_NET_PCNT		
		DISTRB_ALL_TOT_HA		
		DISTRB_ALL_TOT_PCNT		
		NON_DISTRB_ALL_TOT_HA		
		NON_DISTRB_ALL_TOT_PCNT		
		RD_LENGTH_KM	Length of Road in Assessment Unit	
		STRM_LENGTH_KM	Length of Stream in Assessment Unit	

4.4 - Salmon Escapement Script

1. Get spreadsheet or table into processing GDB so that the averaging script can run on it
2. Run Averaging script for each table
3. Join a single output table (from Averaging Script) to the survey stream layer keeping only matching layers
4. Export the join

5. Repeat for all tables of interest
6. Merge the exported features
7. Check that the Point features overlap with the AU
8. Spatial Join with the assessment unit feature

Salmon Stream
https://data.salmonwatersheds.ca/data-library/ResultDetails.aspx?id=114

4.5 - Riparian Disturbance - Add Fire and Insect

Purpose of analysis: to establish the % of insect and fire disturbance within the riparian zone (30 metres) of streams for each watershed feature listed in the ESI 2018 Aquatics Summary.	
The underlying input data used in this analysis is the same as the 2018 BC Cumulative Effects Aquatic Ecosystems Current Condition Assessment document: \\spatialfiles.bcgov\work\srm\smt\Workarea\ArcProj\P17_Skeena_ESI\Documents\CE\Aquatic_Protocol_Appendix_GIS_Indicators_Inputs_DataDict_20180115	
Insect Disturbance Layer:	
VRI from the BCGW	
Definition Query:	EARLIEST_NONLOGGING_DIST_TYPE LIKE 'I%' and (STAND_PERCENTAGE_DEAD >= 10 or STAND_PERCENTAGE_DEAD is null)
Added 30 metre buffer.	
Erased 30m fire and 30m human disturbance buffer to eliminate overlap.	
Fire Disturbance layer:	
Merged current, historical, and burn severity BCGW layers.	
For Burn Severity Def Quer	BURN_SEVERITY_RATING <> 'Unburned'
Definition Query:	FIRE_YEAR >= 1960

Added 30 metre buffer.	
Erased 30m human disturbance buffer to eliminate overlap.	
Human Disturbance Layer:	
BTM tiles are located in:	\\spatialfiles.bcgov\work\srm\bcce\shared\data_library\tile_whse\consolidated_disturbance\2019\README_How_To_merge_tiles_for_AOI.txt for more information about how to get the distrubance feature
CEF version didn't include roads, trails, and fire guards	
Roads, trails, and fire guards buffer erased from Human Disturbance, and then added in	
30 metre buffer added	

4.6 - ECA Recovery Curves

Interior				
Min tree height (m)	**Max tree height (m)**	**Median tree height (m)**	**Hydrologic recovery (%)**	**ECA contribution (%)**
0	2	NA	0	100.0
2	3	2.5	0.2	99.8
3	4	3.5	3.1	96.9
4	5	4.5	9.9	90.1
5	6	5.5	19.3	80.7
6	7	6.5	29.9	70.1
7	8	7.5	40.5	59.5
8	9	8.5	50.3	49.7
9	10	9.5	59.1	40.9
10	11	10.5	66.7	33.3

11	12	11.5	73.1	26.9
12	13	12.5	78.3	21.7
13	14	13.5	82.7	17.3
14	15	14.5	86.2	13.8
15	16	15.5	89.0	11.0
16	17	16.5	91.3	8.7
17	18	17.5	93.1	6.9
18	19	18.5	94.6	5.4
>19	NA	NA	100.0	0.0

Citation: Winkler, R., and S. Boon. 2015. Revised snow recovery estimates for pine-dominated forests in interior British Columbia. Prov. B.C., Victoria, B.C. Exten. Note 116. www.for.gov.bc.ca/hfd/pubs/Docs/En/En116.htm

Formula: 100*(1-EXP(-0.24*(HEIGHT-2)))^2.909

Coastal (all elevations)				
Min tree height (m)	**Max tree height (m)**	**Median tree height (m)**	**Hydrologic recovery (%)**	**ECA contribution (%)**
0	2	NA	0.0	100.0
2	3	2.5	0.9	99.1
3	4	3.5	5.2	94.8
4	5	4.5	10.6	89.4
5	6	5.5	16.5	83.5

6	7	6.5	22.4	77.6
7	8	7.5	28.2	71.8
8	9	8.5	33.7	66.3
9	10	9.5	39.1	60.9
10	11	10.5	44.1	55.9
11	12	11.5	48.8	51.2
12	13	12.5	53.1	46.9
13	14	13.5	57.2	42.8
14	15	14.5	60.9	39.1
15	16	15.5	64.4	35.6
16	17	16.5	67.6	32.4
17	18	17.5	70.5	29.5
18	19	18.5	73.1	26.9
19	20	19.5	75.6	24.4
20	21	20.5	77.8	22.2
21	22	21.5	79.9	20.1
22	23	22.5	81.7	18.3
23	24	23.5	83.4	16.6
24	25	24.5	84.9	15.1
25	26	25.5	86.3	13.7
26	27	26.5	87.6	12.4
27	28	27.5	88.8	11.2
28	29	28.5	89.8	10.2
29	30	29.5	90.8	9.2
30	31	30.5	91.6	8.4
31	32	31.5	92.4	7.6
32	33	32.5	93.1	6.9
33	34	33.5	93.8	6.2
34	35	34.5	94.4	5.6
35	36	35.5	94.9	5.1

>36	NA	NA	100.0	0.0

Citation: Hudson, R., and G. Horel. 2007. An operational method of assessing hydrologic recovery for Vancouver Island and south coastal BC. Res. Sec., Coast For. Reg., BC Min. For., Nanaimo, BC. Technical Report TR-032/2007.

Formula: 100*(1-EXP(-0.1*(HEIGHT-2.1)))^1.45

4.7 – meta Disturbance

Group - SubGroup Rank	Disturbance Group	Sub Group	Description	Human Disturbance Class
0-1	Road_Buffers	OGC Road Buffers	OGC SLU Road buffers	Current
0-2	Road_Buffers	CEF Integrated Roads	BC CEF Integrated road lines, with those under OGC buffer erased. DRA trails not included.	Current
0-1	Fire_Guard_Buffers	Fire Guard Buffers	Custom BC Wildfire Service fire guard buffers - 2017-2019	Current
1-1	Mining_and_Extraction	Custom - North Area 2015	GeoBC - Custom mine footprints digitized for the North Area	Current
1-2	Mining_and_Extraction	Baseline Thematic Mapping	BTM - Mining - mineral extraction or quarry	Current
1-3	Mining_and_Extraction	VRI Mining	VRI - Gravel pits, mines, rubbly mine spoils, mine tailings (>= 20% cover).	Current
1-4	Mining_and_Extraction	TRIM Enhanced Base Map	TRIM - Mines and quarries	Current
2-1	Rail_and_Infrastructure	Railway BC	GeoBase - Rail lines buffered by 7.5m	Current

