Skeena Sustainability Assessment Forum's State of the Values Report for Wetlands

Skeena ESI Area

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

Version 2.1. (01.11.2021)

Citation

Skeena Sustainability Assessment Forum's (SSAF) State of the Value Report for Wetlands. 2020. Prepared by Neil Fletcher, Molly Dubé, and Alana Higginson BC Wildlife Federation, Don Morgan Ministry of Environment and Climate Change, Jesse Fraser Ministry of Forests, Lands, Natural Resource Operations, and Rural Development, and Simon Casley and John Arnett Chartwell Consultants Ltd. for the Skeena East Environmental Stewardship Initiative Science and Technical Committee (STC). 150 pp.

Acknowledgements

This report has been endorsed by the Skeena Sustainability Assessment Forum (SSAF), based on the work conducted through the Skeena ESI Science and Technical Committee (STC). STC review and discussions have contributed greatly to this report.

Date	Version #	Author(s)	Description of Changes
March 3, 2020	1.1	NF	First draft prepared by Neil Fletcher and Molly Dubé of BC Wildlife Federation, Simon Casley and John Arnett of Chartwell Consultants Ltd., Don Morgan of ENV, and Jesse Fraser of FLNRORD
April/May 2020	1.1	STC	Incorporation of STC comments into revised draft
May 31st, 2020	1.2	NF	Second draft
June-October, 2020	1.2	STC	Incorporation of STC comments into revised draft
November 6, 2020	1.3	DM, NF, STC	STC review and approval of version 1.2, minor changes needed
November 20, 2020	2.1	DM, NF	Final draft prepared by Don Morgan and Neil Fletcher with assistance from Molly Dubé, and Alana Higginson of BC Wildlife Federation

Table of Contents

Table of Contents 3
List of Figures 4
List of Tables 2
Executive Summary 3
State of the Value Report - Disclaimer 7
Skeena ESI Values 8
1. Introduction 9
1.1 Report Purpose 12
1.2 Report Context and Content 12
2. Wetlands Overview 13
2.1 Wetland General Information 13
2.2 Wetland Conservation Status – Legal Framework 17
2.3 Threats to Wetlands 19
2.4 Cultural Relevance of Wetlands to SSAF Nations 21
2.5 Linkages of Wetlands to other ESI Values 22
3. Overview of Wetland Indicators 23
4. Assessment Results for Each Indicator 25
Watershed Level Analysis 25
4.1 Stressor: Equivalent Clear-Cut Area 25
4.2 Stressor: Point Sources for Pollution 28
4.3 Stressor: Road Density within the Watershed 30
Tier 1: Documented Wetland Analysis 33
4.4 Stressor: Road Density within 100m of wetlands (km/km2) 33
4.5 Stressor: Road Density within 2 km of wetlands (km/km2) 36
4.6 Stressor: % Natural/Semi-Natural within 2 km 37
4.7 Function: Hydrologic Support: Flood Reduction Potential 39
4.8 Benefit: Flood Reduction 44
4.9 Function: Water Purification Potential 45
4.10 Benefit: Water Purification 49
4.11 Function: Aquatic Life Support (Fish) 51
4.12 Function: Wildlife Habitat: Availability of Moose Forage and Screening 52
4.13 Function: Wildlife Habitat: Connectivity 55
4.14 Function: Parks, Protected Areas, and other Wildlife Conservation Designations 60

4.15 Benefit: Cultural Value: Archeological Records or Identified Wetland of Significance to Communities 64
4.16 Benefit: Cultural Value: Accessibility 66
5. Interpretation of Key Drivers of Results 68
5.1 Stressors: Development Poses Potential Impacts to Wetlands in Region 68
5.2 Wetlands and Associated Functions and Values are Variable on the Landscape 69
5.3 Data Paucity for Wetlands 69
6. Monitoring 70
6.1 Tier 2 (i.e., WESP – Skeena Region and Ecological Plots) 70
6.2 Tier 3 - Lake Babine Studies – Indigenous Stewardship Project 71
6.3 Gitanyow Wetland Data Collection 71
6.4 Forest Range Evaluation Program – Wetland Health Assessment 71
7. Potential Next Steps 72
7.1 Improvements to this Assessment 72
7.2 Predictive Wetland Mapping 72
7.3 Targeted Sampling 73
7.4 Management Actions 73
8. Literature Cited 74
APPENDIX A – SUPPLIMENTARY TABLES: 81
APPENDIX B – Data Dictionary (GIS Methodology) 98
APPENDIX C- Common Pressures 144

List of Figures

Figure 1. Illustrative summary of the Skeena Sustainability Assessment Forum five values. Created by Colleen Stevenson from Four Directions Management Services. 8
Figure 2. Skeena Sustainability Assessment Fourm Study Area 11
Figure 3. Distribution of wetlands (green polygons) within Study Area. The watersheds depicted here are coloured by major watershed group: light yellow: Skeena; light blue: Nass; light green: coastal; light pink: Peace; light purple: Stuart; light grey: Nechacko; off-white: other Fraser tributaries. The Yellow Line represents the SSAF Study Area. 14
Figure 4. Conceptual model for linkages between human activities/natural processes and wetland functions. 20
Figure 5. Indicator 4.1 Equivalent Clear-cut Area (ECA) Indicator. ECA within Watershed Assessment Units colour coded as High (Orange >20% ECA), Medium (Yellow <20% & >15% ECA), and Low (Green <15% ECA). 27
Figure 6. Map of number of point source pollution within Watershed Assessment Unit, where 0 (dark green), 1 (mid-green), 2 (light green), 3-4 (yellow), 5-10 (orange), >10 (red). 29
Figure 7. Bar graph of number of source points for pollutants and the number of impacted wetlands. 30

Figure 8. Map Road Density of Skeena regions, where green represents Low Density (<0.4 km/km2); yellow represents Moderate Density (0.4 – 1.2 km/km2); orange represents High Density (>1.2 km/km2).
Figure 9 Map Road Density within buffer of 100 m of wetlands, where green represents Low Density (<0.08 km/km2); orange represents Moderate Density (0.08 – 0.16 km/km2); red represents High Density (>0.16 km/km2). 34
Figure 10. Map Road Density within 2km of wetland, where green represents Low Density (<0.40 km/km2); orange represents Moderate Density (0.40 – 1.2 km/km2); red represents High Density (>1.2 km/km2). 37
Figure 11. Map of intactness of landscape within 2km of wetlands, where green represents Low Threat (>90 % Natural/Semi-Natural); orange represents Moderate Threat (60-90%Natural/Semi-Natural); red represents High Threat (<60% Natural/Semi-Natural). 39
Figure 12. Map of flood reduction potentials, where green represents "High", yellow represents "Medium", orange represents "Low", and red represents "Very Low to Zero" 42
Figure 13. Examples of waterflow path in Lower Dean River region, where Green = "Throughflow"; Purple = "Outflow"; Yellow = "Vertical Flow"; Red = "Inflow"; Pink = "Bidirectional Flow". 43
Figure 14. Map of flood reduction benefit of wetlands for societal assets 5 km downstream, where red shows "No Societal Asset 5 km Downstream of Wetland", orange shows "Fish Habitat 5 km Downstream of Wetland", and green shows "Community and Fish Habitat 5 km Dow 45
Figure 15. Map of water purification function of wetlands by region, where green represents High Functioning, orange represents Medium Functioning, and red represents Low Functioning wetlands. 47
Figure 16. Map of water purification benefits of wetlands to societal assets 5km downstream, where green represents High Benefit, orange represents Medium Benefit, and red represents Low Benefit. 50
Figure 16a. Histogram of water quality score for the wetlands located upstream of important assets, such as communities, fish habitat and homes in the Skeena region. 51
Figure 17. Map showing the ability of wetlands to support aquatic life, where green is "High", orange represents "Moderate", and red represents "Low". 52
Figure 18. Wetlands that have suitable moose forage material (orange polygons). 54
Figure 19. Proportion of wetlands that have suitable moose forage materials. Green = proportion of wetlands that are categorized as high value moose forage. Red = proportion not categorized as high value moose forage 55
Figure 20. Landscape Connectivity – Mature and Old Forests within 2 km (green), target wetland blue. 57
Figure 21. Map showing the proportion of wetlands that pass the minimum threshold of mature and old growth forest within 2km of wetlands (green) compared to wetlands that do not (red). 58
Figure 22. Map showing the wetlands that are located within parks, protected areas, existing or proposed ungulate winter range, or Wildlife Management Areas. 61
Figure 23. Map showing the proportion of wetlands that are located within parks, protected areas, existing or proposed ungulate winter range, or Wildlife Management Areas (green) compared to those that are not (red). 62
Figure 24. Map showing the wetlands that have a site of archaeological significance within 500 m. 65
Figure 25. Map showing the number of wetlands that have a site of archaeological significance within 500 m compared to the number of wetlands that do not. 66
Figure 26. Map that shows the level of accessibility to wetlands, where green represents "High Accessibility", orange represents "Moderate Accessibility", and red represents "Low Accessibility". 68

List of Tables

Table 1a. Wetland polygons by size class within ESI Skeena East Study Area. 15
Table 1b. Wetland polygons by Nation and Watershed Group within the ESI Skeena East Study Area. ... 16
Table 2. Description of wetlands by biogeoclimatic zone and variant. 17
Table 3. Overview of wetland indicators with descriptor. 23
Table 4. Percent of land area and corresponding road density values. 35
Table 5. Flood reduction potential by BEC zone. 43
Table 6. Watersheds by region with granitic bedrock. 48
Table 7. Minimal targets for mature and old forest coverage (Skeena Region in bold). Minimal targets for mature and old forest coverage (Skeena Region in bold). Source: Parminter, J. 1995. Biodiversity Guidebook - Forest Practices Code of British Columbia. B.C. Min. For. And B.C. Environ., Victoria, B.C. .. 56
Table 8. Percent breakdown, by Watershed Group, of wetlands that meet mature and old growth forest cover targets within 2 km. 58
Table 9. Wetlands "protected" by watershed group. 63

Executive Summary

Wetlands have an outsized importance on the landbase; they are small features, yet are ecosystems that bridge the terrestrial (e.g., forests) and aquatic (e.g., streams and lakes) realms. Among the services they provide to society for free, wetlands can: filter water, attenuate floods, and support a variety of wildlife species which have important spiritual, cultural, and economic importance (e.g., moose & fish). First Nation communities have long recognized these areas as being significant locations to gather medicines, foods, and as special places with spiritual significance. The Skeena Sustainability Assessment Forum's (SSAF) State of the Values (SoV) Report for Wetlands provides an overview of the current condition of wetlands in the SSAF study area and describes some of their key attributes.

The framework includes stressors, functions, benefits, & cultural elements, and is displayed as follows:

- potential **stressors** that may impact wetlands (i.e., road density at the watershed assessment unit scale, road density within 100m and 2000m of wetlands, equivalent clear-cut area at the watershed assessment unit scale, point sources for pollutants, and % un-natural landbase).
- relative capacity for wetlands to perform specific hydrological and habitat **functions** (i.e., hydrological functions include flood attenuation and water purification; habitat includes: aquatic life (fish) support, moose browse and screening, connectivity to mature and old forests relative to ecological targets, and percent protected).
- relative **benefit** of a wetland's ability to perform a function (e.g., shown as hydrological benefits of flood reduction potential and water purification protection for downstream communities or societal assets), and
- relative **cultural** significance (e.g., ease of access and documented archeological sites)

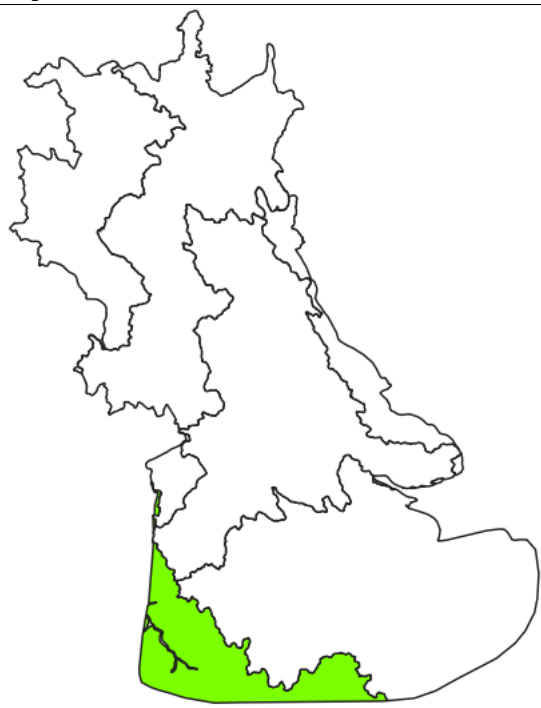
In the following pages of this Executive Summary, the results of this study are displayed as a dashboard for the 5 major SSAF watersheds (i.e., Coastal, Nass, Nechako/Fraser, Skeena East, and Skeena West). Stressors are presented as box plots where large vertical lines represents the median, whiskers represent the 5^{th} and 95^{th} percentiles, and dots are outliers. The function, benefit, and cultural indicators are presented as bar charts with distribution of wetlands categorized into levels of performance by high, medium, low, or zero categories.

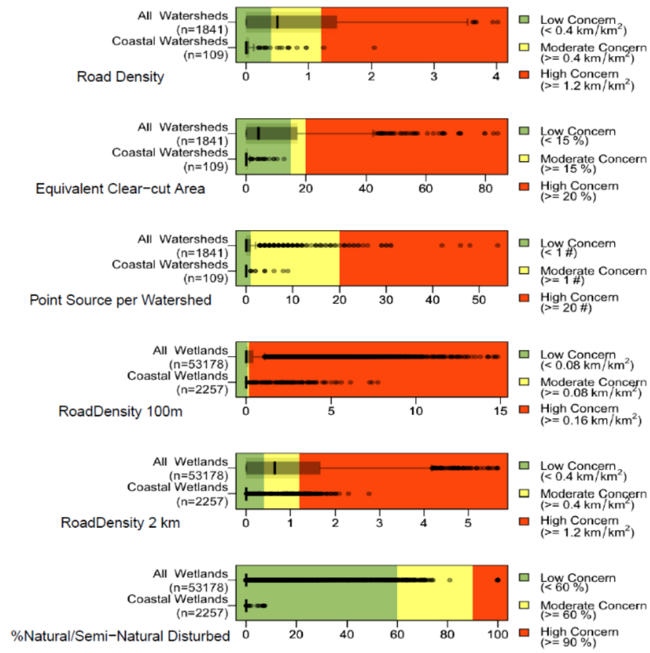
This SoV report is a coarse filter assessment, referred to as a Tier 1 assessment, that is based on our current knowledge of readily available data that spans the entire SSAF study area. Complimentary initiatives will enhance our understanding of the state of wetlands by collecting and analyzing information from direct analysis and observations (Tier 1.5, 2, 3). Tier 1.5 involves detailed remote sensing analysis from a subsample of wetlands to help calibrate a Wetland Ecosystem Services Protocol (a more detailed functional and benefit assessment tool). Tier 2 involves relatively rapid field assessments to gather ecological, functional, and stressor information from a subsample of wetlands to calibrate a Wetlands Ecosystem Services Protocol and improve/validate the wetland model. Tier 3 involves more intensive studies to answer specific management questions, such as the studies on wetlands within Lake Babine.

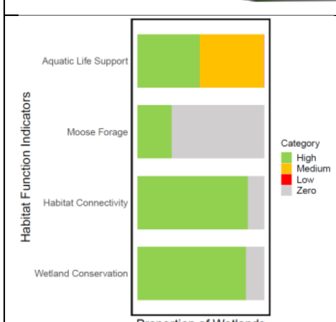
When combined with the other Tiers of information and the other SoV reports, this resport is a source of information that can be used to support decision making. Information provided within the report, and the associated database that was developed through this process, can be reframed to support decision makers - contingent on the specified management needs.

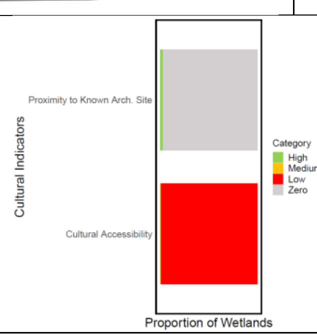
Coastal Unit Summary

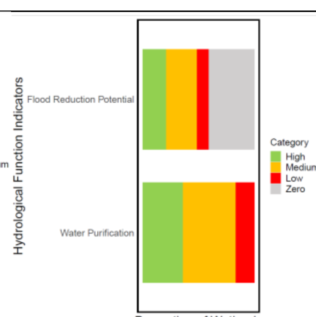
The Coastal Unit contains the fewest wetlands in the SSAF study area (i.e., 2248[1] documented wetlands, 14,520 Ha of wetlands (4.2%)). Wetlands are located primarily in BEC zones: ESSFmc, SBPSmc, and SBSmc2. Wetlands in the Coastal Unit have relatively less intense stressors, such as a lower density of roads and lower percent of Equivalent Clear-cut Area within the nested watershed assessment units. A relatively high proportion of wetlands are conserved through land-based conservation measures (e.g., parks, protected areas, ungulate winter range). There is relatively high habitat connectivity of Mature and Old Forests near wetlands. Approximately half of the wetlands are connected to fish bearing streams, and the remainder are within 5 km of a fish bearing stream. Wetlands in this Unit are relatively inaccessible to settlements and far from roads for human/cultural uses. Like most of the other Units, only a small fraction are associated with documented archeological sites within 500m, but this finding is assumed to largely underestimate the historic and current use by Indigenous communities, and primarily speaks to the lack of information publicly available. For hydrologic performance, the Coastal Unit has a moderate level of performance relative to other regions in terms of Flood Reduction Potential with about half of the wetlands performing this service (i.e., ranging from low to high function) and relatively low Water Purification function due to steep terrain and granitic bedrock.

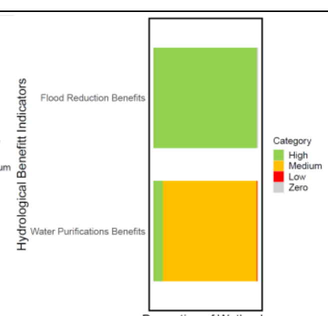








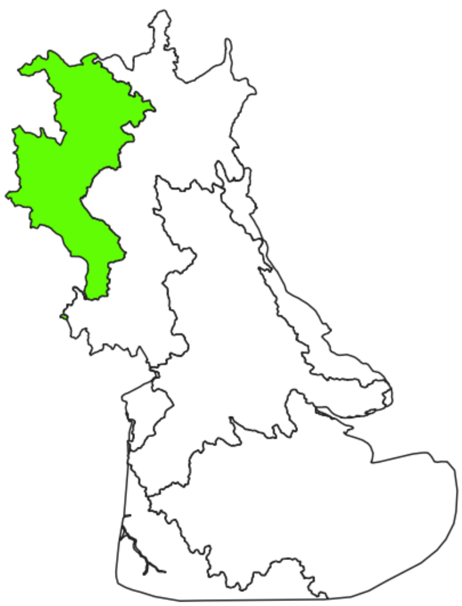


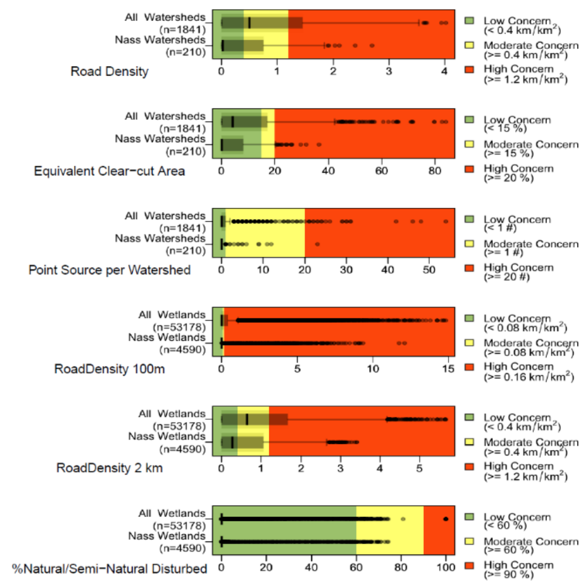


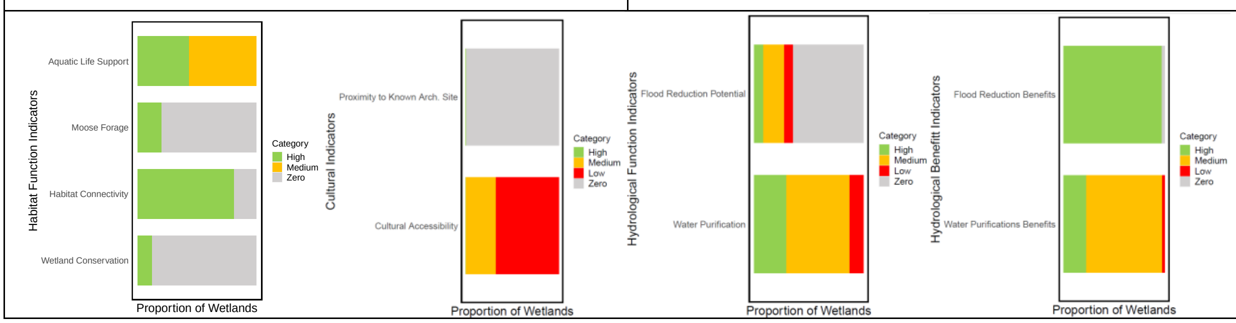
[1] Includes only wetlands within the SSAF area, the analysis results presented uses all wetlands that intersect the SSAF area.

Nass Unit Summary

The Nass Unit contains the second smallest proportion of wetlands out of all wetlands in the SSAF study area (i.e., 4467[1] documented wetlands, 17,013 Ha of wetlands (8.6%)). Wetlands are located primarily in BEC zones: ICHmc1, MHmm2, and ESSFwv. Compared to the entire SSAF study area, wetlands in the Nass Unit have relatively less intense stressors, such as a lower density of roads and lower percent of Equivalent Clear-cut Area within associated watershed assessment units. Slightly less than half of the wetlands are connected to fish bearing streams, and the remainder are within 5 km of a fish bearing stream. A relatively small number of wetlands are close to roads and within 50 km of a community enabling human/cultural use Like most of the other Units, only a small fraction of wetlands are associated with documented archeological sites within 500m, but this finding is assumed to largely underestimate the historic and current use by Indigenous communities, and primarily speaks to the lack of information available. For hydrologic performance, wetlands in the Nass Unit generally have a lower level of performance relative to other regions in terms of Flood Reduction Potential with less than half of the wetlands performing this function to some degree, and lower Water Purification Potential due to steeper terrain.

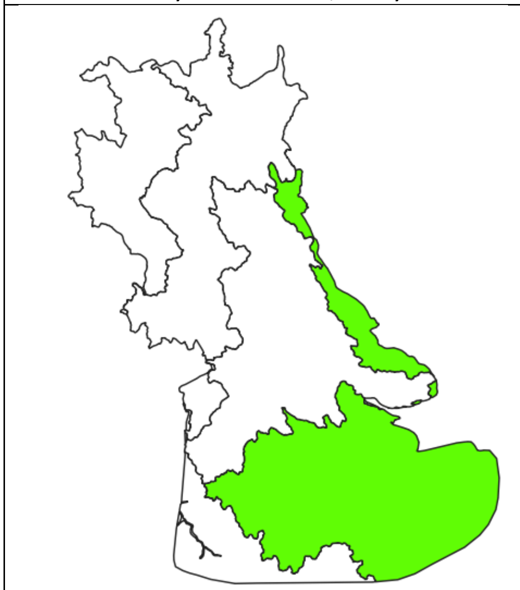


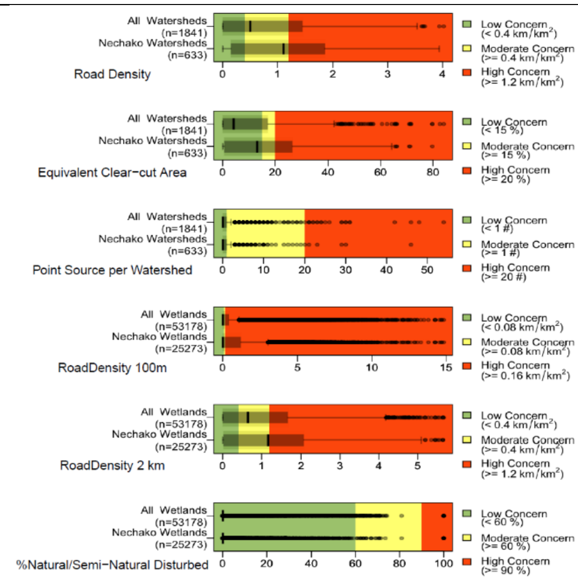


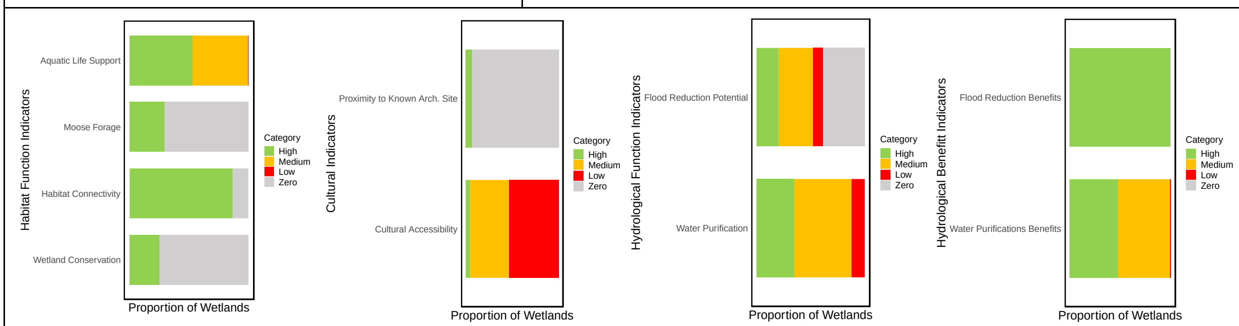


Nechacko/Fraser Unit Summary

The Nechacko/Fraser Unit contains the highest number of wetlands in the SSAF study area (i.e., 25,201[1] documented wetlands, 168,802 Ha of wetlands (47.5%)). Wetlands are located primarily in BEC zones: SBSmc2, SBSdk, and ESSFmc. Wetlands in the Nechacko/Fraser Unit have relatively more pronounced stressors, such as a higher density of roads and higher percent of Equivalent Clear-cut Area within the nested watershed assessment units. This unit ranks second with a relatively higher proportion of wetlands conserved through land-based conservation measures (e.g., parks, protected areas, ungulate winter range). Despite the higher ECA, the quantity of Mature and Old Forests near wetlands generally conforms to target thresholds for landscape objectives; this is possibly because the threshold for the SBS zone is set lower due to a more frequent Natural Disturbance Regime. Approximately half of the wetlands are connected to fish bearing streams, and the remainder are within 5 km of a fish bearing stream. Wetlands in this Unit are relatively accessible to settlements or close to roads for human/cultural uses. Like most of the other Units, only a small fraction are associated with documented archeological sites within 500m, but this finding is assumed to largely underestimate the historic and current use by Indigenous communities, and primarily speaks to the lack of information available. For hydrologic performance, the Nechako/Fraser Unit has a slightly elevated level of performance relative to other regions in terms of Flood Reduction Potential and Water Quality Purification, likely attributed to the less mountainous terrain.

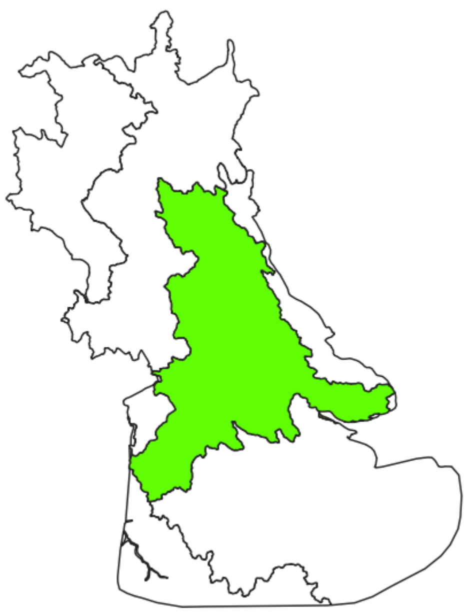


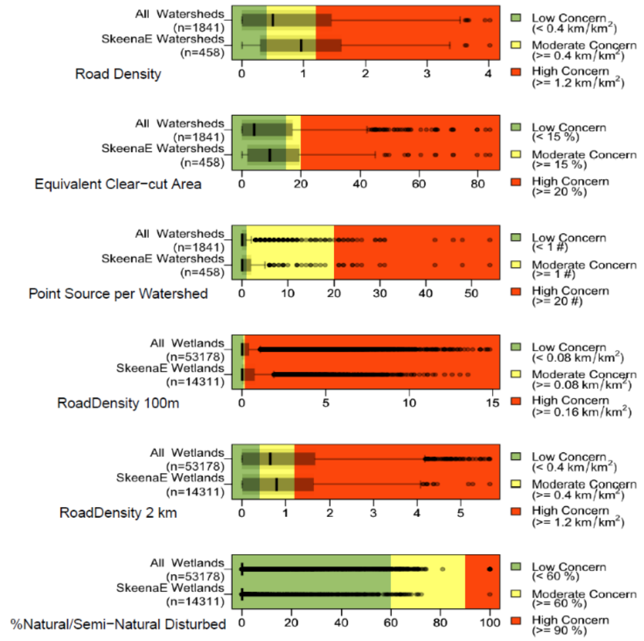


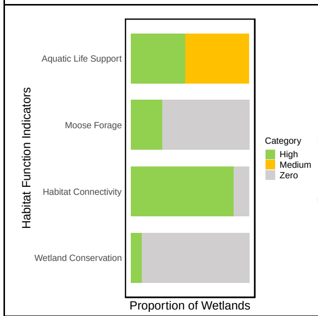


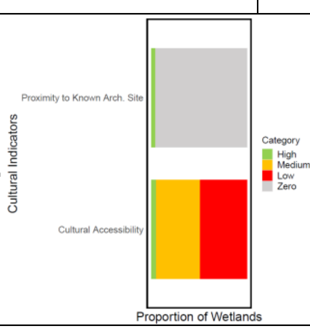
Skeena East Unit Summary

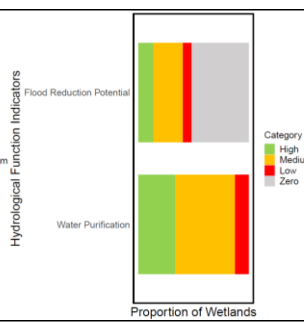
The Skeena East Unit contains the second highest proportion of wetlands out of all wetlands in the SSAF study area (i.e., 14,298[1] documented wetlands, 100,750 Ha of wetlands (27%)). Wetlands are located primarily in BEC zones: SBSmc2, ESSFmc, and SBSdk. Wetlands in the Skeena East Unit have relatively more pronounced stressors, such as a higher density of roads and higher percent of Equivalent Clear-cut Area within the nested watershed assessment units. A relatively lower proportion of wetlands are conserved through land-based conservation measures (e.g., parks, protected areas, ungulate winter range). Slightly less than half of the wetlands are connected to fish bearing streams, and the remainder are within 5 km of a fish bearing stream. Wetlands in this Unit are relatively more accessible to settlements or close to roads for human/cultural uses. Like most of the other Units, only a small fraction are associated with documented archeological sites within 500m, but this finding is assumed to largely underestimate the historic and current use by Indigenous communities, and primarily speaks to the lack of information available. For hydrologic performance, the Skeena East Unit has a moderate level of performance relative to other regions in terms of Flood Reduction Potential, with slightly less than half of the wetlands performing this function; Water Purification function also perform moderately.

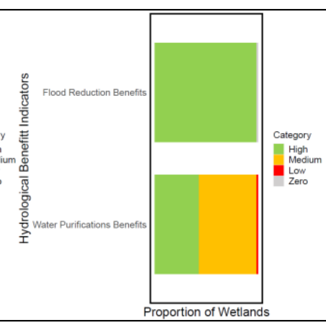






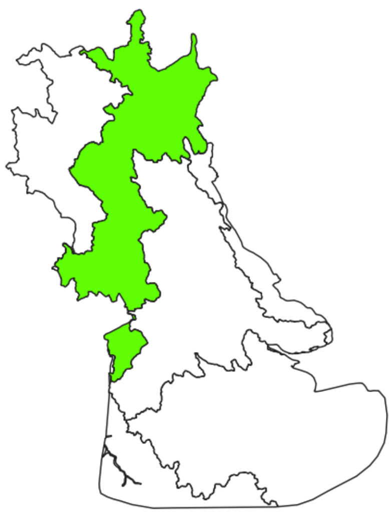


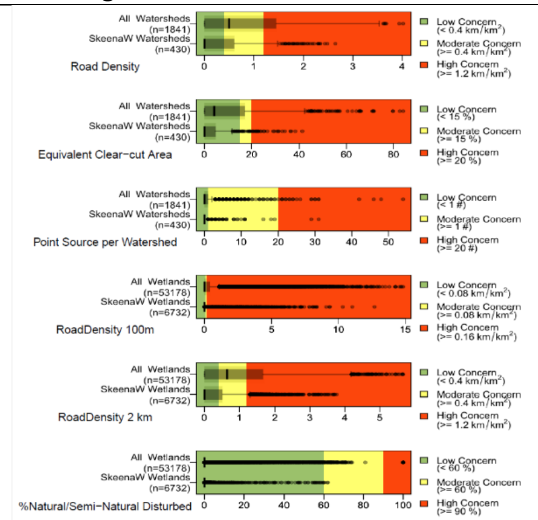


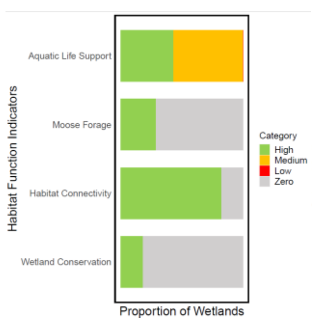


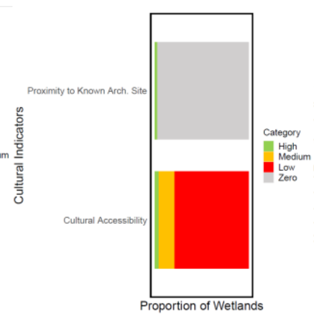
Skeena West Unit Summary

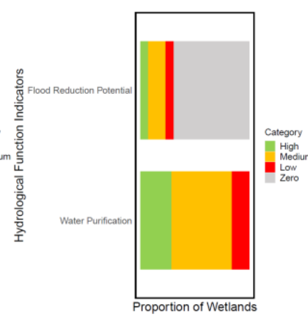
The Skeena West Unit contains the third highest proportion of wetlands out of all wetlands in the SSAF study area (i.e., 6,712[1] documented wetlands, 46,500 Ha of wetlands (12.7%)). Wetlands are located primarily in BEC zones: ESSFwv, ESSFmc,SBSmc2, and ICHmc1. Wetlands in the Skeena West Unit has relatively less pronounced stressors, such as a lower density of roads and lower percent of Equivalent Clear-cut Area within the nested watershed assessment units. A significant proportion of wetlands are conserved through land-based conservation measures (e.g., parks, protected areas, ungulate winter range). Slightly less than half of the wetlands are connected to fish bearing streams, and the remainder are within 5 km of a fish bearing stream. Many of the wetlands in this Unit are relatively inaccessible to settlements and are far from roads for human/cultural uses. Like most of the other Units, only a small fraction are associated with documented archeological sites within 500m, but this finding is assumed to largely underestimate the historic and current use by Indigenous communities, and primarily speaks to the lack of information available. For hydrologic performance, the Skeena West Unit has a low level of performance relative to other regions in terms of Flood Reduction Potential with about a third of the wetlands performing this service.

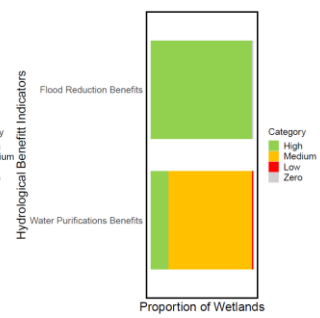












State of the Value Report - Disclaimer

The Skeena Sustainable Assessment Forum (SSAF) Wetland State of the Value Report (SOV) 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 Nation, 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 wetlands in the SSAF study area (see Figure 2). The other sections of the SSAF wetlands program include the Wetland Ecosystem Services Protocol (WESP; Tier 2), Tier 1.5 assessment methods (see Introduction Section for further details), and Tier 3 wetland research conducted by Lake Babine Nation. 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, impacts, and conditions of wetlands across the SSAF study area; the other three components of the SSAF's wetlands program are integral pieces to understand what is happening on the ground and at the individual wetlands level.

The results presented here are intended to inform understanding of the stressors, sensitivity, and functioning condition of wetlands in the SSAF study area, and do not constitute specific management direction. Further research, such as the research undertaken by Lake Babine Nation, is needed to validate the indicator results as presented here and to determine next steps for management and conservation of wetlands.

Information and data used in the development of this report are current to report initiation and are of the highest quality that was readily available.

The SSAF Scientific and Technical Committee acknowledges the knowledge keepers and recognizes that further work is required to reflect the cultural importance of wetlands for food, social, and ceremonial value. A linked project 'Cultural Indicators for the Skeena Enviornmental Stewardship Initiative' is providing a cultural lens to the SSAF Wetland program in the hopes of improving future state of the value reports for wetlands in the SSAF study area.

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 with 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 true collaboration between the Province and First Nations in the northern areas of the Province. The collaborative approach that has been developed through ESI incorporates western science and Indigenous knowledge and is working towards shared principles in 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 Nation, 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 five environmental values selected by the SSAF Project Team are: **Wetlands**, Grizzly Bear, Fish and Fish Habitat, Moose, and Medicinal Plants. Wetlands have almost universal cultural, ecological and economic significance (Gardner et al. 2018). Under phases 1 and 2 of the SSAF work plan, SSAF member Nations conducted First Nations community workshops and a conference to engage community members about local knowledge related to the SSAF values. Following these workshops, Four Dimensions Management Services provided an overview of what First Nation community members believe constitutes healthy wetlands, impacts and pressures, protection opportunities, and cultural uses (included below in Section 2.4).

The SSAF is using a multi-scale approach to assessment and monitoring, and refers to these as Tier 1, Tier 1.5, Tier 2, and Tier 3. 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 function characteristics (e.g. connectivity) or threats (e.g. Mines). The other scale is termed a Tier 2 assessment and is informed by field-based surveys of the condition (e.g. capacity to filter water) or pressures (e.g. land clearing adjacent to wetland) on values. Whereas the Tier 1 assessment provides a high-level overview of the entire SSAF area, the Tier 2 assessment provides detailed information that results from monitoring that is conducted at specific sites selected based on a combination of statistical design and identified importance (e.g. of high cultural or salmon value). The intent of Tier 2 monitoring is to better understand the condition and pressures at a site level. This detailed information can then be extrapolated to the Tier 1 assessment to help with the interpretation of the information presented at the landscape level. The intermediate scale between Tier 1 and Tier 2 is Tier 1.5; this tier is used to better inform Tier 2 monitoring. The Tier 1.5 scale is used to evaluate wetlands, such that a wetland selected for Tier 2 monitoring is evaluated in more detail using remotely sensed data, such as satellite imagery and more detailed summary of the hydrological characteristics by evaluating the condition of a wetland's catchment. Lastly, there is a Tier 3 where the focus is on research. For example, Lake Babine Nation undertook Tier 3 assessment of wetlands which included a more detailed evaluation of the wetland's water table through the use of Piezometers. Over time, the learnings from Tier 3 can be incorporated into the Tier 1 and 2 assessments.

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 wetland projects in the Skeena Region (ERM 2016a, ERM 2016b, Fletcher and Adamus 2019, Morgan 2020a, Morgan 2020b, Gitxsan Environmental Services 2020, Fletcher 2020). SSAF Wetland program includes a Tier 1.5 assessment method to provide more detailed information for specific wetlands that are being considered for field-based monitoring (Fletcher 2020). Skeena East ESI also has a Tier 2 monitoring component, termed the wetland functional assessment tool or Wetland Ecosystem Services Protocol (WESP; Fletcher and Adamus 2019, Morgan 2020b). The intent of the WESP is to provide a relative score/value of a wetland that can be used, for example, to inform decisions related to the compensation offsets that would be required if the wetland is impacted from a development activity. This can provide a market-based mechanism whereby the development may not proceed if the associated replacement costs of impacting a highly valuable wetland is too high. The SSAF can use the Tier 1, Tier 1.5 and Tier 2 methods and results to inform knowledge gaps, to identify further projects, and to better understand and communicate risks to wetland health from human impacts and climate change.

The assessment and monitoring work done under the SSAF will support the setting of SSAF wetland 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 wetland outcomes. Wetland objectives may include maintaining the range of wetland ecosystem services. Ongoing monitoring can be implemented to determine trends in wetland health and responses to resource management and environmental change. See Figure 1 for the extent of the Study Area and the watershed groupings used to summarize wetland indicators. Watershed groupings were determined using the BC Government's Freshwater Atlas Dataset.

