FREP Report #42

Assistant Deputy Minister Resource Stewardship Report: Regional Results of the Forest and Range Evaluation Program

Assessing the functioning condition of a non-alluvial S2 stream and riparian vegetation in the North Island – Central Coast District. Photo by Paul Barolet.

April, 2019

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MESSAGE FROM THE ASSISTANT DEPUTY MINISTER OF RESOURCE STEWARDSHIP

I am pleased to present the seventh Assistant Deputy Minister (ADM) Stewardship Report on the results of the Forest and Range Evaluation Program (FREP). FREP is a cornerstone in the governance of the *Forests and Range Practices Act* (FRPA). Under this results-based approach, FREP is responsible for monitoring and evaluating the condition of the 11 FRPA values, and the effectiveness of forest practices. This valuable data informs resource managers and provides a foundation of evidence to enable continuous improvement in resource stewardship practices.

This report is one product in a broader suite of FREP reporting tools that convey the results of FREP monitoring at different scales – including district, timber supply area and region - to support the needs of resource professionals and decision makers. FREP monitoring results are also a key component of Integrated Monitoring and Assessment (IMA) Reports – that summarize the results of monitoring and assessment from multiple programs and agencies, to convey the condition and trend of values for areas such as districts or First Nations traditional territories. IMA reports support a broad range of resource stewardship initiatives and decision making, and in particular, are intended to provide a foundation for modernized land use planning. Given government's current priority for completing IMA reports across the province, the ADM stewardship report will move to a bi-annual cycle of publication.

This ADM Stewardship Report summarizes results of FREP monitoring over roughly a ten year period for each natural resource region across the province. It summarizes the results of field-based monitoring for stand level biodiversity, riparian, water quality, cultural heritage resources, and visual quality on, or near, cutblocks in each region, as well as field-based assessments of range use on upland sites, streams and wetlands. Regional landscape-level biodiversity assessments are also included to provide context for stand-level monitoring results, and provide additional information for decision making.

The following are observations on provincial level trends in the results presented in this report.

Stand Level Biodiversity
Retaining wildlife tree retention areas (WTRAs) around important ecological anchors such as large veteran trees, bear dens, bat hibernacula, raptor nests or areas of high wildlife use, is an important strategy for maintaining stand level biodiversity through time. It is encouraging to see that WTRAs encompass ecological anchors more than 70% of the time with the exception of two regions; the lowest being 59%. In addition, the capture of ecological anchors within WTRAs has either increased or remained stable in all but one region. While the percent of a given cut block retained as a WTRA has declined in our more recent samples, the amount retained is significantly greater than default practice requirements across all regions.

The use of dispersed retention on the coast is less than a third of that in the interior. Given the contribution dispersed retention can make to late rotation coarse wood debris (CWD) within cutblocks it is worth investigating why in future monitoring efforts. In general the retention of large snags, large living wildlife trees and CWD has room for improvement across the province.

Riparian areas
Riparian monitoring results are variable across the province, which may in part be related to a difference in landscape characteristics and/or natural disturbances that may leave a stream reach in a sensitive state. However, there does appear to be a general decline in harvest-related impacts to streams over time in a few regions, indicating that practices are improving in those areas. Resource managers should use site-specific field assessments combined with any other local or supporting data to tailor riparian prescriptions to meet

government's objectives for riparian areas. This approach ensures planning and practices implement appropriate strategies for sites in sensitive states, such as second-growth or beetle-killed stands or in areas of highly erodible soils, to ensure that the post-harvest outcomes of streams and riparian areas are in properly functioning condition.

Water Quality
The results of water quality sampling for roughly 7,000 sites across the Province indicate that 75% of sites assessed are considered to have very low to low impact, meaning they were generating some fine sediment but likely within normal background ranges. Twenty percent of sites were assessed as moderate impact, meaning that resources managers need to consider instream and downstream values such as fish habitat and downstream domestic intakes and take corrective action as appropriate. Five percent scored in the High and Very High impact range, meaning substantial water quality impacts had or are occurring at these sites and corrective action is required.

When the data is viewed over the life cycle of a resource road, 40% of identified issues were related to road location and design, 40% with construction and maintenance, and 20% were related to road deactivation. This means that 40% of potential water quality impacts can be addressed if sediment and erosion control measures are incorporated into the road location and road design phases of road development. If so, potential impacts resulting from roads close to streams, long grades and ditchlines leading to stream crossings, too few culverts, maintaining natural drainage patterns and poor construction materials would likely be addressed.

Within the road construction and road maintenance phases, the most frequent issues related to impacted water quality related to the presence of grader berms directing surface water to a stream crossing, the need for re-seeding/re-vegetation of exposed soil surfaces on cutbanks and fill slopes, coarser surfacing materials (if available), raised bridge decks, and lack of rolling grades.

Visual quality
FREP visual quality effectiveness evaluations assess the rate at which harvesting practices are in compliance with visual quality objectives (VQO's). The assessment of recently evaluated landforms indicates an improvement in VQO compliance in five of the eight regions, when compared to the previous evaluation era. The combined results for all regions indicate a general increase in the VQO compliance rate in recently evaluated samples. It is evident in the results that in-block tree retention is a key design factor that contributes to the achievement of VQO's.

I encourage all resource professionals and managers to review the results of monitoring conveyed in this report for your respective regions, along with the opportunities for improvements to practices that have been identified, and consider how you might use this information to inform your own area of practice and responsibility.

Tom Ethier
Assistant Deputy Minister
Resource Stewardship Division
Forest, Lands, Natural Resource Operations and Rural Development

INTRODUCTION

This seventh ADM Stewardship Report summarizes the results of Forest and Range Evaluation Program (FREP) monitoring at a regional scale, over roughly a ten year period, along with recommendations for continued improvement of on-the-ground resource management practices. With a target audience of natural resource professionals and decision makers, this report aims to encourage dialogue and inform decision-making among those who manage British Columbia's natural resource values on behalf of the public.

FREP was established in 2003 as a cornerstone of the results-based *Forest and Range Practices Act* framework. As part of this framework, government establishes the objectives for resource management, and forest professionals are provided flexibility in defining the results and strategies they will use to meet government objectives. Government undertakes compliance and enforcement monitoring, as well as effectiveness monitoring through FREP, to evaluate whether practices on the ground are ultimately meeting government's objectives.

FREP began resource value monitoring in 2005, and has collected and reported on over 10,000 samples since. The monitoring protocols used in FREP are science-based, resulting in trusted and high-quality data. By providing this information to resource managers, FREP supports professional reliance and the continuous improvement of land and resource stewardship. This information is also used to inform decisions on whether to amend provincial policies and legislation, if needed to improve outcomes.

For information on individual monitoring protocols, please go to:
http://www2.gov.bc.ca/gov/content?id=BFD4A19913F44973A134F96F5E042404.
For more information on FREP, and to see how the program is influencing change, please go to:
http://www2.gov.bc.ca/gov/content?id=F799814F5E004CA0A02A02D63CB69E55.

RESOURCE VALUE ASSESSMENTS AND RATINGS

Landscape-level biodiversity assessments are presented for each natural resource region. These regional summaries provide context for the site/stand-level monitoring results. Landscape-level biodiversity assessments consider the entire forested landscape, including parks, protected areas, conservancies and other 'no harvest' areas as well as commercial forest, while stand-level assessments are confined to the working forest land base, and do not include the ecological contributions of protected areas.

Results of field-based site/stand-level assessments of water quality, cultural heritage resources, riparian, and biodiversity are summarized for each region[1] using four impact ratings to assess the effect of development on these resource values: very low, low, moderate, high.[2] Results of field-based visual quality assessments are summarized for each region using four effectiveness evaluation ratings to assess whether the legal objective was achieved: well met, met, borderline, not met. Please see Tables 1 and 2 for the criteria used to determine the resource development impact ratings and effectiveness evaluation ratings. Sample locations in each natural resource region for these resource values are provided in Figure 1.

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[1] Results for cultural heritage resource monitoring are provided for the Omineca, Skeena, Thompson-Okanagan, and West Coast Regions. The remaining regions will report results once sufficient samples have been collected.
[2] This rating system is also used for Multiple Resource Value Assessments. See http://www2.gov.bc.ca/gov/content?id=3404A95D195C48A5BAE6DA51462014A0.

Table 1. Evaluation question, indicators, and criteria used to determine the development impact ratings for stand-level biodiversity, riparian, water quality, and cultural heritage resources.

Resource Value	FREP Evaluation Question	Indicators	Resource Development Impact Rating Criteria	Very low	Low	Moderate	High
Stand-level Biodiversity	Is stand-level retention providing the range of habitat and attributes understood as necessary for maintaining species dependent on wildlife trees and coarse woody debris?	Quantity and type of retention[3] (percent of within-block retention, average patch size, presence of within-patch ecological anchors, and presence of dispersed retention)	Total cutblock score (100 points max)	>80 points	45-80 points	<45 points	<3.5% retention (regardless of total score)
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 "no" answers = *'properly functioning condition'*	3–4 "no" answers = *'functioning condition but at risk'*	5–6 "no" answers =*'functioning condition but at high risk'*	>6 "no" answers =*'not properly functioning condition'*
Water Quality	Are forest practices effective in protecting water quality?	Fine sediment potential	Amount of fine sediment resulting from expected surface erosion or past mass wasting	$<0.1\ m^3$	$<1\ m^3$	$1–5\ m^3$	$>5\ m^3$
Cultural Heritage Resources	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	Block rated well/very well & no features rated poor/very poor	Block rated well/very well & ≥1 feature rated poor/very poor ***OR*** Block rated moderate & no features rated poor/very poor	Block rated moderate & ≥1 feature rated poor/very poor	Block rated poor/very poor

Table 2. Evaluation question, indicators, and criteria used to determine the effectiveness evaluation ratings for visual quality.

Resource Value	FREP Evaluation Question	Indicators	Effectiveness Evaluation Rating Criteria	Well Met	Met	Borderline	Not Met
Visual Quality	Are forest practices achieving established visual quality objectives in scenic areas?	Visibleness of alteration, use of visual landscape design elements, percent of landform altered, visual impact of roads, percent of block with visible tree retention	Basic visual quality class (VQC) is determined using the ocular assessment method. Adjusted VQC is derived using the percent alteration assessment method, which includes adjustment factors. The two measures are combined to determine a final rating.	Both methods indicate VQO achieved and percent alteration is low or mid-range	Both methods indicate VQO achieved, but percent alteration for one or both is close to alteration limit	Only one method indicates VQO achieved	Both methods indicate VQO not achieved

[3] Indicators of tree retention quality and coarse woody debris retention quality are reported separately and are not included in the development impact rating score.

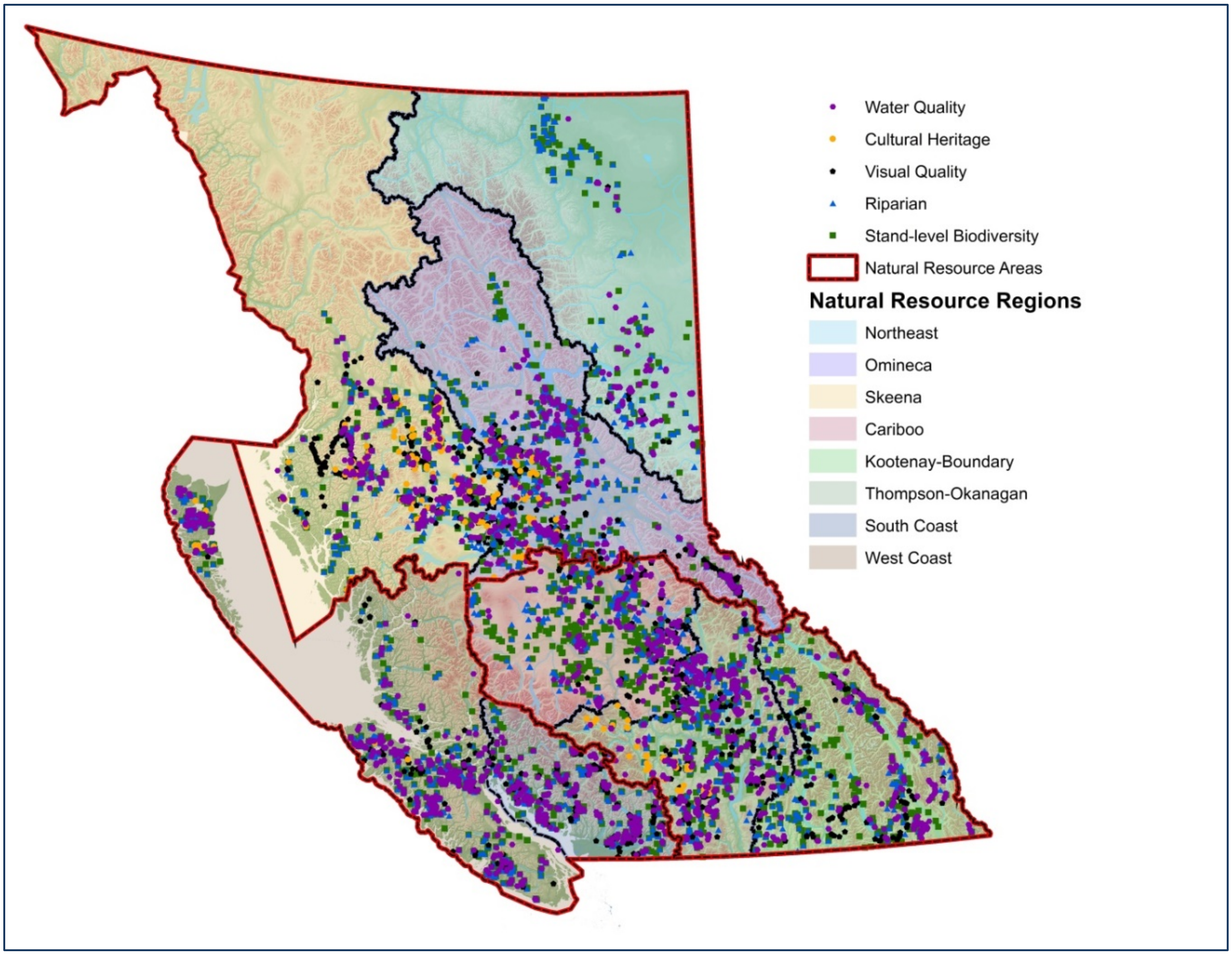


Figure 1. Sample locations of FREP resource stewardship monitoring for water quality, cultural heritage resources, visual quality, riparian, and stand-level biodiversity.

Results of field-based site assessments of rangeland health are summarized for the province using five condition ratings: properly functioning, slightly at risk, moderately at risk, highly at risk, non-functional. Sites that are in properly functioning condition and slightly at risk are considered to be in good condition. Moderately at risk sites are considered to be in fair condition and should be re-assessed within a few years as this rating often indicates that the site is moving in either a positive or negative direction. Highly at risk and non-functional sites are considered to be in poor condition and should be assessed for management changes or improvements to reduce livestock impacts and allow the area to recover.

NORTHEAST NATURAL RESOURCE REGION

The following section presents the status of landscape-level biodiversity and the outcomes of site/stand-level monitoring for biodiversity, riparian condition, water quality, and visual quality in the Northeast Natural Resource Region.

Status of Landscape-level Biodiversity in the Northeast Region

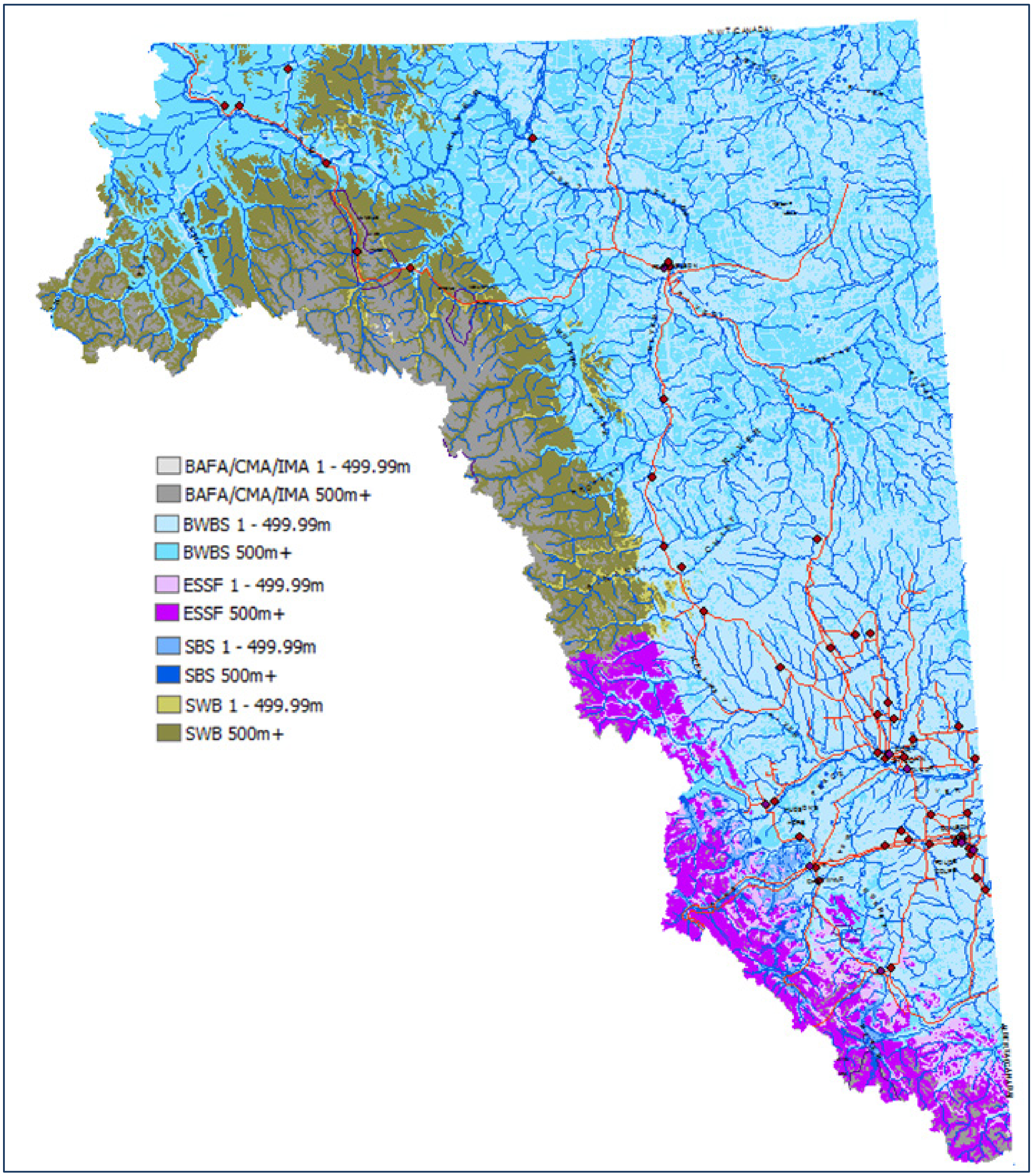


Figure 1. Distribution of roaded areas (less than 500 metres to a road) and roadless areas (500 metres or more to a road) by biogeoclimatic zone in the Northeast Region.

Data Source

The expected seral stage distribution was calculated by natural disturbance unit (NDU) using the return intervals and stand-age thresholds recommended by Delong.[4] Seral stage distributions are reported by biogeoclimatic ecosystem classification (BEC) zone (instead of by NDU) for provincial consistency. Stand age was not adjusted to account for mountain pine beetle infestation or fire. Mature and old seral stages were combined because the age classes that comprise these seral stages are not reliably classified in the provincial vegetation resource inventory. Delong provided a range of expected proportions for each seral stage, the total of those ranges not equaling 100%. This made reporting separate expected amounts of early and mid-seral forest difficult, thus these stages were also combined. An additional state, "alienated forest" (mines, tailings, spoils, gravel pits, roads, rail surfaces, cutbanks, reservoir margins, landings, airports, and urban areas) is also reported. Publicly available corporate datasets were used to conduct the spatial analysis: BEC units (2016 version), vegetation resource inventory (stand age projected to 2017), harvest depletions (as of spring 2017), roads (as of spring 2017), mountain pine beetle infestations (up to 2017), fires (2000-2017), and "land protection designations" (current as of 2016) (i.e., old growth management areas, parks, protected areas, conservancies, no-harvest ungulate winter range, and no-harvest wildlife habitat areas).

Summary

The Northeast Region captures four forested biogeoclimatic zones: Boreal White and Black Spruce (BWBS), Engelmann Spruce – Subalpine Fir (ESSF), Sub-Boreal Spruce (SBS), and Spruce – Willow – Birch (SWB) (Figure 1). The amount and percentage of roadless forest (forest 500 metres or more to a road[5]) was determined for each biogeoclimatic zone (Figure 1, Table 1). For the purposes of this report, roadless forest is presumed to be less disturbed, and may have higher biodiversity value than forest within 500 metres of a road. More than half of the ESSF and SWB zones, and less than half of the BWBS and SBS zones, are comprised of roadless forest. In general, higher elevation and remote biogeoclimatic zones in the Northeast Region are largely composed of roadless forest.

Table 1. Hectares and percentage of roadless forest by biogeoclimatic zone in the Northeast Region.

Biogeoclimatic Zone	Forest ≥500m to a Road	
	Hectares (Rounded to nearest 1000 ha)	Percentage
Boreal White and Black Spruce (BWBS)	4,650,000	43%
Engelmann Spruce – Subalpine Fir (ESSF)	751,000	67%
Sub-Boreal Spruce (SBS)	59,000	25%
Spruce – Willow – Birch (SWB)	1,341,000	91%
ALL ZONES	**6,801,000**	**50%**

The observed seral stage distribution was compared to the expected seral stage distribution for each biogeoclimatic zone (Figure 2).[6] The observed amounts of mature/old forest are within the natural range of variability for the SBS and BWBS zones, while the observed amount of mature/old forest slightly exceeds the

[4] Delong, Craig. 2011. Land Units and Benchmarks for Developing Natural Disturbance-Based Forest Management Guidance for Northeastern British Columbia. Technical Report 059.

[5] British Columbia. Ministry of Environment. 2018. Status of Roads & Roadless Area. Environmental Reporting BC. Ministry of Environment. http://www.env.gov.bc.ca/soe/indicators/land/roads.html

[6] This is not a compliance report against legal orders and no "ecological score" has been provided. That said, the authors of the 1995 Biodiversity Guidebook argued that biodiversity can be more likely maintained if forest management seeks to retain habitat patterns and seral stages that are similar to natural landscapes.

maximum expected amount for the ESSF and SWB zones. This suggests the expected return intervals for the ESSF and SWB zones may be too short.
In summary, at the biogeoclimatic zone level, observed seral stage distributions are not less than the amounts expected.

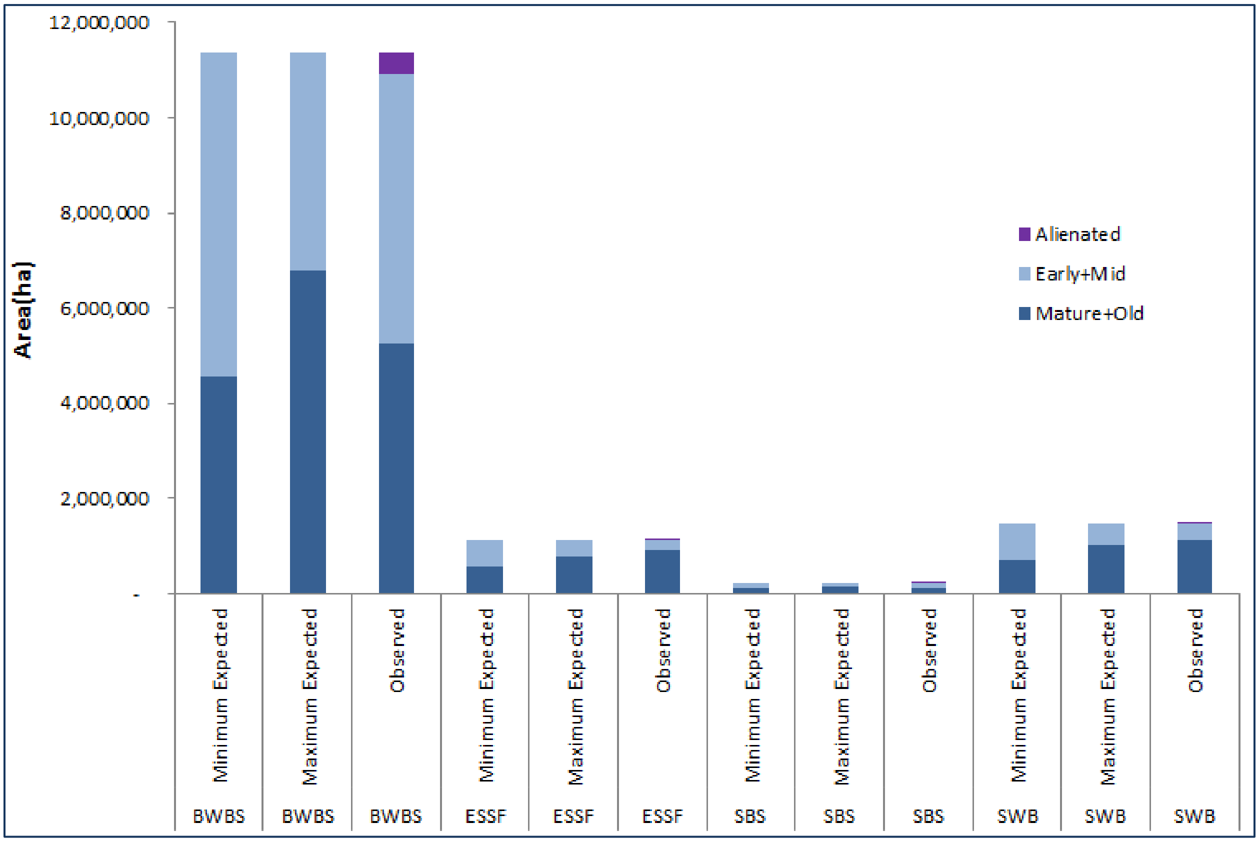


Figure 2. Expected versus observed seral stage distribution by biogeoclimatic zone in the Northeast Region.

The amount and percentage of mature/old forest protected from harvest in various resource stewardship designations was determined for each biogeoclimatic zone (Table 2). The condition of protected and unprotected mature/old forest in each zone was assessed using distance to road and natural disturbance impacts as indicators (Figures 3 and 4). Mature/old forest impacted by both mountain pine beetle and fire is reported in the appropriate fire category (2000-2016 or 2017).

In the ESSF zone, 41% of mature/old forest is protected from harvest. In the BWBS, SBS and SWB zones, substantially less mature/old forest is protected from harvest (12%, 19% and 19%, respectively). In the ESSF and SWB zones, the majority of the protected mature/old forest is roadless, whereas in the BWBS and SBS zones, approximately half of the protected mature/old forest is roadless. As for unprotected mature/old forest, the majority in the ESSF and SWB zones, approximately half in the BWBS zone, and less than half in the SBS zone is roadless. Mountain pine beetle and/or fire have not impacted the condition of the majority of the mature/old forest in the region in the SWB and BWBS zones. Approximately half of the mature/old forest in the ESSF and SBS zones has been impacted.

In summary, the majority of the mature/old forest in the Northeast Region is roadless and has not been recently impacted by mountain pine beetle and/or fire.

Table 2. Hectares and percentage of mature/old forest protected from harvest by biogeoclimatic zone in the Northeast Region.

Biogeoclimatic Zone	Mature/Old Forest Protected from Harvest	
	Hectares (rounded to nearest 100 ha)	Percentage
Boreal Black and White Spruce (BWBS)	624,000	12%
Engelmann Spruce – Subalpine Fir (ESSF)	371,000	41%
Sub-Boreal Spruce (SBS)	26,000	19%
Spruce – Willow – Birch (SWB)	217,000	19%
ALL ZONES	**1,238,000**	**17%**

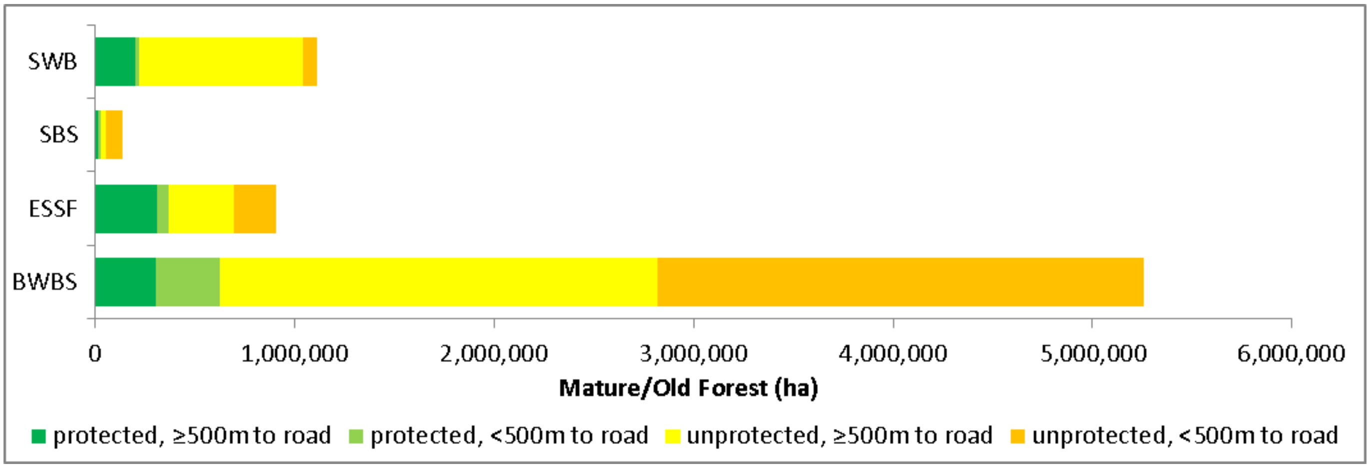


Figure 3. Hectares of protected roadless, protected roaded, unprotected roadless, and unprotected roaded mature/old forest by biogeoclimatic zone in the Northeast Region.

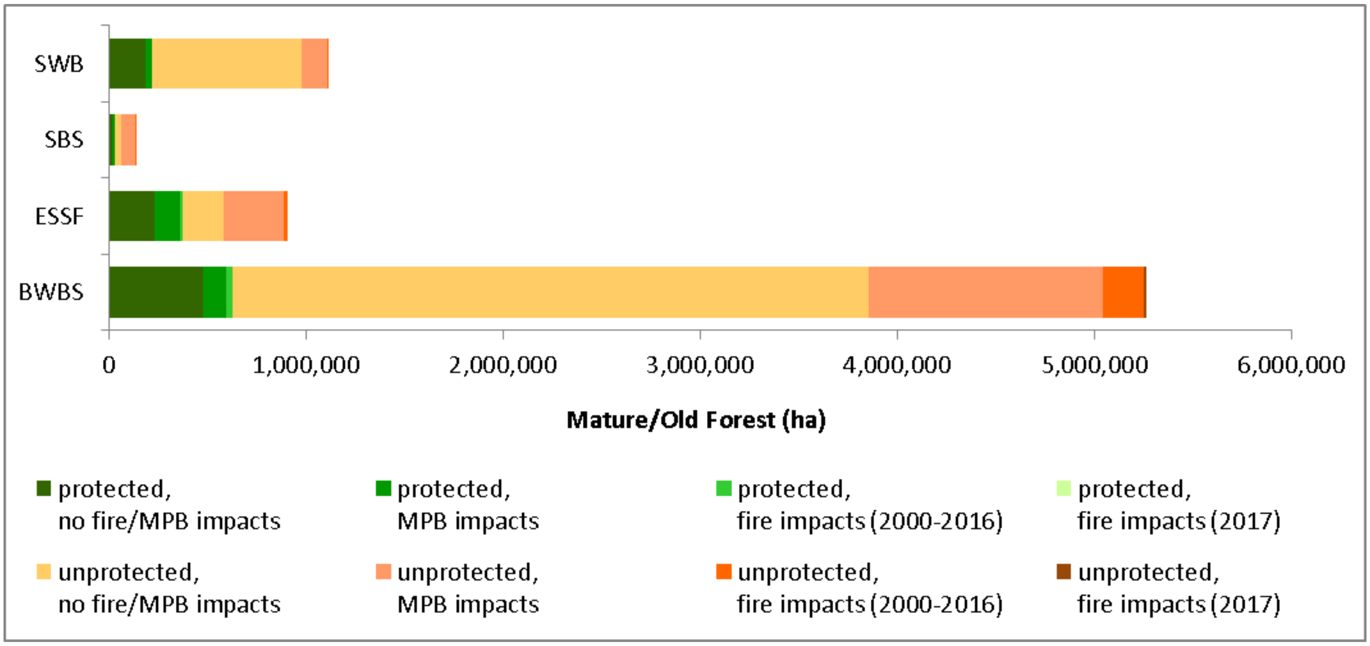


Figure 4. Hectares of protected and unprotected mature/old forest impacted by mountain pine beetle and/or fire by biogeoclimatic zone in the Northeast Region.

Post-harvest Condition of Stand-level Biodiversity in the Northeast Region

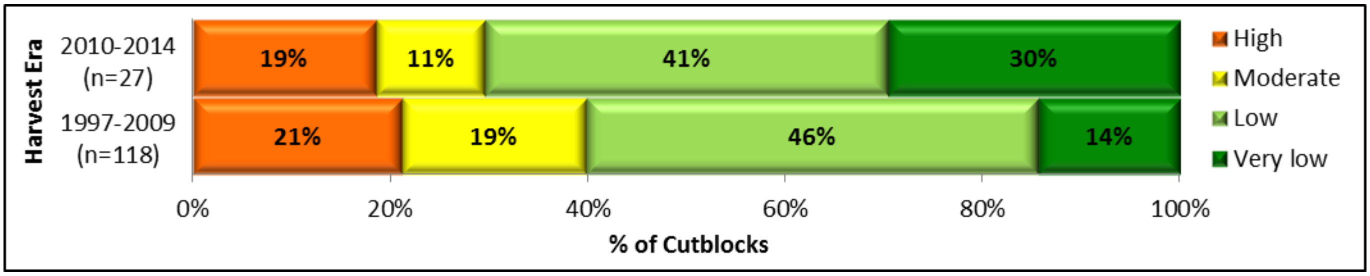


Figure 1. Quantity and type of retention by harvest era: Percentage of cutblocks in high, moderate, low, and very low impact categories.

Table 1. Quality of tree retention compared to pre-harvest benchmark by harvest era.

	Large Live Tree Density	Large Snag Density	Tree Species Diversity
2010-2014 (n=27)	Comparable	Comparable	Comparable
Quality Trend	*No change*	*No change*	***Improving***
1997-2009 (n=118)	Comparable	Comparable	Less

Table 2. Quality of coarse woody debris (CWD) retention compared to pre-harvest benchmark by harvest era.

	Large Piece Volume	Large & Long Piece Density
2010-2014 (n=27)	Comparable	Not Comparable
Quality Trend	*No change*	*No change*
1997-2009 (n=118)	Comparable	Not Comparable

Data Source

Assessments were conducted by trained personnel from 2006 to 2016 using the FREP stand-level biodiversity (SLBD) monitoring protocol to evaluate whether retention of wildlife tree patches and riparian reserves is achieving the desired levels and types of structures to maintain species diversity. The sample population consists of randomly selected cutblocks harvested from 1997 to 2014. A total of 145 SLBD samples have been collected in the Northeast Region, of which 27 represent recently harvested blocks.

Summary

Quantity and Type of Retention: The impact rating for each cutblock with respect to quantity and type of retention was determined by assessing percent of within-block retention, patch size, presence of within-patch ecological anchors, and presence of dispersed retention. If a cutblock scored greater than 80 out of 100 points, it was rated as very low impact. If a cutblock scored between 45 and 80 points, it was rated as low impact. If a cutblock scored less than 45 points, it was rated as moderate impact. If a cutblock had less than 3.5% retention (regardless of total score), it was rated as high impact.

Seventy-one percent of recently harvested cutblocks were in the low and very low impact categories compared to 60% of the sites harvested before 2010 (Figure 1). The average score has not changed significantly over time (Figure 2). Although average percent of within-block retention, median patch size and use of ecological anchors did not differ significantly between harvest eras, the use of dispersed retention increased significantly on recently harvested blocks (Figure 3)

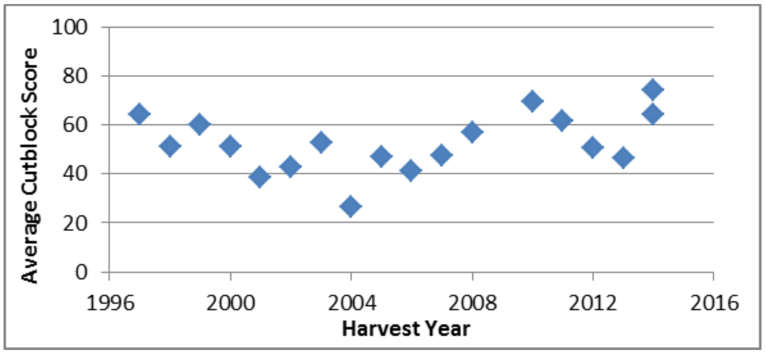


Figure 2. Average cutblock score with respect to retention quantity and type by harvest year.

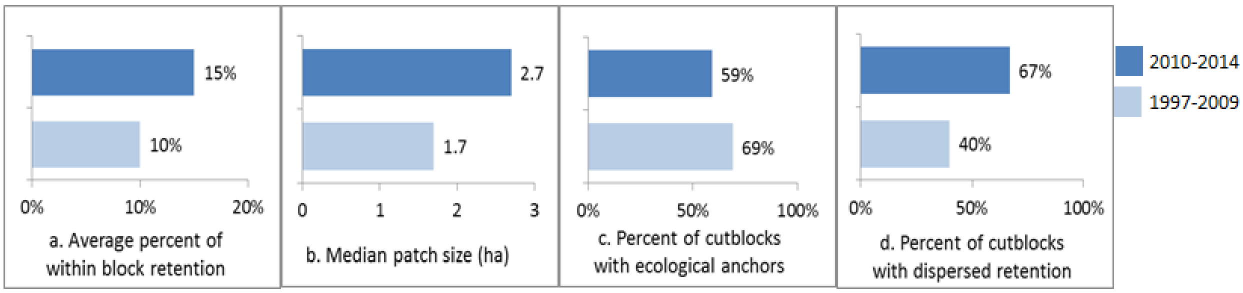


Figure 3. Quantity and type of retention by harvest era.

Quality of Tree Retention: Assessment of tree retention quality was conducted in aggregate for the entire region because pre-harvest condition is unknown for the vast majority of the blocks assessed. Assuming that timber cruise data is an appropriate surrogate for pre-harvest condition, a benchmark was adopted for each harvest era to reflect that the characteristics of the harvested stands differ between the two eras. The density of large live trees and snags (>40 or >50 or >70 cm dbh, dependent on biogeoclimatic subzone) and the diversity of tree species retained for each harvest era were compared to cruise data from approximately the same harvest era and for the same biogeoclimatic subzone (Table 1). The density of large trees and snags was comparable to pre-harvest conditions for both harvest eras. Tree species diversity was less than pre-harvest conditions on cutblocks harvested before 2009 but was comparable to the benchmark on recently harvested cutblocks.

Quality of Coarse Woody Debris (CWD) Retention: An assessment of CWD retention quality was also conducted in aggregate against a pre-harvest benchmark for each harvest era. The volume of large pieces (>20cm diameter) and density of large and long pieces (>20 cm diameter, >10 m long) in harvested areas were compared to retention patches (Table 2). For both harvest eras, large piece volume reflected pre-harvest conditions, whereas large and long piece density was not comparable to the benchmark.

Opportunities for Improvement and/or Continuation of Practices to Manage Stand-level Biodiversity

- Continue to include ecological anchors within patches when available.
- Continue to leave dispersed retention throughout harvested areas.
- Continue to retain large live trees and snags in densities comparable to pre-harvest conditions.
- Continue to retain a diversity of tree species comparable to pre-harvest conditions.
- Continue to retain large CWD in volumes comparable to pre-harvest conditions.
- Improve CWD retention quality by leaving large and long CWD pieces in densities representative of pre-harvest conditions.

Post-harvest Condition of Streams and Riparian Areas in the Northeast Region

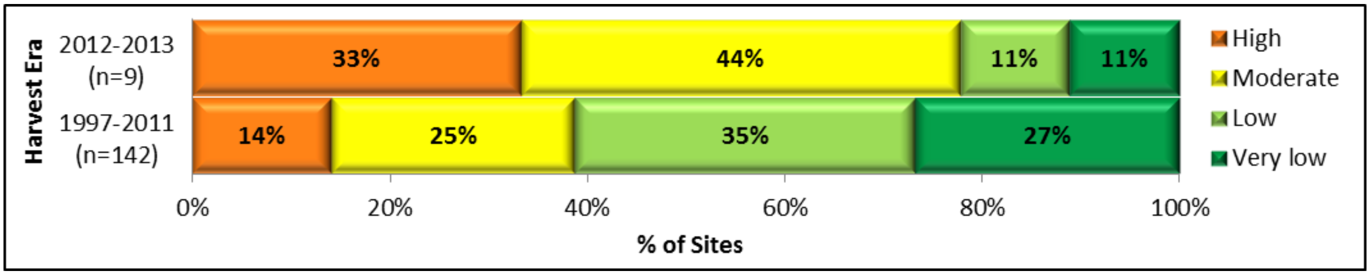


Figure 1. Percentage of sites in high, moderate, low, and very low impact categories by harvest era.

Data Source

Assessments were conducted by trained personnel from 2006 to 2016 using the FREP riparian monitoring protocol to evaluate whether riparian forestry and range practices are effective in maintaining the structural integrity and functions of stream ecosystems and other aquatic resources. The sample population includes randomly selected cutblocks with streams within or adjacent to them. A total of 151 riparian samples have been collected in the Northeast Region, of which nine represent stream reaches harvested since 2012. Because the protocol requires a time lag of one to two winters to allow for impacts such as windthrow to manifest, there is little or no data for blocks harvested within the last two years.

Summary

Twenty-two percent of the recently harvested sites were in the low or very low impact categories compared to 62% of the sites harvested before 2012 (Figure 1). Of the nine recently harvested sites, seven were in the high or moderate impact categories. Of these, six were S6 streams and one was an S2 stream (Table 1). Five S6 stream were located within the block. The remaining streams were located adjacent to the cutblock.

Table 1. Number of recently harvested sites by stream class and impact category.

Stream Class	Impact Category				Total
	High	Moderate	Low	Very Low	
S1	0	0	0	0	0
S2	1	0	0	0	1
S3	0	0	0	0	0
S4	0	0	0	0	0
S5	0	0	0	0	0
S6	2	4	1	1	8
Total	**3**	**4**	**1**	**1**	**9**

Causal Factors

The largest causal factors of impacts were logging (48%) and natural events (34%) at sites that had been recently harvested (Figure 2). The average number of logging-related impacts per year ranged from 0.5 to 3.0 (Figure 3). There is no statistical trend when considering all data points over time.

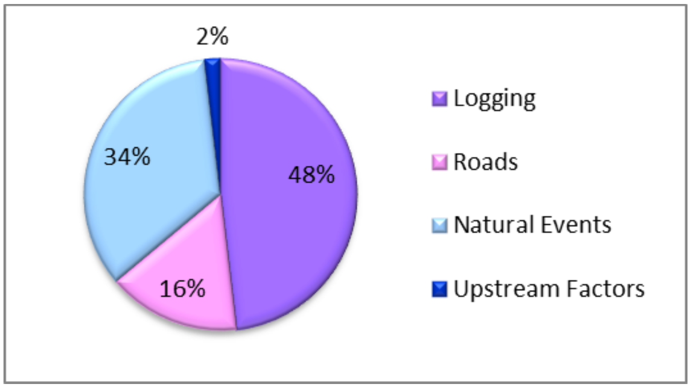


Figure 2. Percentage of impacts by causal factor at recently harvested sites.

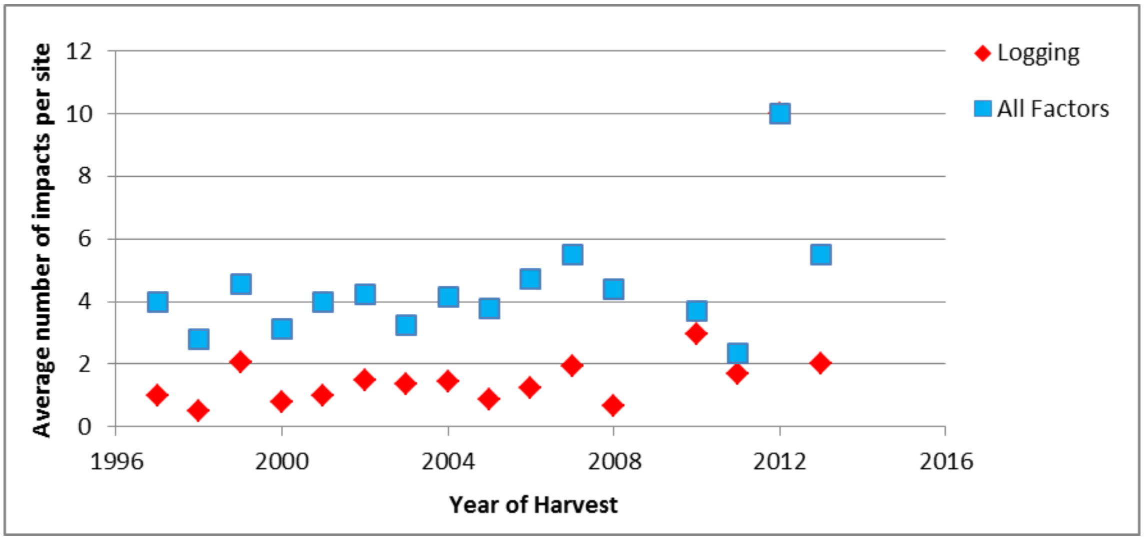


Figure 3. Average number of logging-related impacts and average number of impacts caused by all factors by year of harvest.

