Natural Resource Stewardship Monitoring and Assessment Report for the Peace Natural Resource District

October 2018

BRITISH COLUMBIA
Ministry of
Forests, Lands, Natural
Resource Operations
and Rural Development

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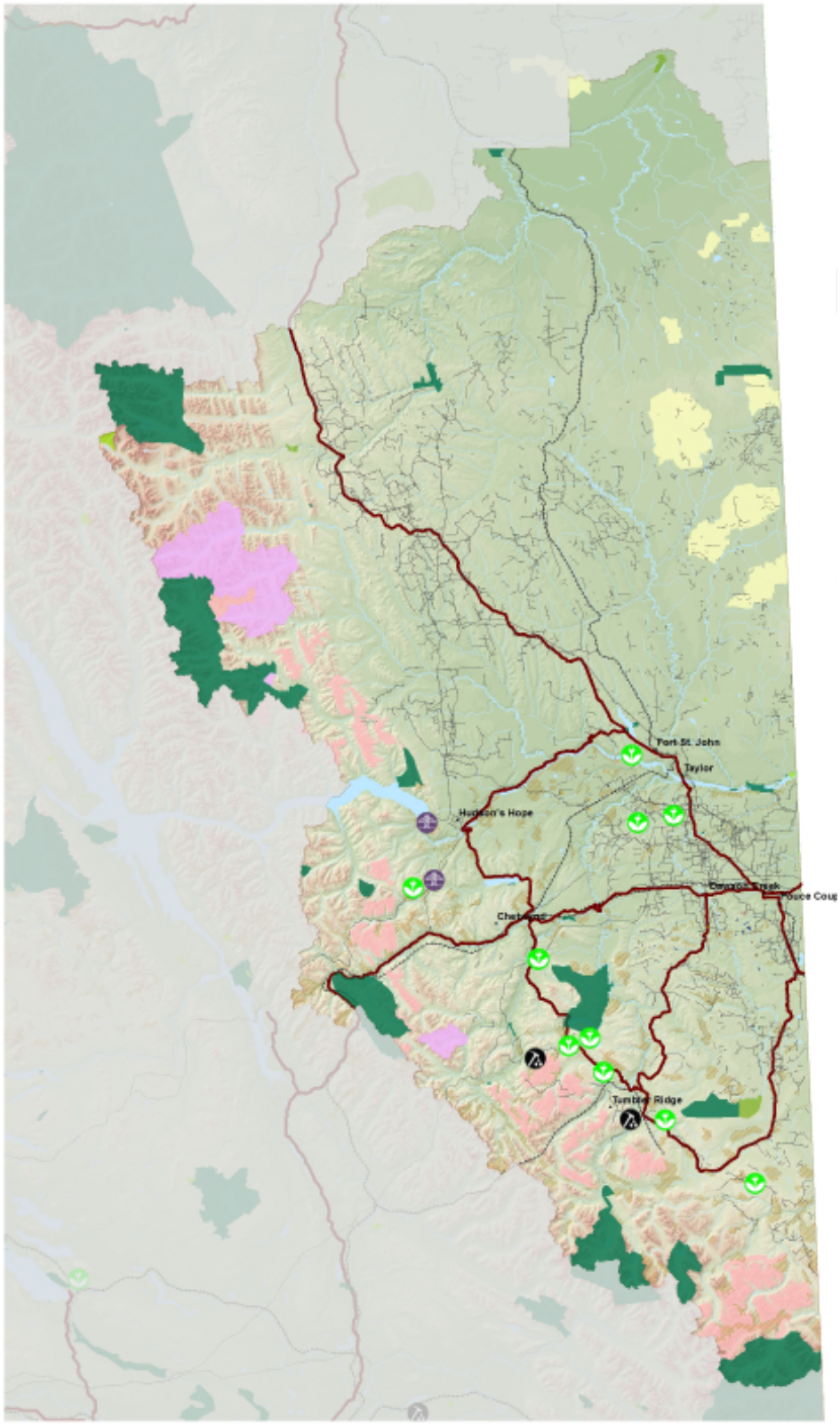


Figure 1: Peace Resource District major resource sector developments and protected areas

Natural Resource Sector Major Projects

- Major Mines
- Clean Energy (Hydro, wind)
- Utilities
- OGC Pipeline Rights of Way - Permits (Approved or Post Construction)
- Old Growth Management Areas - Legal
- Ecological Reserves
- Provincial Parks
- Protected Areas

Wildlife Habitat Areas

- Black-Throated Green warbler
- Boreal Caribou
- Connecticut warbler
- Data sensitive
- Fisher
- Mountain Goat
- Northern Caribou
- BC Highways
- Rail Line

REPORT CONTEXT

Natural Resource Stewardship Monitoring and Assessment Reports are a summary of existing resource value monitoring and assessment information for a given geographic area such as a Natural Resource District or First Nation hereditary territory. For each resource value, or source of information, there is a one-two page summary of status, trends, causal factors, and opportunities for improvement. The reports include information from cumulative effects assessments, OGC's area-based analysis and FREP field-based monitoring. In addition, each report contains a Provincial government statutory decision maker commentary on government expectations for the management of those natural resource values. In the case of First Nation's territory reports, there is also a First Nation's commentary. Each source of information is referenced in a way that describes the data age, sample design, and where more detailed information can be found.

Consistent with Cumulative Effects Framework policy and direction from the Regional Executive Director, the purpose of these reports is to present available monitoring and assessment information in a concise document to inform and assist multiple levels of decision making and facilitate resource stewardship dialogue based on a common understanding of the status, trends and causal factors associated with resource values and potential cumulative effects. The results drawn from these reports will help to define monitoring priorities by resource value or geographic area that combined with management direction can contribute to the foundation of regional land use planning. The primary target audience is government decision makers, First Nations, and resource industries.

Specifically, this document is intended to:

- Provide transparency and accountability for the management of public resources;
- Provide information to help inform balanced decision making in consideration of environmental, social, and economic factors; and
- Guide ongoing improvement of resource management practices, policies and legislation.

All natural resource development affects ecosystem conditions. The role of natural resource monitoring and assessments is to assess the impacts of resource development and or natural factors, identify the status and trends of British Columbia's natural resource values, and identify related causal factors and opportunities for ongoing resource management improvement.

There are two levels of results presented in this report – site level (S) and landscape/watershed level (L). Site-level assessments are generally "boots on the ground" observations of impacts at localized sites, such as where a road crosses a stream, an individual forestry cutblock, or other industrial development. Landscape or watershed-level assessments are usually an office-based geographic information system (GIS) analyses. Site-level assessments are often used to validate landscape-level assessments.

Data has been arranged in the following categories:

Fish and Water

- Riparian (Fish) Habitat (FREP) S
- Fish Passage (FLNRO/ENV) S
- Riparian Reserve Zone Status (OGC) L
- Water Quality (Sediment) (FREP) S

Social and Economic

- Visual Quality (FREP) S
- Cultural Heritage (FREP) S

Wildlife

- Grizzly Bear (ENV/CE) L
- Moose (ENV) L
- Mountain Caribou (ENV) L

Biodiversity and Air Quality

- Stand-level Biodiversity (FREP) S
- Landscape-level Biodiversity (FREP) L
- Forest Health S/L
- Air Quality (ENV) L

This report summarizes monitoring results for the Peace Natural Resource District. The Provincial government statutory decision maker commentary in this report is intended to clarify government's resource stewardship expectations, and promote the open and transparent discussion needed to achieve short- and long-term sustainable resource management in British Columbia.

The content of this report informs evidence-based decision making and professional reliance. This report does not fetter the discretion of a statutory decision maker.

SOURCES OF INFORMATION

This report contains monitoring information from a variety of sources within the Peace Resource District. Not all data have the same level of scientific rigour and this noted in each data summary and in Figure 2. Over time, it is expected that these data sources will be further improved and other reliable monitoring data will become available for future reports. A brief description of the data source is provided with the results for each resource value. Appendix A details the original data source, reports, web links, and contact names.

LIST OF ACRONYMS

ABA	Area Based Analysis
AQMS	Air Quality Management System
BEC	Biogeoclimatic Ecosystem Classification BTM Baseline Thematic Mapping
BWBSwk1	Boreal white and Black Spruce Zone, Murray wet cool
BWBSwk2	Boreal white and Black Spruce Zone, Graham wet cool
BWBSmw	Boreal white and Black Spruce Zone, moist warm
CAAQS	Canadian Ambient Air Quality Standards
DBH	Diameter at Breast Height
ESSFmv2	Englemann Spruce-Subalpine Fir Zone, Bullmoose moist very cold
FLNRORD	Ministry of Forests, Lands, Natural Resource Operations and Rural Development
FREP	Forest and Range Evaluation Program
FRPA	Forest and Range Practices Act
FSJPP	Fort St. John Pilot Project
FSR	Forest Service Road
GIS	Geographic Information System
GMZ	Game Management Zone
GBPU	Grizzly Bear Population Units
H_2S	Hydrogen sulphide
LNG	Liquefied Natural Gas
LWD	Large Woody Debris
MPB	Mountain Pine Beetle
ENV	Ministry of Environment and Climate Change Strategy
MRVA	Multiple Resource Value Assessment
MU	Management Unit
NAR	Net Area to be Reforested
NCD	Non-classified Drainage
NDU	Natural Disturbance Unit
NO_2	Nitrogen Dioxide
NRV	Natural Range of Variability
O_3	Ground-level ozone
OGC	Oil and Gas Commission
OGMA	Old Growth Management Areas
$PM_{2.5}$	Particulate matter with aerodynamic diameter less than 2.5 micrometers
PM_{10}	Particulate matter with aerodynamic diameter less than 10 micrometers
SO_2	Sulphur dioxide
ppb	Parts per billion
RESULTS	Reporting Silviculture Updates and Land Status Tracking
RMA	Riparian Management Area
TEM	Terrestrial Ecosystem Mapping TFL Tree Farm License
TRS	Total reduced sulphur compounds
TSA	Timber Supply Area
UWR	Ungulate Winter Range
VQO	Visual Quality Objective
VRI	Vegetation Resources Inventory
WHA	Wildlife Habitat Areas
WMB	Watershed Management Basins
WMU	Wildlife Management Units
Y2Y	Yellowstone to Yukon Conservation Initiative

RESOURCE VALUE ASSESSMENT CLASSIFICATIONS AND MEANINGS

Much of the information in this report summarizes site-level, field-based assessments that inform us of the ecological condition of resource values. The results of site-level assessments are confined to the working land-base and do not include the ecological contribution of parks and other protected areas. The landscape-level assessments in this report include the entire forested land base including parks and commercial forest. The "natural cause and resource development impact ratings" indicate the effect of resource development (e.g., forest harvesting) and natural impacts (e.g., forest health and flood events) on individual resource values. The "very low" and "low" impact ratings are considered consistent with the Province's goal of sustainable resource management. Through the use of impact ratings, resource managers/decision makers can apply the "consequence" lens (social, economic, environmental) to better understand and be able to make decisions based on defining overall acceptable risk levels to each of the resource values. For a description of the criteria used for determining resource development and natural cause impact ratings, see Appendix B.

Some of the information presented in this report is focused on the ecological state of the values, and provides useful information to resource managers and other professionals on the outcomes of plans and practices.

Additional information is provided to enhance the broader context of the ecological state of the land base for future management and monitoring activities. With additional data collection, the scale at which monitoring information is reported can be further enhanced to better reflect local information and decision making needs.

The presentation style used in this report includes an "Impact Ratings" diagram illustrating the effect of resource development and natural impacts on the resource value, from "very low" to "high" impact. The "Summary" presents a descriptive outline of the monitoring results. The "Causal Factors" for the impact ratings are derived from field-based data and/or an interpretation of potential reasons for the state of the value. The "Opportunities for Improvement" are based on practices that resulted in the best outcomes and (or) expert knowledge.

Where sufficient data is available, the "Overall Stewardship Trend" shows trends between time periods. A chi-squared test, which determines a probability value, is used to determine trends between sampling eras for riparian, water quality, stand-level biodiversity, and visual quality results.

PEACE NATURAL RESOURCE DISTRICT – ENVIRONMENTAL AND STEWARDSHIP CONTEXT

The Peace Natural Resource District is one of two districts that make up the Northeast Natural Resource Region of British Columbia. The Peace District covers approximately 7.2 million hectares and encompasses the Dawson Creek TSA, TFL 48 and Fort St John TSA (Figure 1). It is bounded by the Fort Nelson Natural Resource District to the north, the Alberta border to the east and the Hart Ranges to the south. To the west lies the height of the Rocky Mountains, characterized by mountainous terrain and steep valleys.

In 2016, the Peace District population was estimated at about 63,000 persons with over half the population located in Dawson Creek and Fort St. John and surrounding areas.

The Peace District lies completely within Treaty 8 Territory. The West Moberly, Saulteau, Blueberry River, Doig River and Halfway River First Nations are signatories of Treaty 8 and have reserves and territories within the District with a combined population of approximately 2,450 persons. Other Treaty 8 signatories that have traditional territory that encompasses the district but their reserve lands are outside the district are the McLeod Lake Indian Band, Fort Nelson First Nation, and the Prophet River First Nation, and the Dene Tha First Nation in Alberta. None of the aforementioned First Nations were involved in the development of this report.

The District lies primarily within two ecoregions: the Boreal Plains in the east, and the Central Canadian Rocky Mountains in the west. Rivers are the dominate water feature of the District. The 'Site C' development will create a reservoir downstream of Hudson's Hope and upstream of Taylor on the Peace River.

The Peace Natural Resource District provide a wide range of natural resources, including forest products, forage, minerals, recreation and tourism amenities, oil and gas reserves, and fish and wildlife habitats. There are a number of provincial parks, protected areas and special management zones in the Peace District. Larger areas include Monkman Provincial Park, Graham Laurier Provincial Park, Redfern Kelly Provincial Park, Bearhole Lake Provincial Park and Protected Area, Sikanni Chief Falls Protected Area, and notably, the Muskwa-Kechika Management Area which overlaps the northwest area of the district.

The Fort St. John Pilot Project (FSJPP), implemented across the Fort St John TSA in 2001, outlines forest management practices under a Sustainable Forest Management Plan. The Fort St. John TSA covers 4.86 million hectares, of which 57% is crown forest. The Crown forest management land base in the Dawson Creek TSA is about 1.6 million hectares and management of these lands is under FRPA and associated regulations. Mountain pine beetle infestations has impacted lodgepole pine stands since 2004 though the expectation is that a return to the normal harvesting profile is imminent as the infestations continue to wane. Spruce Bark Beettle is moving its way east through the Pine Pass and the district is seeing moderate impacts from the current infestation within the Omineca Region. Management of Spruce Bark Beetle is being maintained through the Chief Forester's Expectations based on harvest prioritization. The south and south-eastern portions of the Peace District are predominantly used for agriculture and have a high concentration of private land.