This State of Values report focuses on the wetlands value. Chapter 2 starts with an overview of wetlands and wetland classes and presents some of the basic summary information regarding their distribution within the Study Area (Figure 2). Chapter 3 introduces the indicators that were developed to further assess the threats, functions, and benefits associated with wetland ecosystems. Chapter 4 provides a more detailed overview of each indicator and summarizes the results of the analysis. Chapter 5 discusses some of the key drivers of the assessment. Chapter 6 describes current monitoring activities that relate to wetlands in the region. Finally, Chapter 7 investigates some potential next steps.

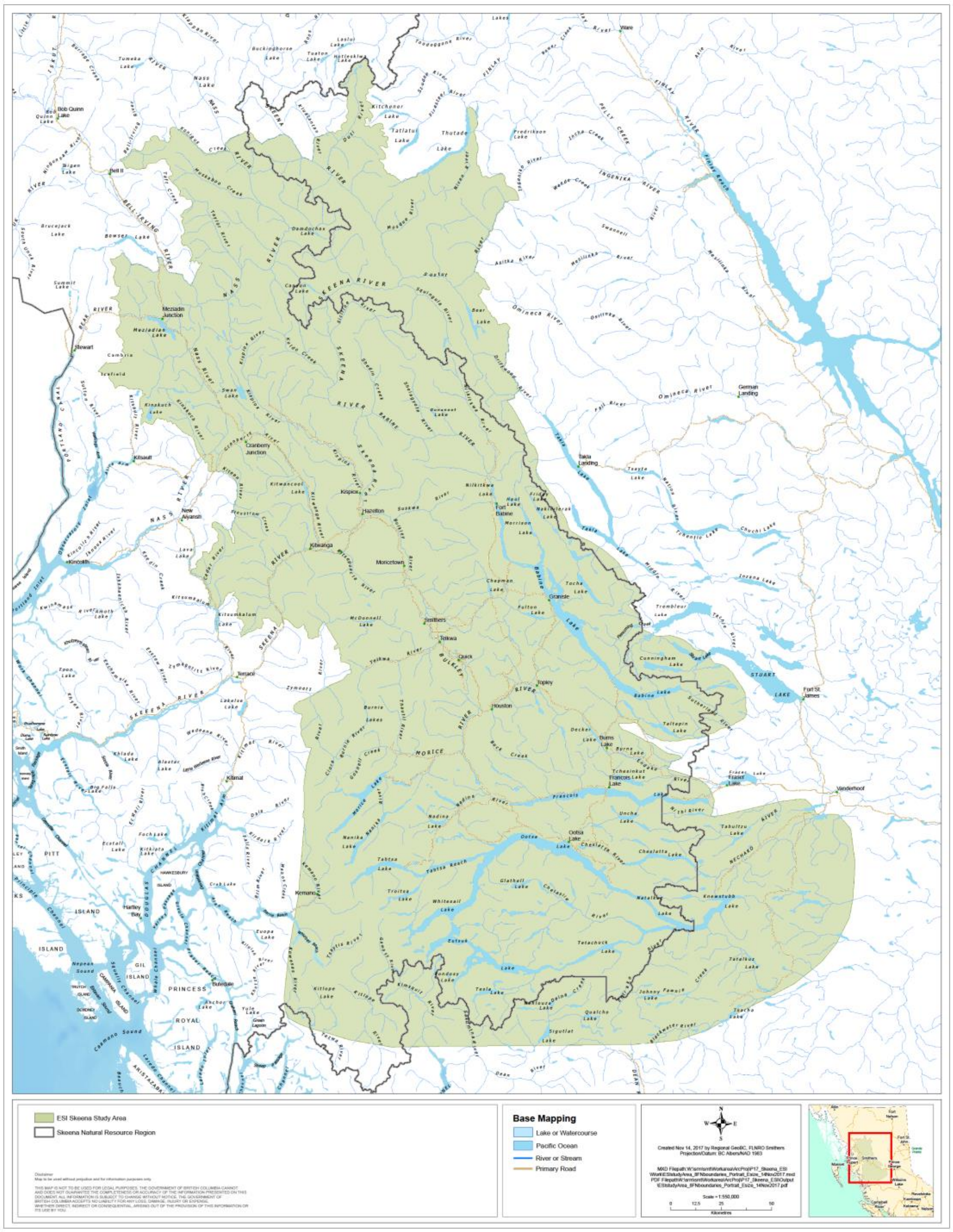


Figure 2. Skeena Sustainability Assessment Fourm Study Area

1.1 Report Purpose

The primary purpose of this report is to provide an overview of the current condition of wetlands in the SSAF area. It also provides recommendations for future Skeena ESI expenditures on wetlands and wetland monitoring, building on work already conducted (Fletcher and Adamus 2019, Morgan 2020a, Morgan 2020b, Gitxsan Environmental Services 2020, Fletcher 2020). Thirdly, the report, plus further investigation and analysis of the results by the Skeena ESI, is intended to help inform the array of resource management decisions that impact the conservation and management of wetlands 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

Wetland monitoring and assessment is carried out to understand the function, condition, and threats to wetlands.

The SSAF looks to Indigenous knowledge to better inform the 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 or developed, reviewed, and agreed-upon by SSAF members. Secondly, this report is an example of enhancements made to Provincial CEF reports, such as the Aquatic Protocol, through incorporation of a regional, local as well as Indigenous knowledge. Thirdly, throughout this report, the SSAF has included SSAF-specific perspectives on each of the indicators, including a specific section on the cultural relevance of wetlands (see section 2.4 below).

This report provides a current condition report on wetlands. The report uses an assessment methodology that examines wetlands using 16 indicators of current conditions. The assessment is based on 2018 data and methodology as outlined in the SSAF Wetland Landscape Level Assessment Procedure (Fletcher 2019). 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 overview of wetland ecology, threats, First Nation and Government objectives and legal protection tools relevant to wetlands;
- an overview of indicators and methods used to assess the current condition of wetlands in the Skeena ESI, including limitations of the assessment;
- results for each indicator, including descriptive maps, interpretation of those maps, and links to further detailed maps and data;
- a summary of the results and key contributing factors influencing the results;
- a summary of other information on the current condition of wetlands in the Skeena; and
- a summary of opportunities to enhance wetland functioning condition in the Skeena based on the results outlined in this report.

2. Wetlands Overview

Wetlands are unique ecosystems that bridge the interface of terrestrial and aquatic realms of our landscape. One of the most basic ways of describing them is that they are, very simply: lands that are wet. Ecologists look for three ingredients to delineate a wetland: water, soil, and plants. Water needs to be slightly above (up to 2 m), slightly below (within 0.3 m), or at the surface for a prolonged enough period throughout the year to affect the conditions of the two other ingredients: the soils and the plants. When soils are inundated with water for a prolonged period, the soils exhibit characteristics that are different than their terrestrial counterparts. Mineral soils often change color as the iron and manganese are chemically reduced throughout the soil matrix (i.e., the soil profile takes on a blue/grey or mottled appearance). When persistently inundated, organic soils build up because the lack of oxygen inhibits and slows down the rate of organic soil decomposition. Plant communities are often also drastically different in wetlands, in comparison to their terrestrial counterparts, as they are composed of hydrophytic vegetation (i.e., water loving plants) (Warner and Rubec 1997).

Within the BC Wetland classification system (which closely is modelled from the Canadian Wetland Classification System), there are five major freshwater wetland classes (Mackenzie and Moran 2004). Bogs are dominated by poorly decomposed organic soils built up by sphagnum moss. Fens also have poorly decomposed organic soils, but sphagnum moss is less pronounced, and instead the plant community tends to be dominated by graminoid species - primarily sedges. Since bogs and fens are often situated on thick layers of poorly decomposed organic soils they are commonly referred to as peatlands; and large tracts of peatlands are sometimes referred to as muskeg. Marshes are defined as having non-woody emergent plants (e.g., cattails, sedges, grasses) with either well decomposed organic soils or inorganic soils. Swamps, on the other hand, are characterized as having woody plants such as shrubs and trees that dominate the canopy, while their soils are similar to marshes (i.e., well decomposed organic soils or inorganic soils). Lastly, shallow open water wetlands are characterized by the plant assemblage having floating or submerged aquatic vegetation. The five wetland classes can further be categorized based on their unique plant associations (Mackenzie and Moran 2004). Variances in water depth, pH, seasonal fluctuations, climate, and nutrients can influence the type of wetland that develops on a site over time (Mackenzie and Moran 2004, Warner and Rubec 1997).

Documented wetlands cover 4.3% of the of the SSAF Study Area; with a small footprint, these ecosystems are disproportionately important for the many values that they provide.

The wetlands analyzed within this study were based on two BC wide datasets: the BC Freshwater Atlas (i.e., Wetlands Layer) and the Vegetation Resource Inventory (i.e., BCLCS Level 3 = W). Prior to analysis, these two layers were merged, and any internal wetland boundaries were dissolved in order to treat these systems as wetland complexes.

2.1 Wetland General Information

There are a total of 56,709 documented wetland complexes, that total 383,740 hectares (1 hectare = 100m x 100m), within the ESI Skeena East boundary. Wetlands cover 4.3% of the land-base in the Study Area. In this report watersheds are used to summarize information on wetlands. The SSAF contains parts of the Skeena, Nass, Coastal, Peace-Williston, Fraser-Stuart, ‘Major Watershed Regions’, these are further subdivided into ‘Watershed Groups’, which are collections of smaller ‘Watershed Assessment Units’. Presenting wetland indicators by Watershed Group provides a summary of Watershed Assessment Unit or individual wetlands, detail on individual wetlands is available in the wetland assessment geospatial data set. As shown in Figure 2, the distribution of wetlands, within Major Watershed Groups, is more scattered and abundant to the east of the Study Area where the terrain is relatively flatter in the Nechako, Stuart and eastern portion of the Skeena watershed. On the other hand, wetlands are clustered primarily along valley bottoms and rivers further west where the terrain is more mountainous in the Nass, Coastal and western portions of the Skeena watershed.

Figure 3. Distribution of wetlands (green polygons) within Study Area. The watersheds depicted here are coloured by major watershed group: light yellow: Skeena; light blue: Nass; light green: coastal; light pink: Peace; light purple: Stuart; light grey: Nechacko; off-white: other Fraser tributaries. The Yellow Line represents the SSAF Study Area.

Within the Study Area, the size of wetlands varies substantially with the majority being less than 2 hectares in size (Table 1a). Of note, two massive wetland complexes are greater than 1000 hectares in size: a complex in the Sustut Watershed (3443 ha), and the other straddling Babine Lake and Babine River Watershed Groups (1471 ha).

Table 1a. Wetland polygons by size class within ESI Skeena East Study Area.

Hectares	Count
< 1	20937
1 < 2	9754
2 < 5	12300
5 < 10	6483
10 < 20	3831
20 < 50 ha	2240
50 < 100 ha	704
100 < 250	346
250 < 500	85
500 < 1000	27
1001 < 3444	2
Total	56709

As various First Nations work towards conserving wetlands within their traditional territories, Table 1b offers an overview of wetlands, in terms of both numbers of wetland complexes and their size (in hectares), by Watershed Groups and First Nation boundary. The objective of developing this table was to display this information in a format which may be more relevant for individual Nations. To simplify the report in terms of information dissemination, most of the remainder of this document displays information for the entire Study Area, but conducting subsequent analysis for a subset of the area, such as a specific First Nation territory is possible based on the datasets that were developed.

Table 2 provides a breakdown of wetlands by biogeoclimatic classification and variant. Of note, most of the wetlands occupy the ESSFmc (53,069 hectares ~ 13.8% of wetlands by area within the Study Area), SBSdk (55,960 ~ 14.6%), and SBSmc2 (114,207 ~ 29.7%), with smaller percentages spread across the other zones and variants.

Table 1b. Wetland polygons by Nation and Watershed Group within the ESI Skeena East Study Area.

	Witset		Wet su wet en FN		Gitxsan Hereditary Chiefs		Lake Babine Nation		Nee Tahi Buhn		Skin Tyee Nation		Office of the Wet suwet en		Gitanyow Hereditary Chiefs		Total	
Watershed Group Name	Size (Ha)	Count	Size (Ha)	Count	Size (Ha)	Count	Size (Ha)	Count	Size (Ha)	Count	Size (Ha)	Count	Size (Ha)	Count	Size (Ha)	Count	Size (Ha)	Count
Babine Lk[P]	1,089	97	1,552	131			36,967	4,029	405	39			1,717	156			**37,949**	**4,220**
Babine Ri					14,518	3,203	19,001	3,040									**22,628**	**4,003**
Blackwater Ri[P]											1,384	54					**2,442**	**194**
Bulkley Ri	19,052	2,879	15,180	2,116	957	160	7,452	848	8,426	1,033	5,890	814	24,285	3,541			**26,120**	**3,779**
Cheslatta Ri			1,169	226					2,171	363	10,756	1,693	934	198			**10,756**	**1,693**
Chilako Ri[P]											8,345	1,199					**9,609**	**1,348**
Driftwood Ri[P]					5,922	704	1,982	216									**7,314**	**887**
Euchiniko Lk[P]											10,272	1,003					**16,725**	**1,707**
Euchiniko Ri[P]											5,785	604					**6,341**	**692**
Firesteel Ri[P]					2,876	255											**4,138**	**477**
Francois Lk[P]	10,074	2,002	22,651	4,277			527	103	27,246	4,930	21,269	3,987	24,773	4,555			**30,151**	**5,239**
Ingenika Ri[P]					33	1											**33**	**1**
Kalum Ri[P]	9	2			1,559	313											**2,438**	**384**
Khutze Ri[P]											106	15					**129**	**23**
Kinskuch Ri															4,083	747	**4,083**	**747**
Kispiox Ri	217	64			6,052	1,673	22	5					4	6	1,624	313	**7,365**	**1,957**
Kitimat Ri[P]																	**3**	**4**
Kitlope River[P]									156	19	2,744	214					**2,761**	**224**
Kshwan River[P]																	**52**	**12**
Lakelse[P]			2	2													**28**	**15**
Lw. Bell -Irving Ri[P]					55	14									335	69	**916**	**170**
Lw. Dean Ri[P]									198	73	11,076	1,901					**12,356**	**2,161**
Lw. Eutsuk Lk			91	20					11,527	1,515	14,699	2,051	57	7			**14,699**	**2,051**
Lw. Nass Ri[P]					57	28									1,584	607	**2,775**	**719**
Low.Nechako Res									66	5	14,200	1,991					**14,200**	**1,991**
Middle Ri[P]							352	39									**798**	**124**
Mid. Skeena Ri					11,031	1,201											**11,031**	**1,201**
Morice Ri	14,184	2,435	13,720	2,386					10,023	1,620	14,183	2,434	14,182	2,434			**14,184**	**2,435**
Nass Ri					1,725	610									4,682	1,408	**6,322**	**1,999**
Nechako Ri[P]											11,903	1,732					**13,955**	**1,987**
Stuart Lk[P]							2,328	337									**4,287**	**541**
Sustut Ri[P]					8,102	794											**8,597**	**843**
Takla Lk[P]							10,705	769									**12,579**	**921**
Taylor Ri[P]					1,220	291											**1,220**	**291**
Tsaytis Ri[P]									102	5	399	60					**412**	**64**
Up. Bell -Irving Ri[P]					39	9											**168**	**21**
Up. Dean Ri[P]											489	81					**794**	**160**
Up. Eutsuk Lk									8,715	2,007	28,865	4,526	92	19			**28,865**	**4,526**
Up. Nass Ri[P]					4,085	919											**4,399**	**1,019**
Up. Nechako Res	8,597	1,934	6,738	1,390					13,620	2,966	13,787	2,995	13,003	2,827			**13,787**	**2,995**
Up. Omineca Ri[P]					239	1											**393**	**23**
Up. Skeena Ri[P]					13,079	1,109											**14,705**	**1,267**
Up. Trembleur Lk[P]							4,989	549									**5,795**	**614**
Zymoetz Ri[P]	3,761	830	1,212	306	1,399	391					1,190	294	2,677	441			**4,173**	**980**
TOTAL	**56,983**	**10,243**	**62,315**	**10,854**	**72,948**	**11,676**	**84,326**	**9,935**	**82,655**	**14,575**	**177,342**	**27,648**	**81,726**	**14,184**	**12,308**	**3,144**	**382,481**	**56,709**

Explanatory notes: Due to overlaps among Nation territories the totals in the two columns to the far right of the table represent totals for the Study Area, and are not the sums of the columns to the left. [P] = Only partial analysis conducted in Watershed where SSAF Study Area boundary bisects watershed polygon. Lk = Lake, Lw = Lower, Ha = Hectares (100x100 meters), Mid = Middle, Res = Reservoir, Ri = River, Up = Upper

Table 2. Description of wetlands by biogeoclimatic zone and variant.

BGC_variant	Hectares (Ha) inside SSAF Wetland AU	Count	Ha of Wetland	Average Wetland Size (Ha)	% of Wetland Cover with each BGC Variant
BAFAun	742,884	54	263	4.9	0.04%
BAFAunp	17,017	9	37	4.1	0.22%
BWBSdk	1,785	15	36	2.4	2.02%
CMAun	367,949	5	5	1	0.00%
CWHms2	8,726	36	436	12.1	5.00%
CWHvm1	72,096	124	745	6	1.03%
CWHvm2	29,763	15	68	4.5	0.23%
CWHwm	2,656	5	22	4.4	0.83%
CWHws1	46,256	142	1,723	12.1	3.72%
CWHws2	332,018	687	4,205	6.1	1.27%
ESSFmc	1,061,114	9,790	53,069	5.4	5.00%
ESSFmcp	206,730	509	2,742	5.4	1.33%
ESSFmk	179,465	1,119	5,266	4.7	2.93%
ESSFmkp	53,417	35	172	4.9	0.32%
ESSFmv1	179,488	1,182	5,514	4.7	3.07%
ESSFmv3	121,169	808	4,573	5.7	3.77%
ESSFmvp	24,983	35	96	2.8	0.38%
ESSFun	34,883	66	282	4.3	0.81%
ESSFunp	54,032	2	3	1.5	0.01%
ESSFwv	626,272	3,511	12,821	3.7	2.05%
ESSFwvp	193,317	250	694	2.8	0.36%
ESSFxv1	3,709	6	30	5	0.81%
ICHmc1	497,371	2,795	12,164	4.4	2.45%
ICHmc1a		81	531	6.6	Null
ICHmc2	294,728	1,001	7,298	7.3	2.48%
ICHvc	130,541	663	3,813	5.8	2.92%
MHmm2	350,294	1,215	4,206	3.5	1.20%
MHmmp	287,317	103	295	2.9	0.10%
MSxv	34,537	325	3,250	10	9.41%
SBPSdc	15,888	189	1,357	7.2	8.54%
SBPSmc	244,863	3,352	26,237	7.8	10.71%
SBPSmk	17,535	188	1,133	6	6.46%
SBSdk	884,364	7,196	55,960	7.8	6.33%
SBSdw2	35,721	511	3,923	7.7	10.98%
SBSdw3	156,906	1,021	8,479	8.3	5.40%
SBSmc2	1,891,012	15,109	114,207	7.6	6.04%
SBSmc3	260,692	2,579	27,027	10.5	10.37%
SBSmk1	11	1	4	4.4	35.54%
SBSun	2,368	3	32	10.5	1.35%
SBSwk3	190,372	1,285	14,646	11.4	7.69%
SBSwk3a		25	117	4.7	Null
SWBmk	118,486	595	5,969	10	5.04%
SWBmks	86,386	53	235	4.4	0.27%
(blank)		15	56	3.7	Null
Grand Total	9,859,123	56,709	383,740	6.8	3.89%

2.2 Wetland Conservation Status – Legal Framework

Though the values, benefits, and functions of wetlands are understood, there is no current overarching provincial policy for their protection nor a standard for assessing and collecting data on wetlands. Instead, there are numerous Federal and Provincial Acts, as well as other land management directives, that use a siloed approach to manage or restrict activities pertaining to certain wetlands, at certain times of the year (ERM 2017). Below is a summary of the current framework of laws and regulations that pertain to wetlands as presented in the *Skeena ESI Expert Workshop Backgrounder on Wetlands: Knowledge Summary Report* by ERM Consulting Ltd (2017).

Federal Wetland Legislation

Federally there are overarching laws that inadvertently protect wetlands in BC through the protection of other ecosystems or species. The *Fisheries Act* (1985), *Migratory Bird Convention Act* (1994), and *Species at Risk Act* (SARA; 2002b) are three such Acts that may inhibit certain activities if specific species use wetlands during their lifecycle. As well, certain federal environmental review processes, such as the *Canadian Impact Assessment Act* (IAA 2019) may apply to wetlands in BC. Though this legislation exists, it is inconsistent, only applying to some wetlands, and does not provide overarching management directives (ERM 2017).

Provincial Wetland Legislation

There is no single provincial policy or legislation that provides protection or conservation measures for wetlands in BC. Instead, there are other acts or regulations that include provisions for specific types of wetland ecosystems or aspects of wetland function. Provincial Acts such as the *Wildlife Act* (1996c), *Riparian Areas Protection Act* (2016), and *Forest and Range Practices Act* (2002a) are limited in the protections that they provide as they apply only to identified species or wetlands that are identified as providing functions. The *Environmental Management Act* (2003) has been used to protect wetlands in the province from deposition of waste through prohibiting the release of deleterious substances into the environment. The *Mines Act* (1996a) requires that wetlands must be mapped to a "suitable scale" in proposed mine sites and sampled beforehand to establish baseline metal levels (BC MEM 2016). The greatest measure for wetland protection at the Provincial level is the *Water Sustainability Act* (2016c) which has indirect protection measures for some wetlands (swamps, marshes, and fens as defined in the WSA) through the ecosystem services they provide and their connection to surface and groundwater systems (ERM 2017).

Other Land Management Directives

In addition to the few federal and provincial policies and regulations in place, wetlands are also managed through a variety of other directives, including: industry specific guidance, land or sustainable resource management plans, non-government organizations (NGOs) and best practices (ERM 2017). The province has developed best management practices (BMP) and guidelines to help industries comply with the relevant acts and regulations. This includes documents such as *Wetland Ways* (Cox and Cullington 2009), *BC Oil and Gas Commission (OGC) Environmental Protection and Management Guideline* (BC OGC 2017), and *Health, Safety and Reclamation Code for Mines in British Columbia* (MEM 2017). Land and Resource Management Plans (LRMPs), Sustainable Resource Management Plans (SRMPs), Strategic Land-Use Plan Agreements (SLUPAs) and Sustainable Forest Management Plans have been developed for regions in the SSAF Study Area. Though some of the plans have conservation priorities that have specified: wetlands, levels of retention around wetlands, and prohibited operations in wetlands, many were developed between 1998 and 2008 and need to be updated (ERM 2017). Still, these plans are used by local or regional governments, organizations, industries, and First Nations for planning purposes and are not legally binding. BMPs such as the Wetland Habitat Information Form for wetland data collection (in development by the BC Wildlife Federation) *and Resource Roads and Wetlands: A Guide for Planning, Construction, and Maintenance* (Partington et al. 2016) have been developed by NGOs to standardize data collection methods and reduce the impacts of activities that may affect wetlands.

The current laws and regulations in place to conserve wetlands are inconsistent, indirect and insufficient (Ecological Resolutions 2017, ERM 2017). The work conducted for this project highlights this management gap and works to address it. One of the outcomes of this project for the SSAF study area is a calibrated tool to compare wetlands in other areas at the Tier 2 level. This is something that could be conducted across the Province to better support an integrated policy for the protection of wetlands. If the location, benefits, functions, and threats of each wetland are understood, the province will be better situated to develop and implement an overarching policy for the conservation of wetlands.

2.3 Threats to Wetlands

Both at a global and North American scale, wetlands have been disappearing at a rapid rate. In BC, wetland loss would have accelerated shortly after new settlers arrived in the early to mid-1800s (Biebighauser 2007, Boyle et al., 1997). In developed areas of Canada, wetland loss ranges between 60 to 98% (Bond et al. 1992). Wetland loss may be relatively higher than other ecosystems as wetlands tend to have a greater abundance in flatter terrain and in valley bottoms where agriculture and other human developments are more prominent. Since 1970, approximately 35% of global wetlands were lost - a rate that is three times the loss of forests (Gardner and Finlayson 2018). Trends in wetland gains or losses are not specifically available for the SSAF Study Area. In a recent analysis using Landsat data, no significant trends in total wetland loss or gain between 1984 and 2016 were reported for the Montane Cordillera and Pacific Maritime ecozones, which are larger landscape units that envelop the SSAF Study Area (Wulder et al. 2018). However, more localized impacts are documented or observable for wetlands within settled areas. The Town of Smithers, for instance, was developed on a forested wetland (Shervill 1981), and many of the lands cleared for agriculture within the Bulkley Valley for instance show markers of wetland drainage from a simple review of satellite imagery. Anthropogenic and natural activities can both positively and negatively influence the extent and health of wetlands. Figure 4, developed as part of the 2017 Environmental Sustainability Initiative (ESI) Steering Technical Committee (STC) Working Group Workshop (Eco-Logical Resolutions 2017), provides a conceptual model of how various human actions and natural phenomenon affect wetland functions. In addition to loss, there are many threats that can degrade the ecological health of a wetland site. A few of the key threats to wetland loss and degradation are listed below.

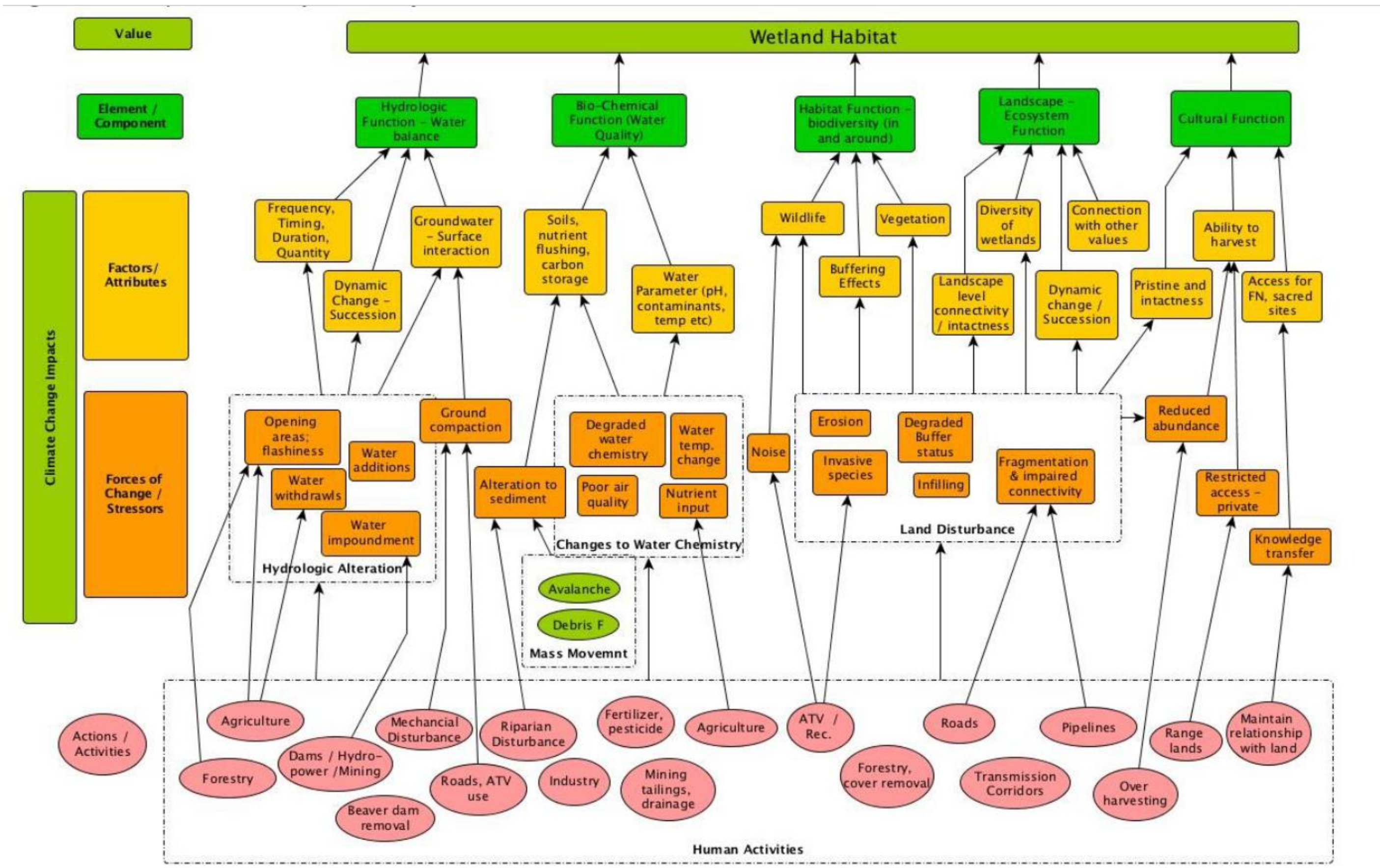


Figure 4. Conceptual model for linkages between human activities/natural processes and wetland functions.

Invasive Species

Invasive plants and animals may outcompete and eventually displace native species. According to the Invasive Species Council of BC, invasive species are the second largest threat to wetlands, after habitat loss. The ESI Skeena Region is fortunate to have many of its wetland ecosystems still intact with relatively few problematic invasive species compared to other parts of the Province (e.g., South-western BC) (MOE 2015). Exceptions are noted for parts of the SBSdk and along roadsides which have a greater abundance of invasive species relative to other areas within the Skeena region (FLNRORD 2015). Future development and climate change may increase the spread and distribution of invasive species (FLNRORD 2015). Disturbed soils due to development and construction activities are highly susceptible to invasive plant introductions (Lozon and MacIsaac 1997). Early detection and rapid removal is warranted for new introductions, as invasive species tend to highly competitive and spread relatively quickly (MOE 2015). Wetland and riparian associated plants that are currently on the Early Detection and Rapid Response (EDRR) list for the region include: Japanese knotweed (*Fallopia japonica*), Himalayan Balsam (*Impatiens glandulifera*), Himalayan Blackberry (*Rubus discolor*), Marsh Plume Thistle (*Cirsium palustre*), Purple Loosestrife (*Lythrum salicaria*), Yellow flag iris (*Iris pseudacorus*), Yellow floating heart (*Nymphoides peltata*), Yellow Loosestrife (*Lysimachia vulgaris*) (NWIPC 2020). Reed Canary Grass (*Phalaris arundinacea*) is not on the list but is known to be problematic within wetlands in agricultural areas as it can dominate wetland habitats (Mackenzie and Moran 2004); it has been found along forest service roads in remote areas of the Skeena region, introduced as a roadside revegetation mix (Personal observation).

Resource Extraction and Roads

Mines, forestry, pipelines, and transmission corridors are dominant economic drivers in the region but can also impact wetlands due to their footprint on the landscape. For example, industry specific water discharges, air emissions, and spills can degrade water quality in receiving waterbodies. Extensive resource road networks in the region are one of the more ubiquitous impacts due to their broad distribution. Linear features, such as roads, pipelines, and other Right of Ways (ROW), can impact wetlands through their direct footprint or potential impacts to hydrologic regimes by disrupting surface and sub-surface flows. Fragmentation of the landscape increases human-pressure on remote areas, and other well documented threats (Boston 2016, Daigle 2010). Best practices for working in and around wetlands are available for practitioners in BC (e.g., Cox and Cullington 2009) and continue to be developed for the resource sector (DUC 2014).

Climate Change

Climate change can also affect wetlands by adding more stressors to the system such as range expansion of invasive species (Price and Daust 2016, Flanagan et al. 2014); shifting natural disturbance regimes, and increased sedimentation during extreme weather events (Pike et al. 2010). Wetlands that rely on surface water inputs are likely most at risk of drying (per comm. Greg Utzig, Bunnell et al. 2010). Price and Daust (2020) recently examined the potential impacts to wetlands based on Climate Change scenarios within the SSAF Study Area. Based on their analysis, which focused on potential drying indices (i.e., an index that combines forecasted models of precipitation as snow and summer heat moisture indices) they've reported that small wetlands less than 2 hectares in size and not associated with lakes are most at risk. The authors further postulate that the potential for water loss will be most severe towards the south-east of the Study Area, as well as at lower elevations throughout the Study Area. The percent of wetlands with a drying index greater than 8 (a relatively high chance of drying) will rise from 0.03% to 44% by 2055.

2.4 Cultural Relevance of Wetlands to SSAF Nations

Indigenous peoples in the Skeena Region have had a close relationship with wetlands for millennia – and still do. Among other benefits, wetlands provide access to clean water; a variety of edible and medicinal plants; access to wildlife harvesting; and offer non-consumptive benefits (e.g., areas of important spiritual significance). It is of no surprise that many well-worn ancestral and current trails frequently pass by the edges of wetland sites. Indigenous peoples often recognize that wetlands are inherently interconnected to the rest of the land; and they have thought of them as holistically intertwined with the mountains, forests, rivers, and lakes.

During the Fall 2017 Skeena East ESI expert working group, three closely related themes were identified and highlighted as being important to participating First Nations:

- Accessibility – Nations need to continue to be able to physically access wetlands for cultural practices (e.g., gathering medicines); and younger generations need access and opportunities to learn more about their cultural history and connections to wetlands so that Nations can sustain their culture and practices.

- Harvest opportunities – the abundance of resources (e.g., moose, medicines, berries) within wetlands need to be sustained and safeguarded in light of potential impacts such as berry harvesting pressures and landscape level impacts.
- Wetlands need to remain intact and pristine for spiritual reasons, potency of medicines, and quality of harvested resources.

Source: Eco-Logical Resolutions 2017

2.5 Linkages of Wetlands to other ESI Values

Although wetlands occupy less than 5% of the study region, they are disproportionately important in terms of the ecological functions that they perform and the services they provide to wildlife and communities. There are clear linkages between wetlands and the other Skeena ESI Values:

Fish Habitat: Wetlands can help to clean water for downstream receiving bodies (i.e., streams & lakes), they can help to moderate and maintain stream flow, and may provide direct habitat structure for fish species (e.g., coho). Not all wetlands preform all these functions, nor do they perform these functions at a similar magnitude, so as part of this State of Value (SOV) initiative, we have included a couple indicators from a geospatially available data Tier 1 level that may help indicate a wetland's relative performance towards fish habitat (i.e., water purification capacity and proximity to documented/predicted fish habitat).

Moose: Moose utilize wetlands for various aspects of their life cycle: thermal regulation, food, and visual screening are habitat requirements that wetlands offer (MacCracken et al. 1993). A basic indicator included in this SOV report includes the relative availability of browse and screening for moose in wetland complexes.

Grizzly Bear: Grizzly bears are associated with wetlands for a portion of their life cycle (Mackenzie and Moran 2004). Grizzly bear adults and cubs can be found foraging on wetland plants (e.g., *carex sp.*) in early spring. Grizzly Bear critical habitat includes willow swamps and willow-sedge wetlands (where willow >20% cover) and skunk cabbage sites (CWHws2/11, ICHmc2/07, ICHmcI/06) (Gitanyow Land Use Plan 2016). No indicator was specifically developed for grizzly bear at a Tier 1 level within this wetland SOV report, however the complimentary field work may provide an opportunity to identify high value sites.

Traditional and Medicinal Plants: Participants in previous focus group sessions within the Skeena Region recognized there are many plants used for medicines and food that occur within wetland habitats (Ecological Resolutions 2017). In consultation with expert ethnobotanist Nancy Turner, at least 96 plant species were identified as riparian or wetland plants of cultural use to various Nations around BC (Fletcher et al. 2020). Further work is needed to better understand the species that are of importance to SSAF Nations; it is possible that not all of these species were included within that list. No indicator at a Tier 1 level specifically addresses traditional and medicinal plants, but complimentary field work may provide an opportunity to identify high value sites through a more thorough documentation of plant associations present within various wetlands within the region.

Accessibility to wetlands was considered within this evaluation through a wetland's proximity to communities and roads (indicator 4.16). The quality of wetlands was considered based on its level of intactness (indicators 4.6 and 4.13)

3. Overview of Wetland Indicators

Indicators within this report are divided into two spatial scales: (1) **Watershed Level Analysis** which provides summary information for wetlands within a particular Watershed Assessment Unit; and (2) **Documented Wetland Analysis** which provides summary statistics for each wetland complex documented within the Study Area. Information for both types is rolled up into Watershed Groups for ease of reporting and to provide a more comprehensive overview.

In addition, indicators are broken down into several groupings: (1) **Stressors** - that document potential threats to wetland and watershed health; (2) **Functions** – that document a wetland's relative capacity to perform a function (e.g., flood attenuation, water purification); and (3) **Value/Benefit** – a wetland's relative value from an anthropocentric or societal perspective in terms of the services that a wetland provides (e.g., distance to community or stated community value). Table 3 provides an overview of the Wetland Indicators.

Table 3. Overview of wetland indicators with descriptor.

Indicator	Descriptor
Tier 1: Watershed Level Analysis	
Stressor: Equivalent Clear-Cut Area	Percent of total area of a watershed assessment unit (i.e., smaller than Watershed Group Unit) that is considered comparable to a clear-cut forest.
Stressor: Point Source Pollution	Number of Point Source Pollutants within a watershed assessment unit.
Stressor: Road Density within Watershed	Length of road divided by the area of a watershed assessment unit (km/km^2).
Tier 1: Documented Wetland Analysis	
Stressor: Road Density within 100m of wetlands (km/km2)	Percent of wetlands, by major watershed group, with high, medium, and low road density (km/km^2) within a 100m buffer area around documented wetlands.
Stressor: Road Density within 2 km of wetlands (km/km2)	Percent of wetlands, by major watershed group, with high, medium, and low road density (km/km^2) within a 2 km buffer area around documented wetlands.
Stressor: % Natural/Semi-Natural within 2 km	Percent of wetlands, by major watershed group, with high, medium, and low percent natural/semi-natural habitat within 2 km of documented wetlands.
Function: Hydrologic Support: Flood Reduction Potential	Percent of wetlands, by major watershed group, with high, medium, and low capacity for a wetland to retain water and mitigate flood events based on landscape position.
Benefit: Hydrologic Support: Flood Reduction	Percent of wetlands, by major watershed group, with high vs low relative importance of a wetland to mitigate flood events based on documented downstream values (e.g., fish-habitat and human infrastructure).
Function: Water Purification	Percent of wetlands, by major watershed group, with high, medium, and low capacity to clean water based on landscape position.
Benefit: Water Purification	Percent of wetlands, by major watershed group, with high vs low relative importance of a wetland to clean water based on documented downstream values (e.g., fish-habitat and human infrastructure) or upstream threats.
Function: Aquatic Life Support (Fish)	Percent of wetlands, by major watershed groups, with relatively high, medium, and low fish habitat value based on proximity to documented fish habitat.
Function: Wildlife Habitat: Availability of Moose Forage and Screening	Percent of wetlands, by major watershed groups, identified with potential high forage value for moose.

Function: Wildlife Habitat: Connectivity	Percent of wetlands, by major watershed group, that sufficiently contains mature and old growth forest habitat within a 2 km buffer.
Function: Wildlife Habitat: Management Areas	Percent of wetlands, by major watershed group, that are provided a greater level of protection based on ownership (e.g., conservation lands), management regime (e.g., park) or special provisions (e.g., ungulate winter range).
Benefit: Cultural Value: Archeological Records or Identified Wetland of Significant to Communities	Percent of wetlands, by major watershed group, that are within 500 m of a documented or potential archeological site.
Benefit: Cultural Value: Accessibility	Percent of wetlands, by major watershed group, that are more, moderately, or less accessible to settled areas for the purpose of acquiring a provision of services (e.g., harvesting traditional medicines).

4. Assessment Results for Each Indicator

This section provides assessment results for both the watershed level analysis (Indicator 4.1 to 4.3), and documented wetland analysis (Indicator 4.4 to 4.16). Each indicator is in a subsection which begins with an **indicator description** to provide a rationale for the indicator and provides the data sources. An **interpretation key** is provided to help the reader better interpret the content of the output. **References** or rationale for the indicator and associated thresholds are provided. A **commentary** section is included that provides a narrative and discusses the implications of the assessment results. The output of the **assessment results** for the indicators are displayed as tables and/or figures. To streamline the flow of this document, the full methodology for preparing the GIS analysis is provided within Appendix B.

Disclaimer: Due to the nature of a Tier 1 mapping project and the associated data availability and model development, numerous assumptions are inherent to this assessment. The data is constrained by possible omissions and errors and may not accurately reflect true conditions on the ground. The impacts or issues highlighted within this analysis help to flag possible wetlands or watersheds of concern, but will typically require further investigation/analysis (such as Tier 1.5, Tier 2, or Tier 3 assessments) prior to taking specific management actions.

Watershed Level Analysis

4.1 Stressor: Equivalent Clear-Cut Area

Indicator Description:

The Equivalent Clear-cut Area (ECA) is a common metric to summarize cumulative watershed effects that combine various land disturbances and forest regrowth and equates them to the "proportion of the watershed that responds hydrologically as a clear-cut" (Winkler and Boon 2017). Regrowth of vegetation is taken into account, by setting ECA = A x (1-HR), where *A* is the area disturbed, and *HR* is the hydrologic recovery since disturbance. Disturbances in a watershed such as main roads or areas permanently converted to non-vegetated uses have a ECA of 100% and a HR set to 0, whereas forest regrowth would increase the hydrologic recovery over time. At a watershed scale, ECA provides a broadly accepted measure of threats to the potential for flash flooding, erosion, transport of sediments, and landscape connectivity for wildlife (Porter et al. 2017). The data used for this analysis were pulled from Agriculture, Disturbance History of Wildfire, Disturbance History of Logging, Burned Area, and Cut block data sources (please see Appendix B for more detail).