2-2	Rail_and_Infrastructure	Railway NEBC	GeoBase - Rail lines buffered by 17.5m	Current
2-3	Rail_and_Infrastructure	VRI Airports	VRI - Airport or associated areas (buildings, parking) (>= 20% cover)	Current
2-4	Rail_and_Infrastructure	TRIM Airfields	TRIM - Runway, airstrip	Current
3-1	OGC_Infrastructure	Surface Land Use - OGC	OGC - Oil and Gas pipelines, well facilities, and ancillary features	Current
4-1	Power	Dams	Water - Linear dams, buffered by 25m	Current
4-2	Power	Transmission	GeoBase - Transmission lines, buffered to 12.5 m	Current
5-1	ROW	Surveyed ROW	Tantalis - Surveyed rights-of-way - including private and some crown	Current
5-2	ROW	Crown ROW	Tantalis - Surveyed rights-of-way - crown	Current
6-1	Urban	Baseline Thematic Mapping	BTM - Urban and Residential Agriculture Mixtures	Current
6-2	Urban	VRI Builtup	VRI - Urban and builtup areas (>= 20% cover)	Current
6-3	Urban	TRIM Enhanced Base Map	TRIM - Urban and builtup areas	Current
7-1	Recreation	BTM - Recreation	BTM - Recreation activities e.g. ski resort, golf course	Current
8-1	OGC_Geophysical	Surface Land Use - Geophysical	OGC Geophysical represents seismic survey activity in NE BC from the Oil & Gas industry. The disturbance from this survey type are cutlines in the vegetation cover. Airborne surveys were not considered a disturbance. It is anticipated this survey time will decline in the future for less invasive methods.	Current
9-1	Cutblocks	Current - FAIB	FAIB - Forest harvesting cutblocks since 1999 - excluding select reserves	Current
9-2	Cutblocks	Historic - FAIB	FAIB - Forest harvesting cutblocks pre 1999 - excluding select reserves	Historic (>20 yrs)

9-3	Cutblocks	Historic - BTM	BTM - Historically logged or selectively logged areas - does not consider reserves	Historic (>20 yrs)
10-1	Agriculture_and_Clearing	Baseline Thematic Mapping	BTM - Agricultural areas	Current
10-2	Agriculture_and_Clearing	VRI Clearing	VRI - Clearings and agricultural areas - clearings are undifferentiated as to type (type may vary)	Current
11-1	RESULTS_Reserves	RESULTS Reserves	Select harvest reserves < 90 years old from RESULTS. For the Aquatic/Watershed assessment, these are considered as un-recovered (disturbed) areas. This is a custom dataset with a specific selection criteria.	Current
11-2	RESULTS_Reserves	RESULTS Reserves gt90 yrs	Select harvest reserves greater than 90 years old and natural feature from RESULTS. For the Aquatic/Watershed assessment, these are considered as undisturbed/part of the natural landbase. This is a custom dataset with a specific selection criteria. Reserves with trees > 90 yrs are considered as recovered. Reserves coded as 'natural' (e.g. lake, meadow, rock, swamp) within a block, are also considered in this category.	Natural Landbase
12-1	BTM Natural Landbase - Range Lands	BTM - Range Lands	Unimproved pasture and grasslands, sparse forest	Natural Landbase
12-1	BTM Natural Landbase - Forest Land	BTM - Forest Land	Forested areas or old burns	Natural Landbase
12-1	BTM Natural Landbase - Shrubs	BTM - Shrubs	Naturally occurring shrub cover with at least 50% coverage	Natural Landbase
12-1	BTM Natural Landbase - Wetlands Estuaries	BTM - Wetlands Estuaries	Swamps, marshes, bogs or fens; salt water mud flats and inter tidal areas	Natural Landbase
12-1	BTM Natural Landbase - Fresh Water	BTM - Fresh Water	Rivers, Lakes	Natural Landbase

12-1	BTM Natural Landbase - Salt Water	BTM - Salt Water	Salt water, ocean	Natural Landbase
12-1	BTM Natural Landbase - Alpine SubAlpine Barren	BTM - Alpine SubAlpine Barren	Alpine or sub alpine areas virtually devoid of trees; rock barrens, badlands, sand and gravel flats, dunes and beaches where un-vegetated surfaces predominate	Natural Landbase
12-1	BTM Natural Landbase - Glaciers and Snow	BTM - Glaciers and Snow	Glaciers and relatively permanent snow	Natural Landbase

Appendix 5—Historical Salmon Escapements in Skeena and Nass Basin Indicator Streams within the SSAF Study Area

Data in this section are presented only to illustrate generalized patterns and trends across SSAF salmon species and are not intended to represent detailed stock assessment of salmon population or stock status. The STC acknowledges that there are significant data gaps, and that this table requires significant revisions in future versions of this report.

Indicator Stream Location	Stream ID	Species	Total Years Surveyed	Date Range (first 10 observations)		Data Range (last 10 observations)		Average (first 10 observations)	Average (last 10 observations)	Change (%)
Atna River	2346	Lake Sockeye	13	1963	1980	1966	2017	325	290	-10.8
Azuklotz Creek	3415	Coho	12	1950	1962	1953	2012	244	236	-3.0
Azuklotz Creek	10	Lake Sockeye	51	1950	1960	2001	2017	1325	2226	68.0
Babine Lake	11	Lake Sockeye	1	1992	1992	1992	1992	5000	5000	0.0
Babine River-Section 4	2133	Chum	29	1950	1962	1980	1998	15	3	-83.6
Babine River-Section 4	2152	Coho	43	1950	1959	2003	2012	1243	13326	972.2
Babine River-Section 4	12	Lake Sockeye	60	1950	1959	2001	2017	79625	10918	-86.3
Babine River-Section 4	2286	Pink (Even)	33	1950	1968	1996	2014	24981	76976	208.1
Babine River-Section 4	2070	Pink (Odd)	31	1951	1969	1993	2011	43137	141443	227.9
Babine River-Section 4 (Fence)	2243	Chinook	68	1950	1959	2008	2017	6303	1911	-69.7
Babine River-Section 5	2244	Chinook	54	1951	1961	2008	2017	1700	1226	-27.9
Babine River-Section 5	2134	Chum	2	1959	1960	1959	1960	100	100	0.0
Babine River-Section 5	2153	Coho	19	1951	1962	1962	1971	1138	600	-47.3

Indicator Stream Location	Stream ID	Species	Total Years Surveyed	Date Range (first 10 observations)		Data Range (last 10 observations)		Average (first 10 observations)	Average (last 10 observations)	Change (%)
Babine River-Section 5	13	Lake Sockeye	4	1965	1997	1965	1997	1250	1250	0.0
Babine River-Section 5	2287	Pink (Even)	15	1954	1972	1964	1988	2800	26050	830.4
Babine River-Section 5	2071	Pink (Odd)	18	1953	1971	1969	1987	5257	28357	439.4
Babine River-Sections 1 To 3	14	Lake Sockeye	68	1950	1959	2008	2017	101389	82333	-18.8
Babine River-Unaccounted	15	Lake Sockeye	58	1951	1962	2004	2014	100223	160507	60.1
Barnes Creek	3343	Lake Sockeye	15	2001	2010	2006	2017	174	184	5.6
Bear Lake	2246	Chinook	4	1970	1973	1970	1973	500	500	0.0
Bear Lake	3416	Coho	6	1953	1975	1953	1975	279	279	0.0
Bear Lake	46	Lake Sockeye	31	1950	1959	1972	2013	6857	1404	-79.5
Bear River	2247	Chinook	67	1950	1959	2008	2017	18611	4290	-77.0
Bear River	3417	Coho	30	1952	1966	2006	2017	944	1241	31.5
Bear River	47	Lake Sockeye	16	1950	1975	1968	1999	1664	1056	-36.6
Bear River	2289	Pink (Even)	6	1950	1990	1950	1990	1390	1390	0.0
Bear River	2073	Pink (Odd)	18	1951	1969	1967	2001	8151	72457	789.0
Beaverlodge Creek	2157	Coho	11	1986	2007	1987	2008	513	533	3.8
Beirnes Creek	3418	Coho	1	2008	2008	2008	2008	8	8	0.0
BELL-IRVING RIVER	5568	Chinook	2	1992	1993	1992	1993	4303	4303	0.0
Bern-Ann Creek	16	Lake Sockeye	11	1994	2008	1996	2011	586	598	2.0
Big Fish Creek	2158	Coho	3	1986	1989	1986	1989	35	35	0.0
Big Loon Creek	2159	Coho	1	2003	2003	2003	2003	34	34	0.0
Big Loon Creek	17	Lake Sockeye	8	1959	2012	1959	2012	189	189	0.0
Boucher Creek	2248	Chinook	4	1977	1998	1977	1998	21	21	0.0
Boucher Creek	2161	Coho	15	1952	1994	1967	2017	103	105	2.8
Boucher Creek	18	Lake Sockeye	18	1952	1998	1997	2017	763	119	-84.4
Boucher Creek	2290	Pink (Even)	15	1964	2000	1992	2014	1212	1014	-16.3
Boucher Creek	2074	Pink (Odd)	17	1957	1997	1993	2017	792	2501	215.7
BROWN BEAR CREEK	5563	Chinook	1	1980	1980	1980	1980	2	2	0.0
BROWN BEAR CREEK	3665	Coho	15	1978	2006	1983	2017	170	92	-46.1
BROWN BEAR CREEK	3690	River Sockeye	18	1978	2007	2006	2017	240	369	53.9
Brown Paint Creek	2162	Coho	3	2003	2005	2003	2005	173	173	0.0
Buck Creek	3360	Chinook	7	1970	1993	1970	1993	49	49	0.0