DISTRICT MANAGER COMMENTARY

As a compilation of monitoring and assessment information from a wide range of sources, this document marks a significant step forward in reporting the condition of the collective natural resource values.

Each monitored value defines data sources, summarizes monitoring results relative to selected indicators, makes a statement on overall stewardship trend, and discusses opportunities for improvement. Given the many natural resource management activities, demands and pressures (ecological, social and economic) occurring over the land base, decision making is a challenging task. The information in this report is a basis for discussions that can lead to balanced and durable decision making. The monitoring results in this report, considered in combination with objectives set by government, science-based indicators/ thresholds, strategic plans, government initiatives such as the Cumulative Effects Framework, and existing consultation documents, can assist with complex resource stewardship decision making.

While this report is an excellent start to transparent reporting of resource value status and trends, my expectation is that future reports will include additional natural resource and cultural values, as identified by Treaty 8 signatories, in support of their treaty rights.

Over time, with additional data, the values being reported on, and the scale at which monitoring information is reported, can be refined to best reflect local information, shared values and resource management decision making needs. This report is a step in the right direction; it is not the end destination.

My expectation is that dialogue between the provincial government, First Nations and industry, resulting from this report will:

- Be a starting place to work collaboratively with Indigenous peoples, specifically the Treaty 8 First Nations to identify the values that are important to understanding the condition of the land base and the resource values that are key to their treaty rights.
- Enable staff to prioritize non-core monitoring activities in order to fill the data gaps identified by First Nations
- Facilitate industry and government staff use of the information contained in this report as part of their due diligence as resource professionals and decision makers.

Specifically, I request that resource professionals and managers carefully review the status, trend and causal factor information for each value, along with opportunities for improvement, at a tactical level in their development/ approval of Forest Stewardship Plan, the Dawson Creek TSA and the Sustainable Forestry Management Plan covering the Fort St. John TSA. Additionally, this report can support and guide operational-level management in site plans and operational activities.

In particular, the results for fish and water values are of concern to me. These results indicate a need for improved management such as more attention to retention adjacent to, and avoidance of small streams, during industrial activities. Fine sediment is naturally high in the Peace, management practices that unnecessarily add to these natural high levels can have a detrimental impact on drinking water and fish habitat. The assessment results for caribou and moose all indicate a need for higher levels of planning co-operation between government, First Nations and industry.

Finally, because this is a new type of reporting, a debrief will be conducted to ensure future reports incorporate "lessons learned" as well as determining where more value can be added for the stewardship and decision-making purposes of resource professionals and land managers.

Mark Van Tassel
A/District Manager
Peace Natural Resource District

MONITORING RESULTS IN BRIEF

Effective resource management requires understanding of the condition of individual resource values and how these values relate to each other. This report provides a summary snapshot for monitoring conducted in the Peace Natural Resource District. A description of the criteria used for determining resource development impact rating criteria can be found in Appendix B. The results in this report are summaries of more detailed data/reports as noted in Appendix A. The scoring and locations of FREP samples within the Peace Natural Resource District are presented in Appendix C.

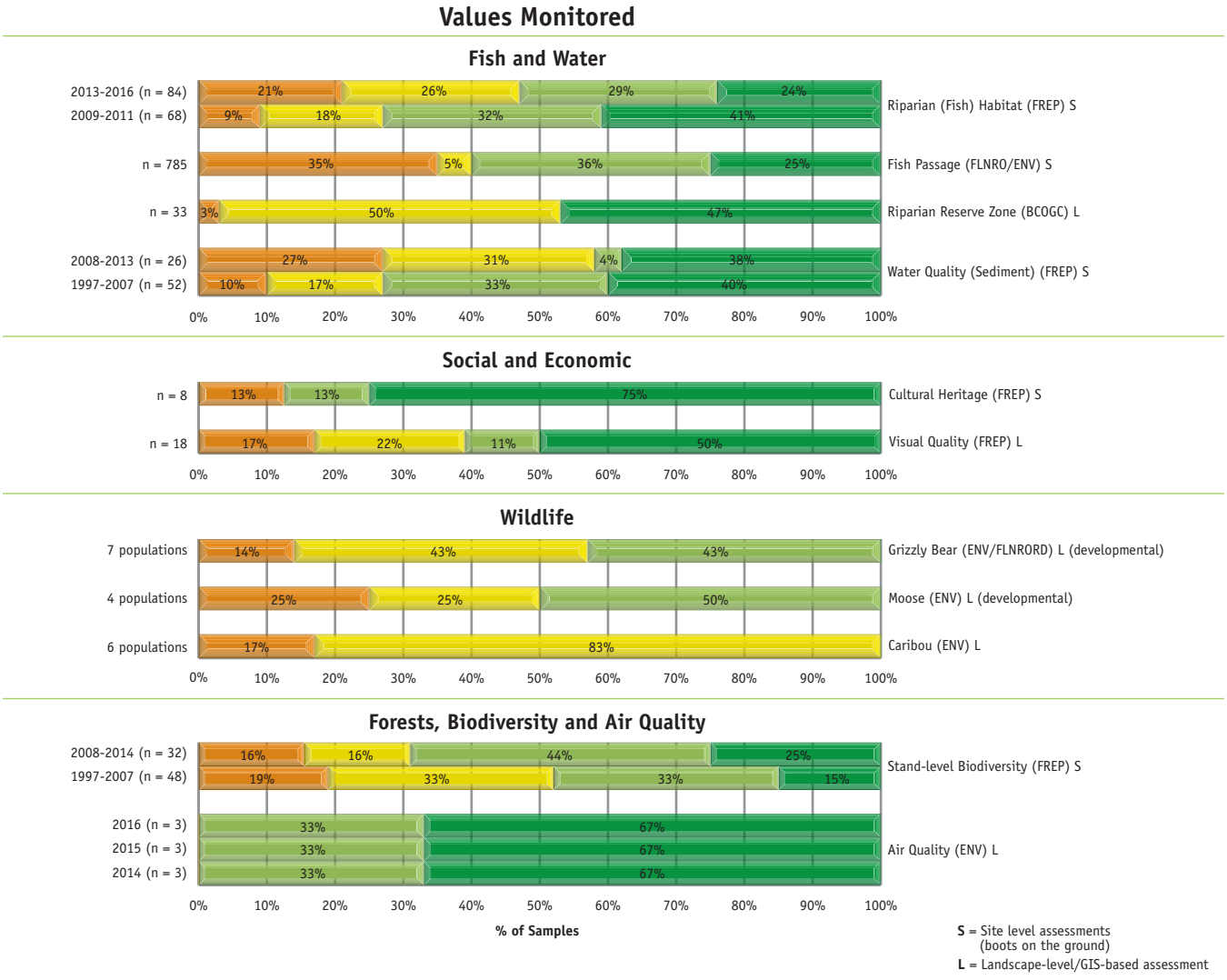


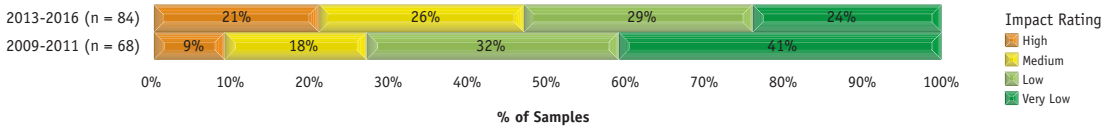
Figure 2: Peace Natural Resource District impact rating by resource value

1.0 MONITORING AND ASSESSMENT RESULTS: FISH AND WATER

1.1 Riparian (Fish) Habitat Value

Monitoring the condition of stream channels and their adjacent riparian management areas determines whether resource management practices are achieving the desired result of protecting fish values by maintaining stream channel integrity and riparian functions.

Riparian: Resource Development and Natural Impacts on Stream Function



Data Source: The data for riparian stream assessments was collected by FLNRO staff using the FREP riparian monitoring protocol. The sample population for stream assessment consists of randomly selected cutblocks with streams in or adjacent to cutblock boundaries. The data was collected from 2006 to 2016, from blocks harvested from 1997 to 2013. Riparian stream classification is presented in Appendix D.

Summary: Results from recent riparian stream assessments (blocks harvested from 2008 to 2013) found that 15 out of the 26 stream reaches (58%) were not properly functioning or functioning, but at high risk (high and medium impact ratings). However, the causal factors were varied.

Samples by Stream Class and Impact Rating 2008-2013:

Class	High	Medium	Low	Very Low	Total
S2	2				**2**
S3		1		1	**2**
S4				2	**2**
S5	1				**1**
S6	4	7	1	7	**19**
Total	**7**	**8**	**1**	**10**	**26**

Causal Factors for 2008 to 2013 harvest era:

Factor	% of negative responses
Logging	51
Natural events	37
Roads	7
Upstream factors	1

Specific Impacts for 2008 to 2013 harvest era:

Factor	Specific Impact	Percentage of sites with Specific Impact (*n* = 26)
Logging	Windthrow	58
	Falling and yarding	46
	Low retention	46
	Old logging	31
Natural events	Floods	42
	High natural background sediment levels	23
Roads	Running surface eroding into stream	8
	Fill or cut slopes eroding into stream	8
	Ditches eroding into stream	8

Stewardship Trend: There is a statistical difference between sampling eras (χ^2, p=0.01).

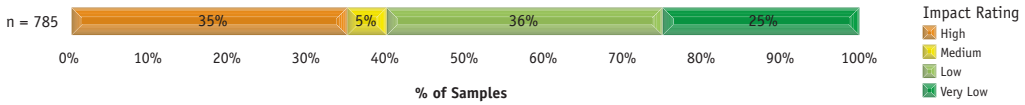
Opportunities for improvement (and/or continuation) based on streams with the best outcomes:

- Avoid streams when planning forestry cutblocks or other activities requiring clearing of trees by:
  - o Using streams as natural boundaries where possible and buffering them on the cutblock side. Cut out any headwater reaches that originate inside the block.
  - o Anchoring wildlife tree patches or other retention to streams that fall inside the block.
  - o Using a qualified professional to classify watercourses and identify perennial/important streams as well as NCDs and less important streams (small ephemeral or not connected S6s) for strategic block placement.
- Leave non-merchantable timber and understory around small streams where possible. In areas where understory and non-merch growth is not vigorous (such as second growth stands), reserve enough merchantable timber to maintain bank stability, contribute shade, and supply LWD. Ensure streambank timber is windfirm by pruning, feathering, or buffering RMA where needed.
- Consider high stumping around small streams where full tree retention is not possible, especially in steeper areas to prevent debris from entering the water channel.
- Ribbon retention and/or provide maps on georeferenced iPads to help inform operators.
- Fall and yard away whenever possible.
- Provide training to operators about the importance of streams and best practices in riparian areas. Monitor harvesting to ensure operators are using methods that will minimize disturbance.
- Recognize risk of erosion in areas that are naturally high in fine sediments.
- Plan, maintain, and deactivate roads to minimize transport of sediments to stream channels.

1.2 Fish Passage Value

The fish passage protocol assesses the resource road structures put in place at fish stream crossings such as culverts and bridges to determine if there are any barriers to fish passage. Unimpeded fish passage is important to maintaining access to fish habitat and maintaining healthy fish populations.

Fish: Ability of Stream Crossings to Successfully Pass Fish



Data Source: Fish passage data was collected using a standardized protocol developed by a federal and provincial Fish Passage Technical Working Group. The sampling population is a census of all road crossings in a given geographic area. Potential fish streams are identified based on a combination of historical fish observation points, natural barriers, and GIS-derived stream gradients less than 30%. Data are collected by government staff and contractors, and made public through iMap BC and the Provincial Stream Crossing Inventory System.

Summary: 785 stream crossings on 660 streams were assessed for fish passage from 2006 to 2009 in the Peace Natural Resource District (for locations see Appendix E).

35% of these crossings are "high" impact because they block or impede fish movements upstream to access. The average stream length blocked by crossings designated as "high" impact was 3 km, ranging from 100 m up to 29 km. This potentially represents impeded access to over 800 km of fish habitat (0-15% gradient).5% of crossings are considered "medium" impact because they block fish movements to only short sections of good habitat or less suitable steeper gradient fish habitat (15-25%, depending on stream order).

The 36% of crossings with a "low" impact were either passable to fish (n=263, mostly bridges, but also fords, pipe arches, a few wood box culverts and the rare round metal culvert) or blocked access to only very steep fish habitat (n=19). Crossings with a "very low" impact (25%) had little to no fish habitat upstream.

Causal Factors: Closed-bottomed, round metal culverts account for all of the fish passage problems encountered. Culverts that blocked or impeded fish did so mainly because they were not embedded, which increased flow velocities. Not embedded means part or all of the culvert length lacked natural stream bed (roughness) to break up the flow of water and provide micro-rest areas for fish trying to swim through the culvert.

Other common problems (in order of significance) were placing culverts at too steep an angle and constricting the stream channel. Culverts that were too long were less frequent problems.

Table 1. The top ten stream crossings with the longest lengths of good fish habitat blocked.

Stream	Crossing ID	Road Name
Gwillim River	7360	Gwillim Boat Launch Road
Elbow Creek	125654	Pink Mountain outfitter Road
Townsend Creek Trib	125692	Alaska HWY
Suprenant Creek	7387	Smokehouse Road Km 9
Townsend Creek Trib	125693	Alaska HWY
Murray River Trib	7180	Murray River FSR
Rat Lake Creek	7412	Rat Lake Road Km 0.5
Fearless Creek	7394	Wapiti (500 Road) FSR Km 14.4
Calamagrostis Creek	7217	Boundary Road
Horseshoe Creek Trib	124879	Upper Halfway Road

Stewardship Trend: All new crossings on fish streams are required to maintain fish passage. This is creating a positive trend on new crossings.

Opportunities For Improvement and (or) Continuation of Resource Road Management Practices that Successfully Pass Fish: Once blocked sites are identified as candidates for remediation, a four-step process is normally recommended for restoration of fish passage.

Step 1 – Confirm the quantity and quality of habitat to be gained at the site merits remediation

Step 2 – Prioritize structures for remediation

Step 3 – Commission a site plan and design

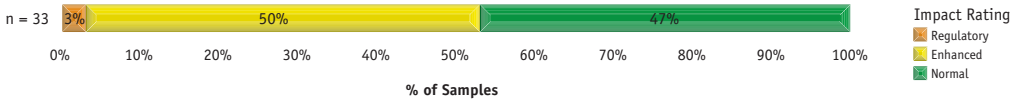
Step 4 – Carry out construction to remediate the stream crossings and reconnect fish habitat.