Interpretation Key:

< 15% (low); 15-20% (moderate); > 20% (high)

Reference:

Thresholds in available literature for ECA were reviewed by the SSAF Science Technical Committee and conservatively selected based on a precautionary principle (PSF 2013, Porter et al. 2014)

Commentary:

The Equivalent Clear-cut Area of Watershed Assessment Units tends to be higher towards the south and east of the Study Area. This area corresponds with a greater population densities, more active agriculture and forestry sectors, as well as more frequent natural disturbances (e.g., stand initiating events such as fires that are typical for the Sub-Boreal Spruce biogeoclimatic zone). A higher ECA may contribute to greater incidence of flash flooding, increased erosion, and habitat fragmentation (Porter et al. 2019). Due to the anticipated increase in flashy stream flows and habitat fragmentation, wetlands within south east portion of the SSAF area may serve a greater relative importance to both society and ecosystem function in terms of their ability to attenuate flood events, moderate stream flows, filter water, serve as fire breaks, and provide refuge for wildlife.

Assessment Results:

See Figure 5

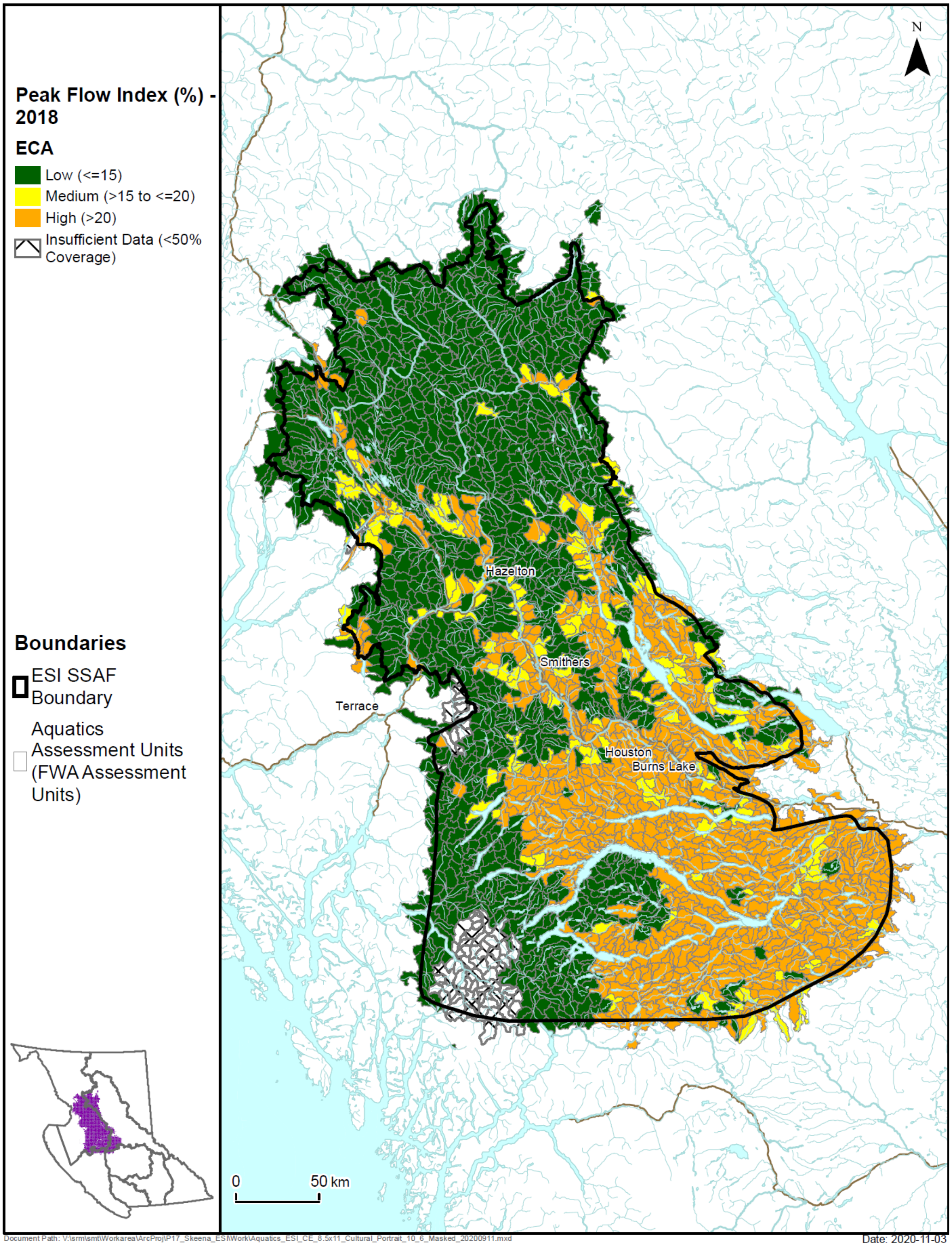


Figure 5. Indicator 4.1 Equivalent Clear-cut Area (ECA) Indicator. ECA within Watershed Assessment Units colour coded as High (Orange >20% ECA), Medium (Yellow <20% & >15% ECA), and Low (Green <15% ECA).

4.2 Stressor: Point Sources for Pollution

Indicator Description:

Point sources for pollution can include: contaminated sites, mines, mineral tenures (identifying future sites of point source). These can present a risk to downstream wetlands which may lead to elevated levels of metals, nutrients, changes in pH, and other toxins. Point sources for pollutants are derived from a combination of the following datasets: MOE Authorization Database; Notice of Work Mineral Tenure (Provincial BCGW); Mineral, Placer, and Coal (MTA) Tenures (Provincial BCGW); and Remediation Sites – Contaminated (Provincial BCGW).

Interpretation Key:

The number of point sources for pollutants per watershed assessment units are binned into a few categories with 0 (dark green), 1 (mid-green), 2 (light green), 3-4 (yellow), 5-10 (orange), >10 (red)

Reference:

Since the relative impact of a point sources for pollutants could vary substantially, thresholds are not established at this level of analysis . Instead the number of point source pollutants were binned into number per watershed assessment unit to help flag watersheds that may be at risk (Porter et al. 2019).

Commentary:

The distribution of point sources for pollutants is scattered, with higher concentrations in the north-west, center, and south-east of the Study Area (Figure 5). Nearly 29% of wetlands within the SSAF Study Area are in Watershed Assessment Units with at least one point source for pollutants (Figure 6). Point sources for pollutants are higher in watershed assessment units with settlements, and current or potential mining activities (i.e., mineral tenures). Water quality within wetlands in these watersheds may be, or become, compromised relative to other watershed units. The relative risk associated with the point sources for pollutants was not explored within this study, therefore a single point source for pollutants may pose a greater or smaller risk (Porter et al. 2019).

Assessment Results:

See Figures 6 and 7 .

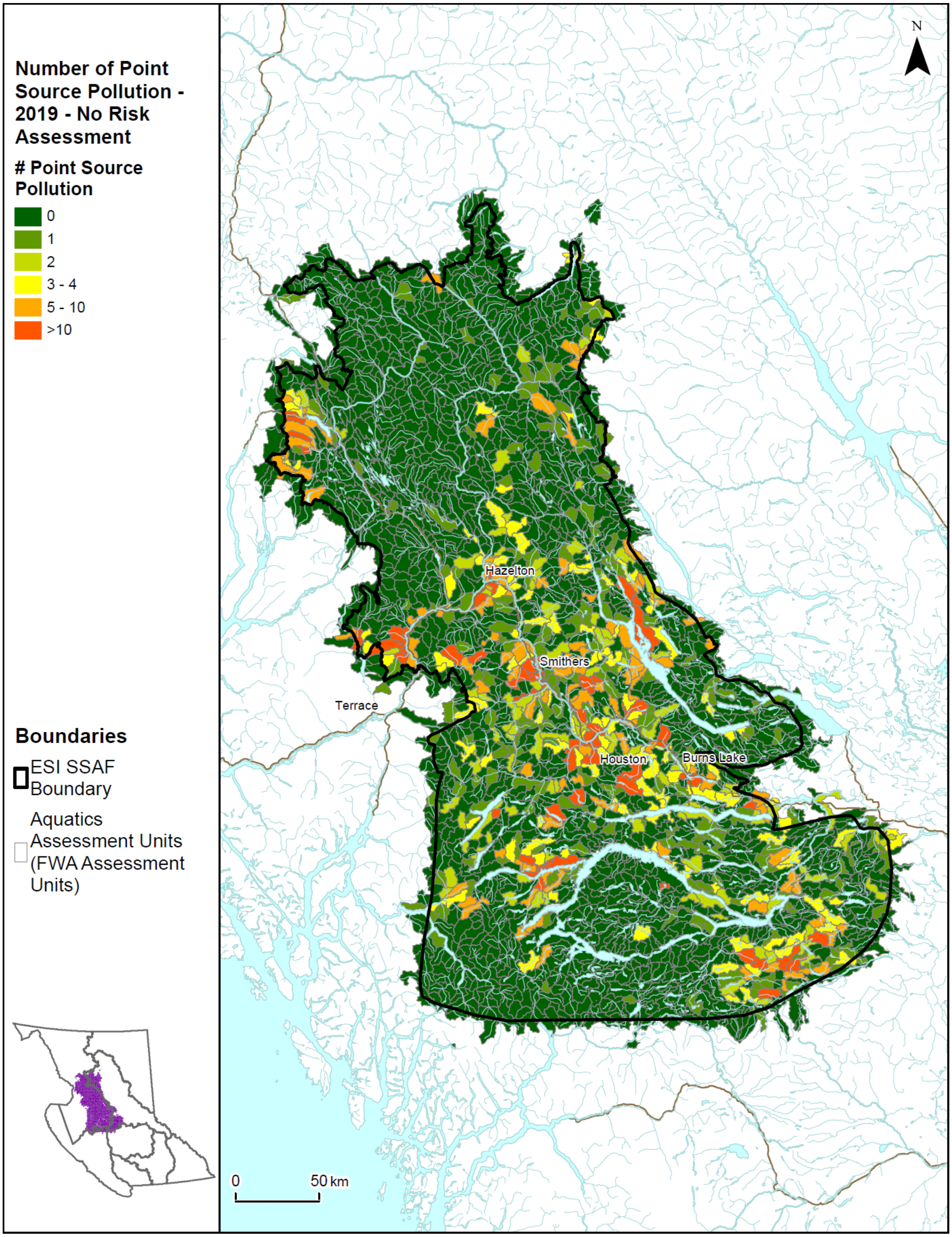


Figure 6. Map of number of point source pollution within Watershed Assessment Unit, where 0 (dark green), 1 (mid-green), 2 (light green), 3-4 (yellow), 5-10 (orange), >10 (red).

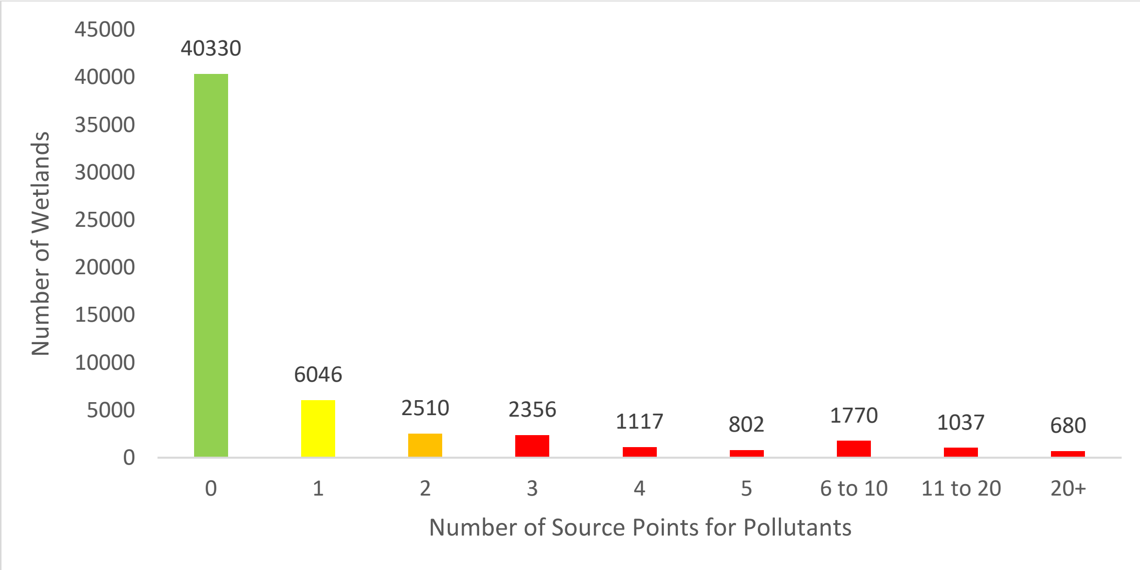


Figure 7. Bar graph of number of source points for pollutants and the number of impacted wetlands.

4.3 Stressor: Road Density within the Watershed

Indicator Description:

The density of roads is commonly used as a proxy for potential stressors within a landscape context and is frequently a metric in cumulative effects frameworks (Salmo Consulting Inc. et al. 2003) For example, an increase in roads typically leads to increases in: invasive species presence and movement, human recreation and hunting pressure, fragmentation of wildlife habitat, and risk of erosion (Boston 2016, Daigle 2010, Trombulak and Frissell 2000). In resource sector areas, roads can directly pose one of the greatest threats to wetlands as they can disrupt surface and shallow groundwater flows (per. comm. Tom Biebighauser 2018, Partington et al. 2016). Roads can either cause the development of wetlands upstream by flooding upstream areas, or remove water from downstream wetland sites.

Roads information is derived from the province's Consolidated Roads layer which combines DRA, TRIM, FTEN, OGC, and RESULTS in-block roads layers.

Interpretation Key:

<0.4 km/km2 (low); 0.4 – 1.2 km/km2 (moderate); > 1.2 km/km2 (high) (PSF 2013, Porter et al. 2014)

Reference:

Thresholds for road densities in watersheds were reviewed by the SSAF Science Technical Committee and conservatively selected based on a precautionary principle from available literature sources (PSF 2013, Porter et al. 2014)

Commentary

Many watersheds, especially in the central and south-east sections of the SSAF Study Area contain a high density of roads (>1.2 km/km^2). Higher road densities coincide with more populated communities and forest service roads. Road density is lowest in the extreme north (e.g., Upper Nass, Middle Skeena, and Upper Skeena River watershed groups,) and south of the study area (Kitlope River, Lower Dean River, and Upper Eutsuk Lake watershed groups).

Assessment Results:

See Figure 8

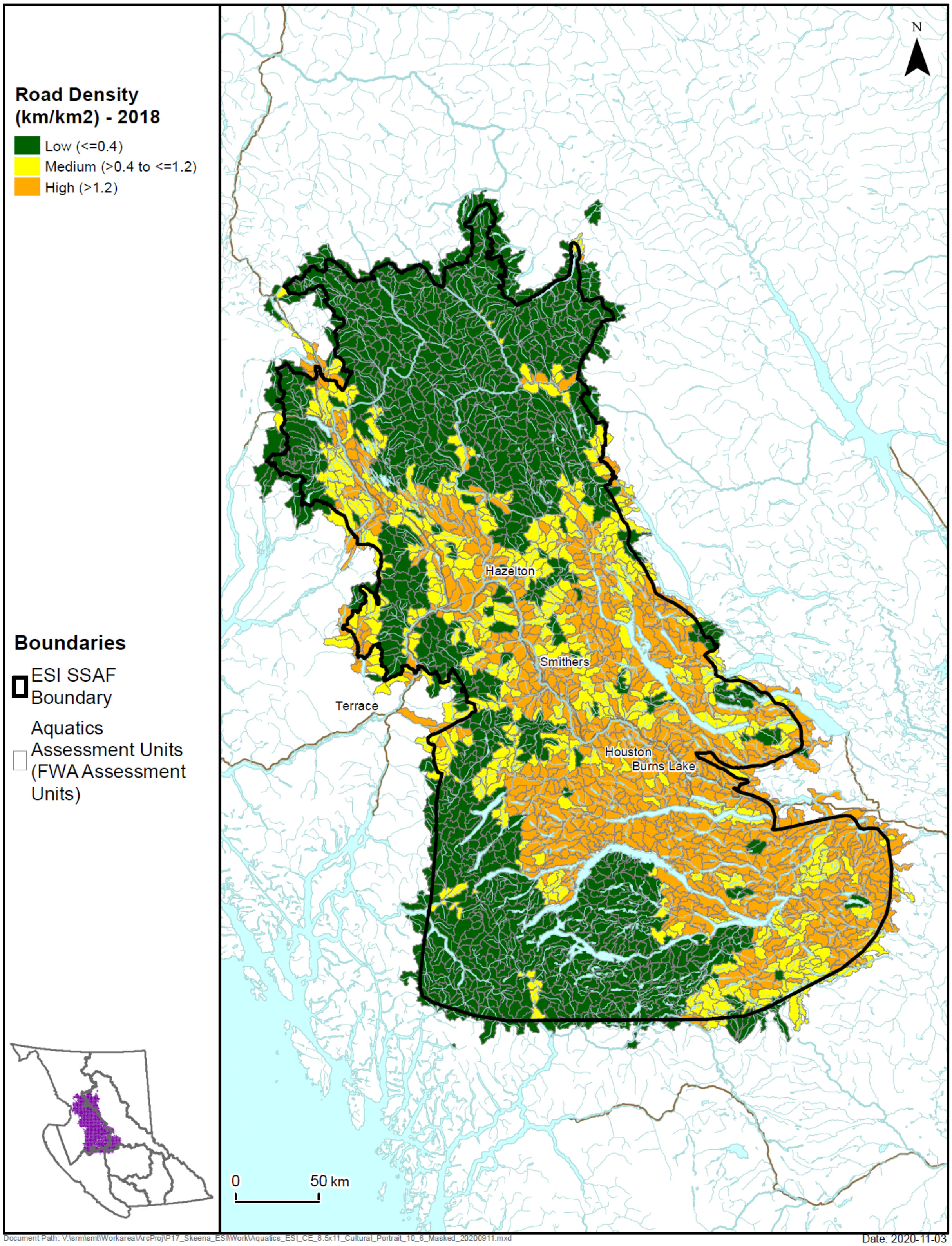


Figure 8. Map Road Density of Skeena regions, where green represents Low Density (<0.4 km/km2); yellow represents Moderate Density (0.4 – 1.2 km/km2); orange represents High Density (>1.2 km/km2).

Tier 1: Documented Wetland Analysis

Indicators 4.1 to 4.3 discussed previously consider stressors at the Fresh Water Atlas (FWA) Watershed Assessment Unit level, the remainder of indicators are in reference to the wetlands themselves. For ease of displaying this information, data is rolled up into larger FWA Watershed Groups, and data is displayed as pie charts to represent the proportion of wetlands that meet a specific condition. Indicators 4.4 to 4.6 continue to focus on potential stressors, whereas 4.7 to 4.14 relate the functional attributes and associated benefits of wetlands.

4.4 Stressor: Road Density within 100m of wetlands (km/km2)

Indicator Description:

Roads located near wetlands, and within the 100 m buffer area, can disrupt surface and subsurface flows which can result in negative hydrologic impacts to the wetlands (Partington et al. 2016). Other impacts may include noise pollution, sedimentation, fragmentation of habitat, increased pressures from hunters and recreational users, reduction in visual screening, and other potentially negative effects on wetlands and wetland dependant species. A buffer of 100m can be considered a conservative buffer for meeting species needs. For example, a literature review on core area for amphibian needs found that amphibian's core habitat needs ranged between 159 to 290 m and reptile core habitat needs ranged from 127 to 289 m (Semlitsch and Bodie 2003).

Buffer analysis within 100m of wetland edge includes the following data sources: CE Integrated Roads (SkeenaESI_Extend_ConsRd_inclKispBulk_DSS_190918), and Consolidated wetland complexes (ESI_basic_Wetland_Complexes_190912).

Interpretation Key:

< 0.08 km/km2 (low); 0.08 – 0.16 km/km2 (moderate); > 0.16 km/km2 (high) (MOE/FLNRO 2015)

Reference:

Thresholds for road densities within 100 m were reviewed by the SSAF Science Technical Committee and conservatively selected based on a precautionary principle from available literature sources (PSF 2013, Porter et al. 2014)

Commentary:

Eighteen of the Watershed Groups have at least a quarter of their wetlands with roads at high density within 100 m (Figure 9 and Table 4). Some Watershed Groups have nearly half of all their wetlands with roads within 100 m of their boundaries and at high densities (especially to the south east of the study area). It is possible that a high percentage of these roads have since been decommissioned in the area and no longer provide vehicle access – as was observed during the 2019 field reconnaissance. A further analysis that stratifies active and decommissioned roads would be valuable, but data regarding the status of roads is poorly developed within the region. Both active and de-activated sections of road may affect wetland hydrology (upslope and downslope), increase runoff and erosion, alter surface flow direction, and increase predator access to wildlife prey (e.g., moose) (Trombulak and Frissell 2000).

Assessment Results:

Refer to Figure 9

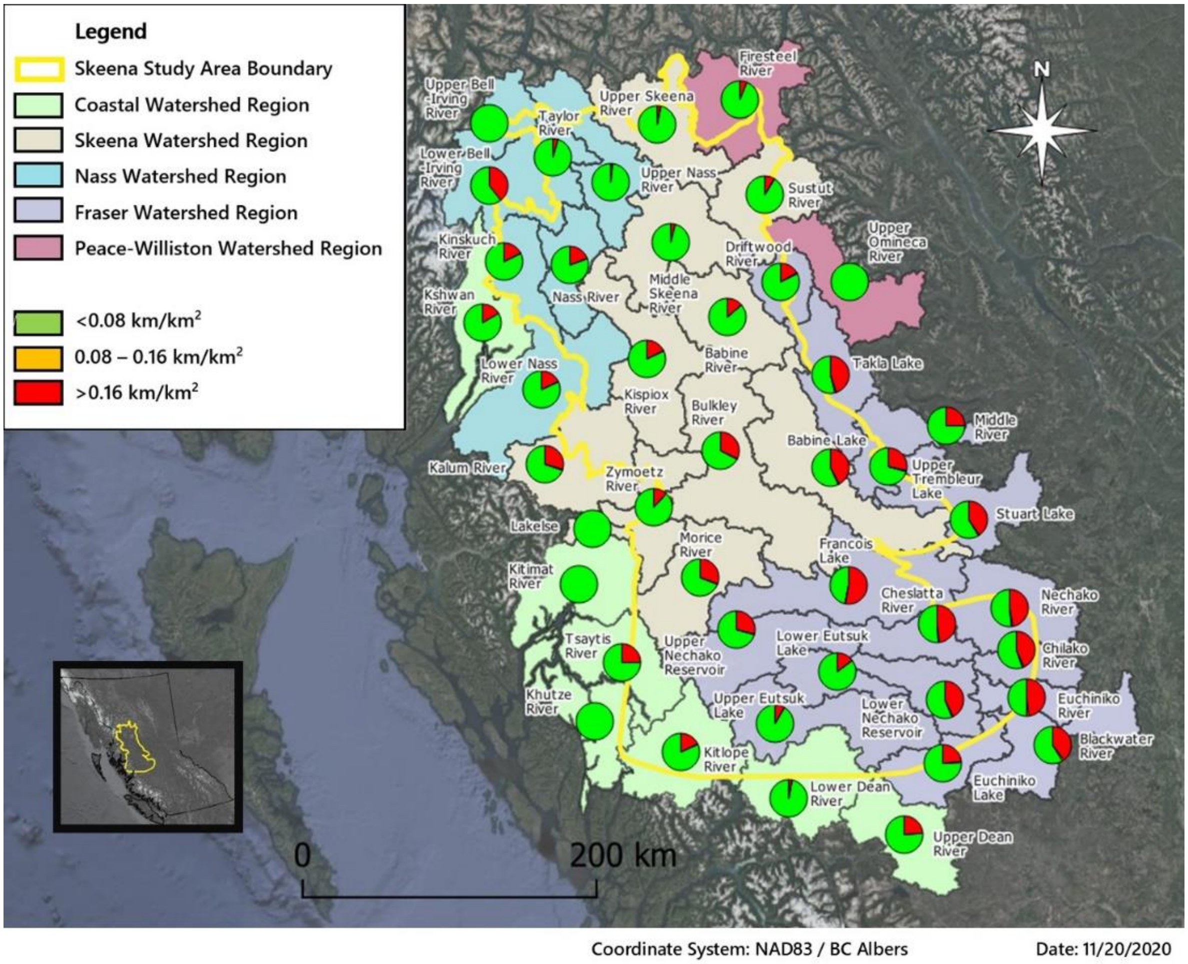


Figure 9 Map Road Density within buffer of 100 m of wetlands, where green represents Low Density (<0.08 km/km2); orange represents Moderate Density (0.08 – 0.16 km/km2); red represents High Density (>0.16 km/km2).

Table 4. Percent of land area and corresponding road density values.

Region	Percent of land area with **Low Road Density**		Percent of land area with **Medium Road Density**		Percent of land area with **High Road Density**	
	within 100 m of wetlands *(<0.08 km/km2)*	within 2 km of wetlands *(<0.40 km/km2)*	within 100 m of wetlands *(0.08 - 0.16 km/km2)*	within 2 km of wetlands *(0.40 - 1.2 km/km2)*	within 100 m of wetlands *(>0.16 km/km2)*	within 2 km of wetlands *(>1.2 km/km2)*
Coastal Tributaries Other	**93.9%**	**85.6%**	**0.2%**	**7.5%**	**5.9%**	**6.9%**
Khutze River	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Kitimat River	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Kitlope River	81.7%	63.4%	0.4%	23.7%	17.9%	12.9%
Kshwan River	83.3%	83.3%	0.0%	16.7%	16.7%	0.0%
Lower Dean River	97.0%	93.0%	0.1%	2.6%	2.8%	4.4%
Tsaytis River	75.0%	75.0%	0.0%	21.9%	25.0%	3.1%
Upper Dean River	76.3%	18.8%	0.0%	46.3%	23.8%	35.0%
Fraser-Stuart	**65.6%**	**34.3%**	**0.7%**	**17.4%**	**33.8%**	**48.2%**
Blackwater River	58.8%	17.5%	1.5%	38.1%	39.7%	44.3%
Cheslatta River	51.1%	9.5%	0.9%	23.4%	48.0%	67.1%
Chilako River	55.3%	10.8%	1.3%	22.5%	43.4%	66.7%
Driftwood River	82.3%	60.2%	0.9%	21.5%	16.8%	18.3%
Euchiniko Lake	75.8%	44.1%	0.5%	34.9%	23.7%	21.0%
Euchiniko River	50.0%	4.0%	1.9%	22.8%	48.1%	73.1%
Francois Lake	46.8%	5.1%	0.5%	11.7%	52.7%	83.2%
Lower Eutsuk Lake	85.0%	65.7%	0.4%	8.7%	14.6%	25.6%
Lower Nechako Reservoir	56.2%	12.7%	1.0%	25.3%	42.9%	62.0%
Middle River	75.0%	57.3%	0.0%	33.1%	25.0%	9.7%
Nechako River	51.7%	8.9%	1.1%	23.7%	47.3%	67.4%
Stuart Lake	58.6%	20.9%	1.1%	22.9%	40.3%	56.2%
Takla Lake	53.9%	22.9%	1.2%	23.7%	45.0%	53.4%
Upper Eutsuk Lake	91.6%	84.4%	0.3%	9.9%	8.2%	5.7%
Upper Nechako Reservoir	70.7%	44.1%	0.5%	10.9%	28.8%	44.9%
Upper Trembleur Lake	70.5%	33.9%	1.0%	25.4%	28.5%	40.7%
Nass Tributaries	**84.9%**	**55.5%**	**0.2%**	**24.0%**	**14.9%**	**20.5%**
Kinskuch River	82.2%	48.3%	0.3%	30.8%	17.5%	20.9%
Lower Bell -Irving River	60.6%	15.3%	0.0%	41.2%	39.4%	43.5%
Lower Nass River	81.8%	49.9%	0.3%	26.0%	17.9%	24.1%
Nass River	80.4%	34.7%	0.3%	34.7%	19.3%	30.7%
Taylor River	95.5%	100.0%	0.0%	0.0%	4.5%	0.0%
Upper Bell -Irving River	100.0%	81.0%	0.0%	19.0%	0.0%	0.0%
Upper Nass River	98.3%	99.2%	0.0%	0.8%	1.7%	0.0%
Peace-Williston	**94.2%**	**91.6%**	**0.0%**	**6.6%**	**5.8%**	**1.8%**
Firesteel River	93.9%	91.2%	0.0%	6.9%	6.1%	1.9%
Upper Omineca River	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Skeena Tributaries	**75.8%**	**48.4%**	**0.5%**	**22.0%**	**23.8%**	**29.6%**
Babine Lake	56.9%	20.0%	0.8%	28.1%	42.3%	51.9%
Babine River	86.1%	62.3%	0.3%	24.1%	13.5%	13.6%
Bulkley River	67.3%	32.3%	0.5%	23.8%	32.1%	43.9%
Ingenika River	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%
Kalum River	69.8%	36.7%	0.8%	17.7%	29.4%	45.6%
Kispiox River	82.0%	49.0%	0.4%	27.6%	17.6%	23.4%
Lakelse	100.0%	26.7%	0.0%	46.7%	0.0%	26.7%
Middle Skeena River	96.2%	90.1%	0.0%	8.5%	3.8%	1.4%
Morice River	69.0%	40.1%	0.6%	18.0%	30.5%	41.9%
Sustut River	91.1%	78.1%	0.5%	13.7%	8.4%	8.2%
Upper Skeena River	96.8%	93.6%	0.2%	6.4%	2.9%	0.0%
Zymoetz River	88.2%	64.6%	0.2%	24.8%	11.6%	10.6%

4.5 Stressor: Road Density within 2 km of wetlands (km/km2)

Indicator Description:

A buffer distance of 2km is used as an interim proxy for the wetland's contributing area since contributing areas for wetlands are currently not available for the Study Area. Contributing areas refer to the wetland's catchment area where all surface water theoretically flows towards a wetland's outlet(s). Roads have a propensity to disrupt surface water and subsurface groundwater flows and thus alter a wetland's hydrology (Trombulak and Frissell 2000).

Buffer analysis within 2km of wetland edge includes the following data sources: CE Integrated Roads (SkeenaESI_Extend_ConsRd_inclKispBulk_DSS_190918), and Consolidated wetland complexes (ESI_basic_Wetland_Complexes_190912).

Interpretation Key:

< 0.4 km/km2 (low); 0.4 – 1.2 km/km2 (moderate); > 1.2 km/km2 (high)

Reference

Thresholds for road densities within 2 km were reviewed by the SSAF Science Technical Committee and conservatively selected based on a precautionary principle from available literature sources (PSF 2013, Porter et al. 2014)

Commentary

A 2 km buffer was used, in part, as a proxy for a wetland's hydrological contributing area. Even when the road density thresholds are less stringent in comparison to the last indicator (from 0.16 to 1.2km/km^2 between medium and high) the proportion of wetlands with high density roads within their buffer area increases substantially as the buffer width is increased from 100 m to 2 km. This finding indicates that many wetlands are within proximity to the road network and among other potential stressors, *may* have tributaries or other surface water flows that are potentially disrupted by a road; although, the presence of a road does not necessarily indicate that there is an impact to the wetland.

Assessment Results:

Refer to Figure 10 and Table 4

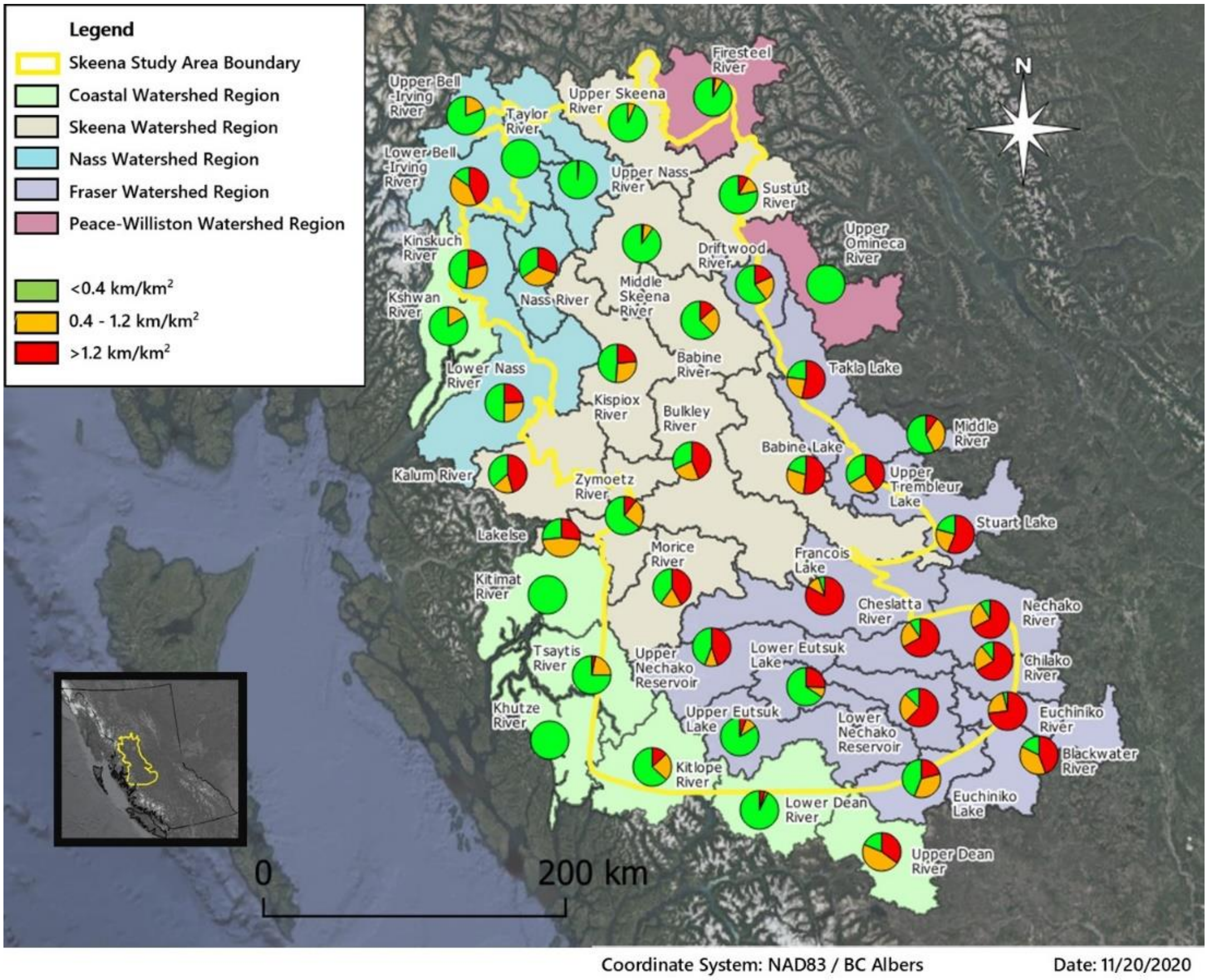


Figure 10. Map Road Density within 2km of wetland, where green represents Low Density (<0.40 km/km2); orange represents Moderate Density (0.40 – 1.2 km/km2); red represents High Density (>1.2 km/km2).

4.6 Stressor: % Natural/Semi-Natural within 2 km

Indicator Description:

The percent of natural and semi-natural land provides a measure of the ecological integrity of the surrounding landscape. Landcover is broken down based on broad classifications and then separated between Natural/Semi-natural and non-natural/developed. A BC version of this indicator was developed by DeGroot and Casley 2016 and based off of Faber-Langendoen et al. 2012. The BC indicator is an interim metric used by the Conservation Data Centre to estimate ecological integrity of an element occurrence. Other researchers have used similar metrics in other parts of North America (Tiner 2004, Hruby 2004). Estimate Percent natural/semi-natural compared to total land cover within 2000m (2km) buffer.

Natural/Semi-natural areas were classified from the GIS layer “CE PseudoBTM 2019 landcover (CEF_SSAF_Ext_BTM_2019_191003)” under the attribute labeled "CEF_DISTURB_GROUP". The following classes were considered Natural/Semi-natural: ‘BTM Alpine SubAlpine Barren’; ‘BTM Forest Land’; ‘BTM – Fresh Water’; ‘BTM – Glaciers and Snow’; ‘BTM Range Lands’; ‘BTM – Salt Water’; ‘BTM Shrubs’; ‘BTM Wetlands Estuaries’; ‘Cutblocks’; ‘RESULTS_Reserves’. Conversely, Natural/Semi-Natural excluded the following disturbance layers: 'Agriculture_and_Clearing', 'Industrial', 'Lodges_and_Camps', 'Mining_and_Extraction', 'OGC_Infrastructure', 'Power', 'Rail_and_Infrastructure', 'Recreation', 'ROW', 'Urban'.

Interpretation Key:

>90 % Natural/Semi-Natural (low threat); 60-90%Natural/Semi-Natural (moderate threat); <60% Natural/Semi-Natural (high threat)

Reference:

Thresholds were derived from Faber-Langendoen et al. (2012).

Commentary

Most wetlands in Watershed Groups in the region contain >90% Natural/Semi-Natural area surrounding them. Watershed groups that are relatively impacted (60-90% Natural/Semi-Natural) include: Nechacko River, Cheslatta River, Francois Lake, Bulkley River, Nass River and Lower Nass River (Figure 11). It should be noted that cut blocks were treated as semi-natural as native vegetation tends to recover over time. The extent of cut blocks is better captured under the ECA indicator. Of note, the Skeena Region in general appears fairly intact through the lens of this indicator, a similar analysis of other regions of the Province where agricultural activities and urban development are more predominant may highlight this observation.

Assessment Results:

See Figure 11.

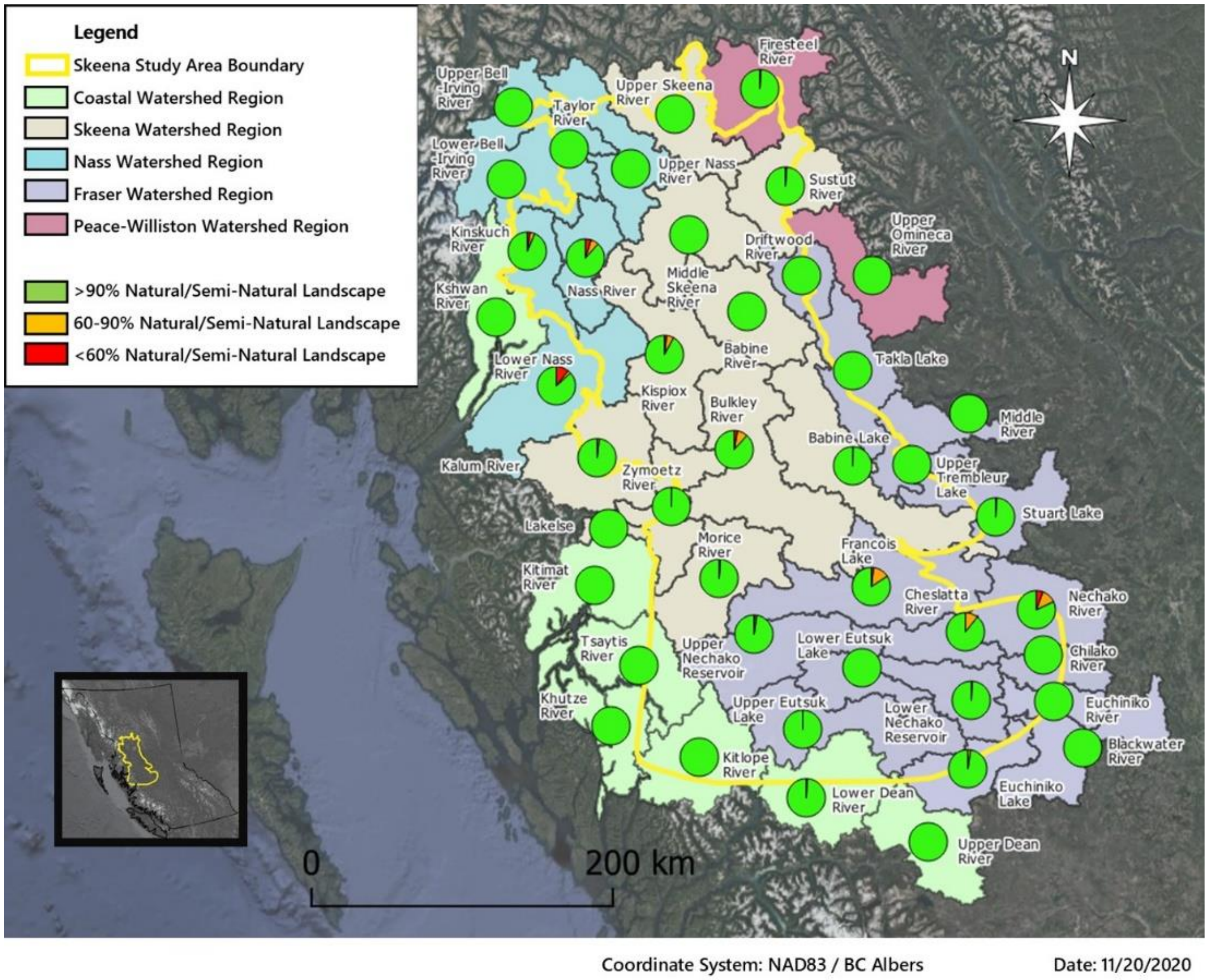


Figure 11. Map of intactness of landscape within 2km of wetlands, where green represents Low Threat (>90 % Natural/Semi-Natural); orange represents Moderate Threat (60-90%Natural/Semi-Natural); red represents High Threat (<60% Natural/Semi-Natural).