Indicator Stream Location	Stream ID	Species	Total Years Surveyed	Date Range (first 10 observations)		Data Range (last 10 observations)		Average (first 10 observations)	Average (last 10 observations)	Change (%)
Buck Creek	2163	Coho	25	1950	1960	1967	1982	177	190	7.3
Buck Creek	2075	Pink (Odd)	1	1967	1967	1967	1967	100	100	0.0
Bulkley River-Lower	2258	Chinook	24	1950	1968	1973	1993	483	202	-58.3
Bulkley River-Lower	2164	Coho	17	1954	1965	1963	1973	2617	1663	-36.5
Bulkley River-Lower	2291	Pink (Even)	17	1950	1970	1966	1990	1357	2928	115.7
Bulkley River-Lower	2076	Pink (Odd)	19	1951	1969	1969	1993	5193	20043	286.0
Bulkley River-Lower	3177	River Sockeye	6	1950	1955	1950	1955	681	681	0.0
Bulkley River-Upper	3361	Chinook	54	1950	1959	1996	2006	757	1601	111.5
Bulkley River-Upper	2165	Coho	45	1950	1959	1995	2005	2969	1115	-62.4
Bulkley River-Upper	2292	Pink (Even)	3	1966	1972	1966	1972	217	217	0.0
Bulkley River-Upper	2077	Pink (Odd)	6	1953	1989	1953	1989	210	210	0.0
Bulkley River-Upper	3178	River Sockeye	17	1960	1975	1973	1995	245	142	-41.9
Burdick Creek	2166	Coho	5	1950	1984	1950	1984	60	60	0.0
Burdick Creek	2293	Pink (Even)	11	1950	1990	1952	1992	350	344	-1.8
Burdick Creek	2078	Pink (Odd)	9	1951	1991	1951	1991	988	988	0.0
Canyon Creek	2167	Coho	17	1950	1960	1958	1970	101	225	122.8
Causqua Creek	2294	Pink (Even)	3	1950	1962	1950	1962	313	313	0.0
Causqua Creek	2079	Pink (Odd)	3	1953	1989	1953	1989	608	608	0.0
Cedar River	1735	Chinook	54	1955	1966	2001	2011	515	1000	94.2
Cedar River	1974	Coho	33	1961	1971	1985	2000	760	382	-49.8
Cedar River	1757	Lake Sockeye	36	1956	1967	1984	1998	1330	1100	-17.3
Chicago Creek	2135	Chum	1	1989	1989	1989	1989	50	50	0.0
Chicago Creek	2168	Coho	19	1950	1962	1962	1986	183	50	-72.7
Chicago Creek	2295	Pink (Even)	11	1950	1990	1954	1992	593	581	-2.0
Chicago Creek	2080	Pink (Odd)	12	1951	1989	1955	1993	617	1000	62.2
Chipmunk Creek	3419	Coho	2	2008	2011	2008	2011	226	226	0.0
Clear Creek	1736	Chinook	48	1956	1965	1994	2004	175	97	-44.7
Clear Creek	1977	Coho	40	1950	1961	1983	2000	281	175	-37.8
Clear Creek	1758	Lake Sockeye	37	1950	1960	1978	1992	821	192	-76.7
Clifford Creek	2169	Coho	41	1965	1974	2006	2017	175	99	-43.2
Clifford Creek	2296	Pink (Even)	4	1984	1990	1984	1990	634	634	0.0

Indicator Stream Location	Stream ID	Species	Total Years Surveyed	Date Range (first 10 observations)		Data Range (last 10 observations)		Average (first 10 observations)	Average (last 10 observations)	Change (%)
Clifford Creek	2081	Pink (Odd)	7	1983	2009	1983	2009	1606	1606	0.0
Club Creek-Lower [Between Club Lake & Stephens Lake]	3340	Lake Sockeye	64	1950	1959	2008	2017	2364	3857	63.1
Club Creek-Upper	2260	Chinook	4	1964	1992	1964	1992	44	44	0.0
Club Creek-Upper	2171	Coho	18	1964	1974	1973	1987	850	363	-57.4
Club Creek-Upper	3344	Lake Sockeye	55	1950	1959	2004	2015	258	246	-4.6
Cole Creek	1981	Coho	5	1998	2002	1998	2002	56	56	0.0
Comeau Creek	2261	Chinook	1	1990	1990	1990	1990	10	10	0.0
Comeau Creek	2136	Chum	1	1984	1984	1984	1984	10	10	0.0
Comeau Creek	2172	Coho	4	1950	1983	1950	1983	88	88	0.0
Comeau Creek	2297	Pink (Even)	7	1950	1992	1950	1992	604	604	0.0
Comeau Creek	2082	Pink (Odd)	8	1951	1993	1951	1993	808	808	0.0
CRANBERRY RIVER	5566	Chinook	29	1965	1975	1985	2017	1830	2889	57.8
CRANBERRY RIVER	5576	Coho	23	1965	1975	1979	1990	3450	2314	-32.9
Cross Creek	19	Lake Sockeye	39	1950	1977	2000	2017	1004	653	-35.0
Cullon Creek	2262	Chinook	11	1966	1976	1968	1977	25	25	0.0
Cullon Creek	2138	Chum	2	1991	1992	1991	1992	113	113	0.0
Cullon Creek	2174	Coho	38	1950	1970	2005	2016	175	517	195.5
Cullon Creek	2298	Pink (Even)	11	1950	1990	1960	1992	170	330	94.1
Cullon Creek	2083	Pink (Odd)	9	1961	1991	1961	1991	800	800	0.0
DAMDOCHAX CREEK	3644	Chinook	36	1957	1979	2006	2017	3425	1571	-54.1
DAMDOCHAX CREEK	5582	Coho	6	1977	1982	1977	1982	750	750	0.0
DAMDOCHAX CREEK	3683	Lake Sockeye	51	1956	1971	2007	2016	9429	2801	-70.3
Damshilgwit Creek	2263	Chinook	4	2007	2013	2007	2013	11	11	0.0
Damshilgwit Creek	3420	Coho	18	2000	2009	2008	2017	1667	2420	45.2
Damshilgwit Creek	135	Lake Sockeye	18	2000	2009	2008	2017	415	509	22.6
Damshilgwit Creek	2299	Pink (Even)	1	2012	2012	2012	2012	3	3	0.0
Damshilgwit Creek	2084	Pink (Odd)	1	2013	2013	2013	2013	1	1	0.0
Date Creek	2264	Chinook	8	1964	1992	1964	1992	64	64	0.0
Date Creek	2139	Chum	24	1960	1974	1981	2010	225	42	-81.3
Date Creek	2175	Coho	21	1950	1975	1977	2009	150	73	-51.7