The top ten crossings with the greatest length of stream habitat blocked (Table 1) account for 23% of all the total high value fish habitat blocked. These are a good starting point for confirming the quantity and quality of fish habitat that could be gained if fish passage is restored. GIS analysis indicated this may restore 190 km of the estimated 809 km of valuable fish habitat that is currently isolated by impassable culverts.

Fish passage restoration is arguably the most effective means of improving fish outcomes in B.C.'s streams and rivers. Funding opportunities that exist to conduct further assessments and develop restoration plans should be pursued. In the meantime, all new crossings should at a minimum maintain normal channel width and channel bed roughness.

1.3 Riparian Reserve Zone Status Value

Riparian Reserve Zone Status: Area Based Analysis



Data Source: Area-based Analysis (ABA) is a framework established by the BC Oil and Gas Commission to manage for cumulative impacts in northeast B.C. ABA measures disturbance to environmental values at a landscape level, considering all known past, present and reasonably foreseeable industrial disturbance. Mapped disturbances are oil and gas surface land use associated with wells sites, roads, pipelines, ancillary facilities and clearing for geophysical (seismic) exploration. Other land uses mapped are other (non-oil and gas) roads and forestry cutblocks. For the Riparian Reserve Zone, status Watershed Management Basins (WMB)[2] are assigned a status that can be normal, enhanced management or regulatory policy based on the level of incursions into the riparian reserve zone as defined in the *Environmental Protection and Management Regulation* of the *Oil and Gas Activities Act*. The assessment is conducted only on the Crown land portion of the land base.[3]

Summary:

For riparian reserve zone status the ABA defines an

- enhanced management trigger as less than 95% of the zone intact which indicates that a change in management is required to address a potentially escalating impact.
- regulatory/policy trigger as less than 90% of the zone intact which indicates that statutory, regulatory and/or policy requirements have been exceeded.[4]

Approximately half (16 of 33) the WMBs in the Peace Resource District exceed the enhanced management trigger. A single WMB, the Pouce Coupe River WMB, slightly exceeds the regulatory/policy trigger with just under 90% of the riparian zone on Crown land that is intact.

Causal Factors:

The water management basins range in size from 20,894 ha to 640,472 ha, and the percent riparian reserve zone range between 2.5% and 5.85%. The disturbance within the riparian reserve zones varies considerable by water management basin and by sector, and reflects historic development patterns.[5] In general, WMBs in the northern and northwestern portion of the District have low levels of riparian zone disturbance.

WMBs in the central and west central portion of the District have higher levels of disturbance because of a combination of land uses, including oil and gas, forestry, mining and wind power generation.

Overall Stewardship Trend:

Results provided are current to May 2017. The OGC will continue to review riparian reserve zone status over time.

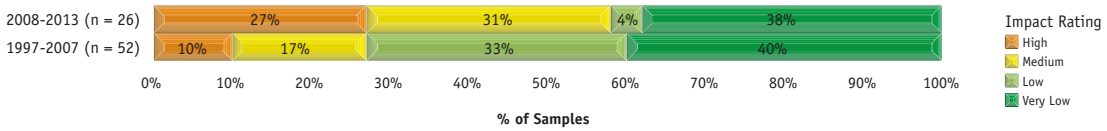
Opportunities for Improvement and Continuation of Successful Management Practices:

- Where WMB are in the "Enhanced Management" status the oil and gas industry is generally expected to avoid riparian reserve zones and, when building new facilities (wells pad, roads, pipelines, ancillary facilities), they are to maximize the use of existing disturbed areas and to minimize the footprint of new areas. When conducting geophysical (seismic) work they are to minimize new disturbance through the use of low and minimal impact seismic techniques.[6] Specific details about desired outcomes and what industry is expected to consider during their oil and gas activity planning phase are available from the OGC.[7]
- In the Pouce Coupe WMB, where the "regulatory/policy" limit has been exceeded the current process is to:
  1. escalate the review process within the commission and to require a mitigation strategy from a qualified professional,
  2. undertake a field investigation to verify the escalated status, and determine appropriate next steps[8], and
  3. other industrial development should be encouraged to adopt similar management practices to improve the consistency in management of the riparian resource.

1.4 Water Quality (Sediment) Value

Water quality refers to a number of key factors, including chemical, physical, biological, and radiological characteristics of water. The most common standards used to assess water quality relate to the health of ecosystems, safety of human contact, and drinking water.

Water Quality (fine sediment/turbidity): Resource Development Impacts on Water Quality



Data Source: Data for water quality assessments was collected by FLNRO staff using the Forest and Range Evaluation Program water quality monitoring protocol between 2009 and 2016. The sampling sites used for water quality (potential for fine sediment generation) were roads and/or mass wasting (landslides) connected to fish habitat and/or drinking water sources that originate at randomly selected recently harvested forestry cutblocks.

Summary:

In the four-year period of water quality sampling from 2013-2016, encompassing 84 assessments, 40 of those sites were found to have moderate, high or very high potential for fine sediment generation into streams (high and medium impact rating).

Causal Factors for 2013 to 2016 Sample Years

See opportunities for improvement for medium and high impacted road segments. Some opportunities will apply to ongoing maintenance issues, while others apply mainly to new road construction.

Overall Stewardship Trend:

There is a statistical difference (p=0.03) between sampling eras, with more recent years showing an increase in high and medium impact ratings. Trending for water quality is based on survey years, to capture impact of road traffic and maintenance.

Opportunities for improvement and/or continuation of practices that help minimize sediment:

The most common recommendations for improvement for "medium" or "high" impact road segments were:

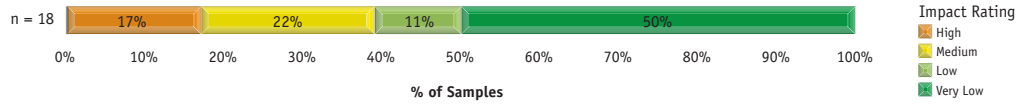
- Avoid long gradients approaching streams when considering road alignments,
- Armour, seed and protect bare soil during construction of road and harvesting of cutblocks (or other similar land disturbances) as well as use good quality road materials, and
- Increase number of strategically located culverts during road design to avoid excess drainage water concentration.

2.0 MONITORING AND ASSESSMENTS RESULTS: SOCIAL AND ECONOMIC

2.1 Visual Quality Value

The Province is entrusted to manage the scenic values of B.C. The primary tool used is under the *Forest and Range Practices Act*, which focuses on forestry activities. Visual Quality Objectives (VQO's) are defined in legislation to provide qualitative descriptions of expected visual conditions. Scenic areas with established VQO's are required to be managed in a manner that timber harvesting does not compromise the designated objective. Visual quality research suggests that scale of alteration for clearcutting and remaining tree density (volume/stems per hectare) for partial cutting are indicators of achieved visual condition.

Visual Quality: Resource Development Impacts on Achievement of Visual Quality Objectives (VQO)



Data Source: Data for visual quality assessments was collected by FLNRO field staff from 2010-2013 using the Forest and Range Evaluation Program visual quality monitoring protocol. The sampling population for visual quality is landforms with visual quality objectives, randomly selected based on recently harvest cutblocks.

Summary:

Visual quality assessments were conducted in the Peace Natural District in 2010, 2013 and 2016. Of the 18 samples, VQOs were well met ("very low" impact) on 50% of landforms, met ("low" impact) on 11%, borderline ("medium" impact) on 22%, not met or clearly not met ("high" impact) on 17%.

Number of Samples by VQO and Impact Rating:

VQO[1]	High	Medium	Low	Very Low	Total
MM				1	**1**
M	1	3	2	5	**11**
PR	2			2	**4**
R		1		1	**2**
Total	**3**	**4**	**2**	**9**	**18**

* MM = maximum modification, M = modification, PR = partial retention, R = retention

Causal Factors:

For the seven landforms where VQOs were not achieved or were borderline:

- Two had neutral design and five had no or poor design
- All but one had poor retention within openings
- Most had high (5% to 29%) alteration of the landform relative to their established VQOs, with one borderline sample with an established VQO of R having 0.5% alteration

Nine landforms had VQOs that were fully achieved. For these blocks with well met VQO's,

- Five had good design, one had neutral design and three had no or poor design
- Seven had poor in-block tree retention and two had moderate in-block tree retention
- All had % alteration lower than the maximum for their VQO

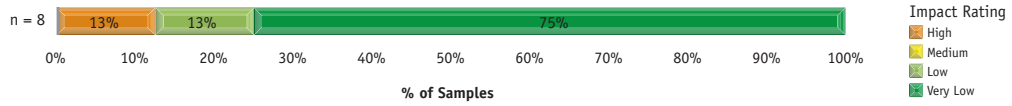
Opportunities for Improvement Based on Viewscapes that Meet Visual Quality Objectives:

When in scenic areas:

- Use visual landscape design techniques to create more natural-looking openings and better achieve VQO's
- Improve in-block tree retention
- Use partial cutting to retain higher levels of volume/stems and/or reduce opening size to meet percent alteration levels for VQO
- Support other resource activities to follow the same landscape design techniques recommended by the VQO

2.2 Cultural Heritage Value

Cultural Heritage: Resource Development Impacts on Cultural Heritage Resources



Data Source: Cultural heritage is protected through several statutes, including the *Heritage Conservation Act*, the *B.C. Archaeology Regulations*, and are intrinsically connected to Indigenous peoples' cultural, ceremonial and traditional activities. This assessment in this report uses only the information gathered under the *Forest and Range Practices Act*, and is therefore limited to forestry-related disturbances. Cultural heritage assessment data was collected by FLNRORD field staff, often with the assistance of local First Nations. Sampling sites consist of a minimum of 50% randomly selected sites and up to 50% targeted sites based on First Nations and/or licensee requests. Sites were selected from recently harvested cutblocks with known cultural heritage resource values. Data presented was collected in 2016 from cutblocks harvested from 2013 to 2015.

Summary:

There are currently only eight cultural heritage samples in the Peace Natural Resource District. Six were rated "very low" impact on the various areas of potential and lithic scatter, one "low" and one "high". At the feature level, 10 showed no evidence of harvest damage, while four had harvest damage (excavation of site, exposed soils, machine disturbance and windthrow). Only one site had irreversible damage, making the site unsuitable for continued use. Two of the blocks had no management strategy in their site plan.

Causal Factors:

Sites selected were forestry cutblocks, therefore causal factors are from machinery and in some cases, wind. The best outcomes for cultural heritage were associated with exclusion of cultural features from harvest areas either through modifying block boundaries, shifting road locations and/or locating windfirm wildlife tree patches around features. Establishing machine-free zones and harvesting during winter helped to prevent ground and soil disturbance of sites. Poorer outcomes were associated with a lack of buffers and/or non-windfirm buffers, harvesting and road building or slash burning over sites.

Opportunities for Improvement and/or Continuation of Practices that Effectively Manage CHR:

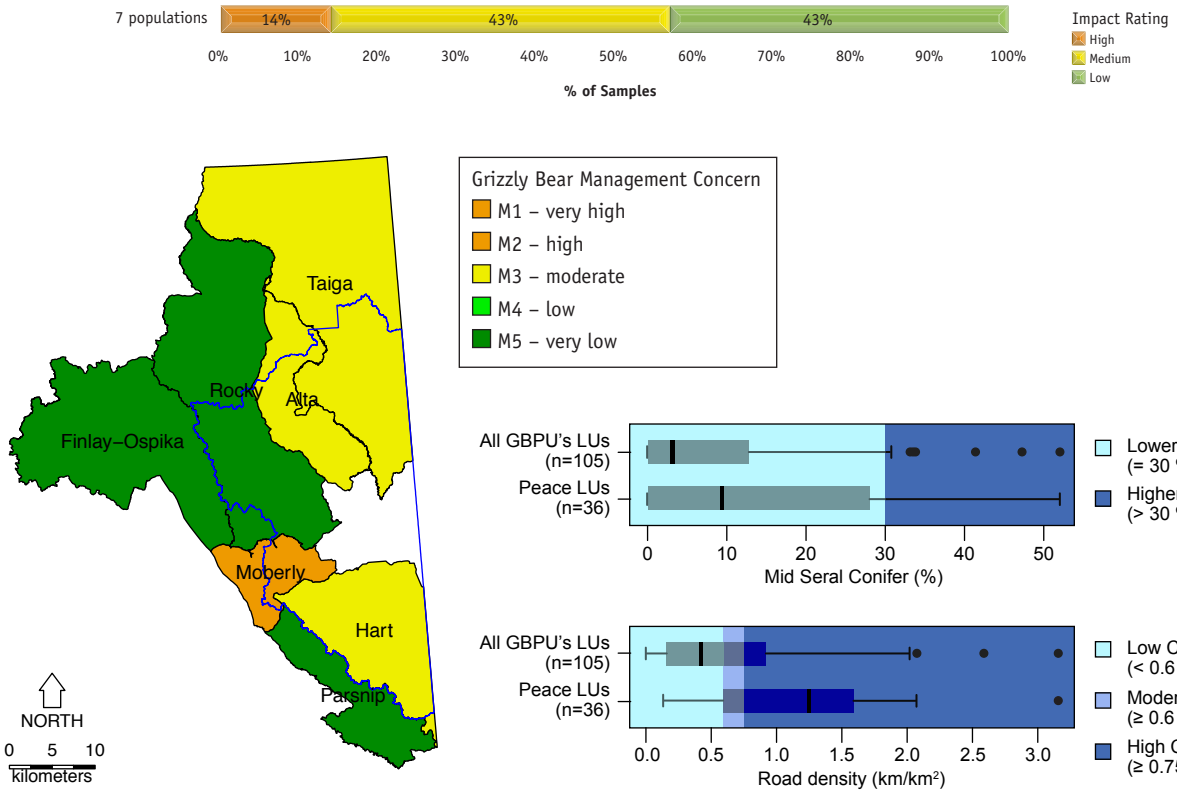
- Continue careful consideration of CHR values in the planning phase.
- Engage in licensee and First Nation discussions to:
  - o Enhance understanding of perspectives; and
  - o Ensure existing CHR information is shared and increase effective identification of on-site.
- Put CHR features on site plans and logging plans, and ribbon features to ensure avoidance.
- Communicate management actions (verbally and with maps) to operators before harvesting begins.

3.0 MONITORING AND ASSESSMENTS RESULTS: WILDLIFE

3.1 Grizzly Bear Value

Approximately 15,000, or 25% of the North American population of grizzly bears live in British Columbia. Grizzly bears are an iconic international symbol of British Columbia's wild areas.