Specific Impacts

The most common logging-related activities that contributed to impacts observed at recently harvested sites include low retention and windthrow. These activities have been linked to reduced riparian vegetation vigour and structure, excessive blowdown, blockages to aquatic connectivity, and increased in-stream fine sediments (Table 2).

Natural events that contributed to impacts observed at recently harvested sites include floods, high background sediment levels, and beetle kills. These events lead to blockages to aquatic connectivity, high levels of in-stream fine sediments, and decreased moss abundance/condition (Table 2).

Table 2. Causal factors and related impacts for recently harvested sites.

% of All Factors	Most Common Specific Impacts
Logging (48%) *Low Retention* *Windthrow*	Riparian vegetation form/vigour↓ Excessive blowdown ↑ In-stream blockages ↑ In-stream sediments ↑
Natural Events (34%) *Floods* *High background sediment levels* *Beetle kills*	In-stream blockages ↑ In-stream sediments ↑ Moss abundance/condition ↓
Roads (16%) *Running surface eroding into stream* *Ditches eroding into stream* *Fill or cut slopes eroding into stream*	In-stream sediments ↑ Soil disturbance/bare ground ↑
Upstream Factors (2%)	In-stream sediments ↑ Moss abundance/condition ↓

Opportunities for Improvement and/or Continuation of Practices that Protect Stream and Riparian Conditions

- Recognize the risk of erosion in areas that are naturally high in fine sediments. Apply strategies related to timing of harvest and methods to minimize compaction and exposure of bare ground in the riparian area. Plan, maintain and deactivate roads to minimize the transport of sediments to stream channels.
- Reduce windthrow by increasing buffer widths or use more selective harvest practices for windthrow-prone timber, including beetle-killed stands.
- Increase retention width and complexity around small streams, especially wider perennial streams that make significant contributions of water, sediment, debris and nutrients to downstream fish habitats, and contribute to watershed function.
- Provide training to equipment operators about the importance of streams and best practices in riparian areas. Monitor harvesting to ensure operators are utilizing methods that will minimize disturbance.

Water Quality in the Northeast Region

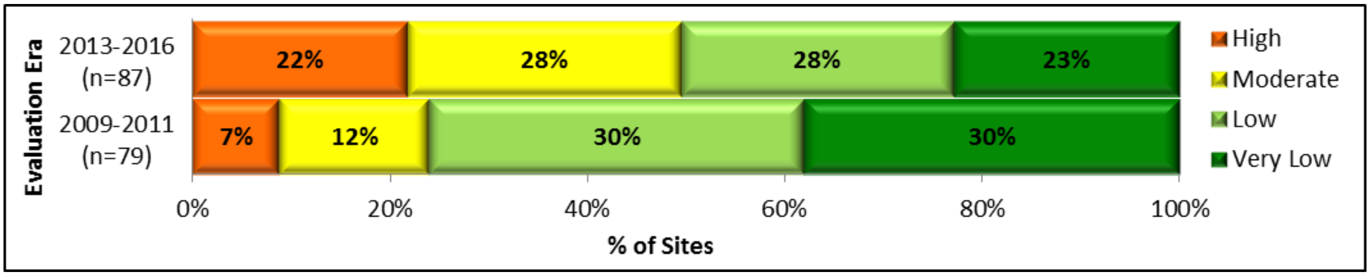


Figure 1. Percentage of sites in high, moderate, low, and very low impact categories by evaluation era.

Data Source

Assessments were conducted by trained personnel from 2009 to 2016 using the FREP water quality monitoring protocol to evaluate the potential for fine sediment transfer into streams. The sample population consists of roads and/or mass wasting sites connected to fish habitat and/or drinking water sources originating at randomly selected recently harvested cutblocks. A total of 166 samples have been collected in the Northeast Region, of which 87 represent recently evaluated sites. The number of sites sampled each year ranged from 5 to 55.

Summary

Forty-nine percent of recently evaluated sites had moderate or high potential for fine sediment transfer into streams compared to 24% of sites evaluated from 2009 to 2011 (Figure 1). Since 2009, there has been a moderate upward trend (Pearson's *r* = 0.57) in the annual percentage of sites in the moderate and high impact categories (Figure 2). This suggests that impacts to water quality from road crossings are generally increasing. It is unknown why this trend is occurring, indicating that further investigation is needed.

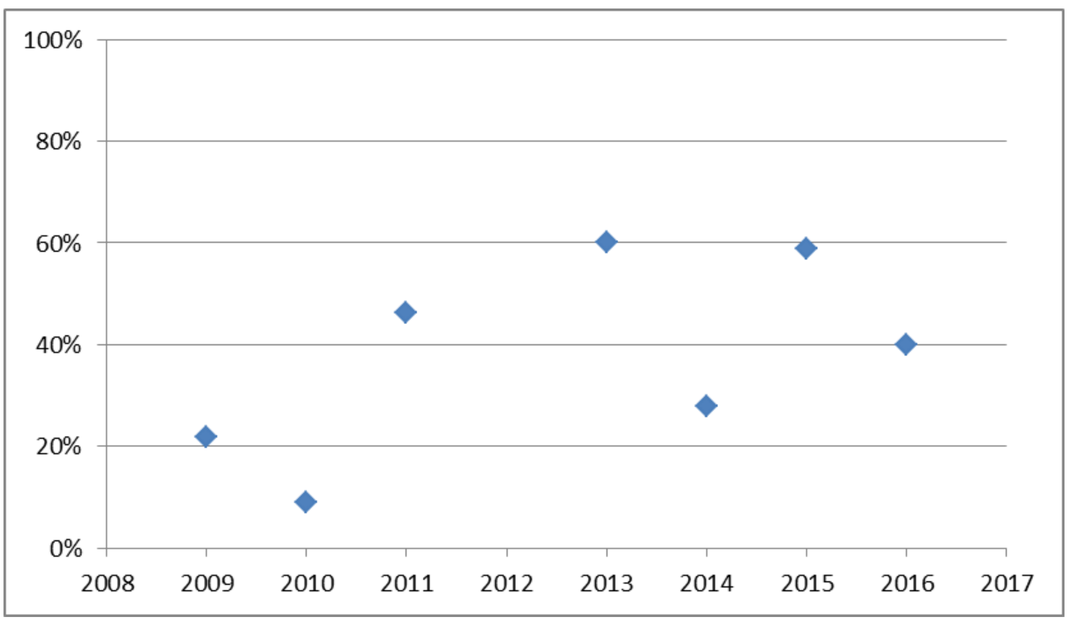


Figure 2. Percentage of sites in the moderate and high impact categories.

Causal Factors
The potential for fine sediment transfer into streams may be caused by several factors, including road location, road materials, maintenance techniques, resource road traffic, recreational activities, and storm damage.

Opportunities for Improvement of Practices to Minimize Fine Sediment Transfer to Streams

- When determining the location of roads, avoid long gradients when approaching streams to prevent drainage reaching the steam.
- Avoid the use of low quality road materials during road construction.
- Prevent storm flow incision into native soils by armoring areas of concentrated flow during harvesting.
- During road and cutblock design, ensure there are a sufficient number of properly sized and located culverts.
- Remove any berms present during road management.

Road license holders should be promptly informed of sites with moderate or high impact ratings so that they can remediate these sites.

Visual Quality in the Northeast Region

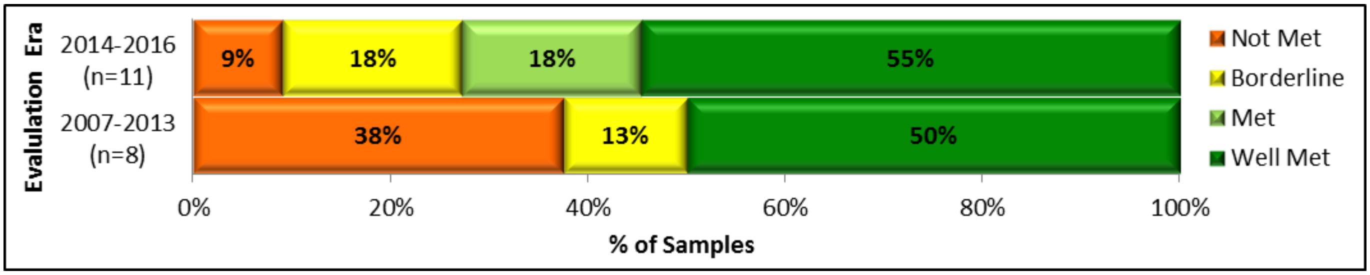


Figure 1. Percentage of landforms in each effectiveness evaluation rating category by evaluation era.

Data Source

Effectiveness evaluations were conducted by trained personnel from 2007 to 2016 using the FREP visual quality monitoring protocol to evaluate whether legally established visual quality objectives (VQOs) in designated scenic areas are being achieved. The sample population consists of landforms (distinct three-dimensional topographic features defined in perspective view) that include randomly selected cutblocks harvested under the *Forest and Range Practices Act*. A total of 19 samples have been collected in the Northeast Region, of which 11 represent recently evaluated landforms.

Summary

Seventy-three percent of recently evaluated landforms achieved *(met or well met)* the VQO compared to 50% of landforms evaluated from 2007 to 2013 (Figure 1). For recently evaluated landforms, 25% of landforms with modification VQOs and 50% of landforms with retention VQOs did not achieve the objective *(borderline or not met)* (Table 1).

Table 1. Percentage of recently evaluated landforms by visual quality objective and rating category.

Landforms Evaluated 2014-2016		Rating Category			
		Not Met	**Borderline**	**Met**	**Well Met**
Visual Quality Objective	**Max Modification (n=0)**	-	-	-	-
	Modification (n=8)	**12.5%** (1)	**12.5%** (1)	**25%** (2)	**50%** (4)
	Partial Retention (n=1)	0% (0)	0% (0)	0% (0)	**100%** (1)
	Retention (n=2)	0% (0)	**50%** (1)	0% (0)	**50%** (1)
	Preservation (n=0)	-	-	-	-

Ocular Assessment Results for Recently Evaluated Landforms

<u>Borderline/Not Met Ratings:</u> For 67% of the landforms where the VQO was not achieved, the appearance, scale and visibleness of the alteration did not meet the criteria as defined in section 1.1 of the Forest Planning and Practices Regulation (FPPR) (Table 2).
<u>Met/Well Met Ratings:</u> For 100% of the landforms where the VQO was achieved, the appearance, scale and visibleness of the alteration met the criteria as defined in FPPR s.1.1 (Table 2).

Table 2. Achievement of criteria (appearance, scale and visibleness) defined in section 1.1 of the Forest Planning and Practices Regulation (FPPR) for recently evaluated landforms.

Landforms Evaluated 2014-2016		Criteria in FPPR Definition	
		Not Met	Met
Effectiveness Evaluation Rating	Borderline/Not Met	67%	33%
	Met/Well Met	0%	100%

Percent Alteration Assessment Results for Recently Evaluated Landforms

***Borderline/Not Met Ratings*: Initial percent alteration exceeded the upper limit of the range for the established VQO for 67% of the landforms (Table 3). Visual condition was negatively influenced by poor use of visual landscape design elements and by visual impacts of roads for 33% of the landforms (Tables 4 and 5). Additionally, in-block tree retention was not sufficient to improve visual condition for 67% of the landforms (Table 6).

***Met/Well Met Ratings*: Initial percent alteration was below or within the range for the established VQO for 100% of the landforms (Table 3). Visual condition was positively influenced by good use of visual landscape design elements and moderate in-block tree retention for 25% of the landforms (Tables 4 and 6). Additionally, roads had no visual impacts for 88% of the landforms (Table 5).

Table 3. Comparison of initial percent alteration to the range for the established VQO for recently evaluated landforms.

Landforms Evaluated 2014-2016		Initial Percent Alteration Compared to Range for Established VQO		
		Exceeded Range	Within Range	Below Range
Effectiveness Evaluation Rating	Borderline/Not Met	67%	33%	0%
	Met/Well Met	0%	50%	50%

Table 4. Use of visual landscape design elements for recently evaluated landforms.

Landforms Evaluated 2014-2016		Use of Visual Landscape Design Elements		
		Poor	Moderate	Good
Effectiveness Evaluation Rating	Borderline/Not Met	33%	33%	33%
	Met/Well Met	25%	50%	25%

Table 5. Visual impacts of roads on recently evaluated landforms.

Landforms Evaluated 2014-2016		Visual Impacts of Roads			
		Dominant	Significant	Subordinate	None
Effectiveness Evaluation Rating	Borderline/Not Met	0%	0%	33%	67%
	Met/Well Met	0%	0%	12%	88%

Table 6. In-block tree retention for recently evaluated landforms.

Landforms Evaluated 2014-2016		In-Block Tree Retention		
		Poor	Moderate	Good
Effectiveness Evaluation Rating	Borderline/Not Met	67%	33%	0%
	Met/Well Met	75%	25%	0%

Opportunities for Improvement and/or Continuation of Practices to Manage for Visual Quality

- Reduce the opening size to ensure the initial percent alteration is within the range for the established VQO.
- Increase in-block tree retention to reduce the amount of visible bare ground.

OMINECA NATURAL RESOURCE REGION

The following section presents the status of landscape-level biodiversity and the outcomes of site/stand-level monitoring for biodiversity, riparian condition, water quality, cultural heritage resources, and visual quality in the Omineca Natural Resource Region.

Status of Landscape-level Biodiversity in the Omineca Region

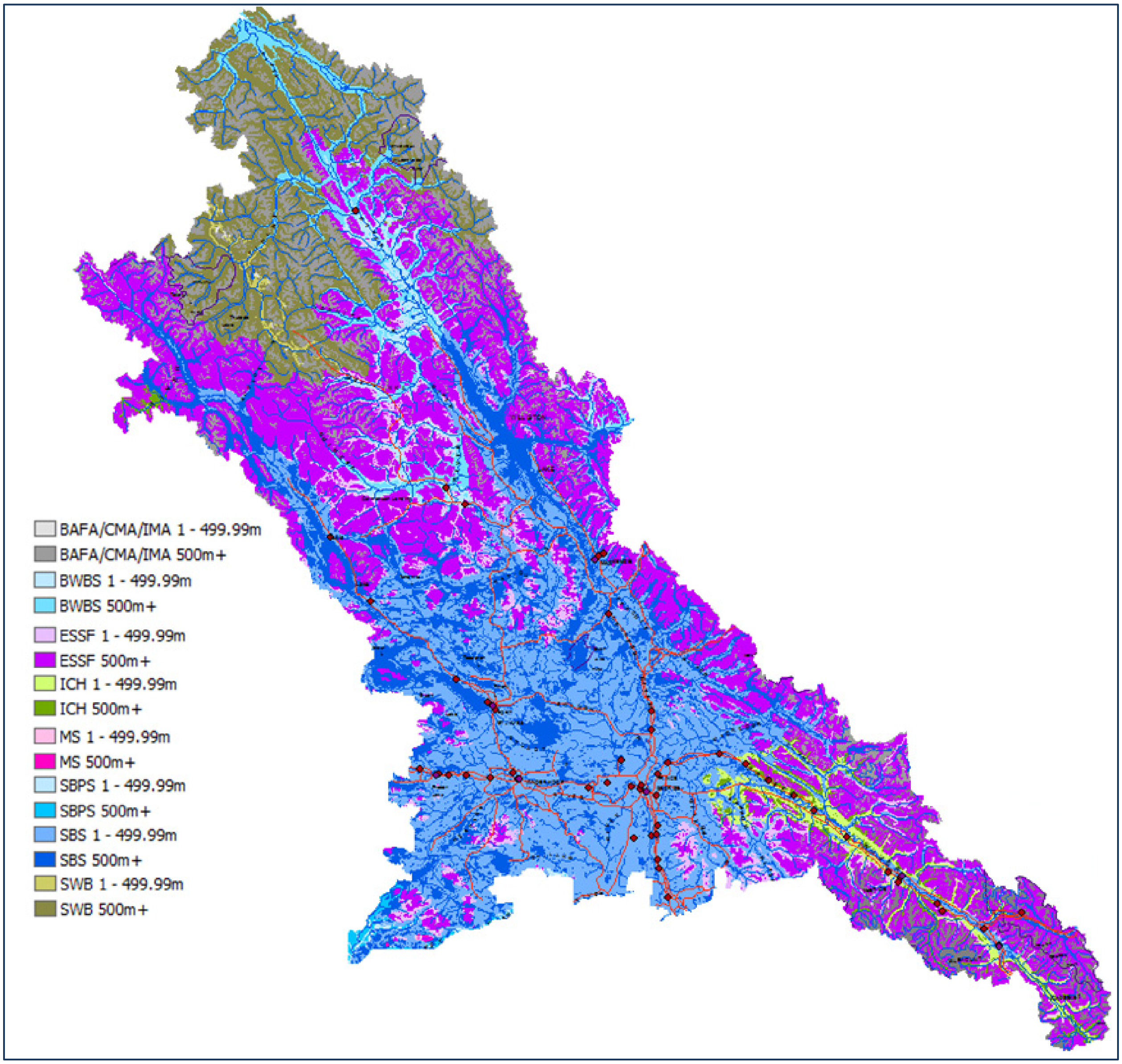


Figure 1. Distribution of roaded areas (less than 500 metres to a road) and roadless areas (500 metres or more to a road) by biogeoclimatic zone in the Omineca Region.

Data Source

The expected seral stage distribution was calculated by natural disturbance unit (NDU) using the return intervals and stand-age thresholds recommended by Delong.[7] Seral stage distributions are reported by biogeoclimatic ecosystem classification (BEC) zone (instead of by NDU) for provincial consistency. Stand age was not adjusted to account for mountain pine beetle infestation or fire. Mature and old seral stages were combined because the age classes that comprise these seral stages are not reliably classified in the provincial vegetation resource inventory. Delong provided a range of expected proportions for each seral stage, the total of those ranges not equaling 100%. This made reporting separate expected amounts of early and mid-seral forest difficult, thus these stages were also combined. An additional state, "alienated forest" (mines, tailings, spoils, gravel pits, roads, rail surfaces, cutbanks, reservoir margins, landings, airports, and urban areas) is also reported.

Publicly available corporate datasets were used to conduct the spatial analysis: BEC units (2016 version), vegetation resource inventory (stand age projected to 2017), harvest depletions (as of spring 2017), roads (as of spring 2017), mountain pine beetle infestations (up to 2017), fires (2000-2017), and "land protection designations" (current as of 2016) (i.e., old growth management areas, parks, protected areas, conservancies, no-harvest ungulate winter range, and no-harvest wildlife habitat areas).

Summary

The Omineca Region captures seven forested biogeoclimatic zones: Boreal White and Black Spruce (BWBS), Engelmann Spruce – Subalpine Fir (ESSF), Interior Cedar – Hemlock (ICH), Montane Spruce (MS), Sub-Boreal Pine – Spruce (SBPS), Sub-Boreal Spruce (SBS), and Spruce Willow Birch (SWB) (Figure 1). The amount and percentage of roadless forest (forest 500 metres or more to a road[8]) was determined for each biogeoclimatic zone (Figure 1, Table 1). For the purposes of this report, roadless forest is presumed to be less disturbed, and may have higher biodiversity value than forest within 500 metres of a road. More than half of the BWBS, ESSF, MS, SBPS and SWB zones, and less than half of the SBS and ICH zones, are comprised of roadless forest. In general, higher elevation and remote biogeoclimatic zones in the Omineca Region are largely composed of roadless forest.

Table 1. Hectares and percentage of roadless forest by biogeoclimatic zone in the Omineca Region.

Biogeoclimatic Zone	Forest ≥500m to a Road	
	Hectares (rounded to nearest 1000 ha)	Percentage
Boreal White and Black Spruce (BWBS)	520,000	67%
Engelmann Spruce – Subalpine Fir (ESSF)	3,270,000	83%
Interior Cedar – Hemlock (ICH)	152,000	37%
Montane Spruce (MS)	2,000	63%
Sub-Boreal Pine – Spruce (SBPS)	36,000	58%
Sub-Boreal Spruce (SBS)	1,244,000	24%
Spruce Willow Birch (SWB)	970,000	95%
ALL ZONES	**6,195,000**	**54%**

[7] Delong, Craig. 2011. Land Units and Benchmarks for Developing Natural Disturbance-Based Forest Management Guidance for Northeastern British Columbia. Technical Report 059.

[8] British Columbia. Ministry of Environment. 2018. Status of Roads & Roadless Area. Environmental Reporting BC. Ministry of Environment. http://www.env.gov.bc.ca/soe/indicators/land/roads.html

The observed seral stage distribution was compared to the expected seral stage distribution for each biogeoclimatic zone (Figure 2).[9] The observed amounts of mature/old forest are within the natural range of variability for the SBPS zone, equivalent to the expected minimum for the ICH and SBS zones, and equivalent to the expected maximum for the BWBS zone. The observed amount of mature/old forest exceeds the expected amount for the ESSF, MS and SWB zones, suggesting Delong's expected return intervals for the natural disturbance units that underlie these zones are either too short or fire suppression has influenced the observed seral stage distribution.

In summary, at the biogeoclimatic zone level, observed seral stage distributions are not less than the amounts expected.

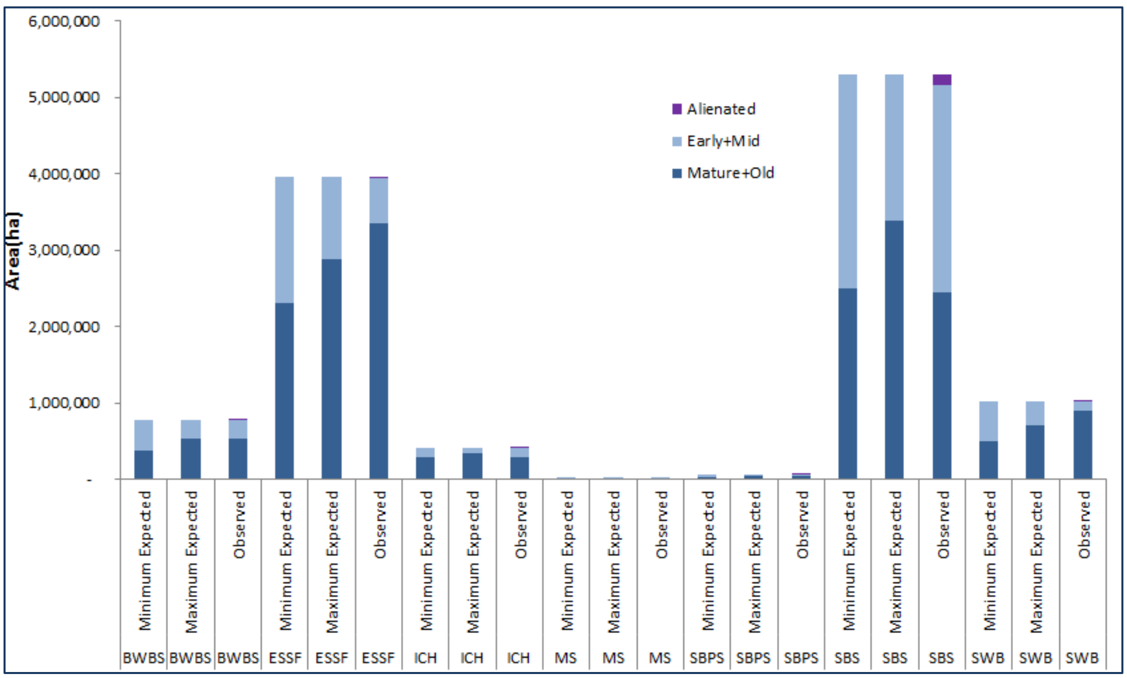


Figure 2. Expected versus observed seral stage distribution by biogeoclimatic zone in the Omenica Region.

The amount and percentage of mature/old forest protected from harvest in various resource stewardship designations was determined for each biogeoclimatic zone (Table 2). The condition of protected and unprotected mature/old forest in each zone was assessed using distance to road and natural disturbance impacts as indicators (Figures 3 and 4). Mature/old forest impacted by both mountain pine beetle and fire is reported in the appropriate fire category (2000-2016 or 2017).

In the MS and SBPS zones, 92% and 41%, respectively of mature/old forest is protected from harvest, yet these two zones constitute only 1% of the mature/old forest in the region. Of the zones with more than 100,000 hectares of mature/old forest within the region, the ESSF zone has the most protected mature old forest (41%), and the SBS zone has the least (10%). The amount of protected mature/old forest in the remaining zones ranges between 25% and 28%. In all zones, most of the protected mature/old forest is roadless. As for unprotected mature/old forest, the majority is roadless in the BWBS, ESSF MS, and SWB zones, whereas the opposite is the

[9] This is not a compliance report against legal orders and no "ecological score" has been provided. That said, the authors of the 1995 Biodiversity Guidebook argued that biodiversity can be more likely maintained if forest management seeks to retain habitat patterns and seral stages that are similar to natural landscapes.

case for the ICH, SBPS and SBS zones. The majority of mature/old forest in the BWBS and SBS zones has been impacted by mountain pine beetle. In the ESSF, ICH, and SWB zones, most of the mature/old forest has not been impacted. In summary, the mature/old forest closest to the main population centres in the region is the least protected and has been impacted the most by mountain pine beetle and/or fire.

Table 2. Hectares and percentage of mature/old forest protected from harvest by biogeoclimatic zone in the Omineca Region.

Biogeoclimatic Zone	Mature/Old Forest Protected from Harvest	
	Hectares (rounded to the nearest 1000 ha)	Percentage
Boreal White and Black Spruce (BWBS)	151,000	28%
Engelmann Spruce – Subalpine Fir (ESSF)	982,000	29%
Interior Cedar – Hemlock (ICH)	71,000	25%
Montane Spruce (MS)	3,000	92%
Sub-Boreal Pine – Spruce (SBPS)	15,000	41%
Sub-Boreal Spruce (SBS)	251,000	10%
Spruce Willow Birch (SWB)	237,000	26%
ALL ZONES	**1,709,000**	**23%**

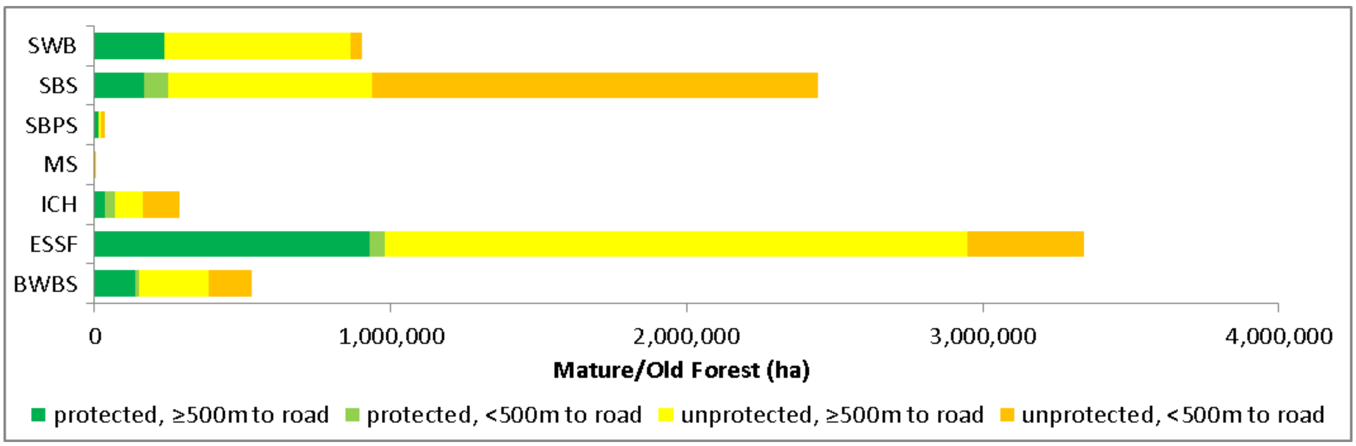


Figure 3. Hectares of protected roadless, protected roaded, unprotected roadless, and unprotected roaded mature/old forest by biogeoclimatic zone in the Omineca Region.

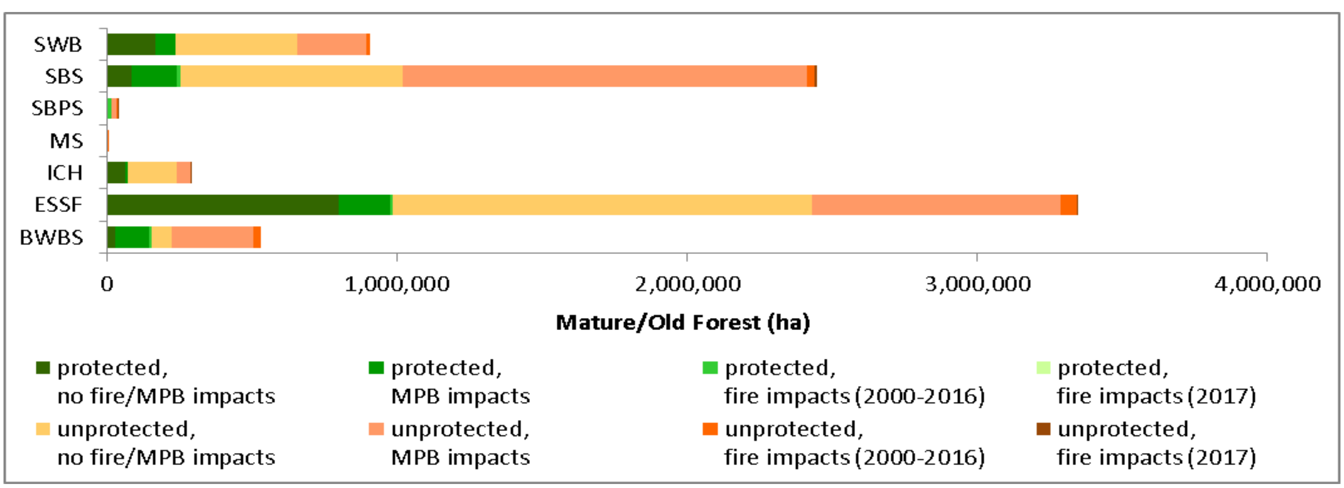


Figure 4. Hectares of protected and unprotected mature/old forest impacted by mountain pine beetle and/or fire by biogeoclimatic zone in the Omineca Region.

Post-harvest Condition of Stand-level Biodiversity in the Omineca Region

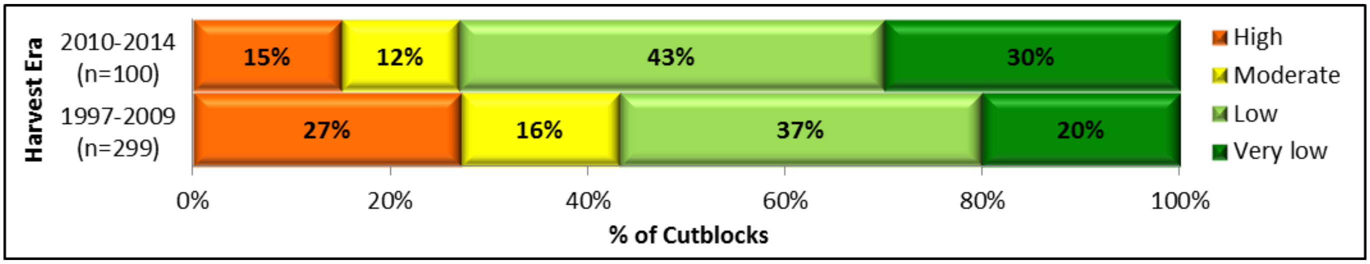


Figure 1. Quantity and type of retention by harvest era: Percentage of cutblocks in high, moderate, low, and very low impact categories.

Table 1. Quality of tree retention compared to pre-harvest benchmark by harvest era.

	Large Live Tree Density	Large Snag Density	Tree Species Diversity
2010-2014 (n=100)	Comparable	Less	Comparable
Quality Trend	***Improving***	*No Change*	***Improving***
1997-2009 (n=299)	Less	Less	Less

Table 2. Quality of coarse woody debris (CWD) retention compared to pre-harvest benchmark by harvest era.

	Large Piece Volume	Large & Long Piece Density
2010-2014 (n=100)	Comparable	Not Comparable
Quality Trend	***Improving***	*No Change*
1997-2009 (n=299)	Not Comparable	Not Comparable

Data Source

Assessments were conducted by trained personnel from 2006 to 2016 using the FREP stand-level biodiversity (SLBD) monitoring protocol to evaluate whether retention of wildlife tree patches and riparian reserves is achieving the desired levels and types of structures to maintain species diversity. The sample population consists of randomly selected cutblocks harvested from 1997 to 2014. A total of 399 SLBD samples have been collected in the Omineca Region, of which 100 represent recently harvested blocks.

Summary

Quantity and Type of Retention: The impact rating for each cutblock with respect to quantity and type of retention was determined by assessing percent of within-block retention, patch size, presence of within-patch ecological anchors, and presence of dispersed retention. If a cutblock scored greater than 80 out of 100 points, it was rated as very low impact. If a cutblock scored between 45 and 80 points, it was rated as low impact. If a cutblock scored less than 45 points, it was rated as moderate impact. If a cutblock had less than 3.5% retention (regardless of total score), it was rated as high impact.

Seventy-three percent of recently harvested cutblocks were in the low and very low impact categories compared to 57% of the sites harvested before 2011 (Figure 1). The average score has increased significantly since 1997 (Figure 2). Although average percent of within-block retention, use of ecological anchors, and use of dispersed retention did not differ significantly between harvest eras, the median patch size increased significantly on recently harvested blocks (Figure 3).

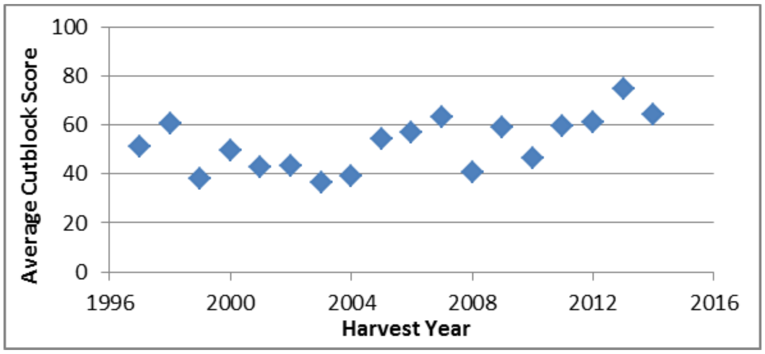


Figure 2. Average cutblock score with respect to retention quantity and type by harvest year.

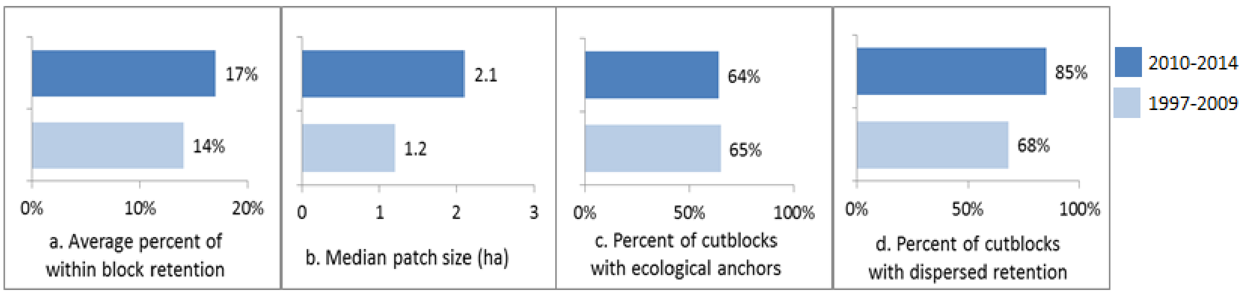


Figure 3. Quantity and type of retention by harvest era.

Quality of Tree Retention: Assessment of tree retention quality was conducted in aggregate for the entire region because pre-harvest condition is unknown for the vast majority of the blocks assessed. Assuming that timber cruise data is an appropriate surrogate for pre-harvest condition, a benchmark was adopted for each harvest era to reflect that the characteristics of the harvested stands differ between the two eras. The density of large live trees and snags (>40 or >50 or >70 cm dbh, dependent on biogeoclimatic subzone) and the diversity of tree species retained for each harvest era were compared to cruise data from approximately the same harvest era and for the same biogeoclimatic subzone (Table 1). Large tree density and tree species diversity were less than pre-harvest conditions on cutblocks harvested before 2010 but were comparable to pre-harvest conditions on recently harvested cutblocks. Large snag density was less than the benchmark for both harvest eras.

Quality of Coarse Woody Debris (CWD) Retention: An assessment of CWD retention quality was also conducted in aggregate against a pre-harvest benchmark for each harvest era. The volume of large pieces (>20cm diameter) and density of large and long pieces (>20 cm diameter, >10 m long) in harvested areas were compared to retention patches (Table 2). Large piece volume changed to reflect pre-harvest conditions on recently harvested cutblocks. Large and long piece density was not comparable to the benchmark for both harvest eras.

Opportunities for Improvement and/or Continuation of Practices to Manage Stand-level Biodiversity

- Continue to include ecological anchors within patches when available.
- Continue to leave dispersed retention throughout harvested areas.
- Continue to retain large live tree densities and tree species diversity comparable to pre-harvest conditions.
- Improve tree retention quality by leaving large snags in densities representative of pre-harvest conditions.
- Continue to retain large CWD in volumes comparable to pre-harvest conditions.
- Improve CWD retention quality by leaving large and long CWD pieces in densities representative of pre-harvest conditions.

Post-harvest Condition of Streams and Riparian Areas in the Omineca Region

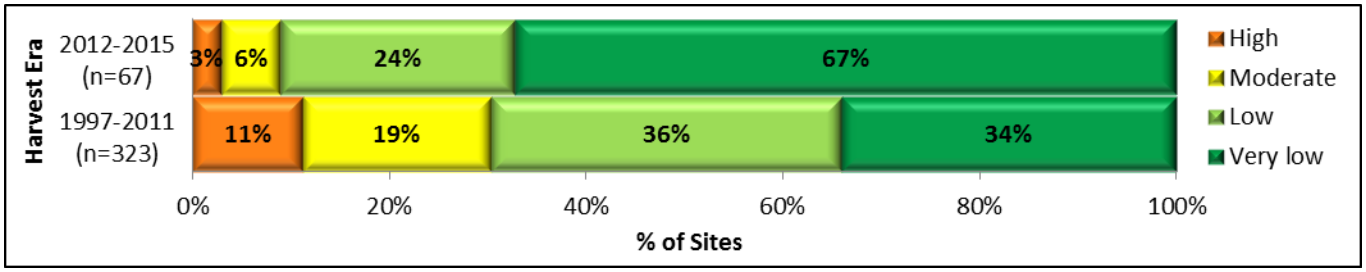


Figure 1. Percentage of sites in high, moderate, low, and very low impact categories by harvest era.

Data Source

Assessments were conducted by trained personnel from 2006 to 2016 using the FREP riparian monitoring protocol to evaluate whether riparian forestry and range practices are effective in maintaining the structural integrity and functions of stream ecosystems and other aquatic resources. The sample population includes randomly selected cutblocks with streams within or adjacent to them. A total of 390 riparian samples have been collected in the Omineca Region, of which 67 represent stream reaches harvested since 2012. Because the protocol requires a time lag of one to two winters to allow for impacts such as windthrow to manifest, there is little or no data for blocks harvested within the last two years.

Summary

Ninety-one percent of the recently harvested sites were in the low or very low impact categories compared to 70% of the sites harvested before 2012 (Figure 1). Of the 67 recently harvested sites, six were in the high or moderate impact categories. Of these, three were S6 streams, two were S4 streams, and one was an S3 stream (Table 1). One S4 stream and one S3 stream were located adjacent to the block. The remaining streams were in the cutblock.

Table 1. Number of recently harvested sites by stream class and impact category.

Stream Class	Impact Category				Total
	High	Moderate	Low	Very Low	
S1	0	0	0	0	0
S2	0	0	3	1	4
S3	1	0	7	28	36
S4	0	2	3	11	16
S5	0	0	0	0	0
S6	1	2	3	5	11
Total	**2**	**4**	**16**	**45**	**67**

Causal Factors

The largest causal factors of impacts were natural events (53%) and logging (29%) at sites that had been recently harvested (Figure 2). The average number of logging-related impacts per year ranged from 0.5 to 3.8 (Figure 3). Impacts caused by harvesting have been in a steady decline since 1997 (Pearson's *r* = -0.7).

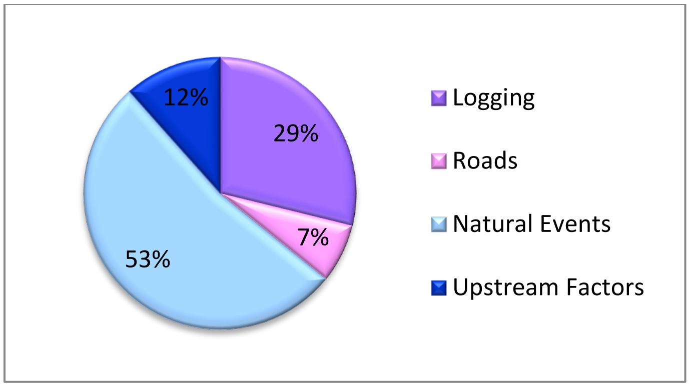


Figure 2. Percentage of impacts by causal factor at recently harvested sites.

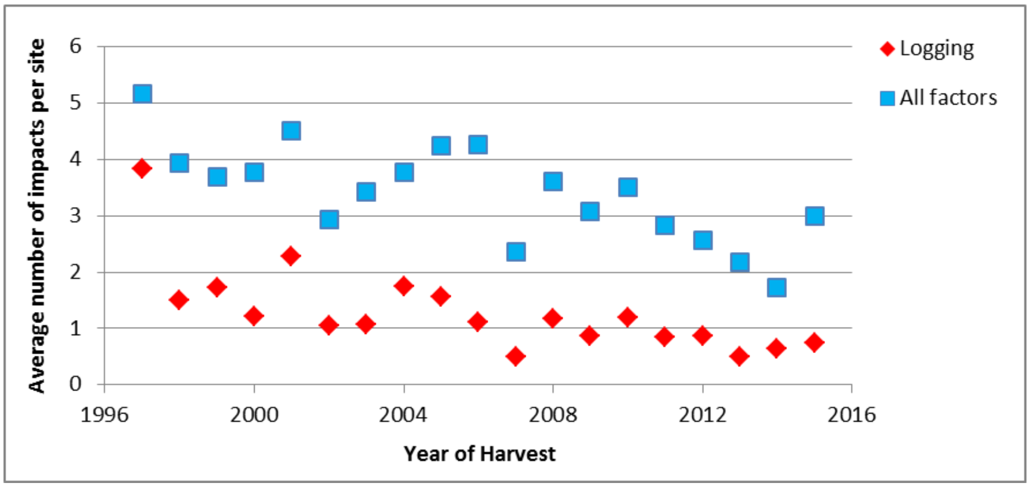


Figure 3. Average number of logging-related impacts and average number of impacts caused by all factors by year of harvest.

Specific Impacts

Natural events that contributed to impacts observed at recently harvested sites include high background sediment levels, wind, and beetle kills. These events lead to high levels of in-stream fine sediments, decreased moss abundance/condition, and blockages to aquatic connectivity (Table 2).

The most common logging-related activities that contributed to impacts observed at recently harvested sites were windthrow and low retention. These activities have been linked to excessive blowdown, reduced riparian vegetation vigour and structure, reduced large woody debris (LWD) supply/root network, and increased in-stream fine sediments (Table 2).

Table 2. Causal factors and related impacts for recently harvested sites.

% of All Factors	Most Common Specific Impacts
Natural Events (53%) *High background sediment levels* *Wind* *Beetle kills*	In-stream sediments ↑ Moss abundance/condition ↓ In-stream blockages ↑
Logging (29%) *Windthrow* *Low Retention*	Excessive blowdown ↑ Riparian vegetation form/vigour ↓ LWD supply/root network ↓ In-stream sediments ↑
Upstream Factors (12%)	In-stream sediments ↑ Moss abundance/condition ↓
Roads (7%) *Running surface eroding into stream*	Soil disturbance/bare ground ↑ In-stream sediments ↑

Opportunities for Improvement and/or Continuation of Practices that Protect Stream and Riparian Conditions

- Recognize the risk of erosion in areas that are naturally high in fine sediments. Apply strategies related to timing of harvest and methods to minimize compaction and exposure of bare ground in the riparian area. Plan, maintain and deactivate roads to minimize the transport of sediments to stream channels.
- Reduce windthrow by increasing buffer widths or use more selective harvest practices for windthrow-prone timber, including beetle-killed stands.
- Increase retention width and complexity around small streams, especially wider perennial streams that make significant contributions of water, sediment, debris and nutrients to downstream fish habitats, and contribute to watershed function.
- Provide training to equipment operators about the importance of streams and best practices in riparian areas. Monitor harvesting to ensure operators are utilizing methods that will minimize disturbance.