Indicator Stream Location	Stream ID	Species	Total Years Surveyed	Date Range (first 10 observations)		Data Range (last 10 observations)		Average (first 10 observations)	Average (last 10 observations)	Change (%)
Date Creek	2300	Pink (Even)	10	1950	1990	1950	1990	369	369	0.0
Date Creek	2085	Pink (Odd)	11	1951	1989	1953	1991	983	2557	160.0
Deep Canoe Creek	2265	Chinook	1	1990	1990	1990	1990	10	10	0.0
Deep Canoe Creek	2301	Pink (Even)	1	1990	1990	1990	1990	75	75	0.0
Deep Canyon Creek	2302	Pink (Even)	1	1990	1990	1990	1990	500	500	0.0
Deep Canyon Creek	2086	Pink (Odd)	1	1989	1989	1989	1989	350	350	0.0
Donalds Creek	20	Lake Sockeye	12	1953	1991	1957	2007	266	623	134.3
Douglas Creek	1987	Coho	60	1950	1960	2003	2012	144	71	-50.6
Douglas Creek	1759	Lake Sockeye	45	1950	1959	2003	2012	200	115	-42.4
Driftwood Creek	2177	Coho	16	1950	1959	1956	1970	107	146	36.3
Elf Creek	1989	Coho	6	1998	2005	1998	2005	76	76	0.0
Falls Creek	2178	Coho	1	1952	1952	1952	1952	500	500	0.0
Falls Creek	3345	Lake Sockeye	18	1950	2007	2006	2017	1086	410	-62.2
Fiddler Creek	1916	Chinook	15	1966	1975	1971	1980	100	100	0.0
Fiddler Creek	1939	Chum	15	1966	1976	1972	2009	100	80	-20.0
Fiddler Creek	1994	Coho	23	1950	1972	1976	2009	295	282	-4.4
Fiddler Creek	2476	Pink (Even)	13	1950	1978	1966	1984	595	515	-13.4
Fiddler Creek	1866	Pink (Odd)	11	1957	1981	1961	1983	290	290	0.0
Five Mile Creek	21	Lake Sockeye	45	1951	1965	2002	2017	446	213	-52.2
Five Mile Creek	2087	Pink (Odd)	1	1995	1995	1995	1995	40	40	0.0
Footsore Lake Creek	2180	Coho	15	1986	2007	2003	2012	223	124	-44.4
Forks Creek	22	Lake Sockeye	1	1959	1959	1959	1959	600	600	0.0
Four Mile Creek	23	Lake Sockeye	67	1950	1959	2008	2017	2809	4151	47.8
Fulton River	2249	Chinook	10	1998	2013	1998	2013	9	9	0.0
Fulton River	2182	Coho	18	1951	2006	2005	2015	1131	1209	6.8
Fulton River	2303	Pink (Even)	8	1998	2012	1998	2012	40	40	0.0
Fulton River	2089	Pink (Odd)	9	1999	2015	1999	2015	149	149	0.0
Fulton River-Above Weir	2250	Chinook	10	1975	1997	1975	1997	22	22	0.0
Fulton River-Above Weir	2183	Coho	35	1953	1962	1987	1997	621	234	-62.3
Fulton River-Above Weir	2304	Pink (Even)	7	1978	1996	1978	1996	142	142	0.0
Fulton River-Above Weir	2090	Pink (Odd)	7	1973	1997	1973	1997	72	72	0.0

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George Creek	1996	Coho	1	1999	1999	1999	1999	20	20	0.0
Glen Vowell Creek	2184	Coho	19	1950	1969	1969	1978	88	25	-71.4
Glen Vowell Creek	2305	Pink (Even)	6	1950	1976	1950	1976	100	100	0.0
Glen Vowell Creek	2091	Pink (Odd)	4	1951	1977	1951	1977	50	50	0.0
Gosnell Creek	2185	Coho	29	1955	1965	1991	2011	2250	1455	-35.3
Gosnell Creek	2306	Pink (Even)	3	1982	1990	1982	1990	1175	1175	0.0
Gosnell Creek	2092	Pink (Odd)	3	1975	1987	1975	1987	5467	5467	0.0
Gullwing Creek	24	Lake Sockeye	58	1950	1962	2004	2017	1493	806	-46.0
Harold Price Creek	2268	Chinook	4	1982	1992	1982	1992	28	28	0.0
Harold Price Creek	2140	Chum	1	1989	1989	1989	1989	10	10	0.0
Harold Price Creek	2187	Coho	6	1980	1989	1980	1989	55	55	0.0
Harold Price Creek	2307	Pink (Even)	1	1986	1986	1986	1986	25	25	0.0
Hazelton Creek	2188	Coho	1	1983	1983	1983	1983	15	15	0.0
Hazelton Creek	2308	Pink (Even)	10	1950	1990	1950	1990	359	359	0.0
Hazelton Creek	2094	Pink (Odd)	13	1951	1983	1957	1991	242	695	187.6
Hazelwood Creek	25	Lake Sockeye	1	1980	1980	1980	1980	50	50	0.0
Hevenor Creek	2269	Chinook	2	1986	1987	1986	1987	35	35	0.0
Hevenor Creek	2141	Chum	2	1984	1992	1984	1992	35	35	0.0
Hevenor Creek	2189	Coho	26	1950	1975	1982	2001	342	180	-47.3
Hevenor Creek	2309	Pink (Even)	6	1950	1992	1950	1992	223	223	0.0
Hevenor Creek	2095	Pink (Odd)	5	1951	1989	1951	1989	231	231	0.0
Hodder Lake Creek	2190	Coho	14	1986	2007	2001	2017	70	28	-60.6
Ironside Creek	2191	Coho	41	1965	1974	2007	2017	1270	191	-85.0
Ironside Creek	2310	Pink (Even)	5	1984	1992	1984	1992	157	157	0.0
Ironside Creek	2096	Pink (Odd)	4	1983	1989	1983	1989	283	283	0.0
Jackson Creek	3196	River Sockeye	14	2001	2011	2005	2017	90	105	16.6
Kathlyn Creek	2193	Coho	47	1950	1959	1988	2002	463	365	-21.2
Kathlyn Creek	2311	Pink (Even)	2	1962	1978	1962	1978	1325	1325	0.0
Kathlyn Creek	2097	Pink (Odd)	3	1963	1989	1963	1989	534	534	0.0
Kew Creek	26	Lake Sockeye	3	1953	1959	1953	1959	267	267	0.0
KINSKUCH RIVER	5565	Chinook	3	1976	1978	1976	1978	25	25	0.0