Wildlife: Grizzly bear



Data Source:

Conditions in Grizzly Bear Population Units (GBPU) that intersect or neighbour the Peace Natural Resource District are summarized using two sources of information. First; the Province's NatureServe GBPU ranking provides an overall assessment of the management concern for the GBPUs.[9] Results are shown in the map above. Second; grizzly bear habitat condition is assessed as a part of the Cumulative Effects Value Foundation.[10] The box plots summarize road density and mid-seral forest condition indicators.[11]

Introduction and Rationale:

Condition is assessed at two spatial scales; GBPUs and Landscape Units (LUs).[12] GBPUs are used for management planning, but rarely reflect unique biological populations; although groups of GBPUs may, in some cases, form larger meta-populations.[13] Assessments characterize concern about grizzly bear populations within GBPUs. GBPUs are too large to reflect spatial heterogeneity relevant to individual bears so LUs are used as a finer scale; usually the size of one to several female grizzly bear home ranges. Habitat and mortality indicators of concern are calculated for each LU. The combination of GBPU and LU assessments provide appropriate detail for decision making.

In December 2017, the Province announced a provincial ban on grizzly bear hunting (other than hunting by First Nations for food, social and ceremonial purposes) to conserve grizzly bear populations that are threatened by habitat loss and fragmentation as well as by direct human-caused bear mortality.

Road density is an important indicator of concern about grizzly bear populations partly because road density is a proxy for the cumulative impact of resource development on the landscape but, more importantly, because grizzly bears near roads die from illegal hunting, human-bear conflict and vehicle collisions.[14] As road density increases, concern about grizzly bear mortality increases,[16] although nearby areas of high quality secure habitat can reduce the impact of high road density.[17] Determining thresholds of concern about road density is challenging because of the variety of factors about both bear and human behaviour involved. Several studies have recommended thresholds of 0.6 km/km^2, and planning processes in B.C., Alberta and the U.S. have used these recommendations.[18]

LUs with greater than 30% closed-canopy, conifer-dominated, mid-seral forest (40-100 years old depending on ecosystem)[19] have a higher concern for grizzly bear forage supply. Forage supply is often a function of the amount of open, shrubby vegetation and associated berry patches, that are an important bear food sourc,[20] and mid-seral, conifer-dominated forests can have a dense, closed canopy with little understory, and are therefore sub-optimal for forage production.

Regional expertise suggests that grizzly bears in the Northeast behave differently than bears in other parts of the province, and the Provincial modelling population estimate likely does not adequately describe the Northeast population. Regional staff and local people widely believe that grizzly bear populations in the Northeast are higher than modelling estimates suggest. The difference in behaviour and in particular diet may have considerable impact on ungulate densities as grizzlies preferentially select ungulate calves as fat and protein sources upon emerging from torpor in the Spring, most notably moose and caribou. The following assessment information should be viewed through that perspective, and recognize that the results may not reflect population effects. However, direct population inventory is limited, and landscape level habitat threats remain relevant.

Peace Area Summary and Causal Factors:

Levels of management concern for the GBPUs that include or neighbor Peace Resource District are: Low for the Parsnip, Finlay-Ospika and Rocky, moderate to high for the Alta, Hart and Taiga, and high for the Moberly. There is an area in the east-central portion of the resource district, surrounding Fort St. John where grizzly bears have been extirpated.

Half (53%) of the LUs in the Peace area have road densities higher than the low concern threshold of 0.6 km/km2. On average, in the Peace, there is a high concern about grizzly bear mortality due road density and concern is higher than in the surrounding area.

Landscape-level forage supply is not currently a significant issue for the Peace area grizzly bears. Fifteen percent of the LUs have greater than 30% mid-seral forest.

GBPU Summary

Taiga

The Taiga GBPU is of high moderate concern, ranked at M2M3. Oil and gas activity has created a dense network of roads and this is likely one of the most impacted area in the Peace Region. Industries are active year-round in the area. There are few old growth forests left; most forests are young and coniferous dominated. Habitat is sub-optimal for grizzly bears, but few areas (such as the Milligan Hills Provincial Park next to Alberta's Chinchaga wildland park) have high grizzly bear suitability. No grizzly bears have been harvested (hunting or animal control) in the Taiga GBPU in the past 10 years (at least since 2007) prior to the hunting ban in December 2017.

Alta

The Alta GBPU is ranked at M2M3 and is of high concern. This GPBU has been highly impacted by industrial activity as it is along the Alaska Highway. There is a dense network of roads (mostly from oil and gas), many roads have not been reclaimed/deactivated despite industries stopping their development. Prior to the recent ban, hunting pressure was moderate – this area is very accessible and was popular with resident hunters. Habitat is suitable for grizzly bears as it consists of some foothills, some mature forest, but also a lot of black spruce-dominated stands.

Rocky

The Rocky GBPU is of low management concern ranked at M5. This GBPU overlaps with the Muskwa-Kechika Management Area where industrial development and disturbance is minimal. There are a few points of access, but overall this GBPU has a low human footprint. The habitat has likely high value for grizzly bears – foothills and mountains. Notably, in discussing moose, this area is where moose have seen the starkest declines and the lowest calf recruitment numbers. Wildlife biologists believe low calf recruitment may be reflective of predator, including bear mortality on calves.

Moberly

The Moberly GBPU is of very high management concern with an M1 ranking. Forestry has opened the landscape in the past 20 years. The population estimate is below 100 individuals. However, this estimate is based on a multiple regression modelling exercise and population within this GBPU in particular may be under estimated. ENV, FLNRO in collaboration with Y2Y has been mapping the ecosystems using TEM standards, the results of which suggests that this GBPU contains high-value habitat. With this project, habitat suitability for grizzly bears has been quantified. Old regenerating burns, berry-covered meadows, alpine habitat are present and likely providing excellent habitat for grizzly bears. Forestry and LNG are major threats to grizzlies in the Moberly due to new road developments associated with these industries.

Hart

The Hart is ranked at M2M3 is of high management concern. The agricultural lands on the eastern portion of this GBPU are the most affected by farms, roads and forestry. On the west-side, there still exists a substantial amount of suitable habitat. There exists very high-value habitat for grizzlies in this GBPU as it contains foothills, alpine, old burns, and mature mixed forests. Similarly to the Moberly, there is some habitat loss and fragmentation due to forestry, wind towers and mining.

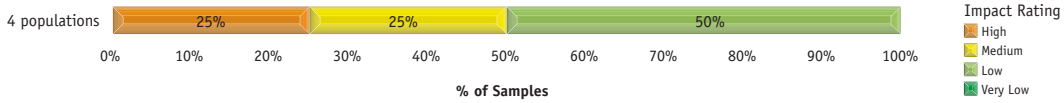
Opportunities for Improvement:

- Deactivate and/or restrict access on roads and corridors that are in high priority grizzly bear habitat (i.e. to connect and enhance habitat and core security).
- Establish grizzly bear wildlife habitat areas in locations where grizzly bear habitat capability is high.
- Adjust forest planning practices in priority grizzly bear habitat to conserve or enhance seasonal foraging habitats (i.e. areas with berry production).
- Conduct research, inventory and monitoring to refine the regional understanding of grizzly bear populations, density, habitat use, diet, and threats (e.g. through the Interim Grizzly Bear Protocol as part of the Provincial Cumulative Effects Framework)

3.2 Moose Value

Moose are highly valued by Treaty 8 First Nations and non-indigenous hunters. Over the last decade, populations have declined significantly in some parts of interior regions of B.C. which are the subject of an ongoing research effort. While the Northeast has not experienced declines as seen in some other areas of the Province, there are localized areas of decline. First Nations and stakeholders are concerned about the continued availability of moose. Moose respond well to human landscapes in many cases, preferring open early seral habitat for foraging, but do require some level of forested landscape for thermal and security cover.

Moose: Population Status and Harvest Review



Data Source: Information is from Poole and DeMars (2015)[21] and 4 recent population survey reports.[22] Moose population density estimates and demographics (calf:cow ratios) relied on aerial survey data. Hunter harvest data was summarized from information in questionnaires completed by hunters.

Summary: The Peace Resource District overlaps all of the North Peace and South Peace Game Management Zones (GMZ = moose population management units) and substantial portions of the Northeast Rockies and Fort Nelson GMZs.

Moose population densities are estimated to be highest in the South and North Peace GMZs (~0.3-0.61 and ~0.85-1.3/km^2, respectively) and lower in the Northeast Rockies GMZ (~0.25-0.35/km^2) and the Ft. Nelson GMZ (~0.05-.25/km^2).

The calf:cow ratio required to maintain a stable population in the absence of hunting has been estimated at about 25 calves:100 cows,[23] but may be considerably higher in harvested populations.[24,25] Poole and DeMars (2015) found that calf ratios were high in the North and South Peace and Ft. Nelson (~30–50 calves:100 cows).

Recent (2016) surveys found similar ratios in the North and South GMZs (MUs 7-34 and 7-20). In the Ft. Nelson GMZ (MU 7-49) a ratio of ~23:100 was found. In the Northeast Rockies very low calf ratios were reported in a 2015 (~12 calves:100 cows; MU 7-42) and 2017 (~13 calves:100 cows MUs 7-57 and 7-58). Low calf recruitment is indicative of a particular challenge likely unrelated to habitat alteration, and may reflect increased predation by black and grizzly bears in particular, which may select calves as prey in the post-natal period when bears emerge from dens.

Hatter (1998)[26] suggested that a resident hunter should be able to harvest a moose with 25 to 35 days of effort. For the last year on record (2013) the average days per kill exceeded the upper target of 35 days in all 4 GMZs. In general, hunter success has declined throughout the area since the mid-2000s.

It is likely that moose populations have decreased since intensive predator control efforts throughout the 20th century were halted. However, densities remain high at a minimum of nearly 0.4 per km^2, which estimates (Pederson 1955) suggest is reflective of historic densities before predator control and most densities are considerably higher.

Stewardship Trend and Causal Factors:

Population trends for this region are difficult to specify because of limited and variable survey data prior to 2010.

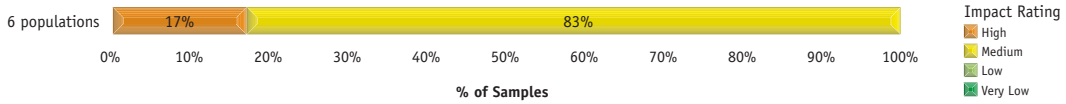
Poole and DeMars (2015) conclude that populations may be stable to increasing in the Ft. Nelson and North Peace GMZs. In contrast, a 2016 survey of one WMU (7-34) in the North Peace GMZ showed a decline in population since 1997. However a 2015/16 survey suggests this decline reversed. In general, a decline or increase of up to 20% would trigger additional monitoring but is within natural variability limits. In the Northeast Rockies GMZ, Poole and DeMars (2015) report on surveys from only one WMU (7-42) where there has been a significant decrease in the population over time. Recent surveys in that GMZ (WMU 7-42, 7-57 and 7-58) had calf:cow ratios that suggest concerns about population sustainability. In the South Peace GMZ, Poole and DeMars (2015) did not have enough information to draw a conclusion however given the limited industrial development in these Management Units there are likely to be other causative factors than habitat alteration. A 2017 survey showed an increase in the population in the South Peace GMZ (WMU 7-20 increase of 53% since 1998).

Several factors that could be contributing to the declining trends in some moose populations and poor hunter success should be further examined:

- Changes (increases) in predator abundance. Landscape change and access may result in changes to distribution of moose that are not indicative of overall decline.
- Reduction in prescribed burning for moose habitat enhancement.
- Influence of winter ticks on moose survival.
- Silvicultural practices that support forest regeneration rather than moose forage productivity.

3.3 Mountain Caribou Value

Central Mountain Caribou: Population Status



Data Source: The population status and trend of the Central Mountain Caribou in the Peace Resource District was summarized as of 2015.[27] Populations were estimated using a variety of methods; aerial survey, mark-resight, modelling and a photo census. Calf recruitment and adult mortality data has been obtained from aerial surveys of herds with collared animals since 2003 (2006 for calf recruitment of 2 herds). Another summary of population status, including response to recovery management actions conducted in 2016, was prepared.[28]

Summary: Five caribou herds in the Peace Resource District, south of the Peace River are part of the Central Mountain Caribou Designatable Unit:[29] Moberly, Burnt Pine, Quintette, Bearhole-Redwillow and South Narraway[30] Most caribou that inhabit the eastern side of the Rocky Mountains (Moberly, Burnt Pine, and Quintette) remain in mountainous habitat for the winter. These caribou primarily forage on windswept alpine ridges for terrestrial lichens, but also make use of arboreal lichens in old growth parkland and subalpine forests. The Bearhole-Redwillow and South Narraway herds winter in low-elevation boreal forests where they crater for terrestrial lichens and forage on arboreal lichens in forests dominated by black spruce, pine and tamarack tree species.

Minimum population counts for all herds show significant declines over the past 10 years – and the Burnt Pine herd has likely been extirpated. The average calf recruitment in all herds, over the last 10 years, been below the generally accepted level required to ensure a stable or increasing population (15-16%)[31] with particularly low recruitment levels in the Bearhole-Redwillow and South Narraway herds.

Causal Factors: The recent declines in caribou have corresponded to a period of extensive industrial activities including forest harvesting, road building, mining, and gas exploration and other development within caribou ranges. It is widely accepted that those habitat changes have altered the predator-prey balance leading to unnaturally high levels of wolf predation and caribou mortality.[32]

Overall Stewardship Trend:

The Federal *Species at Risk Act* lists these caribou as threatened;[33] however, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has recommended they be listed as endangered.[34] The B.C. Conservation Data Centre has recently revised the rank of these caribou to S1S2 (critically imperiled to imperiled).[35]

Opportunities for Improvement and Continuation Successful of Management Practices:

As noted above the immediate (proximate) cause of decline in these herds is excessive predation, primarily by wolves, but the underlying cause is industrial landscape change which has facilitated expansion of moose populations into caribou range and also allows wolves to be more effective at killing caribou. Over the next decades, efforts to protect and restore habitat will be necessary to re-establish caribou herds. It is critically important that those efforts apply to all industrial users of the land and that they apply both to the core caribou habitat and the "matrix" habitat where moose populations are supporting high wolf populations.

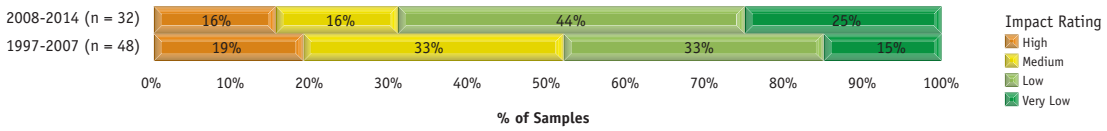
In the meantime the habitat remains unsuitable for the survival of caribou. If caribou populations are to be maintained in the South Peace, direct control of predation will be required. The Moberly herd is the subject of an ongoing maternal penning project to capture pregnant caribou in a pen throughout the calving period to protect the calves from predators.[36] A wolf control program has been ongoing since January 2015 in the area of the Moberly and Quintette herds.[37] These management actions appear to have improvedcalf and adult survival resulting in increases in the populations of the herds involved. The combined effect of maternal penning and wolf removal has been successful in the short term, however long term success relies on protection and restoration of key habitat, which ultimately should reduce moose overlap with caribou habitat.