Water Quality in the Omineca Region

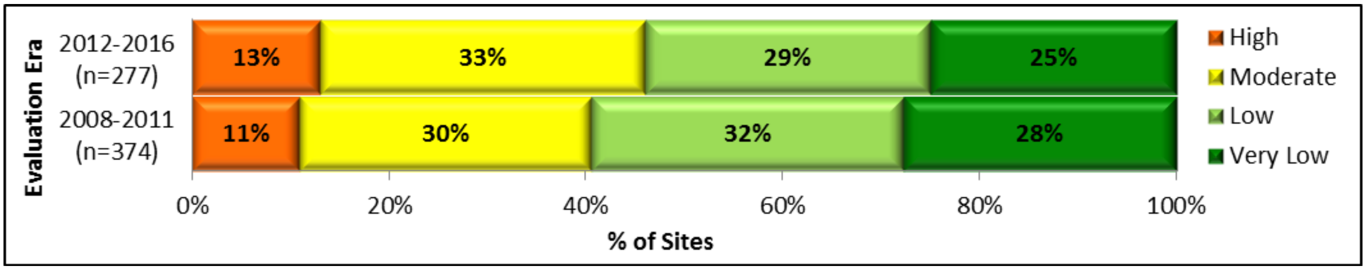


Figure 1. Percentage of sites in high, moderate, low, and very low impact categories by evaluation era.

Data Source

Assessments were conducted by trained personnel from 2008 to 2016 using the FREP water quality monitoring protocol to evaluate the potential for fine sediment transfer into streams. The sample population consists of roads and/or mass wasting sites connected to fish habitat and/or drinking water sources originating at randomly selected recently harvested cutblocks. A total of 651 samples have been collected in the Omineca Region, of which 277 represent recently evaluated sites. The number of sites sampled each year ranged from 5 to 150.

Summary

Forty-six percent of recently evaluated sites had moderate or high potential for fine sediment transfer into streams compared to 41% of sites evaluated from 2008 to 2011 (Figure 1). The annual percentage of sites in the moderate and high impact categories ranged between 20% and 59%, with no strong statistical trend (Figure 2). This suggests water quality impacts from roads are not increasing or decreasing. Although the percentage of sites in the moderate and high impact categories was notably lower in 2016 than in previous years, only five sites were sampled. Future sampling will determine if impacts remain low.

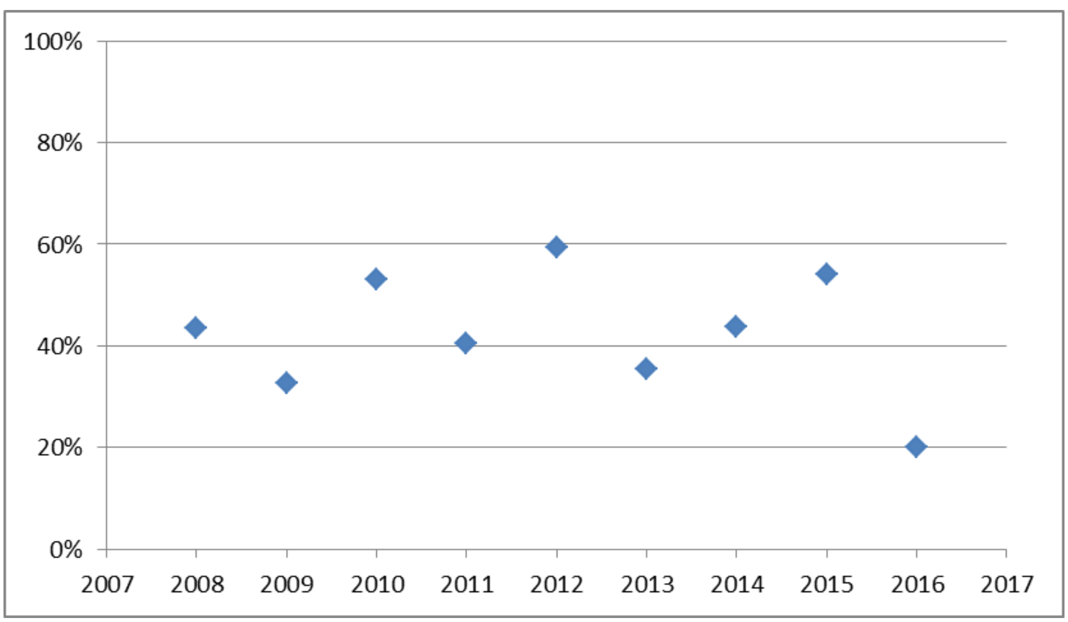


Figure 2. Percentage of sites in the moderate and high impact categories.

Causal Factors

The potential for fine sediment transfer into streams may be caused by several factors, including road location, road materials, maintenance techniques, resource road traffic, recreational activities, and storm damage.

Opportunities for Improvement of Practices to Minimize Fine Sediment Transfer to Streams

- Remove any berms present during road management.
- Prevent road rutting by using good quality material and crowning the road.
- During road and cutblock design, ensure sufficient culverts are properly placed.
- Amour, seed or spread out logging debris over disturbed areas to protect soil during harvesting and road construction.
- Avoid deep ditches near streams when designing road and cutblocks.
- Avoid long gradients approaching streams to prevent surface flow from reaching streams when planning road locations.
- Install strategically placed cross ditches, water bars, and ditch blocks to disperse storm flow when deactivating roads.

Road license holders should be promptly informed of sites with moderate or high impact ratings so that they can remediate these sites.

Post-harvest Condition of Cultural Heritage Resources in the Omineca Region

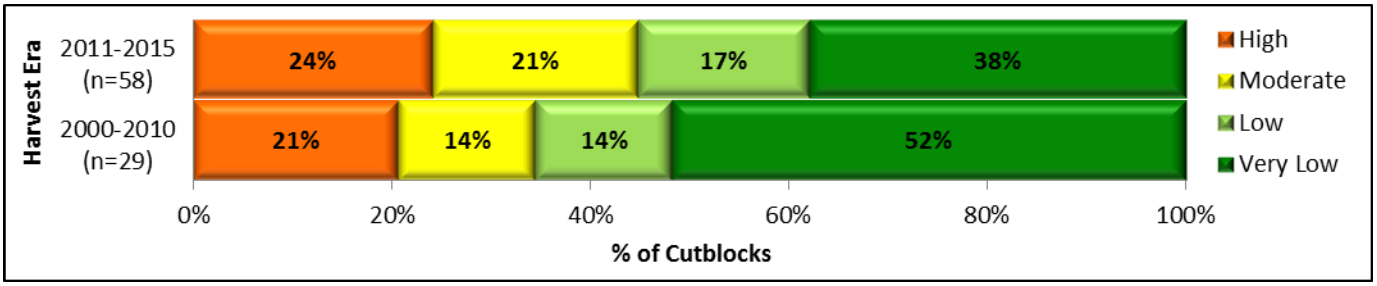


Figure 1. Percentage of cutblocks in high, moderate, low, and very low impact categories by harvest era.

Data Source

Assessments were conducted by trained personnel, often with the assistance of local First Nations and licensee forestry professionals, from 2009 to 2016 using the FREP cultural heritage resource (CHR) monitoring protocol to evaluate the conservation or protection of site-specific First Nations' CHRs. The sample population consists of randomly selected cutblocks with known CHR features as well as targeted cutblocks of special importance to First Nations. A total of 87 samples have been collected in the Fort St. James, Mackenzie, Prince George and Vanderhoof Natural Resource Districts, of which 58 represent recently harvested cutblocks. A cutblock may present more than one CHR feature – up to 20 features have been found on a single cutblock in the Omineca Region. Of the 278 features assessed to date, 171 features were assessed on recently harvested cutblocks. Features were located prior to harvest, predominantly through archaeological impact assessments (61%) and preliminary field reconnaissance (26%).

Summary

The impact rating for each cutblock is determined by assessing overall management of CHRs and protection of individual cultural features. Fifty-five percent of recently harvested cutblocks were in the low or very low impact categories compared to 66% of cutblocks harvested before 2011 (Figure 1). The most common features located on recently harvested cutblocks were archaeological resources (34%), culturally modified trees (33%), and cultural trails (18%) (Figure 2).

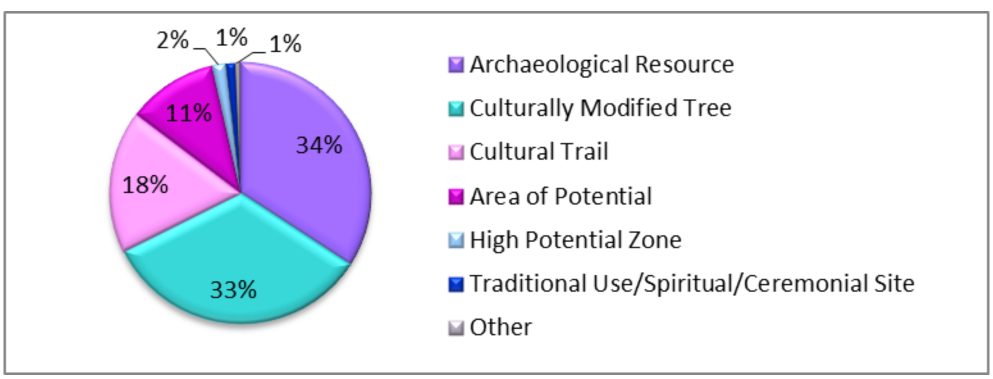


Figure 2. Percentage of CHR feature types located on recently harvested cutblocks.

Causal Factors for Recently Harvested Cutblocks

Logging activities were the main source of impacts on CHR features, although on some cutblocks there may have been combined impacts of harvesting, livestock grazing, and mountain pine beetle. Impacts were directly caused by machine disturbance and windthrow often in association with non-windfirm buffers. Operational factors limiting CHR management options were largely associated with site plans that did not allow for extended protection of CHR features, such as roads crossing cultural trails or blocks located in an area with a large abundance of culturally modified trees. Impacts were often a result of insufficient marking of features in the field prior to harvest and inaccurate location of features in records. Approximately half of the damaged features had been identified in an archaeological impact assessment and management recommendations were issued; impacts occurred when these recommendations were not followed for all features on the block.

Opportunities for Improvements and/or Continuation of Practices to Manage for Cultural Heritage Resources

- Follow the recommendations resulting from archaeological impact assessments and preliminary field reconnaissance.
- Clearly identify features in the field prior to harvest to improve visibility for machine operators.
- Include features in long-term (at least one rotation) windfirm reserves (e.g., wildlife tree retention areas) or exclude features from the harvest area by modifying cutblock boundaries.
- Ensure buffers intended to protect features are windfirm. Discuss management options and potential impacts with local First Nations prior to harvest.
- Select a management approach for culturally modified trees (e.g., stubbing above cultural mark, preserving with a windfirm buffer, or including in a reserve) based on discussions with local First Nations and consideration of site context and tree species/condition.
- Protect cultural trails by establishing machine-free zones, marking trail buffers with high stubbed lines, and identifying a limited number of designated skidder crossings of the trail.
- Implement strategies to limit livestock access to sensitive areas (e.g., use strategic fencing where cultural trails cross creeks, and limit livestock salting/feeding on cultural trails and near water).

Visual Quality in the Omineca Region

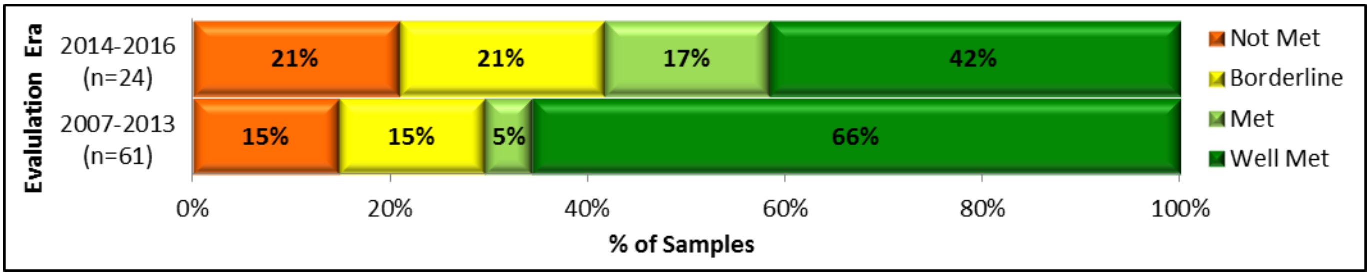


Figure 1. Percentage of landforms in each effectiveness evaluation rating category by evaluation era.

Data Source

Effectiveness evaluations were conducted by trained personnel from 2007 to 2016 using the FREP visual quality monitoring protocol to evaluate whether legally established visual quality objectives (VQOs) in designated scenic areas are being achieved. The sample population consists of landforms (distinct three-dimensional topographic features defined in perspective view) that include randomly selected cutblocks harvested under the *Forest and Range Practices Act*. A total of 85 samples have been collected in the Omineca Region, of which 24 represent recently evaluated landforms.

Summary

Fifty-nine percent of recently evaluated landforms achieved *(met or well met)* the VQO compared to 71% of landforms evaluated from 2007 to 2013 (Figure 1). For recently evaluated landforms, 50% of landforms with modification VQOs, 38% of landforms with partial retention VQOs, and 50% of landforms with retention VQOs did not achieve the objective *(borderline or not met)* (Table 1).

Table 1. Percentage of recently evaluated landforms by visual quality objective and rating category.

Landforms Evaluated 2014-2016		Rating Category			
		Not Met	**Borderline**	**Met**	**Well Met**
Visual Quality Objective	**Max Modification (n=0)**	-	-	-	-
	Modification (n=6)	**17%** (1)	**33%** (2)	**33%** (2)	**17%** (1)
	Partial Retention (n=16)	**19%** (3)	**19%** (3)	**12%** (2)	**50%** (8)
	Retention (n=2)	**50%** (1)	0% (0)	0% (0)	**50%** (1)
	Preservation (n=0)	-	-	-	-

Ocular Assessment Results for Recently Evaluated Landforms

<u>Borderline/Not Met Ratings:</u> For 70% of the landforms where the VQO was not achieved, the appearance, scale and visibleness of the alteration did not meet the criteria as defined in section 1.1 of the Forest Planning and Practices Regulation (FPPR) (Table 2).
<u>Met/Well Met Ratings:</u> For 100% of the landforms where the VQO was achieved, the appearance, scale and visibleness of the alteration met the criteria as defined in FPPR s.1.1 (Table 2).

Table 2. Achievement of criteria (appearance, scale and visibleness) defined in section 1.1 of the Forest Planning and Practices Regulation (FPPR) for recently evaluated landforms.

Landforms Evaluated 2014-2016		Criteria in FPPR Definition	
		Not Met	Met
Effectiveness Evaluation Rating	Borderline/Not Met	70%	30%
	Met/Well Met	0%	100%

Percent Alteration Assessment Results for Recently Evaluated Landforms

Borderline/Not Met Ratings: Initial percent alteration exceeded the upper limit of the range for the established VQO for 80% of the landforms (Table 3). Visual condition was negatively influenced by poor use of visual landscape design elements and by visual impacts of roads for 60% of the landforms (Tables 4 and 5). Additionally, in-block tree retention was not sufficient to improve visual condition for 40% of the landforms (Table 6).

Met/Well Met Ratings: Initial percent alteration was below or within the range for the established VQO for 100% of the landforms (Table 3). Visual condition was positively influenced by good use of visual landscape design elements and moderate/good in-block tree retention for 50% of the landforms (Tables 4 and 6). Additionally, roads had no visual impacts for 57% of the landforms (Table 5).

Table 3. Comparison of initial percent alteration to the range for the established VQO for recently evaluated landforms.

Landforms Evaluated 2014-2016		Initial Percent Alteration Compared to Range for Established VQO		
		Exceeded	Within Range	Below
Effectiveness Evaluation Rating	Borderline/Not Met	80%	20%	0%
	Met/Well Met	0%	57%	43%

Table 4. Use of visual landscape design elements for recently evaluated landforms.

Landforms Evaluated 2014-2016		Use of Visual Landscape Design Elements		
		Poor	Moderate	Good
Effectiveness Evaluation Rating	Borderline/Not Met	60%	20%	20%
	Met/Well Met	29%	21%	50%

Table 5. Visual impacts of roads on recently evaluated landforms.

Landforms Evaluated 2014-2016		Visual Impacts of Roads			
		Dominant	Significant	Subordinate	None
Effectiveness Evaluation Rating	Borderline/Not Met	0%	20%	40%	40%
	Met/Well Met	0%	7%	36%	57%

Table 6. In-block tree retention for recently evaluated landforms.

Landforms Evaluated 2014-2016		In-Block Tree Retention		
		Poor	Moderate	Good
Effectiveness Evaluation Rating	Borderline/Not Met	40%	50%	10%
	Met/Well Met	50%	29%	21%

Opportunities for Improvement and/or Continuation of Practices to Manage for Visual Quality

- Reduce the opening size to ensure the initial percent alteration is within the range for the established VQO.
- Use visual landscape design techniques to create openings that appear natural.

SKEENA NATURAL RESOURCE REGION

The following section presents the status of landscape-level biodiversity and the outcomes of site/stand-level monitoring for biodiversity, riparian condition, water quality, cultural heritage resources, and visual quality in the Skeena Natural Resource Region.

Status of Landscape-level Biodiversity in the Skeena Region

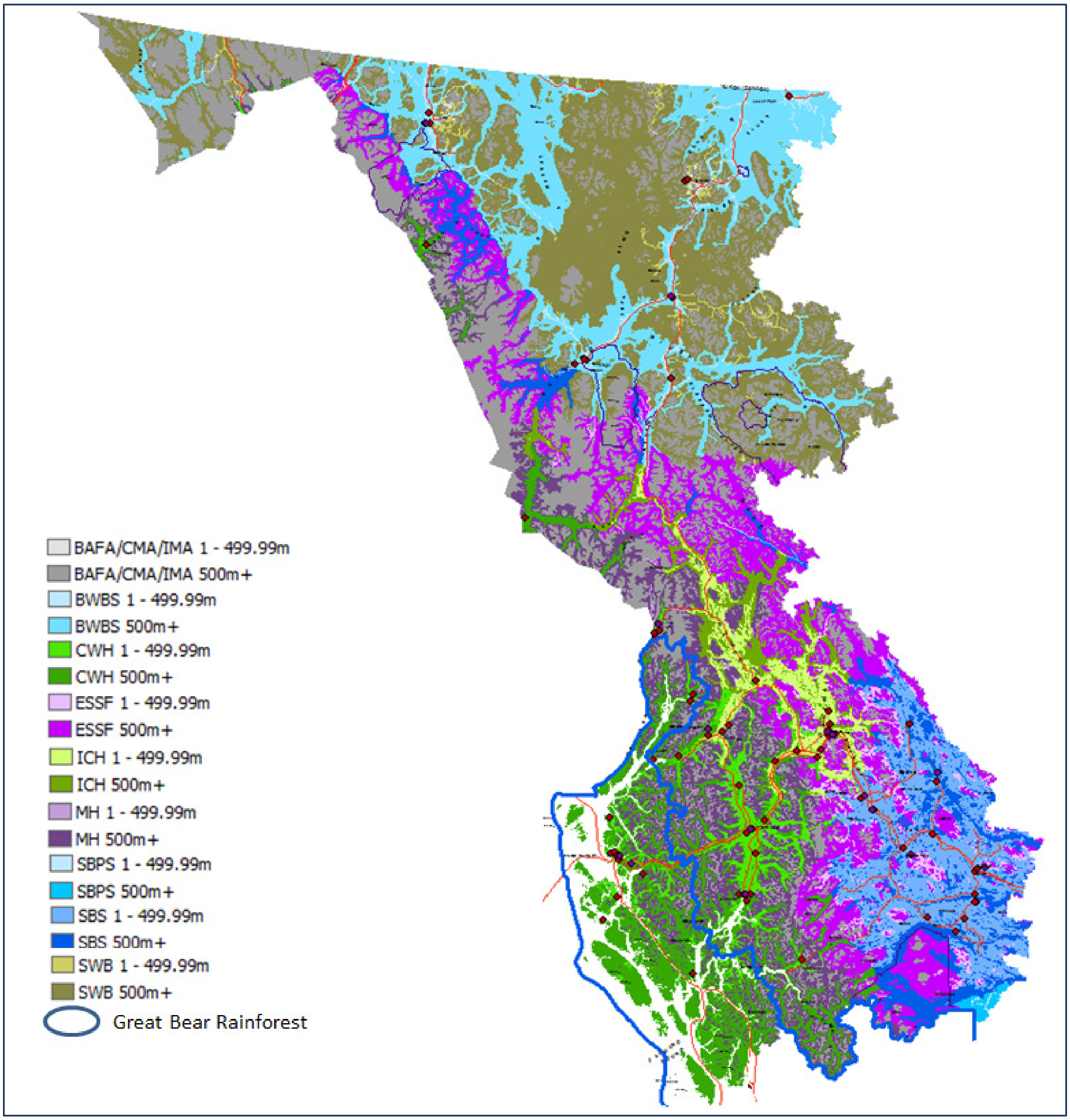


Figure 1. Distribution of roaded areas (less than 500 metres to a road) and roadless areas (500 metres or more to a road) by biogeoclimatic zone in the Skeena Region.

Data Source

For the area outside the Great Bear Rainforest, the expected seral stage distribution was calculated by natural disturbance type (NDT) and biogeoclimatic ecosystem classification (BEC) zone using the return intervals and stand-age thresholds in the *Biodiversity Guidebook*.[10] For the area within the Great Bear Rainforest, the expected seral stage distribution was calculated by NDT and BEC zone using the return intervals recommended by Price and Daust[11] and the stand-age thresholds in the *Biodiversity Guidebook*. Stand age was not adjusted to account for mountain pine beetle infestation or fire. Mature and old seral stages were combined because the age classes that comprise these seral stages are not reliably classified in the provincial vegetation resource inventory. An additional state, "alienated forest" (mines, tailings, spoils, gravel pits, roads, rail surfaces, cutbanks, reservoir margins, landings, airports, and urban areas) is also reported.

Publicly available corporate datasets were used to conduct the spatial analysis: BEC units (2016 version), vegetation resource inventory (stand age projected to 2017), harvest depletions (as of spring 2017), roads (as of spring 2017), mountain pine beetle infestations (up to 2017), fires (2000-2017), and "land protection designations" (current as of 2016) (i.e., old growth management areas, parks, protected areas, conservancies, no-harvest ungulate winter range, and no-harvest wildlife habitat areas).

Summary

The Skeena Region captures eight forested biogeoclimatic zones: Boreal White and Black Spruce (BWBS), Coastal Western Hemlock (CWH), Engelmann Spruce – Subalpine Fir (ESSF), Interior Cedar – Hemlock (ICH), Mountain Hemlock (MH), Sub-Boreal Pine – Spruce (SBPS), Sub-Boreal Spruce (SBS), and Spruce – Willow – Birch (SWB) (Figure 1). The amount and percentage of roadless forest (forest 500 metres or more to a road[12]) was determined for each biogeoclimatic zone (Figure 1, Table 1). For the purposes of this report, roadless forest is presumed to be less disturbed, and may have higher biodiversity value than forest within 500 metres of a road. More than half of the BWBS, CWH, ESSF, MH and SBPS zones, and less than half of the ICH, SBS and SWB zones, are comprised of roadless forest. In general, the Skeena Region (like the West Coast Region) captures more biogeoclimatic zones largely composed of roadless forest than other regions.

Table 1. Hectares and percentage of roadless forest by biogeoclimatic zone in the Skeena Region.

Biogeoclimatic Zone	Forest ≥500m to a Road	
	Hectares (rounded to the nearest 1000 ha)	Percentage
Boreal White and Black Spruce (BWBS)	2,130,000	91%
Coastal Western Hemlock (CWH)	1,490,000	74%
Engelmann Spruce – Subalpine Fir (ESSF)	1,518,000	84%
Interior Cedar – Hemlock (ICH)	425,000	45%
Mountain Hemlock (MH)	725,000	94%
Sub-Boreal Pine – Spruce (SBPS)	45,000	90%
Sub-Boreal Spruce (SBS)	729,000	34%
Spruce – Willow – Birch (SWB)	1,608,000	44%
ALL ZONES	**8,670,000**	**50%**

[10] Anonymous. 1995. Biodiversity Guidebook. Forest Practices Code of British Columbia. Victoria BC. Ministry of Forests, Ministry of Environment. https://www.for.gov.bc.ca/hfd/library/documents/bib19715.pdf.

[11] Price, Karen, and Dave Daust. 2003. The Frequency of Stand-Replacing Natural Disturbance in the CIT Area. Coast Information Team. https://www.for.gov.bc.ca/tasb/slrp/citbc/b-DistFreq-PriceDaust-Oct03.pdf.

[12] British Columbia. Ministry of Environment. 2018. Status of Roads & Roadless Area. Environmental Reporting BC. Ministry of Environment. http://www.env.gov.bc.ca/soe/indicators/land/roads.html

The observed seral stage distribution was compared to the expected seral stage distribution for each biogeoclimatic zone within the Great Bear Rainforest (Figure 2a).[13] Only trace amounts of the ESSF and SBS zones exist within the mapped boundaries of the Great Bear Rainforest, hence the lack of discernable area for these zones in Figure 2a. In all zones, the observed amount is similar to the expected amount for all seral stages.

The observed seral stage distribution was also compared to the expected seral stage distribution for each biogeoclimatic zone outside of the Great Bear Rainforest (Figure 2b). In all zones, the observed amount of mature/old forest exceeds the expected amount, suggesting that the return intervals in the *Biodiversity Guidebook* may be too short.

In summary, at the biogeoclimatic zone level, observed seral stage distributions are not less than the amounts expected.

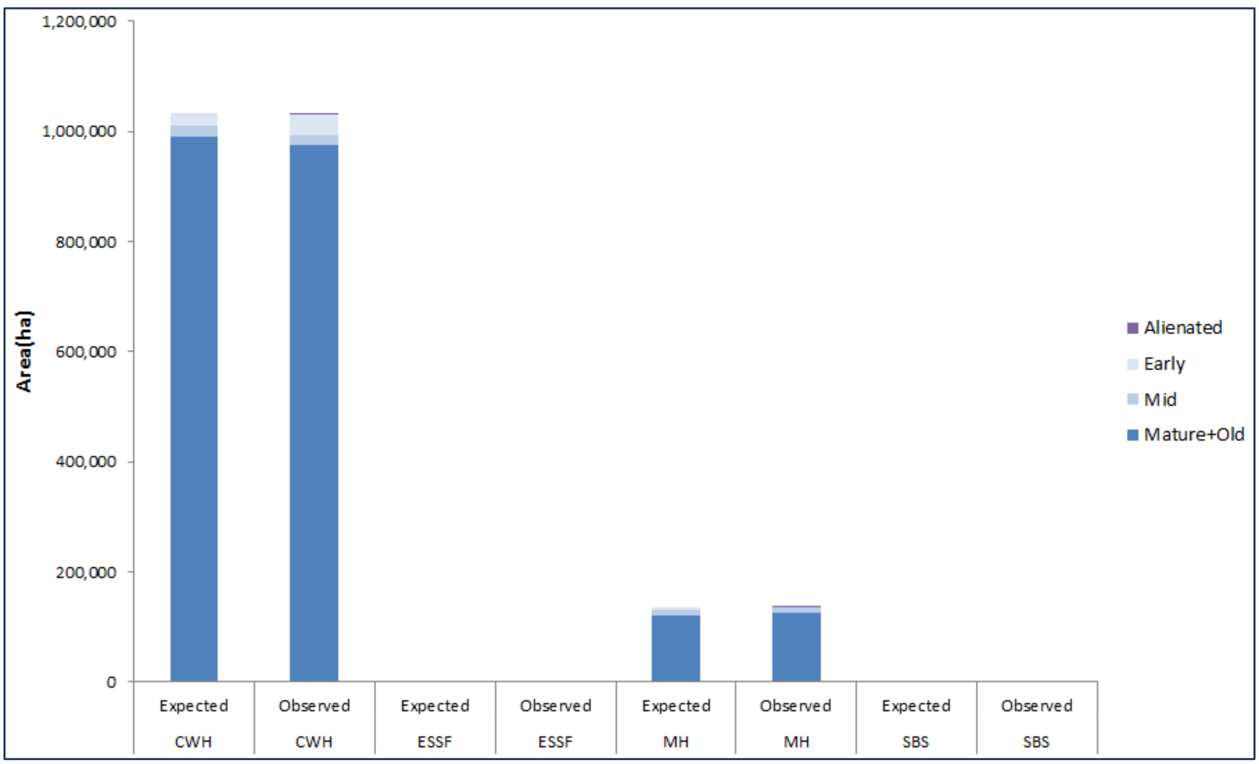


Figure 2a. Expected versus observed seral stage distribution by biogeoclimatic zone within the Great Bear Rainforest in the Skeena Region.

[13] This is not a compliance report against legal orders and no "ecological score" has been provided. That said, the authors of the 1995 Biodiversity Guidebook argued that biodiversity can be more likely maintained if forest management seeks to retain habitat patterns and seral stages that are similar to natural landscapes.

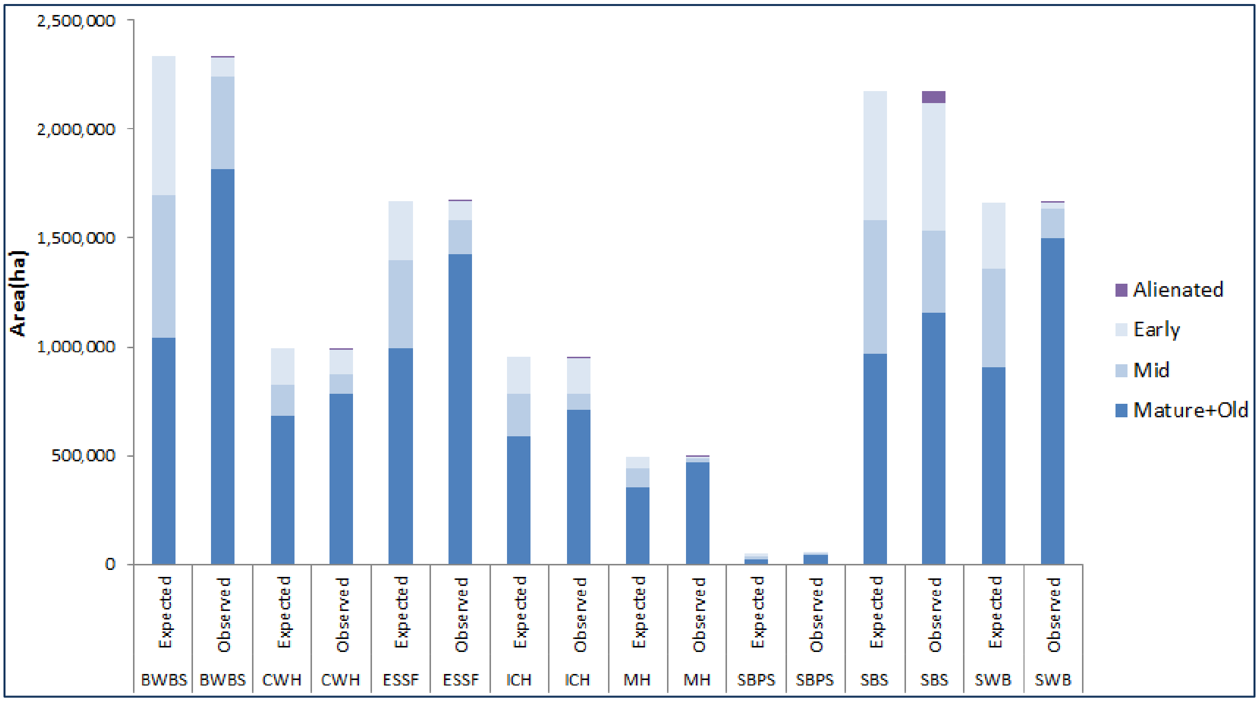


Figure 2b. Expected versus observed seral stage distribution by biogeoclimatic zone outside the Great Bear Rainforest in the Skeena Region.

The amount and percentage of mature/old forest protected from harvest in various resource stewardship designations was determined for each biogeoclimatic zone (Table 2). The condition of protected and unprotected mature/old forest in each zone was assessed using distance to road and natural disturbance impacts as indicators (Figures 3 and 4). Mature/old forest impacted by both mountain pine beetle and fire is reported in the appropriate fire category (2000-2016 or 2017).

All of the mature/old forest in the SBPS zone is protected from harvest. Although the proportion of protected mature/old forest in the remaining zones is substantially lower, (ranging from 16% in the ICH zone to 31% in the BWBS zone), the physical area protected is much greater. Almost all of the protected mature/old forest is roadless. Except for the SBS and ICH zones, most of the unprotected mature/old forest is roadless.

With the exception of the SBS zone, most of the mature/old forest in the Skeena region has not been impacted by mountain pine beetle and/or fire. In the SBS zone, protected and unprotected mature/old forest was equally impacted, mostly by mountain pine beetle.

In summary, this suggests the Skeena Region is relatively undeveloped compared to other parts of the province. That said, reporting at the biogeoclimatic zone level for zones that have a large north/south range hides pockets of local development.

Table 2. Hectares and percentage of mature/old forest protected from harvest by biogeoclimatic zone in the Skeena Region.

Biogeoclimatic Zone	Mature/Old Forest Protected from Harvest	
	Hectares (rounded to nearest 1000 ha)	Percentage
Boreal White and Black Spruce (BWBS)	564,000	31%
Coastal Western Hemlock (CWH)	500,000	28%
Engelmann Spruce – Subalpine Fir (ESSF)	412,000	29%
Interior Cedar – Hemlock (ICH)	116,000	16%
Mountain Hemlock (MH)	141,000	24%
Sub-Boreal Pine – Spruce (SBPS)	40,000	100%
Sub-Boreal Spruce (SBS)	309,000	27%
Spruce – Willow – Birch (SWB)	340,000	23%
ALL ZONES	**2,423,000**	**27%**

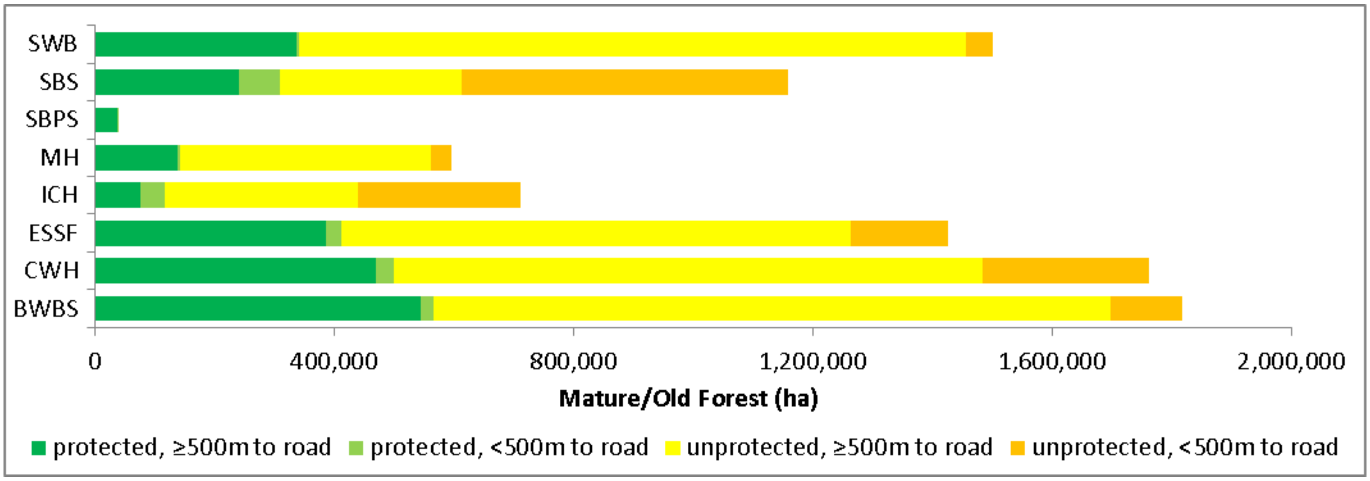


Figure 3. Hectares of protected roadless, protected roaded, unprotected roadless, and unprotected roaded mature/old forest by biogeoclimatic zone in the Skeena Region.

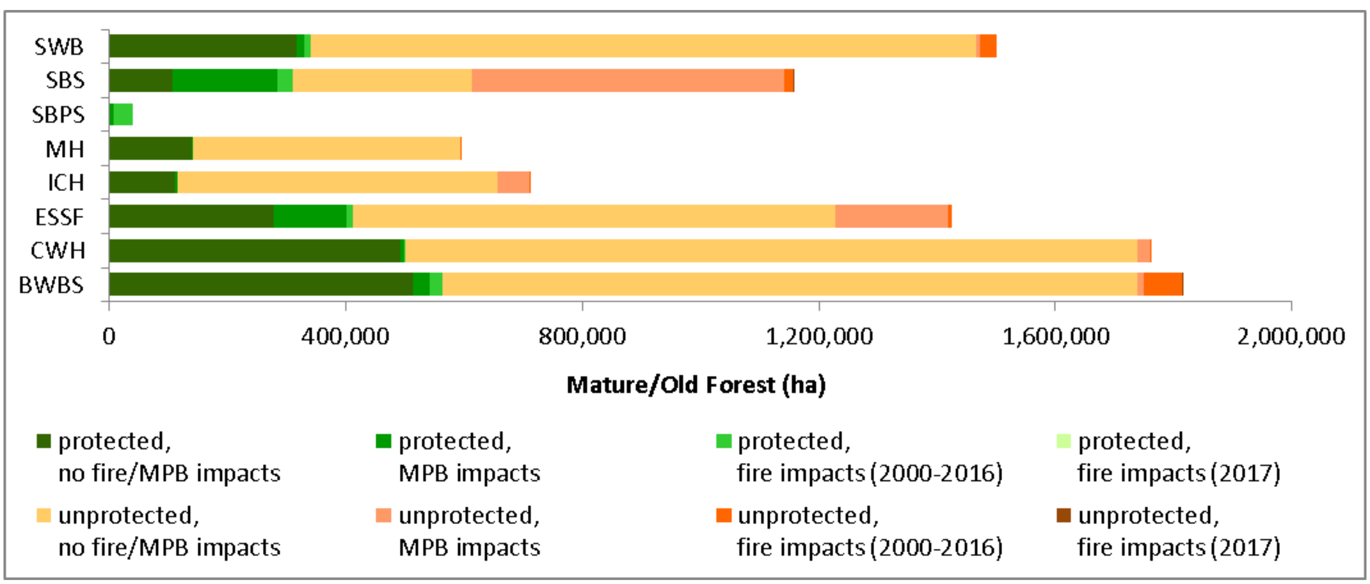


Figure 4. Hectares of protected and unprotected mature/old forest impacted by mountain pine beetle and/or fire by biogeoclimatic zone in the Skeena Region.

Post-harvest Condition of Stand-level Biodiversity in the Skeena Region

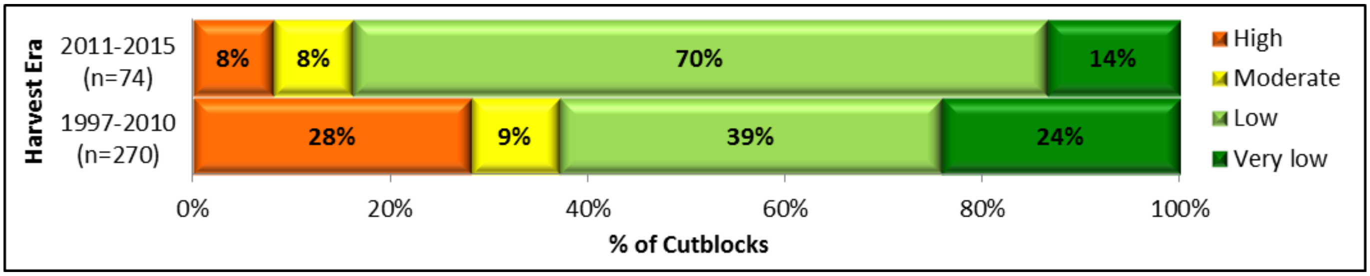


Figure 1. Quantity and type of retention by harvest era: Percentage of cutblocks in high, moderate, low, and very low impact categories.

Table 1. Quality of tree retention compared to pre-harvest benchmark by harvest era.

	Large Live Tree Density	**Large Snag Density**	**Tree Species Diversity**
2011-2015 (n=74)	Less	Comparable	Less
Quality Trend	*No Change*	***Improving***	*No Change*
1997-2010 (n=270)	Less	Less	Less

Table 2. Quality of coarse woody debris (CWD) retention compared to pre-harvest benchmark by harvest era.

	Large Piece Volume	**Large & Long Piece Density**
2011-2015 (n=74)	Comparable	Comparable
Quality Trend	***Improving***	*No Change*
1997-2010 (n=270)	Not Comparable	Comparable

Data Source

Assessments were conducted by trained personnel from 2006 to 2016 using the FREP stand-level biodiversity (SLBD) monitoring protocol to evaluate whether retention of wildlife tree patches and riparian reserves is achieving the desired levels and types of structures to maintain species diversity. The sample population consists of randomly selected cutblocks harvested from 1997 to 2015. A total of 344 SLBD samples have been collected in the Skeena Region, of which 74 represent recently harvested blocks.

Summary

Quantity and Type of Retention: The impact rating for each cutblock with respect to quantity and type of retention was determined by assessing percent of within-block retention, patch size, presence of within-patch ecological anchors, and presence of dispersed retention. If a cutblock scored greater than 80 out of 100 points, it was rated as very low impact. If a cutblock scored between 45 and 80 points, it was rated as low impact. If a cutblock scored less than 45 points, it was rated as moderate impact. If a cutblock had less than 3.5% retention (regardless of total score), it was rated as high impact.

Eighty-four percent of recently harvested cutblocks were in the low and very low impact categories compared to 63% of the sites harvested before 2011 (Figure 1). The average score has increased significantly since 1997 (Figure 2). Although the average percent of within-block retention and median patch size did not differ significantly between harvest eras, the use of ecological anchors and dispersed retention increased significantly on recently harvested cutblocks (Figure 3).

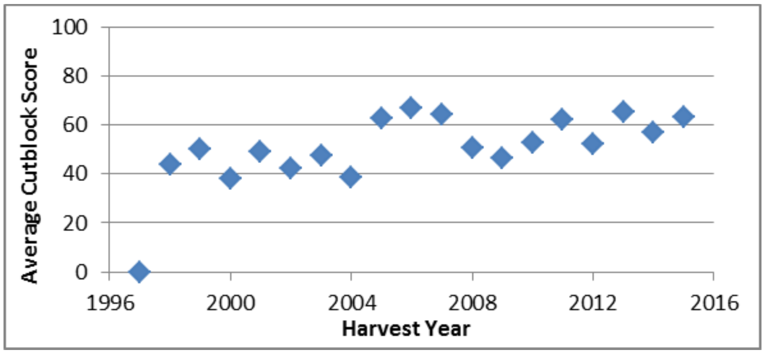


Figure 2. Average cutblock score with respect to retention quantity and type by harvest year.

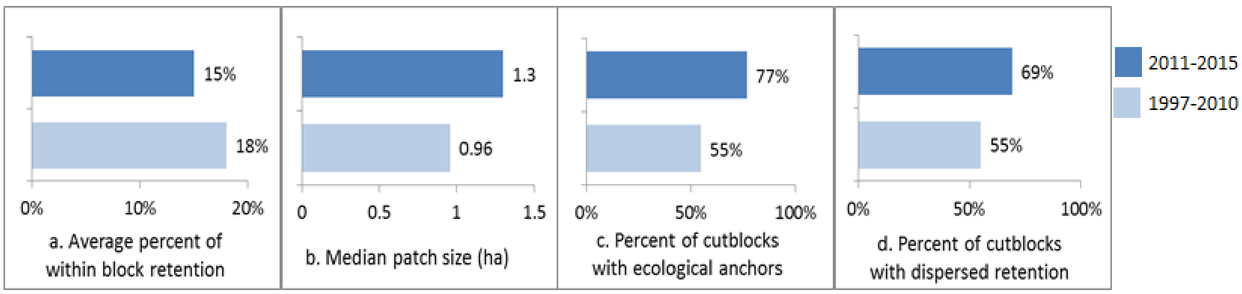


Figure 3. Quantity and type of retention by harvest era.

<u>Quality of Tree Retention:</u> Assessment of tree retention quality was conducted in aggregate for the entire region because pre-harvest condition is unknown for the vast majority of the blocks assessed. Assuming that timber cruise data is an appropriate surrogate for pre-harvest condition, a benchmark was adopted for each harvest era to reflect that the characteristics of the harvested stands differ between the two eras. The density of large live trees and snags (>40 or >50 or >70 cm dbh, dependent on biogeoclimatic subzone) and diversity of tree species retained for each harvest era were compared to cruise data from approximately the same harvest era and for the same biogeoclimatic subzone (Table 1). Large live tree density and tree species diversity were less than the pre-harvest condition for both harvest eras. Large snag density was less than pre-harvest conditions on cutblocks harvested before 2011 but was comparable to the benchmark on recently harvested cutblocks.

<u>Quality of Coarse Woody Debris (CWD) Retention:</u> An assessment of CWD retention quality was also conducted in aggregate against a pre-harvest benchmark for each harvest era. The volume of large pieces (>20 or >30 cm diameter, dependent on biogeoclimatic zone) and density of large and long pieces (>20 cm diameter, >10 m long) in harvested areas were compared to retention patches (Table 2). Large piece volume changed to reflect pre-harvest conditions on recently harvested cutblocks. Large and long piece density was comparable to the benchmark for both harvest eras.