Indicator Stream Location	Stream ID	Species	Total Years Surveyed	Date Range (first 10 observations)		Data Range (last 10 observations)		Average (first 10 observations)	Average (last 10 observations)	Change (%)
KINSKUCH RIVER	5575	Coho	11	1975	1984	1976	1990	27	27	0.0
Kispiox River	2270	Chinook	46	1954	1965	1994	2010	4600	4757	3.4
Kispiox River	2142	Chum	41	1954	1964	1989	2010	3446	507	-85.3
Kispiox River	2194	Coho	37	1954	1965	1985	2001	9093	1319	-85.5
Kispiox River	2312	Pink (Even)	23	1950	1970	1978	1998	59643	69286	16.2
Kispiox River	2098	Pink (Odd)	24	1955	1973	1983	2001	304111	178800	-41.2
Kispiox River	3185	River Sockeye	1	1992	1992	1992	1992	1000	1000	0.0
KITEEN RIVER	5567	Chinook	23	1965	1978	1982	1993	488	303	-37.8
KITEEN RIVER	5577	Coho	17	1965	1977	1972	1984	1142	290	-74.6
Kitseguecla River	2271	Chinook	13	1966	1988	1981	1991	106	96	-9.1
Kitseguecla River	2143	Chum	4	1986	1990	1986	1990	63	63	0.0
Kitseguecla River	2195	Coho	18	1950	1981	1980	2001	492	425	-13.6
Kitseguecla River	2313	Pink (Even)	7	1950	1992	1950	1992	761	761	0.0
Kitseguecla River	2099	Pink (Odd)	8	1951	1993	1951	1993	1934	1934	0.0
Kitseguecla River	3186	River Sockeye	1	1982	1982	1982	1982	50	50	0.0
Kitsumkalum River-Upper	1740	Chinook	18	1961	1977	1976	2015	208	1413	578.2
Kitsumkalum River-Upper	1949	Chum	1	1982	1982	1982	1982	25	25	0.0
Kitsumkalum River-Upper	2016	Coho	33	1951	1972	1991	2001	3200	753	-76.5
Kitsumkalum River-Upper	1762	Lake Sockeye	17	1969	1978	1976	1985	713	370	-48.1
Kitsumkalum River-Upper	2504	Pink (Even)	1	1982	1982	1982	1982	25	25	0.0
Kitsuns Creek	3187	River Sockeye	1	1990	1990	1990	1990	200	200	0.0
Kitwanga River	2273	Chinook	57	1950	1962	2008	2017	375	868	131.5
Kitwanga River	2144	Chum	56	1950	1959	2008	2017	2619	467	-82.2
Kitwanga River	2197	Coho	44	1961	1971	2006	2017	356	4150	1065.0
Kitwanga River	1764	Lake Sockeye	30	1960	1980	2008	2017	160	5351	3244.6
Kitwanga River	2314	Pink (Even)	32	1950	1968	1994	2016	72813	50587	-30.5
Kitwanga River	2100	Pink (Odd)	34	1951	1969	1999	2017	138750	205999	48.5
Kluatantan River	3410	Chinook	2	2008	2009	2008	2009	87	87	0.0
Kluatantan River	1766	Lake Sockeye	1	1970	1970	1970	1970	50	50	0.0
KWINAGEESE RIVER	3645	Chinook	38	1968	1978	2008	2017	1486	718	-51.7
KWINAGEESE RIVER	5574	Coho	21	1971	1986	2002	2017	1617	1033	-36.1

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KWINAGEESE RIVER	3684	Lake Sockeye	48	1957	1972	2002	2017	18200	5476	-69.9
Lean-To Creek	1741	Chinook	1	1964	1964	1964	1964	25	25	0.0
Lean-To Creek	2020	Coho	36	1952	1971	1991	2003	175	117	-33.2
Lean-To Creek	2526	Pink (Even)	1	1964	1964	1964	1964	200	200	0.0
Legate Creek	2021	Coho	1	1986	1986	1986	1986	25	25	0.0
Limonite Creek	3635	Chinook	4	1992	2001	1992	2001	164	164	0.0
Limonite Creek	2022	Coho	1	1998	1998	1998	1998	50	50	0.0
Little Fish Creek	2199	Coho	4	1985	1989	1985	1989	58	58	0.0
Maxan Creek	3362	Chinook	2	1988	1993	1988	1993	35	35	0.0
Maxan Creek	2200	Coho	6	1965	1972	1965	1972	262	262	0.0
Mccully Creek	2274	Chinook	8	1966	1992	1966	1992	47	47	0.0
Mccully Creek	2145	Chum	18	1960	1973	1972	1992	151	69	-54.1
Mccully Creek	2201	Coho	18	1965	1974	1973	2010	175	39	-77.6
Mccully Creek	2315	Pink (Even)	15	1950	1978	1970	1992	39	250	535.6
Mccully Creek	2101	Pink (Odd)	15	1951	1983	1971	1993	445	558	25.5
MCKNIGHT CREEK	5578	Coho	17	1976	1985	1983	1992	354	266	-24.9
MEZIADIN RIVER	3646	Chinook	53	1956	1973	2008	2017	1544	215	-86.1
MEZIADIN RIVER	3666	Coho	48	1969	1979	2008	2017	3050	4952	62.4
MEZIADIN RIVER	3685	Lake Sockeye	57	1957	1970	2008	2017	89510	152052	69.9
Moonlit Creek	2275	Chinook	1	2001	2001	2001	2001	50	50	0.0
Moonlit Creek	2316	Pink (Even)	2	1990	1992	1990	1992	725	725	0.0
Moonlit Creek	2102	Pink (Odd)	2	1989	1993	1989	1993	650	650	0.0
Moosevale Creek	3425	Coho	2	1978	1981	1978	1981	63	63	0.0
Morice Lake	2202	Coho	1	1980	1980	1980	1980	20	20	0.0
Morice Lake	2347	Lake Sockeye	5	1965	2009	1965	2009	289	289	0.0
Morice River	2252	Chinook	67	1950	1959	2008	2017	9000	11832	31.5
Morice River	2203	Coho	36	1950	1959	1977	2013	8200	3675	-55.2
Morice River	2348	Lake Sockeye	8	1950	1975	1950	1975	879	879	0.0
Morice River	2317	Pink (Even)	20	1954	1990	1992	2012	22728	46370	104.0
Morice River	2103	Pink (Odd)	29	1953	1973	1993	2011	3544	84800	2292.5
Morrison Creek	2204	Coho	23	1950	1961	1967	2011	304	186	-38.9