4.0 MONITORING AND ASSESSMENTS RESULTS: FOREST, BIODIVERSITY AND AIR QUALITY

4.1 Stand-level Biodiversity Value

The goal of stand-level biodiversity (SLBD) monitoring is to determine whether the retaining wildlife tree patches and riparian reserves is achieving the desired levels and types of structures to maintain species diversity. Stand-level biodiversity assesses the quality (size, species, condition) and quantity (amount) of tree and woody debris retention left after forest harvesting.

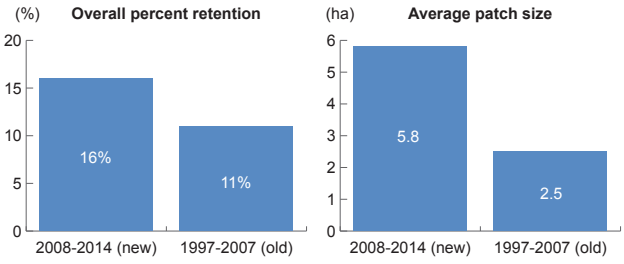
Stand-level Biodiversity: Resource Development Impacts on Stand-level Biodiversity



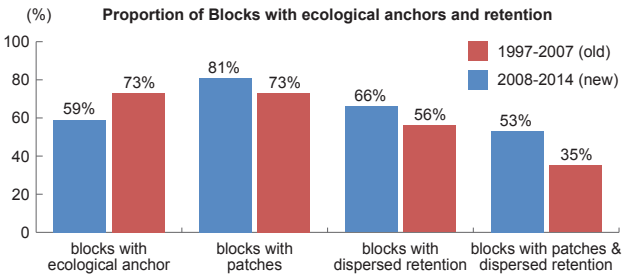
Data Source: The data for the SLBD assessments was collected by FLNRO staff using the FREP SLBD Protocol. The sample population for SLBD assessment consists of randomly selected cut blocks. The data was collected from 2006 to 2016 from blocks harvested from 1997 to 2014. Two eras of harvesting were analyzed—1997 to 2007 (old era, 48 blocks) and 2008 to 2014 (new era, 32 blocks).

Summary and Causal Factors:

Patch assessment: The assessment of the patches (results shown above) considered retention levels, average patch size and the presence of ecological anchors in the patch and the presence of dispersed retention. Cutblocks with retention levels of less than 3.5% were rated as high impact. As harvesting moved from 1997-2007 to 2008-2014 the median size of blocks with less than 3.5% retention dropped from 28 to 11.2 ha. Both the reduction in non-compliance and the size of these blocks is seen as evidence of improved practice.



Ecological anchors, patch and dispersed retention: The graphic below shows the proportion of cut blocks harvested with ecological anchors, patches retention, dispersed retention and both patch and dispersed retention.



The proportion of blocks with patches, retention or both increased between 2008 and 2014 compared to those harvested between 1997 and 2007. This is evidence of improving retention practices. The proportion of blocks with ecological anchors declined in the newer harvesting eras. It is unknown whether this reduction was due to fewer anchors being present pre-harvest on more recently harvested blocks or less attention being paid to retention of ecological anchors during harvest planning.

The characteristics of the trees retained within harvest cutblocks were:

- the number of large live stems per hectare on a cut block;
- the number of large snags per hectare on a cut block; and
- the number of mature species retained on a cut block.

These criteria were compared to a benchmark consisting of cruise data from a large sample of cut blocks harvested between 2005 and 2009 within the same Biogeoclimatic (BEC) subzones as the blocks accessed in this report. Unfortunately, at the time of writing, cruise data describing the pre-harvest stand condition of the 80 individual blocks assessed were not available. The definition of large trees (live or dead) varied by subzone ranging from 40 to 50 cm DBH. The analysis compared the distributions of large live trees, snags and number of species to the distribution of those attributes for the benchmark.

The results of this analysis are shown in the table below.

	2008-2014	1997-2007
Number of large live trees/ha	Not statistically[36] different from pre-harvest benchmark	Statistically less than the pre-harvest benchmark
Number of large snags/ha	Not statistically different from pre-harvest benchmark	Statistically less than the pre-harvest benchmark
Number of mature species	Statistically less than the pre-harvest benchmark (median = 75% of benchmark)	Statistically less than the pre-harvest benchmark (median = 75% of benchmark)

Two characteristics of the CWD left in the harvested portion of each block (the NAR) were assessed in the analysis:

- volume/ha of large pieces per hectare based on diameter (> 20 cm) alone; and
- volume/ha of large pieces per hectare based on diameter and length (> 20 cm, > 10 m).

In this part of the analysis the CWD measured in the patch was used as the (natural condition) benchmark. The results of this analysis are presented in the table below.

	2008-2014	1997-2007
Number of large CWD pieces per hectare—diameter alone	NAR not statistically different from the patch	NAR not statistically different from the patch
Number of large CWD pieces per hectare—diameter and length	NAR statistically less than the patch (median = zero pieces)	NAR statistically less than the patch (median = zero pieces)

Stewardship Trend: The stewardship trends for the two harvesting eras are shown below.

	% retention	Average patch size(ha)	% Blocks with ecological Anchors	% Blocks with patches	% Blocks with dispersed retention	% Blocks with both dispersed and patch retention	Number of large live trees/ha	% Blocks with patches > 2ha
2008-2014	↑	↑	↓	↑	↑	↑	↑	↑
1997-2007								

↓ = declining
↑ = improving
↔ = no change

	Large Live Trees (#/ha)	Large Snags (#/ha)	# Tree Species	Large diameter CWD	Large diameter and long CWD
2008-2014	↑	↑	↔	↑	↔
1997-2007	↔	↔	↔	↑	↔

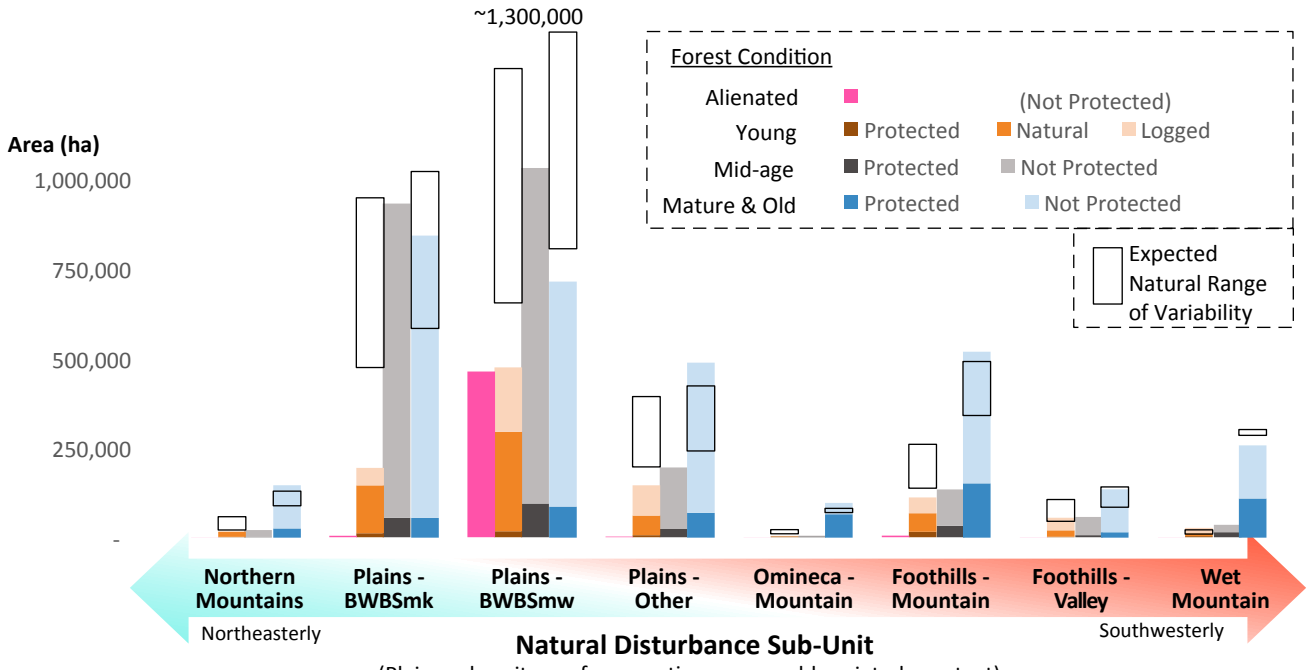
Opportunities for Improvement and Continuation Successful of Management Practices:

- increase patch retention;
- increase patch size;
- include ecological anchors within patches when available;
- in addition to leaving patches, leave dispersed retention throughout the NAR;
- the species composition of the retention should be representative of the NAR unless the retention patch is located in a draw and the NAR is primarily mid-slope;
- the size of the trees retained in the patch should either be representative of those in the NAR or greater; and
- retain some longer (greater than five and 10 metres) pieces of CWD in the NAR.

4.2 Landscape-level Biodiversity Value

In British Columbia, it is assumed that biodiversity can be more likely maintained if management seeks to create or maintain a seral stage distribution similar to that of the natural landscape prior to harvesting. Therefore, the degree of departure between the observed and the expected seral stage distribution is an indicator of risk to landscape-level biodiversity. The amount of young natural forest and the amount of protected older forest are used as indicators of condition since these elements are known to be in short supply in some areas of the province. The distinction between mature forest and old forest is not made because the ages reported in forest cover maps are often not precise enough to do so.[38]

Forest: Landscape-level Biodiversity-Forest Seral Stage Indicator



(Plains sub-units are for reporting; names abbreviated: see text)
(Alienated forest land is primarily converted to agricultural uses but includes urban, mines, etc.)

Data Source: Specification of the extent of the natural disturbance sub-units, the ages of forest seral stages and the expected natural range of variability (NRV) were provided in Delong (2011).[39] Amounts of forest by condition class (seral stage, alienated lands e.g. urban, agricultural fields, mines, etc.) and logging are derived from the VRI, RESULTS, fire perimeter mapping (all updated to June 2017) and BTM (for those areas with no VRI). All alienated land is assumed to have been previously forested, although minor amounts may not have been, and was included in the total forest area used to calculate the expected amounts of seral stages based on the NRV. Protected areas are all provincial and federal parks, OGMAs, and WHAs and UWRs where forest harvesting is largely prohibited. In the graphic, "Plains" refers to Boreal Plains and "Northern Mountains" refers to Northern Boreal Mountains. The Boreal Plains reporting units are not defined in Delong (2011) but are shown here in an attempt to demonstrate the variability within the unit. The Boreal Plains – Other sub-unit consists mainly of the BWBSwk1, BWBSwk2 and ESSFmv2 (94% of the unit). The eight reporting units shown represent 99.5% of the forest in the Peace Resource District. Small amounts of the Omineca – Valley (19,000 ha) and the Wet Trench – Mountain (10,000 ha) NDUs are present but are not shown. Numerical results are provided in Appendix F.

Introduction and Rationale:

In Northeastern British Columbia it has been assumed "the biota of a forest (its biodiversity) is adapted to the conditions created by natural disturbances and thus should cope more easily with the ecological changes associated with forest management activities if the pattern and structure created resemble those of natural disturbance."[40] Therefore, the results shown indicate the degree of departure between the observed seral stage distribution and the expected amounts of historically forested area, given the natural range of variability resulting from the disturbance regime. This constitutes the indicator of risk to landscape level biodiversity.

We portray the amount of young natural forest and the amount of protected forest as indicators of condition since these elements are likely to be in short supply in managed landscape.[41] We do not distinguish between mature forest and old forest because the ages reported in the forest cover maps are often not precise enough to do so.[42]

Stewardship Trends and Causal Factors:

Over the entire forest the amount of young seral stage is much lower than the minimum of NRV (66%). In the mountain sub-units and the higher elevation "Boreal Plains – Other" unit the amount of mature and old forest is higher than the maximum expected range, with the exception of the Wet Mountains. This situation has been attributed to "effective fire control over the past 40–50 years that has slowed the natural disturbance rate. This has had the compound effect of increasing the amount of old forest in more remote areas where harvesting has not occurred and reducing young forest established by fire."[43] Further evidence of this is the large amount of 'mid-aged' forest in the Boreal Plains BWBS mk and mw units. However, the relatively high amounts of young forest of natural origin resulting from recent fires (ranging from 33% in the Boreal Foothills – Valley to nearly 100% in the Northern Boreal Mountains) indicate that the recent fire history may be more like the historical one. In the Wet Mountains NDU there is more young forest as well as less mature and old forest than would be expected. More than half the young forest is the result of recent forest harvesting (15,000 ha) and, because of the very long disturbance return interval (i.e., 900 years) very little early seral forest is expected to occur naturally (3-7%).

In the BWBSmw variant of the Boreal Plains there is substantially less young forest and mature & old forest than the minimum NRV, in large part because 20% (460,000 ha) of the variant's forest has been converted to agricultural uses, so this area does not contribute to the seral stage distribution. Note that the agricultural areas can provide limited habitat for some 'pioneer' (early seral) species and also that logged areas do not provide the same habitat as young seral forest created by natural disturbances. Note also that, while forest harvesting results in a temporary loss of older forest, conversion to agriculture is intended to be a permanent loss. Therefore maintaining a portion of the mid-age forest is more critical in the BWBSmw.

Provincial parks, OGMAs and UWRs and WHAs are largely in place for Boreal and Northern Caribou. Very little young forest is protected overall (6%) although the Omineca Mountains have 54% of the young forest protected (see Appendix F).

Caveats and Opportunities for Improvement and Continuation Successful of Management Practices:

Care must be taken when interpreting these results in the area for two principal reasons: First, over 75% of the forest in the area occurs in the three Boreal Plains reporting units. The results provided show the overall condition of those sub-units but, because of their size, some substantial variability in condition is to be expected. Second, forestry, agriculture and oil and gas activities have had some extensive effects on the seral stage distribution but these results do not reflect all effects; including forest fragmentation and changes in access as a result of road building and some seismic activity.

Delong (2011) provides some detailed recommended practices for forestry in the different natural disturbance units. Consistent advice throughout the document is that "some proportion of natural disturbances should be left unsalvaged to provide habitat (e.g., burned snags) that cannot be provided by young managed stands."[44]

General opportunities for improvement:

This assessment will be refined in collaboration with Provincial Cumulative Effects Assessment Program, primarily including refinements to the seral stage mapping and methods of incorporating the effects of fire and MPB infestations.