Opportunities for Improvement and/or Continuation of Practices to Manage Stand-level Biodiversity

- Continue to include ecological anchors within patches when available.
- Continue to leave dispersed retention throughout harvested areas.
- Continue to leave large snags in densities comparable to pre-harvest conditions.
- Improve tree retention quality by leaving densities of large live trees and diversity of tree species representative of pre-harvest conditions.
- Continue to retain large CWD in volumes comparable to pre-harvest conditions.
- Continue to retain large and long CWD pieces in densities comparable to pre-harvest conditions.

Post-harvest Condition of Streams and Riparian Areas in the Skeena Region

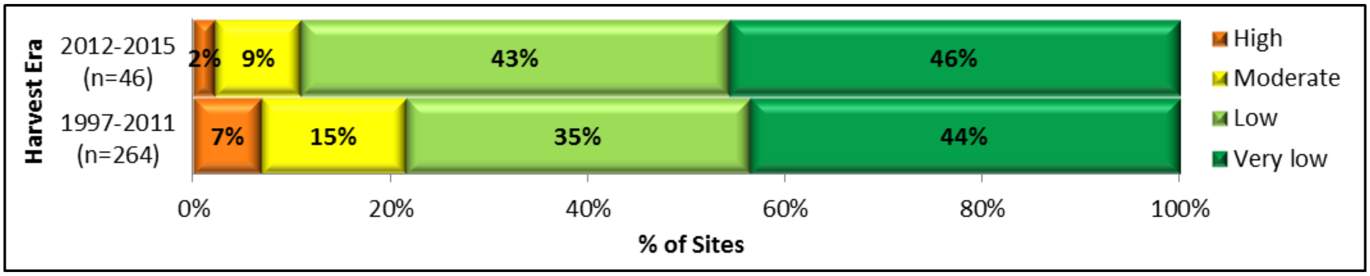


Figure 1. Percentage of sites in high, moderate, low, and very low impact categories by harvest era.

Data Source

Assessments were conducted by trained personnel from 2006 to 2016 using the FREP riparian monitoring protocol to evaluate whether riparian forestry and range practices are effective in maintaining the structural integrity and functions of stream ecosystems and other aquatic resources. The sample population includes randomly selected cutblocks with streams within or adjacent to them. A total of 310 riparian samples have been collected in the Skeena Region, of which 46 represent stream reaches harvested since 2012. Because the protocol requires a time lag of one to two winters to allow for impacts such as windthrow to manifest, there is little or no data for blocks harvested within the last two years.

Summary

Eighty-nine percent of the recently harvested sites were in the low or very low impact categories compared to 79% of the sites harvested before 2012 (Figure 1). Of the 46 recently harvested sites, five were in the high or moderate impact categories. Of these, three were S6 streams, one was an S5 stream, and one was an S3 stream (Table 1). One S6 stream was located within the block. The remaining streams were located adjacent to the cutblock.

Table 1. Number of recently harvested sites by stream class and impact category.

Stream Class	Impact Category				Total
	High	Moderate	Low	Very Low	
S1	0	0	1	1	2
S2	0	0	3	2	5
S3	0	1	4	3	8
S4	0	0	6	5	11
S5	0	1	0	2	3
S6	1	2	6	8	17
Total	**1**	**4**	**20**	**21**	**46**

Causal Factors

The largest causal factors of impacts were natural events (45%), roads (27%), and logging (23%) at sites that had been recently harvested (Figure 2). The average number of logging-related impacts per year ranged from 0.1 to 2.7 (Figure 3). There is no statistical trend when considering all data points over time; however, if sites harvested before 2000 are not included, the impacts caused by harvesting have been in steady decline (Pearson's r = -0.77).

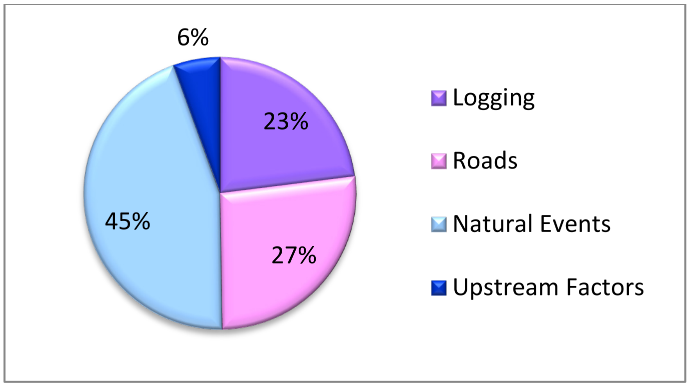


Figure 2. Percentage of impacts by causal factor at recently harvested sites.

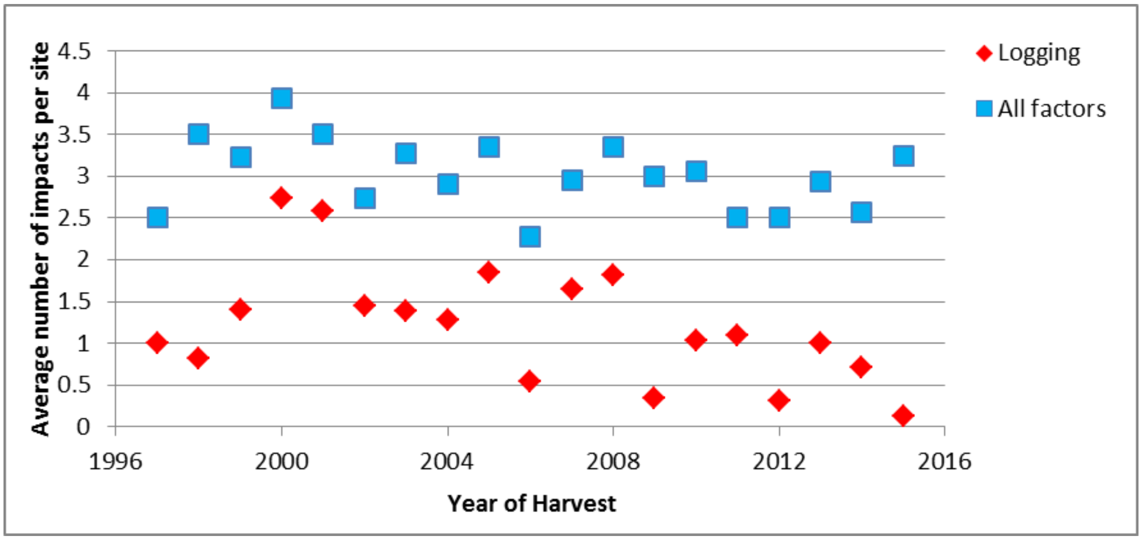


Figure 3. Average number of logging-related impacts and average number of impacts caused by all factors by year of harvest.

Specific Impacts

Natural events that contributed to impacts observed at recently harvested sites include wind, floods, and high background sediment levels. These events lead to high levels of in-stream fine sediments, blockages to aquatic connectivity, decreased moss abundance/condition, and increased channel bed disturbance (Table 2).
The most common road-related activities that contributed to impacts observed at recently harvested sites include running surfaces, ditches, and fill/cut slopes eroding into streams. These activities have been linked to higher levels of in-stream fine sediments, blockages to aquatic connectivity, and increased soil disturbance/bare ground (Table 2).

The most common logging-related activities that contributed to impacts observed at recently harvested sites include windthrow, low retention, and old logging. These activities have been linked to reduced riparian vegetation vigour and structure, excessive blowdown, blockages to aquatic connectivity, increased in-stream fine sediments, and reduced large woody debris (LWD) supply (Table 2). Although old logging is not a result of recent management decisions, it remains a logging-related causal factor in the protocol. However, if all other indicator questions are given positive responses and there is retention of second-growth forest in the riparian area, historic logging alone will not be enough to downgrade the stream from properly functioning condition. Second-growth forests are potentially less resilient and more susceptible to disturbance because the dense canopy of second-growth stands often limits understory growth. Thus, removing riparian timber in these stands could have a greater effect on stream bed/bank stability than harvesting older stands with more complex root networks.

Table 2. Causal factors and related impacts for recently harvested sites.

% of All Factors	Most Common Specific Impacts
Natural Events (45%) *Wind* *Floods* *High background sediment levels*	In-stream sediments ↑ In-stream blockages ↑ Moss abundance/condition ↓ Channel bed disturbance ↑
Roads (27%) *Running surface eroding into stream* *Ditches eroding into stream* *Fill or cut slopes eroding into stream*	In-stream sediments ↑ In-stream blockages ↑ Soil disturbance/bare ground ↑
Logging (23%) *Windthrow* *Low Retention* *Old Logging*	Riparian vegetation form/ vigour↓ Excessive blowdown ↑ In-stream blockages ↑ In-stream sediments ↑ LWD supply ↓
Upstream Factors (6%)	In-stream sediments ↑

Opportunities for Improvement and/or Continuation of Practices that Protect Stream and Riparian Conditions

- Recognize the risk of erosion in areas that are naturally high in fine sediments. Apply strategies related to the timing of harvest and methods to minimize compaction and exposure of bare ground in the riparian area. Plan, maintain, and deactivate roads to minimize the transport of sediments to stream channels.
- Account for the reduced resiliency of second-growth forests by maintaining a treed buffer where riparian logging has previously occurred.
- Reduce windthrow by increasing buffer widths or use more selective harvest practices for windthrow-prone timber.
- Increase retention width and complexity around small streams, especially wider perennial streams that make significant contributions of water, sediment, debris, and nutrients to downstream fish habitats, and contribute to watershed function.
- Provide training to equipment operators about the importance of streams and best practices in riparian areas. Monitor harvesting to ensure operators are utilizing methods that will minimize disturbance.

Water Quality in the Skeena Region

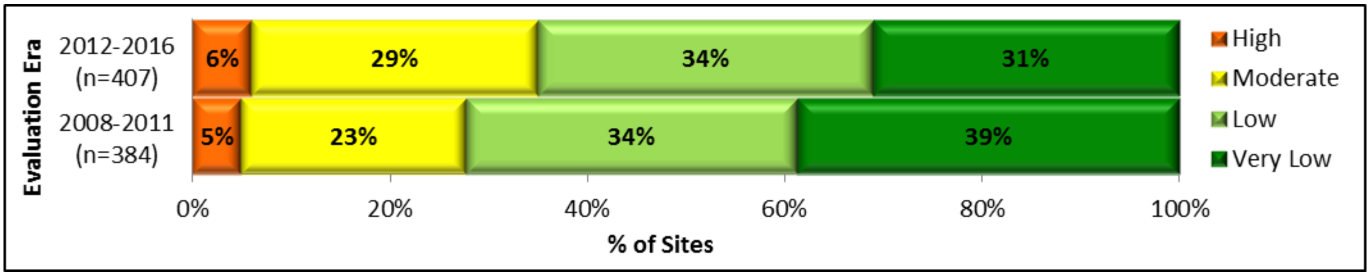


Figure 1. Percentage of sites in high, moderate, low, and very low impact categories by evaluation era.

Data Source

Assessments were conducted by trained personnel from 2008 to 2016 using the FREP water quality monitoring protocol to evaluate the potential for fine sediment transfer into streams. The sample population consists of roads and/or mass wasting sites connected to fish habitat and/or drinking water sources originating at randomly selected recently harvested cutblocks. A total of 791 samples have been collected in the Skeena Region, of which 407 represent recently evaluated sites. The number of sites sampled each year ranged from 43 to 129.

Summary

Thirty-five percent of recently evaluated sites had moderate or high potential for fine sediment transfer into streams compared to 28% of sites evaluated from 2008 to 2011 (Figure 1). Since 2008, there has been a moderate upward trend (Pearson's $r = 0.46$) in the annual percentage of sites in the moderate and high impact categories (Figure 2). This suggests that impacts to water quality from road crossings are generally increasing. It is unknown why this trend is occurring, indicating that further investigation is needed.

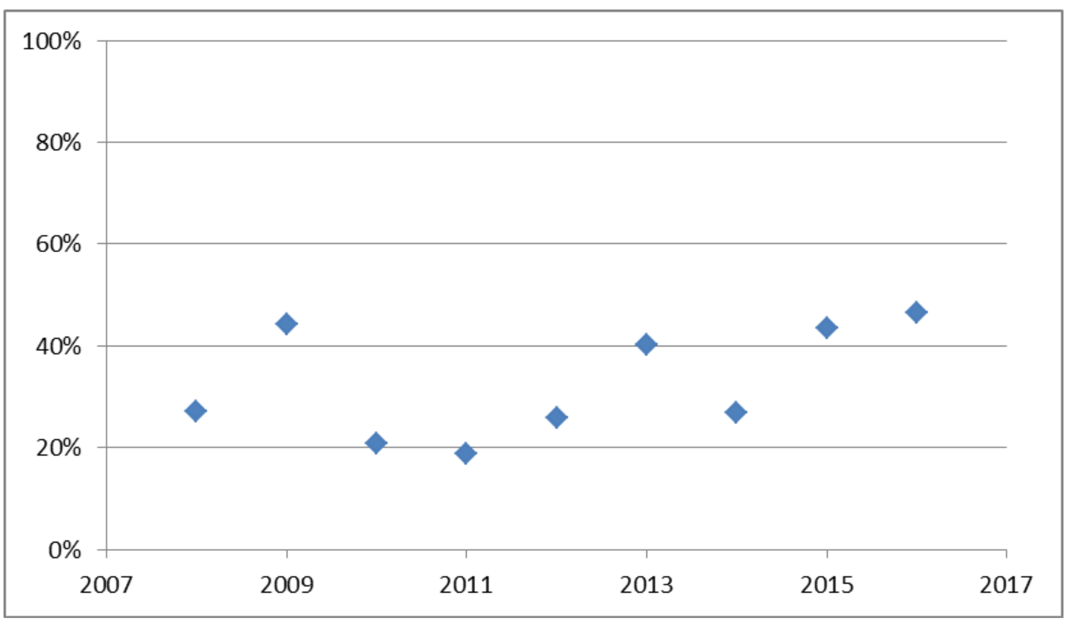


Figure 2. Percentage of sites in the moderate and high impact categories.

Causal Factors

The potential for fine sediment transfer into streams may be caused by several factors, including road location, road materials, maintenance techniques, resource road traffic, recreational activities, and storm damage.

Opportunities for Improvement of Practices to Minimize Fine Sediment Transfer to Streams

- During road and cutblock design, ensure there are a sufficient number of properly sized and located culverts.
- Install strategically placed cross ditches, water bars, and ditch blocks to disperse storm flow when deactivating roads.
- Remove any berms present during road management.
- Prevent road rutting by using good quality material and crowning the road surface.
- Armour, seed or spread out logging debris over disturbed areas to protect the soil during harvesting and road construction.
- When old culverts have become blocked or collapsed, ensure that they are removed and armour the crossing.

Road license holders should be promptly informed of sites with moderate or high impact ratings so that they can remediate these sites.

Post-harvest Condition of Cultural Heritage Resources in the Skeena Region

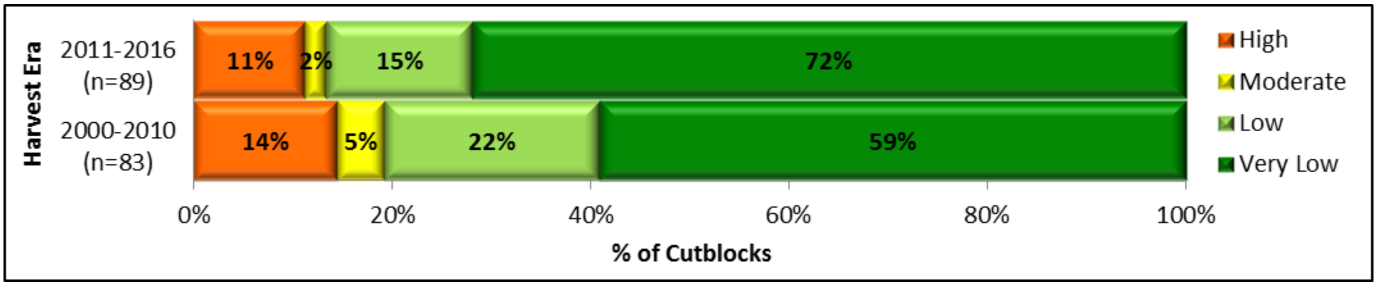


Figure 1. Percentage of cutblocks in high, moderate, low, and very low impact categories by harvest era.

Data Source

Assessments were conducted by trained personnel, often with the assistance of local First Nations and licensee forest professionals, from 2009 to 2016 using the FREP cultural heritage resource (CHR) monitoring protocol to evaluate the conservation or protection of site-specific First Nations' CHRs. The sample population consists of randomly selected cutblocks with known CHR features as well as targeted cutblocks of special importance to First Nations.

A total of 171 samples have been collected in the Coast Mountains, Nadina and Skeena Stikine Natural Resource Districts, of which 89 represent recently harvested cutblocks. A cutblock may present more than one CHR feature – up to 20 features have been found on a single cutblock in the Skeena Region. Of the 501 features assessed to date, 280 features were assessed on recently harvested cutblocks. Features were located prior to harvest, predominantly through archaeological impact assessments (65%).

Summary

The impact rating for each cutblock is determined by assessing overall management of CHRs and protection of individual features. Eighty-seven percent of recently harvested cutblocks were in the low or very low impact categories compared to 81% of cutblocks harvested before 2011 (Figure 1). The most common features monitored on recently harvested cutblocks were culturally modified trees (75%), cultural trails (12%), and archaeological resources (8%) (Figure 2).

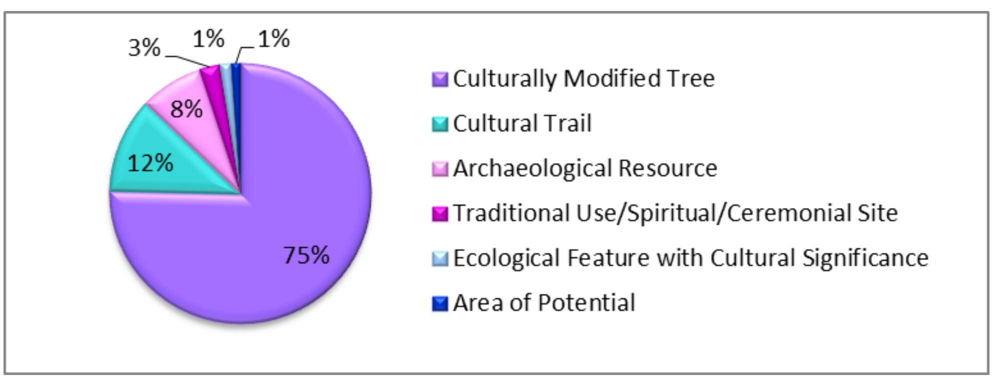


Figure 2. Percentage of CHR feature types located on recently harvested cutblocks.

Causal Factors for Recently Harvested Cutblocks
Logging activities were the main source of impacts on CHR features, although on some cutblocks there may have been combined impacts of harvesting, livestock grazing, and mountain pine beetle. Impacts during harvesting activities were directly caused by machine disturbance and windthrow often in association with non-windfirm buffers. Cutblocks with high impact ratings often presented a large number of features and only a fraction were managed to avoid damage. There were largely no operational factors limiting CHR management, although dead trees were identified as a safety hazard in two recent assessments. Impacts were often a result of insufficient marking of features in the field prior to harvest and lack of communication between licensees and First Nations.

Opportunities for Improvements and/or Continuation of Practices to Manage for Cultural Heritage Resources
- Review CHR documentation during planning and operations.
- Increase management prescriptions in site plans.
- Clearly identify features in the field prior to harvest to improve visibility for machine operators.
- Include features in long-term (at least one rotation) windfirm reserves (e.g., wildlife tree retention areas) or exclude features from the harvest area by modifying cutblock boundaries.
- Ensure buffers intended to protect features are windfirm. Discuss management options and potential impacts with local First Nations prior to harvest.
- Select a management approach for culturally modified trees (e.g., stubbing above the cultural mark, preserving with a windfirm buffer, or including in a reserve) based on discussions with local First Nations and consideration of site context and tree species/condition.
- Protect cultural trails by establishing machine-free zones, marking trail buffers with high stubbed lines, and identifying a limited number of designated skidder crossings of the trail.
- Implement strategies to limit livestock access to sensitive areas (e.g., use strategic fencing where cultural trails cross creeks, and limit livestock salting/feeding on cultural trails and near water).
- Use low impact harvest methods or harvest when ground is frozen and with sufficient snowpack to minimize soil disturbance to avoid damaging surface/sub-surface cultural features that may exist, where an archaeological impact assessment (AIA) recommendation states that these methods may be appropriate.

Visual Quality in the Skeena Region

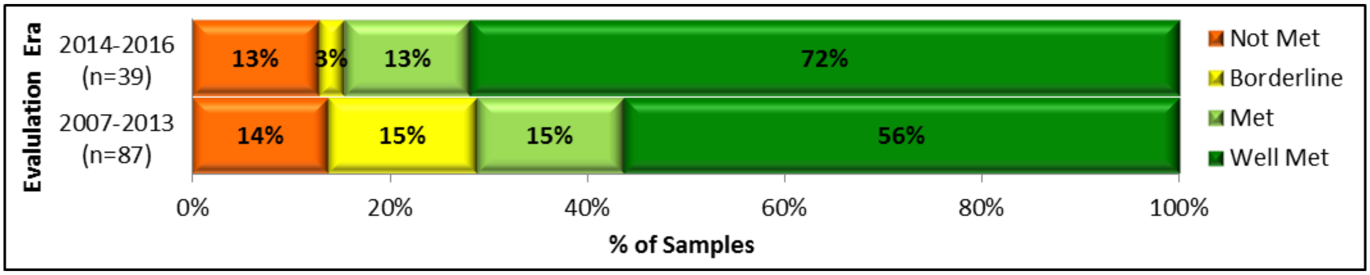


Figure 1. Percentage of landforms in each effectiveness evaluation rating category by evaluation era.

Data Source

Effectiveness evaluations were conducted by trained personnel from 2007 to 2016 using the FREP visual quality monitoring protocol to evaluate whether legally established visual quality objectives (VQOs) in designated scenic areas are being achieved. The sample population consists of landforms (distinct three-dimensional topographic features defined in perspective view) that include randomly selected cutblocks harvested under the *Forest and Range Practices Act*. A total of 126 samples have been collected in the Skeena Region, of which 39 represent recently evaluated landforms.

Summary

Eighty-five percent of recently evaluated landforms achieved *(met or well met)* the VQO compared to 71% of landforms evaluated from 2007 to 2013 (Figure 1). For recently evaluated landforms, 10% of landforms with modification VQOs and 27% of landforms with partial retention VQOs did not achieve the objective (Table 1). All of the recently evaluated landforms with retention VQOs achieved the objective (Table 1).

Table 1. Percentage of recently evaluated landforms by visual quality objective and rating category.

Landforms Evaluated 2014-2016		Rating Category			
		Not Met	**Borderline**	**Met**	**Well Met**
Visual Quality Objective	**Max Modification (n=0)**	-	-	-	-
	Modification (n=20)	**5%** (1)	**5%** (1)	**15%** (3)	**75%** (15)
	Partial Retention (n=15)	**27%** (4)	0% (0)	**6%** (1)	**67%** (10)
	Retention (n=4)	0% (0)	0% (0)	**25%** (1)	**75%** (3)
	Preservation (n=0)	-	-	-	-

Ocular Assessment Results for Recently Evaluated Landforms

Borderline/Not Met Ratings: For 83% of the landforms where the VQO was not achieved, the appearance, scale and visibleness of the alteration did not meet the criteria as defined in section 1.1 of the Forest Planning and Practices Regulation (FPPR) (Table 2).

Met/Well Met Ratings: For 100% of the landforms where the VQO was achieved, the appearance, scale and visibleness of the alteration met the criteria as defined in FPPR s.1.1 (Table 2).

Table 2. Achievement of criteria (appearance, scale and visibleness) defined in section 1.1 of the Forest Planning and Practices Regulation (FPPR) for recently evaluated landforms

Landforms Evaluated 2014-2016		Criteria in FPPR Definition	
		Not Met	Met
Effectiveness Evaluation Rating	Borderline/Not Met	83%	17%
	Met/Well Met	0%	100%

Percent Alteration Assessment Results for Recently Evaluated Landforms

Borderline/Not Met Ratings: Initial percent alteration exceeded the upper limit of the range for the established VQO for 50% of the landforms (Table 3). Visual condition was negatively influenced by poor use of visual landscape design elements for 50% of the landforms (Table 4) and by visual impacts of roads for 83% of the landforms (Table 5). Additionally, in-block tree retention was not sufficient to improve visual condition for 83% of the landforms (Table 6).

Met/Well Met Ratings: Initial percent alteration was below or within the range for the established VQO for 97% of the landforms (Table 3). Visual condition was positively influenced by good use of visual landscape design elements for 61% of the landforms (Table 4) and by moderate/good in-block tree retention for 54% of the landforms (Table 6). Additionally, roads had no visual impacts for 73% of the landforms (Table 5). For the 3% of the landforms where initial percent alteration exceeded the upper limit of the range for the established VQO (Table 3), the visual quality class was adjusted due to good use of visual landscape design elements, resulting in VQO achievement.

Table 3. Comparison of initial percent alteration to the range for the established VQO for recently evaluated landforms.

Landforms Evaluated 2014-2016		Initial Percent Alteration Compared to Range for Established VQO		
		Exceeded	Within Range	Below
Effectiveness Evaluation Rating	Borderline/Not Met	50%	50%	0%
	Met/Well Met	3%	24%	73%

Table 4. Use of visual landscape design elements for recently evaluated landforms.

Landforms Evaluated 2014-2016		Use of Visual Landscape Design Elements		
		Poor	Moderate	Good
Effectiveness Evaluation Rating	Borderline/Not Met	50%	17%	33%
	Met/Well Met	12%	27%	61%

Table 5. Visual impacts of roads on recently evaluated landforms.

Landforms Evaluated 2014-2016		Visual Impacts of Roads			
		Dominant	Significant	Subordinate	None
Effectiveness Evaluation Rating	Borderline/Not Met	0%	33%	50%	17%
	Met/Well Met	0%	3%	24%	73%

Table 6. In-block tree retention for recently evaluated landforms.

Landforms Evaluated 2014-2016		In-Block Tree Retention		
		Poor	Moderate	Good
Effectiveness Evaluation Rating	Borderline/Not Met	83%	0%	17%
	Met/Well Met	45%	18%	36%

Opportunities for Improvement and/or Continuation of Practices to Manage for Visual Quality

- Increase in-block tree retention to reduce the amount of visible bare ground.
- Align roads to blend with the landform and minimize visibility. Deactivate and rehabilitate roads upon completion of harvesting.

CARIBOO NATURAL RESOURCE REGION

The following section presents the status of landscape-level biodiversity and the outcomes of site/stand-level monitoring for biodiversity, riparian condition, water quality, and visual quality in the Cariboo Natural Resource Region.

Status of Landscape-level Biodiversity in the Cariboo Region

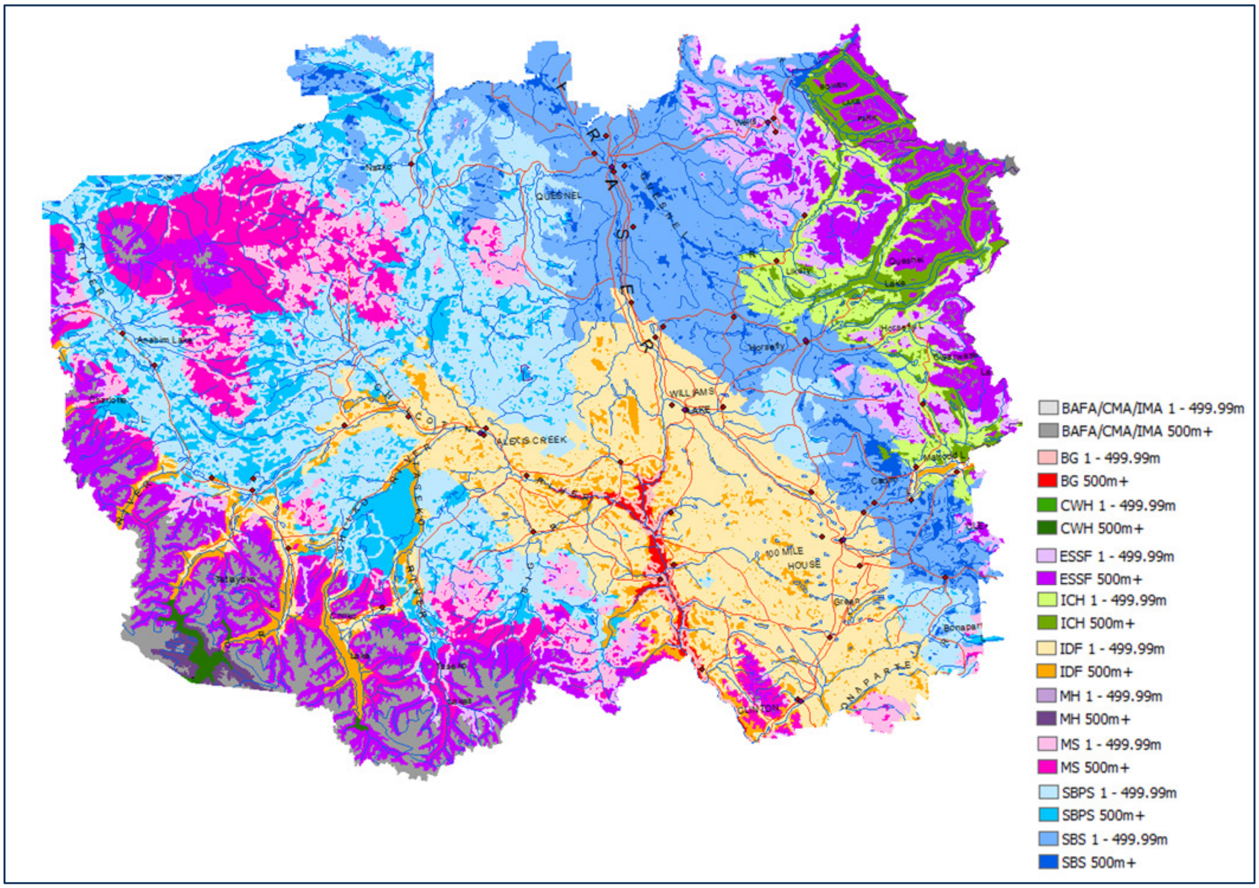


Figure 1. Distribution of roaded areas (less than 500 metres to a road) and roadless areas (500 metres or more to a road) by biogeoclimatic zone in the Cariboo Region.

Data Source

The expected seral stage distribution was calculated by natural disturbance type (NDT) and biogeoclimatic ecosystem classification (BEC) zone using the return intervals and stand-age thresholds in the Biodiversity Guidebook.[14] Stand age was not adjusted to account for mountain pine beetle infestation or fire. Mature and old seral stages were combined because the age classes that comprise these seral stages are not reliably classified in the provincial vegetation resource inventory. An additional state, “alienated forest” (mines, tailings, spoils, gravel pits, roads, rail surfaces, cutbanks, reservoir margins, landings, airports, and urban areas) is also reported.

[14] Anonymous. 1995. Biodiversity Guidebook. Forest Practices Code of British Columbia. Victoria BC. Ministry of Forests, Ministry of Environment. https://www.for.gov.bc.ca/hfd/library/documents/bib19715.pdf.

Publicly available corporate datasets were used to conduct the spatial analysis: BEC units (2016 version), vegetation resource inventory (stand age projected to 2017), harvest depletions (as of spring 2017), roads (as of spring 2017), mountain pine beetle infestations (up to 2017), fires (2000-2017), and “resource stewardship designations” (current as of 2016) (e.g., old growth management areas, parks, protected areas, conservancies, no-harvest ungulate winter range, and no-harvest wildlife habitat areas).

Summary

The Cariboo Region captures eight forested biogeoclimatic zones: Coastal Western Hemlock (CWH), Engelmann Spruce – Subalpine Fir (ESSF), Interior Cedar – Hemlock (ICH), Interior Douglas-fir (IDF), Mountain Hemlock (MH), Montane Spruce (MS), Sub-Boreal Pine – Spruce (SBPS), and Sub-Boreal Spruce (SBS) (Figure 1). The amount and percentage of roadless forest (forest 500 metres or more to a road[15]) was determined for each biogeoclimatic zone (Figure 1, Table 1). For the purposes of this report, roadless forest is presumed to be less disturbed, and may have higher biodiversity value than forest within 500 metres of a road. More than half of the CWH, ESSF, MH and MS zones, and less than half of the ICH, IDF, SBPS and SBS zones, are comprised of roadless forest. In general, the Cariboo Region (like the Thompson-Okanagan Region) has a low proportion of roadless forest when compared to other regions.

Table 1. Hectares and percentage of roadless forest by biogeoclimatic zone in the Cariboo Region.

Biogeoclimatic Zone	**Forest ≥500m to a Road**	
	Hectares (rounded to nearest 1000 ha)	**Percentage**
Coastal Western Hemlock (CWH)	16,000	99%
Engelmann Spruce – Subalpine Fir (ESSF)	497,000	61%
Interior Cedar – Hemlock (ICH)	128,000	34%
Interior Douglas-fir (IDF)	213,000	15%
Mountain Hemlock (MH)	7,000	100%
Montane Spruce (MS)	474,000	53%
Sub-Boreal Pine – Spruce (SBPS)	434,000	24%
Sub-Boreal Spruce (SBS)	85,000	8%
ALL ZONES	**1,855,000**	**29%**

The observed seral stage distribution was compared to the expected seral stage distribution for each biogeoclimatic zone (Figure 2).[16] In the CWH, ESSF, ICH, MH, MS and SBPS zones, the observed amount is similar to the expected amount for all seral stages. In the SBS zone, the observed amount of early seral exceeds the expected amount by approximately 150,000 ha, which is consistent with increased harvest due to mountain pine beetle salvage.

In the IDF zone, the observed and expected seral stage distributions are potentially misleading. The concept of seral stage is based on a natural disturbance regime of stand-destroying events (e.g., catastrophic fire) that result in single-aged stands. This does not apply in the IDF zone because it is in the natural disturbance type 4

[15] British Columbia. Ministry of Environment. 2018. Status of Roads & Roadless Area. Environmental Reporting BC. Ministry of Environment. http://www.env.gov.bc.ca/soe/indicators/land/roads.html

[16] This is not a compliance report against legal orders and no “ecological score” has been provided. That said, the authors of the 1995 Biodiversity Guidebook argued that biodiversity can be more likely maintained if forest management seeks to retain habitat patterns and seral stages that are similar to natural landscapes.

(NDT4) where stand-maintaining fires result in multi-aged stands.[17] Additionally, IDF stands in this region have been primarily partially harvested (rather than clearcut), also resulting in multi-aged rather than single-aged stands, hence the stand age in the vegetation resource inventory for IDF stands is time since last entry, not time since last stand-destroying event.

In summary, when rolled up to the zone level, the observed seral stage distributions observed across the landscape are similar to expected.

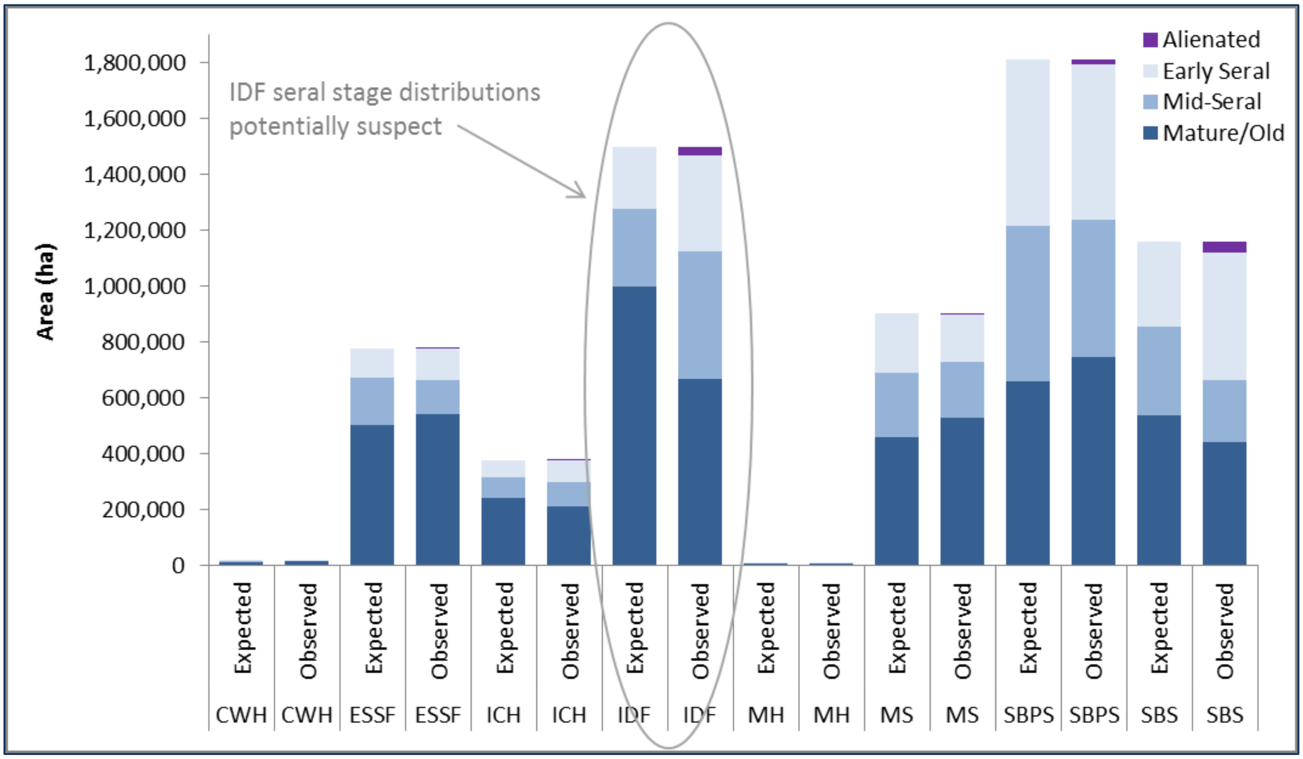


Figure 2. Expected versus observed seral stage distribution by biogeoclimatic zone in the Cariboo Region.

The amount and percentage of mature/old forest protected from harvest in various resource stewardship designations was determined for each biogeoclimatic zone (Table 2). The condition of protected and unprotected mature/old forest in each zone was assessed using distance to road and natural disturbance impacts as indicators (Figures 3 and 4). Mature/old forest impacted by both mountain pine beetle and fire is reported in the appropriate fire category (2000-2016 or 2017).

In the CWH, ESSF and ICH zones, 79%, 55% and 51%, respectively of mature/old forest is protected from harvest, and the majority of this protected mature/old forest is roadless and has not been impacted by fire or mountain pine beetle. In the IDF, SBPS and SBS zones, substantially less is protected from harvest (30%, 16% and 23%, respectively) and the majority of both the protected and unprotected mature/old forest in these zones is within 500 metres of a road and has been impacted by fire and/or mountain pine beetle.

In summary, the majority of mature/old forest closer to population centres has been heavily developed and impacted by fire, mountain pine beetle or both.

[17] Eng, Marvin, 2018. Using Natural Disturbance Return Intervals to Estimate Expected Seral Stage Distribution of Forests. A literature review and discussion. Forest and Range Evaluation Program, Ministry of Forests, Lands, Natural Resource Operations and Rural Development.

Table 2. Hectares and percentage of mature/old forest protected from harvest by biogeoclimatic zone in the Cariboo Region.

Biogeoclimatic Zone	Mature/Old Forest Protected from Harvest	
	Hectares(K=1000s)	**Percentage**
Coastal Western Hemlock (CWH)	12K	79%
Engelmann Spruce – Subalpine Fir (ESSF)	300K	55%
Interior Cedar – Hemlock (ICH)	107K	51%
Interior Douglas-fir (IDF)	199K	30%
Mountain Hemlock (MH)	2K	30%
Montane Spruce (MS)	206K	39%
Sub-Boreal Pine – Spruce (SBPS)	123K	16%
Sub-Boreal Spruce (SBS)	99K	23%
ALL ZONES	**1000K**	**33%**

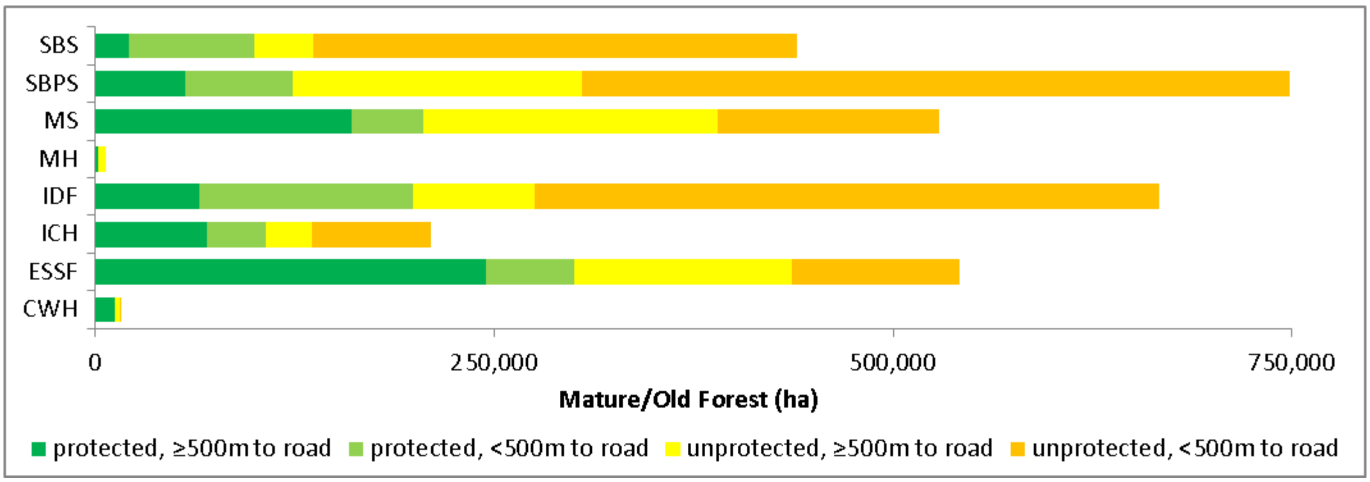


Figure 3. Hectares of protected roadless, protected roaded, unprotected roadless, and unprotected roaded mature/old forest by biogeoclimatic zone in the Cariboo Region.

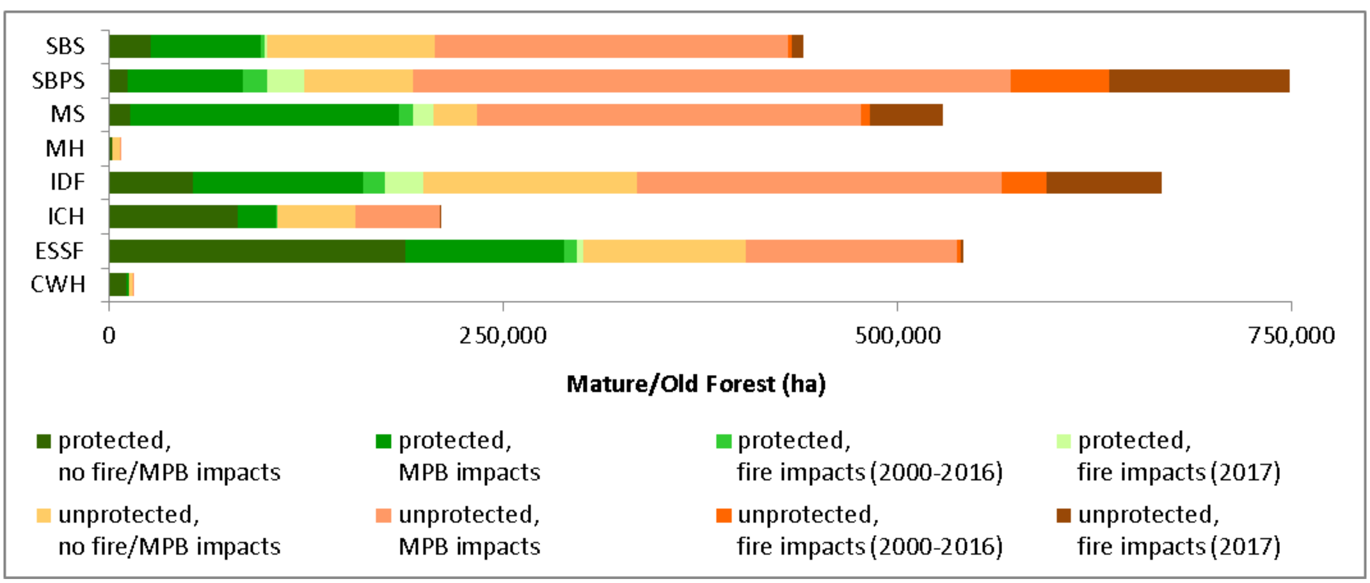


Figure 4. Hectares of protected and unprotected mature/old forest impacted by mountain pine beetle and/or fire by biogeoclimatic zone in the Cariboo Region.