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Morrison Creek	27	Lake Sockeye	67	1950	1959	2007	2017	11000	16211	47.4
Morrison Creek	2318	Pink (Even)	1	1982	1982	1982	1982	10	10	0.0
Morrison Creek	2104	Pink (Odd)	4	1983	2003	1983	2003	27	27	0.0
Motase Lake	3426	Coho	11	1970	2010	2001	2011	209	223	6.9
Motase Lake	2378	Lake Sockeye	28	1970	1992	2003	2017	556	321	-42.3
Murder Creek	2205	Coho	40	1950	1971	2005	2015	281	107	-62.0
Murder Creek	2319	Pink (Even)	1	1950	1950	1950	1950	75	75	0.0
Murder Creek	2105	Pink (Odd)	3	1961	1985	1961	1985	163	163	0.0
Nangeese River	2276	Chinook	24	1966	1976	1987	2010	100	279	179.4
Nangeese River	2147	Chum	6	1984	1993	1984	1993	93	93	0.0
Nangeese River	2206	Coho	43	1965	1974	2008	2017	669	1164	74.1
Nangeese River	2320	Pink (Even)	11	1966	1990	1970	1992	221	225	1.6
Nangeese River	2106	Pink (Odd)	12	1965	1989	1973	1993	530	3279	518.6
Nangeese River	3190	River Sockeye	2	1981	1992	1981	1992	106	106	0.0
Nanika River	2254	Chinook	46	1959	1977	2007	2016	140	395	182.0
Nanika River	2207	Coho	15	1959	1970	1966	1991	285	230	-19.3
Nanika River	2349	Lake Sockeye	63	1950	1961	2008	2017	15168	10491	-30.8
Nanika River	2321	Pink (Even)	2	1986	1996	1986	1996	12550	12550	0.0
Nanika River	2107	Pink (Odd)	2	1991	1993	1991	1993	1575	1575	0.0
Nichyeskwa Creek	2255	Chinook	17	1953	1962	1960	1994	336	163	-51.6
Nichyeskwa Creek	2208	Coho	18	1953	1962	1961	2005	543	336	-38.2
Nichyeskwa Creek	2322	Pink (Even)	1	1994	1994	1994	1994	50	50	0.0
Nichyeskwa Creek	2108	Pink (Odd)	7	1967	2009	1967	2009	918	918	0.0
Nilkitkwa River	2256	Chinook	3	1960	1962	1960	1962	150	150	0.0
Nilkitkwa River	2209	Coho	16	1960	2007	2004	2017	330	389	17.9
Nilkitkwa River	43	Lake Sockeye	24	1963	1996	2002	2017	174	153	-12.0
Nine Mile Creek	2210	Coho	4	1952	2003	1952	2003	55	55	0.0
Nine Mile Creek	28	Lake Sockeye	63	1950	1961	2008	2017	1490	1115	-25.2
Nine Mile Creek	2323	Pink (Even)	1	1978	1978	1978	1978	15	15	0.0
Nine Mile Creek	2110	Pink (Odd)	8	1973	2009	1973	2009	394	394	0.0
Owen Creek	2211	Coho	23	1950	1963	1968	2001	300	201	-33.1

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Owen Creek	2324	Pink (Even)	1	1972	1972	1972	1972	12	12	0.0
Owen Creek	3191	River Sockeye	1	1995	1995	1995	1995	20	20	0.0
Pierre Creek	2212	Coho	16	1950	1961	1958	1972	156	160	2.8
Pierre Creek	29	Lake Sockeye	67	1950	1959	2008	2017	23542	15191	-35.5
Pierre Creek	2111	Pink (Odd)	3	1977	2013	1977	2013	17	17	0.0
Pinkut Creek	2257	Chinook	1	2008	2008	2008	2008	1	1	0.0
Pinkut Creek	2213	Coho	13	1998	2010	2001	2015	70	79	14.3
Pinkut Creek	2326	Pink (Even)	1	1998	1998	1998	1998	8	8	0.0
Pinkut Creek	2112	Pink (Odd)	2	1999	2001	1999	2001	6	6	0.0
Pinkut Creek-Above Weir	2214	Coho	32	1951	1960	1986	1997	248	64	-74.4
Pinkut Creek-Above Weir	2327	Pink (Even)	5	1968	1996	1968	1996	58	58	0.0
Pinkut Creek-Above Weir	2113	Pink (Odd)	5	1981	1997	1981	1997	25	25	0.0
Porphyry Creek	2328	Pink (Even)	1	1992	1992	1992	1992	30	30	0.0
Porphyry Creek	2114	Pink (Odd)	2	1991	1993	1991	1993	356	356	0.0
Price Creek	2148	Chum	1	1966	1966	1966	1966	25	25	0.0
Price Creek	2215	Coho	14	1959	1974	1969	1978	35	25	-29.2
Price Creek	2329	Pink (Even)	15	1950	1974	1964	1992	1936	160	-91.7
Price Creek	2115	Pink (Odd)	14	1951	1977	1961	1993	659	451	-31.6
Reiseter Creek	2216	Coho	15	1950	1964	1960	1990	159	129	-18.6
Richfield Creek	3363	Chinook	5	1950	1964	1950	1964	58	58	0.0
Richfield Creek	2217	Coho	16	1950	1964	1960	1978	95	144	51.3
SALADAMIS CREEK	5564	Chinook	1	1978	1978	1978	1978	20	20	0.0
Salix Creek	3428	Coho	2	1962	1963	1962	1963	138	138	0.0
Salix Creek	117	Lake Sockeye	32	1950	1966	1993	2004	380	333	-12.3
Shandilla Creek	2330	Pink (Even)	6	1982	1992	1982	1992	183	183	0.0
Shandilla Creek	2116	Pink (Odd)	7	1979	1993	1979	1993	398	398	0.0
Sharpe Creek	2117	Pink (Odd)	1	1991	1991	1991	1991	13	13	0.0
Shass Creek	2218	Coho	17	1950	1962	1960	1971	121	107	-11.1
Shass Creek	30	Lake Sockeye	49	1950	1959	1989	2016	7313	4685	-35.9
Shegunia River	2277	Chinook	26	1950	1981	1989	1998	50	111	122.0
Shegunia River	2219	Coho	15	1950	1983	1970	1992	225	192	-14.8