Particularly in the Boreal Foothills sub-units, there have been substantial impacts on the forest caused by the recent MPB infestation that are not accounted for in the reported seral stage distributions (10-20% of the forest may have been affected).

The amount of mature and old forest protected over the entire area (18%) is much lower than the provincial average (27%), however, protection is higher in the Omineca – Mountain (67% because of Graham - Laurier Park) and Wet Mountain (42%) sub-units. Over the entire area, protection is about equally divided among the three seral stages.

General uses of this information are to:

- Allow site/stand-level results to be seen in a landscape context (e.g., does a decision maker/licensee want to consider more site level retention in those areas where mature forest occurs – in amounts that are substantially lower than expected under a natural disturbance regime?).
- Identify areas where observed levels of mature forest are substantially above or below naturally expected levels and use this information to help decide on new locations or relocations of set aside areas (e.g., old growth management areas, wildlife habitat areas, etc.) or identify areas where harvesting might be temporarily deferred until the seral stage distribution begins to resemble the natural distribution.

More detailed information about landscape-level forest condition is available from the FREP program. In particular, information is available that summarizes the results by landscape units and about estimates of the amount of old forest.

4.3 Forest Health

The goal of overview forest health monitoring is to provide historical information on the patterns of disturbance across the Provincial forested land base and to identify areas that may require more detailed detection or monitoring.

Forest Health

Data Source: Aerial overview survey data is collected annually by qualified contractors and FLNRO staff in fixed-wing aircraft. Biotic and abiotic forest health factors are monitored through aerial sketch mapping which is designed to cover as much area as possible, while retaining the ability to map forest health incidence and severity. Mortality severity ratings for disturbances that typically result in tree mortality are recorded for bark beetles, root diseases, stem diseases, yellow cedar decline, and abiotic and animal damage. Separate defoliator ratings are used for defoliating insects and foliar diseases that do not typically result in tree mortality. Although aerial overview survey data is available back to 1999, data from 2010 – 2016 is summarized to illustrate recent forest health trends and current issues that require management consideration.

For defoliator population and damage prediction within TSAs, detailed surveys can be conducted during outbreaks including egg mass surveying to help guide management planning. For bark beetle population prediction within TSAs, two types of detailed surveys can be conducted in areas of infestation in order to determine site-level beetle population trends. The trend of an infestation in a specific stand is most commonly measured through ground surveys. Ground based monitoring is only conducted in areas where active bark beetle management is being planned. In all other areas, population monitoring is conducted using aerial overview surveys.

Summary: Bark beetle mortality associated with mountain pine beetle (*Dendroctonus ponderosae*) had the greatest cumulative impact in the Dawson Creek and Fort St. John TSAs between 2010 and 2017. Mountain pine beetle activity has been declining and populations stabilizing. Management considerations are focused on recovering dead timber before it decays or is lost to wildfire. Western balsam bark beetle (*Dryocoetes confusus*) activity is at endemic levels where damage is typically chronic rather than eruptive; hence management considerations are limited and dead timber should be recovered before it decays or is lost to wildfire. Spruce beetle attack (*Dendroctonus rufipennis*) increased throughout BC in 2016; however, the Dawson Creek and Fort St. John TSAs saw a decline for the third year in a row. Spruce beetle activity appears to be at endemic levels. In the case populations do build the following management considerations are recommended:

- co-ordination of effective planning among licensees and government;
- strategic harvesting and application of trap tree programs; and
- recovery of the maximum value from dead spruce timber before it decays or is lost to wildfire.

Table 2. Annual summary of the leading forest health factors in the Fort St. John Timber Supply Area between 2010 and 2016.

Forest Health Factor	Hectares Impacted							
	2010	2011	2012	2013	2014	2015	2016	Total Area (ha)
DLV		7,500	61,271	111,335	54,857	311	2	235,276
IB				86				86
IBB	1,162	1,606	2,122	7,222	59,835	41,477	1,588	115,013
IBM	615,427	1,025,658	627,561	1,971,582	803,307	131,048	2,282	5,176,865
IBS			17		14,228	3,154	1,930	19,329
ID2	498,674	5,412						504,086
ID6	80	1,951	26,049	3,065	19,724			50,869
IDF		312		15,545				15,857
IDN							320	320

Forest Health Factor	Hectares Impacted							
	2010	2011	2012	2013	2014	2015	2016	Total Area (ha)
IDX		127			47,349			47,475
NB	1,722	402	8,639	1,008	15,459	15,469	85,752	128,451
NCA				650				650
ND					13,550	8,161		21,711
NF	110	403	247	977	1,179	1,261	572	4,748
NS	14	28					195	237
NW	271	1,535	413	132	37	54	632	3,074
NY	1	15	15				27	57
Total Area (ha)	1,117,460	1,044,949	726,334	2,111,602	1,029,526	200,935	93,299	6,324,106

Table 3. Annual summary of the leading forest health factors in the Dawson Creek Timber Supply Area between 2010 and 2016.

Forest Health Factor	Hectares Impacted							
	2010	2011	2012	2013	2014	2015	2016	Total Area (ha)
DLV		46,552	36,944	299,573	18,936	249	532	402,786
IB				525				525
IBB	207,457	3,193	18,376	26,453	115,011	127,235	198,459	696,184
IBM	1,259,490	755,854	417,662	393,397	67,835	18,199	18,767	2,931,203
IBS			4,848	142	35,810	9,440	4,048	54,289
ID	0							0
ID2	612,720	3,157				22,452	241	638,570
ID6	5,058	10,774	12,715	68,590	4,042	18,415	496	120,090
IDF	903	3,697	3,363	87,948				95,912
IDN							342	342
IDX					20,942			20,942
NB	664	211	197	1,139	62,110	83	4,129	68,533
NCA				2,008		47		2,055
ND			131	364	1,752	2,665		4,912
NF	47	146	8	838	5,525	28	1,362	7,953
NS			78					78
NW		64	217	130			329	740
NY		887	11				224	1,121
Total Area (ha)	2,086,339	824,535	494,551	881,109	331,963	198,811	228,929	5,046,237

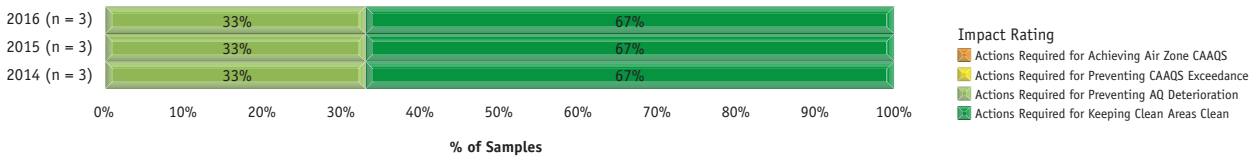
General uses of this information are to:

- Provide general information on the patterns of forest health disturbance which informs management decision and District Forest Health Management Plans
- Summarize the major forest health factors impacting TSAs.
- Outline general management practices that can be utilized to mitigate forest health impacts on timber supply and resource values.

More detailed provincial forest health information is available in the Ministry's Annual Aerial Overview reports and from the forest health program managers and regional specialists.

4.4 Air Quality Value

Air Quality



Data Source: Air quality data come from monitoring stations that measure and upload pollutant concentrations to a publicly available website on an hourly basis. Stations are operated and maintained by the Ministry of Environment and Climate Change Strategy (ENV), the B.C. Oil and Gas Commission (OGC) or industrial (permittee) staff.

Most air quality monitoring stations in B.C. are located either in urban areas or at industrial sites where concerns over air quality are greatest, however in the Peace Regional District there are also numerous air quality monitoring stations in rural areas, owing to the oil and gas industry as well as other large resource projects. Some of these stations are permanent and have lengthy monitoring records while others are temporary with fixed time frames.

The locations of monitoring stations are displayed on Appendix G. Table G-1 lists them, along with basic information such as location, monitoring record as well as the pollutants measured. Table G-1 also indicates whether the station is a permanent station or is associated with a specific project/initiative.

Given the level of industrial activity across the Peace, some First Nations communities likely experience significantly different air quality than that measured within larger communities. This is illustrated by some of the monitoring results in the Summary section.

Summary:

a) Most Relevant Pollutants

In the Peace district commonly measured pollutants include: sulphur dioxide (SO_2), total reduced sulphur compounds (TRS), and particulate matter with aerodynamic diameters less than 2.5 and 10 micrometers ($PM_{2.5}$ and PM_{10} respectively). In some locations nitrogen dioxide (NO_2) and ground-level ozone (O_3) are also measured, though these two pollutants are not discussed in this section.

In the Peace district, oil and gas activities are typical sources of SO_2 and TRS (production wells, gas processing and flaring, etc.), along with the pulp and paper industry. SO_2 is a colourless gas with a pungent odour at higher concentrations. It is produced during the combustion of sulphur-containing fuels and the processing of sulphur-containing materials. TRS is a mixture of several compounds which contain a sulphur component in the reduced form. The most common TRS compound is hydrogen sulphide (H_2S), which has a characteristic "rotten egg" smell that can be detected at low levels. Both SO_2 and H_2S are associated with adverse health effects at varying concentrations.[45]

$PM_{2.5}$ refers to a complex mixture of small particles which often form from incomplete combustion and can easily become suspended in air after their emission. Typical sources of $PM_{2.5}$ include: industrial combustion processes, biomass burning and motor vehicles. $PM_{2.5}$ can also be formed in the atmosphere from the chemical reactions of certain gases.[46] $PM_{2.5}$ exposure leads to a number of adverse health effects.[47] Certain sizes of PM are very effective at scattering light and reducing visibility.

PM_{10} is emitted during incomplete combustion in a similar manner as $PM_{2.5}$. PM_{10} is also emitted as fugitive dust from unpaved roads as well as paved surfaces in the springtim.[48] In the Peace RD there are numerous air quality monitoring stations measuring $PM_{2.5}$ and PM_{10} as part of the Site C dam construction project.

b) Standards and Achievement Methodology

As part of the national Air Quality Management System (AQMS), the federal government set standards for SO_2 and $PM_{2.5}$.[49] Effective in 2020, there are two Canadian Ambient Air Quality Standards (CAAQS) for SO_2, one based on the annual average concentration and the other on the 99th percentile of the daily one-hour maximum concentration (i.e., the fourth-highest daily one-hour maximum value over one year). Achievement for both is calculated by averaging results over three years. The thresholds for both of these standards are presented in Table G-2.

Adopted in 2012, there are two CAAQS for $PM_{2.5}$, one based on the annual average concentration and the other on the annual daily 98th percentile concentration (i.e.: the eighth-highest daily mean concentration over one year). Achievement for both is calculated by averaging results over three years. The thresholds for both of these standards are presented in Table G-2.

The AQMS prescribes management activities at levels both above and below the CAAQS. Air quality monitoring results are categorized into one of four groups and management activities are prescribed for each category. CAAQS levels and generalized management actions are presented in Table 7 for SO_2 and $PM_{2.5}$. The CAAQS values themselves are the numerical values in 'threshold' line between the red and orange management levels. More detailed information can be found at the CCME websites for SO_2[50] and $PM_{2.5}$.[51]

The provincial government has set two objectives for TRS, a one-hour objective of five ppb and a 24-hour average objective of two ppb. A good summary of information concerning TRS and H_2S can be found at the Quesnel Air Quality Roundtable website.[52]

c) Recent Data

SO_2, $PM_{2.5}$ and TRS data are summarized below for the past three years (Tables 4, 5 and 6 respectively). For SO_2 and $PM_{2.5}$, where three years of data exist for a particular station, the appropriate CAAQS management colour level has been assigned. As only two years of data exist at most locations, CAAQS achievement (and management-level classification) cannot be determined yet. For TRS, Table 6 presents the number of hours per year the five ppb objective is exceeded at each station. A more detailed summary can be found at the ENV air quality webpage dedicated to the Northeast Air Quality Monitoring Project.[53]

Table 4. 99th percentile of daily one-hour SO2 maxima. CAAQS colouring is provided for stations with three years of data. Note that CAAQS colouring is based on comparing the three-year average to the management levels identified in Table G-2.

	Long-Term					NE AQ Monitoring Network					
Year	Fort St. John	Taylor	Taylor South	Pine River*	Bessborough	Tomslake	Doig River	Farmington	Rolla 213	Taylor Lone Wolf	Blueberry River
2014	N/A	42.7	20.4	101.0	7.0	8.8	2.9	5.4	N/A	N/A	N/A
2015	6.1	47.5	12.9	117.4	4.5	N/A	2.0	4.7	N/A	N/A	N/A
2016	5.2	25.9	10.3	82.6	4.4	N/A	N/A	N/A	4.1	13.4	N/A

* Note: Human health-based CAAQS are not formally applied to fenceline monitoring stations if they are away from populated areas

Table 5. 98th percentile of daily mean $PM_{2.5}$ concentrations. No station satisfies the CAAQS three-year monitoring requirement. CAAQS management levels can be assigned at the end of 2017.

	Long-Term			Site C	
Year	Fort St. John	Dawson Creek***	Tumbler Ridge***	Fort St. John Old Fort	Peace Valley
2014	N/A	N/A	N/A	N/A	N/A
2015	18.3**	18.1	8.3	16.7	16.4
2016	15.4	12.6	10.2	18.9	14.3

** Wildfires removed from dataset

*** Data come from filter-based samples, and are not real time. Data are not uploaded hourly to the MENV website. CAAQS levels are not assigned to these monitoring results.

Table 6. Exceedances of the one-hour TRS 5 ppb objective per year at all monitoring stations.

	Long-Term				NE AQ Monitoring Network					
Year	Taylor	Taylor South	Pine River	Bessborough	Tomslake	Doig River	Farmington	Rolla 213	Taylor Lone Wolf	Blueberry River
2014	309	2	20	0	2	0	0	N/A	N/A	N/A
2015	286	0	6	0	0	0	0	N/A	N/A	N/A
2016	238	3	1	0	N/A	N/A	N/A	0	294	N/A

Causal Factors:

Monitoring data suggest that air quality is affected by industrial activities in communities with large industrial complexes, namely Taylor. Numerous exceedances of the TRS objectives are recorded on an annual basis there. Air quality is also affected at the property boundary of the Pine River Gas plant.

If SO_2 and $PM_{2.5}$ levels in Fort St. John remain at similar levels in 2017 as the two previous years, the community will have green and yellow colour ratings respectively under the AQMS, and management activities consistent with those colour rating should be implemented.

Concerns about potential human health and environmental effects from oil and gas activities in the Peace led to increased collaboration, monitoring and reporting in this Resource District. With the exception of Taylor Lone Wolf, recent SO_2 and TRS levels at stations associated with the northeast air quality monitoring network are very low.