4.7 Function: Hydrologic Support: Flood Reduction Potential

Indicator Description:

Landscape position provides valuable information about the potential functions a wetland performs. For instance, headwater wetlands play an important role in regulating stream flow and temperature; and fringe wetlands on lakes help prevent shoreline erosion. Tiner (2014) categorizes wetlands based on their Landscape position, Landform, Water flow path, and Waterbody type. He refined a dichotomous key to enhance the U.S. National Wetland Inventory. Similar versions were also adapted by various states (e.g., Montana) and provinces (e.g., Nova Scotia) as a Tier 1 approach to measure relative functions among wetlands. Waterflow path, the wetlands position in relation to streams, is particularly informative at a Tier 1 level, in terms of the capacity of a wetland to intercept waters and moderate floods (Tiner 2018). As part of the Tier 1 assessment, we developed a Water Flow Path, based on work by Tiner, to compare different wetlands and make inferences at a regional scale. The rules set forth to categorize the wetland's water flow path is more consistent with terminology commonly used in BC and Canada.

A wetland was assigned one of 5 categories of waterflow path, based on a wetland's interactions with documented streams, lakes and rivers. The categories are as follows:

Inflow – The wetland receives waters from a stream; but no stream is documented as an outflow. These wetlands may be important for mitigating floods; as they capture water on the landscape while not releasing them via surface water means.

Outflow – The wetland releases water into a stream; but there are no documented streams entering a wetland. These types of wetlands are sometimes also referred to as "headwater wetlands" and may be important at maintaining and moderating flow in receiving waters.

Vertical Flow – The wetland does not have a contributing or receiving stream. These wetlands tend to be isolated from stream networks. They may also be important at mitigating floods, and they may or may not have interactions with groundwater.

Throughflow – The wetland has both a contributing and receiving stream. Depending on how water moves through the wetland, these wetlands may have the capacity to mitigate flood events, and help filter water from upstream tributaries.

Bidirectional – The wetland is along the edge of an open body of water (i.e., lake or pond). However, it is not associated with a stream entering or leaving the lake. These wetlands have waters that rise and fall directly in association with the adjacent body of water. These wetlands can provide shoreline protection. They may provide some flood mitigation relief, but relatively less than other wetland types.

Data Sources for this indicator include: FWA Stream Network, FWA Rivers, FWA Lakes, FWA Man Made Waterbodies, Wetland average slope from modelling provided by Andrew Fall (WetlandInfo.txt, 2019-10-22), Consolidated wetland complexes (ESI_basic_Wetland_Complexes_190912)

Interpretation Key:

The relative flood reduction potential is categorized "Very Low to Zero" to "High" with the following criteria:

'High' where the Water Flow Path is labelled Inflow or Vertical Flow, and the gradient of the wetland is low (i.e., <5% slope).

'Medium' where the Water Flow Path is labelled Outflow or Throughflow, the Stream Order is 2 or less (i.e., a small stream), and the gradient of the wetland is low (i.e., <5% slope)

'Low' where the Water Flow Path is labelled Throughflow, the Stream Order is greater than 2 (i.e., a relatively larger stream), and the gradient of the wetland is low (i.e., <5% slope)

'Very Low to Zero' where the Water Flow Path is labelled Bidirectional, or the gradient of the wetland is relatively high (i.e., >5% slope)

Reference

This approach was novel for BC, but was adapted from Hruby 2014, Hawes 2018, Tiner 2014, and Tiner and Herman 2015.

Commentary

The wetlands in most watershed groups have a broad range in capacity to attenuate flood events (i.e., from low to high capacity). A greater proportion of medium-to-high flood reduction potential (i.e., green and yellow) appears in less mountainous watershed groups – which may occur due to more gradual slopes in these watershed groups (Figure 12). BEC zones SBS and SBPS have a relatively higher proportion of wetlands that scored medium-to-high in comparison to other BEC zones in the Study Area (Figure 13).

The development of this flood reduction potential model required a novel stratification of documented wetlands. It offers a new tool for decision makers and analysts, in this region, that categorizes wetlands based on their landscape position (e.g., headwater, throughflow, bi-directional, etc.). This analysis is primarily developed from a wetland's relationship with the FWA stream layer. It adds value to the existing wetland data set. See Figure 13 for an example of the model's output.

Assessment Results

See Figure 12.

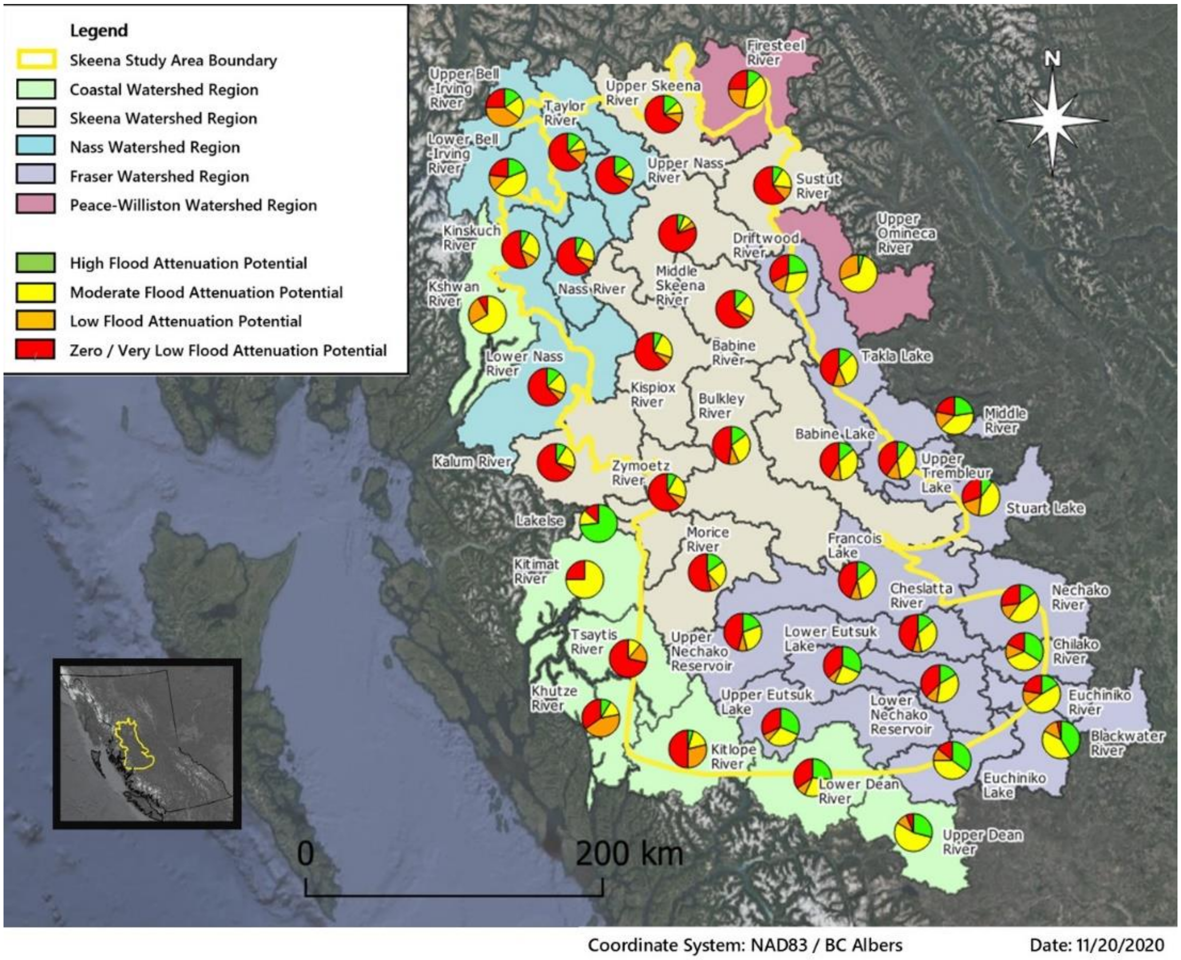


Figure 12. Map of flood reduction potentials, where green represents "High", yellow represents “Medium”, orange represents “Low”, and red represents “Very Low to Zero”.

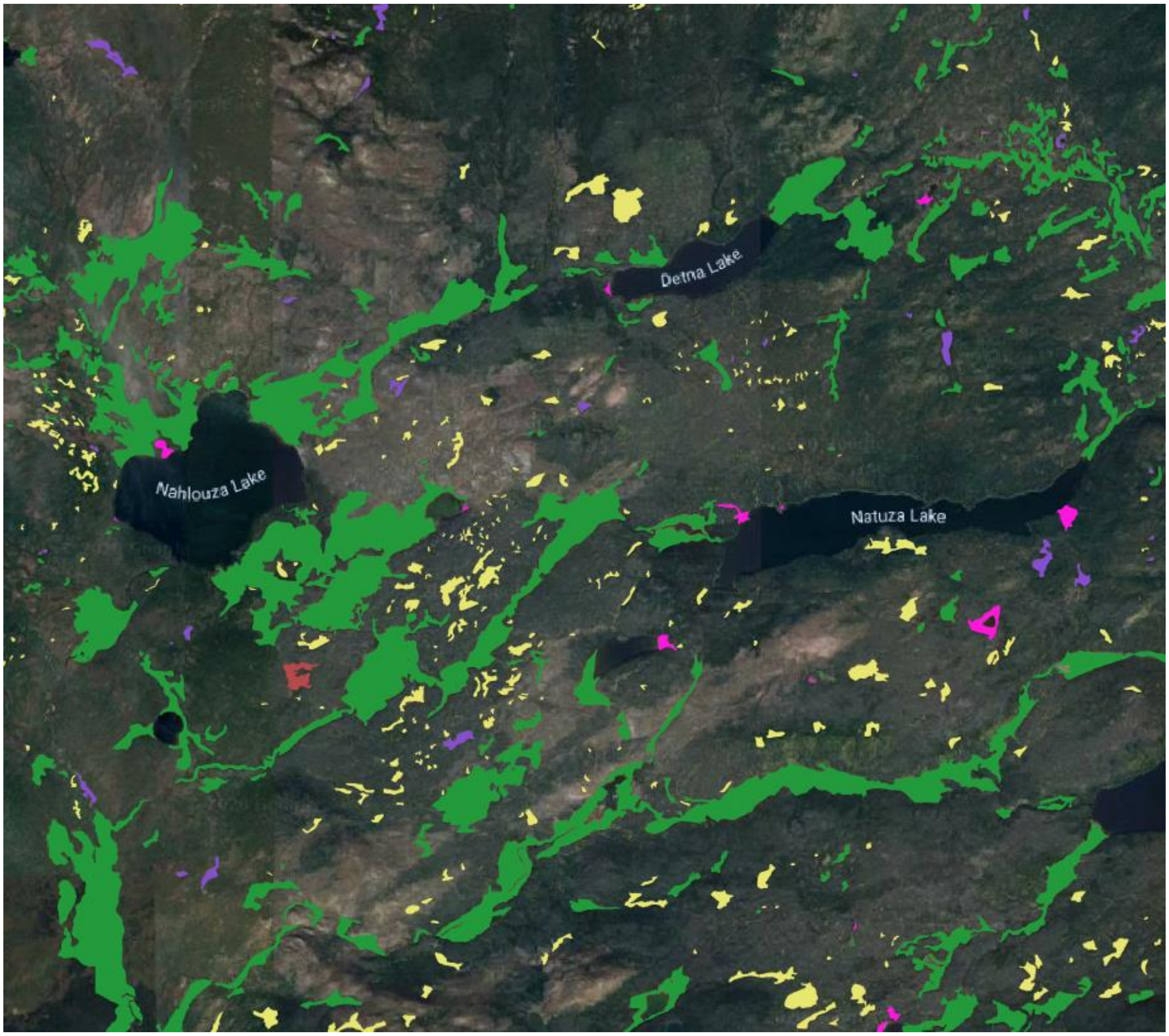


Figure 13. Examples of waterflow path in Lower Dean River region, where Green = "Throughflow"; Purple = "Outflow"; Yellow = "Vertical Flow"; Red = "Inflow"; Pink = "Bidirectional Flow".

Table 5. Flood reduction potential by BEC zone.

BEC Zone	High		Medium		Low		Very Low to Zero	
BAF	2	3.2%	9	14.3%			52	82.54%
BWB	3	21.4%	7	50.0%	3	21.4%	1	7.14%
CMA			1	20.0%			4	80.00%
CWH	118	11.8%	210	21.0%	150	15.0%	521	52.15%
ESSF	2033	11.8%	3160	18.4%	747	4.3%	11233	65.41%
ICH	456	10.1%	1304	29.0%	469	10.4%	2266	50.41%
MH	75	5.7%	119	9.1%	44	3.4%	1073	81.85%
MS	109	35.6%	144	47.1%	45	14.7%	8	2.61%
SBPS	1402	38.1%	1319	35.9%	410	11.1%	548	14.90%
SBS	5280	19.3%	9613	35.1%	3093	11.3%	9434	34.41%
SWB	79	12.7%	213	34.2%	147	23.6%	184	29.53%

4.8 Benefit: Flood Reduction

Indicator Description:

Wetlands located upstream of important assets (e.g., homes, human lives, community watersheds, or fish habitat) are often emphasized as offering relatively greater value in comparison to other wetlands, as they can reduce damages to these assets by moderating downstream flood events and reducing sedimentation (Hruby 2014, Adamus 2015). Whereas the previous indicator explored the relative *function* of Flood Reduction (i.e., a wetland's capacity to reduce downstream flooding), this indicator explores the *benefit* of a wetland's ability to perform that function from a societal perspective. In this case, the benefit relates to the proximity and upstream position of a wetland to a societal asset. Wetlands were selected as providing a flood reduction benefit if receiving watersheds were identified within 5 km that were occupied by a settlement, fish habitat (any species), or labeled as a community watershed.

Data sources for this indicator included: Communities (Hmn_Structure_Density_ESI_ExtendedAUarea_191001, DENSITY_CLASS_CD >= 3), BC MOE modelled fish habitat (2019-06-20), Consolidated wetland complexes (ESI_basic_Wetland_Complexes_190912), and FWA Fundamental Watersheds

Interpretation Key:

Pie charts depict the percent of wetlands, by FWA Watershed Group, in several categories. Green indicates percent of wetlands that are 5km upstream of *both* settlements (or community watersheds) and fish habitat, orange indicates wetlands that are 5 km upstream of either settlements (or community watersheds) or fish habitat, and red indicates that neither settlements (or community watersheds) or fish habitat are within 5 km downstream.

Reference:

No BC reference available. Indicator was adapted by: Hruby 2014, Adamus 2015.

Assessment Results:

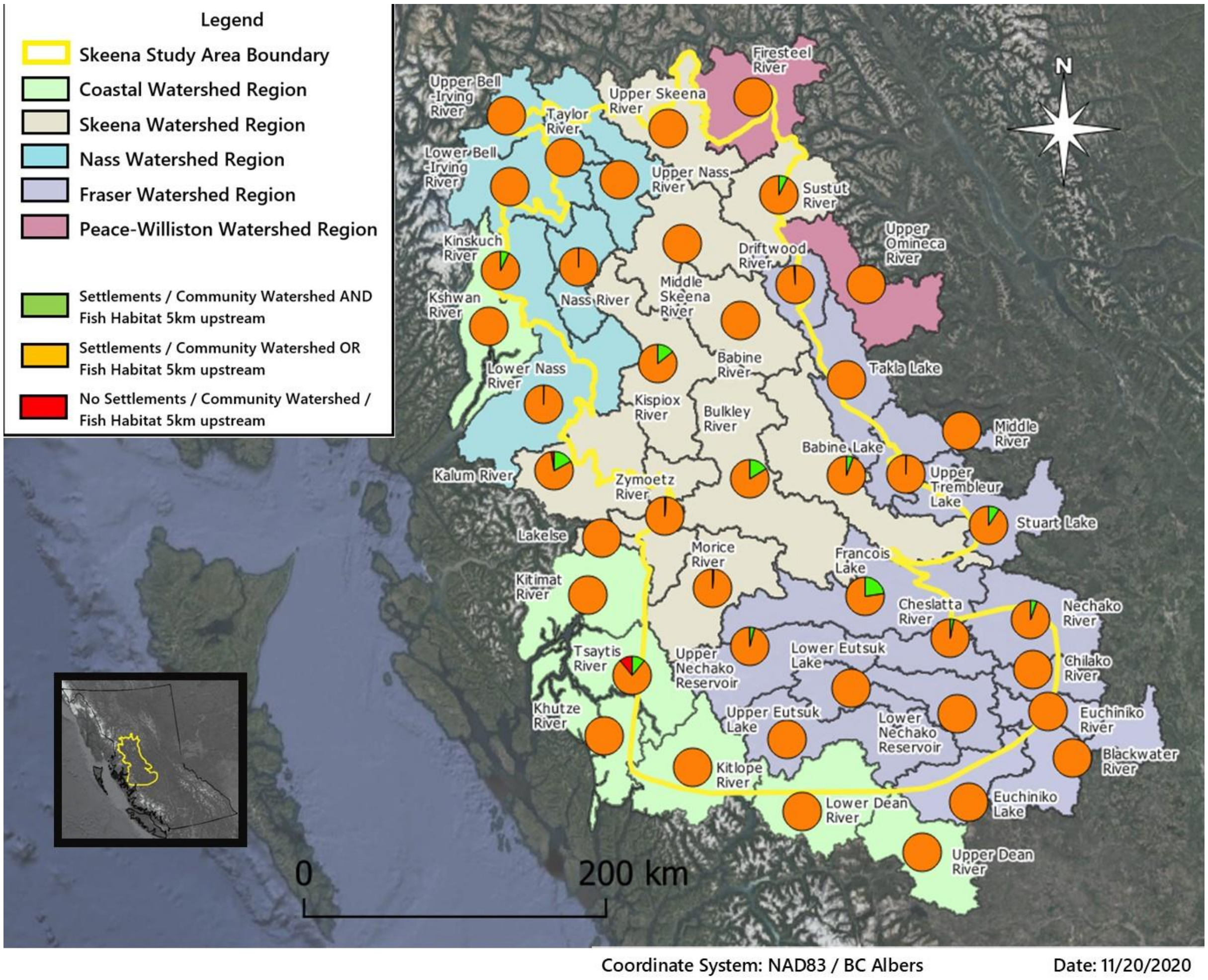


Figure 14. Map of flood reduction benefit of wetlands for societal assets 5 km downstream, where red shows "No Societal Asset 5 km Downstream of Wetland", orange shows "Fish Habitat 5 km Downstream of Wetland", and green shows "Community and Fish Habitat 5 km Dow

Commentary

This indicator helps inform the relative value of a wetlands flood reduction potential. Nearly all wetlands in the Study Area have fish habitat 5km downstream from them, and some of the more developed watersheds also have a proportion of their wetlands with communities, or community watersheds, downstream.

4.9 Function: Water Purification Potential

Indicator Description:

Water purification potential is a wetland's capacity to capture sediment, and interact with water inputs to trap pollutants and nutrients. A wetland's water purification potential is based on several variables: Water Flow Path type (i.e., as categorized in section 4.8), stream order (smaller streams assumed to treat water better), relatively lower slopes (i.e., lower slopes provide greater contact time for water passing through the wetland), and subsurface type (i.e., non-granitic versus granitic bed rock – where non-granitic bedrock are assumed to have greater water purification capacity) (Adamus per com. 2019, Hruby 2014).

Data Sources include: FWA Stream Network, FWA Rivers, FWA Lakes, FWA Man Made Waterbodies, Wetland average slope from modelling provided by Andrew Fall (WetlandInfo.txt, 2019-10-22), BC Bedrock (2018-04-05), wetlands were based on the "ESI_basic_Wetland_Complexes_190912" data set.

Interpretation Key:

Percent area of High Functioning (Green), Medium Functioning (Orange), Low Functioning (Red) wetlands regarding Water purification in watershed.

To assign a relative level of function (i.e., high, medium, or low), each variable was first assigned a sub-score, and then the subscores were tallied. The subscores were ranked as follows:

Water Flow Path (WFP = inflow or vertical flow : Subscore = 6

WFP = Outflow or Throughflow & Stream Order <2 : Subscore = 4

WFP = Throughflow & Stream Order >2 : Subscore = 2

WFP = Bidirectional : Subscore = 0

Internal Wetland Slope(IWS) <1% = Subscore = 3

IWS >1%-2% = Subscore = 2

IWS >2%-5% ; Subscore =1

IWS >5% : Subscore = 0

Granitic Soils/Bedrock (GS) = N : Subscore = 0

GS = Y : Subscore =(-2)

Functional Score = WFP + IWS + GS

Functional Score Rating: Low: -2 to 2 (Red); Med: 3 to 5 (Orange); High: 6 to 9 (Green)

Reference:

No provincial reference available. Indicator was adapted by Hruby 2014, and adjusted for available datasets.

Assessment Results:

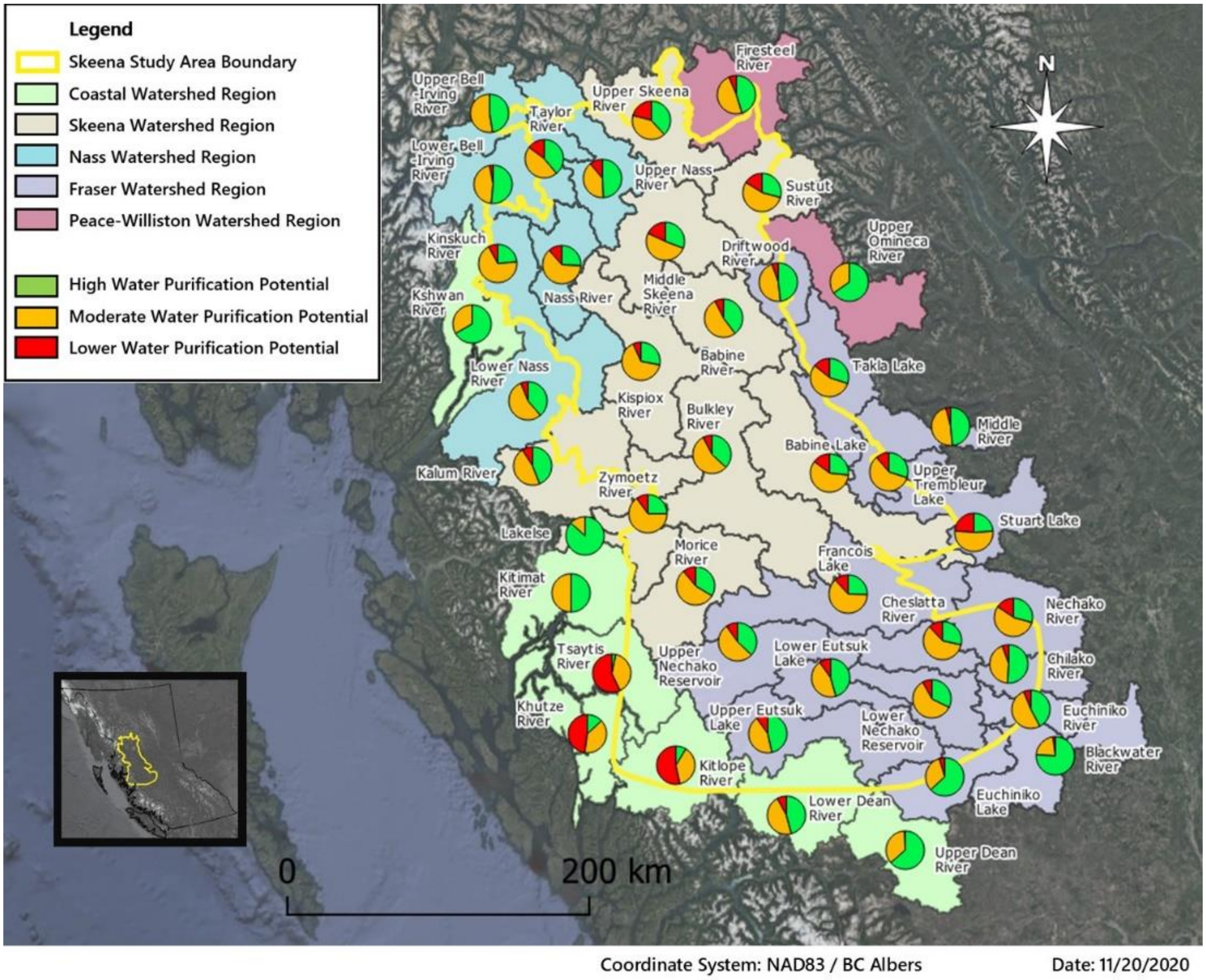


Figure 15. Map of water purification function of wetlands by region, where green represents High Functioning, orange represents Medium Functioning, and red represents Low Functioning wetlands.

Commentary

Most of the watersheds contain a high proportion of wetlands that score either medium to high functional score for water purification. This provides a preliminary indication that many wetlands in the region are likely playing an important role in filtering water within their watersheds. Lower scores for some Watershed Groups are in part due to higher content of granitic bedrock in particular watersheds such as Tsaytis, Khutze, Kitlope, and Stuart (Figure 15 and Table 6).

Table 6. Watersheds by region with granitic bedrock.

Watershed Group	Watersheds without granitic bedrock	Watershed with granitic bedrock	Total number of wetlands	Percent of watersheds with granitic bedrock
Babine Lake	3370	850	4220	20.1%
Babine River	3973	30	4003	0.7%
Blackwater River	194		194	0.0%
Bulkley River	3651	128	3779	3.4%
Cheslatta River	1521	172	1693	10.2%
Chilako River	1196	152	1348	11.3%
Driftwood River	849	38	887	4.3%
Euchiniko Lake	1675	32	1707	1.9%
Euchiniko River	690	2	692	0.3%
Firesteel River	477		477	0.0%
Francois Lake	4579	660	5239	12.6%
Ingenika River	1		1	0.0%
Kalum River	352	32	384	8.3%
Khutze River	3	20	23	87.0%
Kinskuch River	746	1	747	0.1%
Kispiox River	1956	1	1957	0.1%
Kitimat River	3	1	4	25.0%
Kitlope River	67	157	224	70.1%
Kshwan River	12		12	0.0%
Lakelse	15		15	0.0%
Lower Bell -Irving River	170		170	0.0%
Lower Dean River	2060	101	2161	4.7%
Lower Eutsuk Lake	1944	107	2051	5.2%
Lower Nass River	711	8	719	1.1%
Lower Nechako Reservoir	1958	33	1991	1.7%
Middle River	82	42	124	33.9%
Middle Skeena River	1201		1201	0.0%
Morice River	2227	208	2435	8.5%
Nass River	1999		1999	0.0%
Nechako River	1319	668	1987	33.6%
Stuart Lake	245	296	541	54.7%
Sustut River	833	11	844	1.3%
Takla Lake	676	245	921	26.6%
Taylor River	291		291	0.0%
Tsaytis River	31	33	64	51.6%
Upper Bell -Irving River	21		21	0.0%
Upper Dean River	160		160	0.0%
Upper Eutsuk Lake	3956	570	4526	12.6%
Upper Nass River	1019		1019	0.0%
Upper Nechako Reservoir	2719	276	2995	9.2%
Upper Omineca River	21	2	23	8.7%
Upper Skeena River	1267		1267	0.0%
Upper Trembleur Lake	537	77	614	12.5%
Zymoetz River	945	35	980	3.6%

4.10 Benefit: Water Purification

Indicator Description:

As an extension to the last indicator, which looked at the *functional capacity* a wetland to filter water, this indicator looks at the relative *benefit* of a wetland performing that same function. There are two considerations regarding the benefit of a wetland performing water purification/filtering: (1) societal assets below, and (2) stressors above. Wetlands located upstream of important assets (e.g., homes, human lives, community watersheds, or fish habitat) are emphasized as offering relatively greater value in comparison to other wetlands, as the filtered water provides a critical service to a known value (Hruby 2014, Adamus 2015). Wetlands located downstream of a potential water quality threat are also considered to have greater value as there is an identified need for water quality improvement. Potential stressors include: Remediation Sites – Contaminated, Mines, Mineral Tenures, and linear features (Road Layer, pipelines).

Data Sources include: Communities (Hmn_Structure_Density_ESI_ExtendedAUarea_191001, DENSITY_CLASS_CD >= 3), BC MOE modelled fish habitat (2019-06-20), Consolidated wetland complexes (ESI_basic_Wetland_Complexes_190912), FWA Fundamental Watersheds, CE integrated roads (SkeenaESI_Extend_ConsRd_inclKispBulk_DSS_190918), Point source pollution features (from Skeena ESI Tier 1 Watershed analysis), Waste Water Discharge locations from MOE Authorizations Database (WWDischarge_FWAextend_191104 [Status = Active]), WHSE_MINERAL_TENURE.MMS_NOTICE_OF_WORK (2018-11-29) (NoticeOfWork_Mines_181129), WHSE_WASTE.SITE_ENV_RMDTN_SITES_SVW (2019-04-12) (Additional_RemediationSites_SkeenaEast_190412), and WHSE_MINERAL_TENURE.MTA_ACQUIRED_ TENURE _GOV_SVW (2018-11-29) intersected with FWA Streams

Interpretation Key:

Benefit of water purification is categorized into High, Moderate and Low benefit based on a scoring schematic whereby:

Number of wetlands within 1 km down gradient of a point source pollution, subscore = 2

Wetland within 200 m down gradient of a primary or secondary linear feature (high), subscore = 2

Number of Wetlands within 200 m down gradient of a tertiary or temporary/abandoned feature. (moderate), subscore = 1

Number of wetlands within 5 km upstream of settlement, community watershed, or known fish habitat, subscore = 2

High: >2, Moderate: 1-2, Low: 0

Reference:

Adapted from OWES 2013, Hruby 2013

Commentary:

The presence of a road or other type of development upstream of a wetland increases the value of the wetland in terms of its ability to trap sediment and clean water. Conversely, a downstream feature that benefits from the filtering properties of wetlands (such as a community watershed or fish habitat) adds to the assumed societal value of the wetland. Most wetlands in the study have an upstream threat, benefit a downstream societal value through filtration, or satisfy both conditions. Less than 1% of all the wetlands scored low (i.e., not satisfying either condition), approximately 60 % scored moderate (i.e., with a societal water quality score of 1 or 2), and 39% scored high (i.e., score >2) (Refer to Figure 16a). Approximately 2% of the wetlands scored very high (with values of 5 or 6). Further investigation of wetlands that score very high within this indicator may help better quantify the water filtration functions and services that these wetlands supposedly support. It is possible that these high scoring wetlands may warrant prioritization for protecting of downstream assets.

Assessment Results:

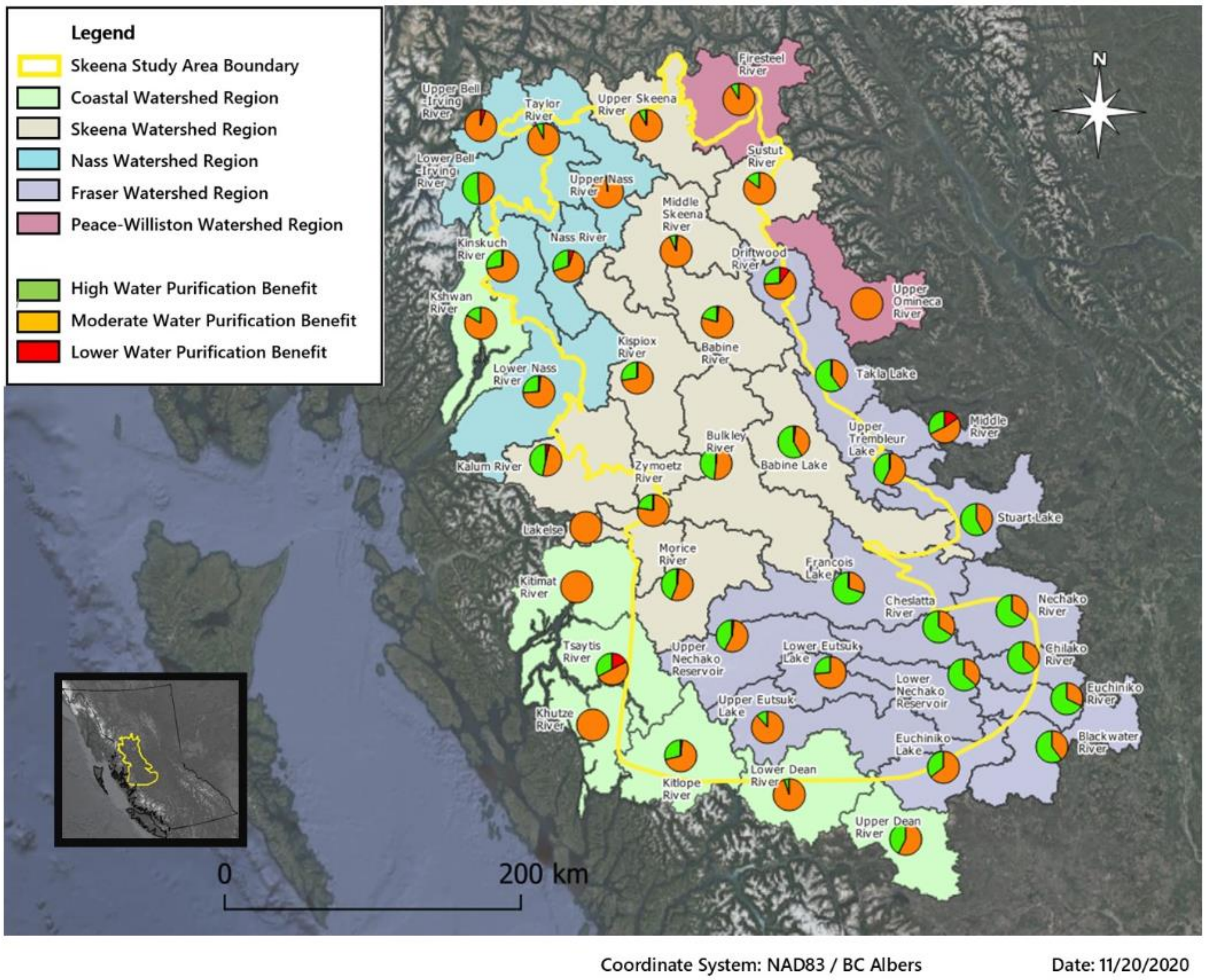


Figure 16. Map of water purification benefits of wetlands to societal assets 5km downstream, where green represents High Benefit, orange represents Medium Benefit, and red represents Low Benefit.

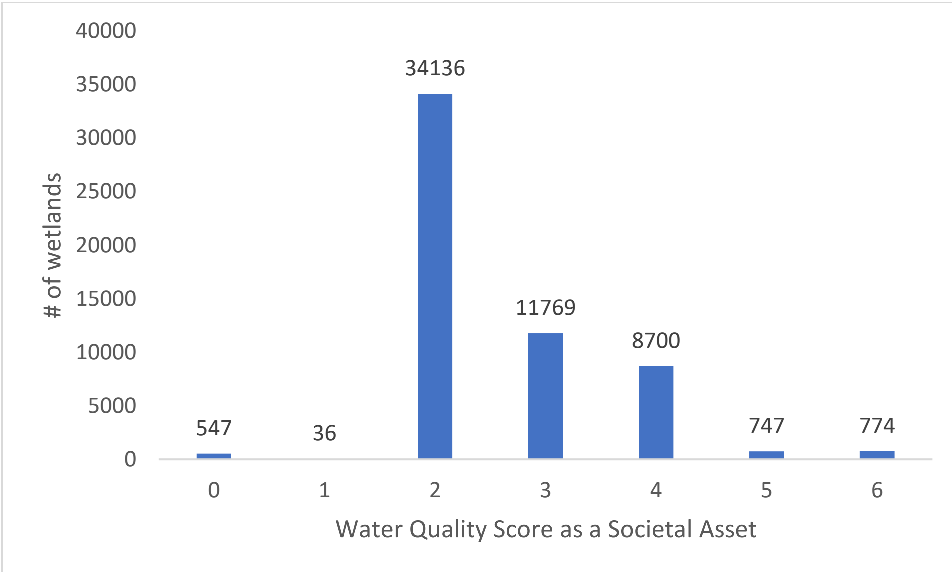


Figure 16 a. Histogram of water quality score for the wetlands located upstream of important assets, such as communities, fish habitat and homes in the Skeena region.

4.11 Function: Aquatic Life Support (Fish)

Indicator Description:

Wetlands can directly support fish populations with open water and channel features. They can indirectly support fish populations through stream flow regulation in summer months, and transport of nutrients for healthy aquatic invertebrate populations (food sources). The closer the proximity of wetlands are to fish streams and observation points, then the more likely they will have greater benefit to fish.

Data Sources include: BC MOE modelled fish habitat (2019-06-20) and "ESI_basic_Wetland_Complexes _190912" data set.

Interpretation Key:

Wetlands intersecting potential fish bearing streams score high (green), wetlands within 5 km of potential fish bearing streams score moderate (orange), and wetlands not within 5 km of potential fish bearing streams score low (red).

Reference:

Adapted from Hruby 2004 and per comm. P. Adamus.

Commentary:

Most wetlands in the study area are directly connected to fish bearing streams or within 5 km of fish habitat. Proportions of wetlands within a watershed group directly connected to fish bearing streams range between 25 to 75% within a watershed group – with slight trend in relatively higher proportions towards the southeast.

Assessment Results:

Refer to Figure 17.

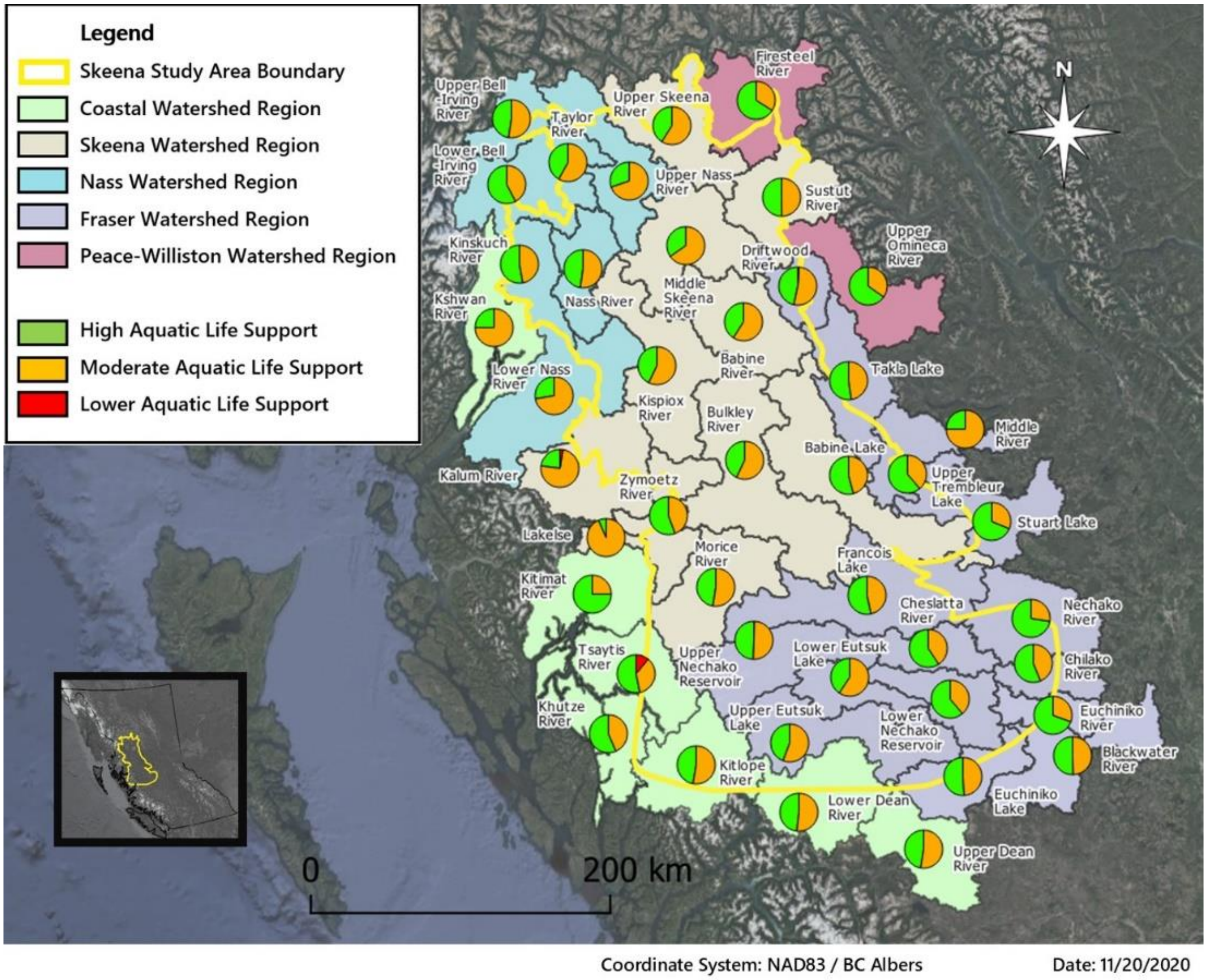


Figure 17. Map showing the ability of wetlands to support aquatic life, where green is "High", orange represents "Moderate", and red represents "Low".