Post-harvest Condition of Stand-level Biodiversity in the Cariboo Region

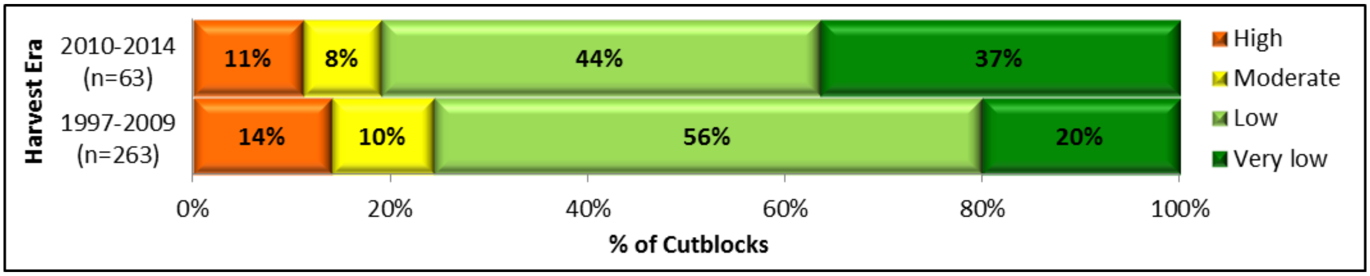


Figure 1. Quantity and type of retention by harvest era: Percentage of cutblocks in high, moderate, low, and very low impact categories.

Table 1. Quality of tree retention compared to pre-harvest benchmark by harvest era.

	Large Live Tree Density	**Large Snag Density**	**Tree Species Diversity**
2010-2014 (n=63)	Less	Comparable	Comparable
Quality Trend	***Declining***	***Improving***	*No Change*
1997-2009 (n=263)	Comparable	Less	Comparable

Table 2. Quality of coarse woody debris (CWD) retention compared to pre-harvest benchmark by harvest era.

	Large Piece Volume	**Large & Long Piece Density**
2010-2014 (n=63)	Comparable	Not Comparable
Quality Trend	*No Change*	*No Change*
1997-2009 (n=263)	Comparable	Not Comparable

Data Source

Assessments were conducted by trained personnel from 2006 to 2016 using the FREP stand-level biodiversity (SLBD) monitoring protocol to evaluate whether retention of wildlife tree patches and riparian reserves is achieving the desired levels and types of structures to maintain species diversity. The sample population consists of randomly selected cutblocks harvested from 1997 to 2014. A total of 326 samples have been collected in the Cariboo Region, of which 63 represent recently harvested blocks.

Summary

<u>Quantity and Type of Retention:</u> The impact rating for each cutblock with respect to quantity and type of retention was determined by assessing percent of within-block retention, patch size, presence of within-patch ecological anchors, and presence of dispersed retention. If a cutblock scored greater than 80 out of 100 points, it was rated as very low impact. If a cutblock scored between 45 and 80 points, it was rated as low impact. If a cutblock scored less than 45 points, it was rated as moderate impact. If a cutblock had less than 3.5% retention (regardless of total score), it was rated as high impact.

Eighty-one percent of recently harvested cutblocks were in the low and very low impact categories compared to 76% of the sites harvested before 2009 (Figure 1). The average score has increased significantly since 1997 (Figure 2). Although use of ecological anchors and dispersed retention did not differ significantly between harvest eras, the average percent of within-block retention and median patch size increased significantly on recently harvested cutblocks (Figure 3).

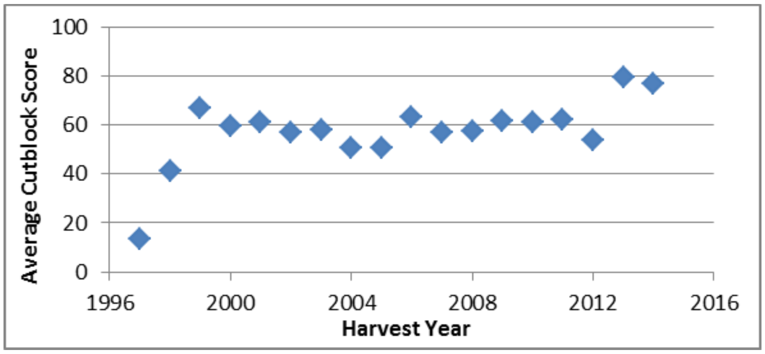


Figure 2. Average cutblock score with respect to retention quantity and type by harvest year.

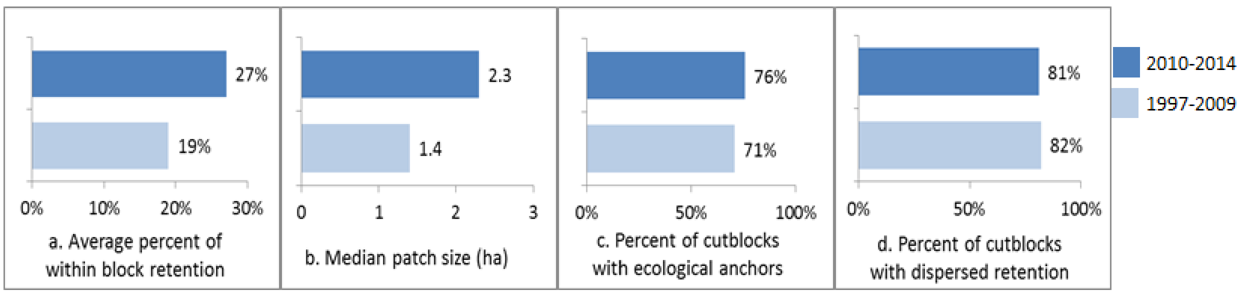


Figure 3. Quantity and type of retention by harvest era.

<u>Quality of Tree Retention:</u> Assessment of tree retention quality was conducted in aggregate for the entire region because pre-harvest condition is unknown for the vast majority of the blocks assessed. Assuming that timber cruise data is an appropriate surrogate for pre-harvest condition, a benchmark was adopted for each harvest era to reflect that the characteristics of the harvested stands differ between the two eras. The density of large live trees and snags (>40 or > 50 or >70 cm dbh, dependent on biogeoclimatic subzone) and the diversity of tree species retained for each harvest era were compared to cruise data from approximately the same harvest era and for the same biogeoclimatic subzone (Table 1). Large live tree density decreased whereas large snag density increased to pre-harvest conditions on recently-harvested cutblocks. Tree species diversity was comparable to the benchmark for both harvest eras.

<u>Quality of Coarse Woody Debris (CWD) Retention:</u> An assessment of CWD retention quality was also conducted in aggregate against a pre-harvest benchmark for each harvest era. The volume of large pieces (>20cm diameter) and density of large and long pieces (>20 cm diameter, >10 m long) in harvested areas were compared to retention patches (Table 2). For both harvest eras, large piece volume reflected pre-harvest conditions whereas large and long piece density was not comparable to the benchmark.

Opportunities for Improvement and/or Continuation of Practices to Manage for Stand-level Biodiversity

- Continue to include ecological anchors within patches when available.
- Continue to leave dispersed retention throughout harvested areas.
- Continue to retain large snag densities and tree species diversity comparable to pre-harvest conditions.
- Improve tree retention quality by leaving large live trees in densities representative of pre-harvest conditions.
- Continue to retain large CWD in volumes comparable to pre-harvest conditions.
- Improve CWD retention quality by leaving large and long CWD pieces in densities representative of pre-harvest conditions.

Post-harvest Condition of Streams and Riparian Areas in the Cariboo Region

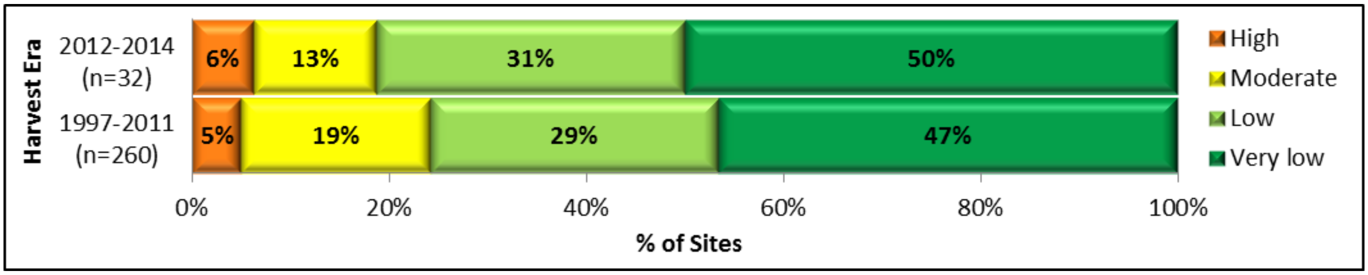


Figure 1. Percentage of sites in high, moderate, low, and very low impact categories by harvest era.

Data Source

Assessments were conducted by trained personnel from 2006 to 2016 using the FREP riparian monitoring protocol to evaluate whether riparian forestry and range practices are effective in maintaining the structural integrity and functions of stream ecosystems and other aquatic resources. The sampling population includes randomly selected cutblocks with streams within or adjacent to them. A total of 292 samples have been collected in the Cariboo Region, of which 32 represent stream reaches harvested since 2012. Because the protocol requires a time lag of one to two winters to allow for impacts such as windthrow to manifest, there is little or no data for blocks harvested within the last two years.

Summary

Eighty-one percent of the recently harvested sites were in the low or very low impact categories compared to 76% of the sites harvested before 2012 (Figure 1). Of the 32 recently harvested sites, six were in the high or moderate impact categories. Of these, five were S6 streams and one was an S3 stream (Table 1). Three S6 streams were located adjacent to the cutblock. The remaining S6 and S3 streams were within the block.

Table 1. Number of recently harvested sites by stream class and impact category.

Stream Class	Impact Category				Total
	High	Moderate	Low	Very Low	
S1	0	0	0	0	0
S2	0	0	1	1	2
S3	1	0	3	7	11
S4	0	0	2	2	4
S5	0	0	0	0	0
S6	1	4	4	6	15
Total	**2**	**4**	**10**	**16**	**32**

Causal Factors

The two largest causal factors of impacts were natural events (41%) and logging (35%) at sites that had been recently harvested (Figure 2). The average number of logging-related impacts per year ranged from 0.5 to 1.6 (Figure 3). There is no statistical trend when considering all data points over time; however, if sites harvested before 2009 are not included, then impacts caused by harvesting have been in steady decline (Pearson's $r = -0.72$). Despite this decline, the average number of logging-related impacts for sites harvested since 2009 remains higher than for those logged previously. Future sampling will determine whether this negative trend continues.

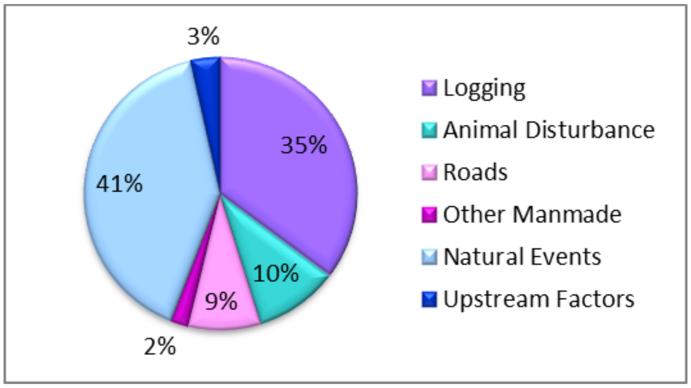


Figure 2. Percentage of impacts by causal factor at recently harvested sites.

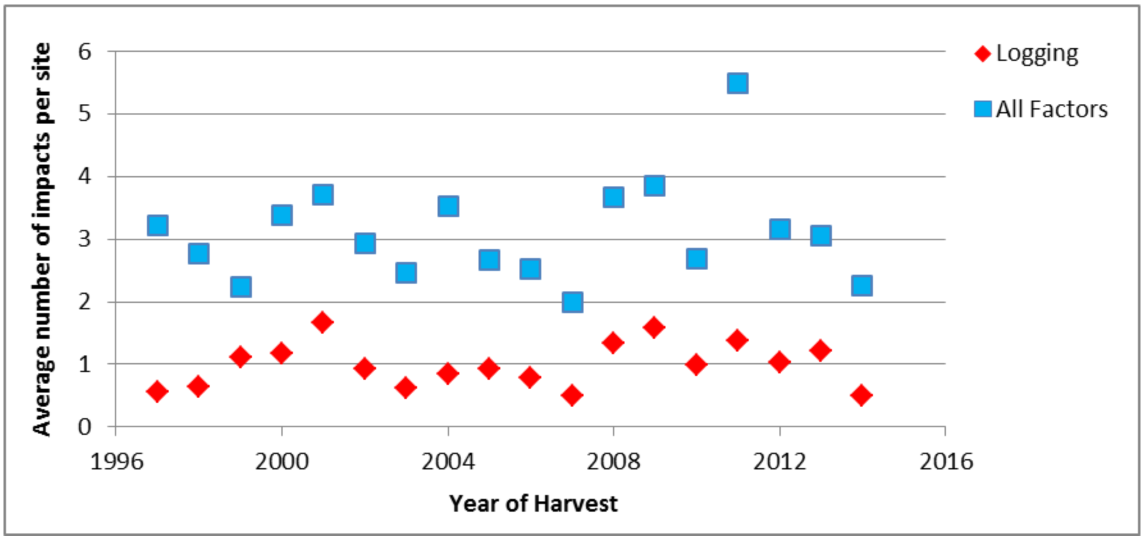


Figure 3. Average number of logging-related impacts and average number of impacts caused by all factors by year of harvest.

Specific Impacts

Natural events that contributed to impacts observed at recently harvested sites include beetle-kills, wind, floods, and high background sediment levels. These events lead to high levels of in-stream fine sediments, blockages to aquatic connectivity, channel bed disturbance, and low levels of aquatic invertebrate diversity (Table 2).

The most common logging-related activities that contributed to impacts observed at recently harvested sites include windthrow, low retention, and machine disturbance. These activities have been linked to excessive blowdown, reduced riparian vegetation vigour and structure, reduced large woody debris (LWD) supply, and increased fine sediments (Table 2).

Animal disturbance contributed to 10% of the impacts observed. Specific actions by animals included trampling and excessive browsing/grazing which result in channel bed and bank disturbance and increased fine sediments to the stream.

Table 2. Causal factors and related impacts for recently harvested sites.

% of All Factors	Most Common Specific Impacts
Natural Events (41%) *Beetle Kill* *Wind* *High background sediment levels* *Floods*	In-stream sediments ↑ In-stream blockages ↑ Channel bed disturbance ↑ Aquatic invertebrate diversity ↓
Logging (35%) *Windthrow* *Low Retention* *Machine Disturbance*	Excessive blowdown ↑ Riparian vegetation form/vigour↓ LWD supply ↓ In-stream sediments ↑
Animal Disturbance (10%) *Trampling* *Excessive grazing/browsing*	Channel bed disturbance ↑ In-stream sediments ↑ Channel bank disturbance ↑
Roads (9%) *Erosion causing sedimentation*	In-stream sediments ↑ Soil disturbance/bare ground ↑ Moss abundance/condition ↓
Upstream Factors (3%)	In-stream sediments ↑
Other Manmade (2%)	In-stream blockages ↑ Soil disturbance/bare ground ↑

Opportunities for Improvement and/or Continuation of Practices that Protect Stream and Riparian Conditions

- Recognize the risk of erosion in areas that are naturally high in fine sediments. Apply strategies related to timing of harvest and methods to minimize compaction and exposure of bare ground in the riparian area. Plan, maintain, and deactivate roads to minimize the transport of sediments to stream channels.
- Reduce windthrow by increasing buffer widths or use more selective harvest practices for windthrow-prone timber, including beetle-killed stands
- Increase retention width and complexity around small streams, especially wider perennial streams that make significant contributions of water, sediment, debris, and nutrients to downstream fish habitats, and contribute to watershed function.
- Create range barriers and stable fords in areas where cattle roam to limit post-harvest access to the stream.
- Provide training to equipment operators about the importance of streams and best practices in riparian areas. Monitor harvesting to ensure operators are utilizing methods that will minimize disturbance.

Water Quality in the Cariboo Region

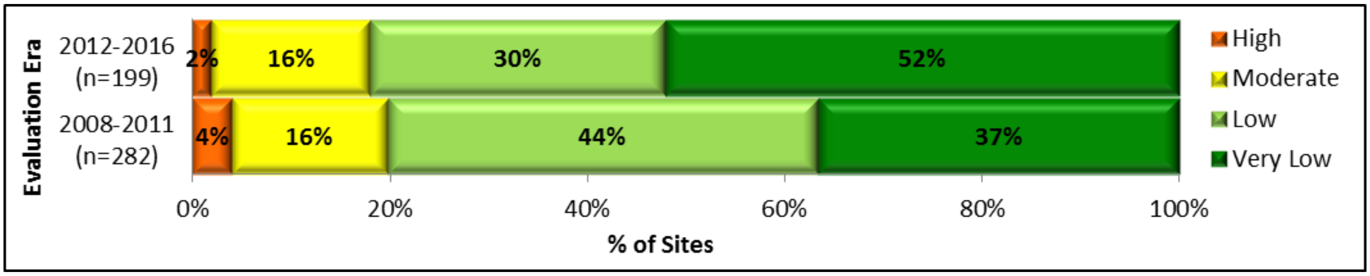


Figure 1. Percentage of sites in high, moderate, low, and very low impact categories by evaluation era.

Data Source

Assessments were conducted by trained personnel from 2008 to 2016 using the FREP water quality monitoring protocol to evaluate the potential for fine sediment transfer into streams. The sample population consists of roads and/or mass wasting sites connected to fish habitat and/or drinking water sources originating at randomly selected recently harvested cutblocks. A total of 481 samples have been collected in the Cariboo Region, of which 199 represent recently evaluated sites. The number of sites sampled each year ranged from 11 to 94.

Summary

Eighteen percent of recently evaluated sites had moderate or high potential for fine sediment transfer into streams compared to 20% of sites evaluated from 2008 to 2011 (Figure 1). From 2008 to 2015, there was a moderate downward trend (Pearson's r = 0.57) in the annual percentage of sites in the moderate and high impact categories (Figure 2). In 2016, 41% of sites sampled were in the moderate and high impact categories. It is unclear why impacts were higher in 2016, but in most years multiple samples may be collected along the same road, thus if construction is in an area of erodible soils or the road was poorly maintained, any subsequent impacts will appear multiple times.

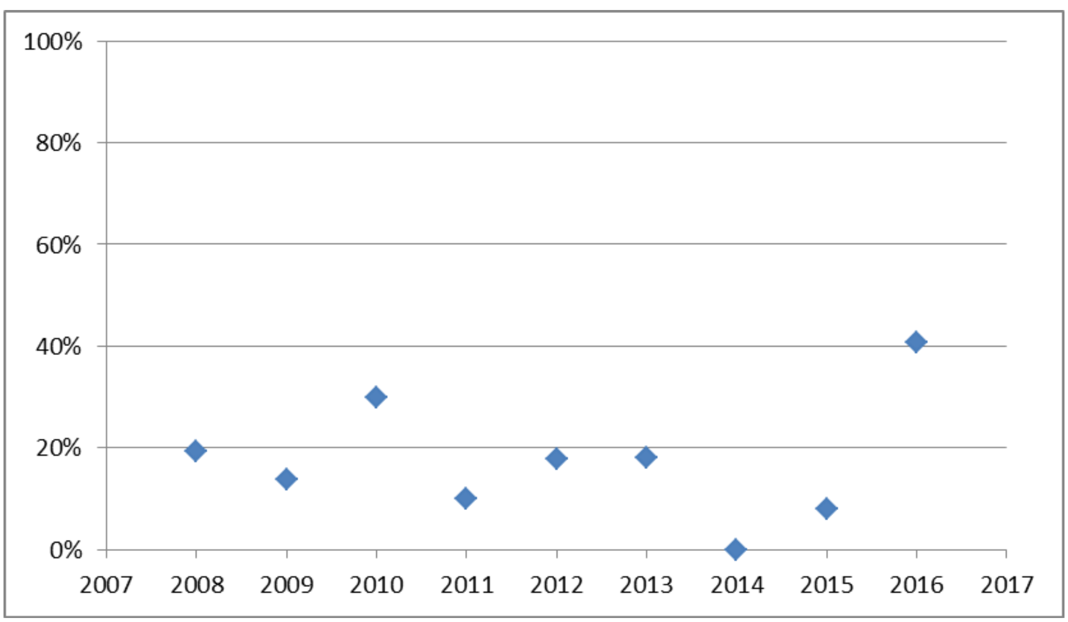


Figure 2. Percentage of sites in the moderate and high impact categories.

Causal Factors
The potential for fine sediment transfer into streams may be caused by several factors, including road location, road materials, maintenance techniques, resource road traffic, recreational activities, and storm damage.

Opportunities for Improvement of Practices to Minimize Fine Sediment Transfer to Streams

- During road and cutblock design, construct sediment traps to prevent coarse sediment from reaching streams.
- Install strategically placed cross ditches, water bars, and ditch blocks to disperse storm flow when deactivating roads.
- Avoid long gradients approaching streams to prevent surface flow from reaching streams when planning road locations.
- Prevent storm flow incision into native soil by armoring areas of concentrated flow during harvesting.

Road license holders should be promptly informed of sites with moderate or high impact ratings so that they can remediate these sites.

Visual Quality in the Cariboo Region

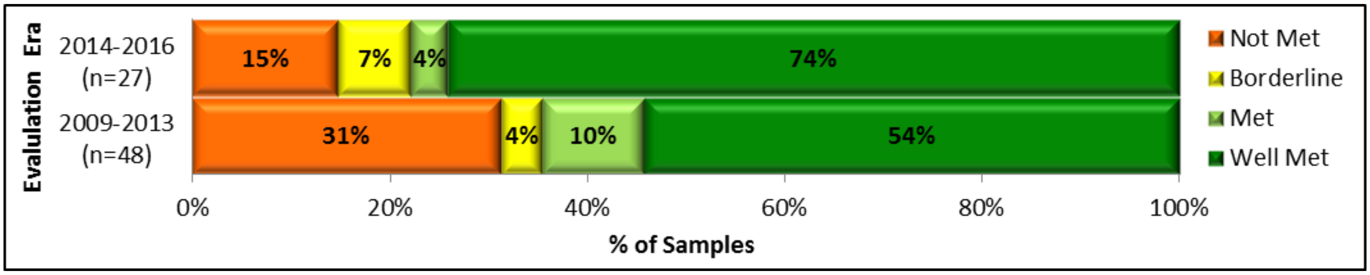


Figure 1. Percentage of landforms in each effectiveness evaluation rating category by evaluation era.

Data Source

Effectiveness evaluations were conducted by trained personnel from 2007 to 2016 using the FREP visual quality monitoring protocol to evaluate whether legally established visual quality objectives (VQOs) in designated scenic areas are being achieved. The sample population consists of landforms (distinct three-dimensional topographic features defined in perspective view) that include randomly selected cutblocks harvested under the *Forest and Range Practices Act*. A total of 75 samples have been collected in the Cariboo Region, of which 27 represent recently evaluated landforms.

Summary

Seventy-eight percent of recently evaluated landforms achieved *(met or well met)* the VQOs compared to 64% of landforms evaluated from 2007 to 2013 (Figure 1). For recently evaluated landforms, 8% of landforms with modification VQOs, 28% of landforms with partial retention VQOs, and 100% of landforms with retention VQOs did not achieve the objective *(borderline or not met)* (Table 1).

Table 1. Percentage of recently evaluated landforms by visual quality objective and rating category.

Landforms Evaluated 2014-2016		Rating Category			
		Not Met	**Borderline**	**Met**	**Well Met**
Visual Quality Objective	**Max Modification (n=0)**	-	-	-	-
	Modification (n=12)	**8%** (1)	0% (0)	0% (0)	**92%** (11)
	Partial Retention (n=14)	**14%** (2)	**14%** (2)	**7%** (1)	**64%** (9)
	Retention (n=1)	**100%** (1)	0% (0)	0% (0)	0% (0)
	Preservation (n=0)	-	-	-	-

Ocular Assessment Results for Recently Evaluated Landforms

Borderline/Not Met Ratings: For 83% of the landforms where the VQO was not achieved, the appearance, scale and visibleness of the alteration did not meet the criteria as defined in section 1.1 of the Forest Planning and Practices Regulation (FPPR) (Table 2).
Met/Well Met Ratings: For 100% of the landforms where the VQO was achieved, the appearance, scale and visibleness of the alteration met the criteria as defined in FPPR s.1.1 (Table 2).

Table 2. Achievement of criteria (appearance, scale and visibleness) defined in section 1.1 of the Forest Planning and Practices Regulation (FPPR) for recently evaluated landforms.

Landforms Evaluated 2014-2016		Criteria in FPPR Definition	
		Not Met	Met
Effectiveness Evaluation Rating	Borderline/Not Met	83%	17%
	Met/Well Met	0%	100%

Percent Alteration Assessment Results for Recently Evaluated Landforms

Borderline/Not Met Ratings: Initial percent alteration exceeded the upper limit of the range for the established VQO for 83% of the landforms (Table 3). Visual condition was negatively influenced by poor use of visual landscape design elements and by visual impacts of roads for 33% of the landforms (Tables 4 and 5). Additionally, in-block tree retention was not sufficient to improve visual conditions for 33% of the landforms (Table 6).

Met/Well Met Ratings: Initial percent alteration was below or within the range for the established VQO for 90% of the landforms (Table 3). Visual condition was positively influenced by good use of visual landscape design elements for 67% of the landforms (Table 4) and by good/moderate in-block tree retention for 52% of the landforms (Table 6). Additionally, roads had no visual impacts for 90% of the landforms (Table 5). For the 9% of the landforms where initial percent alteration exceeded the upper limit of the range for the established VQO (Table 3), the rating was positively adjusted due to good use of visual landscape design elements and good/moderate in-block tree retention, resulting in VQO achievement.

Table 3. Comparison of initial percent alteration to the range for the established VQO for recently evaluated landforms.

Landforms Evaluated 2014-2016		Initial Percent Alteration Compared to Range for Established VQO		
		Exceeded	Within Range	Below
Effectiveness Evaluation Rating	Borderline/Not Met	83%	17%	0%
	Met/Well Met	9%	24%	67%

Table 4. Use of visual landscape design elements for recently evaluated landforms.

Landforms Evaluated 2014-2016		Use of Visual Landscape Design Elements		
		Poor	Moderate	Good
Effectiveness Evaluation Rating	Borderline/Not Met	33%	50%	17%
	Met/Well Met	19%	14%	67%

Table 5. Visual impacts of roads on recently evaluated landforms.

Landforms Evaluated 2014-2016		Visual Impacts of Roads			
		Dominant	Significant	Subordinate	None
Effectiveness Evaluation Rating	Borderline/Not Met	0%	0%	33%	67%
	Met/Well Met	0%	0%	10%	90%

Table 6. In-block tree retention for recently evaluated landforms.

Landforms Evaluated 2014-2016		In-Block Tree Retention		
		Poor	Moderate	Good
Effectiveness Evaluation Rating	Borderline/Not Met	33%	67%	0%
	Met/Well Met	48%	33%	19%

Opportunities for Improvement and/or Continuation of Practices to Manage for Visual Quality

- Reduce the opening size to ensure the initial percent alteration is within the range for the established VQO.
- Increase in-block tree retention to reduce the amount of visible bare ground.

KOOTENAY-BOUNDARY NATURAL RESOURCE REGION

The following section presents the status of landscape-level biodiversity and the outcomes of site/stand-level monitoring for biodiversity, riparian condition, water quality, and visual quality in the Kootenay-Boundary Natural Resource Region.

Status of Landscape-level Biodiversity in the Kootenay-Boundary Region

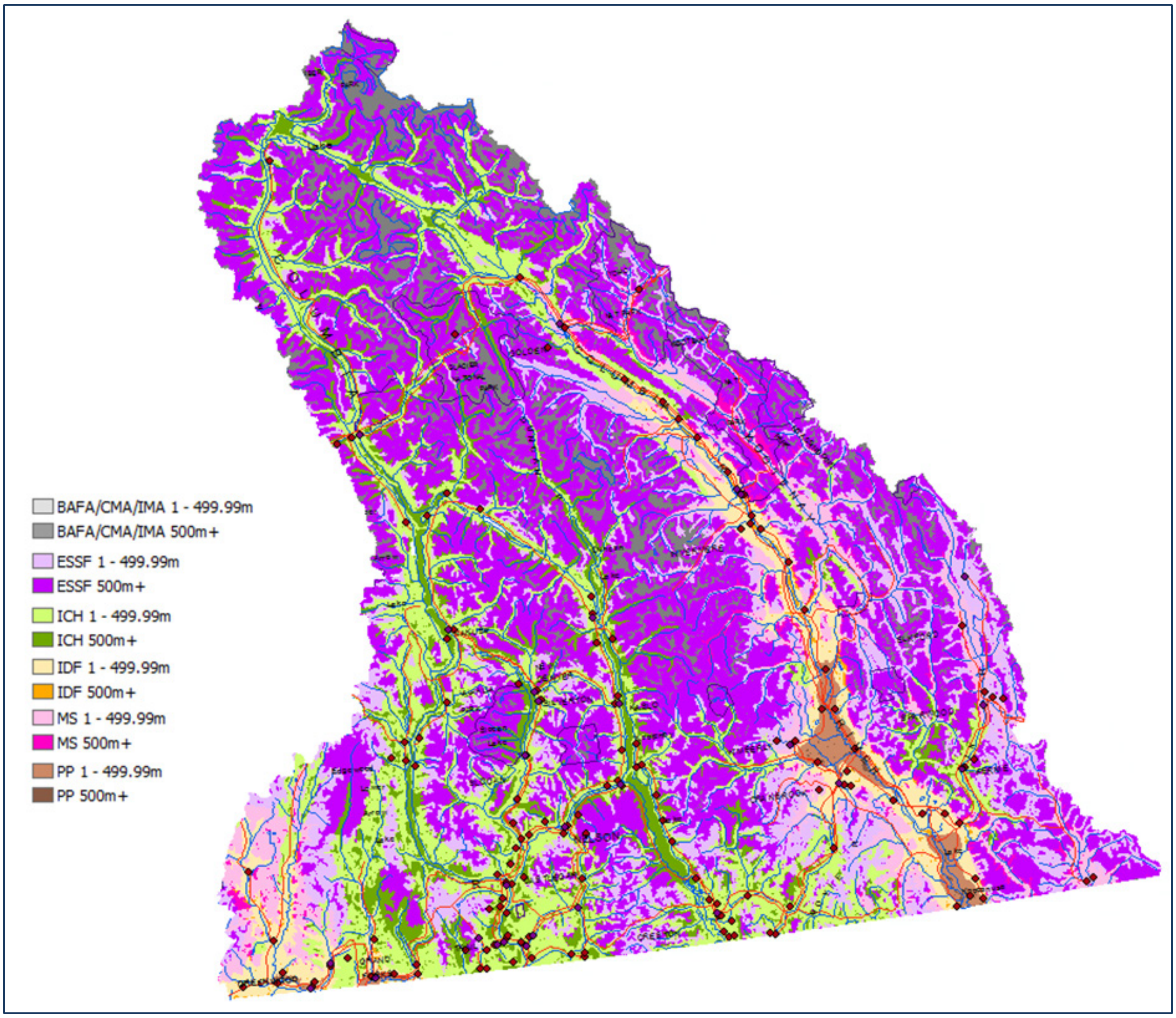


Figure 1. Distribution of roaded areas (<500m to a road) and roadless areas (≥500m to a road) by biogeoclimatic zone in the Kootenay-Boundary Region.

Data Source

The expected seral stage distribution was calculated by natural disturbance type (NDT) and biogeoclimatic ecosystem classification (BEC) zone using the return intervals and stand-age thresholds in the *Biodiversity*

Guidebook.[18] Stand age was not adjusted to account for mountain pine beetle infestation or fire. Mature and old seral stages were combined because the age classes that comprise these seral stages are not reliably classified in the provincial vegetation resource inventory. An additional state, "alienated forest" (mines, tailings, spoils, gravel pits, roads, rail surfaces, cutbanks, reservoir margins, landings, airports, and urban areas) is also reported.

Publicly available corporate datasets were used to conduct the spatial analysis: BEC units (2016 version), vegetation resource inventory (stand age projected to 2017), harvest depletions (as of spring 2017), roads (as of spring 2017), mountain pine beetle infestations (up to 2017), fires (2000-2017), and "resource stewardship designations" (current as of 2016) (i.e., old growth management areas, parks, protected areas, conservancies, no-harvest ungulate winter range, and no-harvest wildlife habitat areas).

Summary

The Kootenay-Boundary Region captures five forested biogeoclimatic zones: Engelmann Spruce – Subalpine Fir (ESSF), Interior Cedar – Hemlock (ICH), Interior Douglas-fir (IDF), Montane Spruce (MS), and Ponderosa Pine (PP) (Figure 1). The amount and percentage of roadless forest (forest 500 metres or more to a road[19]) was determined for each biogeoclimatic zone (Figure 1, Table 1). For the purposes of this report, roadless forest is presumed to be less disturbed, and may have higher biodiversity value than forest within 500 metres of a road. More than half of the ESSF zone, and less than half of the ICH, IDF, MS and PP zones, are comprised of roadless forest. In general, higher elevation and remote biogeoclimatic zones in the Kootenay-Boundary Region are largely composed of roadless forest.

Table 1. Percentage of roadless forest by biogeoclimatic zone in the Kootenay-Boundary Region.

Biogeoclimatic Zone	Forest ≥500m to a Road	
	Hectares(K=1000s)	**Percentage**
Engelmann Spruce – Subalpine Fir (ESSF)	1575K	61%
Interior Cedar – Hemlock (ICH)	472K	25%
Interior Douglas-fir (IDF)	13K	4%
Montane Spruce (MS)	94K	14%
Ponderosa Pine (PP)	1K	3%
ALL ZONES	**2157K**	**39%**

The observed seral stage distribution was compared to the expected seral stage distribution for each biogeoclimatic zone (Figure 2).[20] In the ESSF zone, the observed amount is similar to the expected amount for all seral stages. In the ICH and MS zones, the observed amount of early seral forest is similar to the expected amount; however, due to an excess of mid-seral forest, the amount of observed mature/old forest is less than expected. In the IDF and PP zones, the observed and expected seral stage distributions are potentially misleading. The concept of seral stage is based on a natural disturbance regime of stand-destroying events (e.g.,

[18] Anonymous. 1995. Biodiversity Guidebook. Forest Practices Code of British Columbia. Victoria BC. Ministry of Forests, Ministry of Environment. https://www.for.gov.bc.ca/hfd/library/documents/bib19715.pdf.

[19] British Columbia. Ministry of Environment. 2018. Status of Roads & Roadless Area. Environmental Reporting BC. Ministry of Environment. http://www.env.gov.bc.ca/soe/indicators/land/roads.html

[20] This is not a compliance report against legal orders and no "ecological score" has been provided. That said, the authors of the 1995 Biodiversity Guidebook argued that biodiversity can be more likely maintained if forest management seeks to retain habitat patterns and seral stages that are similar to natural landscapes.

catastrophic fire) that result in single-aged stands.[21] This does not apply to the IDF and PP zones because these zones are in natural disturbance type 4 (NDT4) where stand-maintaining fires result in multi-aged stands. Additionally, IDF stands in this region have been primarily partially harvested (rather than clearcut), also resulting in multi-aged rather than single-aged stands, hence the stand age reported in the vegetation resource inventory for IDF stands is time since last entry, not time since last stand-destroying event.

In summary, the observed seral stage distributions of the biogeoclimatic zones that dominate valley bottoms differ from that expected.

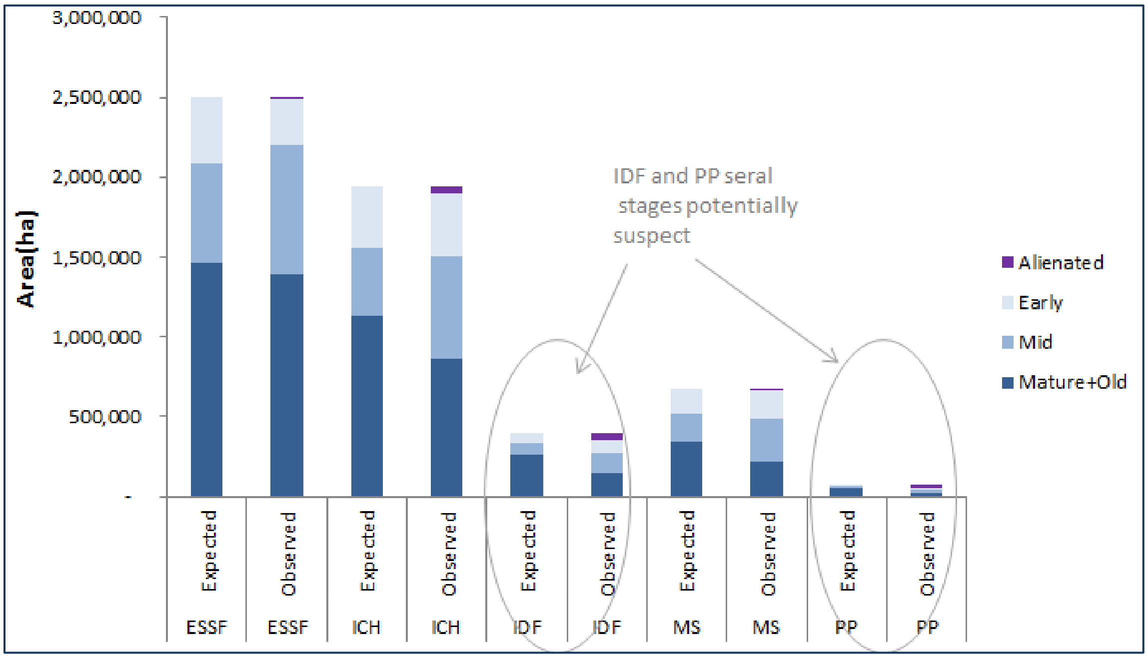


Figure 2. Expected versus observed seral stage distribution by biogeoclimatic zone in the Kootenay-Boundary Region.

The amount and percentage of mature/old forest protected from harvest in various resource stewardship designations was determined for each biogeoclimatic zone (Table 2). The condition of protected and unprotected mature/old forest in each zone was assessed using distance to road and natural disturbance impacts as indicators (Figures 3 and 4). Mature/old forest impacted by both mountain pine beetle and fire is reported in the appropriate fire category (2000-2016 or 2017).

In the ESSF zone, 50% of the mature/old forest is protected from harvest, and the majority of this protected mature/old forest is roadless and has not been impacted by either fire or mountain pine beetle since 2000. In the MS and ICH zones, 38% and 30%, respectively of the mature/old forest is protected from harvest but less than half is roadless. The majority of the protected mature/old forest in the MS zone has been impacted by mountain pine beetle. In the IDF and PP zones, which dominate the valley bottoms within the region, substantially less is protected from harvest (12% and 9%, respectively), and the majority of both protected and unprotected mature/old forest in these zones is within 500 metres of a road.

In summary, the majority of mature/old forest in the biogeoclimatic zones that dominate the valley bottoms has been heavily developed and is substantially less protected than mature/old forest at higher elevations.

[21] Eng, Marvin, 2018. Using Natural Disturbance Return Intervals to Estimate Expected Seral Stage Distribution of Forests. A literature review and discussion. Forest and Range Evaluation Program, Ministry of Forests, Lands, Natural Resource Operations and Rural Development.

Table 2. Percentage of mature/old forest protected from harvest by biogeoclimatic zone in the Kootenay-Boundary Region.

Biogeoclimatic Zone	Mature/Old Forest Protected from Harvest	
	Hectares (rounded to nearest 1000 ha)	Percentage
Engelmann Spruce – Subalpine Fir (ESSF)	690,000	50%
Interior Cedar – Hemlock (ICH)	263,000	30%
Interior Douglas-fir (IDF)	18,000	12%
Montane Spruce (MS)	84,000	38%
Ponderosa Pine (PP)	2,000	9%
ALL ZONES	**1,000,000**	**40%**

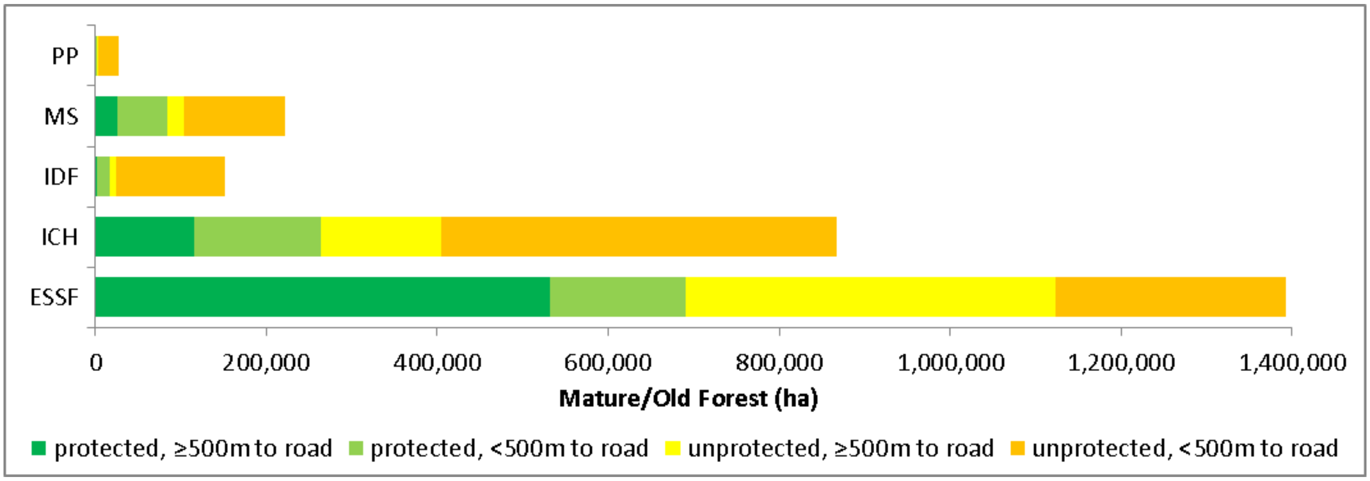


Figure 3. Hectares of protected roadless, protected roaded, unprotected roadless, and unprotected roaded mature/old forest by biogeoclimatic zone in the Kootenay-Boundary Region.

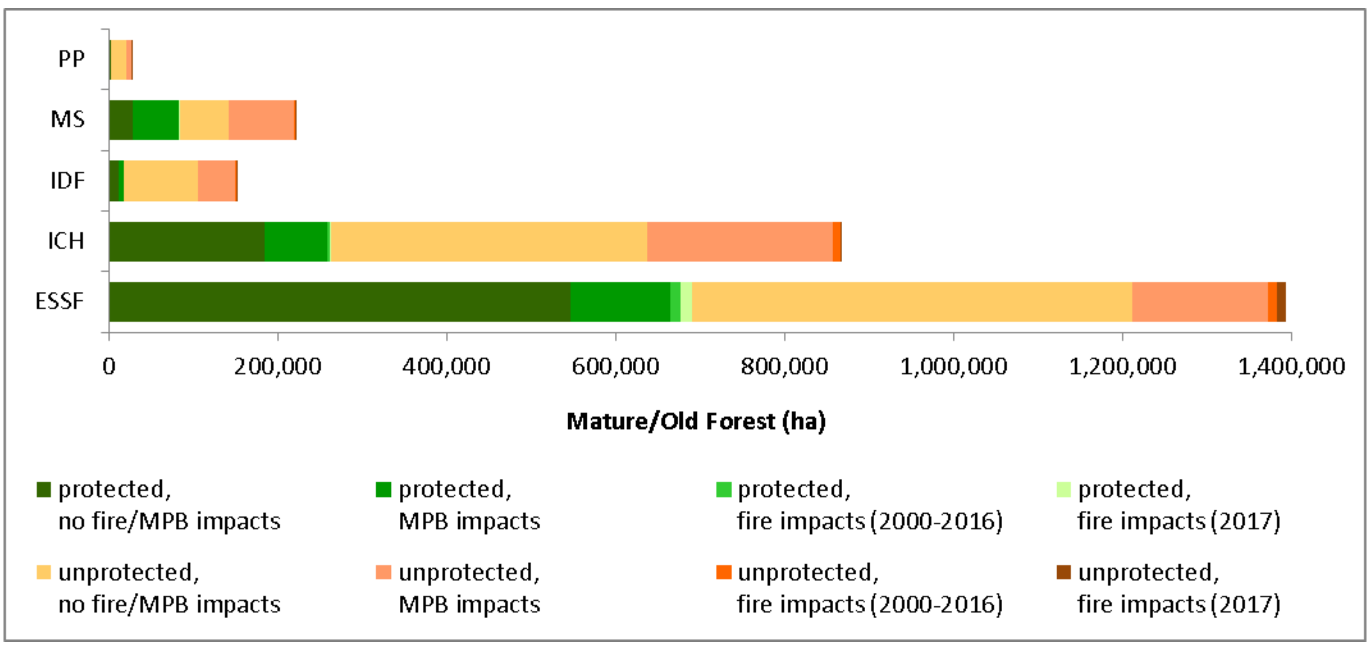


Figure 4. Hectares of protected and unprotected mature/old forest impacted by mountain pine beetle and/or fire by biogeoclimatic zone in the Kootenay-Boundary Region.

Post-harvest Condition of Stand-level Biodiversity in the Kootenay-Boundary Region

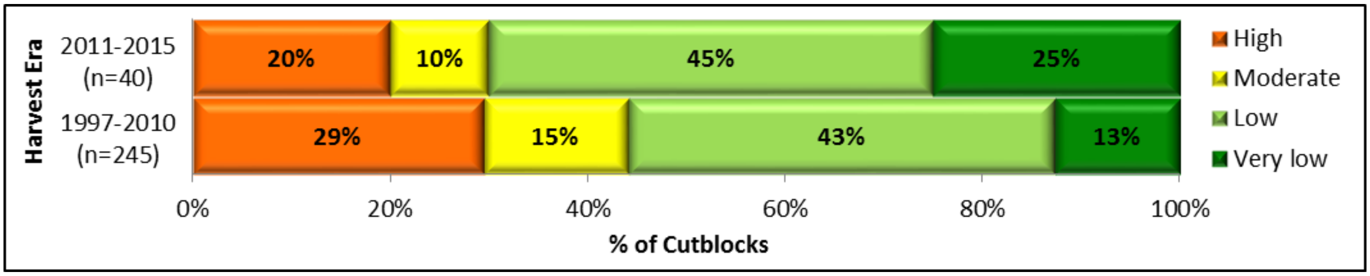


Figure 1. Quantity and type of retention by harvest era: Percentage of cutblocks in high, moderate, low, and very low impact categories.