Additional information from the Northeast Air Monitoring Project can be found at its dedicated website.[54] There is an extensive summary of available air quality data from 1998 – 2013,[55] as well as more documentation about the Northeast Air Monitoring Project.

A human health risk assessment led by the Ministry of Health was also conducted; overall findings suggest that the risks of adverse health effects associated with air pollutants from oil and gas activities are low.[56] Additional information can be found online.[57] Numerous recommendations from the health study are also available.[58]

$PM_{2.5}$ concentrations at stations associated with the construction of the Site C dam are similar to Fort St. John.

Stewardship Trends:

At most stations in the Peace RD there is insufficient data to determine trends.

SO_2 levels at long-term monitoring stations decreased over the past three years.

H_2S exceedances in Taylor and at Pine River decreased over the past three years.

APPENDIX A – INFORMATION SOURCE DETAILS

Table A-1. List of data sources, links to contacts, websites reports and data (as available) referenced in this report. Primary contact: Greg Van Dolah, District Manager, Peace Natural resource District, Greg.VanDolah@gov.bc.ca, 250 787-3534.

Data Source	Contact	Website	Data
FREP Riparian	Lisa.J.Nordin@gov.bc.ca	https://www2.gov.bc.ca/gov/content?id=264E8CCD546044B5B3CEA2DA8FD2F0D3 Available from contact	
Fish Passage	Richard.Thompson@gov.bc.ca, Lars.ReeseHansen@gov.bc.ca	https://www2.gov.bc.ca/gov/content?id=8E79C6B1F4A7475CBEA14EA06404A0C7	Provincial Stream Crossing Inventory System Assessments
Oil and Gas Commission Area Base Analysis – Riparian Reserve Zone	Nicole.Curnow@bcogc.ca	https://www.bcogc.ca/	
FREP Water Quality	David.Maloney@gov.bc.ca	https://www2.gov.bc.ca/gov/content?id=1A902ED2C6A04A13880FC2EDE3BC5785	Available from contact
FREP Visual Quality	Peter.Williams@gov.bc.ca	https://www2.gov.bc.ca/gov/content?id=7AAB2A4610FE4D1B83BADB7BC781991F	Available from contact
Grizzly Bear	Audrey.GagneDelorme@gov.bc.ca Don.Morgan@gov.bc.ca Tony.Hamilton@gov.bc.ca		Available from contact
Moose	Kristen.Peck@gov.bc.ca		Available from contact
Caribou	Dale.Seip@gov.bc.ca		Available from contact
FREP Stand-level Biodiversity & Landscape-level Biodiversity	Barry.Snowdon@gov.bc.ca	https://www2.gov.bc.ca/gov/content?id=384567FF80B94B29AC4A1CC7CE5E2707	Available from contact
Cultural Heritage	Peter.Bradford@gov.bc.ca	https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/integrated-resource-monitoring/forest-range-evaluation-program/frep-monitoring-protocols/cultural-heritage	Available from contact
Air Quality	Ben.Weinstein@gov.bc.ca	http://www.bcairquality.ca/	Available from contact

APPENDIX B – SUMMARY DESCRIPTION OF RESOURCE DEVELOPMENT IMPACT RATING CRITERIA

Table B-1 shows the criteria used to determine the resource development impact ratings for each resource value. Detailed rating criteria, methodology, and definition of terms used are described in the companion document *FREP Technical Note #6: Methodologies for Converting FREP Monitoring Results to Multiple Resource Value Assessment (MRVA) Resource Development Impact Ratings* (http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/frep/frep-docs/frep_technical_note_06.pdf). The ratings of "very low," "low," "medium," and "high" are technical ratings based on best available science.

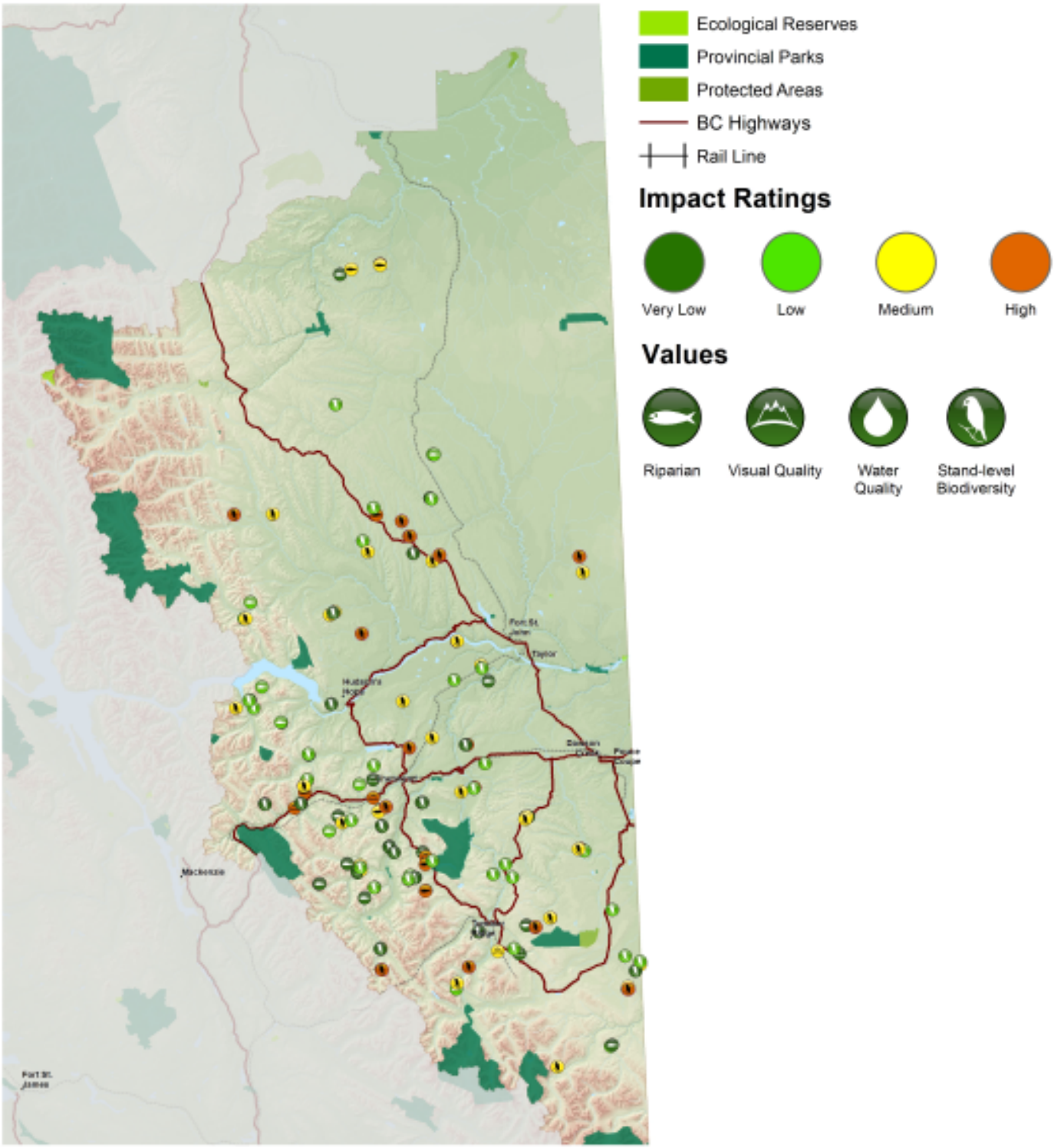
Table B-1. Criteria for determining resource development impact rating outcomes for each resource value.

Resource Value	Evaluation Question	Indicators	Resource Development Impact Rating Criteria	Very low	Low	Medium	High
Riparian	Are riparian forestry and range practices effective in maintaining the proper functioning of riparian areas?	Fifteen key questions (e.g., intact channel banks, fine sediments, riparian vegetation)	Number of "no" answers on assessment questions of channel and riparian conditions	0–2	3–4	5–6	> 6
Fish Passage	Are stream crossings allowing for unobstructed fish movements on streams with medium and high value fish habitat, or confirmed fish use?	Stream width/crossing structure width ratio, structure length, slope, embeddedness, outlet drop at zero flow.	Cumulative score of all indicators on streams deemed to have medium and high fish habitat values, where scores are 0, 5 or 10 for embeddedness, outlet drop and slope, and 0, 3 or 6 for structure length and stream width/structure width ratio	Passable (cumulative score <15)		Potential barrier (cumulative score 15-20), or structure is a barrier but fish use is unconfirmed	Barrier (cumulative score >20)
Water Quality (sediment)	Are forest practices effective in protecting water quality?	Fine sediment potential	Fine sediment (m3) due to expected surface erosion or past mass wasting	< 0.1	< 1	1–5	> 5
Visual Quality	How are we managing views in scenic areas and achieving visual quality objectives?	Visual evaluation of block, design of block, percent of landform altered, impact of roads, tree retention and view point importance	Basic visual quality class (determined using the VQC definitions) is compared with the Adjusted VQC (derived using percent alteration measurements and adjustment factors) to determine if VQO is achieved.	VQO achieved, and % alteration low or mid-range	VQO achieved, but % alteration for one or both close to alteration limit	Only one method indicates VQO achieved	Both methods indicate VQO not achieved

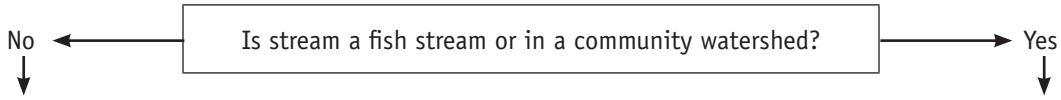
Resource Value	Evaluation Question	Indicators	Resource Development Impact Rating Criteria	Very low	Low	Medium	High
Stand-level Biodiversity	Is stand-level retention providing the range of habitat and attributes understood as necessary for maintaining species dependant on wildlife trees and coarse woody debris?	% retention, retention quality (e.g., big patches, density of large diameter trees), coarse woody debris volume, coarse woody debris quality (e.g., density of pieces ≥ 10 m and 20 cm, and volume of large diameter pieces).	Cumulative score. A 60/40 weighting is used for tree retention versus coarse woody debris, recognizing the longer-term ecological value of standing retention.	> 70%	55–70%	40–55%	< 40%
Air Quality	Is air quality being adversely affected?	Daily average concentration of PM2.5 (µg/m3) at monitoring stations for the 8th worst day of each year, averaged over three years.	PM2.5 daily mean (µg/m3) is given a management level and action according to Canadian Ambient Air Quality Standards.	Actions Required for Keeping Clean Areas Clean (<10 µg/m3 PM2.5)	Actions Required for Preventing AQ Deterioration (10-18 µg/m3 PM2.5)	Actions Required for Preventing CAAQS (19-28 µg/m3 PM2.5)	Actions Required for Achieving Air Zone (>28 µg/m3 PM2.5)
Riparian Reserve Zone Status	Is the riparian reserve zone being adversely impacted by resource development?	Level of incursions on the riparian reserve zone summarized over watershed management basins	Percentage of the reserve zone in a watershed management basin that is intact	>95%	Not Used	95% to 90%	< 90%
Cultural heritage	Are cultural heritage resources being conserved and where necessary protected for First Nations cultural and traditional activities?	Evidence and extent of damage to features, operational limitations, management strategies, and type and extent of features	Combined overall cutblock assessment results with consideration of individual feature assessment results	See methodology report			

Resource Value	Evaluation Question	Indicators	Resource Development Impact Rating Criteria	Very low	Low	Medium	High
Grizzly Bear	What level of management concern is there for grizzly bear populations?	Population size and threat assessment modified by population trend and degree of isolation	NatureServe Element Occurrence Viability Calculator Version 1 results are binned into four classes.	M5	M4	M3	M1
Moose	What is the status of moose populations?	Population demographics	Trend in population size and Cow:Calf ratios	Population increasing; Cow:Calf ratios >25:100	Population stable or increasing; Cow:Calf ratios >25:100	Population stable or decreasing; Cow:Calf ratios <25:100	Population decreasing; Cow:Calf ratios <15:100
Mountain Caribou	What is the status of caribou populations?	Population demographics	Trend in population size and Cow:Calf ratios	Population increasing; Cow:Calf ratios >15:100	Population stable; Cow:Calf ratios >15:100	Population declining; Cow:Calf ratios <15:100	Population extirpated
Landscape-level Biodiversity	How well is the forested matrix at the landscape-level receiving protection and providing the range of habitat understood as necessary for maintaining ecosystem function?	Amount of protection by forest seral stage and ecological unit Deviation from naturally expected amounts of forest by seral stage and ecological unit	Not applicable (resource development impact ratings not provided)	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Air Quality	Is air quality being adversely affected?	Daily average concentration of PM2.5 (µg/m3) at monitoring stations for the 8th worst day of each year, averaged over three years.	Daily average concentration of PM2.5 (µg/m3) at monitoring stations for the 8th worst day of each year, averaged over three years.	Actions Required for Keeping Clean Areas Clean (<10 µg/m3 PM2.5)	Actions Required for Keeping Clean Areas Clean (<10 µg/m3 PM2.5)	Actions Required for Preventing CAAQS (19-28 µg/m3 PM2.5)	Actions Required for Achieving Air Zone (>28 µg/m3 PM2.5)