4.12 Function: Wildlife Habitat: Availability of Moose Forage and Screening

Indicator Description:

Moose utilize wetlands throughout the year for both food and security. Moose browse and screening generally consists of shrubs and pole saplings with structural stages 3 & 4 (per. comm. Audrey Gagné-Delorme and Vanderstar 2016). Although the Vegetation Resource Inventory (VRI) does not contain structural stages (as defined by LMH25 in the BC Describing Terrestrial Ecosystems Field Manual), the proposed indicator uses basic cover types within VRI as a proxy. Structural stages have previously been derived from VRI in other studies (See: McGill, J., and A. Leong 2004.) High value wetlands are considered as polygons dominated by broadleaf trees, mixed trees, tall shrubs and short shrubs.

Data sources include: Vegetation Resources Inventory and the ESI_basic_Wetland_Complexes_190912 data set.

Interpretation Key:

Higher value wetlands for moose browse and screening are in green, and intersect with VRI polygons dominated by broadleaf trees, mixed trees, tall shrubs, or short shrubs.

Lower value wetlands for moose browse and screening are in red, and do not intersect with VRI polygons dominated by broadleaf trees, mixed trees, tall shrubs, or short shrubs.

Reference:

No reference available. Indicator based on (per comm. Audrey Gagné-Delorme and Vanderstar 2016).

Commentary:

Based on this coarse filter analysis, approximately 25% of the wetlands in the ESI study contain relatively higher value forage and screening for moose. The Sustut, Cheslatta, and Upper Skeena watersheds contain the highest proportions at 42,42, and 46 percent respectively. A subsequent analysis could refine these results further, e.g., removing low nutrient wetland types (e.g., A and B), although only 4 out of 5 of wetlands in the SSAF Study Area contain information on nutrient regimes within the VRI. Furthermore, a comparison of results from this analysis to more detailed moose studies in the region would help determine the validity of this Tier 1 approach (e.g., comparison to predictive studies such as Pollard 2014). The ESI moose habitat layer, when complete, could provide more detail on moose forage and screening.

Assessment Results:

See Figure 18 and 19.

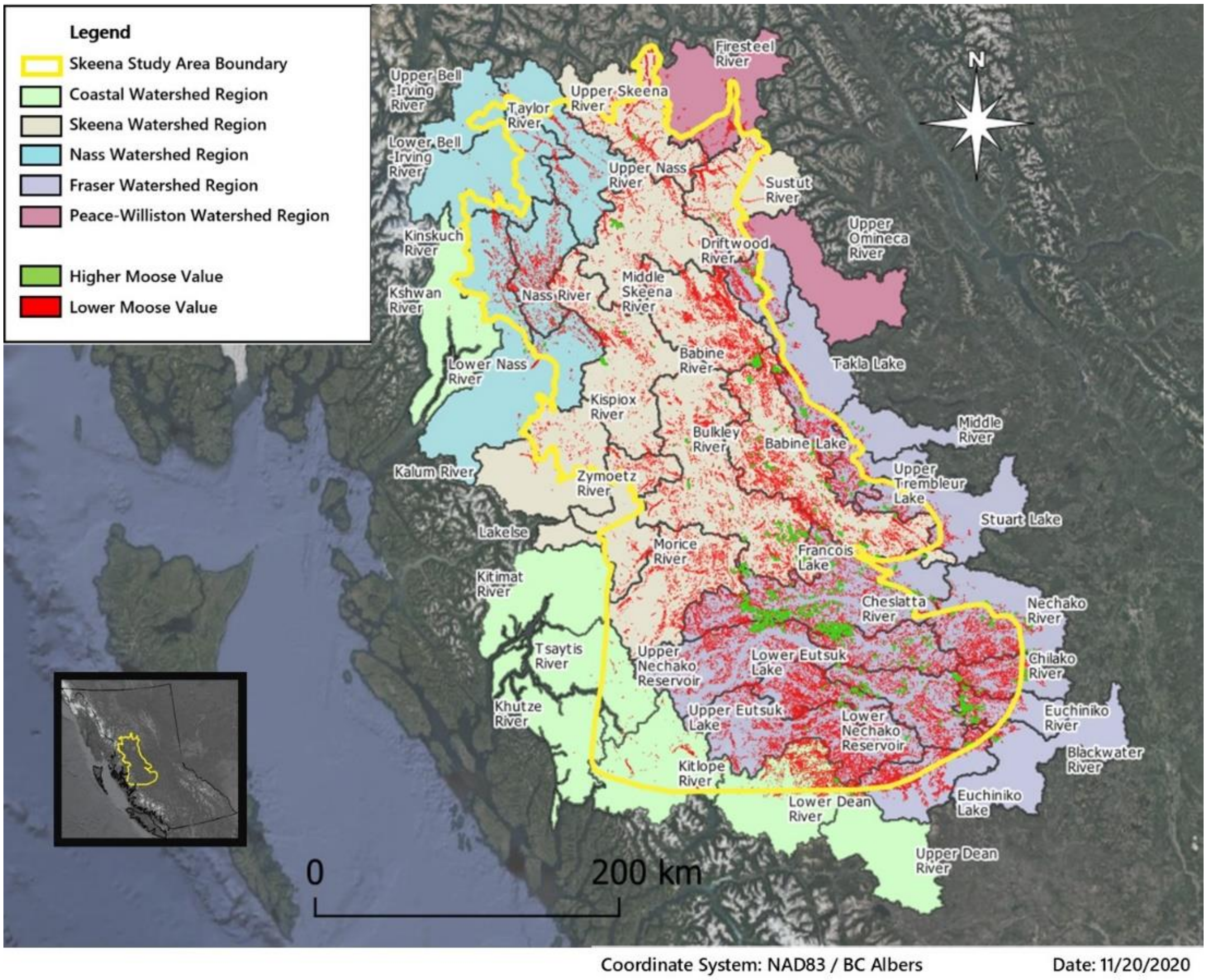


Figure 18. Wetlands that have suitable moose forage material (orange polygons).

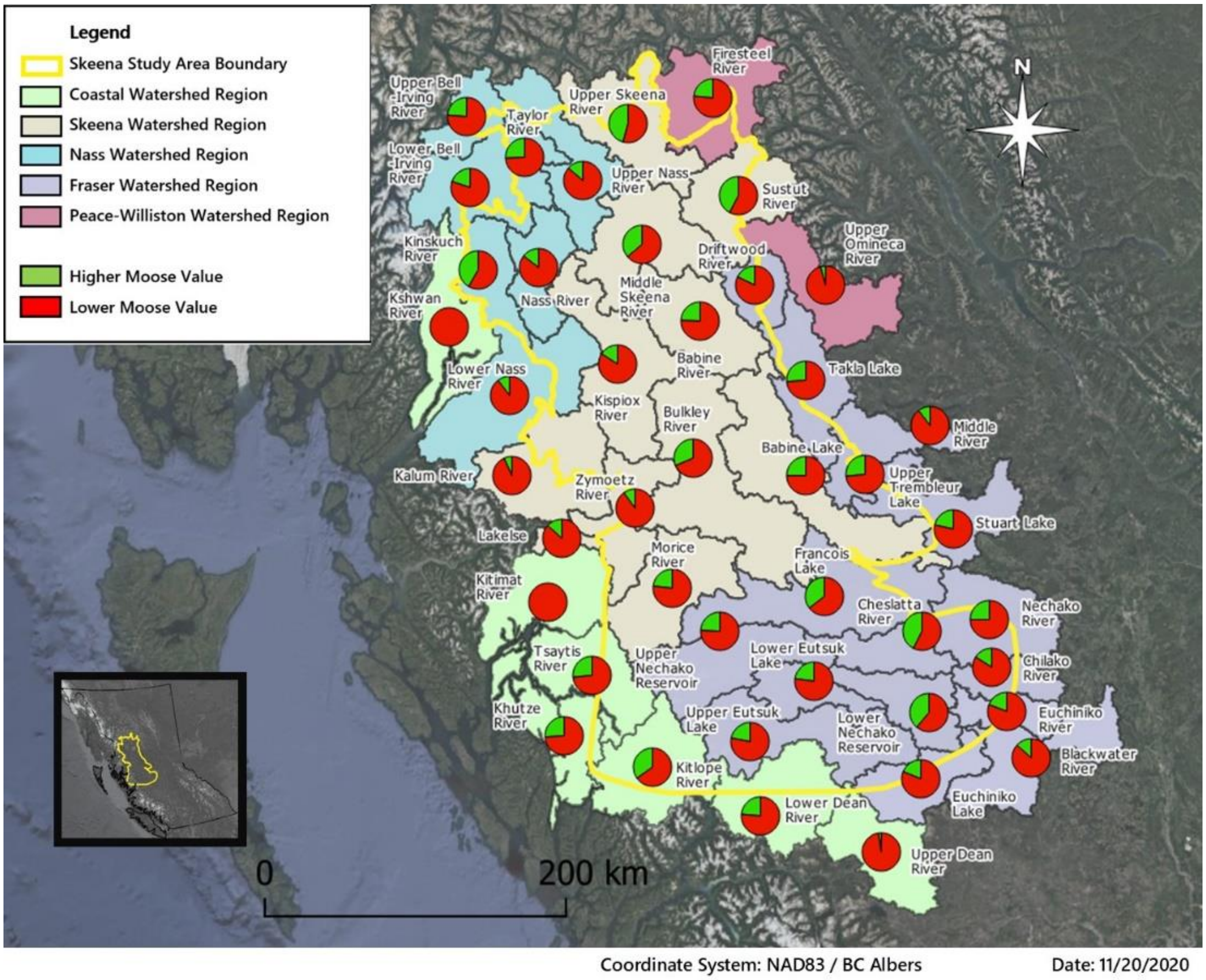


Figure 19. Proportion of wetlands that have suitable moose forage materials. Green = proportion of wetlands that are categorized as high value moose forage. Red = proportion not categorized as high value moose forage.

4.13 Function: Wildlife Habitat: Connectivity

Indicator Description:

Landscape connectivity helps provide wildlife with sufficient and different habitat types to adequately meet their life needs. Gaps in connectivity can increase risk of predation, reduce suitable habitat, and ultimately limit chances of survival (Bannerman 1997). The amount of intact habitat required can vary among species. The following indicator was adapted from a broadly utilized methodology in North America to estimate landscape connectivity around wetlands and other landscape features of interest. A similar methodology is utilized by the Conservation Data Centre of BC. Here we apply a threshold of percent of mature and old forests that surrounds a wetland as a proxy of landscape connectivity. The targeted % of mature and old forest varies by the site's natural disturbance regime and biogeoclimatic zones (Fletcher et al. 2020).

Data sources include: Vegetation Resource Inventory, ESI_basic_Wetland_Complexes_190912 data set, and BEC Biogeoclimatic Polygons

Interpretation Key:

Targets vary depending on Natural Disturbance Type and biogeoclimatic zone. A high threat is when there is insufficient mature and old forest within 2 km buffer (Parminter 1995, Fletcher et al. 2020). See Table 7 below for a range of targets.

Table 7. Minimal targets for mature and old forest coverage (Skeena Region in bold). Minimal targets for mature and old forest coverage (Skeena Region in bold). Source: Parminter, J. 1995. Biodiversity Guidebook - Forest Practices Code of British Columbia. B.C. Min. For. And B.C. Environ., Victoria, B.C.

Natural Disturbance Type	BGZ & variant	Upland-Wetland Objective	Minimal % Target for Mature+Old	Minimal Age
NDT1				
	CWH	**High**	**54**	**80**
	ICH	**High**	**51**	**100**
	ESSF	**High**	**54**	**120**
	MH	**High**	**54**	**120**
NDT2				
	CWH	**Mod**	**34**	**80**
	CDF	Mod	34	80
	ICH	**Mod**	**31**	**100**
	SBS	Mod	31	100
	ESSF	**Mod**	**28**	**120**
	SWB	**Mod**	**28**	**120**
NDT3				
	SBPS	**Low**	**8**	**100**
	SBSdk	**Low**	**11**	**100**
	SBSdw	**Low**	**11**	**100**
	SBSmk	**Low**	**11**	**100**
	SBSmc3	**Low**	**11**	**100**
	SBSwk1	Low	11	100
	SBS – other	**High**	**34**	**100**
	BWBSmw	Low	11	80/100*
	BWBSdk	Low	11	80/100*
	BWBSwk	Low	11	80/100*
	BWBS – other	High	34	80/100*
	MS – other	High	39	100
	MSxv	**moderate-high**	**26**	**100**
	ESSF	High	34	120
	ICH	High	34	100
	CWH	High	34	80
NDT4				
	ICH	High	51	100
	IDFdk	moderate-high	34	100
	IDF - other	High	51	100
	PP	High	51	100

*For BWBS, minimal target age is 80 years for deciduous prominent & 100 years for coniferous prominent

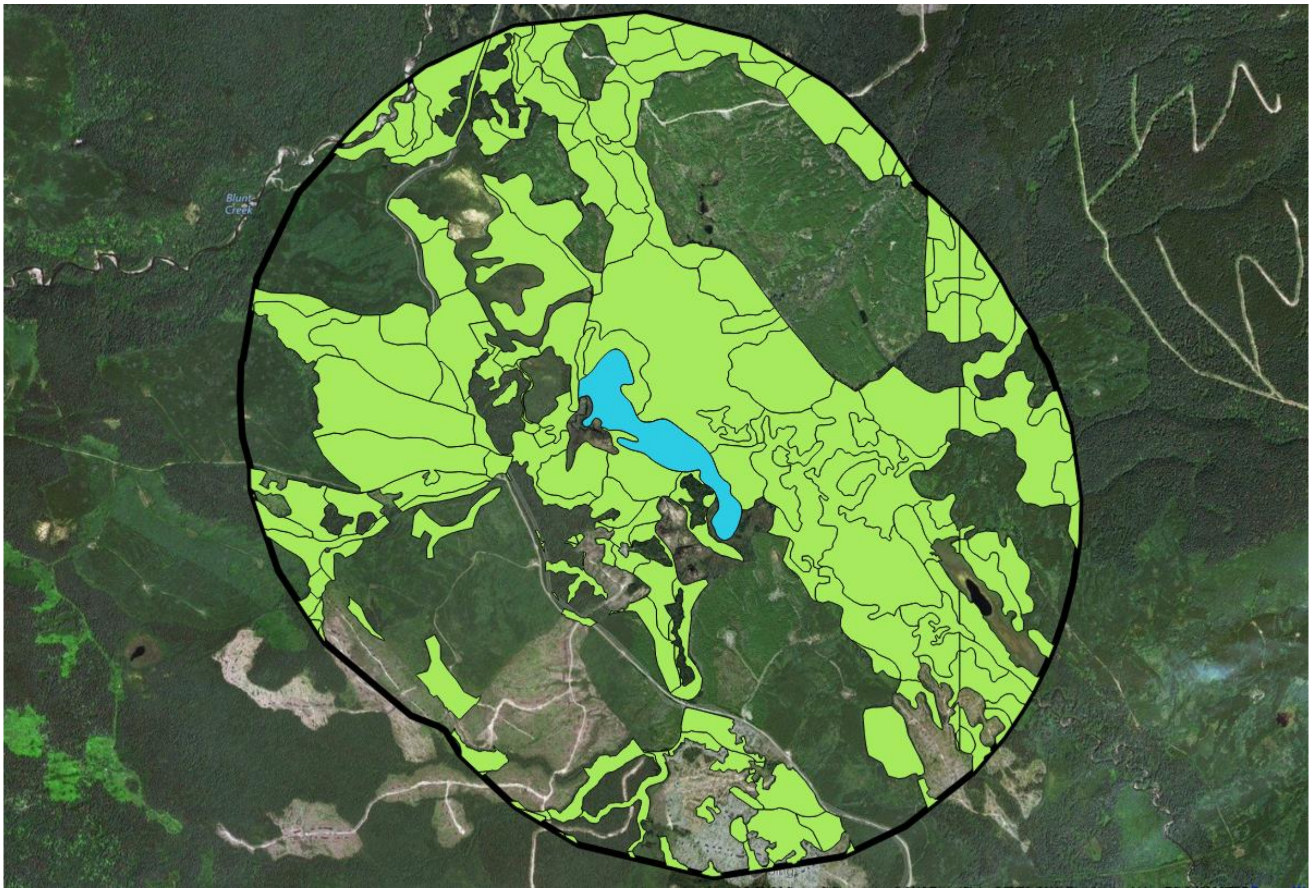


Figure 20. Landscape Connectivity – Mature and Old Forests within 2 km (green), target wetland blue.

In this example, shown in Figure 20., the wetland is within a Natural Disturbance Type of NDT3 and the BEC zone and variant is SBSmc2. From the look up table, the target mature and old forest is greater than 34%, and the minimal age is 100. The sum of polygons results in 47.6% of the forest land base meeting these two criteria, therefore the wetland has sufficient mature and old forest.

References

Fletcher et al. 2020

Commentary:

Most Watershed Groups in the Study Area have a relatively larger proportion of wetlands that achieve the minimum percent mature and old forest canopy cover within 2km (Figure 21 and Table 8). Exceptions primarily include watershed groups towards the far west. It is possible that the thresholds set, influence these results as the targets are relatively low for biogeoclimatic zones further east where SBS targets range between 8-11% mature and old growth versus targets that range upwards of 28-54% for some of the more coastal zones (e.g., CWH, ESSF). Price et al. (2020) note that the thresholds may be too low because targets were set with the assumption that a specific proportion of the land base, per BEC, was already protected through parks, and they further consider the level of protection afforded by these designations as debatable. Increasing the target for mature and old growth may be warranted, but is beyond the scope of this paper.

Assessment Results:

Refer to Figure 21.

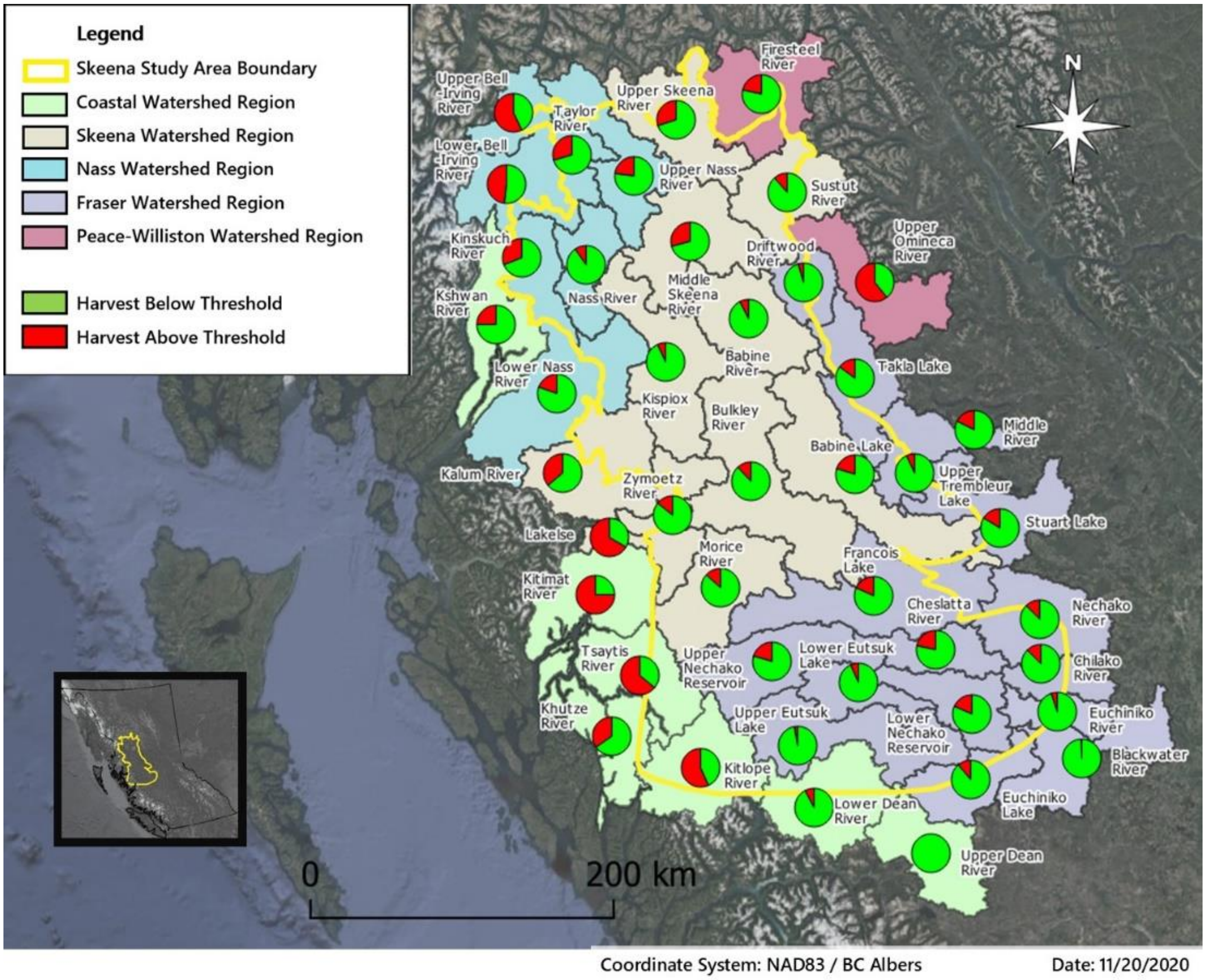


Figure 21. Map showing the proportion of wetlands that pass the minimum threshold of mature and old growth forest within 2km of wetlands (green) compared to wetlands that do not (red).

Table 8. Percent breakdown, by Watershed Group, of wetlands that meet mature and old growth forest cover targets within 2 km.

Watershed Group	Fail (Not connected)	Pass (Connected)	Average Connectivity	Average of Mature Old Growth
Babine Lake	859	3361	79.6%	50.4%
Babine River	307	3696	92.3%	64.4%
Blackwater River	1	193	99.5%	40.6%
Bulkley River	455	3324	88.0%	50.5%
Cheslatta River	368	1325	78.3%	28.8%
Chilako River	170	1178	87.4%	37.5%
Driftwood River	40	847	95.5%	77.2%
Euchiniko Lake	194	1513	88.6%	44.3%
Euchiniko River	35	657	94.9%	38.8%
Firesteel River	103	374	78.4%	49.7%
Francois Lake	951	4288	81.8%	35.4%
Ingenika River		1	100.0%	60.9%
Kalum River	139	245	63.8%	40.2%
Khutze River	8	15	65.2%	50.5%
Kinskuch River	231	516	69.1%	56.5%
Kispiox River	136	1821	93.1%	68.1%
Kitimat River	3	1	25.0%	11.4%
Kitlope River	127	97	43.3%	32.3%
Kshwan River	3	9	75.0%	28.8%
Lakelse	10	5	33.3%	27.8%
Lower Bell -Irving River	82	88	51.8%	47.0%
Lower Dean River	168	1993	92.2%	66.5%
Lower Eutsuk Lake	139	1912	93.2%	59.6%
Lower Nass River	141	578	80.4%	57.8%
Lower Nechako Reservoir	367	1624	81.6%	30.7%
Middle River	22	102	82.3%	56.3%
Middle Skeena River	350	851	70.9%	57.5%
Morice River	327	2108	86.6%	55.6%
Nass River	194	1805	90.3%	67.4%
Nechako River	246	1741	87.6%	36.9%
Stuart Lake	88	453	83.7%	38.7%
Sustut River	98	746	88.4%	61.1%
Takla Lake	137	784	85.1%	52.2%
Taylor River	86	205	70.4%	52.5%
Tsaytis River	41	23	35.9%	28.9%
Upper Bell -Irving River	12	9	42.9%	23.9%
Upper Dean River		160	100.0%	65.4%
Upper Eutsuk Lake	127	4399	97.2%	61.5%
Upper Nass River	235	784	76.9%	65.0%
Upper Nechako Reservoir	616	2379	79.4%	49.1%
Upper Omineca River	14	9	39.1%	24.6%
Upper Skeena River	380	887	70.0%	48.7%
Upper Trembleur Lake	43	571	93.0%	55.4%
Zymoetz River	140	840	85.7%	59.5%

4.14 Function: Parks, Protected Areas, and other Wildlife Conservation Designations

Indicator Description:

Areas designated as parks, protected areas, or that have special provisions for wildlife management (e.g., Ungulate Winter Range and Wildlife Management Areas) aim to support high habitat value. Although the entire BC landscape is managed for wildlife through overarching policies, such as the BC Wildlife Act, specific area-based conservation tends to prioritize wildlife and ecosystem conservation relative to other land-based objectives. This indicator considers the proportion of the land base that includes special provisions.

Data Sources include: Wildlife Mgmt Area; Proposed Ungulate Winter Range; Ungulate Winter Range; Conservation Lands Database, Parks, and the ESI_basic_Wetland_Complexes_190912.

Interpretation Key:

Wetlands that intersect with parks, protected areas, Wildlife Management Areas, or existing or proposed ungulate winter range are highlighted.

Commentary

A variety of land designations, such as designated ungulate winter range, conservancy lands, and provincial parks, can support the conservation of wetlands by limiting development activities on these lands. Table 9 shows that 65% (30 of the 46) of the major watersheds within the SSAF Study Area under-represent wetland extent within the lands that receive special conservation-based provisions. This means wetlands are afforded less protection in these watersheds relative to other lands. Generally speaking, many large wetlands tend to occupy low lying valleys, and it is possible that some of the watersheds also receive greater development pressure in these lower elevation areas.

Assessment Results:

See Figure 22 and 23.

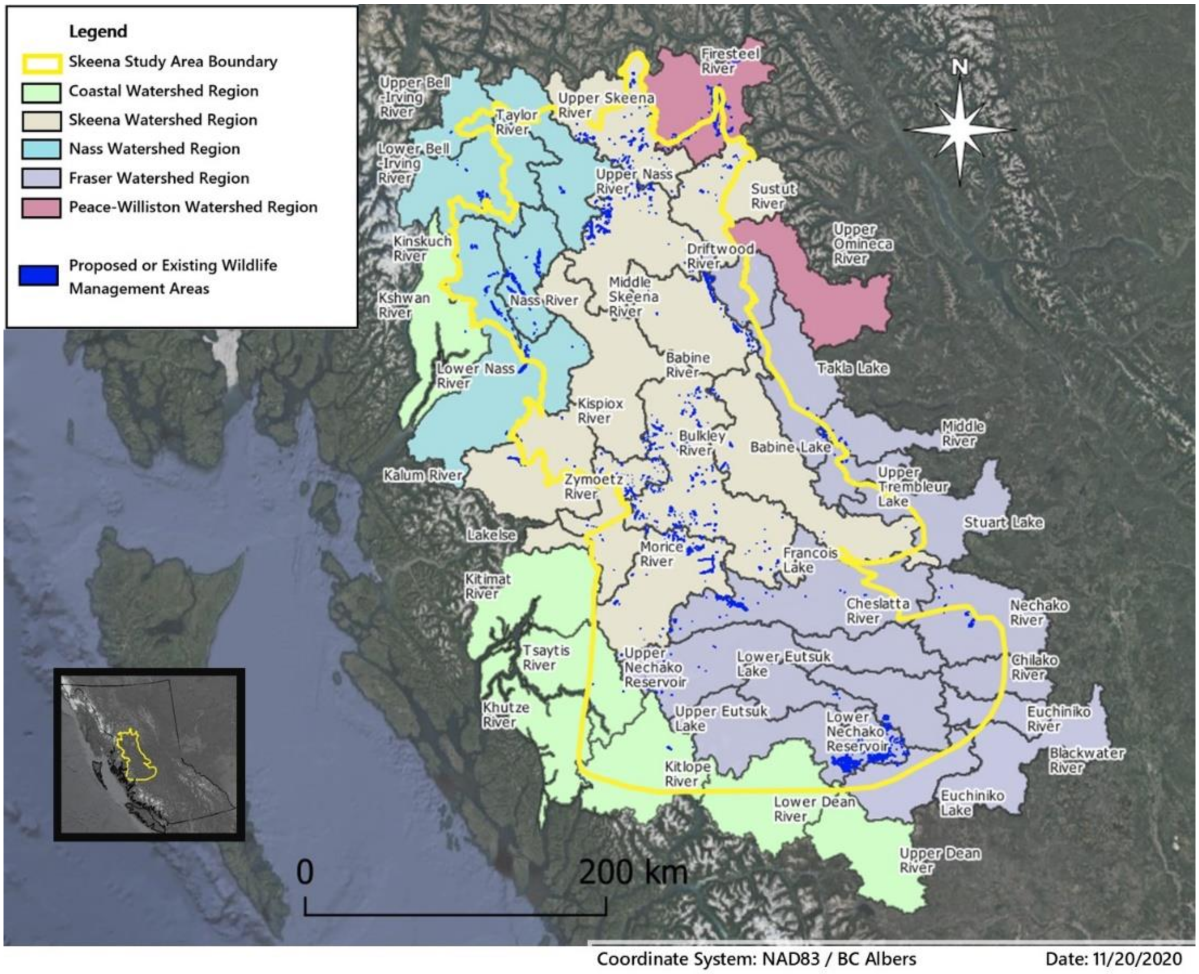


Figure 22. Map showing the wetlands that are located within parks, protected areas, existing or proposed ungulate winter range, or Wildlife Management Areas.

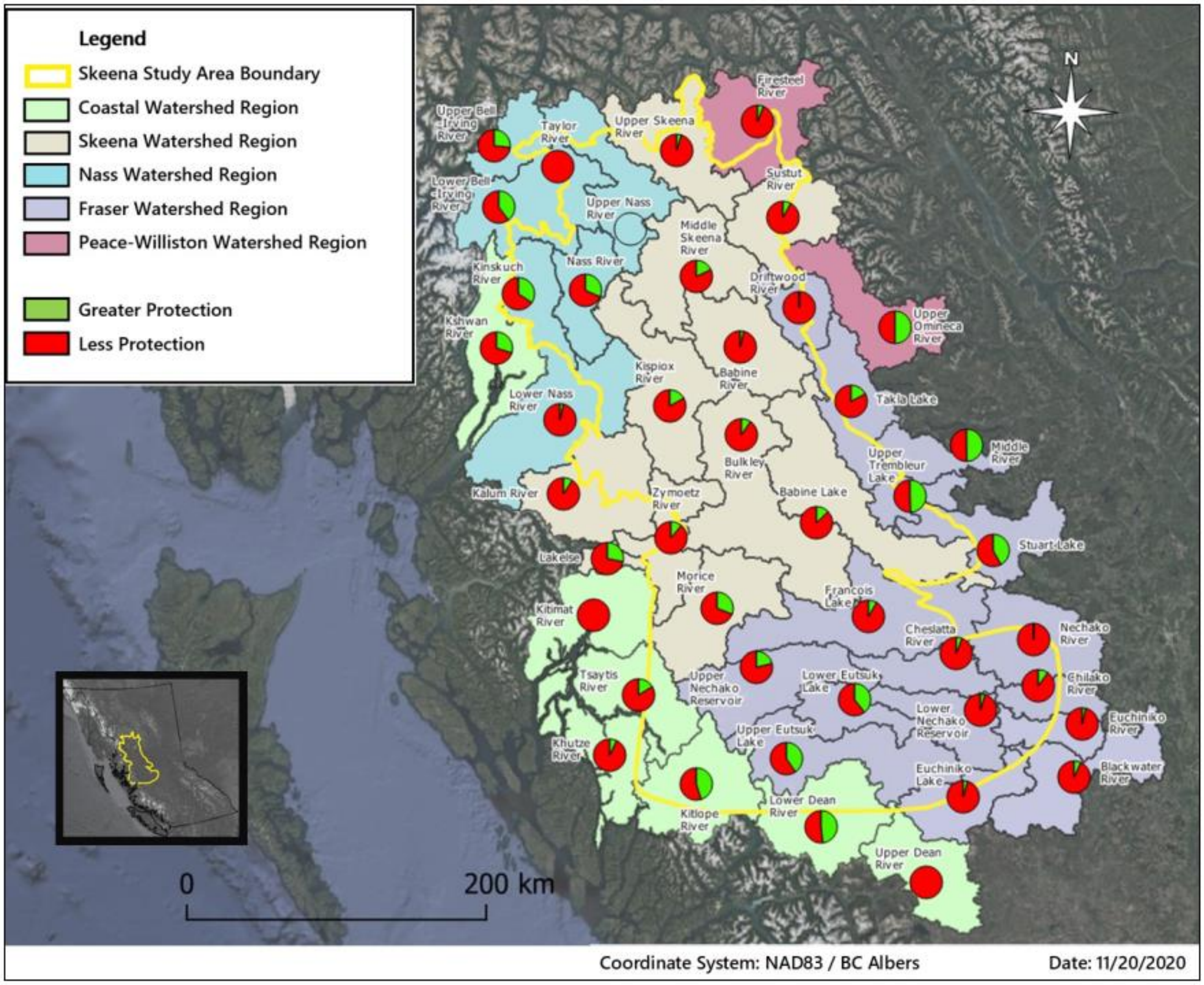


Figure 23. Map showing the proportion of wetlands that are located within parks, protected areas, existing or proposed ungulate winter range, or Wildlife Management Areas (green) compared to those that are not (red).

Table 9. Wetlands "protected" by watershed group.

WATERSHED_GROUP_NAME	Area (Ha)	Total Protected (Ha)	% of Watershed Group Protected	Area of Wetland (Ha)	Area of Protected Wetland (Ha)	Wetlands that are Protected (% Area)	Over or Under Represented
BABINE LAKE	650,704	64,414	10	38,771	5,645	15	5% over
BABINE RIVER	389,238	23,213	6	22,540	801	4	2% under
BLACKWATER RIVER	21,174	2,186	10	2,302	169	7	3% under
BULKLEY RIVER	780,618	120,422	15	26,123	2,708	10	5% under
CHESLATTA RIVER	212,832	14,209	7	10,600	643	6	1% under
CHILAKO RIVER	105,574	17,435	17	9,417	1,029	11	6% under
DRIFTWOOD RIVER	126,908	16,611	13	7,258	31	0	13% under
EUCHINIKO RIVER	75,753	3,869	5	5,955	220	4	1% under
EUCHINIKO LAKE	159,229	24,484	15	14,965	683	5	10 % under
FIRESTEEL RIVER	192,429	52,949	28	4,162	258	6	22% under
FRANCOIS LAKE	586,816	52,287	9	29,666	2,691	9	0% over
INGENIKA RIVER	9,150	54	1	21	0	0	1% under
KHUTZE RIVER	47,696	7,419	16	127	10	8	6% under
KINSKUCH RIVER	211,525	52,998	25	4,076	2,125	52	27% over
KISPIOX RIVER	520,976	119,168	23	7,382	1,497	20	3% under
KITLOPE RIVER	351,281	272,254	78	2,761	2,259	82	4% over
KITIMAT RIVER	37,923	2,880	8	3	0	0	8% under
KALUM RIVER	263,381	55,908	21	1,981	197	10	11% under
KSHWAN RIVER	77,931	22,752	29	52	22	42	13% over
LOWER BELL-IRVING RIVER	131,760	16,783	13	919	604	66	53% over
LOWER DEAN RIVER	217,674	177,742	82	12,274	11,406	93	11% over
LOWER EUTSUK LAKE	194,716	129,247	66	14,680	9,471	65	1% under
LAKELSE	5,637	846	15	28	11	39	11% over
LOWER NASS RIVER	227,542	34,168	15	2,204	78	4	11% under
LOWER NECHAKO RESERVOIR	274,987	15,341	6	15,097	697	5	1% under
MIDDLE RIVER	23,132	23,070	100	836	830	99	1% under
MORICE RIVER	434,893	222,555	51	14,279	6,367	45	6% under
MIDDLE SKEENA RIVER	485,018	104,821	22	11,316	2,475	22	0% over
NASCALL RIVER	3,769	374	10	0	0	0	10% under
NASS RIVER	246,878	36,830	15	6,307	2,913	46	31% over
NECHAKO RIVER	224,358	84	0	13,703	26	0	0% over
STUART LAKE	152,636	127,611	84	4,036	2,905	72	12% under
SUSTUT RIVER	242,414	75,831	31	8,130	699	9	22% under
TAKLA LAKE	160,682	25,915	16	12,314	2,552	21	5% over
TAYLOR RIVER	137,361	4,208	3	1,236	0	0	3% under
TSAYTIS RIVER	193,923	60,319	31	411	78	19	12% under
UPPER BELL-IRVING RIVER	57,559	12,167	21	158	57	36	15% over
UPPER DEAN RIVER	7,519	111	1	771	0	0	1% under

WATERSHED_GROUP_NAME	Area (Ha)	Total Protected (Ha)	% of Watershed Group Protected	Area of Wetland (Ha)	Area of Protected Wetland (Ha)	Wetlands that are Protected (% Area)	Over or Under Represented
UPPER EUTSUK LAKE	520,608	407,559	78	28,928	19,600	68	10% under
UNUK RIVER	319,659	8,843	3	4,119	40	1	2% under
UPPER NECHAKO RESERVOIR	418,791	139,560	33	13,796	3,694	27	6% under
UPPER OMINECA RIVER	12,131	12,114	100	379	379	100	0% over
UPPER SKEENA RIVER	329,181	93,470	28	14,516	692	5	23% under
UPPER STIKINE RIVER	30,101	29,761	99	84	79	93	6% under
UPPER TREMBLEUR LAKE	87,780	85,742	98	5,700	5,574	98	0% over
ZYMOETZ RIVER	276,569	46,211	17	4,121	726	18	1% over

4.15 Benefit: Cultural Value: Archeological Records or Identified Wetland of Significance to Communities

Indicator Description:

Archeological records as well as current usage within a wetland are of value to local First Nations and communities. The identification of sites depends on available archaeological data from Remote Access to Archaeological Data (RAAD) and information provided by local First Nations. Since archeological information is limited, archeological records are acknowledged to underrepresent areas of historical or current cultural importance. Analysis would be improved with contributions from participating communities whom may own their own datasets. Surveys with communities, and field observations, could help revise this wetland list. Data may be sensitive and may require masks or roll up summaries for dissemination.

Wetlands were identified from the “ESI_basic_Wetland_Complexes_190912” data set, and Arch Sites were identified from the “Additional_RAAD_ArchSites_190501” data set. These Arch Sites were given a buffer of 500 m around them. Any wetlands that fell within this buffer area were classified as a wetland of significance to nearby communities.

Interpretation Key:

Record “Y” if wetland within 500 m of record.

Commentary:

Based currently only on information from the RAAD, only a small fraction of wetlands appear to be within 500 m of a predicted or documented archaeological site – with greater proportions generally observed to the South-East of the study area. The percentage of wetlands associated with archaeological sites is likely an underestimate based on limited data availability. Information provided by Nations through community surveys or data retained from FN offices would help to better inform this indicator. The project team is in the process of seeking input on additional layers for this analysis.

Assessment Results:

Refer to Figure 24 and 25.

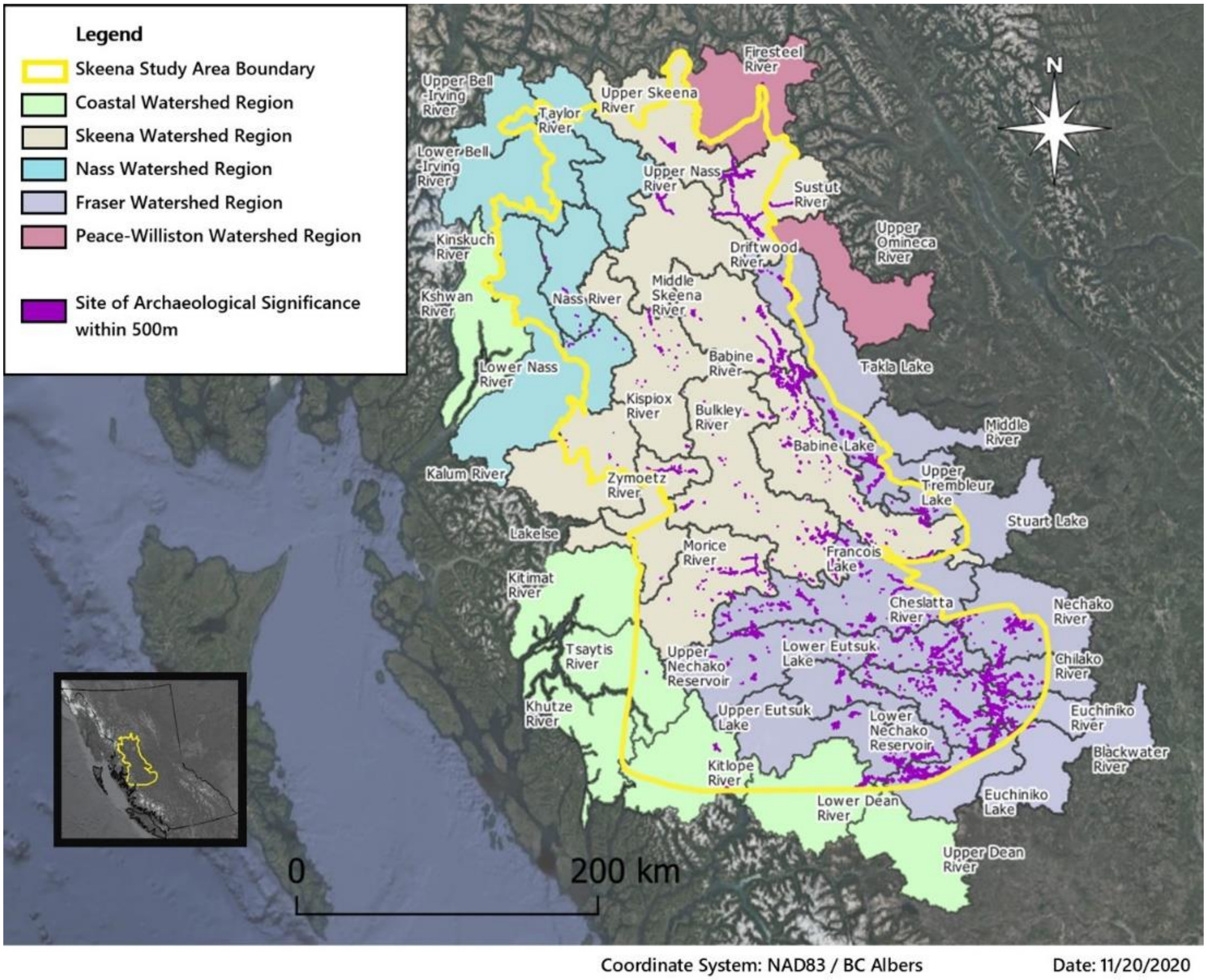


Figure 24. Map showing the wetlands that have a site of archaeological significance within 500 m.