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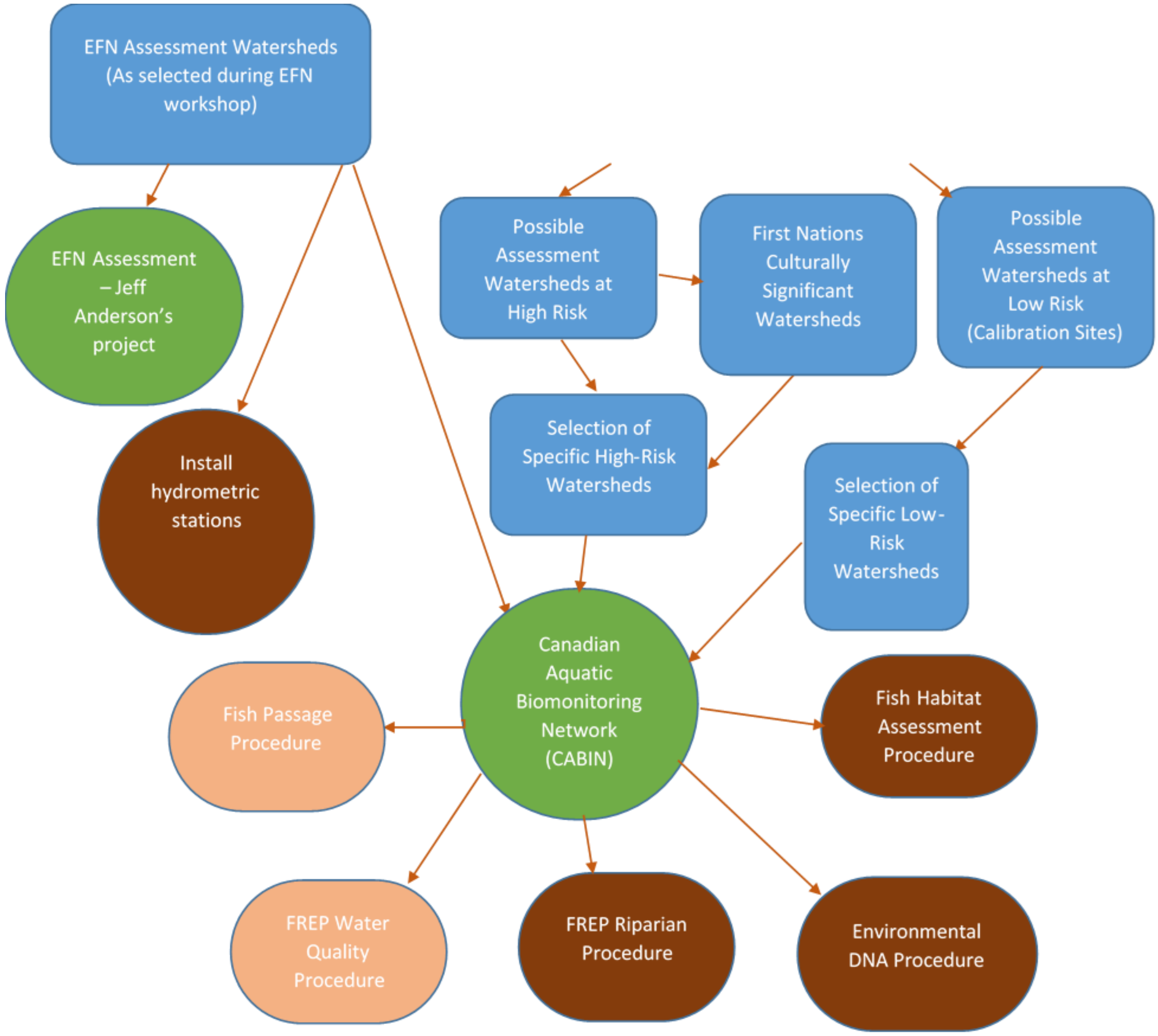
Shegunia River	2331	Pink (Even)	12	1950	1992	1978	1996	883	942	6.6
Shegunia River	2118	Pink (Odd)	10	1979	1997	1979	1997	5836	5836	0.0
Shilahou Creek	2278	Chinook	5	2000	2006	2000	2006	47	47	0.0
Shilahou Creek	3429	Coho	1	2006	2006	2006	2006	50	50	0.0
Shilahou Creek	3239	Lake Sockeye	2	2004	2006	2004	2006	9	9	0.0
Sicintine River	3114	Lake Sockeye	2	1964	1965	1964	1965	100	100	0.0
Simpson Creek	2279	Chinook	8	1998	2007	1998	2007	27	27	0.0
Skunsnat Creek	2220	Coho	37	1965	1974	2003	2013	442	117	-73.5
Skunsnat Creek	2333	Pink (Even)	4	1984	1990	1984	1990	175	175	0.0
Skunsnat Creek	2119	Pink (Odd)	5	1983	1991	1983	1991	1260	1260	0.0
Slamgeesh River	2280	Chinook	5	1978	1988	1978	1988	375	375	0.0
Slamgeesh River	3431	Coho	2	1978	1986	1978	1986	2500	2500	0.0
Slamgeesh River	3240	Lake Sockeye	9	1964	1987	1964	1987	1106	1106	0.0
Slamgeesh River	2334	Pink (Even)	1	1986	1986	1986	1986	700	700	0.0
Slamgeesh River	2120	Pink (Odd)	2	1965	1987	1965	1987	310	310	0.0
Sockeye Creek	31	Lake Sockeye	57	1950	1962	2002	2017	1548	1547	-0.1
Sockeye Creek	2121	Pink (Odd)	1	2005	2005	2005	2005	51	51	0.0
Station Creek	2149	Chum	1	1992	1992	1992	1992	75	75	0.0
Station Creek	2222	Coho	32	1965	1977	2003	2012	50	383	665.6
Station Creek	2335	Pink (Even)	14	1950	1984	1972	1992	471	796	69.0
Station Creek	2122	Pink (Odd)	15	1951	1983	1975	1993	1535	1928	25.6
Steep Canyon Creek	2223	Coho	11	2003	2015	2004	2016	138	120	-12.9
Stephens Creek	2281	Chinook	30	1950	1960	1984	1998	134	93	-30.2
Stephens Creek	2224	Coho	34	1950	1959	1977	1992	165	231	40.2
Stephens Creek	3341	Lake Sockeye	24	1951	1969	1974	1993	377	500	32.6
Suskwa River	2282	Chinook	13	1960	1989	1969	1992	139	74	-47.1
Suskwa River	2225	Coho	20	1958	1969	1970	1992	804	233	-71.1
Suskwa River	2336	Pink (Even)	6	1968	1992	1968	1992	119	119	0.0
Suskwa River	2124	Pink (Odd)	6	1967	1991	1967	1991	1867	1867	0.0
Sustut River	3413	Chinook	12	1978	1994	1984	2016	456	557	22.1
Sustut River	3432	Coho	6	1960	2016	1960	2016	184	184	0.0

Indicator Stream Location	Stream ID	Species	Total Years Surveyed	Date Range (first 10 observations)		Data Range (last 10 observations)		Average (first 10 observations)	Average (last 10 observations)	Change (%)
Sustut River	3342	Lake Sockeye	29	1957	1967	1980	2016	532	1255	135.9
Sutherland River	32	Lake Sockeye	7	1973	2016	1973	2016	663	663	0.0
Swan Lake	3346	Lake Sockeye	4	1993	1997	1993	1997	2000	2000	0.0
Swan Lake Creek	3347	Lake Sockeye	5	1993	2011	1993	2011	526	526	0.0
Swan Lake Creek Unnamed #2	3348	Lake Sockeye	4	2001	2004	2001	2004	173	173	0.0
Sweetin River	2283	Chinook	29	1966	1976	1991	2010	167	189	13.3
Sweetin River	2150	Chum	1	1986	1986	1986	1986	25	25	0.0
Sweetin River	2228	Coho	9	1980	1992	1980	1992	166	166	0.0
Sweetin River	2337	Pink (Even)	6	1980	1992	1980	1992	533	533	0.0
Sweetin River	2125	Pink (Odd)	6	1981	1993	1981	1993	525	525	0.0
Tachek Creek	2229	Coho	2	1950	2003	1950	2003	59	59	0.0
Tachek Creek	33	Lake Sockeye	64	1950	1962	2007	2017	2773	2596	-6.4
Tachek Creek	2126	Pink (Odd)	3	2003	2009	2003	2009	95	95	0.0
Tahlo Creek-Lower	2230	Coho	1	1986	1986	1986	1986	200	200	0.0
Tahlo Creek-Lower	3350	Lake Sockeye	62	1951	1960	2005	2017	6906	9675	40.1
Tahlo Creek-Upper	3351	Lake Sockeye	17	1951	1974	1964	2016	1003	874	-12.9
TCHITIN RIVER	5562	Chinook	8	1976	1993	1976	1993	120	120	0.0
TCHITIN RIVER	5572	Coho	12	1976	1991	1978	1993	156	225	44.0
TCHITIN RIVER	5594	River Sockeye	4	1990	1993	1990	1993	383	383	0.0
Telkwa River	2232	Coho	31	1960	1970	2000	2017	500	6583	1216.7
Telzato Creek	34	Lake Sockeye	4	1959	1970	1959	1970	450	450	0.0
Thautil River	2233	Coho	5	1966	1970	1966	1970	250	250	0.0
Thautil River	2127	Pink (Odd)	1	1987	1987	1987	1987	5000	5000	0.0
Thomas Creek	3637	Chinook	13	1992	2005	1998	2013	185	188	1.2
Thomas Creek	2049	Coho	5	1998	2002	1998	2002	117	117	0.0
Toboggan Creek	2284	Chinook	2	1992	1993	1992	1993	2	2	0.0
Toboggan Creek	2234	Coho	68	1950	1959	2008	2017	581	4400	657.8
Toboggan Creek	2338	Pink (Even)	5	1962	1990	1962	1990	193	193	0.0
Toboggan Creek	2128	Pink (Odd)	6	1959	1991	1959	1991	5510	5510	0.0
Touhy Creek	2235	Coho	1	2009	2009	2009	2009	472	472	0.0
Trapline Creek	3638	Chinook	1	2001	2001	2001	2001	4	4	0.0