APPENDIX C – LOCATIONS OF FREP SAMPLES WITHIN THE PEACE NATURAL RESOURCE DISTRICT



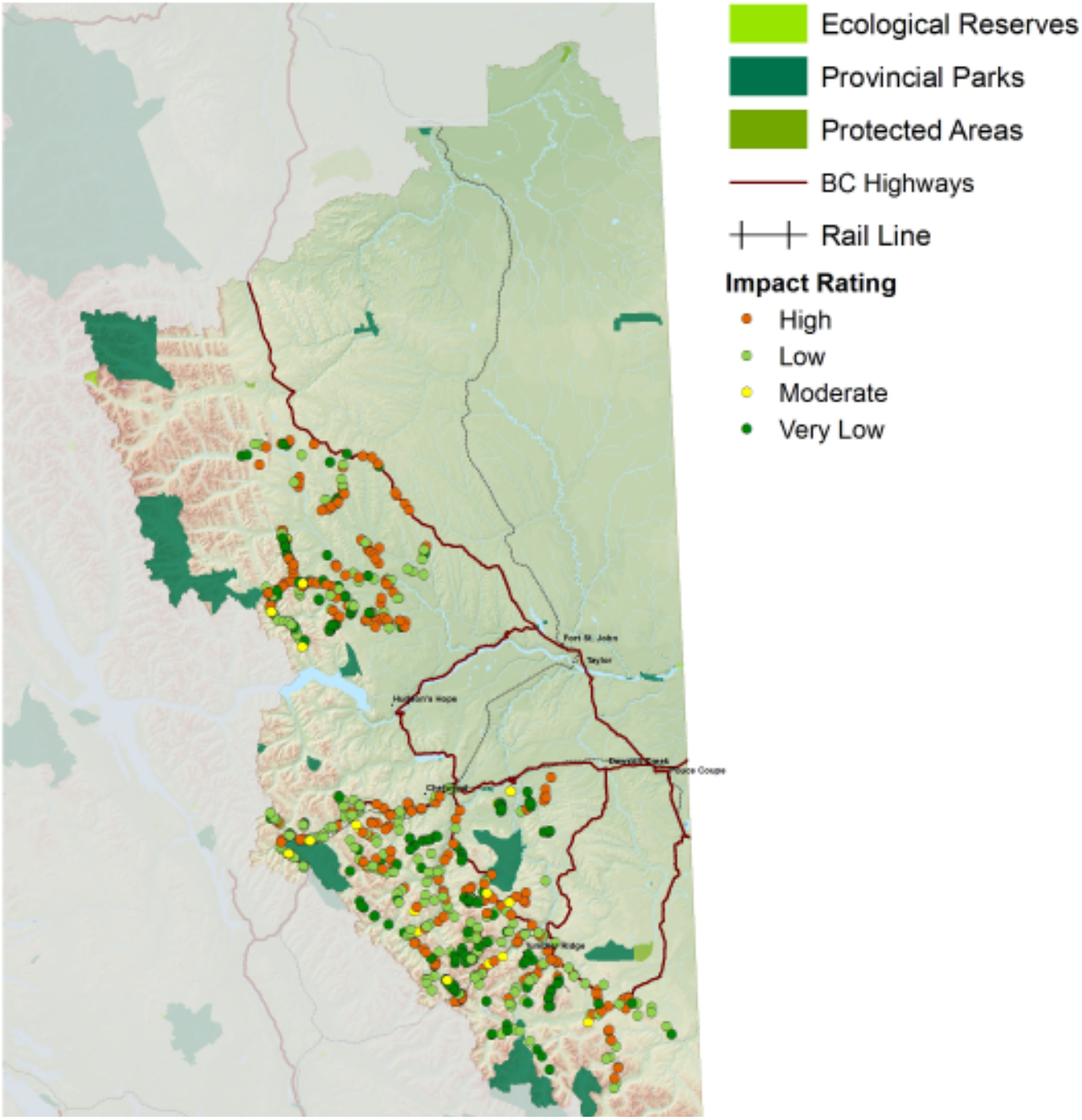
APPENDIX D – KEY TO BRITISH COLUMBIA RIPARIAN STREAM CLASSIFICATION (FROM THE RIPARIAN MANAGEMENT AREA GUIDEBOOK, DECEMBER 1995)



Average Channel Width	Riparian Class
> 3 m	S5
< 3 m	S6

Stream Width	Riparian Class
> 20 m	S1
> 5 – 20 m	S2
1/5 – 5 m	S3
<1.5 m	S4

APPENDIX E – STREAM CROSSING LOCATIONS ASSESSED AND IMPACT RATINGS WITHIN THE PEACE NATURAL RESOURCE DISTRICT

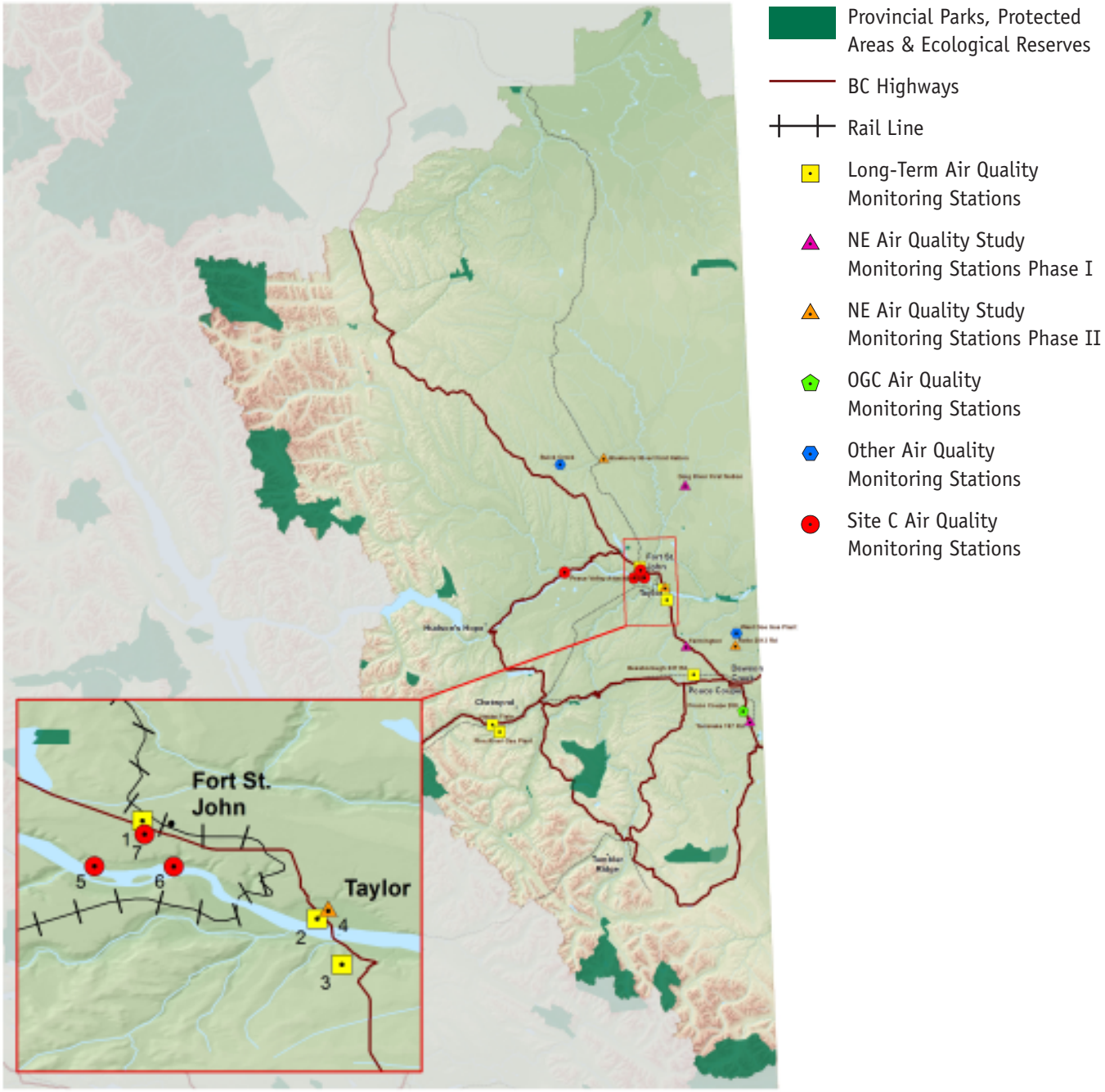


APPENDIX F – LANDSCAPE LEVEL BIODIVERSITY

Table F-1. Landscape-level biodiversity hectares by age class

all in hectares		Young Forest			Mid Age		Old & Mature		Expected Range of Natural Variability					
									bottom of black outlined box	size of box	bottom of black outlined box	size of box	top of black outlined box	top of black outlined box
NDU subunit – GRAPH LABELS	Alienated	Logged	Natural	Protected	Not Protected	Protected	Not Protected	Protected	Early Minium	Early Maximum	Mature Minimum	Mature Maximum	expected young	expected mature
Northern Mountains	18	–	14,353	1,113	18,451	1,619	109,497	23,320	20,205	37,042	80,818	37,042	57,246	117,860
Plains – BWBSmk	4,029	48,776	133,606	11,052	876,525	54,184	715,534	49,965	473,418	473,418	530,228	397,671	946,836	927,899
Plains – BWBSmw	462,200	179,904	277,305	16,568	935,873	94,035	570,176	78,758	653,705	653,705	732,149	549,112	1,307,410	1,281,261
Plains – Other	1,759	84,452	54,733	5,690	171,653	23,004	380,690	62,810	196,198	196,198	219,741	164,806	392,396	384,548
Omineca – Mountain	1	1,013	850	2,144	2,011	2,320	28,692	59,372	9,640	11,568	63,626	10,604	21,209	74,230
Foothills – Mountain	4,405	44,075	51,680	15,263	101,494	31,878	333,616	137,588	136,800	122,400	309,600	136,800	259,200	446,399
Foothills – Valley	283	35,173	17,702	1,497	50,793	5,812	108,879	13,648	44,420	60,785	77,150	51,433	105,204	128,583
Wet Mountain	22	15,024	7,991	3,066	20,582	14,072	134,637	99,223	8,839	11,785	259,263	14,731	20,623	273,994
Omineca – Valley	129	978	1,065	256	1,217	613	10,314	4,810	3,683	5,039	6,396	4,264	8,722	10,660
Wet Trench – Mountain	–	–	6	137	–	895	355	8,714	404	707	8,389	910	1,112	9,298
Grand Total	472,846	409,395	559,291	56,786	2,178,599	228,432	2,392,390	538,208	1,547,310	1,572,646	2,287,360	1,367,372		

APPENDIX G – AIR QUALITY MONITORING STATIONS WITHIN THE PEACE NATURAL RESOURCE DISTRICT



Air Quality Monitoring Stations
1 Fort St. John Key Learning Centre
2 Taylor Townsite
3 Taylor South Hill
4 Taylor Lone Wolf
5 Fort St. John North Camp
6 Fort St. John Old Fort
7 Fort St. John 85th Ave

Table G-1. Coordinates and Monitoring Periods of Air Quality Monitoring Stations

		Station Name	Location		Monitoring Period		Parameters Measured
			Lat	Long	Start	End	
Long-Term		Fort St. John Key Learning Centre	56.244744°	-120.855991°	(Feb 2016	- current)	SO_2, NO_2, O_3, $PM_{2.5}$, PM_{10}
		Taylor Townsite	56.150051°	-120.686632°	(Jan 1994	- current)	SO_2, TRS, NO_2, O_3
		Taylor South Hill	56.105869°	-120.662818°	(Mar 1998	- current)	SO_2, TRS
		Hasler Flats*	55.605599°	-121.973549°	(Jun 1999	- current)	SO_2, TRS
		Pine River Gas Plant	55.574505°	-121.921281°	(Jan 1994	- current)	SO_2, TRS
		Bessborough 237 Rd.	55.791944°	-120.483611°	(Jan 2014	- current)	SO_2, TRS
NE AQ Monitoring Study	Phase I	Tomslake 197 Rd.	55.590150°	-120.085830°	(Dec 2013	- Nov 2015)	SO_2, TRS
		Doig River First Nation	56.578083°	-120.497480°	(Dec 2013	- Nov 2015)	SO_2, TRS
		Farmington Community Hall	55.913303°	-120.531460°	(Dec 2013	- Nov 2015)	SO_2, TRS
	Phase II	Rolla 2013 Rd.	55.907610°	-120.169010°	(Dec 2015	- Nov 2017)	SO_2, TRS, NO_2, O_3
		Blueberry River First Nation	56.701655°	-121.104290°	(Jun 2016	- Nov 2017)	SO_2, TRS, NO_2, O_3
		Taylor Lone Wolf	56.160080°	-120.675984°	(Jan 2016	- current)	SO_2, TRS, NO_2, O_3, $PM_{2.5}$
OGC		Pouce Coupe 200 CAMEL	55.634323°	-120.132649°	(Sep 2016	- current)	SO_2, TRS, NO_2, O_3, $PM_{2.5}$, PM_{10}, CO, VOC
Site C		Peace Valley Attachie Flat	56.231213°	-121.419440°	(Jan 2015	- current)	$PM_{2.5}$, PM_{10}
		Fort St John North Camp	56.200998°	-120.902600°	(Aug 2017	- current)	SO_2, $PM_{2.5}$, PM_{10}, CO
		Fort St John Old Fort	56.200780°	-120.825713°	(Jan 2015	- current)	$PM_{2.5}$, PM_{10}
		Fort St John 85th Ave.	56.231792°	-120.853895°	(Jan 2015	- current)	$PM_{2.5}$, PM_{10}
Other**		Buick Creek	56.678207°	-121.433426°	N/A	N/A	SO_2, TRS
		West Doe Gas Plant	55.956313°	-120.157674°	N/A	N/A	SO_2, TRS

* Station not used in analysis due to inappropriate siting

** Data not available at this time

Table G-2. Management levels and generalized actions for the SO_2 and $PM_{2.5}$ CAAQS. The CAAQS thresholds are the numerical values between the orange and red lines.

Management Level	Management Actions	Air Quality Management Threshold Values							
		SO_2 1-hour		SO_2 Annual		$PM_{2.5}$ 24-hour		$PM_{2.5}$ Annual	
		ppb		ppb		(µg/m³)		(µg/m³)	
		2020	2025	2020	2025	2015	2020	2020	2025
Red	Actions for Achieving CAAQS								
CAAQS Threshold Value		70	65	5	4	28	27	10	8
Orange	Actions for Preventing CAAQS Exceedance								
Threshold		50		3		19		6.4	
Yellow	Actions for Preventing AQ Deterioration								
Threshold		30		2		10		4	
Green	Actions for Keeping Clean Areas Clean								

ENDNOTES

[1] Commentary supplied by Greg Van Dolah, District Manager, Peace Natural Resource District

[2] Defined by the OGC

[3] OGC. 2017. Area-based Analysis Data and Process Documentation https://www.bcogc.ca/node/12267/download

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[5] OGC. 2014. Area-based Analysis Results for Northeast British Columbia https://www.bcogc.ca/node/11653/download

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[7] OGC. 2017. Supplementary Information for Area-based Analysis July 2017 Version 1.2 http://www.bcogc.ca/node/12693/download

[8] OGC. 2013. Area-based Analysis: Overview https://www.bcogc.ca/node/12265/download

[9] Ranging from M1 and M2 = high concern through M3 = moderate concern to M4 and M5 = low concern

[10] Provincial Grizzly Bear Technical Working Group. 2016. Assessment Methods for Grizzly Bears in BC (Tier 1 Provincial Scale Grizzly Bear Assessment Protocol) Standards for British Columbia's Values Foundation (ver. 2.2; March 24, 2016). 42 pp.

[11] Box plot description: Dark bar is median value, shaded area defines the 2nd and 3rd quartile. Maximum and minimum values are the end of the lines, excluding outliers. Outliers are <Q1 – 1.5*Inter Quartile Range and >Q3 + 1.5* Inter Quartile Range.

[12] A spatially identified area of land and/or water used for long-term planning of resource management activities. https://catalogue.data.gov.bc.ca/dataset/landscape-units-of-british-columbia-all

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