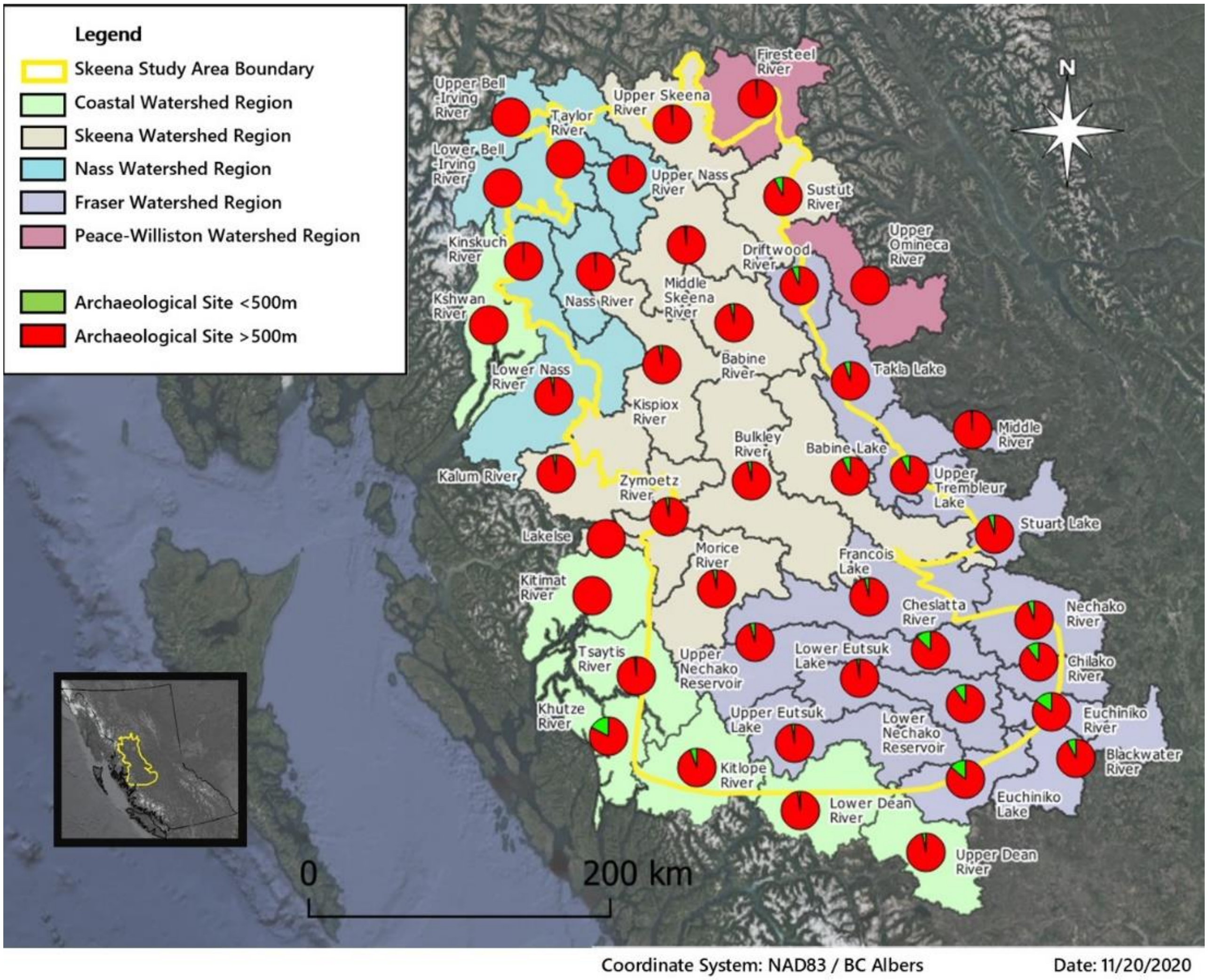


Figure 25. Map showing the number of wetlands that have a site of archaeological significance within 500 m compared to the number of wetlands that do not.

4.16 Benefit: Cultural Value: Accessibility

Indicator Description:

Wetlands closer to settlements and with ease of access are more likely to be accessed for provision of goods and services. Elders and persons with disabilities who wish to gather foods or traditional medicines require access that is close and easily accessible.

Interpretation Key:

Highly accessible wetlands are those that are within 5 km from a community, 500 m from a road, and have gentle slopes (<5%); Moderately accessible wetlands are those that are within 50 km from a community, 500 m from a road, and have gentle slopes (<5%); wetlands are considered to have Low accessibility if they do not meet the criteria above.

(Adapted from Hall 2018)

Commentary

As expected, more wetlands are accessible in watershed groups with more towns and settlements, but only a relatively small portion are ranked highly accessible. Francois Lake watershed appears to have the highest level of accessibility when high and moderate categories are combined. Accessibility may be overrepresented throughout the study area – as the available road layer is not well updated in terms of road deactivations.

The contradiction between this indicator which considers access a societal benefit, and previous indicators which considered access via roads as a possible stressor is fully acknowledged. This indicator is not meant to endorse the development of further roads near wetlands, rather it simply highlights that some wetlands close to settlements and roads may, by *defacto*, support a greater proportion of community members who harvest plants, animals, and other resources.

A nation member from Gitanyow who reviewed this indicator, expressed that a reverse scoring may be more appropriate in the territories – in that higher value should be associated with wetlands that are less accessible. Associating a greater weight to wetlands that are less accessible confers also with comments made during the 2017 workshop where several elders discussed “spirit of a place”, and that noise and disturbance from roads and other disturbances negatively affects the spirit of the place - in addition to concerns about the quality of the materials harvested from the site. If no harvesting or access is anticipated at the site, then the value attributed to remote wetlands is more altruistic, and this could be expressed in terms of an existence value rather than a use value.

Assessment Results:

Refer to Figure 26.

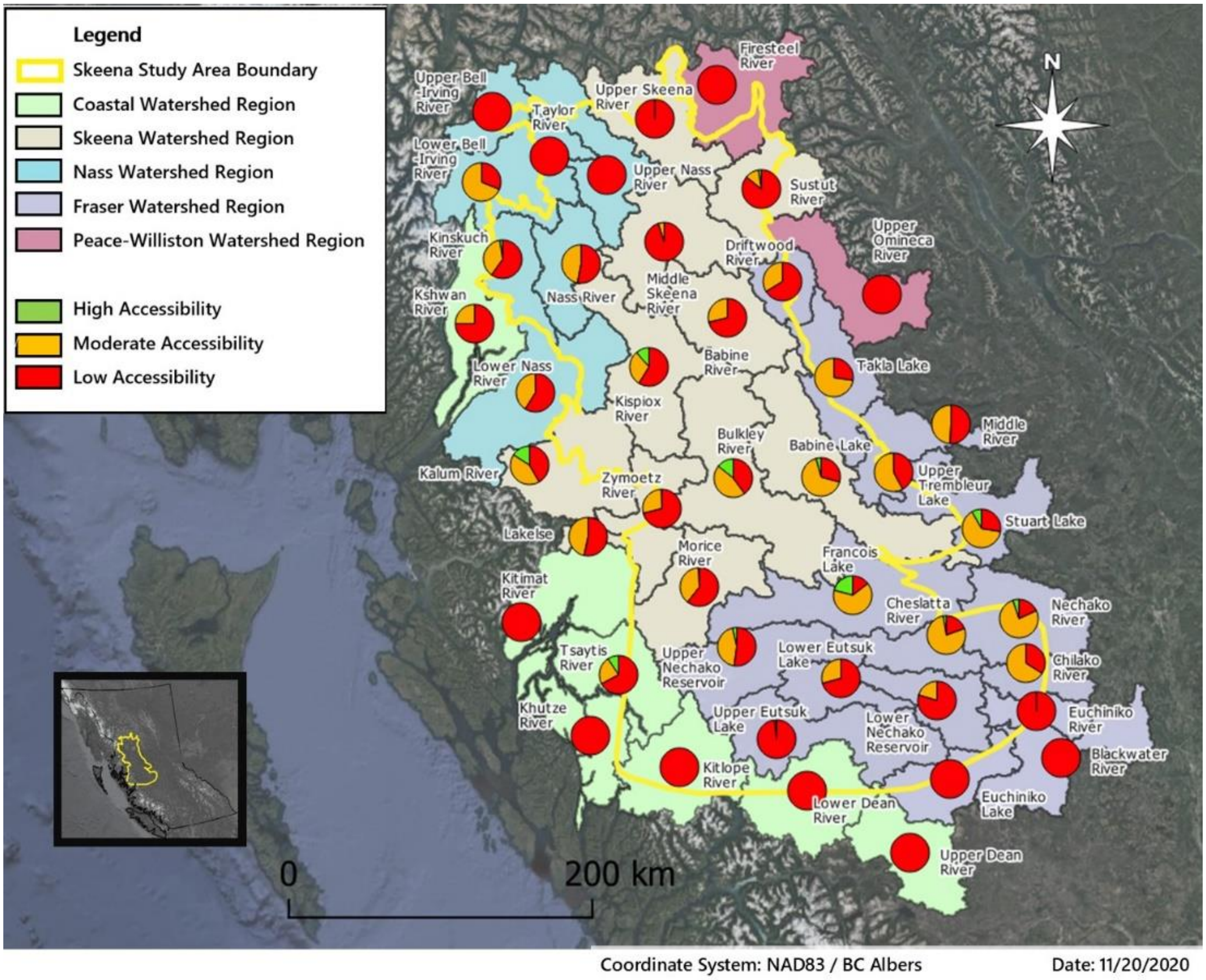


Figure 26. Map that shows the level of accessibility to wetlands, where green represents "High Accessibility", orange represents "Moderate Accessibility", and red represents "Low Accessibility".

5. Interpretation of Key Drivers of Results

As described in Section 3, the indicators within this report are separated into three major types: stressors, functions, and benefits. The narrative below primarily focuses on the stressors that may influence wetlands (i.e., Indicator 4.1 to 4.6), with a brief discussion on the distribution of wetland functions and benefits.

5.1 Stressors: Development Poses Potential Impacts to Wetlands in Region

Indicators 4.3, 4.4, and 4.5 focus on the density of roads at various scales; that is: road density within the watershed assessment unit, and 100m and 2km buffers from the documented wetlands. The road network, especially in the south-east of the Study Area is extensive where some major watershed groups have greater than 50% of the documented wetlands within 100 m of roads. In addition to the impact of the physical road itself, roads can disrupt surface and subsurface flow that can subsequently impact the overall health, cause wetlands to shrink (or expand), and affect the natural trajectory of a wetland.

Although not originally selected as part of the original set of indicators, roads directly intersect 5.9% of the wetlands within the Study Area (i.e., 3359 of 56,602), with a cumulative 787.8 km of road length traversing wetlands, and with a median length of 100.4 m of road per wetland that is intersected. These 3359 wetlands are a subset worth sampling to better understand the impacts of road crossings on wetland hydrology; the challenges relate to obtaining reasonable baseline metrics regarding the pre-impact condition of these wetland sites.

The density distribution of roads generally aligns with the pattern for Equivalent Clear-cut Areas (Indicator 4.1) with extensive road density in the southeast section of the Study Area, as many of the roads are associated with development activities such as forestry. Watersheds with higher ECAs may result in relatively increased peak flows, erosion, and impacts to wildlife that require contiguous mature and old forest. However, as managed forests tend to recover to a relatively natural state overtime (i.e., unlike other activities such as intense agriculture or rural/urban development), the amount of semi-natural/natural cover is not a significant concern over most of the SSAF area (Indicator 4.6).

In contrast to ECA, point sources for pollutants (Indicator 4.2) are more variable in distribution. Some clusters of point sources for pollutants are located in areas with high road density such as settled areas, whereas other point sources for pollutants are located in areas with relatively low road density such as mine sites. It is possible that both ECA and road density may increase around some of the locations documented as point sources for pollutant sites, as a portion of this layer was drawn from mineral tenures; and increased land clearing and road networks may be expected if (or when) the mine site becomes fully operational.

5.2 Wetlands and Associated Functions and Values are Variable on the Landscape

Function and Value/Benefit Indicators 4.7 to 4.16 cover a small sample of the many ecological services that society, watersheds, and wildlife derive from wetlands. Not all wetlands perform the same ecological functions, or to similar degrees. Landscape position, proximity to other features (e.g., fish bearing streams, communities), and water flow path, among other factors can play an important role in how a wetland performs various functions or provides certain ecological services. This Tier 1 analysis provides a preliminary view of the potential distribution and range of ecological functions and benefits within the Study Area. Section 6.1. further describes how our understanding of wetland function and values on the landscape will be further refined through a Tier 2 field calibration tool called the Wetland Ecosystem Services Protocol as part of the broader SSAF wetlands program.

5.3 Data Paucity for Wetlands

Despite the importance of wetlands to wildlife and human health, there is relatively little information available within BC about wetlands. This lack of information is likely due to the minimal attention these ecosystems have received – which is reflective in a lack of policy specific to mitigating wetland impacts (Ecological Resolutions 2017, ERM 2017).

6. Monitoring

This State of the Value Report on wetlands primarily focuses on Provincial and Regionally available data sets using office-based GIS analysis as part of its Tier 1 assessment. As noted in the last section, there is a lack of an overall understanding of wetlands within the Study Area. The following set of monitoring projects provide additional information for the region.

6.1 Tier 2: WESP – Skeena Region and Ecological Plots

In 2019 field work commenced to gather Tier 2 information about wetlands in the region. There are two major elements:

1. A Wetlands Ecosystem Services Protocol (WESP) was adapted for the region as a tool that will provide resource managers and decision makers with a better understanding of wetlands in terms of the relative functions they perform. The Tier 1 analysis, that makes up this State of Values Report, was simplified due to a paucity of data. The WESP incorporates field and office information to rank wetlands in terms of their relative ability to perform a suite of ecological and cultural services, including:
    a. Hydrologic (i.e., Water Storage & Delay)
    b. Water Purification (i.e., Soil Stabilization, Sediment Retention, Nutrient Removal & Retention)
    c. Aquatic Life Support (i.e., Aquatic Primary Productivity, Nutrient Export, Stream Flow & Temperature Support)
    d. Climate Support (i.e., Carbon Accretion Capacity, Carbon Stock)
    e. Habitat (i.e., Fish, Waterbird, Other Wetland Bird, Keystone Mammals, Pollinator, Indigenous Plants)
    f. Social & Cultural (i.e., Fire Resistance, and Cultural Values)

At the time of preparing this document (November 26, 2020), data collection for this phase is currently focused on calibrating the WESP model with approximately 100 field visited reference sites. Once the model is calibrated, the protocol can be utilized in the future on other wetlands of interest/concern to better understand their ecological function relative to the Study Area (based on information from the calibration sites). The field work helps to both validate and refine our understanding of the state of wetlands in the region by providing substantially more detail regarding ecological functions.

This field protocol is a complimentary tool to health protocols such as BC's Forest Range Evaluation Protocol (FREP) - in that it focuses on a complimentary set of information (i.e., ecological function rather than health). At present, a simplified rapid stressor form is also completed at sites during the field reconnaissance to help flag wetlands that may warrant further health assessments (e.g.., such as FREP).

In addition to obtaining a more robust understanding of ecological function through Tier 2; an additional linkage between the Tier 1 and Tier 2 phases relates to site selection. Based on Tier 1 analysis, the team was able to use available datasets and portions of the analysis to help refine strata for sampling in the 2020 field season. Strata include: low wet (ICH - coast) vs low dry (SBS/SBPS – inland) biogeoclimatic zones, high (ESSF/MS) vs low elevation (ICH/SBS/SBPS), and well connected to other water bodies (i.e., throughflow, bidirectional, or within 100m of river or lake) vs less connected to water bodies (i.e., vertical, inflow with no water intersecting, outflow with no water intersecting) (Morgan 2020).

2. The second major element of the field work is to gather field level ecosystem information by gathering field plots and wildlife observations. The plot data gathers details on vegetation, soil, and water to classify the sites' wetland plant association(s) – wherever possible. Further information is collected on any signs of grizzly bear or moose to support other ESI stated values. The plot data provides an opportunity to better understand the types of wetlands that occupy the landscape. Should additional resources become available, then the wetland plots could serve as training/reference points for subsequent efforts to improve landscape level wetland map products such as a Predictive Wetland Layer or Remote Imagery Interpretation (e.g., Filatow et al. 2018)

6.2 Tier 3 - Lake Babine Studies – Indigenous Stewardship Project

Between 2016 and 2019, Lake Babine Nation (LBN) collected wetland ecological and cultural information with a focus on wetlands that may be impacted from development (i.e., proposed mines and pipelines) (Wright et al. 2019). Some Tier 3 level information was collected as there are multiple site visits to stationary plots and a greater emphasis on a few wetlands versus many wetlands. The project is collecting baseline information at each site, including, among other things: plant, wildlife observations, and seasonal hydrologic information. LBN contracted Ecofish Research Ltd to develop the program and facilitate the training with field technicians. The project has also included interviews with approximately 80 community members, including elders, to gather information on wetland use, values important to members, and concerns about wetland health. Through the interviews, community members expressed concern about impacts of logging on wetlands, beaver moving to the lake and out of the watershed, and spraying. In its third year of work, Lake Babine Nation consolidated health assessment information as well as value information into a matrix. The final year of the Lake Babine project will conduct wetland Tier 2 WESP assessment in their study wetlands. Further, there are other wetlands within LBN territory that have not been assessed, and there is a desire to gather more details on these wetlands too.

6.3 Tier 2 - Gitanyow Wetland Data Collection

In 2015, Gitanyow Nation gathered ecological information on some wetlands within their territory (per comm. Kevin Koch). The data collected included ecological information (i.e., plants, soils, water), and also included checkboxes on a variety of functional values based on observable information (e.g., carbon sequestration for fibric/mesic organic soils). Forms were originally provided and adapted from ERM Consulting ltd.

6.4 Tier 2 - Forest Range Evaluation Program – Wetland Health Assessment

The objective of the Forest & Range Evaluation Program Wetland Health Assessment Form and Protocol is to allow for persons with basic working knowledge of wetlands to evaluate the health of wetland sites in or in proximity to industrial and development activities (e.g., forestry). Field evaluators may be forest and range practitioners, First Nation's stewardship personal, consultants, land managers, or other land users. The protocol is intended to be completed within the field, allow for consistency among users, gather pertinent information to inform the health of the wetland, and be cost effective as a Tier 2 approach for monitoring (i.e., relatively quick to use in the field (e.g., 1-4 hours)). The current protocol, established primarily to assess health of wetlands in proximity to forestry operations, evaluates the health of wetlands 2 years after harvesting activities (Fletcher et al 2020).

7. Potential Next Steps

7.1 Improvements to this Assessment

The type and breadth of analysis for wetlands covered within this report is largely unprecedented in BC. Our attempt to "mine" available datasets to better understand wetlands also revealed a lot about the quality of those datasets and highlighted some of their limitations. Learning about the limitations of these datasets was an iterative process. There are a few modifications that would help to improve the analysis within this document.

- Explore opportunities to add a Carbon Storage Indicator section. Consider low soil nutrient regimes as an indicator for peatlands from VRI.
- Refinements to 4.12 - Moose Layer
    - The SSAF is concurrently producing a State of the Value report for Moose in the SSAF study area; these data should be updated once this information is available.
- Imporvements to 4.15 – Wetlands of Cultural Significance:
    - Work with First Nations and other groups (e.g., industry/consultants) to gather additional existing datasets related to important wetlands, or wetlands in proximity to culturally important sites.
    - Survey elders and First Nation community members to identify important wetlands of cultural or spiritual value (e.g., Lake Babine surveys)
    - The SSAF STC is developing a protocol to assess the state of the value of medicinal plants in the SSAF study area. A number of these plants are found in wetlands, and these data could help to better inform this indicator

In future years, assuming that the layers available in this study continue to be updated, it is possible that trend analysis could be completed for some of the layers such as the indicators that look at potential threats and condition.

In addition to the recommended improvements listed above, the Tier 2 component of this project will gather a much more thorough analysis of wetland functions within field sites (i.e., calibration sites). These Tier 2 data can be compared to this dataset to help gauge the accuracy of this assessment and some of the coarse level models that were developed. Further, it will inform future improvements of this Tier 1 analysis.

7.2 Predictive Wetland Mapping

The need for obtaining a better wetland inventory for the Skeena Region was identified during the 2017 wetland expert workshop (Ecological-resolutions 2017). A more accurate and detailed inventory could greatly improve our understanding of the extent and fabric of wetlands within the region, and would better support land use decisions and operational projects. Predictive GIS tools may provide opportunities for improved wetland layers to be developed for the SSAF area (e.g., Filatow et al. 2018;

Wulder et al. 2018; Merchant et al. 2019). Other options for an imporved wetland inventory are more traditional air or satellite imagery interpretation or potentially a combination of both. Field work that is being collected as part of a Tier 2 component of this project will provide helpful training and validation data for any future models that are developed.

7.3 Targeted Sampling

Additional field investigations are warranted to follow up on some of the potential findings of this project. The following are a few of the potential field investigations that may provide additional information or support conservation work in the region:

- o Repeat sampling over time (Tier 3) to determine impacts from potential threats (e.g., climate change and impacts to water levels or changes in vegetative communities)
- o Field reconnaissance to potentially impacted wetlands (e.g,. Wetlands flagged with Point Source Pollutants upstream; wetlands intersected by roads)
- o Identification of potentially high value wetlands for consideration of additional management considerations (e.g., increasing protection/designations).

7.4 Management Actions

The development of an action plan for conserving wetlands in the SSAF area would help to summarize priorities. A few recommendations based on this work include:

- Reviewing revegetation seed mixes utilized within the region (e.g., for road construction/ decommissioning) to ensure the composition of species is appropriate (i.e., excludes invasive species such as Reed Canary Grass);
- Investigate hydrologic impacts to wetlands bi-sected by roads;
- Developing best management practices, such as
    - o When crossing a wetland is unavoidable, limit the ability to operate on the wetland to the wintertime to ensure that impacts to wetlands are mimized;
    - o When activities must occur near wetlands, limit the timining of these activities to avoid breeding bird season; and
    - o Where possible, conduct activities in such a way that best utilizes existing roads; and
- Consider protection mechanisms for wetlands in valley bottoms (not currently protected by current management regime/tools).

The points above are not intended as a complete list. A linked project (SSAF Management Objectives/Recommendations/BMPs) is summarizing potential management actions associated with indicator categories providing a more detailed listing of management actions (e.g. WSP 2010, FLNRORD 2014).

8. Literature Cited

Adamus, P.R. and L.T. Stockwell. 1983. A Method for Wetland Functional Assessment. Vol. I. Critical Review and Evaluation Concepts. Report No. FHWA-IP-82-23. Federal Highway Administration, Washington, D.C.

Adamus, P.R. 2015. Manual for Wetland Ecosystem Services Protocol for Southeast Alaska (WESPAK – SE). For: Southeast Alaska Land Trust and US Fish & Wildlife Service.

Bannerman, S. 1997. Extension Note 15: Landscape Ecology and Connectivity Part 4 of 7. B.C. Ministry of Forests Research Program. Williams Lake, BC. 9p. https://www.for.gov.bc.ca/hfd/pubs/docs/en/en15.pdf

BC MEMPR. 2016. Joint Application Requirements for Mines Act and Environmental Management Act Permits a Permit. British Columbia Ministry of Energy and Mines and Ministry of Environment: Victoria, BC.

BC MEM. 2017. Health, Safety and Reclamation Code for Mines in British Columbia. British Columbia Ministry of Energy and Mines. Victoria, BC.

BC OGC. 2017. BC Oil and Gas Commission (OGC) Environmental Protection and Management Guideline. British Columbia Oil and Gas Commission. Victoria, BC.

B.C. Ministries of Environment and Forests, Lands and Natural Resources (MOE/FLNRO). 2017. Interim assessment protocol for aquatic ecosystems in British Columbia: Standards for British Columbia's Cumulative Effects Framework Values Foundation. Prepared by the Provincial Aquatic Ecosystems Technical Working Group.

Biebighauser, T. R. 2007 Wetland Drainage, Restoration, and Repair. University Press of Kentucky.

Bond, W.K. et al. 1992. Wetland Evaluation Guide: Final Report of the Wetlands are Not Wastelands Project. Issue Paper, No 1992 -1. North American Wetlands Conservation Council (Canada).

Boston, K. 2016. The Potential Effects of Forest Roads on the Environment and Mitigating their Impacts. Integrating Forestry in Land Use Planning. Current Forestry Reports 2: 215-222.

Boyle, C., Lavkulich, L., Schreier, H. and E. Kiss 1997. Changes in Land Cover and Subsequent Effects on Lower Fraser Basin Ecosystems from 1827 to 1990. Environmental Management 21:185-196

Bunnell, F., Wells, R., and A. Moy 2010. Vulnerability of wetlands to Climate Change in the Southern Interior Ecoprovince: Prelmininary Assessment. Final Report. Centre for Applied Conservation Research , University of British Columbia.

Cox and Cullington 2009. Wetland Ways: Interim Guidelines for Wetland Protection and Conservation in BC. https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-planning-strategies/wetlands-in-bc

Creed, I.F., D.A. Aldred, J.N. Serran, F. Accatino 2018. Maintaining the Portfolio of Wetland Functions on Landscapes: A Rapid Evaluation Tool for Estimating Wetland Functions and Values in Alberta, Canada.

Chapter 2.2.12. *In:* Wetland & Stream Rapid Assessments: Development, Validation, and Application Edited by: Dorney, J., R. Savage, R.W. Tiner, and P. Adamus). Elservier 564 p.

Daigle, P. 2010. A Summary of the Environmetal Impacts of Roads, Management Responses, and Research Gaps: A literature review. BC Journal of Ecosystems and Management 10(3):65-89De Groot, A. and Casley, S. 2016. Ecosystem Integrity Analysis Tool Description and User's Manual (Draft)

Ducks Unlimited Canada 2014. Operational Guide for Forest Road Wetland Crossings. Version 1.0

Eco-Logical Resolutions. 2017. *Expert Workshops for Skeena ESI Values – Synthesis Report.* Prepared for the Skeena Environmental Stewardship Initiative Science Technical Committee. Smithers, British Columbia. 85 p.

Environmental Management Act. 2003. [SBC 2003] Chapter 53. Province of British Columbia. http://www.bclaws.ca/civix/document/id/lc/statreg/03053_00

ERM. 2016a. Skeena Wetlands ESI: Status of Wetlands: Knowledge Summary. Prepared for Ministry of Forests Lands and Natural Resource Operations and Rural Development by ERM Consultants Canada Ltd. Vancouver, British Columbia

ERM. 2016b. Skeena Wetlands ESI: Status of Wetlands: Background Review. Prepared for Ministry of Forests Lands and Natural Resource Operations and Rural Development by ERM Consultants Canada Ltd.: Vancouver, British Columbia.

ERM. 2017. *Skeena Wetlands ESI: Skeena ESI Expert Workshop Backgrounder on Wetlands – Review of Assessment Approaches.* Prepared for Ministry of Forests, Lands, Natural Resource Operations and Rural Development by ERM Consultants Canada Ltd.: Smithers, British Columbia.

Faber-Langendoen, D., C. Hedge, M. Kost, S. Thomas, L. Smart, R. Smyth, J. Drake and S. Menard. 2012a. Assessment of wetland ecosystem condition across landscape regions: A multi-metric approach. Part A. Ecological Integrity Assessment overview and field study in Michigan and Indiana. U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC.

Fall, A., and D. Morgan. 2000. Ecological Soil Moisture Prediction Models: Generating Pitless DEMs, Flow Direction (D8 and D∞) and Contributing Area (Streams)

Filatow, D., Carswell, T., and E. Cameron 2018. Predictive Wetland Mapping of the FWCP Peace Management Area. Prepared for: Fish and Wildlife Compensation Program. 72 p.

Fisheries Act. 1985. Last amended on August 28th, 2019. Federal Department of Justice. Published by the Minister of Justice at: http://laws-lois.justice.gc.ca

Flanagan, N.E., Richardson, C.J., M. Ho. 2014. Connecting Differential Responses of Native and Invasive Riparian Plants to Climate Change and Environmental Alteration. Ecological Applications 25(3): 753-767.

Fletcher, N. and P. Adamus. 2019. Skeena ESI Wetland Landscape Level Assessment Procedure. 2019 (DRAFT). Prepared by N. Fletcher of BC Wildlife Federation and P. Adamus for the Skeena East ESI Science and Technical Committee (STC).

Fletcher, N. 2019. Skeena ESI Wetland Landscape Level Assessment Procedure. 2019 (DRAFT). Prepared by N. Fletcher of BC Wildlife Federation and P. Adamus for the Skeena East ESI Science and Technical Committee (STC).

Fletcher, N. 2020. Methods for Wetland Tier 1.5 Assessment. Prepared for the Skeena East ESI Science and Technical Committee (STC).

Fletcher, N., Tripp, D.B., Hansen, P.L., Nordin, L.J., Porter, M., and Morgan, D. 2020. Field Supplement to the Wetland Health Management Routine Effectiveness Evaluation. Forest and Range Evaluation Program, B.C. Ministry of Forests, Lands, Natural Resources Operations and Rural Development, Victoria, B.C.

FLNRORD . 2014. North Area Guidance Document. A Compendium of Wildlife Guidelines for Industrial Development Projects in the North Area, British Columbia Interim Guidance. November 19 2014 Ministry of Forests, Lands and Natural Resource Operations North Area

FLNRORD 2015. Extension note: Adapting forests and Range Management to Climate Change in the Skeena Region: Consideration for Planners and Practitioners. Adapting to Climate Change Series. 19p. https://www.for.gov.bc.ca/ftp/dss/external/!publish/web/Forest%20Health%20Strategy/6_Climate%20Change/References/Climate%20Emails/SkeenaEN150519pdf.pdf

Forest and Range Practices Act. 2002a. [SBC 2002] Chapter 69. Province of British Columbia. http://www.bclaws.ca/civix/document/id/complete/statreg/02069_01

Gardner, R.C. and C.M. Findlayson. 2018. Global Wetland Outlook: State of the World's Wetlands and their Services to People. Gland, Switzerland: Ramsar Convention Secretariat.

Gitxsan Environmental Services Inc. 2020. Gitxsan Nation Indigenous Stewardship Project SSAF Wetlands Field Program FIELD EXECUTION PLAN. Prepared by: Gitxsan Environmental Services Inc. Chaz Ware, Environmental Services Manager.

Hall, J. 2018 Incorporating Traditional Ecological Knowledge and Cultural Information Into Wetland Protection, Management, and Restoration. Tulalip Reservation. Webinar and Presentation through the Association of State Wetland Managers. https://www.aswm.org/pdf_lib/epa_region_10_webinar/incorporating_traditional_ecological_knowledge_110618_hall.pdf

Hawes, K.2018. Review and Update of Wetland Inventory and Evaluation Methods. Version 1.1 DRAFT. Prepared for BC Wildlife Federation by Ecoscape Environmental Consultants.

Hruby, T. 2004. Washington State Wetland Rating System for Eastern Washington – Revised. Washington State Department of Ecology Publication #04-06-15

Lozon, J.D., and H.J. MacIssac 1997. Biological invasions: are they dependent on disturbance? Environmental Reviews 5: 131-144.

MacCracken, JG., Van Ballenberghe, V., and J.M. Peek. 1993. Use of aquatic plants by moose: sodium hunger or foraging efficiency? Can. J. Zool. 71: 2345-2351.

Mackenzie W.H. and J.R. Moran 2004. Wetlands of British Columbia: a guide to identification. Res. Br., B.C. Min. For., Victoria, B.C. Land Manage. Handb. No. 52

Merchant, M., Warren, R., Edwards, R., and J. Kenyon 2019. An Object-Based Assessment of Multi-Wavelength SAR, Optical Imagery and Topographical Datasets for Operational Wetland Mapping in Boreal Yukon, Canada. Canadian Journal of Remote Sensing.

Migratory Birds Convention Act. 1994. Chapter 22. Last amended December 18, 2001. Federal Department of Justice. Published by the Minister of Justice at: SC 1994, c 22 | Migratory Birds Convention Act, 1994 | CanLII.

McGill, J., and A. Leong. 2004. TFL 30 Structural Stage Layer. Process Note. http://www.env.gov.bc.ca/esd/distdata/ecosystems/wis/pem/warehouse/region_7_Peace_Omineca/tfl_30_4051/pem_4051_sts.pdf

Morgan, D. 2020a. 2020 Wetland Monitoring – Site Selection. April 21 -2020. ESI working file. 2 p.

Morgan, D.G. 2020b. Guidance for Implementing the Skeena Sustainability Assessment Forum Wetland State of the Value Assessment Report. Prepared for the Skeena East ESI Science and Technical Committee (STC).

Morgan, D.G. 2020c. Skeena East ESI Wetland Monitoring Sample Design. Prepared for the Skeena East ESI Science and Technical Committee (STC). Sept 30, 2020.

Mines Act. 1996a. [RSBC 1996] Chapter 293. Province of British Columbia. https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/96293_01

Ministry of Environment 2015. Status of Invasive Species in B.C. State of Environment Reporting. Environmental Reporting BC. British Columbia, Canada. http://www.env.gov.bc.ca/soe/indicators/plants-and-animals/invasive-species.html

Mitsch, W.J. and J.G. Gosselink 2007. Wetlands (4th edition). John Wiley & Sons, Inc. 582 p.

Northwest Invasive Plant Council. 2020. Target Invasive Plant List – comprehensive . http://nwipc.org/documents/private/2020_All_IPMA__Target_Plants_FINAL.pdf

Ontario Wetland Evaluation System (OWES). 2013. Northern Manual, 1st Edition, Version 1.2., Ontario Ministry of Natural Resources. University of Waterloo, Ontario

Pacific Salmon Foundation 2013. Skeena lake sockeye Conservation Units: habitat report cards. Report prepared by M. Porter, D. Pickard, S. Casley, N. Ochoski, K. Bryan and S. Huang of ESSA Technologies Ltd. 111 p.

Parminter, J. 1995. Biodiversity Guidebook - Forest Practices Code of British Columbia. B.C. Min. For. And B.C. Environ., Victoria, B.C.

Partington, M., C. Gillies, B. Gringas, C. Smith, and J. Morissette . 2016. Resource Roads and Wetlands: a guide for planning, construction and maintenance. (Special Publication SP-530E) Pointe-Claire, QC. 88p. FPInnovations. https://issuu.com/fpinnovations/docs/sp-530e

Pike, R.G., Bennett, K.E., Redding, T.E., Werner, A.T., Spittlehouse, D.L., Moore, R.D., Murdock, T.Q., Beckers, J., Smerdon, B.D., Bladon, K.D., Foord, V.N., Campbell, D.A., and P.J. Tschaplinski. 2010. Climate Change Effects on Watershed Processes in British Columbia. Chapter 19: Land Management Handbook 66: Compendium of Forest Hydrology and Geomorphology in British Columbia. Ed. Pike, R.G., Redding, T.E., Moore, R.D., Winkler, R.D., and K.D. Bladon. Victoria, B.C.

Pollard, B. 2014. Moose Winter Browse Capability Mapping in Gitanyow's Traditional Territory: Kitwanga-Cranberry Study Area. McElhanney Consulting Services. Prepared for Gitanyow Fisheries Authority and Skeena Region, Ministry of Forests, Lands and Natural Resource Operations.

Porter, M. 2018 (Draft). Skeena ESI Fish Habitat Assessment Procedure for the Skeena East ESI Science and Technical Committee (STC). ESSA Technologies Ltd. 35p.

Porter, M., Casley, S., Arnett, J. and J. Fraser. 2019. Current Condition Report (CCR) for Fish Habitat in the Skeena ESI (East) Study Area – 2019. (1st DRAFT). Skeena East ESI Science and Technical Committee (STC). 130 pp.

Porter, M., S. Casley, D. Pickard, E. Snead, R. Smith, and K. Wieckowski. 2017. Version 3.3, September 2017. Tier I Watershed-level fish values monitoring protocol. Report prepared by ESSA Technologies Ltd. for BC British Columbia Ministry of Forests, Lands and Natural Resource Operations and BC Ministry of the Environment (MOE), Victoria, BC. 26 p.

Porter, M., Pickard, D., Casley, S., and N. Ochoski. 2014. Skeena Salmon Conservation Units Habitat Report Cards: Chinook, coho, pink, chum, and river sockeye. Prepared for Skeena Salmon Program. Pacific Salmon Foundation.

Price, K., and D. Daust. 2016. Climate Change Vulnerability of BC's Fish and Wildlife: First Approximation. Prepared for Ministry of Forest Lands and Natural Resources Operations. BC. Source: https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/nrs-climate-change/adaptation/climate20change20vulnerability20of20bcs20fish20and20wildlife20final20june6.pdf

Price, K., and D. Daust 2020. Adding Climate Change to Skeena Values: Climate Exposure, Vulnerability and Monitoring in the Environmental Stewardship Initiative Study Area. Prepared for Environmental Stewardship Initiative, Science and Technical Committee.

Price, K. Holt, R., and D.Daust. 2020. Old Growth Forest: A last stand for biodiversity. Task force report on the state of BC's old growth forest. https://veridianecological.files.wordpress.com/2020/05/bcs-old-growth-forest-report-web.pdf

Warner, B.G., and C.D.A. Rubec 1997. The Canadian Wetland Classification System (2nd Ed). National Wetlands Working Group. Wetlands Research Centre. Waterloo, ON.

Riparian Areas Protection Regulation. 2016a. Last amended May 4, 2020. Province of British Columbia. https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/178_2019/search/CIVIX_DOCUMENT_ROOT_STEM:(Residential%20Tenancy%20Act)%20AND%20CIVIX_DOCUMENT_ANCESTORS:statreg?284

Salmo Consulting Inc. and Diversified Environmental Services 2003. Volume 2: Cumulative Effects Indicators, Threshold and Case Studies. BC Oil and Gas Research and Innovation Society. 83 p. http://www.bcogris.ca/documents/scek/Final_Reports/CEAMF%20Final%20Report2.pdf

Semlitsch R.D. and J.R. Bodie 2003. Biological Criteria for Buffer Zones around Wetland Riparian Habitats for Amphibians and Reptiles. Conservation Biology 17(5): 1219-1228.

Shervill, R.L. 1981. Smithers: From Swamp to Village. Published by the Town of Smithers. D.W. Friesen & Sons Ltd. 128 pp.

Species at Risk Act. 2002b. Last amended on June 20th, 2017. Federal Department of Justice. Published by the Minister of Justice at: http://laws-lois.justice.gc.ca

Tiner, R.W. 2014a. Dichotomous Keys and Mapping Codes for Wetland Landscape Position, Landform, Water Flow Path, and Waterbody Type Descriptors. Version 3.0. U.S. Fish and Wildlife Service, National Wetland Inventory Program, Northeast Region, Hadley, MA.

Tiner, R.W. 2004b. Remotely-sensed indicators for monitoring the general condition of "natural habitat" in watersheds: an application for Delaware's Nanticoke River watershed. Ecological Indicators 4: 227-243

Tiner, R.W. and J. Herman. 2015. Wetlands of Southwestern Vermont and Neighboring New York: Inventory, Characterization, and Preliminary Landscape-level Functional Assessment. U.S. Fish and Wildlife Service, Northeast Region, Hadley, MA. 38 pp. plus appendices.

Tiner, R.W. 2018. A Landscape-Level Wetland Functional Assessment Tool: Building a Framework for Watershed-Based Assessments in the United States. Chapter 2.2.1 *In:* Wetland & Stream Rapid Assessments: Development, Validation, and Application Edited by: Dorney, J., R. Savage, R.W. Tiner, and P. Adamus). Elservier 564 p.