Indicator Stream Location	Stream ID	Species	Total Years Surveyed	Date Range (first 10 observations)		Data Range (last 10 observations)		Average (first 10 observations)	Average (last 10 observations)	Change (%)
Trapline Creek	2051	Coho	1	1998	1998	1998	1998	6	6	0.0
Trout Creek	2236	Coho	12	1950	1969	1952	1994	148	155	5.1
Trout Creek	2339	Pink (Even)	2	1962	1964	1962	1964	1800	1800	0.0
Trout Creek	2129	Pink (Odd)	1	1963	1963	1963	1963	1500	1500	0.0
Tsezakwa Creek	2237	Coho	4	1973	1980	1973	1980	47	47	0.0
Tsezakwa Creek	35	Lake Sockeye	29	1959	1998	2008	2017	251	1244	395.0
Tsezakwa Creek	2340	Pink (Even)	2	1978	2000	1978	2000	2	2	0.0
Tsezakwa Creek	2130	Pink (Odd)	8	1977	2017	1977	2017	936	936	0.0
Twain Creek	36	Lake Sockeye	66	1950	1959	2008	2017	8043	3245	-59.7
Twain Creek	2341	Pink (Even)	2	1990	1996	1990	1996	15	15	0.0
Twain Creek	2131	Pink (Odd)	1	1977	1977	1977	1977	12	12	0.0
Twin Lake Creek	2239	Coho	4	1985	1989	1985	1989	18	18	0.0
Twin Lake Creek	2342	Pink (Even)	1	1990	1990	1990	1990	50	50	0.0
Twin Lake Creek	2132	Pink (Odd)	1	1989	1989	1989	1989	50	50	0.0
VAN DYKE CREEK	5573	Coho	6	1979	1985	1979	1985	86	86	0.0
Wesach Creek	2052	Coho	4	1954	1965	1954	1965	250	250	0.0
Wesach Creek	1763	Lake Sockeye	15	1953	1964	1958	1985	1606	463	-71.2
Wilson Creek	2056	Coho	4	1970	1973	1970	1973	50	50	0.0
Wilson Creek	2597	Pink (Even)	4	1968	1978	1968	1978	300	300	0.0
Wilson Creek	1906	Pink (Odd)	2	1971	1983	1971	1983	238	238	0.0
Zymoetz River-Upper	3640	Chinook	1	1960	1960	1960	1960	200	200	0.0
Zymoetz River-Upper	2059	Coho	37	1951	1960	1979	2014	1688	2372	40.6
Zymoetz River-Upper	2065	Lake Sockeye	57	1950	1959	2007	2017	2893	2226	-23.0

Appendix 6 – Tier 1 and 2 linkages



Colour coding

Blue – processes to determine sample watersheds

Green – high priority

Orange – recommended

Brown – to be undertaken based on time and resources

Appendix 7 - Guidance for Implementing the SSAF Fish and Fish Habitat State of the Value Assessment Report

The Skeena Sustainability Assessment Forum (SSAF) Fish and Fish Habitat State of the Value (SoV) Assessment Report is a GIS-based assessment of a series of indicators commonly associated with watershed integrity. This work was undertaken in the Skeena ESI Study Area (Figure 6.4). This assessment is referred to as a Tier 1 assessment of potential risks to watershed integrity. Some level of field assessment has been conducted using a series of protocols (listed below).

When forest activities or land-based prescriptions are being developed (e.g., forest harvesting, road construction, any activity that would create a disturbance in a watershed, or restoration planning) this SoV provides guidance on the potential current condition of a watershed.

Individual indicators in the moderate to high categories should be explored in the field using an appropriate protocol. Some indicators such as a moderate or high equivalent clearcut area should be explored through a watershed assessment. When a series of indicators are in the moderate to high categories this indicates the potential for cumulative effects. This indicates the need for a watershed assessment since individual protocols will not integrate the total potential risks to watershed integrity.

Fish Habitat Assessment Procedure – http://a100.gov.bc.ca/appsdata/acat/documents/r15711/Fish_Habitat_Assessment_Procedures_1229454360370_60d06fb366d66d9a96f0f58ea082db1abc58c0fc1e3805cd799cd37fc0143bdb.pdf

Channel Assessment Procedure – http://www.llbc.leg.bc.ca/public/PubDocs/bcdocs/278791/Channel_assessment_procedure.pdf

FREP Riparian Assessment – https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/integrated-resource-monitoring/forest-range-evaluation-program/frep-monitoring-protocols/fish-riparian

FREP Water Quality Assessment – https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/integrated-resource-monitoring/forest-range-evaluation-program/frep-monitoring-protocols/water-quality

Fish Passage Procedure – culv2000.pdf (gov.bc.ca)

Watershed Assessment – PP Guidelines - Watershed Assessment and Management of Hydrologic and Geomorphic Risk in the Forest Sector V1.0 (egbc.ca)

McQuarrie Creek Trib1393			
Watershed notes: area - 51 km2, forested land - 78%, road length 32 km, stream length 87.4 km, no water licences in this tributary but there is a water licence downstream. Given that low flows are an issue it would be important to ensure that environment flows are maintained possibly through restrictions on water use.			
Colour scheme: black: not an issue unless identified in the field; Yellow: recommended to investigate; Red: should be investigated in the field.			
Indicator	**Score**	**Assessment result**	**Interpretation and possible action**
Salmonid habitat	106 km	level 2	**moderately important fish habitat given the channel length. If possible it would be good to get an estimate on habitat quality and use.**
Salmon spawning	no data		
Salmon escapement	no data		
ECA	7.68%	less than 15% so low	shouldn't be an issue for peak flows
Total land disturbance	9.70%	less than 25% so low	shouldn't be an issue for peak flows
Riparian disturbance (total)	9.7 km or 11%	moderate 5-15%	**although moderate a riparian assessment should be considered**
Young second growth	279 ha or 5.9%	level 2 so shouldn't be an issue	**keep an eye on this indicator because this tributary is identified as flow sensitive in both summer and winter**
Road density	0.68km/km2	medium hazard - 0.4-0.8	**getting close to high. Consideration should be given to road deactivation and carefully considering new proposed roads**
Road stream crossing density	0.8/km2	greater than 0.32/km2	**very high. This should be investigated in the field - are Trim streams really streams - this has been an issue in the past. Based on initial field review this could call for fish passage assessment and FREP Water Quality monitoring**
Road density near streams	0.25 km/km2	greater than 0.16km/km2 - so very high	**very high. This calls for fish passage assessment and FREP Water Quality monitoring**
Road density on steep slopes	0.001 km/km2	low less than 0.06 km/km2	**not an issue but should be explored while investigating the other indicators**
Lakes and wetlands	472ha or 9.4%	moderate 5-10%	**this indicates that lakes and wetlands most likely perform important hydrologic buffering and habitat roles. ESI wetland assessments should be considered to ensure maintenance of these roles**
low flow sensitivity	Summer and Winter - 100%	High	This highlights the need to undertake fish passage assessments
Drainage density ruggedness	1045	(km of streams/area) x relief. Less than 2000 is class 1 or low.	not an issue
Dams and impoundments	0		
Groundwater wells	0		
Water allocation restrictions	0		**see note above about a downstream water licence**
water licences	0		
Mines	1 notice of work	moderate	**it is important to find out what this work entails and why - contact EMPR and Front Counter**
Point source pollution	0		