Table 1. Quality of tree retention compared to pre-harvest benchmark by harvest era.

	Large Live Tree Density	Large Snag Density	Tree Species Diversity
2011-2015 (n=40)	Less	Less	Less
Quality Trend	*No Change*	*No Change*	*No Change*
1997-2010 (n=245)	Less	Less	Less

Table 2. Quality of coarse woody debris (CWD) retention compared to pre-harvest benchmark by harvest era.

	Large Piece Volume	Large & Long Piece Density
2011-2015 (n=40)	Not Comparable	Comparable
Quality Trend	*No Change*	*No Change*
1997-2010 (n=245)	Not Comparable	Comparable

Data Source

Assessments were conducted by trained personnel from 2006 to 2016 using the FREP stand-level biodiversity (SLBD) monitoring protocol to evaluate whether retention of wildlife tree patches and riparian reserves is achieving the desired levels and types of structures to maintain species diversity. The sample population consists of randomly selected cutblocks harvested from 1997 to 2015. A total of 285 SLBD samples have been collected in the Kootenay-Boundary Region, of which 40 represent recently harvested blocks.

Summary

<u>Quantity and Type of Retention</u>: The impact rating for each cutblock with respect to quantity and type of retention was determined by assessing percent of within-block retention, patch size, presence of within-patch ecological anchors, and presence of dispersed retention. If a cutblock scored greater than 80 out of 100 points, it was rated as very low impact. If a cutblock scored between 45 and 80 points, it was rated as low impact. If a cutblock scored less than 45 points, it was rated as moderate impact. If a cutblock had less than 3.5% retention (regardless of total score), it was rated as high impact.

Seventy percent of recently harvested cutblocks were in the low and very low impact categories compared to 56% of the sites harvested before 2010 (Figure 1). The average score has increased significantly since 1997 (Figure 2). Although average percent of within-block retention and use of dispersed retention did not differ significantly between harvest eras, median patch size and the use of ecological anchors increased significantly on recently harvested blocks (Figure 3).

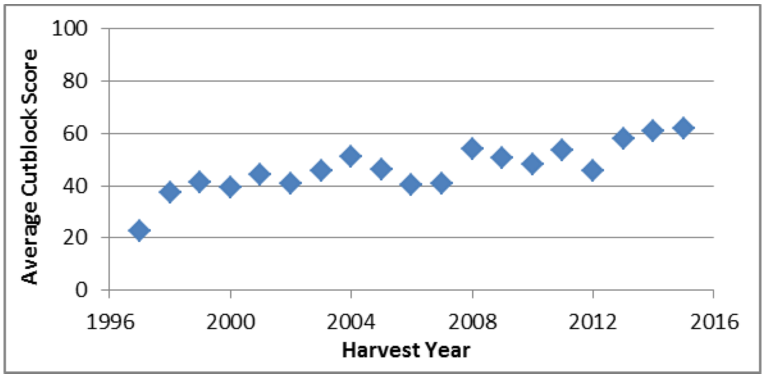


Figure 2. Average cutblock score with respect to retention quantity and type by harvest year.

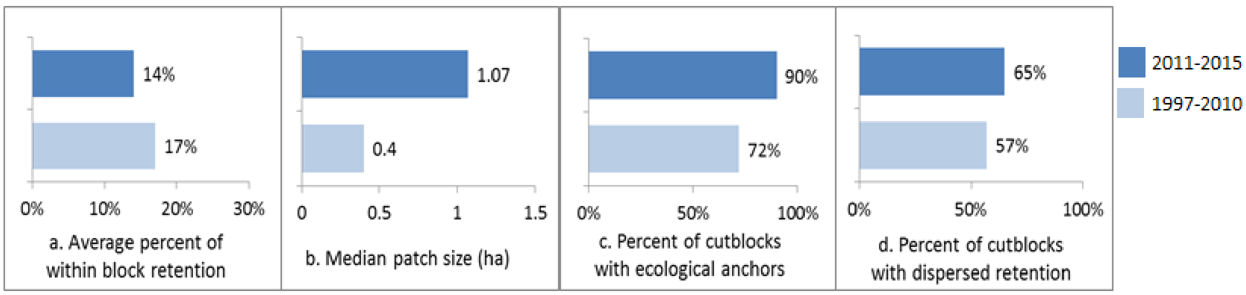


Figure 3. Quantity and type of retention by harvest era.

Quality of Tree Retention: Assessment of tree retention quality was conducted in aggregate for the entire region because pre-harvest condition is unknown for the vast majority of the blocks assessed. Assuming that timber cruise data is an appropriate surrogate for pre-harvest condition, a benchmark was adopted for each harvest era to reflect that the characteristics of the harvested stands differ between the two eras. The density of large live trees and snags (>40 or >50 or >70 cm dbh, dependent on biogeoclimatic subzone) and diversity of tree species retained for each harvest era were compared to cruise data from approximately the same harvest era and for the same biogeoclimatic subzone (Table 1). Large live tree density, large snag density, and tree species diversity was less than pre-harvest conditions for both harvest eras.

Quality of Coarse Woody Debris (CWD) Retention: An assessment of CWD retention quality was also conducted in aggregate against a pre-harvest benchmark for each harvest era. The volume of large pieces (>20cm diameter) and density of large and long pieces (>20 cm diameter, >10 m long) in harvested areas were compared to retention patches (Table 2). For both harvest eras, large piece volume was not comparable to the benchmark, whereas large and long piece density reflected pre-harvest conditions.

Opportunities for Improvement and/or Continuation of Practices to Manage Stand-level Biodiversity

- Continue to include ecological anchors within patches when available.
- Continue to leave dispersed retention throughout harvested areas.
- Improve tree retention quality by leaving densities of large live trees, densities of large snags, and diversity of tree species representative of pre-harvest conditions.
- Continue to retain large and long CWD pieces in densities comparable to pre-harvest conditions.
- Improve CWD retention quality by leaving large CWD in volumes representative of pre-harvest conditions.

Post-harvest Condition of Streams and Riparian Areas in the Kootenay-Boundary Region

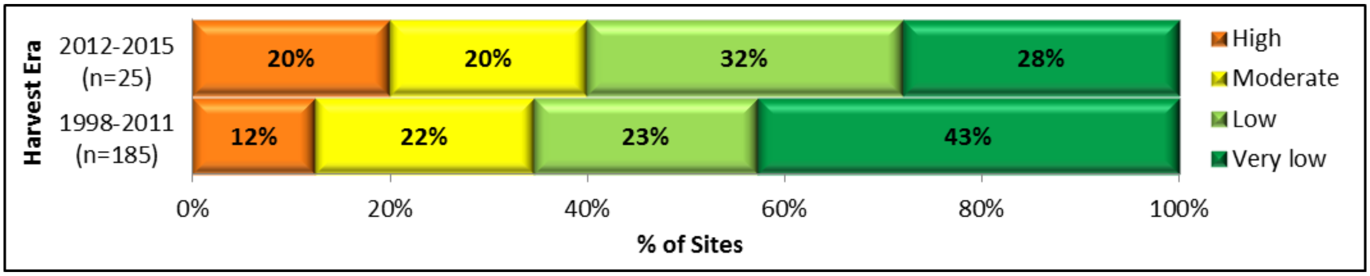


Figure 1. Percentage of sites in high, moderate, low, and very low impact categories by harvest era.

Data Source

Assessments were conducted by trained personnel from 2006 to 2016 using the FREP riparian monitoring protocol to evaluate whether riparian forestry and range practices are effective in maintaining the structural integrity and functions of stream ecosystems and other aquatic resources. The sample population includes randomly-selected cutblocks with streams within or adjacent to them. A total of 210 riparian samples have been collected in the Kootenay-Boundary Region, of which 25 represent stream reaches harvested since 2012. Because the protocol requires a time lag of one to two winters to allow for impacts such as windthrow to manifest, there is little or no data for blocks harvested within the last two years.

Summary

Sixty percent of the recently harvested sites were in the low or very low impact categories compared to 66% of the sites harvested before 2012 (Figure 1). Of the 25 recently harvested sites, 10 were in the high or moderate impact categories. Of these, five were S6 streams, three were S5 streams, and two were S2 streams (Table 1). One S5 stream and both S2 streams were located adjacent to the block. The remaining streams were in the block.

Table 1. Number of recently harvested sites by stream class and impact category.

Stream Class	Impact Category				Total
	High	Moderate	Low	Very Low	
S1	0	0	0	1	1
S2	2	0	2	0	4
S3	0	0	3	1	4
S4	0	0	1	2	3
S5	0	3	1	1	5
S6	3	2	1	2	8
Total	**5**	**5**	**8**	**7**	**25**

Causal Factors

The largest causal factors of impacts were natural events (43%) and logging (36%) at sites that had been recently harvested (Figure 2). The average number of logging-related impacts per year ranged from 1.0 to 4.3 (Figure 3). There is no statistical trend when considering all data points over time.

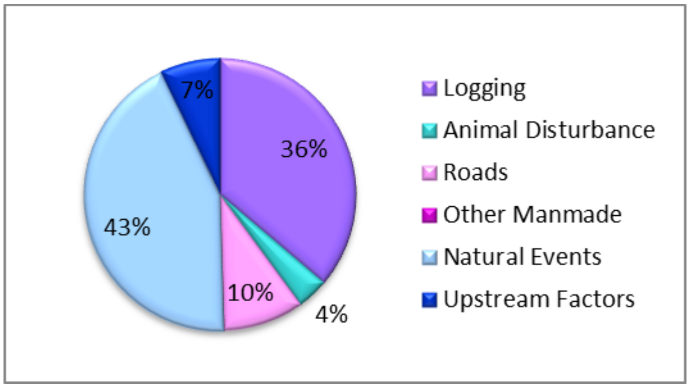


Figure 2. Percentage of impacts by causal factor at recently harvested sites.

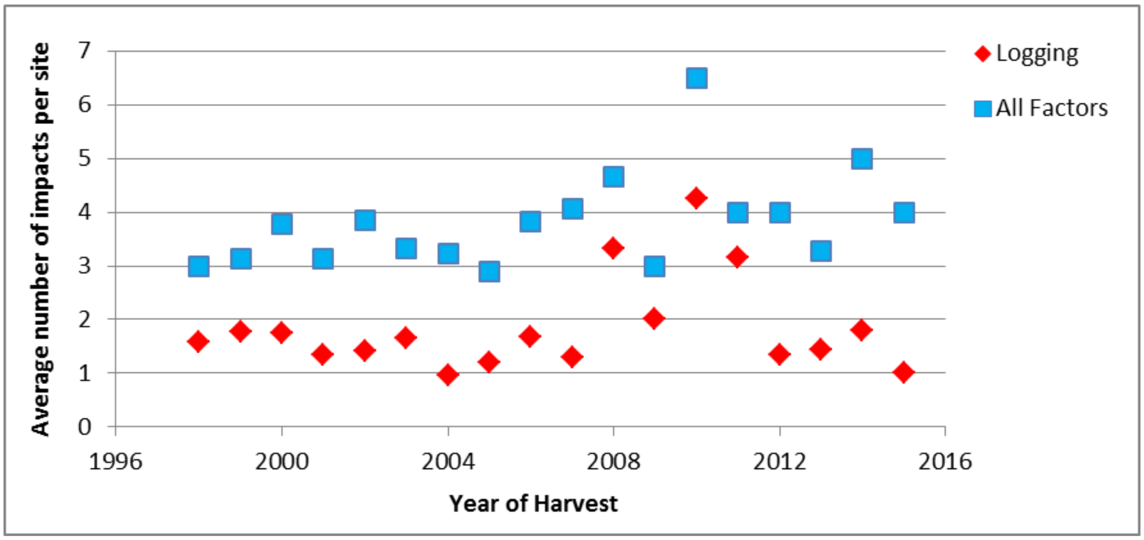


Figure 3. Average number of logging-related impacts and average number of impacts caused by all factors by year of harvest.

Specific Impacts

Natural events that contributed to impacts observed at recently harvested sites include floods, torrents, and high background sediment levels. These events lead to decreased moss abundance/condition, high levels of in-stream fine sediments, blockages to aquatic connectivity, and decreased fish cover diversity (Table 2).

The most common logging-related activities that contributed to impacts observed at recently harvested sites include low retention, windthrow, and falling/yarding. These activities have been linked to reduced large woody debris (LWD) supply/root network, reduced riparian vegetation vigour and structure, reduced shade, and impaired in-stream LWD function (Table 2).

Table 2. Causal factors and related impacts for recently harvested sites.

% of All Factors	Most Common Specific Impacts
Natural Events (43%) *Floods* *Torrents* *High background sediment levels*	Moss abundance/condition ↓ In-stream sediments ↑ In-stream blockages ↑ Fish cover diversity ↓
Logging (36%) *Low Retention* *Windthrow* *Falling/Yarding*	LWD supply/root network ↓ Riparian vegetation form/vigour↓ Shade/microclimate ↓ In-stream LWD function ↓
Roads (10%) *Fill or cut slopes eroding into stream* *Running surface eroding into stream*	In-stream sediments ↑ Soil disturbance/bare ground ↑ In-stream blockages ↑ Moss abundance/condition ↓
Upstream Factors (7%)	Aquatic invertebrate diversity ↓ In-stream sediments ↑ Moss abundance/condition ↓ In-stream blockages ↑
Animal Disturbance (4%) *Trampling*	In-stream sediments ↑

Opportunities for Improvement and/or Continuation of Practices to Protect Stream and Riparian Conditions

- Recognize the risk of erosion in areas that are naturally high in fine sediments. Apply strategies related to timing of harvest and methods to minimize compaction and exposure of bare ground in the riparian area. Plan, maintain, and deactivate roads to minimize the transport of sediments to stream channels.
- Reduce windthrow by increasing buffer widths or use more selective harvest practices for windthrow-prone timber.
- Increase retention width and complexity around small streams, especially wider perennial streams that make significant contributions of water, sediment, debris, and nutrients to downstream fish habitats, and contribute to watershed function.
- Fall and yard away from the stream whenever possible. Establish yarding corridors where this is not possible to limit the introduction of broken stems and branches into the stream.
- Create range barriers and stable fords in areas where cattle roam to limit post-harvest access to the stream.Provide training to equipment operators about the importance of streams and best practices in riparian areas. Monitor harvesting to ensure operators are utilizing methods that will minimize disturbance.

Water Quality in the Kootenay-Boundary Region

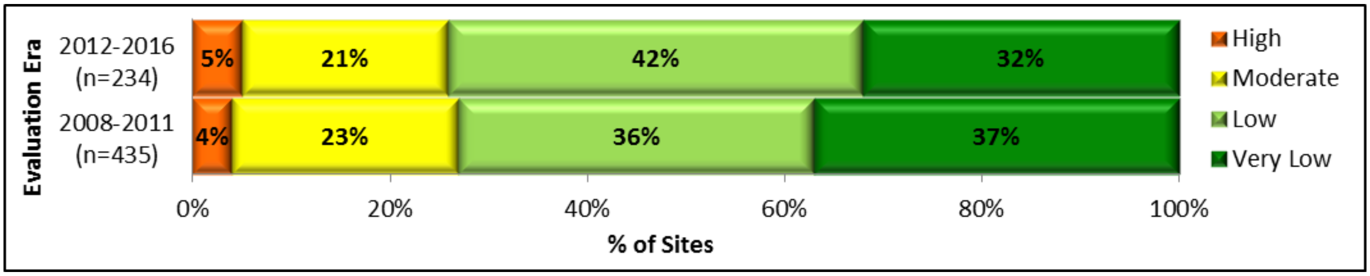


Figure 1. Percentage of sites in high, moderate, low, and very low impact categories by evaluation era.

Data Source

Assessments were conducted by trained personnel from 2008 to 2016 using the FREP water quality monitoring protocol to evaluate the potential for fine sediment transfer into streams. The sample population consists of roads and/or mass wasting sites connected to fish habitat and/or drinking water sources originating at randomly selected recently harvested cutblocks. A total of 669 samples have been collected in the Kootenay-Boundary Region, of which 234 represent recently evaluated sites. The number of sites sampled each year ranged from 13 to 167.

Summary

Twenty-six percent of recently evaluated sites had moderate or high potential for fine sediment transfer into streams compared to 27% of sites evaluated from 2008 to 2011 (Figure 1). From 2008 to 2015, there was a strong downward trend (Pearson's *r* = 0.78) in the annual percentage of sites in the moderate and high impact categories (Figure 2). In 2016, 30% of sites sampled were in the moderate and high impact categories. It is unclear why impacts were higher in 2016 compared to the previous three years.

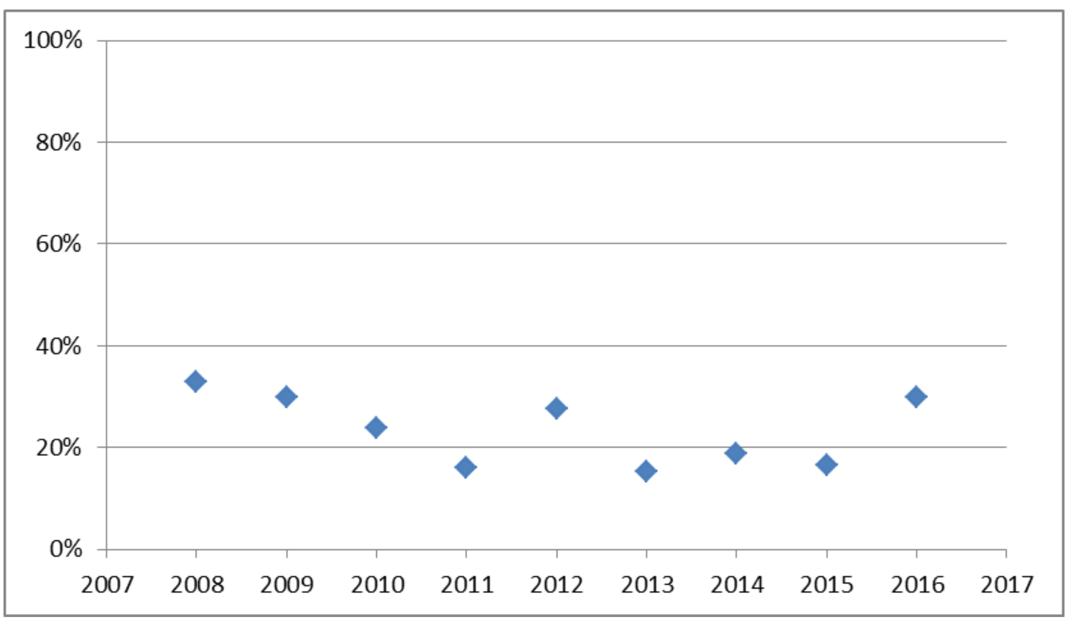


Figure 2. Percentage of sites in the moderate and high impact categories.

Causal Factors
The potential for fine sediment transfer into streams may be caused by several factors, including road location, road materials, maintenance techniques, resource road traffic, recreational activities, and storm damage.

Opportunities for Improvement of Practices to Minimize Fine Sediment Transfer to Streams
- Install strategically placed cross ditches, water bars, and ditch blocks to disperse storm flow when deactivating roads.
- Amour, seed or spread out logging debris over disturbed areas to protect soil during harvesting and road construction.
- During road and cutblock design, construct sediment traps to prevent coarse sediment from reaching streams.
- Prevent road rutting by using good quality material and crowning the road.
- During road and cutblock design, ensure sufficient culverts are properly placed.

Road license holders should be promptly informed of sites with moderate or high impact ratings so that they can remediate these sites.

Visual Quality in the Kootenay-Boundary Region

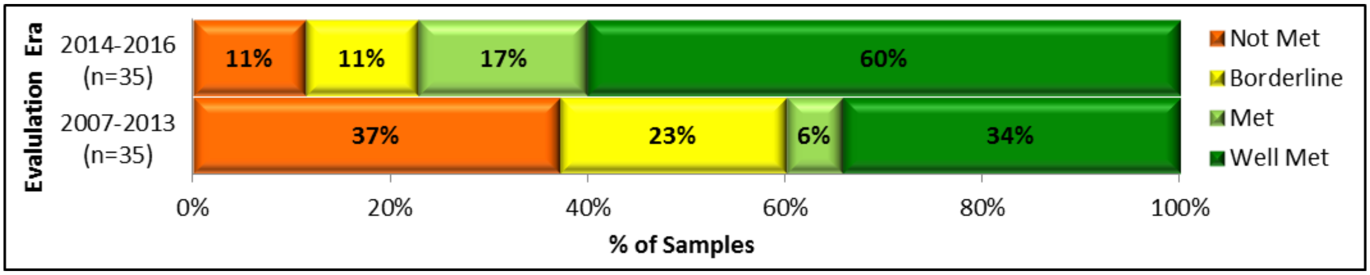


Figure 1. Percentage of landforms in each effectiveness evaluation rating category by evaluation era.

Data Source

Effectiveness evaluations were conducted by trained personnel from 2007 to 2016 using the FREP visual quality monitoring protocol to evaluate whether legally established visual quality objectives (VQOs) in designated scenic areas are being achieved. The sample population consists of landforms (distinct three-dimensional topographic features defined in perspective view) that include randomly selected cutblocks harvested under the *Forest and Range Practices Act*. A total of 70 samples have been collected in the Kootenay-Boundary Region, of which 35 represent recently evaluated landforms.

Summary

Seventy-seven percent of recently evaluated landforms achieved *(met or well met)* the VQO compared to 40% of landforms evaluated from 2007 to 2013 (Figure 1). For recently evaluated landforms, 14% of landforms with modification VQOs and 28% of landforms with partial retention VQOs did not achieve the objective *(borderline or not met)* (Table 1).

Table 1. Percentage of recently evaluated landforms by visual quality objective and rating category.

Landforms Evaluated 2014-2016		Rating Category			
		Not Met	Borderline	Met	Well Met
Visual Quality Objective	Max Modification (n=0)	-	-	-	-
	Modification (n=14)	7% (1)	7% (1)	14% (2)	71% (10)
	Partial Retention (n=21)	14% (3)	14% (3)	19% (4)	52% (11)
	Retention (n=0)	-	-	-	-
	Preservation (n=0)	-	-	-	-

Ocular Assessment Results for Recently Evaluated Landforms

Borderline/Not Met Ratings: For 100% of the landforms where the VQO was not achieved, the appearance, scale and visibleness of the alteration did not meet the criteria as defined in section 1.1 of the Forest Planning and Practices Regulation (FPPR) (Table 2).

Met/Well Met Ratings: For 100% of the landforms where the VQO was achieved, the appearance, scale and visibleness of the alteration met the criteria as defined in FPPR s.1.1 (Table 2).

Table 2. Achievement of criteria (appearance, scale and visibleness) defined in section 1.1 of the Forest Planning and Practices Regulation (FPPR) for recently evaluated landforms.

Landforms Evaluated 2014-2016		Criteria in FPPR Definition	
		Not Met	Met
Effectiveness Evaluation Rating	Borderline/Not Met	100%	0%
	Met/Well Met	0%	100%

Percent Alteration Assessment Results for Recently Evaluated Landforms

Borderline/Not Met Ratings: Initial percent alteration exceeded the upper limit of the range for the established VQO for 37% of the landforms (Table 3). Visual condition was negatively influenced by poor use of visual landscape design elements for 63% of the landforms (Table 4) and by visual impacts of roads for 57% of the landforms (Table 5). Additionally, in-block tree retention was not sufficient to improve visual condition for 75% of the landforms (Table 6).
Met/Well Met Ratings: Initial percent alteration was below or within the range for the established VQO for 100% of the landforms (Table 3). Visual condition was positively influenced by good use of visual landscape design elements for 52% of the landforms (Table 4) and by moderate/good in-block tree retention for 37% of the landforms (Table 6). Additionally, roads had no visual impacts for 78% of the landforms (Table 5).

Table 3. Comparison of initial percent alteration to the range for the established VQO for recently evaluated landforms.

Landforms Evaluated 2014-2016		Initial Percent Alteration Compared to Range for Established VQO		
		Exceeded Range	Within Range	Below Range
Effectiveness Evaluation Rating	Borderline/Not Met	37%	63%	0%
	Met/Well Met	0%	67%	33%

Table 4. Use of visual landscape design elements for recently evaluated landforms.

Landforms Evaluated 2014-2016		Use of Visual Landscape Design Elements		
		Poor	Moderate	Good
Effectiveness Evaluation Rating	Borderline/Not Met	63%	25%	12%
	Met/Well Met	33%	15%	52%

Table 5. Visual impacts of roads on recently evaluated landforms.

Landforms Evaluated 2014-2016		Visual Impacts of Roads			
		Dominant	Significant	Subordinate	None
Effectiveness Evaluation Rating	Borderline/Not Met	0%	43%	14%	43%
	Met/Well Met	0%	0%	22%	78%

Table 6. In-block tree retention for recently evaluated landforms.

Landforms Evaluated 2014-2016		In-Block Tree Retention		
		Poor	Moderate	Good
Effectiveness Evaluation Rating	Borderline/Not Met	75%	25%	0%
	Met/Well Met	63%	30%	7%

Opportunities for Improvement and/or Continuation of Practices to Manage for Visual Quality

- Use visual landscape design techniques to create openings that appear natural.
- Align roads to blend with the landform and minimize visibility. Deactivate and rehabilitate roads upon completion of harvesting.

THOMPSON-OKANAGAN NATURAL RESOURCE REGION

The following section presents the status of landscape-level biodiversity and the outcomes of site/stand-level monitoring for biodiversity, riparian condition, water quality, cultural heritage resources, and visual quality in the Thompson-Okanagan Natural Resource Region.

Status of Landscape-level Biodiversity in the Thompson-Okanagan Region

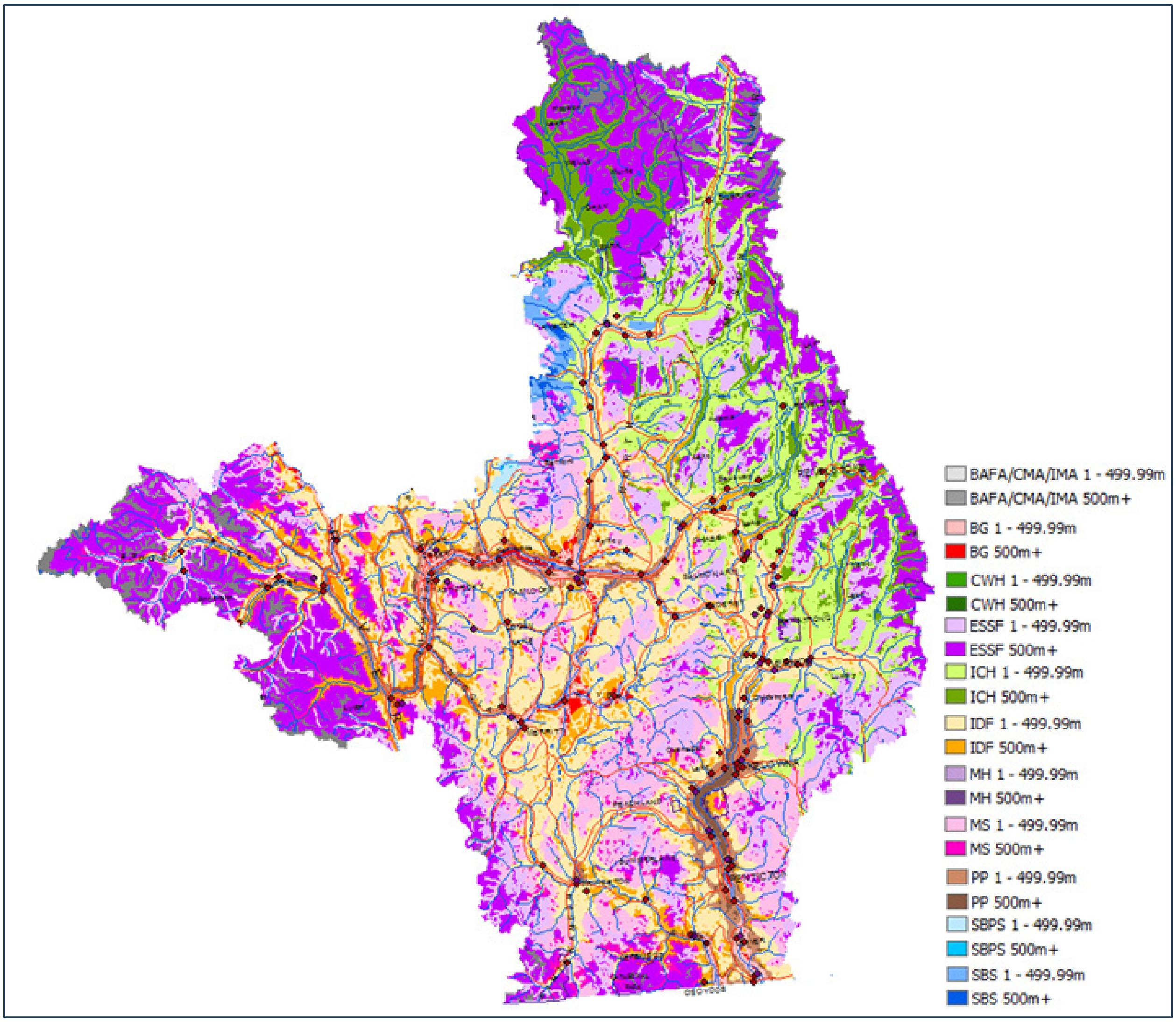


Figure 1. Distribution of roaded areas (less than 500 metres to a road) and roadless areas (500 metres or more to a road) by biogeoclimatic zone in the Thompson-Okanagan Region.

Data Source

The expected seral stage distribution was calculated by natural disturbance type (NDT) and biogeoclimatic ecosystem classification (BEC) zone using the return intervals and stand-age thresholds in the *Biodiversity*

Guidebook.[22] Stand age was not adjusted to account for mountain pine beetle infestation or fire. Mature and old seral stages were combined because the age classes that comprise these seral stages are not reliably classified in the provincial vegetation resource inventory. An additional state, “alienated forest” (mines, tailings, spoils, gravel pits, roads, rail surfaces, cutbanks, reservoir margins, landings, airports, and urban areas) is also reported.

Publicly available corporate datasets were used to conduct the spatial analysis: BEC units (2016 version), vegetation resource inventory (stand age projected to 2017), harvest depletions (as of spring 2017), roads (as of spring 2017), mountain pine beetle infestations (up to 2017), fires (2000-2017), and “resource stewardship designations” (current as of 2016) (i.e., old growth management areas, parks, protected areas, conservancies, no-harvest ungulate winter range, and no-harvest wildlife habitat areas).

Summary

The Thompson-Okanagan Region captures nine forested biogeoclimatic zones: Coastal Western Hemlock (CWH), Engelmann Spruce – Subalpine Fir (ESSF), Interior Cedar – Hemlock (ICH), Interior Douglas-fir (IDF), Mountain Hemlock (MH), Montane Spruce (MS), Ponderosa Pine (PP), Sub-Boreal Pine – Spruce (SBPS), and Sub-Boreal Spruce (SBS) (Figure 1). The amount and percentage of roadless forest (forest 500 metres or more to a road[23]) was determined for each biogeoclimatic zone (Figure 1, Table 1). For the purposes of this report, roadless forest is presumed to be less disturbed, and may have higher biodiversity value than forest within 500 metres of a road. Less than half of all biogeoclimatic zones in this region are comprised of roadless forest. In general, the Thompson-Okanagan Region has the lowest proportion of roadless forest when compared to other regions.

Table 1. Hectares and percentage of roadless forest by biogeoclimatic zone in the Thompson-Okanagan Region.

Biogeoclimatic Zone	Forest ≥500m to a Road	
	Hectares (rounded to nearest 1000 ha)	Percentage
Coastal Western Hemlock (CWH)	1,000	23%
Engelmann Spruce – Subalpine Fir (ESSF)	775,000	48%
Interior Cedar – Hemlock (ICH)	284,000	25%
Interior Douglas-fir (IDF)	287,000	17%
Mountain Hemlock (MH)	<1000	20%
Montane Spruce (MS)	175,000	17%
Ponderosa Pine (PP)	21,000	16%
Sub-Boreal Pine – Spruce (SBPS)	<1000	4%
Sub- Boreal Spruce (SBS)	6,000	9%
ALL ZONES	**1,549,000**	**27%**

The observed seral stage distribution was compared to the expected seral stage distribution for each biogeoclimatic zone (Figure 2). In the CWH, ICH, MH, SBPS and SBS zones, the observed amount is similar to the expected amount for all seral stages. In the MS zone, the observed amount of early seral is twice the expected amount, which is consistent with increased harvest due to mountain pine beetle salvage. In the ESSF zone, the observed amount of mature/old forest exceeds the expected amount, suggesting that the return intervals in the

[22] Anonymous. 1995. Biodiversity Guidebook. Forest Practices Code of British Columbia. Victoria BC. Ministry of Forests, Ministry of Environment. https://www.for.gov.bc.ca/hfd/library/documents/bib19715.pdf.

[23] British Columbia. Ministry of Environment. 2018. Status of Roads & Roadless Area. Environmental Reporting BC. Ministry of Environment. http://www.env.gov.bc.ca/soe/indicators/land/roads.html

Biodiversity Guidebook may be too short. In the IDF and PP zones, the observed and expected seral stage distributions are potentially misleading. The concept of seral stage is based on a natural disturbance regime of stand-destroying events (e.g., catastrophic fire) that result in single-aged stands.[24] This does not apply to the IDF and PP zones because these zones are in natural disturbance type 4 (NDT4) where stand-maintaining fires result in multi-aged stands. Additionally, IDF stands in this region have been primarily partially harvested (rather than clearcut), also resulting in multi-aged rather than single-aged stands, hence the stand age reported in the vegetation resource inventory for IDF stands is time since last entry, not time since last stand-destroying event. In summary, when rolled up to the zone level, with the exception of the MS zone, the observed seral stage distributions observed across the landscape are similar to expected.

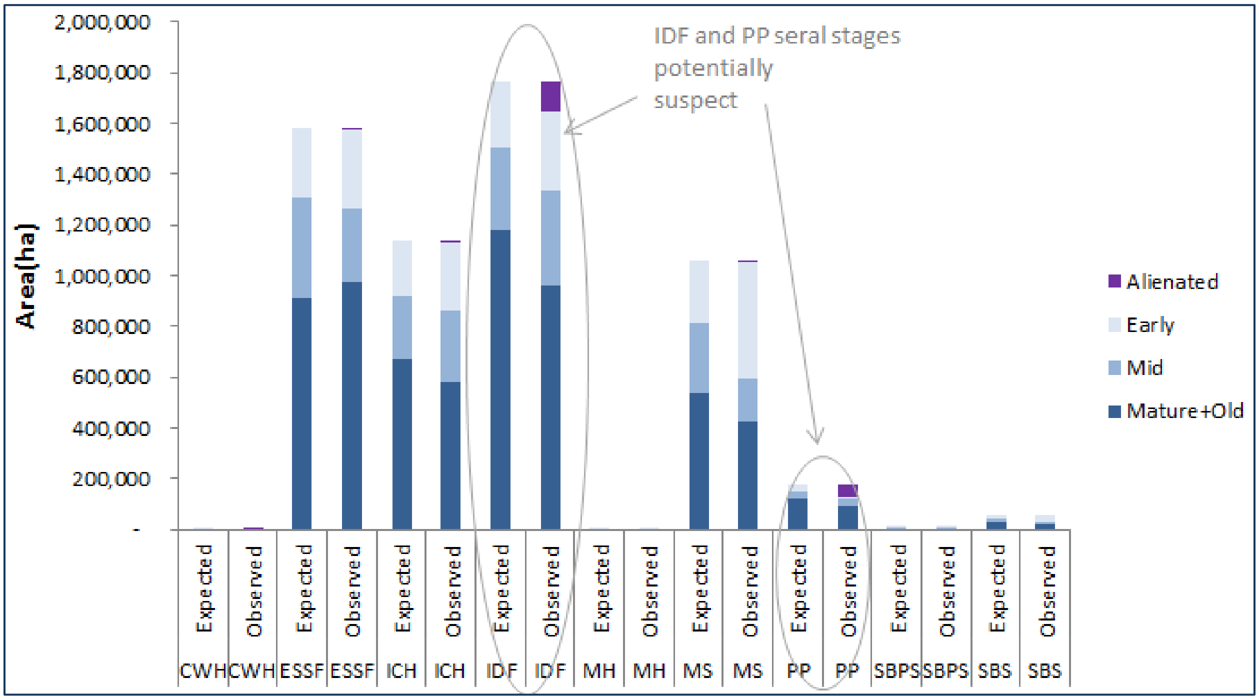


Figure 2. Expected versus observed seral stage distribution by biogeoclimatic zone in the Thompson-Okanagan Region.

The percentage of mature/old forest protected from harvest in various resource stewardship designations was determined for each biogeoclimatic zone (Table 2). The condition of protected and unprotected mature/old forest in each zone was assessed using distance to road and natural disturbance impacts as indicators (Figures 3 and 4). Mature/old forest impacted by both mountain pine beetle and fire is reported in the appropriate fire category (2000-2016 or 2017).

In the ESSF and ICH zones, 43% and 37%, respectively of mature/old forest is protected from harvest, and the majority of this protected mature/old forest is roadless and has not been impacted by fire or mountain pine beetle. In the IDF, MS and PP zones, substantially less is protected from harvest (22%, 25% and 21%, respectively), and the majority of both the protected and unprotected mature/old forest in these zones is within 500 metres of a road and has been impacted by fire and/or mountain pine beetle. In summary, the majority of mature/old forest in the biogeoclimatic zones that dominate the valley bottoms has been heavily developed and impacted by fire or mountain pine beetle or both.

[24] Eng, Marvin, 2018. Using Natural Disturbance Return Intervals to Estimate Expected Seral Stage Distribution of Forests. A literature review and discussion. Forest and Range Evaluation Program, Ministry of Forests, Lands, Natural Resource Operations and Rural Development.

Table 2. Hectares and percentage of mature/old forest protected from harvest by biogeoclimatic zone in the Thompson-Okanagan Region.

Biogeoclimatic Zone	Mature/Old Forest Protected from Harvest	
	Hectares (rounded to nearest 1000 ha)	Percentage
Coastal Western Hemlock (CWH)	1,000	51%
Engelmann Spruce – Subalpine Fir (ESSF)	415,000	43%
Interior Cedar – Hemlock (ICH)	215,000	37%
Interior Douglas-fir (IDF)	207,000	22%
Mountain Hemlock (MH)	<1,000	10%
Montane Spruce (MS)	104,000	25%
Ponderosa Pine (PP)	20,000	21%
Sub-Boreal Pine – Spruce (SBPS)	<1,000	8%
Sub- Boreal Spruce (SBS)	8,000	31%
ALL ZONES	**971,000**	**32%**

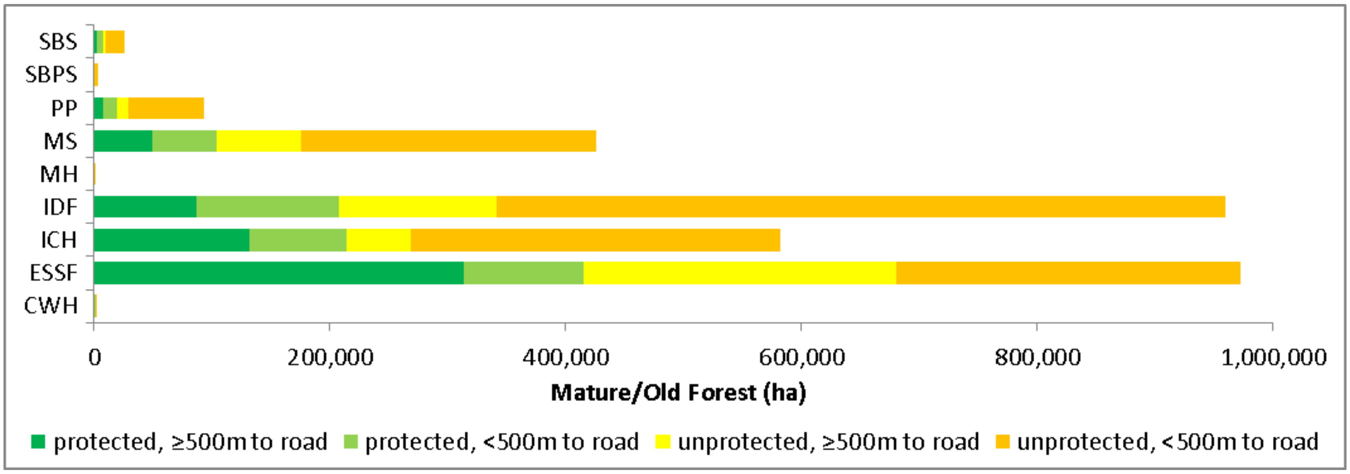


Figure 3. Hectares of protected roadless, protected roaded, unprotected roadless, and unprotected roaded mature/old forest by biogeoclimatic zone in the Thompson-Okanagan Region.

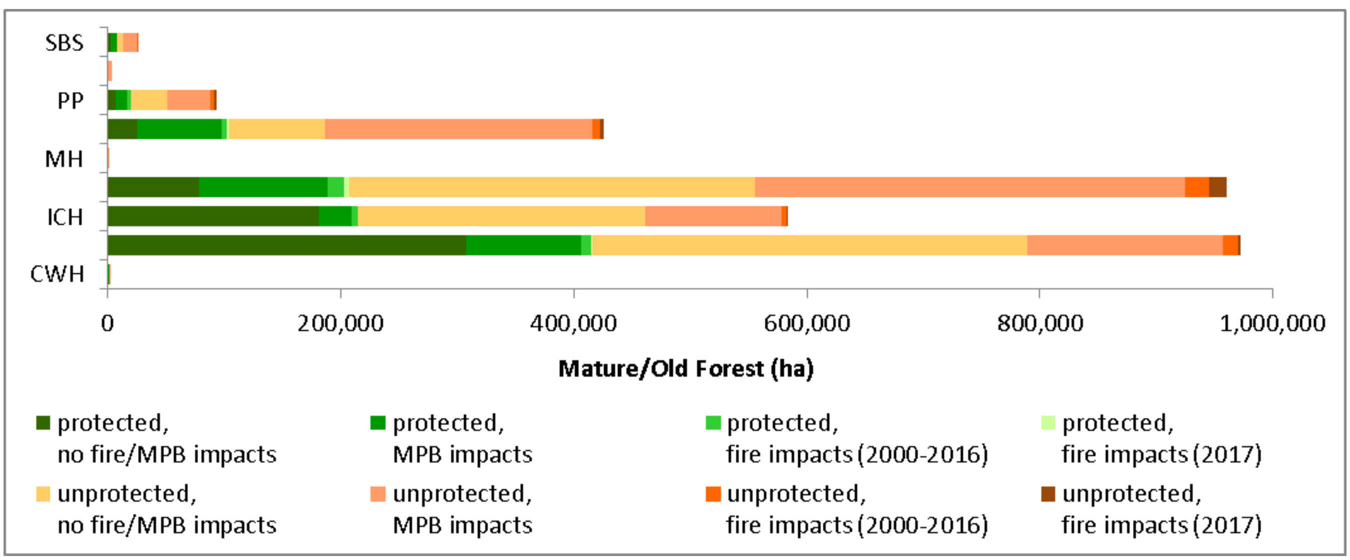


Figure 4. Hectares of protected and unprotected mature/old forest impacted by mountain pine beetle and/or fire by biogeoclimatic zone in the Thompson-Okanagan Region.

Post-harvest Condition of Stand-level Biodiversity in the Thompson-Okanagan Region

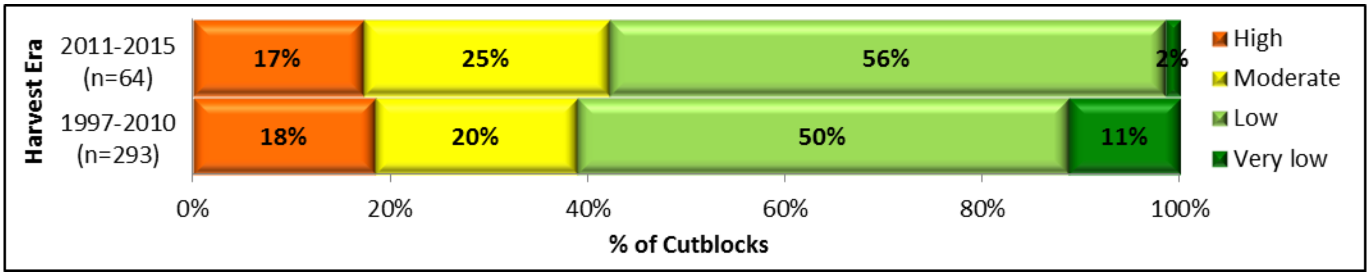


Figure 1. Quantity and type of retention by harvest era: Percentage of cutblocks in high, moderate, low, and very low impact categories.

Table 1. Quality of tree retention compared to pre-harvest benchmark by harvest era.