Trombulak, S.C. and C.A. Frissell 2000 Review of Ecological Effects of Roads on Terrestrial and Aquatic Communities. Conservation Biology 14(1):18-30

Vanderstar, L. 2016 Appendix B: Moose Habitat Attributes for Life Requisites. Gitanyow Land Use Plan information

Warner, B.G., and C.D.A. Rubec 1997. The Canadian Wetland Classification System (2nd Ed). National Wetlands Working Group. Wetlands Research Centre. Waterloo, ON.

Water Sustainability Act (WSA). 2014c. [SBC 2014] Chapter 15. Province of British Columbia. http://www.bclaws.ca/civix/document/id/complete/statreg/14015

WSP (Wetland Stewardship Partnership of BC) , 2010. Wetlands Action Plan for British Columbia. https://bcwetlandsca.files.wordpress.com/2016/11/bcwetlandactionplan_wsp_2010.pdf

Winkler, R. and S. Boon. 2017. Equivalent Clearcut Area as an Indicator of Hydrologic Change in Snow-dominated Watersheds of Southern British Columbia. Extension Note: 118. Ministry of Forest Lands and Natural Resource Operations.

Wright, N., L. Ballin, J. Brown, R. Williams, T. Mitchell, T. Alec, R. Day, M. Dyke, D. Greenacre, K. Chin, J. Kurtz, E. George, V. Powers, B. Patrick, and R. Szelecz. 2019. Lake Babine Indigenous Stewardship

Project Wetland Assessment and Monitoring Report. Consultant's report prepared for MFLNRORD by Lake Babine Nation and Ecofish Research Ltd., March 6, 2019

Wildlife Act. 1996. [SBC 1996] Chapter 488. Province of British Columbia. http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/00_96488_01#section6

Wulder, M., Li, Z., Campbell, E., White, J., Hobart, G., Hermosilla, T., and N. Coops. A National Assessment of Wetland Status and Trends for Canada's Forested Ecosystems Using 33 Years of Earth Observation Sattellite Data. Remote Sens. 2018 (10), 1623.

APPENDIX A – SUPPLIMENTARY TABLES:

Table A1. Indicator 4.1: Equivalent Clear-cut Area (ECA) Indicator. Number of wetlands within watershed assessment units coded as High (>20% ECA), Medium (<20% & >15% ECA), and Low (<15% ECA) by Watershed Groups.

Watershed Group	L	M	H	NA
Babine Lake	2837	700	683	
Babine River	3782	107	114	
Blackwater River	114		80	
Bulkley River	1892	567	1320	
Cheslatta River	349	166	1178	
Chilako River	320	35	993	
Driftwood River	768	119		
Euchiniko Lake	1520	13	174	
Euchiniko River	304		388	
Firesteel River	477			
Francois Lake	1574	587	3078	
Ingenika River	1			
Kalum River	225	25	134	
Khutze River	23			
Kinskuch River	731	16		
Kispiox River	1181	247	529	
Kitimat River	3			1
Kitlope River	126			98
Kshwan River	12			
Lakelse	15			
Lower Bell -Irving River	82	49	39	
Lower Dean River	2161			
Lower Eutsuk Lake	1639	71	341	
Lower Nass River	390	120	178	31
Lower Nechako Reservoir	608	257	1126	
Middle River	103	21		
Middle Skeena River	1201			
Morice River	1711	181	543	
Nass River	1497	128	374	
Nechako River	553	88	1346	
Stuart Lake	242	26	273	
Sustut River	799	13	32	
Takla Lake	525	174	222	
Taylor River	277		14	
Tsaytis River	50			14
Upper Bell -Irving River	21			
Upper Dean River	160			
Upper Eutsuk Lake	4265	150	111	
Upper Nass River	1019			
Upper Nechako Reservoir	2114	59	822	
Upper Omineca River	23			
Upper Skeena River	1267			
Upper Trembleur Lake	314	181	119	
Zymoetz River	771	46	57	106

Note: NA refers to data not available regarding ECA inputs.

Table A2. Indicator 4.2. Count of wetlands relative to count of point source pollution (column) observed in the wetland's watershed assessment units.

Watershed Groups	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	29	30	31	42	46	48	54	Grand Total
Babine Lake	2498	663	262	149	111	102	104	26	45	46						12	64								126		11								4219
Babine River	3588	279	85	29	22																														4003
Blackwater River	114	80																																	194
Bulkley River	1528	509	489	244	227	146	118	55		31			49	8	4	34		86			84	16	7			11				25	83		15	10	3779
Cheslatta River	992	159	156		91	171		80	44																										1693
Chilako River	1013	176	103	52																															1344
Driftwood River	649	222									14																								885
Euchiniko Lake	1081	311	48	136	45		33			13																		28							1695
Euchiniko River	490			129				72																											691
Firesteel River	429	22		26																															477
Francois Lake	2592	1069	253	686	91	57	138	27		38	55	87		72		23													50						5238
Ingenika River	1																																		1
Kalum River	229	7	7	15		16	26				14	14							6	31								4		14					383
Khutze River	23																																		23
Kinskuch River	538	89	8	1	3	58	7			27		7	3											6											747
Kispiox River	1566	219	24	24	59	17	2		15	21		10																							1957
Kitimat River	3	1																																	4
Kitlope River	210				11					3																									224
Kshwan River	12																																		12
Lakelse	15																																		15
Lower Bell -Irving River	156	14																																	170
Lower Dean River	2117	43																																	2160
Lower Eutsuk Lake	1749	106	30	128														37																	2050
Lower Nass River	678	38																																	716
Lower Nechako Reservoir	859	199	323	175	102		77		94								37					85		40											1991
Middle River	103					21																													124
Middle Skeena River	997	119		17					68																										1201
Morice River	1537	371	173	105	37	38	22			15	30		19						45				24						19						2435
Nass River	1941	28	30																																1999
Nechako River	1427	273	134	67	83																														1984
Stuart Lake	491	45																																	536
Sustut River	561	185	21	23	4	33	16																												843
Takla Lake	606	31	39	102	32	52		17	8		33																								920
Taylor River	291																																		291
Tsaytis River	32	15	7		5		1		4																										64
Upper Bell -Irving River	20																																		20
Upper Dean River	160																																		160
Upper Eutsuk Lake	4005	217	97	10	81			53				10	52																						4525
Upper Nass River	971	47																																	1018
Upper Nechako Reservoir	2038	257	152	177	39	16	14		48		56								68	11												106			2982
Upper Omineca River	23																																		23
Upper Skeena River	1123	27	11				97																												1258
Upper Trembleur Lake	436	127			25						26																								614
Zymoetz River	438	98	58	61	49	75				37		74					90																		980
Totals	**40330**	**6046**	**2510**	**2356**	**1117**	**802**	**655**	**330**	**326**	**231**	**228**	**202**	**123**	**80**	**4**	**69**	**191**	**123**	**119**	**42**	**84**	**101**	**31**	**46**	**126**	**11**	**11**	**32**	**69**	**39**	**83**	**106**	**15**	**10**	**56648**

Table A3. Indicator 4.3: Stressor: Road Density within the watershed where green represents Low Density (<0.4km/km2), orange represents Moderate Density (0.4 – 1.2 km/km2), and red represents High Density (>1.2km/km2).

Region	Percent of land area with **Low Road Density**		Percent of land area with **Medium Road Density**		Percent of land area with **High Road Density**	
	within 100 m of wetlands *(<0.08 km/km2)*	within 2 km of wetlands *(<0.40 km/km2)*	within 100 m of wetlands *(0.08 - 0.16 km/km2)*	within 2 km of wetlands *(0.40 - 1.2 km/km2)*	within 100 m of wetlands *(>0.16 km/km2)*	within 2 km of wetlands *(>1.2 km/km2)*
Coastal Tributaries Other	93.9%	85.6%	0.2%	7.5%	5.9%	6.9%
Khutze River	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Kitimat River	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Kitlope River	81.7%	63.4%	0.4%	23.7%	17.9%	12.9%
Kshwan River	83.3%	83.3%	0.0%	16.7%	16.7%	0.0%
Lower Dean River	97.0%	93.0%	0.1%	2.6%	2.8%	4.4%
Tsaytis River	75.0%	75.0%	0.0%	21.9%	25.0%	3.1%
Upper Dean River	76.3%	18.8%	0.0%	46.3%	23.8%	35.0%
Fraser-Stuart	65.6%	34.3%	0.7%	17.4%	33.8%	48.2%
Blackwater River	58.8%	17.5%	1.5%	38.1%	39.7%	44.3%
Cheslatta River	51.1%	9.5%	0.9%	23.4%	48.0%	67.1%
Chilako River	55.3%	10.8%	1.3%	22.5%	43.4%	66.7%
Driftwood River	82.3%	60.2%	0.9%	21.5%	16.8%	18.3%
Euchiniko Lake	75.8%	44.1%	0.5%	34.9%	23.7%	21.0%
Euchiniko River	50.0%	4.0%	1.9%	22.8%	48.1%	73.1%
Francois Lake	46.8%	5.1%	0.5%	11.7%	52.7%	83.2%
Lower Eutsuk Lake	85.0%	65.7%	0.4%	8.7%	14.6%	25.6%
Lower Nechako Reservoir	56.2%	12.7%	1.0%	25.3%	42.9%	62.0%
Middle River	75.0%	57.3%	0.0%	33.1%	25.0%	9.7%
Nechako River	51.7%	8.9%	1.1%	23.7%	47.3%	67.4%
Stuart Lake	58.6%	20.9%	1.1%	22.9%	40.3%	56.2%
Takla Lake	53.9%	22.9%	1.2%	23.7%	45.0%	53.4%
Upper Eutsuk Lake	91.6%	84.4%	0.3%	9.9%	8.2%	5.7%
Upper Nechako Reservoir	70.7%	44.1%	0.5%	10.9%	28.8%	44.9%
Upper Trembleur Lake	70.5%	33.9%	1.0%	25.4%	28.5%	40.7%
Nass Tributaries	84.9%	55.5%	0.2%	24.0%	14.9%	20.5%
Kinskuch River	82.2%	48.3%	0.3%	30.8%	17.5%	20.9%
Lower Bell -Irving River	60.6%	15.3%	0.0%	41.2%	39.4%	43.5%
Lower Nass River	81.8%	49.9%	0.3%	26.0%	17.9%	24.1%
Nass River	80.4%	34.7%	0.3%	34.7%	19.3%	30.7%
Taylor River	95.5%	100.0%	0.0%	0.0%	4.5%	0.0%
Upper Bell -Irving River	100.0%	81.0%	0.0%	19.0%	0.0%	0.0%
Upper Nass River	98.3%	99.2%	0.0%	0.8%	1.7%	0.0%
Peace-Williston	94.2%	91.6%	0.0%	6.6%	5.8%	1.8%
Firesteel River	93.9%	91.2%	0.0%	6.9%	6.1%	1.9%
Upper Omineca River	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Skeena Tributaries	75.8%	48.4%	0.5%	22.0%	23.8%	29.6%
Babine Lake	56.9%	20.0%	0.8%	28.1%	42.3%	51.9%
Babine River	86.1%	62.3%	0.3%	24.1%	13.5%	13.6%
Bulkley River	67.3%	32.3%	0.5%	23.8%	32.1%	43.9%
Ingenika River	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%
Kalum River	69.8%	36.7%	0.8%	17.7%	29.4%	45.6%
Kispiox River	82.0%	49.0%	0.4%	27.6%	17.6%	23.4%
Lakelse	100.0%	26.7%	0.0%	46.7%	0.0%	26.7%
Middle Skeena River	96.2%	90.1%	0.0%	8.5%	3.8%	1.4%
Morice River	69.0%	40.1%	0.6%	18.0%	30.5%	41.9%
Sustut River	91.1%	78.1%	0.5%	13.7%	8.4%	8.2%
Upper Skeena River	96.8%	93.6%	0.2%	6.4%	2.9%	0.0%
Zymoetz River	88.2%	64.6%	0.2%	24.8%	11.6%	10.6%

Table A4. Indicator 4.4 Stressor: Road Density within 100m of wetlands (km/km2) where Low Density is <0.08km/km2, Moderate Density is 0.08-0.16km/km2, and High Density is >0.16km/km2.

Watershed Region	Low	Moderate	High	Grand Totals
Coastal Watershed Region	**2487**	**4**	**157**	**2648**
Khutze River	23			23
Kitimat River	4			4
Kitlope River	183	1	40	224
Kshwan River	10		2	12
Lower Dean River	2097	3	61	2161
Tsaytis River	48		16	64
Upper Dean River	122		38	160
Fraser Watershed Region	**18034**	**191**	**9285**	**27510**
Blackwater River	114	3	77	194
Cheslatta River	865	15	813	1693
Chilako River	745	18	585	1348
Driftwood River	730	8	149	887
Euchiniko Lake	1294	9	404	1707
Euchiniko River	346	13	333	692
Francois Lake	2451	27	2761	5239
Lower Eutsuk Lake	1744	8	299	2051
Lower Nechako Reservoir	1118	19	854	1991
Middle River	93		31	124
Nechako River	1027	21	939	1987
Stuart Lake	317	6	218	541
Takla Lake	496	11	414	921
Upper Eutsuk Lake	4144	12	370	4526
Upper Nechako Reservoir	2117	15	863	2995
Upper Trembleur Lake	433	6	175	614
Nass Watershed Region	**4214**	**10**	**742**	**4966**
Kinskuch River	614	2	131	747
Lower Bell -Irving River	103		67	170
Lower Nass River	588	2	129	719
Nass River	1608	6	385	1999
Taylor River	278		13	291
Upper Bell -Irving River	21			21
Upper Nass River	1002		17	1019
Peace-Williston Watershed Region	**471**		**29**	**500**
Firesteel River	448		29	477
Upper Omineca River	23			23
Skeena Watershed Region	**15978**	**100**	**5008**	**21086**
Babine Lake	2403	34	1783	4220
Babine River	3448	13	542	4003
Bulkley River	2545	20	1214	3779
Ingenika River			1	1
Kalum River	268	3	113	384
Kispiox River	1605	7	345	1957
Lakelse	15			15
Middle Skeena River	1155		46	1201
Morice River	1679	14	742	2435
Sustut River	769	4	71	844
Upper Skeena River	1227	3	37	1267
Zymoetz River	864	2	114	980

Table A5. Indicator 4.5 Stressor: Road Density within 2 km of wetlands (km/km2) where Low Density is <0.40km/km2, Moderate Density is 0.40-1.2km/km2, and High Density is >1.2km/km2.

Watershed Region	Low	Moderate	High	Grand Totals
Coastal Watershed Region	**2266**	**199**	**183**	**2648**
Khutze River	23			23
Kitimat River	4			4
Kitlope River	142	53	29	224
Kshwan River	10	2		12
Lower Dean River	2009	56	96	2161
Tsaytis River	48	14	2	64
Upper Dean River	30	74	56	160
Fraser Watershed Region	**9445**	**4796**	**13269**	**27510**
Blackwater River	34	74	86	194
Cheslatta River	161	396	1136	1693
Chilako River	146	303	899	1348
Driftwood River	534	191	162	887
Euchiniko Lake	753	596	358	1707
Euchiniko River	28	158	506	692
Francois Lake	267	611	4361	5239
Lower Eutsuk Lake	1348	178	525	2051
Lower Nechako Reservoir	253	503	1235	1991
Middle River	71	41	12	124
Nechako River	176	471	1340	1987
Stuart Lake	113	124	304	541
Takla Lake	211	218	492	921
Upper Eutsuk Lake	3820	449	257	4526
Upper Nechako Reservoir	1322	327	1346	2995
Upper Trembleur Lake	208	156	250	614
Nass Watershed Region	**2758**	**1192**	**1016**	**4966**
Kinskuch River	361	230	156	747
Lower Bell -Irving River	26	70	74	170
Lower Nass River	359	187	173	719
Nass River	693	693	613	1999
Taylor River	291			291
Upper Bell -Irving River	17	4		21
Upper Nass River	1011	8		1019
Peace-Williston Watershed Region	**458**	**33**	**9**	**500**
Firesteel River	435	33	9	477
Upper Omineca River	23			23
Skeena Watershed Region	**10199**	**4645**	**6242**	**21086**
Babine Lake	845	1184	2191	4220
Babine River	2494	965	544	4003
Bulkley River	1219	900	1660	3779
Ingenika River	1			1
Kalum River	141	68	175	384
Kispiox River	958	541	458	1957
Lakelse	4	7	4	15
Middle Skeena River	1082	102	17	1201
Morice River	977	438	1020	2435
Sustut River	659	116	69	844
Upper Skeena River	1186	81		1267
Zymoetz River	633	243	104	980

Table A6. Indicator 4.6 Stressor: % Natural/Semi-Natural within 2 km where Low Threat to intactness is >90% Natural/Semi-Natural, Moderate Threat is 60-90% Natural/Semi-Natural, and High Threat to intactness is <60% Natural/Semi-Natural.

	Percent of wetland landscapes with **Low Threat to Intactness** *(>90% Intact Natural or Semi-Natural landcover)*	Percent of wetland landscapes with **Moderate Threat to Intactness** *(60-90% Intact Natural or Semi-Natural landcover)*	Percent of wetland landscapes with **High Threat to Intactness** *(<60% Intact Natural or Semi-Natural landcover)*
Coastal Watershed Region	**99.4%**	**0.6%**	**0.0%**
Khutze River	100.0%	0.0%	0.0%
Kitimat River	100.0%	0.0%	0.0%
Kitlope River	100.0%	0.0%	0.0%
Kshwan River	100.0%	0.0%	0.0%
Lower Dean River	99.2%	0.8%	0.0%
Tsaytis River	100.0%	0.0%	0.0%
Upper Dean River	100.0%	0.0%	0.0%
Fraser Watershed Region	**94.5%**	**4.6%**	**0.8%**
Blackwater River	100.0%	0.0%	0.0%
Cheslatta River	89.2%	10.8%	0.0%
Chilako River	100.0%	0.0%	0.0%
Driftwood River	100.0%	0.0%	0.0%
Euchiniko Lake	97.7%	2.3%	0.0%
Euchiniko River	100.0%	0.0%	0.0%
Francois Lake	84.2%	13.9%	1.9%
Lower Eutsuk Lake	100.0%	0.0%	0.0%
Lower Nechako Reservoir	99.2%	0.8%	0.0%
Middle River	100.0%	0.0%	0.0%
Nechako River	82.0%	12.4%	5.6%
Stuart Lake	99.3%	0.7%	0.0%
Takla Lake	100.0%	0.0%	0.0%
Upper Eutsuk Lake	100.0%	0.0%	0.0%
Upper Nechako Reservoir	97.6%	2.0%	0.4%
Upper Trembleur Lake	100.0%	0.0%	0.0%
Nass Watershed Region	**92.5%**	**3.7%**	**3.8%**
Kinskuch River	93.7%	3.9%	2.4%
Lower Bell -Irving River	100.0%	0.0%	0.0%
Lower Nass River	86.6%	2.8%	10.6%
Nass River	88.4%	6.8%	4.8%
Taylor River	100.0%	0.0%	0.0%
Upper Bell -Irving River	100.0%	0.0%	0.0%
Upper Nass River	100.0%	0.0%	0.0%
Peace-Williston Watershed Region	**99.0%**	**1.0%**	**0.0%**
Firesteel River	99.0%	1.0%	0.0%
Upper Omineca River	100.0%	0.0%	0.0%
Skeena Watershed Region	**96.9%**	**2.4%**	**0.7%**
Babine Lake	99.8%	0.1%	0.0%
Babine River	100.0%	0.0%	0.0%
Bulkley River	88.4%	8.9%	2.8%
Ingenika River	100.0%	0.0%	0.0%
Kalum River	98.2%	1.8%	0.0%
Kispiox River	92.1%	6.0%	1.8%
Lakelse	100.0%	0.0%	0.0%
Middle Skeena River	100.0%	0.0%	0.0%
Morice River	99.0%	1.0%	0.0%
Sustut River	98.8%	1.2%	0.0%
Upper Skeena River	100.0%	0.0%	0.0%
Zymoetz River	99.9%	0.1%	0.0%

Table A7. Indicator 4.7 Function: Hydrologic Support: Flood Reduction Potential where wetlands of Very Low to Zero have bidirectional water path or the gradient of the wetland is relatively high (>5% slope); Low has throughflow water path, Stream Order of 2 or less, and the gradient of the wetland is low (<5% slope); Medium has outflow or throughflow water path, stream order is 2 or less, and gradient of the wetland is low (<5% slope); High has inflow or vertical flow water path and gradient of the wetland is low (<5% slope).

Watershed Groups	High	Medium	Low	Very Low to Zero
Babine Lake	571	1441	419	1741
Babine River	463	807	209	2474
Blackwater River	79	79	26	7
Bulkley River	551	1069	331	1798
Cheslatta River	235	559	131	764
Chilako River	456	467	172	249
Driftwood River	202	262	117	286
Euchiniko Lake	577	665	179	237
Euchiniko River	113	332	90	153
Firesteel River	57	184	101	114
Francois Lake	695	1728	497	2288
Ingenika River		1		
Kalum River	34	78	19	252
Khutze River	2	3	10	8
Kinskuch River	56	190	82	414
Kispiox River	146	443	132	1221
Kitimat River		3		1
Kitlope River	10	37	64	111
Kshwan River		8	3	1
Lakelse	11	2		2
Lower Bell -Irving River	32	74	24	39
Lower Dean River	566	645	182	741
Lower Eutsuk Lake	640	510	136	745
Lower Nass River	88	133	51	443
Lower Nechako Reservoir	323	710	199	738
Middle River	28	50	19	27
Middle Skeena River	70	95	68	960
Morice River	366	559	196	1289
Nass River	145	434	144	1262
Nechako River	288	887	253	530
Stuart Lake	52	216	92	158
Sustut River	74	152	94	513
Takla Lake	114	284	104	409
Taylor River	35	29	42	184
Tsaytis River		7	11	45
Upper Bell -Irving River	3	4	8	5
Upper Dean River	46	87	16	10
Upper Eutsuk Lake	1411	1345	306	1428
Upper Nass River	148	146	65	648
Upper Nechako Reservoir	567	801	229	1362
Upper Omineca River	1	15	7	
Upper Skeena River	167	127	125	830
Upper Trembleur Lake	60	226	77	244
Zymoetz River	78	209	79	600

Table A8. Indicator 4.8 Benefit: Flood Reduction. Number of wetlands within watershed assessment units coded as No Societal Asset (neither settlements, community watershed, nor fish habitat within 5km downstream of a wetland), Societal Asset (settlements are within 5km downstream of a wetland), Community Watershed (community watershed(s) are within 5km downstream of a wetland), and Fish Habitat (fish habitat is within 5km downstream of a wetland) by Watershed Group.

Watershed Group	No Societal Asset	Societal Asset	Community Watershed	Fish Habitat
Babine Lake	86	4134	239	4220
Babine River	59	3944	0	4003
Blackwater River		194	0	194
Bulkley River	25	3754	611	3779
Cheslatta River		1693	51	1693
Chilako River	1	1347	0	1348
Driftwood River	90	797	0	878
Euchiniko Lake		1707	0	1707
Euchiniko River	5	687	0	692
Firesteel River		477	0	477
Francois Lake	22	5217	1185	5239
Ingenika River		1	0	1
Kalum River	21	363	65	374
Khutze River		23	0	23
Kinskuch River	6	741	53	747
Kispiox River	14	1943	278	1957
Kitimat River		4	0	4
Kitlope River	3	221	0	224
Kshwan River		12	0	12
Lakelse		15	0	15
Lower Bell -Irving River		170	0	170
Lower Dean River		2161	0	2161
Lower Eutsuk Lake		2051	0	2051
Lower Nass River	10	709	1	719
Lower Nechako Reservoir		1991	0	1991
Middle River	21	103	0	124
Middle Skeena River	15	1186	0	1201
Morice River	46	2389	26	2435
Nass River	113	1886	1	1999
Nechako River		1987	106	1987
Stuart Lake		541	50	541
Sustut River		844	62	844
Takla Lake	6	915	0	921
Taylor River		291	0	291
Tsaytis River	11	53	7	57
Upper Bell -Irving River	1	20	0	21
Upper Dean River		160	0	160
Upper Eutsuk Lake		4526	0	4526
Upper Nass River		1019	0	1019
Upper Nechako Reservoir	53	2942	120	2988
Upper Omineca River		23	0	23
Upper Skeena River	2	1265	0	1267
Upper Trembleur Lake	1	613	1	614
Zymoetz River	4	976	10	980

Table A9. Indicator 4.9 Function: Water Purification where functional score of Water Flow Path, Internal Wetland Slope, and Granitic Soils/Bedrock where combined to assign relative levels of function. Number of wetlands within watershed assessment units coded by score as High (6 to 9), Medium (3 to 5), and Low (-2 to 2) by Watershed Groups.

Watershed Group	High	Medium	Low
Babine Lake	1106	2430	614
Babine River	1542	2054	289
Blackwater River	145	42	4
Bulkley River	1368	2064	284
Cheslatta River	480	1003	202
Chilako River	686	581	76
Driftwood River	410	394	47
Euchiniko Lake	1045	532	79
Euchiniko River	290	354	43
Firesteel River	204	218	29
Francois Lake	1313	3260	616
Ingenika River		1	
Kalum River	165	176	34
Khutze River	3	9	11
Kinskuch River	171	501	58
Kispiox River	537	1253	131
Kitimat River	2	2	
Kitlope River	19	83	117
Kshwan River	8	4	
Lakelse	13	2	
Lower Bell -Irving River	87	77	5
Lower Dean River	971	977	171
Lower Eutsuk Lake	921	901	200
Lower Nass River	274	391	44
Lower Nechako Reservoir	637	1171	160
Middle River	60	59	5
Middle Skeena River	360	599	213
Morice River	801	1318	265
Nass River	508	1239	228
Nechako River	571	1076	304
Stuart Lake	123	269	123
Sustut River	241	451	134
Takla Lake	272	506	130
Taylor River	110	131	42
Tsaytis River	2	25	36
Upper Bell -Irving River	9	10	
Upper Dean River	101	57	1
Upper Eutsuk Lake	2081	1948	444
Upper Nass River	486	392	109
Upper Nechako Reservoir	1084	1562	290
Upper Omineca River	15	8	
Upper Skeena River	470	501	257
Upper Trembleur Lake	180	354	68
Zymoetz River	238	617	96

Table A10. Indicator 4.10 Benefit: Water Purification. Number of wetlands within watershed assessment units coded as Low (0), Moderate (1-2), and High (>2) by Watershed Group. Scores are based on subscores considering distance downstream from point source pollution, secondary linear features, and tertiary or temporary/abandoned features, as well as distance to societal assets.

Watershed Region	Low	Moderate	High
Babine Lake	81	1652	2487
Babine River	56	3122	825
Blackwater River		76	118
Bulkley River	23	1900	1856
Cheslatta River	7	656	1030
Chilako River		493	855
Driftwood River	88	566	233
Euchiniko Lake		1079	628
Euchiniko River		250	442
Firesteel River		434	43
Francois Lake	11	1531	3697
Ingenika River		1	
Kalum River	12	203	169
Khutze River		23	
Kinskuch River	6	533	208
Kispiox River	13	1411	533
Kitimat River		4	
Kitlope River	3	156	65
Kshwan River		10	2
Lakelse		15	
Lower Bell -Irving River		83	87
Lower Dean River		2039	122
Lower Eutsuk Lake	1	1503	547
Lower Nass River	10	529	180
Lower Nechako Reservoir		733	1258
Middle River	15	63	46
Middle Skeena River	15	1106	80
Morice River	32	1330	1073
Nass River	102	1290	607
Nechako River		679	1308
Stuart Lake	1	263	277
Sustut River		719	125
Takla Lake	5	368	547
Taylor River		270	21
Tsaytis River	11	32	21
Upper Bell -Irving River	1	20	
Upper Dean River		100	60
Upper Eutsuk Lake		4009	517
Upper Nass River		1000	19
Upper Nechako Reservoir	45	1633	1317
Upper Omineca River		23	
Upper Skeena River	4	1154	109
Upper Trembleur Lake	1	354	259
Zymoetz River	4	757	219

Table A11. Indicator 4.11 Function: Aquatic Life Support (Fish). Number of wetlands within watershed assessment units coded as Low (wetlands not within 5km of potential fish bearing streams), Medium (wetlands within 5 km of potential fish bearing streams), and High (wetlands intersecting potential fish bearing streams).

Watershed Group	High	Medium	Low
Babine Lake	2283	1937	
Babine River	1643	2360	
Blackwater River	98	96	
Bulkley River	1624	2155	
Cheslatta River	1004	689	
Chilako River	757	591	
Driftwood River	414	464	9
Euchiniko Lake	871	836	
Euchiniko River	481	211	
Firesteel River	315	162	
Francois Lake	2795	2444	
Ingenika River	1		
Kalum River	88	286	10
Khutze River	13	10	
Kinskuch River	394	353	
Kispiox River	840	1117	
Kitimat River	3	1	
Kitlope River	106	118	
Kshwan River	3	9	
Lakelse	1	14	
Lower Bell -Irving River	98	72	
Lower Dean River	1042	1119	
Lower Eutsuk Lake	835	1216	
Lower Nass River	199	520	
Lower Nechako Reservoir	1219	772	
Middle River	31	93	
Middle Skeena River	417	784	
Morice River	1157	1278	
Nass River	955	1044	
Nechako River	1441	546	
Stuart Lake	372	169	
Sustut River	423	421	
Takla Lake	482	439	
Taylor River	122	169	
Tsaytis River	34	23	7
Upper Bell -Irving River	10	11	
Upper Dean River	76	84	
Upper Eutsuk Lake	2006	2520	
Upper Nass River	307	712	
Upper Nechako Reservoir	1481	1507	7
Upper Omineca River	15	8	
Upper Skeena River	521	746	
Upper Trembleur Lake	376	238	
Zymoetz River	546	434	

Table A12. Indicator 4.12 Function: Wildlife Habitat: Availability of Moose Forage and Screening. Number of wetlands within watershed assessment units coded as No Forage (wetlands do not intersect with VRI polygons dominated by broadleaf trees, mixed trees, tall shrubs, or short shrubs) or Yes Forage (wetlands do intersect with VRI polygons dominated by broadleaf trees, mixed trees, tall shrubs, or short shrubs).

Watershed Region	No Forage	Yes Forage
Babine Lake	4135	85
Babine River	3997	6
Blackwater River	188	6
Bulkley River	3713	66
Cheslatta River	1609	84
Chilako River	1319	29
Driftwood River	868	19
Euchiniko Lake	1694	13
Euchiniko River	662	30
Firesteel River	477	
Francois Lake	4838	401
Ingenika River	1	
Kalum River	384	
Khutze River	23	
Kinskuch River	744	3
Kispiox River	1945	12
Kitimat River	4	
Kitlope River	222	2
Kshwan River	12	
Lakelse	15	
Lower Bell -Irving River	166	4
Lower Dean River	2157	4
Lower Eutsuk Lake	2029	22
Lower Nass River	716	3
Lower Nechako Reservoir	1937	54
Middle River	119	5
Middle Skeena River	1199	2
Morice River	2429	6
Nass River	1995	4
Nechako River	1957	30
Stuart Lake	530	11
Sustut River	839	5
Takla Lake	903	18
Taylor River	291	
Tsaytis River	64	
Upper Bell -Irving River	21	
Upper Dean River	160	
Upper Eutsuk Lake	4514	12
Upper Nass River	1019	
Upper Nechako Reservoir	2924	71
Upper Omineca River	23	
Upper Skeena River	1263	4
Upper Trembleur Lake	608	6
Zymoetz River	980	

Table A13. Indicator 4.13 Function: Wildlife Habitat: Connectivity. Each wetland within a watershed group was evaluated on if the amount of mature and old forests within 2 kilometers was over or under a threshold appropriate for the Biogeoclimatic Zone and Natural Disturbance Type. Column titled "Fail" displays the count of wetlands that do not meet the threshold, whereas "Pass" displays the count of wetlands that surpasses the threshold. Column: Average Connectivity displays the percent of the wetlands that "Pass", where as Mature and Old Forest Column displays the average amount of mature and old forest around wetlands.

Watershed Group	Fail (Not connected)	Pass (Connected)	Average Connectivity	Average of Mature Old Growth
Babine Lake	859	3361	79.6%	50.4%
Babine River	307	3696	92.3%	64.4%
Blackwater River	1	193	99.5%	40.6%
Bulkley River	455	3324	88.0%	50.5%
Cheslatta River	368	1325	78.3%	28.8%
Chilako River	170	1178	87.4%	37.5%
Driftwood River	40	847	95.5%	77.2%
Euchiniko Lake	194	1513	88.6%	44.3%
Euchiniko River	35	657	94.9%	38.8%
Firesteel River	103	374	78.4%	49.7%
Francois Lake	951	4288	81.8%	35.4%
Ingenika River		1	100.0%	60.9%
Kalum River	139	245	63.8%	40.2%
Khutze River	8	15	65.2%	50.5%
Kinskuch River	231	516	69.1%	56.5%
Kispiox River	136	1821	93.1%	68.1%
Kitimat River	3	1	25.0%	11.4%
Kitlope River	127	97	43.3%	32.3%
Kshwan River	3	9	75.0%	28.8%
Lakelse	10	5	33.3%	27.8%
Lower Bell -Irving River	82	88	51.8%	47.0%
Lower Dean River	168	1993	92.2%	66.5%
Lower Eutsuk Lake	139	1912	93.2%	59.6%
Lower Nass River	141	578	80.4%	57.8%
Lower Nechako Reservoir	367	1624	81.6%	30.7%
Middle River	22	102	82.3%	56.3%
Middle Skeena River	350	851	70.9%	57.5%
Morice River	327	2108	86.6%	55.6%
Nass River	194	1805	90.3%	67.4%
Nechako River	246	1741	87.6%	36.9%
Stuart Lake	88	453	83.7%	38.7%
Sustut River	98	746	88.4%	61.1%
Takla Lake	137	784	85.1%	52.2%
Taylor River	86	205	70.4%	52.5%
Tsaytis River	41	23	35.9%	28.9%
Upper Bell -Irving River	12	9	42.9%	23.9%
Upper Dean River		160	100.0%	65.4%
Upper Eutsuk Lake	127	4399	97.2%	61.5%
Upper Nass River	235	784	76.9%	65.0%
Upper Nechako Reservoir	616	2379	79.4%	49.1%
Upper Omineca River	14	9	39.1%	24.6%
Upper Skeena River	380	887	70.0%	48.7%
Upper Trembleur Lake	43	571	93.0%	55.4%
Zymoetz River	140	840	85.7%	59.5%

Table A14. Indicator 4.14 Function: Parks, Protected Areas, and other Wildlife Conservation Designations. Percent of wetlands within watershed unit that intersects with parks, protected areas, Wildlife Management Areas, or existing or proposed ungulate winter range).

Watershed Group	% area with extra protection measures
BABINE LAKE	14.6
BABINE RIVER	3.6
BLACKWATER RIVER	7.3
BULKLEY RIVER	10.4
CHESLATTA RIVER	6.1
CHILAKO RIVER	10.9
DRIFTWOOD RIVER	0.4
EUCHINIKO LAKE	4.6
EUCHINIKO RIVER	3.7
FIRESTEEL RIVER	6.2
FRANCOIS LAKE	9.1
INGENIKA RIVER	0.0
KALUM RIVER	10.0
KHUTZE RIVER	7.6
KINSKUCH RIVER	52.1
KISPIOX RIVER	20.3
KITIMAT RIVER	0.0
KITLOPE RIVER	81.8
KSHWAN RIVER	42.4
LAKELSE	39.2
LOWER BELL-IRVING RIVER	65.7
LOWER DEAN RIVER	92.9
LOWER EUTSUK LAKE	64.5
LOWER NASS RIVER	3.5
LOWER NECHAKO RESERVOIR	4.6
MIDDLE RIVER	99.2
MIDDLE SKEENA RIVER	21.9
MORICE RIVER	44.6
NASCALL RIVER	0.0
NASS RIVER	46.2
NECHAKO RIVER	0.2
STUART LAKE	72.0
SUSTUT RIVER	8.6
TAKLA LAKE	20.7
TAYLOR RIVER	0.0
TSAYTIS RIVER	19.0
UNUK RIVER	1.0
UPPER BELL-IRVING RIVER	36.4
UPPER DEAN RIVER	0.0
UPPER EUTSUK LAKE	67.8
UPPER NECHAKO RESERVOIR	26.8
UPPER OMINECA RIVER	100.0
UPPER SKEENA RIVER	4.8
UPPER STIKINE RIVER	93.4
UPPER TREMBLEUR LAKE	97.8
ZYMOETZ RIVER	17.6

Table A15. Indicator 4.15 Benefit: Cultural Value: Archeological Records or Identified Wetland of Significance to Communities. Number of wetlands within watershed assessment units coded as Yes (wetland within 500m of archaeological record) or No (wetland not within 500m of archaeological record).

Watershed Group	No	Yes
Babine Lake	3925	295
Babine River	3875	128
Blackwater River	179	15
Bulkley River	3659	120
Cheslatta River	1476	217
Chilako River	1208	140
Driftwood River	831	56
Euchiniko Lake	1469	238
Euchiniko River	587	105
Firesteel River	471	6
Francois Lake	5033	206
Ingenika River	1	
Kalum River	374	10
Khutze River	19	4
Kinskuch River	746	1
Kispiox River	1904	53
Kitimat River	4	
Kitlope River	211	13
Kshwan River	12	
Lakelse	15	
Lower Bell -Irving River	170	
Lower Dean River	2115	46
Lower Eutsuk Lake	2006	45
Lower Nass River	701	18
Lower Nechako Reservoir	1794	197
Middle River	123	1
Middle Skeena River	1184	17
Morice River	2361	74
Nass River	1986	13
Nechako River	1877	110
Stuart Lake	513	28
Sustut River	782	62
Takla Lake	872	49
Taylor River	291	
Tsaytis River	63	1
Upper Bell -Irving River	21	
Upper Dean River	155	5
Upper Eutsuk Lake	4419	107
Upper Nass River	1018	1
Upper Nechako Reservoir	2865	130
Upper Omineca River	23	
Upper Skeena River	1252	15
Upper Trembleur Lake	568	46
Zymoetz River	953	27

Table A16. Indicator 4.16 Cultural Value: Accessibility. Number of wetlands within watershed assessment units coded as Low (wetland greater than 50 km away from communities, >5% slope, or >500 m from a road), Medium (wetland within 50km from community, 500m from a road, have gentle slopes (<5%)), High (wetland within 5km from community, 500m from road, have gentle slope (<5%)).

Watershed Group	High	Medium	Low
Babine Lake	182	2807	1231
Babine River		1151	2852
Blackwater River			194
Bulkley River	541	1727	1511
Cheslatta River	45	1319	329
Chilako River		890	458
Driftwood River		300	587
Euchiniko Lake			1707
Euchiniko River		1	691
Firesteel River			477
Francois Lake	1095	3384	760
Ingenika River			1
Kalum River	61	163	160
Khutze River			23
Kinskuch River	18	282	447
Kispiox River	223	583	1151
Kitimat River			4
Kitlope River			224
Kshwan River		3	9
Lakelse		7	8
Lower Bell -Irving River		117	53
Lower Dean River			2161
Lower Eutsuk Lake		601	1450
Lower Nass River	1	294	424
Lower Nechako Reservoir		404	1587
Middle River		61	63
Middle Skeena River		61	1140
Morice River	21	941	1473
Nass River	1	938	1060
Nechako River	102	1524	361
Stuart Lake	45	347	149
Sustut River	21	99	724
Takla Lake		669	252
Taylor River			291
Tsaytis River	6	15	43
Upper Bell -Irving River			21
Upper Dean River			160
Upper Eutsuk Lake		74	4452
Upper Nass River			1019
Upper Nechako Reservoir	110	1322	1563
Upper Omineca River			23
Upper Skeena River		1	1266
Upper Trembleur Lake	1	354	259
Zymoetz River	5	279	696

Table A17. Major Watershed Region by watershed assessment unit.

Coastal Watershed Region		
Khutze River	80	
Kitimat River	85	
Kitlope River	84	
Kshwan River	92	
Lower Dean River	101	
Tsaytis River	209	
Upper Dean River	220	
Fraser Watershed Region		
Blackwater River	12	Fraser
Euchiniko Lake	48	Fraser
Euchiniko River	47	Fraser
Driftwood River	43	Stuart
Middle River	135	Stuart
Stuart Lake	193	Stuart
Takla Lake	200	Stuart
Upper Trembleur Lake	242	Stuart
Cheslatta River	24	Nechako
Chilako River	25	Nechako
Francois Lake	54	Nechako
Lower Eutsuk Lake	102	Nechako
Lower Nechako Reservoir	114	Nechako
Nechacko River	156	Nechako
Upper Eutsuk Lake	221	Nechako
Upper Nechako Reservoir	231	Nechako
Nass Watershed Region		
Kinskuch River	81	
Lower Bell - Irving	97	
Lower Nass River	112	
Nass River	151	
Taylor River	203	
Upper Bell Iriving	217	
Upper Nass River	230	
Peace-Williston Watershed Region		
Firesteel River	51	
Upper Omineca River	234	
Skeena Watershed Region		
Babine Lake	5	
Babine River	6	
Bulkley River	18	
Kalum River	88	
Kispiox River	83	
Lakelse	110	
Middle Skeena River	142	
Morice River	140	
Sustut River	195	
Upper Skeena River	240	
Zymoetz River	246	

APPENDIX B – Data Dictionary (GIS Methodology)

This data dictionary provides the geodatabase references, the indicator summary, and the output field description. Additional information on the wetland complex methodology, watershed group rollup, water flow path methodology, and ECA recovery curves can be found in the associated data package.

Appendix B1 – Data Dictionary

Geodatabase	Dataset Name	Field Name	Description
Wet_Protected_200702.gdb	WatershedGroups_ProtectedWetlands_200702	WATERSHED_GROUP_CODE	Watershed Group Four Letter Code
		WATERSHED_GROUP_NAME	Watershed Group Name
		GEOMETRY_Length	Length of the boundary of the feature
		GEOMETRY_Area	Area of the feature
		AU_protected_area	The amount of protected area in the Watershed Group
		Perc_ofAU_Protected	Percent of Watershed Group that is protected - **(AU_protected_area/GEOMETRY_Area)*100**
		AU_wetland_area	Total Area of Wetland in the Watershed Group
		Perc_ofAU_Wetlands	Percent of Watershed Group that is Wetland - **(AU_wetland_area/GEOMETRY_Area)*100**
		AU_Protected_wetland_area	Total Area of Wetlands that are Protected in the Watershed Group
		Perc_ofAU_Protected_Wetlands	Percent of the Watershed Group that is Protected Wetlands - **(AU_Protected_wetland_area/GEOMETRY_Area)*100**

		Perc_ofWetlands_Protected_ByAU	Percent of Wetlands protected in the Watershed Group - **(AU_Protected_wetland_area/AU_wetland_area)*100**

Appendix B2 – Indicator Summary

Wetland Landscape Level Assessment Procedure Reference		Indicator	Measurement	Formula	Thresholds and NRM Policy	Data Source	Methodology	Notes_References	Field Name
2.1	Disturbance in Watershed	Equivalent Clear-cut Area in Watershed	ECA / total watershed (%) ECA is based on forest stand height and additional disturbance assumptions for harvest, fire, MPB, and	**ECA / total watershed area (%) Revised Hydrologic Recovery Curves: Interior 100*(1-EXP(-0.24*(Tree**	*15, 20 (PSF 2013, Porter et al. 2014)*	BC Cumulative Effects Aquatic Ecosystems Current Condition Assessment	ECA_Final_PCNT	Aquatic_Protocol_Appendix_GIS_Indicators_Inputs_DataDict_2018_20200810_DRAFT	ECA

			human disturba nce. ie. Human develop ment consider ed as 100% ECA. See Feature Criteria column for details. ECA Criteria Updated June 2017: •Restrict ed ECA calculati on to harveste d or 'disturbe d' areas only (see 'feature criteria'	**Heigh t- 2)))^2 .909 with 100% recov ery at > 19m Coast al 100*(1- EXP(- 0.1*(Tree Heigh t- 2.1))) ^1.45 with 100% recov ery at > 36m** **Note that Interi or/Co astal classi**					

			column). • Revised hydrologic recovery curve formulas for interior vs coastal areas. May 2020: • incorporated Fire Severity and fire impacts. For fires without Severity, and where there is no updated VRI information, height is	**fication is based on EAUBC watershed class.** **Proportion of ECA in Watershed: km2/total assessment watershed (%)** **Where >50% of watershed has**					

			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	**VRI Unreported (e.g. TFL), ECA is recorded as 9999 (insufficient data)**					

			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 inventor						

			ied in VRI yet and Site Tools is used to estimate height for the recovery curve. • For firest, harvest, or scattere d vets where there is no species or site index, a general age since disturba nce factor is used to calculate ECA. • For Mountai n 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.						
2.2	Pollution in Watershed	Point Source Pollution in Watershd		**# / assessment watershed**	Yes/ No (PSF 2013, Porter et al. 2014)	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);	WWDischarge_Count + (Count of NoticeOfWork Mines) + (Count of Remediation Sites) + (Count of (MineralTenures_181129 WHERE TENURE_TYPE_DE	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/	Pnt_Src_Pltn_Final_Count

						WHSE_BASEMAPPING. FWA_STREAM_NETWORKS_SP	SCRIPTION = 'Placer') intersected with (FWA Streams WHERE EDGE_TYPE IN (1000, 1050, 1100, 1150, 1250, 2000, 2300)))	dataset/freshwater-atlas-stream-network	
2.3	Roads in Watershed	Road Desnity in Watershed	Total length of roads / total watershed area. Fire guards may be included where available. Weighted road length is used for the Water	**Total length of roads (km) / total (or net) assessment watershed area (km2)**	*0.4, 1.2 (PSF 2013, Porter et al. 2014)*	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.	road length / watershed area -> Rd_Density (Rd_Density_net)	Aquatic_Protocol_Appendix_GIS_Indicators_Inputs_DataDict_2018_20200810_DRAFT	Rd_Density_net

			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.)						

2.4	Road density within buffer area	Road density within 100 m buffer of wetlands	Total length of roads (km) within a 100 m buffer of wetlands divided by total buffer area (km2)	**Rd Length / Wetland Complex Buffer Area**	0.08, 0.16 (CEF 2015 aka MOE/FLNRO 2015) - From Road Density Near Streams	CE Integrated Roads (SkeenaESI_Extend_ConsRd_inclKispBulk_DSS_190918) Consolidated wetland complexes (ESI_basic_Wetland_Complexes_190912)	1) Buffer Consolidated wetlands by 100 m (undissolved) 2) Intersect 100 m wetland buffer with CE integrated roads 3) Create a summary table of road lengths within each 100m wetland buffer 4) Join summary table back to original Consolidated wetlands using unique ID		RoadDensity_100m (km/km2)
2.5	Road density within contributing area of wetland	Road density within 2 km of wetlands	Total length of roads (km) within a 2 km buffer of wetlands divided by total buffer area (km2)	**Rd Length / Wetland Complex Buffer Area**	0.4, 1.2 (PSF 2013) - From Road Density in Watershed	CE Integrated Roads (SkeenaESI_Extend_ConsRd_inclKispBulk_DSS_190918) Consolidated wetland complexes (ESI_basic_Wetland_Complexes_190912)	1) Buffer Consolidated wetlands by 2 km (undissolved) 2) Intersect 2 km wetland buffer with CE integrated roads 3) Create a summary table of road lengths within each 2 km wetland buffer 4) Join summary table back to		RoadDensity_2000m (km/km2)

							original Consolidated wetlands using unique ID		
2.6	Intactness of contributing area	Natural/Semi-natural areas within 2 km of wetlands	% of nautural /semi-natural land cover within 2 km buffer of wetlands	**Area Natural and Semi-Natural / Wetland and Complex Buffer Area**	60,90 - No citation	CE PseudoBTM 2019 landcover (CEF_SSAF_Ext_BTM_2019_191003) Consolidated wetland complexes (ESI_basic_Wetland_Complexes_190912)	1) Buffer Consolidated wetlands by 2 km (undissolved) 2) Intersect 2 km wetland buffer with natural/semi-natural land from the CE PseudoBTM land cover layer 3) Create a summary table of total natural/semi-natural area within each 2 km wetland buffer and proportion of buffer area 4) Join summary table back to original Consolidated wetlands using unique ID	Natural/semi-natural land cover: where "CEF_DISTURB_GROUP" NOT IN ('Agriculture_and_Clearing', 'Industrial', 'Lodges_and_Camps', 'Mining_and_Extraction', 'OGC_Infrastructure', 'Power', 'Rail_and_Infrastructure', 'Recreation', 'ROW', 'Urban')	Nat_SemiNat_PCT (%)

2.7	Hydrologic support function: flood reduction potential	Wetland and Function (flood reduction potential)	Classification of landscape position and water flow path (high/medium/low/very low function)	See Methodology **By Wetland and Complex**	**See Methodology** - Adapted from Hruby 2014, Hawes 2018, Tiner 2014, and Tiner and Herman 2015.	FWA Stream Network FWA Rivers FWA Lakes FWA Man Made Waterbodies Wetland average slope from modelling provided by Andrew Fall (WetlandInfo.txt, 2019-10-22) Consolidated wetland complexes (ESI_basic_Wetland_Complexes_190912)	See "Water Flow Path Methodology" sheet for initial steps. Wetland Function (flood reduction potential) = 'High' WHERE ("Inflow" = 'Yes' OR "Verticalflow" = 'Yes') AND ("mean_slope_pct" < 5 OR "mean_slope_pct" IS NULL) 'Medium' WHERE ("Outflow" = 'Yes' OR "Throughflow" = 'Yes') AND ("max_stream_order" <= 2 OR "max_stream_order" IS NULL) AND ("mean_slope_pct" < 5 OR "mean_slope_pct" IS NULL) 'Low' WHERE "Throughflow" = 'Yes' AND	The FWA Stream Network contains construction lines used to infer flow across a wetland in order to maintain a network topology. These lines can be ignored for this analysis, as we only want to include main flow or secondary flow lines. FWA Streams to include: where "EDGE_TYPE" IN ('1000', '1050', '1100', '1150', '1250', '2000', '2300') See FWA User Guide for edge type code descriptions (https://www2.gov.bc.ca/assets/gov/data/geographic/topography/fwa/fwa_user_guide.pdf) Mean slope was not calculated for 4,546 wetlands (NULL value in WetlandInfo.txt), so for the purpose of calculating wetland function, these wetlands were considered to have minimal slope.	FloodControl_function (High/Medium/Low/Very Low to Zero) Supporting fields: Inflow (Yes/No) Verticalflow (Yes/No) Outflow (Yes/No) Throughflow (Yes/No) Bidirectional (Yes/No) mean_slope_pct (%) max_stream_order (integer)

							"max_stream_order" > 2 AND ("mean_slope_pct" < 5 OR "mean_slope_pct" IS NULL) 'Very Low to Zero' WHERE "Bidirectional" = 'Yes' OR "mean_slope_pct" >= 5		

2.8	Hydrologic support function: flood reduction potential	Wetlands within 5 km upstream of valuable societal assets	Binary; wetlands with a community or fish habitat within 5 km buffer downstream	**Yes/ No by Wetland and Complex**	# of Wetlands	Communities (Hmn_Structure_Density_ESI_ExtendedAUarea_191001, DENSITY_CLASS_CD >= 3) BC MOE modelled fish habitat (2019-06-20) Consolidated wetland complexes (ESI_basic_Wetland_Complexes_190912) FWA Fundamental Watersheds	1a) Select fundamental watersheds that intersect communities and fish habitat streams, and attribute those watersheds accordingly. For each wetland: 1) buffer wetland by 5 km 2) select all fundamental watersheds that intersect 5k buffer 3) intersect (selected) watersheds with wetland 4) for all watersheds that intersect wetland, select all watersheds (from 5 km buffer selection) downstream using watershed code and local watershed code ** 5) If any selected	Exclude isolated wetlands > 100 m from stream Communities defined as areas having a building density > 24.99 buildings/km2 (where "DENSITY_CLASS_CD" >= 3) Fish habitat defined as any modelled or inferred fish habitat from the BC MOE fish habitat data (where "fish_habitat" <> 'NON FISH HABITAT') Freshwater Atlas User Guide, 2010, downloaded from https://www2.gov.bc.ca/assets/gov/data/geographic/topography/fwa/fwa_user_guide.pdf, September 2019.	SocietalAsset_5km_ds (Yes/No)

							downstream watersheds have an attribute that identifies them as intersecting a community or fish habitat (from 1a), set indicator value to "Yes" ** Downstream watershed rule (from Freshwater Atlas User Guide, 2010): if lwc & wc are the same: ("FWA_WATERSHED_CODE" LIKE 'aaa-bbbbbb-cccccc-000000%' AND "LOCAL_WATERSHED_CODE" LIKE 'aaa-bbbbbb-cccccc-000000%' OR "FWA_WATERSHED_CODE" LIKE 'aaa-bbbbbb-000000%' AND		

							"LOCAL_WATERSHED_CODE" < 'aaa-bbbbbb-cccccc' OR "FWA_WATERSHED_CODE" LIKE 'aaa-000000%' AND "LOCAL_WATERSHED_CODE" < 'aaa-bbbbbb') AND "LOCAL_WATERSHED_CODE" <> '') if lwc & wc are different: ("FWA_WATERSHED_CODE" LIKE 'aaa-bbbbbb-cccccc-000000%' AND "LOCAL_WATERSHED_CODE" < 'aaa-bbbbbb-cccccc-[dddddd+1]' OR "FWA_WATERSHED_CODE" LIKE 'aaa-bbbbbb-		

							000000%' AND "LOCAL_WATERSHED_CODE" < 'aaa-bbbbbb-cccccc' OR "FWA_WATERSHED_CODE" LIKE 'aaa-000000%' AND "LOCAL_WATERSHED_CODE" < 'aaa-bbbbbb') AND "LOCAL_WATERSHED_CODE" <> '')		
2.9	Water purification function	Wetland function (water purification)	Classification of landscape position and water flow path (high/medium/low/very	See Methodology By Wetland Complex	Low: -2 to 2; Med: 3 to 5; High: 6 to 9	FWA Stream Network FWA Rivers FWA Lakes FWA Man Made Waterbodies Wetland average slope from modelling provided by Andrew Fall (WetlandInfo.txt, 2019-10-22) BC Bedrock (2018-04-05)	See "Water Flow Path Methodology" sheet for initial steps. WFP_subscore = 6 WHERE "Inflow" = 'Yes' OR "Verticalflow" = 'Yes' 4 WHERE	See Notes for 2.7.	WaterPurification_function (High/Medium/Low) Supporting fields: WaterPurification_score (-2 to 6)

			low function)			(https://catalogue.data.gov.bc.ca/dataset/bedrock-geology) Consolidated wetland complexes (ESI_basic_Wetland_Complexes_190912)	("Outflow" = 'Yes' OR "Throughflow" = 'Yes') AND ("max_stream_order" <= 2 OR "max_stream_order" IS NULL) 2 WHERE "Throughflow" = 'Yes' AND "max_stream_order" > 2 0 WHERE "Bidirectional" = 'Yes' IWS_subscore = 3 WHERE "mean_slope_pct" <= 1 OR "mean_slope_pct" IS NULL 2 WHERE "mean_slope_pct" > 1 AND "mean_slope_pct" <= 2 1 WHERE "mean_slope_pct" > 2 AND "mean_slope_pct" <= 5 0 WHERE "mean_slope_pct"		WFP_subscore (0/2/4/6) IWS_subscore (0 to 3) GS_subscore (0/-2) Inflow (Yes/No) Verticalflow (Yes/No) Outflow (Yes/No) Throughflow (Yes/No) Bidirectional (Yes/No) mean_slope_pct (%) max_stream_order (integer) granitic_bedrock (Yes/No)

							> 5 GS_subscore = -2 WHERE "granitic_bedrock" = 'Yes' 0 WHERE "granitic_bedrock" = 'No' WaterPurification_score = WFP_subscore + IWS_subscore + GS_subscore WaterPurification_function = 'High' WHERE "WaterPurification_function_score" >= 6 'Medium' WHERE "WaterPurification_function_score" >= 3 AND "WaterPurification_function_score" < 6 'Low' WHERE "WaterPurification_function_score" < 3		

2.10	Water purification benefits	Wetlands within 5 km upstream of valuable societal assets or in close proximity to water quality threats	Classification of... i) Wetlands with a point source pollution within 1 km buffer (score +2) ii) Wetlands with primary or secondary linear feature (paved roads) within 200 m buffer (score +2) iii) Wetlands with tertiary or	**Yes/ No by Wetland and Complex**	High: >2, Moderate: 1-2, Low: 0 - Adapted from OWES 2013, Hruby 2013	Communities (Hmn_Structure_Density_ESI_ExtendedAUarea_191001, DENSITY_CLASS_CD >= 3) BC MOE modelled fish habitat (2019-06-20) Consolidated wetland complexes (ESI_basic_Wetland_Complexes_190912) FWA Fundamental Watersheds CE integrated roads (SkeenaESI_Extend_ConsRd_inclKispBulk_DSS_190918) Point source pollution features (from Skeena ESI Tier 1 Watershed analysis): - Waste Water Discharge locations from MOE Authorizations Database (WWDischarge_FWAextend_191104 [Status = Active]) - WHSE_MINERAL_TENURE.MMS_NOTICE_OF_	1) Buffer Consolidated wetlands by 1000 m (undissolved) **2) Select all 1000 m wetland buffers that intersect combined point source pollution inputs: Additional_RemediationSites_SkeenaEast_190412 Mineral_Tenure_Stream_intersection NoticeOfWork_Mines_181129 WWDischarge_FWAextend_191104 (Status = *Active*) score = score + 2** 3) Buffer Consolidated wetlands by 200 m (undissolved) 4) Select all 200 m wetland buffers that intersect primary or secondary roads score = score + 2 5) Select all 200 m wetland buffers	For point source pollution features, combine the following points: 1) Waste Water Discharge points: where "Status" = 'Active' 2) Notice of Work mine points 3) Remediation site points 4) Aquired Tenure polygons (converted to polylines) WHERE TENURE_TYPE_DESCRIPTION = 'Placer') intersected with (FWA Streams WHERE EDGE_TYPE IN (1000, 1050, 1100, 1150, 1250, 2000, 2300) Primary roads: where "Integrated_Road_Class_Descr" IN ('Primary, Paved', 'Hwy, Arterial') Secondary roads: where "Integrated_Road_Class_Descr" = 'Secondary, Local, FSR' Tertiary or temporary/abandoned roads: where "Integrated_Road_Class_Descr" IN ('2WD', '4WD', 'ATV', 'IMPASSABLE_RD', 'IMPASSIBLE_RD', 'PROPOSED', 'Tertiary, Resource, Other')	SocietalAsset_WQ_Class (High/Moderate/Low) Supporting fields: SocietalAsset_WQ_Score (0 to 7) SocietalAsset_5km_ds (Yes/No)

			temporary/abandoned feature (all non-paved/unknown roads) within 200 m buffer (score +1) iv) Wetlands with a community or fish habitat within 5 km buffer downstream (score +2) High = > 2, Moderate = 1 or 2, Low = 0			WORK (2018-11-29) (NoticeOfWork_Mines_181129) - WHSE_WASTE.SITE_ENV_RMDTN_SITES_SVW (2019-04-12) (Additional_RemediationSites_SkeenaEast_190412) - WHSE_MINERAL_TENURE.MTA_ACQUIRED_TENURE_GOV_SVW (2018-11-29) intersected with FWA Streams (Mineral_Tenure_Stream_intersection)	that intersect tertiary or temporary/abandoned roads AND DOESN'T intersect primary road score = score + 1 **6) Select all wetlands where SocietalAsset_5km_ds = 'Yes' score = score + 2** 7) Classify scores: > 2 = "High"; 1 or 2 = "Moderate"; 0 = "Low"		

2.11	Climate support: carbon storage	Proportion of peat wetlands (bogs and fens)	Binary; wetlands with > 50 % peatland coverage	**See Methodology** **By Wetland Complex**	See Methodology	VRI Consolidated wetland complexes (ESI_basic_Wetland_Complexes_190912)	1) Select bogs and poor fens from VRI using the following queries: For bogs and poor fens: BCLCS_LEVEL_3 = 'W' AND BCLCS_LEVEL_4 IN ('SL', 'ST', 'TM', 'HE', 'HG', 'HF', 'BY', 'BM', 'TC') AND SOIL_NUTRIENT_REGIME IN ('A' , 'B') For fens: BCLCS_LEVEL_3 = 'W' AND BCLCS_LEVEL_4 IN ('HE', 'HG', 'HF') AND SOIL_NUTRIENT_REGIME IN ('C') 2) Intersect Consolidated wetlands with queried VRI bog and fen polygons 3) Join (tabular) original		Peatland_GT50PCT (Yes/No) Supporting fields: Peatland_PCT (%)

							Consolidated wetlands with intersected layer created in step 2 4) Create a new field "PCT_BogFen" containing the quotient of the intersected Bog and Fen layer divided by the original consolidated wetland layer. Select complexes where >50% of the area are covered by a bog or fen.		
2.12	Aquatic life support functions (fish habitat)	Wetlands in fish habitat	Binary; wetlands intersecting inferred or observed fish habitat	**See Methodology** **By Wetland and Complex**	See Methodology - Adapted from Hruby 2004 and	BC MOE modelled fish habitat (2019-06-20) Consolidated wetland complexes (ESI_basic_Wetland_Complexes_190912)	1) Select all consolidated wetlands that are within 5km of BC MOE fish habitat. Denote all wetlands selected in the afformentioned query as having 'Medium' aquatic life support		Aquatic_Life_Support (Yes/No)

					per comm. P. Adamus		function. 2) Select all wetlands that touch the BC MOE modelled fish habitat, denoted these as 'High'. 3) Denote all remaining wetlands as 'Low'.		
2.13	Wildlife habitat: moose forage and screening	Wetlands providing forage and screening for moose	Binary; wetlands containing high value forage	**Yes/ No by Wetland Complex**	Yes/ No	VRI Consolidated wetland complexes (ESI_basic_Wetland_Complexes_190912)	1) Query VRI with the following to determine probable moose forage: where "BCLCS_LEVEL_4" IN ('TB' , 'ST' , 'SL') AND "PROJ_AGE_CLASS_CD_1" IN ('1', '2') 2) Intersect the queried moose forage with the consolidated wetlands layer. Mark any wetland polygon touching a moose forage polygons as containing moose forage.		Moose_Forage (Yes/No)

2.14	Wildlife habitat: connectivity	Wetlands providing wildlife connectivity	% of mature and old growth within 2 km buffer of wetland	**Area of Mature and Old Growth / Wetland and Complex Buffer**	High - Insufficienct mature and old (Parminter 1995, Fletcher 2018)	VRI Consolidated wetland complexes (ESI_basic_Wetland_Complexes_190912) BEC Biogeoclimatic Polygons	1) Use the BC BEC Biogeoclimatic layer and the lookup table provided by Parminter (1995) to delinteate "Upland-Wetland objective", "Minimal % target for Mature+Old", and "Minimal Age". Call the resulting layer "BEC_ZONE_WL_objective" 2) Query VRI to select polygons from the forest management landbase (where "FOR_MGMT_LAND_BASE_IND" = 'Y'). Overlay ('Identity') the FMLB VRI polygons with the BEC_ZONE_WL_objective layer. 3) Buffer Consolidated wetlands by 2000 m (undissolved) 4) Intersect the	Minimal Targets for Mature and Old Growth Forest Coverage table: Parminter, J. 1995. Biodiversity Guidebook - Forest Practices Code of British Columbia. B.C. Min. For. And B.C. Environ., Victoria, B.C.	Mature_OG_PCT (%) Supporting fields: NATURAL_DISTURBANCE (natural disturbance type)) MAP_LABEL (dominant biogeoclimatic zone) min_pct_target_Mature_Old (%)

							2000m wetland buffer with the overlay layer created in step 2. 5) Summarize the total area of the FMLB within each 2000m buffer, the total area where the "Minimal Age" exceeds the VRI field "PROJ_AGE_1", and the "Minimal % target for Mature+Old". 6) Calculate the total area where VRI age exceeds the "Minimal Age" table value divided by the total FMLB area within each 2000m buffer. The taget value for the wetland buffer is based on the wetland's dominant biogeoclimatic zone and Natural Disturbance Type.		

2.15	Wildlife habitat: management context	Wetlands protected by management designations	Binary; wetlands intersecting proposed or existing area managed for wildlife	**Yes/ No by Wetl and Complex**	Yes/ No	Conservation Lands (https://catalogue.data.gov.bc.ca/dataset/land-designations-that-contribute-to-conservation-in-bc-spatial-data) WMA UWR Tantalis Parks and Protected Areas Consolidated wetland complexes (ESI_basic_Wetland_Complexes_190912)	Select all wetlands that intersect either Tantalis Parks and Protected areas, designated conservation lands, WMA, or UWR.		Protected_Ovrlp (Yes/No)
2.16	Wildlife habitat: proximity to lake or pond	Wetlands close to lakes/ponds	Classification of wetlands with waterbody within 100 m buffer (high) or 1 km buffer (moderate)	**Distance to closest water body by Wetl and Complex**	See Methodology - Adapted by OWES 2013, Adamus 2015	FWA lakes FWA man made waterbodies Consolidated wetland complexes (ESI_basic_Wetland_Complexes_190912)	1) Combine FWA Lakes and FWA Man Made waterbodies 2) Create 1000 m and 100 m dissolved buffers around the combined FWA Lakes and man made waterbodies 3) Select wetlands that intersect 1000 m buffers and classify as 'Moderate' 4) Select wetlands that intersect 100 m buffers and		Open_Wtr_Class (High/Moderate/Low)

							classify as 'High' 5) Classify all other wetlands as 'Low'		
2.17	Cultural values: archaeological significance	Wetlands close to sites of archaeological significance	Binary; Wetlands with archaeological site within 500 m buffer	**Yes/ No by Wetland and Complex**	Yes if within 500 m of record	RAAD archaeological data (Additional_RAAD_ArchSites_190501) Consolidated wetland complexes (ESI_basic_Wetland_Complexes_190912)	1) Create 500 m buffer around all provided arch sites. 2) Select all wetlands that intersect the 500 m buffer		RAAD_500m (Yes/No)

2.18	Cultural values: accessibility	Wetlands accessible for use	Classification of... i) wetlands within 5 km of a community and 500 m from a road (high) ii) wetlands within 50 km of a community and 500 m from a road (medium)	**Distance to closest community and within 500m of a road by Wetland Complex**	See Methodology - Adapted from Hall 2018	Communities (Hmn_Structure_Density_ESI_ExtendedAUarea_191001, DENSITY_CLASS_CD >= 3) CE Integrated Roads (SkeenaESI_Extend_ConsRd_inclKispBulk_DSS_190918) Consolidated wetland complexes (ESI_basic_Wetland_Complexes_190912)	1) Add a field to the wetlands layer called 'Dist_to_Community' 2) Create 5 km and 50 km dissolved buffers around the communities 3) Select all wetlands that intersect the 50 km buffer and classify "Dist_to_Community" as '5 to 50km'. within 5 km of a community as '<5km', all wetlands >5km to 50km from a community as '5 to 50km', all wetlands further than 50 km from a community as '>50km' 4) Add a field to the wetlands layer called "Dist_to_Road" 5) Buffer Consolidated wetlands by 500 m	Communities defined as areas having a building density > 24.99 buildings/km2 (where "DENSITY_CLASS_CD" >= 3)	Cultural_Access_Class (High/Medium/Low) Supporting fields: Dist_To_Community (<5km/5 to 50km/>50km) Dist_To_Road (<=500m/>500m)

							(undissolved) 6) Select all 500 m wetland buffers that intersect the CE integrated roads and classify "Dist_to_Road" as '<500m'; all other wetlands classify as '>=500m' 7) Select all wetlands where "Dist_to_Community" = '<5km' and "Dist_to_Road" = '<=500m' and classify Cultural Access Class as 'High'. Select all wetlands where "Dist_to_Community" = '5 to 50km' and "Dist_to_Road" = '<=500m' and classify Cultural Access Class as 'Medium'; all remaining wetlands classify as 'Low'.		

Appendix B3 – Output Field Description

Geodatabase	Dataset Name	Field Name	Description
Skeena_ESI_T1_Wetland_20191219 .gdb	Skeena_ESI_T1_Wetland_20191219	OBJECTID	Unique feature ID; geodatabase default field
		Wetland_Co	Unique wetland complex ID
		RoadDensity_100m	Road density (km/km2) within 100 m buffer of wetland complex
		RoadDensity_2000m	Road density (km/km2) within 2 km buffer of wetland complex
		Nat_SemiNat_PCT	Percent natural/semi-natural land cover within 2 km buffer of wetland complex
		Peatland_PCT	Percent of inferred peatland within wetland complex area
		Peatland_GT50PCT	Wetland complex with > 50 % peatland coverage (Yes/No)
		Moose_Forage	Wetland complex containing high value moose forage (Yes/No)
		NATURAL_DISTURBANCE	Dominant natural disturbance type in wetland complex

		MAP_LABEL	Dominant biogeoclimatic zone in wetland complex
		min_pct_target_Mature_Old	Minimal percent coverage target for mature and old growth forest for wetland complex
		Mature_OG_PCT	Percent of mature and old growth forest within 2 km buffer of wetland complex above minimum threshold
		RAAD_500m	Wetland complex with archaeological site within 500 m buffer (Yes/No)
		Aquatic_Life_Support	Wetland complex intersecting inferred or observed fish habitat (Yes/No)
		Open_Wtr_Class	Wetland complex with waterbody within 100 m buffer (High), or within 1 km buffer (Moderate), or > 1 km (Low)
		Cultural_Access_Class	Wetland complex within 5 km of a community and 500 m from a road (High), within 50 km

			of a community and 500 m from a road (Medium)
		Dist_to_Community	Distance of wetland complex to nearest community (<5km, 5 to 50km, > 50km)
		Dist_to_Road	Distance of wetland complex to nearest road (<=500m, >500m)
		Protected_Ovrlp	Wetland complex intersecting proposed or existing area managed for wildlife (Yes/No)
		SocietalAsset_5km_ds	Wetland complex with a community or fish habitat within 5 km buffer downstream (Yes/No)
		SocietalAsset_WQ_Score	Score (from 0 to 7) based on proximity to point source pollution (within 1 km), primary or secondary roads (within 200 m), tertiary or temporary/abandoned roads (within 200 m), and community or fish habitat

			downstream (within 5 km).
		SocietalAsset_WQ_Class	Classification (High, Moderate, Low) based on proximity to point source pollution (within 1 km), primary or secondary roads (within 200 m), tertiary or temporary/abandoned roads (within 200 m), and community or fish habitat downstream (within 5 km).
		stream_intersect	Wetland complex intersects with FWA stream network (filtered, where EDGE_TYPE equals 1000, 1050, 1100, 1150, 1250, 2000, or 2300) (Yes/No)
		lake_intersect	Wetland complex intersects with FWA lakes (Yes/No)
		mmwb_intersect	Wetland complex intersects with FWA man-made waterbodies (Yes/No)

		river_intersect	Wetland complex intersects with FWA river polygons (Yes/No)
		split_by_stream	Wetland complex is split into two or more polygons by the FWA stream network (filtered, where EDGE_TYPE equals 1000, 1050, 1100, 1150, 1250, 2000, or 2300) (Yes/No)
		stream_end	Wetland complex intersects with at least one starting vertex from the FWA stream network lines (filtered, where EDGE_TYPE equals 1000, 1050, 1100, 1150, 1250, 2000, or 2300, and merged) (Yes/No)
		stream_start	Wetland complex intersects with at least one ending vertex from the FWA stream network lines (filtered, where EDGE_TYPE equals 1000, 1050, 1100, 1150, 1250, 2000, or

			2300, and merged) (Yes/No)
		mean_slope_pct	Average slopIe across the wetland complex, determined from BC 25 m DEM cells
		max_stream_order	Maximum stream order of the wetland complex, determined from intersecting FWA stream network lines and/or FWA river polygons
		Verticalflow	Water flow path: wetland complex has vertical flow (Yes/No)
		Bidirectional	Water flow path: wetland complex has bidirectional flow (Yes/No)
		Throughflow	Water flow path: wetland complex has throughflow (Yes/No)
		Outflow	Water flow path: wetland complex has outflow (Yes/No)
		Inflow	Water flow path: wetland complex has inflow (Yes/No)

		granitic_bedrock	Wetland complex has some underlying granitic bedrock (Yes/No)
		WFP_subscore	Water Flow Path subscore (0, 2, 4, or 6) based on water flow path attributes
		IWS_subscore	Internal Wetland Slope subscore (0 to 3) based on mean slope of wetland complex
		GS_subscore	Granitic Soils/Bedrock subscore (0, -2) based on prescence of granitic bedrock
		WaterPurification_score	Water purification score based on sum of WFP, IWS, and GS subscores (-2 to 9)
		WaterPurification_function	Classification (High, Medium, Low) of wetland function regarding water purification based on WaterPurification_score
		FloodControl_function	Classification (High, Medium, Low, Very Low to Zero) of wetland function regarding flood

			reduction potential based on water flow path attributes
Skeena_ESI_T1_Wetland_20200612.gdb	Skeena_ESI_T1_Wetland_Update_20200612	WATERSHED_FEATURE_ID	FWA Assessment Watershed Unique ID. Used as the Cumulative Effects Assessment Unit identifier.
		Rd_Density	Road Density per total AU - km/km2
		ECA_Final_PCNT	ECA Percent of AU, but indicated as 9999 where >50% of AU has VRI unreported.
		POD_Count	count of all Points of Diversion by TPOD_TAG
		Mine_Point_Count	count of MinFile points by Mineral File Number
		AddRemediation_Sites_Count	Count of additional remediation sites.
		WWDischarge_Count	count of Waste Water Discharge points by Authorization Number
		Pnt_Src_Plltn_Final_Count	Total count of all contributing point source pollution counts

		Rd_Density_net	Road Density per net AU (excluding BTM water/glacier/snow) - km/km2
		LANDSCAPE_UNIT_PROVID	Landscape Unit unique ID
		LANDSCAPE_UNIT_NUMBER	Landscape Unit Number
		LANDSCAPE_UNIT_NAME	Landscape Unit Name
		BIODIVERSITY_EMPHASIS_OPTION	Landscape Unit value for certain targets
		WATERSHED_GROUP_ID	Watershed Group ID - Waterhseds all belong to a certain group
		WATERSHED_GROUP_CODE	Watershed Group Code - Numberic version of name
		WATERSHED_GROUP_NAME	Watershed Group Name
		AREA_HA	Watershed Group Area in HA
		FISH_Watershed	The FISH Watershed (larger watersheds created for FISH population assessment)
		Witset_YesNo	Witset FN boundary Overlap (Y/N)
		Wet_suwet_en_First_Nation_YesNo	Wetsuweten FN boundary Overlap (Y/N)

		Gitxsan_Hereditary_Chiefs_YesNo	Gitxsan FN boundary Overlap (Y/N)
		Lake_Babine_Nation_YesNo	Lake Babine FN boundary Overlap (Y/N)
		Nee_Tahi_Buhn_Indian_Band_YesNo	Nee Tahi Buhn boundary Overlap (Y/N)
		Skin_Tyee_Nation_YesNo	Skin Tyee boundary Overlap (Y/N)
		Office_of_the_Wet_suwet_en_YesNo	Office of the Wetsuweten boundary Overlap (Y/N)
		Gitanyow_Hereditary_Chiefs_Office_YesNo	Gitanyow boundary Overlap (Y/N)
		Upper_Skeena_YesNo	Gitxsan Watershed Upper Skeena Watershed boundary Overlap (Y/N)
		Sustut_YesNo	Gitxsan Watershed Sustut boundary Overlap (Y/N)
		Middle_Skeena_YesNo	Gitxsan Watershed Middle Skeena boundary Overlap (Y/N)
		Babine_YesNo	Gitxsan Watershed Babine boundary overlap (Y/N)
		Kispiox_YesNo	Gitxsan Watersehd Kispiox boundary overlap (Y/N)

		Suskwa_YesNo	Gitxsan Watersehd Suskwa boundary overlap (Y/N)
		Gitwangak___Lower_Skeena_YesNo	Gitxsan Watersehd Gitwangak boundary overlap (Y/N)
		Kitseguecla_YesNo	Gitxsan Watersehd Kitseguecla boundary overlap (Y/N)
		Shape_Length_*	DON'T USE - Can't be deleted
		Shape_Area_*	DON'T USE - Can't be deleted
		FWA_WATERSHED_CODE	Hierarchal coding for the Watershed
		LOCAL_WATERSHED_CODE	Hierarchal coding for the Local Watershed
		AU_protected_area	AU Area of protected area
		AU_wetland_area	AU Area of Wetland
		AU_Protected_wetland_area	AU Area of Protected Wetland
		GEOMETRY_Length	DON'T USE - Can't be deleted
		GEOMETRY_Area	DON'T USE - Can't be deleted
		Perc_ofAU_Protected	Percent of AU that is Protected
		Perc_ofAU_Wetlands	Percent of AU that is Wetland
		Perc_ofAU_Protected_Wetlands	Percent of AU that is Protected Wetland

		Perc_ofWetlands_Protected_ByAU	Percent of Wetlands in AU that are Protected Wetlands
		Shape_Length	Length of shape; geodatabase default field
		Shape_Area	Area of shape; geodatabase default field
SSAF_T1_Wetland_V2_2018_200923.gdb	SSAF_T1_Wetland_V2_2018_200923	AU_Area_ha	Area of the Assessment Watershed
		AU_Area_ha_noIceWater	Area of the Assessment Watershed with areas of ice and water

APPENDIX C- Common Pressures

Skeena ESI Science and Technical Committee (STC):

Common Pressures on SSAF Values

Don Morgan

23 November 2020

The Skeena Sustainability Assessment Forum (SSAF) focusses on five values: wetlands, fish and fish habitat, moose, grizzly bears and medicinal plants. These values are widely distributed across the SSAF area and are affected by a range of natural and anthropogenic threats.

The SSAF is conducting value assessments based on guidance from experts and knowledge keepers that have been captured in a conceptual framework that presents key factors – threats, functions and conditions – that influence the state of the values. These high-level assessments (Tier 1) are validated and refined through more detailed spatial (Tier 1.5), field-based monitoring (Tier 2) and research (Tier 3). This work provides transparency on the collective understanding of the condition and trend of values. Over time, this work can be used to develop best management practices and the development of formal legal and policy objectives.

The SSAF value assessments highlight that there are common pressures and, in some cases, common indicators that are used, such as those shared between wetlands, fish and fish habitat, grizzly bear's use of road density metrics. This is consistent with reviews of the conservation literature[2] that have identified the impact of roads on wildlife and aquatic ecosystems. These identified pressures extend beyond the SSAF values and have implications for other wildlife, and more broadly aquatic ecosystems and biodiversity. These indicators provide a deeper understanding of pressures on the land and water from human activities and environmental change.

Natural and anthropogenic pressures, or threats, impact ecological values through habitat conversion, alteration or fragmentation leading to both direct and indirect mortality of wildlife and aquatic organisms. Examples of potential threats include:

- shifts in forest structural composition;
- forest loss due to conversion to non-forest;
- invasive species;
- species range shifts triggered by climate change;
- amount and distribution of linear features such as roads; and

[2] Trombulak, S.C. and C.A. Frissell. 2000. Review of ecological effects of roads on terrestrial and aquatic communities. Conservation Biology. 14: 18-30. DOI: 10.1046/j.1523-1739.2000.99084.x

- ecosystem/habitat disturbance due to natural and human caused events, such as wildfires, insects, industrial development, flooding, and recreational use.

Landscape and aquatic conditions that contribute towards conservation of values include:

- Presence of conservancies, such as legally established protected areas, Wildlife Habitat Areas, Old Growth Management Areas;
- Intact lands, areas that have not been significantly altered by human activity;
- Areas of geo-diversity, such as wetland complexes or areas of varied terrain that provide important habitat and that can be more stable under a changing climate change.
- Landscape connectivity that facilitate species seasonal movement and climate connectivity – linking areas of historic to future climate;

In conclusion, indicators common to values provide a simpler approach to understanding the pressures on terrestrial and aquatic systems. As a result, conservation practices can be designed to reduce pressures and benefit a range of species and organisms. This eliminates the need to do detailed species by species assessments.

The five values identified by the SSAF are supported by a diverse range of indicators. Despite the apparent differences in these values – where values are abiotic, biotic, terrestrial, or aquatic – there are shared indicators that provide deeper insight into common pressures on these components. Land and resource managers can use these common indictors to inform land use planning and conservation prioritization by focusing on reducing pressures that will benefit a range of species and habitats. Assessing indicators that are common across multiple valued components decreases the confusion that can be generated by conducting detailed but independent species assessments.

Indicators	Skeena ESI Values				
	Grizzly Bear	Fish and Fish Habitat	Wetlands	Moose habitat	Medicinal Plants
	Conservation rank	ECA	ECA	Anthropogenic alteration (disturbance)	
	Bear density	Point source pollution	Point source pollution		
	Road density	Road density	Road density within watershed		
	Mortality rates	Road density near streams	Road density within 100 m of wetlands		
	Front country	Road/stream crossing density	Road density within 2 km of wetlands		
	Hunter day density	Road density on Steep slopes	Flood reduction potential		
	BEC Mid-seral dense conifer	Young second growth forest	Flood reduction benefits	Winter shelter	
	Quality food	Riparian disturbance	Water purification functions		
		Total land disturbance	Water purification benefits		
		Dams and impoundments	Carbon storage		
		Water licenses	Aquatic life support function		
		Groundwater wells	Availability of moose forage and screening	Landscape detection risk (sightability) Winter forage	
	Core security areas	Water allocation restrictions	Wildlife habitat connectivity	Habitat capability Habitat Suitability	
	Quality habitat protected	Mines	Wildlife habitat management areas	Winter home range analysis	
		Low flow sensitivity	Wildlife habitat proximity to lake or pond	Proximity analysis – paired habitat	

		Drainage density ruggedness	Cultural value: archeological records or identified wetland of significance		
		Lakes and wetlands	Cultural value: accessibility		
		Salmonid habitat			
		Salmon spawning			
		Salmon escapement			