	Large Live Tree Density	Large Snag Density	Tree Species Diversity
2011-2015 (n=64)	Less	Less	Less
Quality Trend	*No change*	***Declining***	*No change*
1997-2010 (n=293)	Less	Comparable	Less

Table 2. Quality of coarse woody debris (CWD) retention compared to pre-harvest benchmark by harvest era.

	Large Piece Volume	Large & Long Piece Density
2011-2015 (n=64)	Comparable	Not Comparable
Quality Trend	***Improving***	*No change*
1997-2010 (n=293)	Not Comparable	Not Comparable

Data Source

Assessments were conducted by trained personnel from 2006 to 2016 using the FREP stand-level biodiversity (SLBD) monitoring protocol to evaluate whether retention of wildlife tree patches and riparian reserves is achieving the desired levels and types of structures to maintain species diversity. The sample population consists of randomly selected cutblocks harvested from 1997 to 2015. A total of 357 samples have been collected in the Thompson-Okanagan Region, of which 64 represent recently harvested blocks.

Summary

Quantity and Type of Retention: The impact rating for each cutblock with respect to quantity and type of retention was determined by assessing percent of within-block retention, patch size, presence of within-patch ecological anchors, and presence of dispersed retention. If a cutblock scored greater than 80 out of 100 points, it was rated as very low impact. If a cutblock scored between 45 and 80 points, it was rated as low impact. If a cutblock scored less than 45 points, it was rated as moderate impact. If a cutblock had less than 3.5% retention (regardless of total score), it was rated as high impact.

Fifty-eight percent of recently harvested cutblocks were in the low and very low impact categories compared to 61% of the sites harvested before 2011 (Figure 1). The average score has not changed significantly over time (Figure 2). The average percent of within-block retention, median patch size, use of ecological anchors, and use of dispersed retention did not differ significantly between harvest eras (Figure 3).

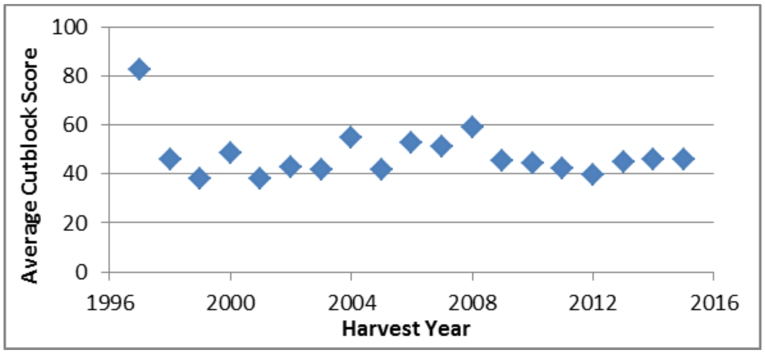


Figure 2. Average cutblock score with respect to retention quantity and type by harvest year.

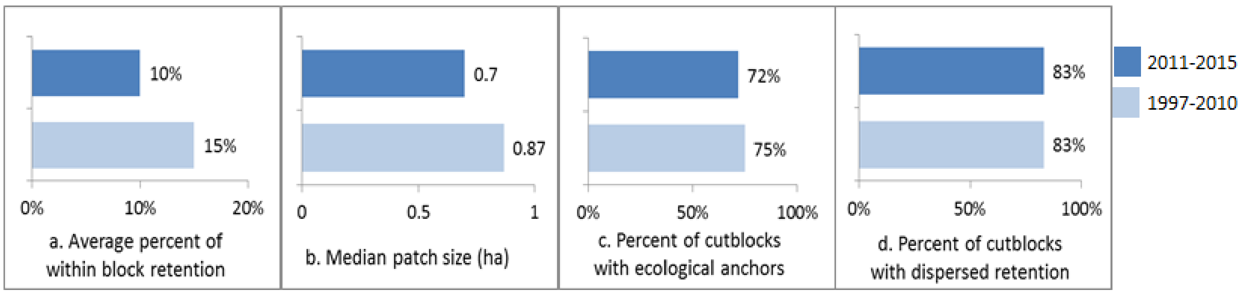


Figure 3. Quantity and type of retention by harvest era.

Quality of Tree Retention: Assessment of tree retention quality was conducted in aggregate for the entire region because pre-harvest condition is unknown for the vast majority of the blocks assessed. Assuming that timber cruise data is an appropriate surrogate for pre-harvest condition, a benchmark was adopted for each harvest era to reflect that the characteristics of the harvested stands differ between the two eras. The density of large live trees and snags (>40, >50 or >70 cm dbh, dependent on biogeoclimatic subzone) and the diversity of tree species retained for each harvest era were compared to cruise data from approximately the same harvest era and for the same biogeoclimatic subzone (Table 1). Large live tree density and tree species diversity were less than pre-harvest condition for both harvest eras. Large snag density was comparable to pre-harvest conditions on cutblocks harvested before 2011 but was less than pre-harvest density on recently harvested cutblocks.

Quality of Coarse Woody Debris (CWD) Retention: An assessment of CWD retention quality was also conducted in aggregate against a pre-harvest benchmark for each harvest era. The volume of large pieces (>20 cm diameter) and density of large and long pieces (>20 cm diameter, >10 m long) in harvested areas were compared to retention patches (Table 2). Large piece volume changed to reflect pre-harvest condition on recently harvested cutblocks. Large and long piece density was not comparable to the benchmark for both harvest eras.

Opportunities for Improvement and/or Continuation of Practices to Manage Stand-level Biodiversity

- Continue to include ecological anchors within patches when available.
- Continue to leave dispersed retention throughout harvested areas.
- Improve tree retention quality by leaving densities of large live trees, densities of large snags, and diversity of tree species representative of pre-harvest conditions.
- Continue to retain large CWD in volumes comparable to pre-harvest conditions.
- Improve CWD retention quality by leaving large and long pieces of CWD in densities representative of pre-harvest conditions.

Post-harvest Condition of Streams and Riparian Areas in the Thompson-Okanagan Region

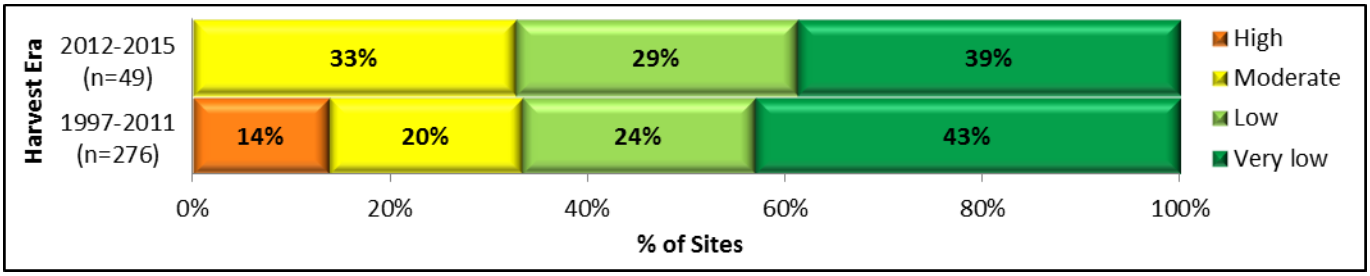


Figure 1. Percentage of sites in high, moderate, low, and very low impact categories by harvest era.

Data Source

Assessments were conducted by trained personnel from 2006 to 2016 using the FREP riparian monitoring protocol to evaluate whether riparian forestry and range practices are effective in maintaining the structural integrity and functions of stream ecosystems and other aquatic resources. The sample population includes randomly selected cutblocks with streams within or adjacent to them. A total of 325 riparian samples have been collected in the Thompson-Okanagan Region, of which 49 represent stream reaches harvested since 2012. Because the protocol requires a time lag of one to two winters to allow for impacts such as windthrow to manifest, there is little or no data for blocks harvested within the last two years.

Summary

Sixty-eight percent of the recently harvested sites were in the low or very low impact categories compared to 67% of the sites harvested before 2012 (Figure 1). Of the 49 recently harvested sites, none were in the high impact category and 16 were in the moderate impact category. Of these, 15 were S6 streams and one was an S4 stream (Table 1). One S6 stream and the S4 stream were located adjacent to the block. The remaining streams were in the block.

Table 1. Number of recently harvested sites by stream class and impact category.

Stream	Impact Category				Total
Class	High	Moderate	Low	Very Low	
S1	0	0	0	0	0
S2	0	0	1	0	1
S3	0	0	1	3	4
S4	0	1	2	2	5
S5	0	0	0	2	2
S6	0	15	10	12	37
Total	**0**	**16**	**14**	**19**	**49**

Causal Factors

The largest causal factors of impacts were logging (52%) and natural events (22%) at sites that had been recently harvested (Figure 2). The average number of logging-related impacts per year ranged from 0.5 to 2.7 (Figure 3). There is no statistical trend when considering all data points over time.

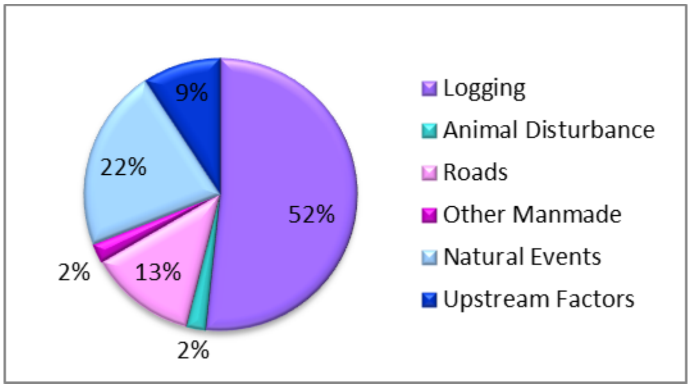


Figure 2. Percentage of impacts by causal factor at recently harvested sites.

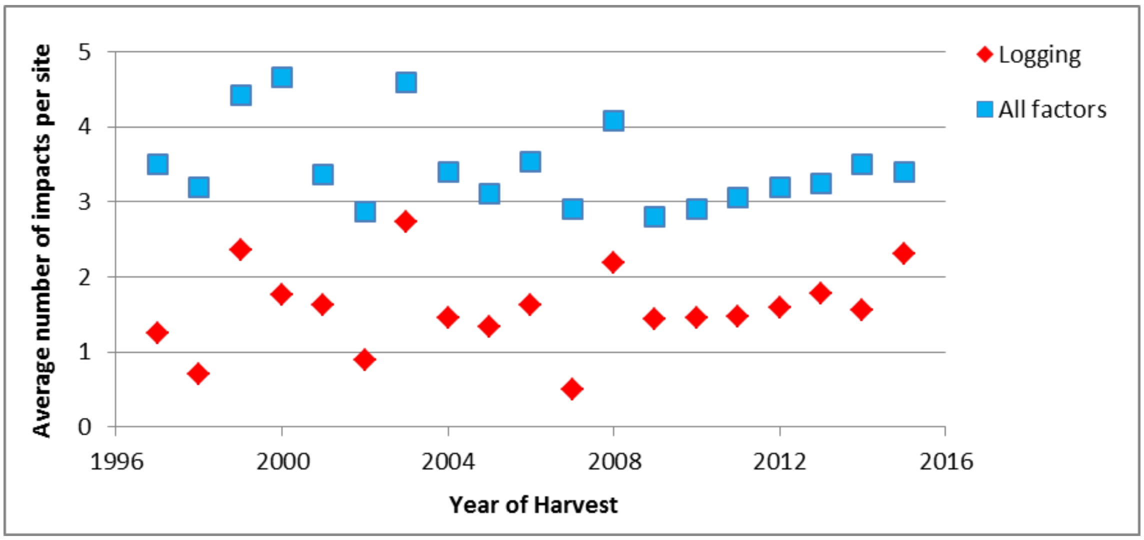


Figure 3. Average number of logging-related impacts and average number of impacts caused by all factors by year of harvest.

Specific Impacts

The most common logging-related activities that contributed to impacts observed at recently harvested sites include low retention, windthrow, and machine disturbance. These activities have been linked to increased in-stream fine sediments, excessive blowdown, reduced riparian vegetation vigour and structure, and reduced large woody debris (LWD) supply/root network (Table 2).

Natural events that contributed to impacts observed at recently harvested sites include high background sediment levels, and organic streambeds. These events lead to high levels of in-stream fine sediments, decreased moss abundance/condition, and blockages to aquatic connectivity (Table 2).

Table 2. Causal factors and related impacts for recently harvested sites.

% of All Factors	Most Common Specific Impacts
Logging (52%) *Low Retention* *Windthrow* *Machine Disturbance*	In-stream sediments ↑ Excessive blowdown ↑ Riparian vegetation form/vigour↓ LWD Supply/Root Network ↓
Natural Events (22%) *High background sediment levels* *Organic streambed*	In-stream sediments ↑ Moss abundance/condition ↓ In-stream blockages ↑
Roads (13%) *Running surface eroding into stream* *Fill or cut slopes eroding into stream*	In-stream sediments ↑ Soil disturbance/bare ground ↑
Upstream Factors (9%)	In-stream sediments ↑ Moss abundance/condition ↓
Animal Disturbance (2%) *Trampling*	In-stream sediments ↑
Other Manmade (2%)	Moss abundance/condition ↓

Opportunities for Improvement and/or Continuation of Practices that Protect Stream and Riparian Conditions

- Recognize the risk of erosion in areas that are naturally high in fine sediments. Apply strategies related to timing of harvest and methods to minimize compaction and exposure of bare ground in the riparian area. Plan, maintain, and deactivate roads to minimize the transport of sediments to stream channels.
- Reduce windthrow by increasing buffer widths or use more selective harvest practices for windthrow-prone timber.
- Increase retention width and complexity around small streams, especially wider perennial streams that make significant contributions of water, sediment, debris, and nutrients to downstream fish habitats, and contribute to watershed function.
- Provide training to equipment operators about the importance of streams and best practices in riparian areas. Monitor harvesting to ensure operators are utilizing methods that will minimize disturbance.
- Create range barriers and stable fords in areas where cattle roam to limit post-harvest access to the stream.

Water Quality in the Thompson-Okanagan Region

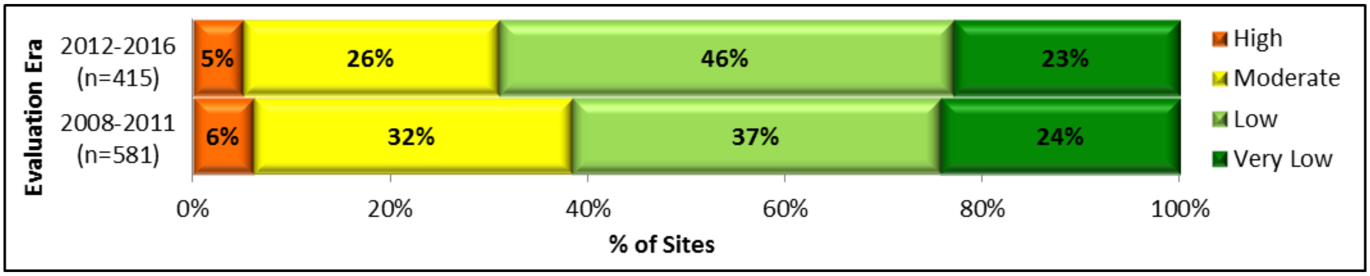


Figure 1. Percentage of sites in high, moderate, low, and very low impact categories by evaluation era.

Data Source

Assessments were conducted by trained personnel from 2008 to 2016 using the FREP water quality monitoring protocol to evaluate the potential for fine sediment transfer into streams. The sample population consists of roads and/or mass wasting sites connected to fish habitat and/or drinking water sources originating at randomly selected recently harvested cutblocks. A total of 996 samples have been collected in the Thompson-Okanagan Region, of which 415 represent recently evaluated sites. The number of sites sampled each year ranged from 19 to 186.

Summary

Thirty-one percent of recently evaluated sites had moderate or high potential for fine sediment transfer into streams compared to 38% of sites evaluated from 2008 to 2011 (Figure 1). Since 2008, there has been a strong downward trend (Pearson's *r* = -0.75) in the annual percentage of sites in the moderate and high impact categories (Figure 2). This suggests that water quality impacts from roads are decreasing, yet the annual percentage of sites with moderate or high impact ratings continues to remain more than 20% of the sites sampled.

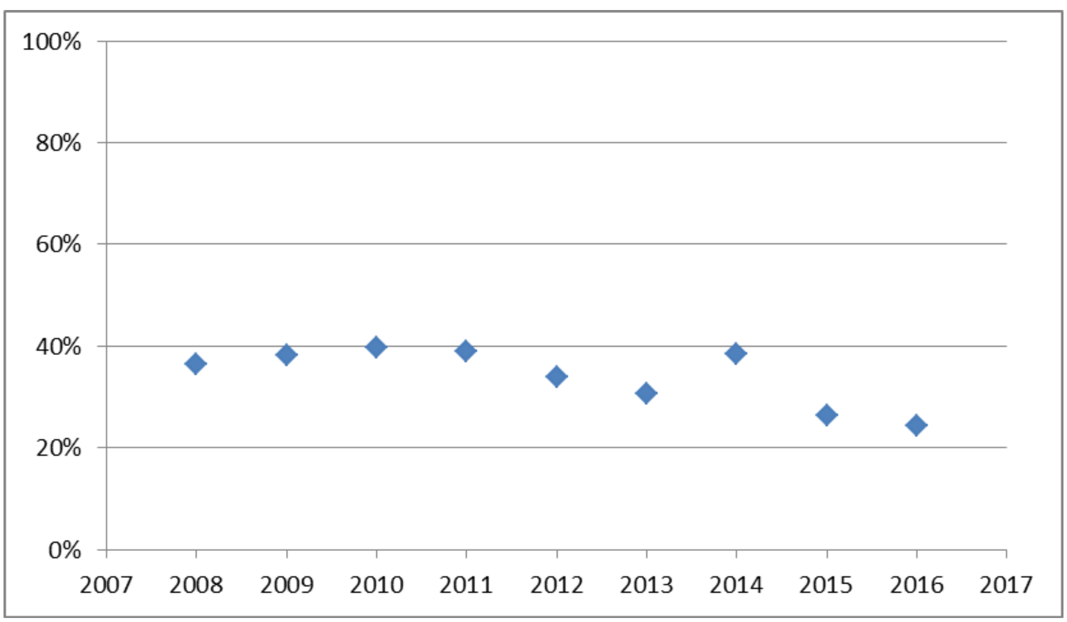


Figure 2. Percentage of sites in the moderate and high impact categories.

Causal Factors
The potential for fine sediment transfer into streams may be caused by several factors, including road location, road materials, maintenance techniques, resource road traffic, recreational activities, and storm damage.

Opportunities for Improvement of Practices to Minimize Fine Sediment Transfer to Streams

- Install strategically placed cross ditches, water bars, and ditch blocks to disperse storm flow when deactivating roads.
- Remove any berms present during road management.
- During road and cutblock design, ensure there are a sufficient number of properly sized and located culverts.
- Prevent road rutting by using good quality material and crowning the road surface.
- Armour, seed or spread out logging debris over disturbed areas to protect the soil during harvesting and road construction.

Road license holders should be promptly informed of sites with moderate or high impact ratings so that they can remediate these sites.

Post-harvest Condition of Cultural Heritage Resources in the Thompson-Okanagan Region

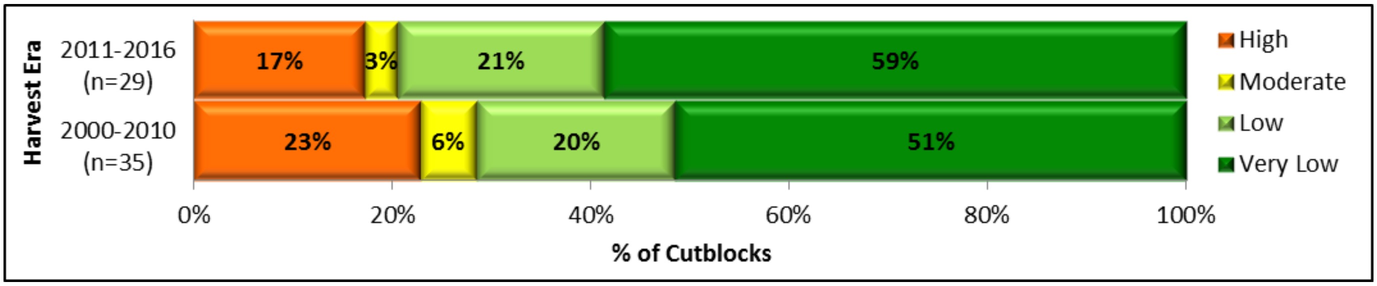


Figure 1. Percentage of cutblocks in high, moderate, low, and very low impact categories by harvest era.

Data Source

Assessments were conducted by trained personnel, often with the assistance of local First Nations and licensee forest professionals, from 2009 to 2016 using the FREP cultural heritage resource (CHR) monitoring protocol to evaluate the conservation or protection of site-specific First Nations' CHRs. The sample population consists of randomly selected cutblocks with known CHR features, as well as targeted cutblocks of special importance to First Nations. A total of 64 samples have been collected in the Cascades Natural Resource District, of which 29 represent recently harvested cutblocks. A cutblock may present more than one CHR feature – up to 7 features have been found on a single cutblock in the Thompson-Okanagan Region. Of the 132 features assessed to date, 54 features were assessed on recently harvested cutblocks. Features were located prior to harvest, predominantly through preliminary field reconnaissance (58%) and site plans (22%). First Nations led the preliminary field reconnaissance of proposed cutblocks.

Summary

The impact rating for each cutblock is determined by assessing the overall management of CHRs and protection of individual cultural features. Eighty percent of recently harvested cutblocks were in the low or very low impact categories compared to 71% of cutblocks harvested before 2011 (Figure 1). The most common features located on recently harvested cutblocks were culturally modified trees (44%), cultural trails (28%), and archaeological resources (13%) (Figure 2).

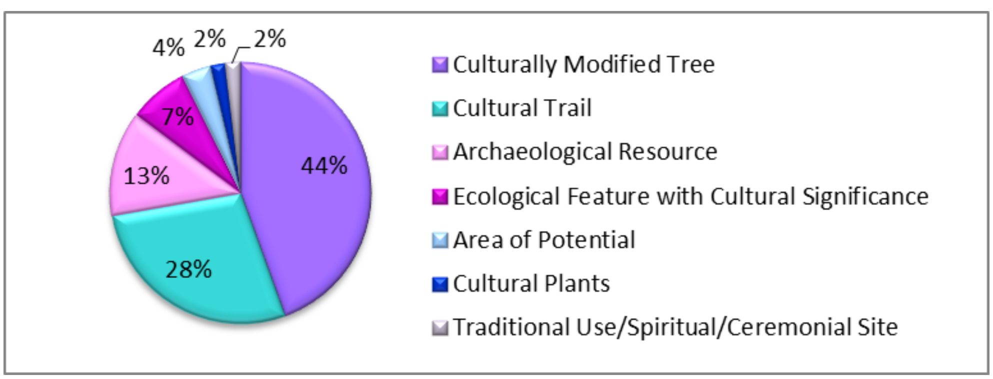


Figure 2. Percentage of CHR feature types located on recently harvested cutblocks.

Causal Factors for Recently Harvested Cutblocks

Harvesting and silvicultural activities were the main sources of impacts on CHR features. Impacts were directly caused by machine disturbance and windthrow, often in association with non-windfirm buffers. Impacts were also attributed to burning of slash piles in proximity to CHR features and the accumulation of debris on cultural trails. Impacts were often a result of insufficient marking of features in the field prior to harvest.

Opportunities for Improvements and/or Continuation of Practices to Manage for Cultural Heritage Resources

- Clearly identify features in the field prior to harvest *and* silvicultural treatments, and ensure requirements for protection of features are communicated to contractors during pre-work sign-off meetings.
- Include features in long-term (at least one rotation) windfirm reserves (e.g., wildlife tree retention areas) or exclude features from the harvest area by modifying cutblock boundaries.
- Ensure buffers intended to protect features are windfirm. Discuss management options and potential impacts with local First Nations prior to harvest.
- Select a management approach for culturally modified trees (e.g., stubbing above cultural mark, preserving with a windfirm buffer, or including in a reserve) based on discussions with local First Nations and consideration of site context and tree species/condition.
- Protect cultural trails by establishing machine free zones, marking trail buffers with high stubbed lines, identifying a limited number of designated skidder crossings of the trail, removing post-harvest debris, and avoiding site preparation/planting of trailbeds.
- Locate burn or slash piles well away from features and reserves.
- Use low impact harvest methods or harvest when ground is frozen and with sufficient snowpack to minimize soil disturbance to avoid damaging surface/sub-surface cultural features that may exist, where an archaeological impact assessment (AIA) recommendation states that these methods may be appropriate.

Visual Quality in the Thompson-Okanagan Region

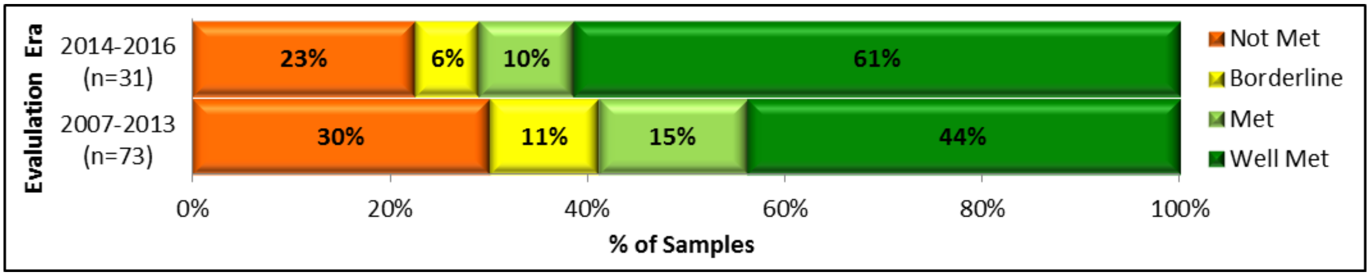


Figure 1. Percentage of landforms in each effectiveness evaluation rating category by evaluation era.

Data Source

Effectiveness evaluations were conducted by trained personnel from 2007 to 2016 using the FREP visual quality monitoring protocol to evaluate whether legally established visual quality objectives (VQOs) in designated scenic areas are being achieved. The sample population consists of landforms (distinct three-dimensional topographic features defined in perspective view) that include randomly selected cutblocks harvested under the *Forest and Range Practices Act*. A total of 104 samples have been collected in the Thompson-Okanagan Region, of which 31 represent recently evaluated landforms.

Summary

Seventy-one percent of recently evaluated landforms achieved *(met or well met)* the VQO compared to 59% of landforms evaluated from 2007 to 2013 (Figure 1). For the recently evaluated landforms, 32% of landforms with partial retention VQOs and 50% of landforms with retention VQOs did not achieve the objective *(borderline or not met)* (Table 1).

Table 1. Percentage of recently evaluated landforms by visual quality objective and rating category.

Landforms Evaluated 2014-2016		Rating Category			
		Not Met	**Borderline**	**Met**	**Well Met**
Visual Quality Objective	**Max Modification (n=0)**	-	-	-	-
	Modification (n=4)	0% (0)	0% (0)	**25%** (1)	**75%** (3)
	Partial Retention (n=25)	**28%** (7)	**4%** (1)	**8%** (2)	**60%** (15)
	Retention (n=2)	0% (0)	**50%** (1)	0% (0)	**50%** (1)
	Preservation (n=0)	-	-	-	-

Ocular Assessment Results for Recently Evaluated Landforms

<u>Borderline/Not Met Ratings:</u> For 100% of the landforms where the VQO was not achieved, the appearance, scale and visibleness of the alteration did not meet the criteria as defined in section 1.1 of the Forest Planning and Practices Regulation (FPPR) (Table 2).
<u>Met/Well Met Ratings:</u> For 100% of the landforms where the VQO was achieved, the appearance, scale and visibleness of the alteration met the criteria as defined in FPPR s.1.1 (Table 2).

Table 2. Achievement of criteria (appearance, scale and visibleness) defined in section 1.1 of the Forest Planning and Practices Regulation (FPPR) for recently evaluated landforms.

Landforms Evaluated 2014-2016		Criteria in FPPR Definition	
		Not Met	Met
Effectiveness Evaluation Rating	Borderline/Not Met	100%	0%
	Met/Well Met	0%	100%

Percent Alteration Assessment Results for Recently Evaluated Landforms

Borderline/Not Met Ratings: Initial percent alteration exceeded the upper limit of the range for the established VQO for 56% of the landforms (Table 3). Visual condition was negatively influenced by poor use of visual landscape design elements for 56% of the landforms (Table 4) and by visual impacts of roads for 22% of the landforms (Table 5). Additionally, in-block tree retention was not sufficient to improve visual condition for 100% of the landforms (Table 6).

Met/Well Met Ratings: Initial percent alteration was below or within the range for the established VQO for 96% of the landforms (Table 3). Visual condition was positively influenced by good use of visual landscape design elements for 32% of the landforms (Table 4) and by moderate/good in-block tree retention for 29% of the landforms (Table 6). Additionally, roads had no visual impacts for 82% of the landforms (Table 5). For the 4% of landforms where initial percent alteration exceeded the upper limit of the range for the established VQO (Table 3), the rating was adjusted due to good use of visual landscape design elements and in-block tree retention, resulting in VQO achievement.

Table 3. Comparison of initial percent alteration to the range for the established VQO for recently evaluated landforms.

Landforms Evaluated 2014-2016		Initial Percent Alteration Compared to Range for Established VQO		
		Exceeded	Within Range	Below
Effectiveness Evaluation Rating	Borderline/Not Met	56%	44%	0%
	Met/Well Met	4%	55%	41%

Table 4. Use of visual landscape design elements for recently evaluated landforms.

Landforms Evaluated 2014-2016		Use of Visual Landscape Design Elements		
		Poor	Moderate	Good
Effectiveness Evaluation Rating	Borderline/Not Met	56%	33%	11%
	Met/Well Met	36%	32%	32%

Table 5. Visual impacts of roads on recently evaluated landforms.

Landforms Evaluated 2014-2016		Visual Impacts of Roads			
		Dominant	Significant	Subordinate	None
Effectiveness Evaluation Rating	Borderline/Not Met	0%	11%	11%	78%
	Met/Well Met	0%	0%	18%	82%

Table 6. In-block tree retention for recently evaluated landforms.

Landforms Evaluated 2014-2016		In-Block Tree Retention		
		Poor	Moderate	Good
Effectiveness Evaluation Rating	Borderline/Not Met	100%	0%	0%
	Met/Well Met	71%	10%	19%

Opportunities for Improvement and/or Continuation of Practices to Manage for Visual Quality

- Use visual landscape design techniques to create openings that appear natural.
- Increase in-block tree retention to reduce the amount of visible bare ground.

SOUTH COAST NATURAL RESOURCE REGION

The following section presents the status of landscape-level biodiversity and the outcomes of site/stand-level monitoring for biodiversity, riparian condition, water quality, and visual quality in the South Coast Natural Resource Region.

Status of Landscape-level Biodiversity in the South Coast Region

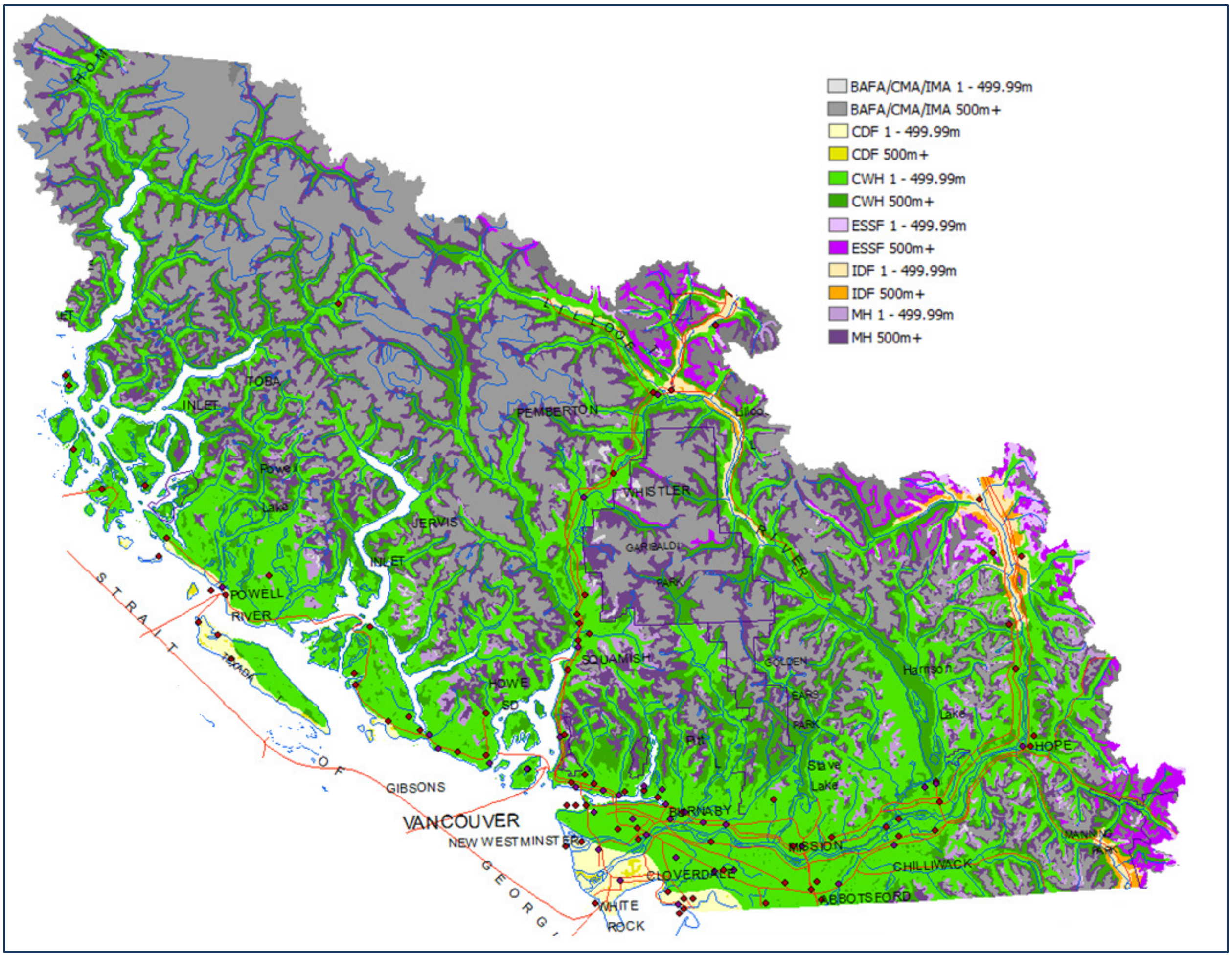


Figure 1. Distribution of roaded areas (less than 500 metres to a road) and roadless areas (500 metres or more to a road) by biogeoclimatic zone in the South Coast Region.

Data Source

The expected seral stage distribution was calculated by natural disturbance type (NDT) and biogeoclimatic ecosystem classification (BEC) zone using the return intervals and stand-age thresholds in the *Biodiversity Guidebook*.[25] Stand age was not adjusted to account for mountain pine beetle infestation or fire. Mature and old seral stages were combined because the age classes that comprise these seral stages are not reliably classified in the provincial vegetation resource inventory. An additional state, "alienated forest" (mines, tailings,

[25] Anonymous. 1995. Biodiversity Guidebook. Forest Practices Code of British Columbia. Victoria BC. Ministry of Forests, Ministry of Environment. https://www.for.gov.bc.ca/hfd/library/documents/bib19715.pdf.

spoils, gravel pits, roads, rail surfaces, cutbanks, reservoir margins, landings, airports, and urban areas) is also reported.

Publicly available corporate datasets were used to conduct the spatial analysis: biogeoclimatic ecosystem classification (BEC) units (2016 version), vegetation resource inventory (stand age projected to 2017), harvest depletions (as of spring 2017), roads (as of spring 2017), mountain pine beetle infestations (up to 2017), fires (2000-2017), and "land protection designations" (current as of 2016) (i.e., old growth management areas, parks, protected areas, conservancies, no-harvest ungulate winter range, and no-harvest wildlife habitat areas).

Summary

The South Coast Region captures five forested biogeoclimatic zones: Coastal Douglas-fir (CDF), Coastal Western Hemlock (CWH), Engelmann Spruce – Subalpine Fir (ESSF), Interior Douglas-fir (IDF) and Mountain Hemlock (MH) (Figure 1). The amount and percentage of roadless forest (forest 500 metres or more to a road[26]) was determined for each biogeoclimatic zone (Figure 1, Table 1). For the purposes of this report, roadless forest is presumed to be less disturbed, and may have higher biodiversity value than forest within 500 metres of a road.

More than half of the ESSF and MH zones, and less than half of the CDF, CWH and IDF zones, are comprised of roadless forest. In general, higher elevation and remote biogeoclimatic zones in the Kootenay-Boundary Region are largely composed of roadless forest.

Table 1. Hectares and percentage of roadless forest by biogeoclimatic zone in the South Coast Region.

Biogeoclimatic Zone	Forest ≥500m to a Road	
	Hectares (rounded to nearest 1000 ha)	**Percentage**
Coastal Douglas-fir (CDF)	2,000	11%
Coastal Western Hemlock (CWH)	477,000	31%
Engelmann Spruce – Subalpine Fir (ESSF)	77,000	70%
Interior Douglas-fir (IDF)	16,000	24%
Mountain Hemlock (MH)	356,000	74%
ALL ZONES	**925,000**	**42%**

The observed seral stage distribution was compared to the expected seral stage distribution for each biogeoclimatic zone (Figure 2).[27] In the CDF zone, the observed distribution is significantly different from the expected distribution because 67% of the forest has been converted to non-forest (alienated). In the CWH zone, the observed distribution also differs from the expected distribution due to alienation (10%). Alienation (or land-use conversion) rather than industrial forestry has had the greatest impact on the distribution of seral stages within the CDF and CWH zones. In the ESSF and MH zones, the observed amount of mature/old forest exceeds the expected amount, suggesting that the return intervals in the *Biodiversity Guidebook* may be too short.

In the IDF zone, the observed and expected seral stage distributions are potentially misleading. The concept of seral stage is based on a natural disturbance regime of stand-destroying events (e.g., catastrophic fire) that

[26] British Columbia. Ministry of Environment. 2018. Status of Roads & Roadless Area. Environmental Reporting BC. Ministry of Environment. http://www.env.gov.bc.ca/soe/indicators/land/roads.html
[27] This is not a compliance report against legal orders and no "ecological score" has been provided. That said, the authors of the 1995 Biodiversity Guidebook argued that biodiversity can be more likely maintained if forest management seeks to retain habitat patterns and seral stages that are similar to natural landscapes.

result in single-aged stands.[28] This does not apply in the IDF zone because it is in the natural disturbance type 4 (NDT4) where stand-maintaining fires result in multi-aged stands. Additionally, IDF stands in this region have been primarily partially harvested (rather than clearcut), also resulting in multi-aged rather than single-aged stands, hence the stand age in the vegetation resource inventory for IDF stands is time since last entry, not time since last stand-destroying event.

In summary, land-use conversion near population centres has had a substantial impact on observed seral stages within this region.

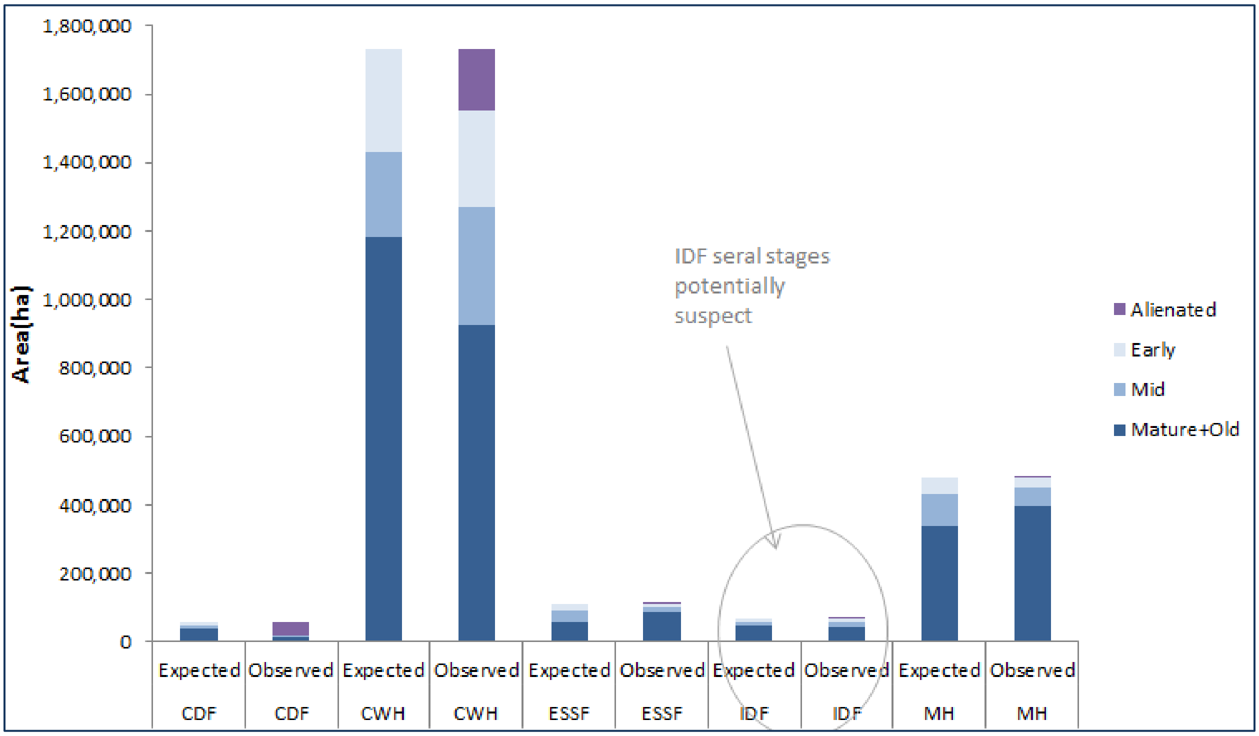


Figure 2. Expected versus observed seral stage distribution by biogeoclimatic zone in the South Coast Region.

The amount and percentage of mature/old forest protected from harvest in various resource stewardship designations was determined for each biogeoclimatic zone (Table 2). The condition of protected and unprotected mature/old forest in each zone was assessed using distance to road and natural disturbance impacts as indicators (Figures 3 and 4). Mature/old forest impacted by both mountain pine beetle and fire is reported in the appropriate fire category (2000-2016 or 2017).

In the CWH, ESSF, IDF and MH zones, 35%, 44%, 56% and 35%, respectively of mature/old forest is protected from harvest. With the exception of the IDF zone, the majority of the protected mature/old forest in these zones is roadless and has not been notably impacted by fire or mountain pine beetle. In the CDF zone, substantially less is protected from harvest (11%) and the majority of both the protected and unprotected mature/old forest in this zone is within 500 metres of a road.
In summary, development has been greatest in the unprotected mature/old forest of the CDF and CWH zones. Mountain pine beetle and/or fire impacts are not significant in the South Coast Region.

[28] Eng, Marvin, 2018. Using Natural Disturbance Return Intervals to Estimate Expected Seral Stage Distribution of Forests. A literature review and discussion. Forest and Range Evaluation Program, Ministry of Forests, Lands, Natural Resource Operations and Rural Development.

Table 2. Hectares and percentage of mature/old forest protected from harvest by biogeoclimatic zone in the South Coast Region.

Biogeoclimatic Zone	Mature/Old Forest Protected from Harvest	
	Hectares (rounded to nearest 1000 ha)	**Percentage**
Coastal Douglas-fir (CDF)	1,000	11%
Coastal Western Hemlock (CWH)	322,000	35%
Engelmann Spruce – Subalpine Fir (ESSF)	37,000	44%
Interior Douglas-fir (IDF)	23,000	56%
Mountain Hemlock (MH)	140,000	35%
All Zones	**524,000**	**36%**

Figure 3. Hectares of protected roadless, protected roaded, unprotected roadless, and unprotected roaded mature/old forest by biogeoclimatic zone in the South Coast Region.

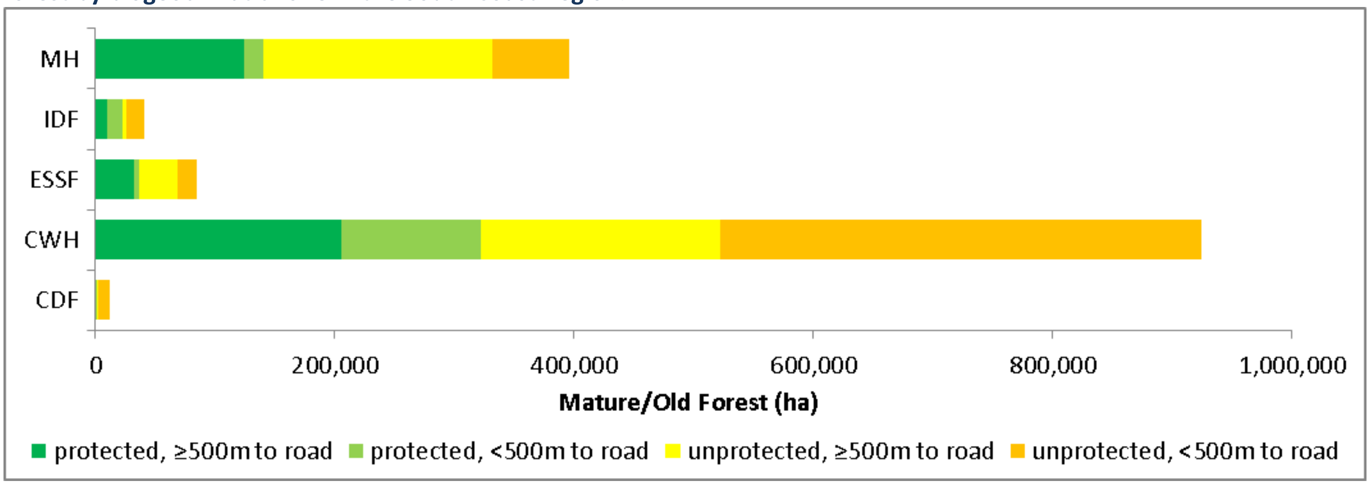
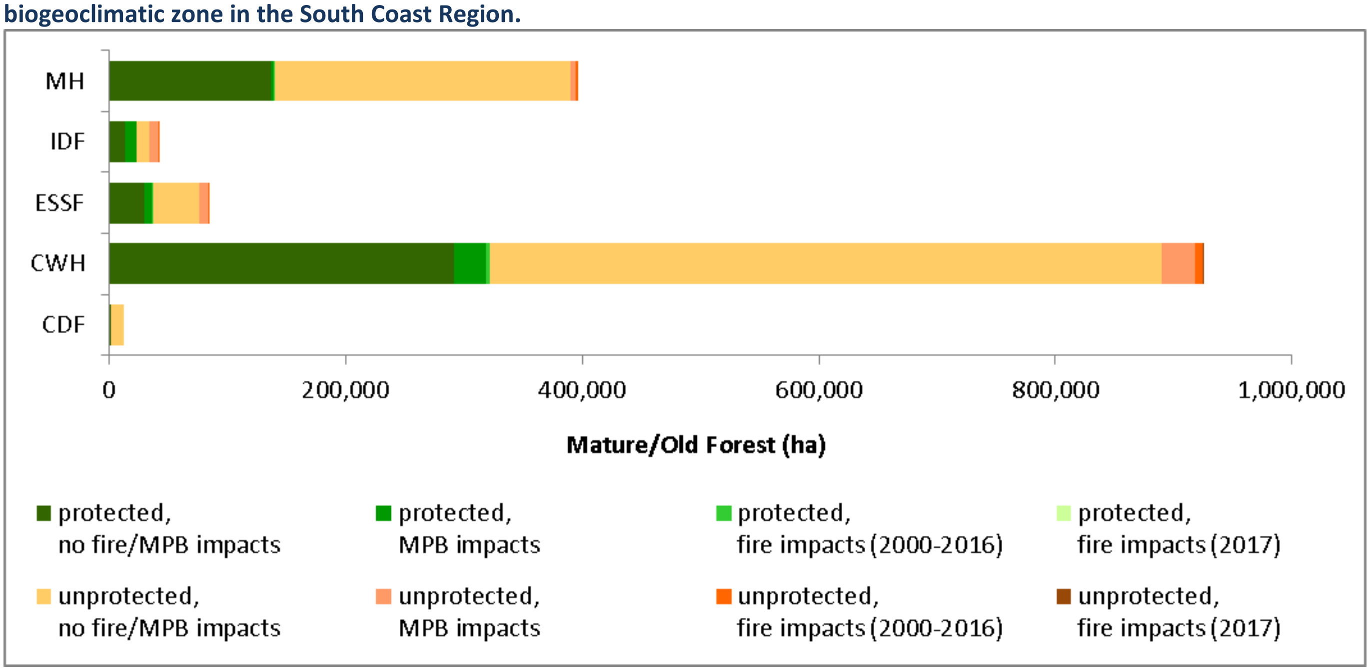


Figure 4. Hectares of protected and unprotected mature/old forest impacted by mountain pine beetle and/or fire by biogeoclimatic zone in the South Coast Region.



Post-harvest Condition of Stand-level Biodiversity in the South Coast Region

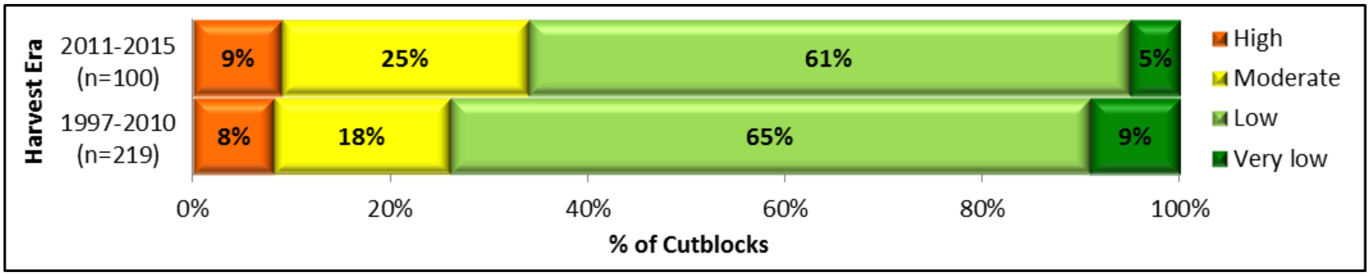


Figure 1. Quantity and type of retention by harvest era: Percentage of cutblocks in high, moderate, low, and very low impact categories.

Table 1. Quality of tree retention compared to pre-harvest benchmark by harvest era

	Large Live Tree Density	Large Snag Density	Tree Species Diversity
2011-2015 (n=100)	Less	Comparable	Less
Quality Trend	No change	No change	No change
1997-2010 (n=219)	Less	Comparable	Less

Table 2. Quality of coarse woody debris (CWD) retention compared to pre-harvest benchmark by harvest era.

	Large Piece Volume	Large & Long Piece Density
2011-2015 (n=100)	Not Comparable	Comparable
Quality Trend	No change	No change
1997-2010 (n=219)	Not Comparable	Comparable

Data Source

Assessments were conducted by trained personnel from 2006 to 2016 using the FREP stand-level biodiversity (SLBD) monitoring protocol to evaluate whether retention of wildlife tree patches and riparian reserves is achieving the desired levels and types of structures to maintain species diversity. The sample population consists of randomly selected cutblocks harvested from 1997 to 2015. A total of 319 SLBD samples have been collected in the South Coast Region, of which 100 represent recently harvested blocks.

Summary

<u>Quantity and Type of Retention</u>: The impact rating for each cutblock with respect to quantity and type of retention was determined by assessing percent of within-block retention, patch size, presence of within-patch ecological anchors, and presence of dispersed retention. If a cutblock scored greater than 80 out of 100 points, it was rated as very low impact. If a cutblock scored between 45 and 80 points, it was rated as low impact. If a cutblock scored less than 45 points, it was rated as moderate impact. If a cutblock had less than 3.5% retention (regardless of total score), it was rated as high impact.

Sixty-six percent of recently-harvested cutblocks were in the low and very low impact categories compared to 74% of the sites harvested before 2011 (Figure 1). The average score has not changed significantly over time (Figure 2). The average percent of within-block retention, median patch size, use of ecological anchors, and use of dispersed retention did not differ significantly between harvest eras (Figure 3).

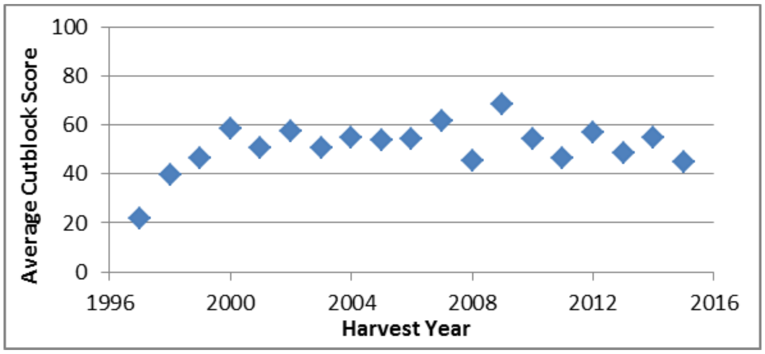


Figure 2. Average cutblock score with respect to retention quantity and type by harvest year.

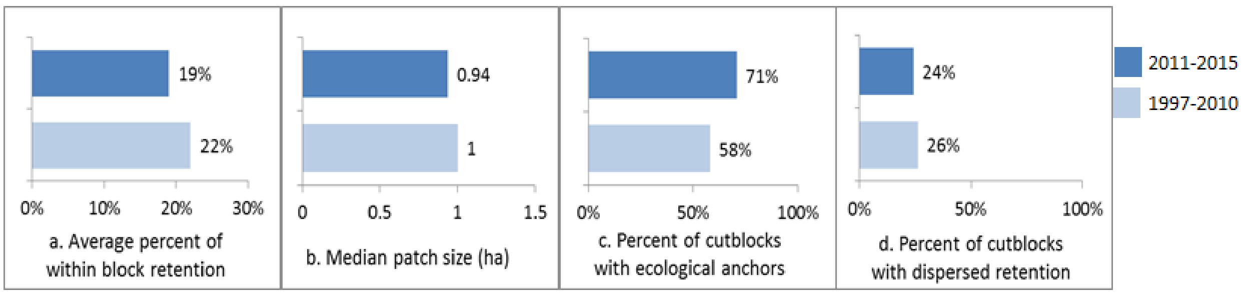


Figure 3. Quantity and type of retention by harvest era.

<u>Quality of Tree Retention:</u> Assessment of tree retention quality was conducted in aggregate for the entire region because pre-harvest condition is unknown for the vast majority of the blocks assessed. Assuming that timber cruise data is an appropriate surrogate for pre-harvest condition, a benchmark was adopted for each harvest era to reflect that the characteristics of the harvested stands differ between the two eras. The density of large live trees and snags (>40 or >50 or >70 cm dbh, dependent on biogeoclimatic subzone) and the diversity of tree species retained for each harvest era were compared to cruise data from approximately the same harvest era and for the same biogeoclimatic subzone (Table 1). For both harvest eras, large snag density was comparable to the benchmark, whereas large live tree density and tree species diversity were less than pre-harvest conditions.

<u>Quality of Coarse Woody Debris (CWD) Retention:</u> An assessment of CWD retention quality was also conducted in aggregate against a pre-harvest benchmark for each harvest era. The volume of large pieces (>30cm diameter) and density of large and long pieces (>20 cm diameter, >10 m long) in harvested areas were compared to retention patches (Table 2). For both harvest eras, large piece volume was not comparable to the benchmark, whereas large and long piece density reflected pre-harvest conditions.

Opportunities for Improvement and/or Continuation of Practices to Manage Stand-level Biodiversity

- Continue to include ecological anchors within patches when available.
- Continue to leave dispersed retention throughout harvested areas.
- Continue to retain large snags in densities similar to pre-harvest conditions.
- Improve tree retention quality by leaving densities of large live trees and diversity of tree species representative of pre-harvest conditions.
- Continue to retain densities of large and longer pieces of CWD similar to pre-harvest conditions.
- Improve CWD retention quality by leaving large piece volumes to reflect pre-harvest conditions.

Post-harvest Condition of Streams and Riparian Areas in the South Coast Region

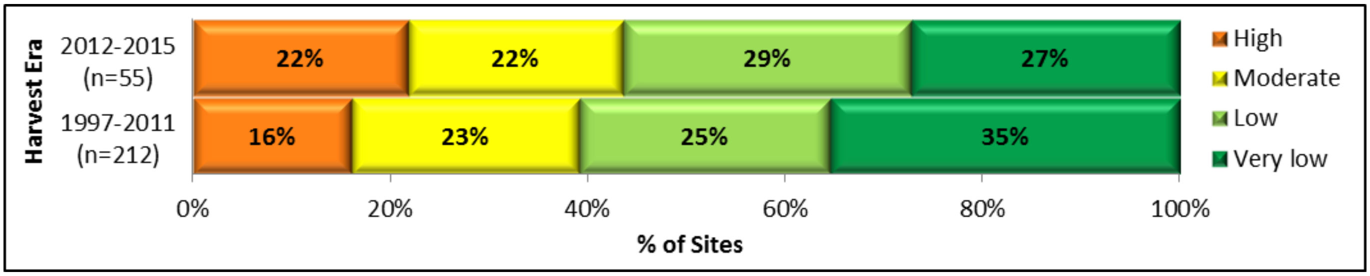


Figure 1. Percentage of sites in high, moderate, low, and very low impact categories by harvest era.

Data Source

Assessments were conducted by trained personnel from 2006 to 2016 using the FREP riparian monitoring protocol to evaluate whether riparian forestry and range practices are effective in maintaining the structural integrity and functions of stream ecosystems and other aquatic resources. The sample population includes randomly selected cutblocks with streams within or adjacent to them. A total of 267 riparian samples have been collected in the South Coast Region, of which 55 represent stream reaches harvested since 2012. Because the protocol requires a time lag of one to two winters to allow for impacts such as windthrow to manifest, there is little or no data for blocks harvested within the last two years.

Summary

Fifty-six percent of the recently harvested sites were in the low or very low impact categories compared to 60% of the sites harvested before 2012 (Figure 1). Of the 55 recently harvested sites, 24 were in the high or moderate impact categories. Of these, 22 were S6 streams, one was an S5 stream, and one was an S3 stream (Table 1). Two S6 streams and one S5 stream were located adjacent to the block. The remaining streams were in the block.

Table 1. Number of recently harvested sites by stream class and impact category.

Stream Class	Impact Category				Total
	High	Moderate	Low	Very Low	
S1	0	0	0	0	0
S2	0	0	0	1	1
S3	1	0	4	2	7
S4	0	0	1	1	2
S5	0	1	1	3	5
S6	11	11	10	8	40
Total	**12**	**12**	**16**	**15**	**55**

Causal Factors

The largest causal factor of impacts was logging (76%) at sites that had been recently harvested (Figure 2). The average number of logging-related impacts per year ranged from 1.4 to 6.8 (Figure 3). There is no statistical trend when considering all data points over time.

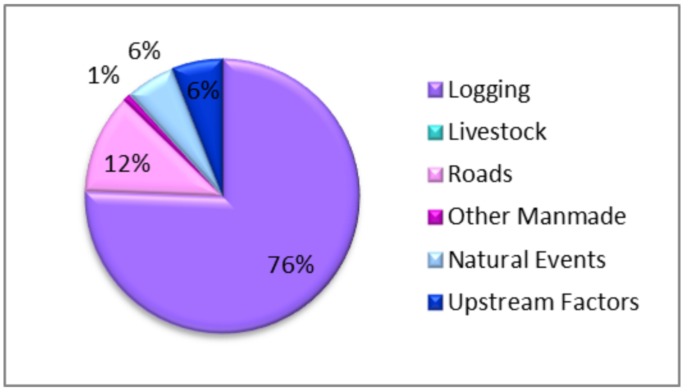


Figure 2. Percentage of impacts by causal factor at recently harvested sites.

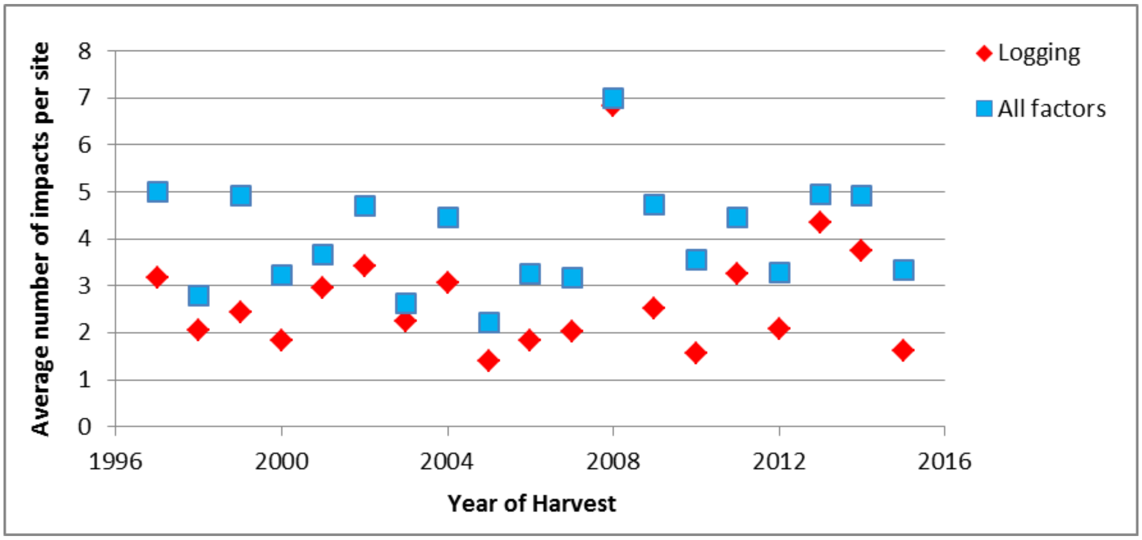


Figure 3. Average number of logging-related impacts and average number of impacts caused by all factors by year of harvest.

Specific Impacts

The most common logging-related activities that contributed to impacts observed at recently harvested sites include falling/yarding and low retention. Other harvest-related factors contributing to impacts at a lesser scale were windthrow and old logging. These activities have been linked to reduced large woody debris (LWD) supply/root network, reduced riparian vegetation vigour and structure, impaired in-stream LWD function, and blockages to aquatic connectivity (Table 2). Although old logging is not a result of recent management decisions, it remains a logging-related causal factor in the protocol. However, if all other indicator questions are given positive responses and there is retention of second-growth forest in the riparian area, historical logging alone will not be enough to downgrade the stream from properly functioning condition. Second-growth forests are potentially less resilient and more susceptible to disturbance because the dense canopy of second-growth stands often limits understory growth. Thus, removing riparian timber in these stands could have a greater effect on stream bed/bank stability than harvesting older stands with more complex root networks.

Table 2. Causal factors and related impacts for recently harvested sites.

% of All Factors	Most Common Specific Impacts
Logging (76%) *Falling/Yarding* *Low Retention* *Windthrow* *Old Logging*	LWD supply/root network ↓ Riparian vegetation form/vigour↓ in-stream LWD function ↓ In-stream blockages ↑
Roads (12%) *Running surface eroding into stream* *Ditches eroding into stream*	In-stream sediments ↑ Soil disturbance/bare ground ↑
Natural Events (6%) *Torrents* *Organic streambed* *Wind*	In-stream blockages ↑ Fish cover diversity ↓ Aquatic invertebrate diversity ↓
Upstream Factors (6%)	In-stream sediments ↑ In-stream blockages ↑
Other Manmade (1%)	In-stream sediments ↑

Opportunities for Improvement and/or Continuation of Practices that Protect Stream and Riparian Conditions

- Apply strategies related to timing of harvest and methods to minimize compaction and exposure of bare ground in the riparian area. Plan, maintain, and deactivate roads to minimize the transport of sediments to stream channels.
- Account for the reduced resiliency of second-growth forests by maintaining a treed buffer where riparian logging has previously occurred.
- Reduce windthrow by increasing buffer widths or use more selective harvest practices for windthrow-prone timber.
- Fall and yard away from the stream whenever possible. Establish yarding corridors where this is not possible to limit the introduction of broken stems and branches to the stream.
- Increase retention width and complexity around small streams, especially wider perennial streams that make significant contributions of water, sediment, debris, and nutrients to downstream fish habitats, and contribute to watershed function.
- Provide training to equipment operators about the importance of streams and best practices in riparian areas. Monitor harvesting to ensure operators are utilizing methods that will minimize disturbance.

Water Quality in the South Coast Region

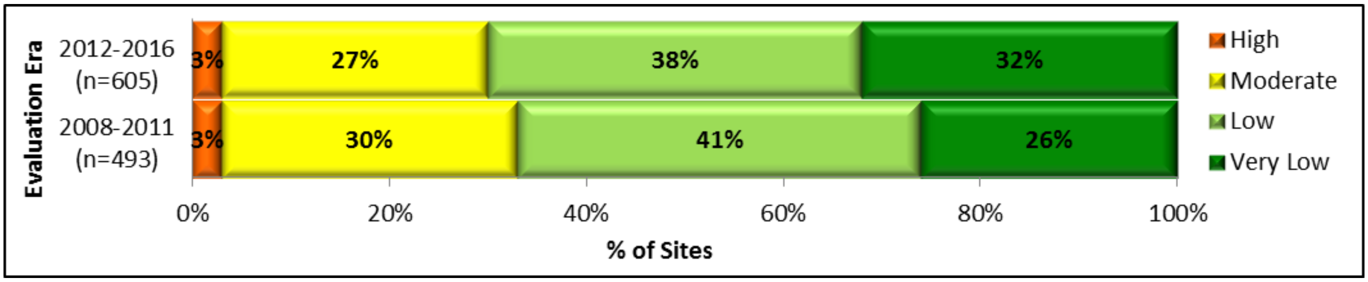


Figure 1. Percentage of sites in high, moderate, low, and very low impact categories by evaluation era.

Data Source

Assessments were conducted by trained personnel from 2008 to 2016 using the FREP water quality monitoring protocol to evaluate the potential for fine sediment transfer into streams. The sample population consists of roads and/or mass wasting sites connected to fish habitat and/or drinking water sources originating at randomly selected recently harvested cutblocks. A total of 1098 samples have been collected in the South Coast Region, of which 605 represent recently evaluated sites. The number of sites sampled each year ranged from 36 to 191.

Summary

Thirty percent of recently evaluated sites had moderate or high potential for fine sediment transfer into streams compared to 33% of sites evaluated from 2008 to 2011 (Figure 1). Except for 2008, the annual percentage of sites in the moderate and high impact categories ranged between 26% and 38%, with no strong statistical trend (Figure 2). This suggests water quality impacts from roads are not increasing or decreasing.

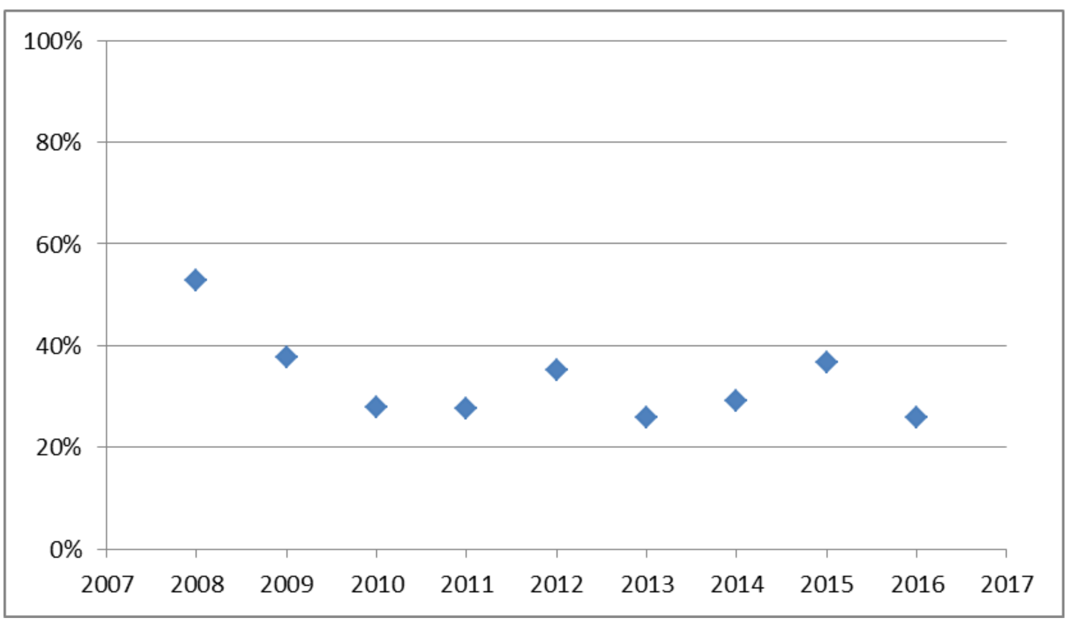


Figure 2. Percentage of sites in the moderate and high impact categories.

Causal Factors
The potential for fine sediment transfer into streams may be caused by several factors, including road location, road materials, maintenance techniques, resource road traffic, recreational activities, and storm damage.

Opportunities for Improvement of Practices to Minimize Fine Sediment Transfer to Streams
- During road and cutblock design, ensure sufficient culverts are properly placed.
- Install strategically placed cross ditches, water bars, and ditch blocks to disperse storm flow when deactivating roads.
- Remove any berms present during road management.
- Prevent road rutting by using good quality material and crowning the road.
- Amour, seed or spread out logging debris over disturbed areas to protect the soil during harvesting and road construction.
- When old culverts have become blocked or collapsed, ensure that they are pulled and armour the crossing.

Road license holders should be promptly informed of sites with moderate or high impact ratings so that they can remediate these sites.

Visual Quality in the South Coast Region

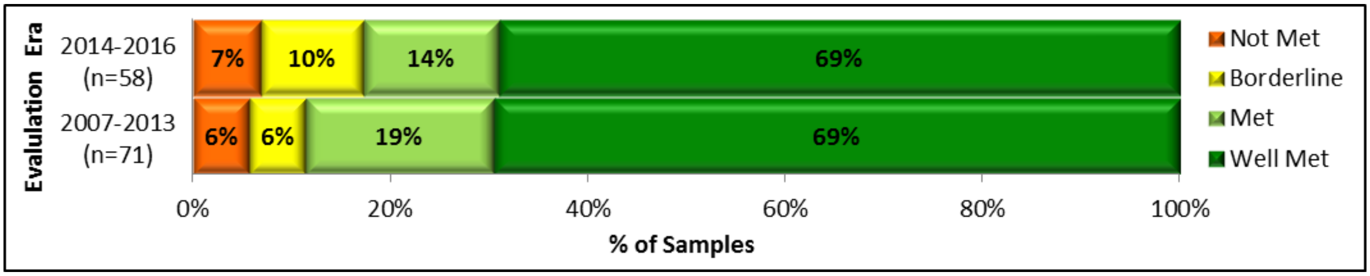


Figure 1. Percentage of landforms in each effectiveness evaluation rating category by evaluation era.

Data Source

Effectiveness evaluations were conducted by trained personnel from 2007 to 2016 using the FREP visual quality monitoring protocol to evaluate whether legally established visual quality objectives (VQOs) in designated scenic areas are being achieved. The sample population consists of landforms (distinct three-dimensional topographic features defined in perspective view) that include randomly selected cutblocks harvested under the *Forest and Range Practices Act*. A total of 129 samples have been collected in the South Coast Region, of which 58 represent recently evaluated landforms.

Summary

Eighty-three percent of recently evaluated landforms achieved *(met or well met)* the VQO compared to 89% of landforms evaluated from 2007 to 2013 (Figure 1). For the recently evaluated landforms, 21% of landforms with partial retention VQOs, and 100% of landforms with retention VQOs did not achieve the objective *(borderline or not met)* (Table 1).

Table 1. Percentage of recently evaluated landforms by visual quality objective and rating category.

Landforms Evaluated 2014-2016		**Rating Category**			
		Not Met	**Borderline**	**Met**	**Well Met**
Visual Quality Objective	**Max Modification (n=0)**	-	-	-	-
	Modification (n=15)	0% (0)	0% (0)	**7%** (1)	**93%** (14)
	Partial Retention (n=42)	**9%** (4)	**12%** (5)	**17%** (7)	**62%** (26)
	Retention (n=1)	0% (0)	**100%** (1)	0% (0)	0% (0)
	Preservation (n=0)	-	-	-	-

Ocular Assessment Results for Recently Evaluated Landforms

Borderline/Not Met Ratings: For 50% of the landforms where the VQO was not achieved, the appearance, scale and visibleness of the alteration did not meet the criteria as defined in section 1.1 of the Forest Planning and Practices Regulation (FPPR) (Table 2).
Met/Well Met Ratings: For 100% of the landforms where the VQO was achieved, the appearance, scale and visibleness of the alteration met the criteria as defined in FPPR s.1.1 (Table 2).

Table 2. Achievement of criteria (appearance, scale and visibleness) defined in section 1.1 of the Forest Planning and Practices Regulation (FPPR) for recently evaluated landforms.

Landforms Evaluated 2014-2016		Criteria in FPPR Definition	
		Not Met	Met
Effectiveness Evaluation Rating	Borderline/Not Met	50%	50%
	Met/Well Met	0%	100%

Percent Alteration Assessment Results for Recently Evaluated Landforms

Borderline/Not Met Ratings: Initial percent alteration exceeded the upper limit of the range for the established VQO for 50% of the landforms (Table 3). Visual condition was negatively influenced by poor use of visual landscape design elements for 50% of the landforms (Table 4) and by visual impacts of roads for 80% of the landforms (Table 5). Additionally, in-block tree retention was not sufficient to improve visual condition for 90% of the landforms (Table 6).
Met/Well Met Ratings: Initial percent alteration was below or within the range for the established VQO for 100% of the landforms (Table 3). Visual condition was positively influenced by good use of visual landscape design elements for 46% of the landforms (Table 4) and moderate/good in-block tree retention for 22% of the landforms (Table 6). Additionally, roads had no visual impacts for 81% of the landforms (Table 5).

Table 3. Comparison of initial percent alteration to the range for the established VQO for recently evaluated landforms.

Landforms Evaluated 2014-2016		Initial Percent Alteration Compared to Range for Established VQO		
		Exceeded	Within Range	Below
Effectiveness Evaluation Rating	Borderline/Not Met	50%	50%	0%
	Met/Well Met	0%	52%	48%

Table 4. Use of visual landscape design elements for recently evaluated landforms.

Landforms Evaluated 2014-2016		Use of Visual Landscape Design Elements		
		Poor	Moderate	Good
Effectiveness Evaluation Rating	Borderline/Not Met	50%	20%	30%
	Met/Well Met	29%	25%	46%

Table 5. Visual impacts of roads on recently evaluated landforms.

Landforms Evaluated 2014-2016		Visual Impacts of Roads			
		Dominant	Significant	Subordinate	None
Effectiveness Evaluation Rating	Borderline/Not Met	0%	30%	50%	20%
	Met/Well Met	0%	2%	17%	81%

Table 6. In-block tree retention for recently evaluated landforms.

Landforms Evaluated 2014-2016		In-Block Tree Retention		
		Poor	Moderate	Good
Effectiveness Evaluation Rating	Borderline/Not Met	90%	10%	0%
	Met/Well Met	77%	20%	2%

Opportunities for Improvement and/or Continuation of Practices to Manage for Visual Quality

- Increase in-block tree retention to reduce the amount of visible bare ground.
- Align roads to blend with the landform and minimize visibility. Deactivate and rehabilitate roads upon completion of harvesting.

WEST COAST NATURAL RESOURCE REGION

The following section presents the status of landscape-level biodiversity and the outcomes of site/stand-level monitoring for biodiversity, riparian condition, water quality, cultural heritage resources, and visual quality in the West Coast Natural Resource Region.

Status of Landscape-level Biodiversity in the West Coast Region

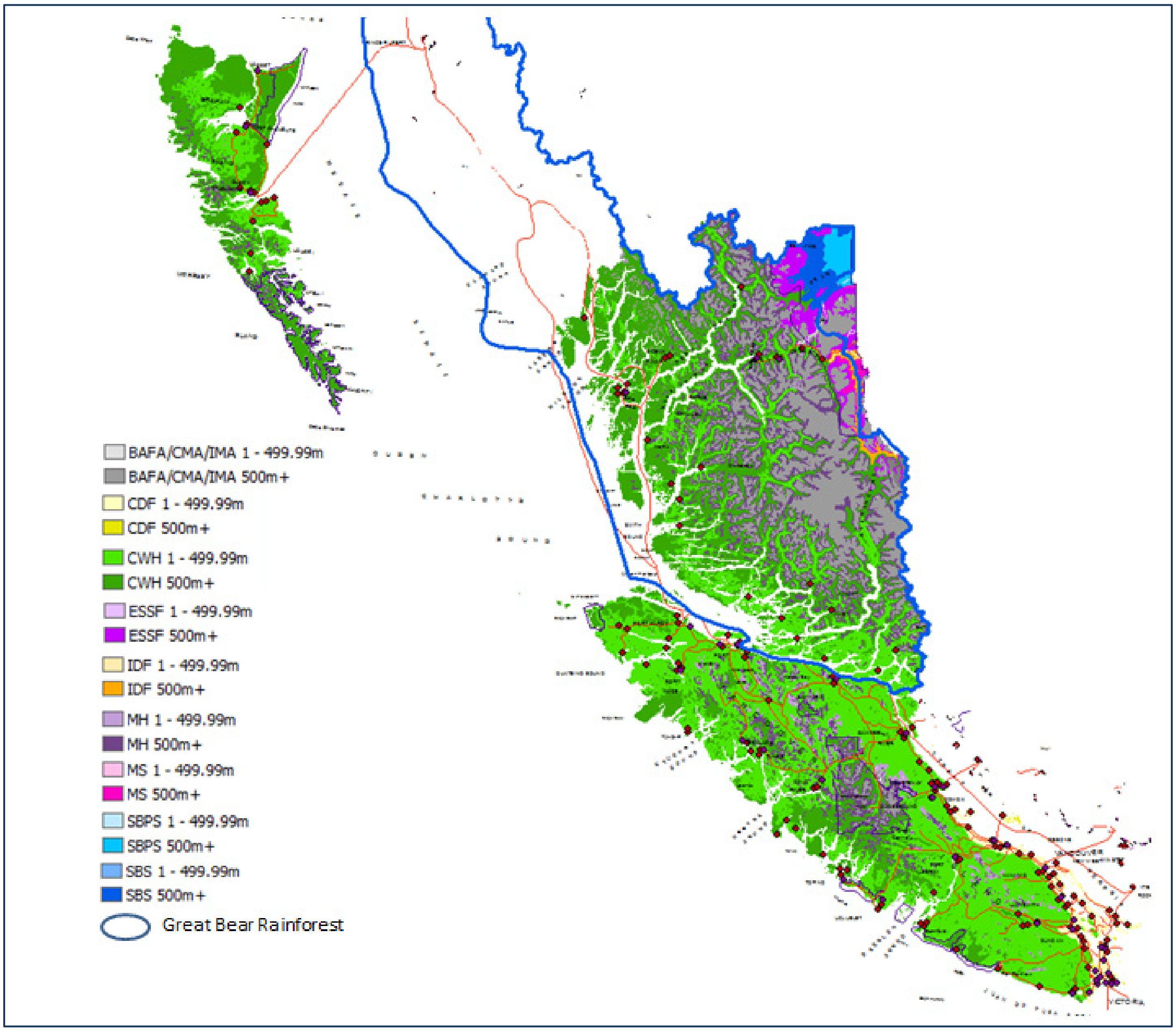


Figure 1. Distribution of roaded areas (less than 500 metres to a road) and roadless areas (500 metres or more to a road) by biogeoclimatic zone in the West Coast Region.

Data Source

For the area outside the Great Bear Rainforest, the expected seral stage distribution was calculated by natural disturbance type (NDT) and biogeoclimatic ecosystem classification (BEC) zone using the return intervals and stand-age thresholds in the *Biodiversity Guidebook.*[29] For the area within the Great Bear Rainforest, the expected seral stage distribution was calculated by NDT and BEC zone using the return intervals recommended by Price and Daust[30] and the stand-age thresholds in the *Biodiversity Guidebook*. Stand age was not adjusted to account for mountain pine beetle infestation or fire. Mature and old seral stages were combined because the age classes that comprise these seral stages are not reliably classified in the provincial vegetation resource inventory. An additional state, "alienated forest" (mines, tailings, spoils, gravel pits, roads, rail surfaces, cutbanks, reservoir margins, landings, airports, and urban areas) is also reported.

Publicly available corporate datasets were used to conduct the spatial analysis: BEC units (2016 version), vegetation resource inventory (stand age projected to 2017), harvest depletions (as of spring 2017), roads (as of spring 2017), mountain pine beetle infestations (up to 2017), fires (2000-2017), and "land protection designations" (current as of 2016) (i.e., old growth management areas, parks, protected areas, conservancies, no-harvest ungulate winter range, and no-harvest wildlife habitat areas).

Summary

The West Coast Region captures eight forested biogeoclimatic zones: Coastal Douglas-fir (CDF), Coastal Western Hemlock (CWH), Engelmann Spruce – Subalpine Fir (ESSF), Interior Douglas-fir (IDF), Mountain Hemlock (MH), Montane Spruce (MS), Sub-Boreal Pine – Spruce (SBPS), and Sub-Boreal Spruce (SBS) (Figure 1). The amount and percentage of roadless forest (forest 500 metres or more to a road[31]) was determined for each biogeoclimatic zone (Figure 1, Table 1). For the purposes of this report, roadless forest is presumed to be less disturbed, and may have higher biodiversity value than forest within 500 metres of a road. More than half of the ESSF, IDF, MH, MS, SBPS and SBS zones, and less than half of the CWH and SBS zones, are comprised of roadless forest. In general, the West Coast Region (like the Skeena Region) captures more biogeoclimatic zones largely composed of roadless forest than other regions.

Table 1. Hectares and percentage of roadless forest by biogeoclimatic zone in the West Coast Region.

Biogeoclimatic Zone	Percentage of Forest ≥500m to a Road	
	Hectares (rounded to nearest 1000 ha)	**Percentage**
Coastal Douglas-fir (CDF)	6,000	6%
Coastal Western Hemlock (CWH)	2,353,000	44%
Engelmann Spruce – Subalpine Fir (ESSF)	157,000	97%
Interior Douglas-fir (IDF)	32,000	88%
Mountain Hemlock (MH)	548,000	81%
Montane Spruce (MS)	17,000	100%
Sub-Boreal Pine – Spruce (SBPS)	55,000	96%
Sub-Boreal Spruce (SBS)	82,000	97%
ALL ZONES	**3,250,000**	**50%**

[29] Anonymous. 1995. Biodiversity Guidebook. Forest Practices Code of British Columbia. Victoria BC. Ministry of Forests, Ministry of Environment. https://www.for.gov.bc.ca/hfd/library/documents/bib19715.pdf.
[30] Price, Karen, and Dave Daust. 2003. The Frequency of Stand-Replacing Natural Disturbance in the CIT Area. Coast Information Team. https://www.for.gov.bc.ca/tasb/slrp/citbc/b-DistFreq-PriceDaust-Oct03.pdf.
[31] British Columbia. Ministry of Environment. 2018. Status of Roads & Roadless Area. Environmental Reporting BC. Ministry of Environment. http://www.env.gov.bc.ca/soe/indicators/land/roads.html

The observed seral stage distribution was compared to the expected seral stage distribution for each biogeoclimatic zone within the Great Bear Rainforest (Figure 2a). [32] In the CWH and MH zones, the observed amounts of mature/old forest are less than expected (87% and 83%, respectively). In the ESSF zone, the observed amounts of mature/old forest are approximately equivalent to expected amounts.

The observed seral stage distribution was also compared to the expected seral stage distribution for each biogeoclimatic zone outside of the Great Bear Rainforest (Figure 2b). The observed amount of mature/old forest in the CWH zone was less than expected (88%). In the MH zone, the observed amounts of mature/old forest are approximately equivalent to expected amounts. In the CDF zone, the major difference between the expected and observed seral distributions was the amount of alienated or converted forest (48%).

Note that mature/old forest is not uniformly distributed across the CWH zone. Concentrations are highest within the Great Bear Rainforest, less so on Haida Gwaii, and least on Vancouver Island.
In summary, the broad north/south range of the biogeoclimatic zones obscures the pattern of development in the region, with development being heaviest on the east and south coasts of Vancouver Island resulting in the lowest concentrations of high value forest.

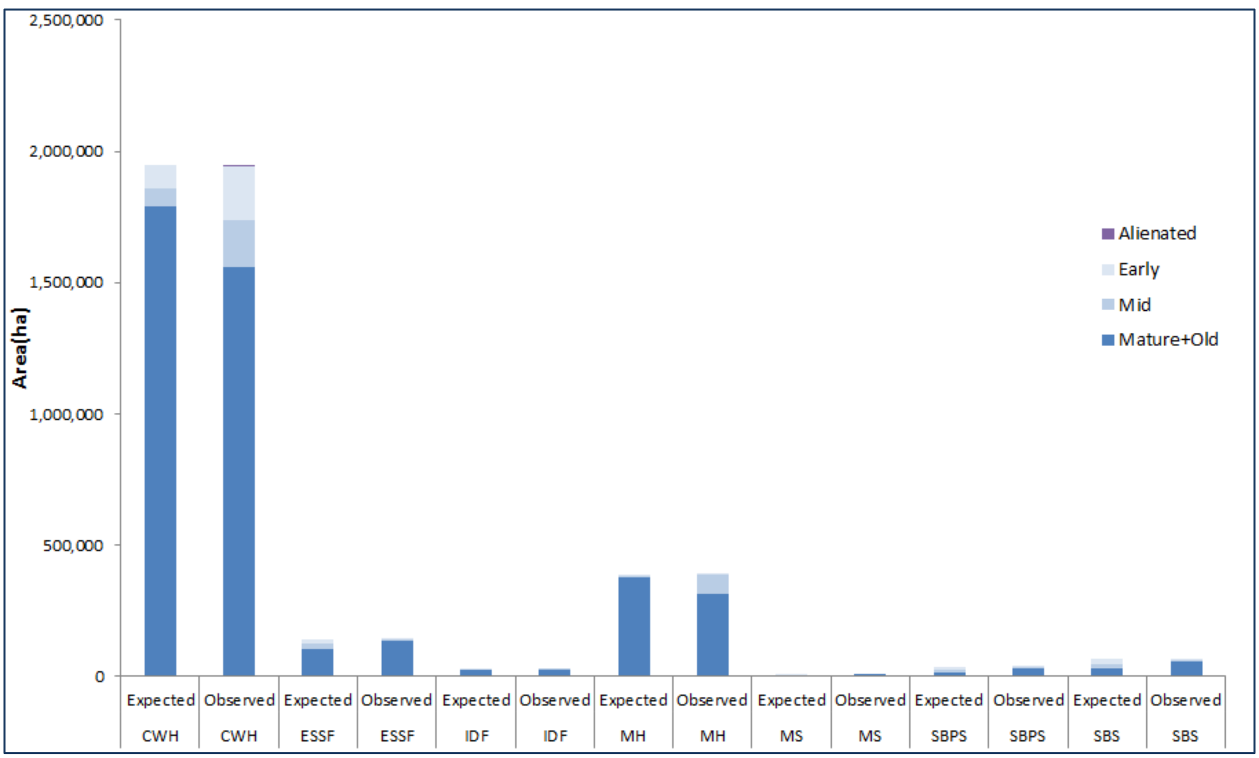


Figure 2a. Expected versus observed seral stage distribution by biogeoclimatic zone within the Great Bear Rainforest in the West Coast Region.

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[32] This is not a compliance report against legal orders and no "ecological score" has been provided. That said, the authors of the 1995 Biodiversity Guidebook argued that biodiversity can be more likely maintained if forest management seeks to retain habitat patterns and seral stages that are similar to natural landscapes.

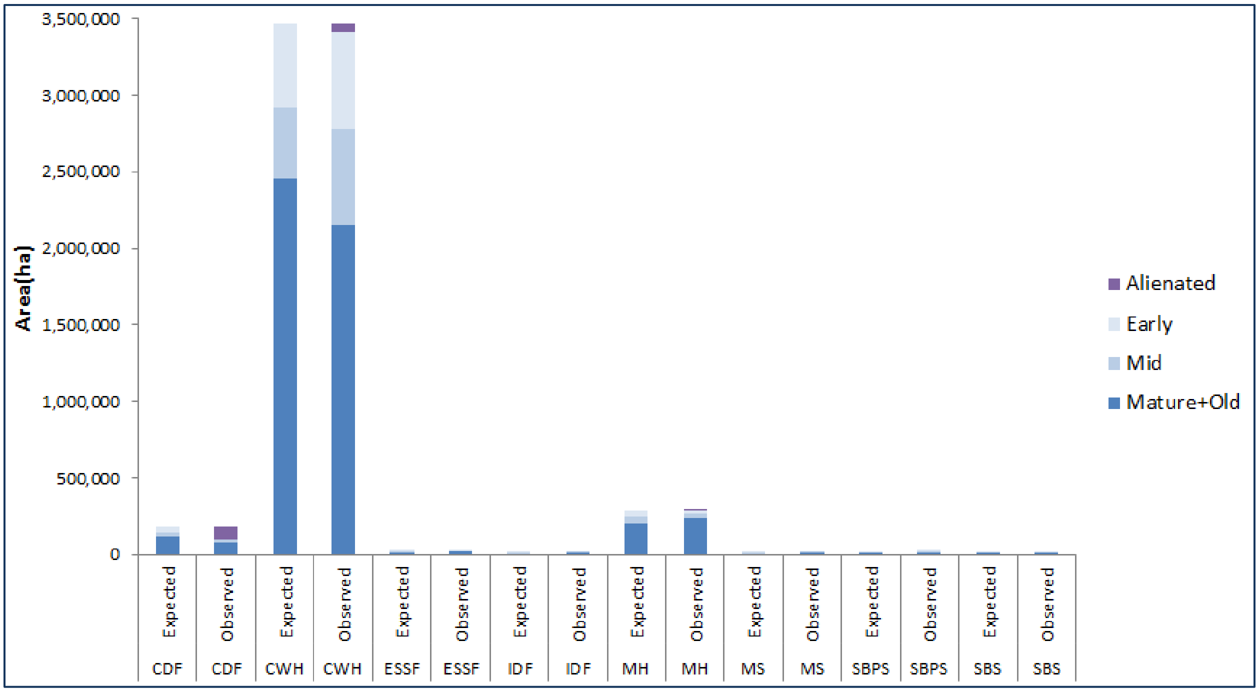

Figure 2b. Expected versus observed seral stage distribution by biogeoclimatic zone outside the Great Bear Rainforest in the West Coast Region.

The percentage of mature/old forest protected from harvest in various resource stewardship designations was determined for each biogeoclimatic zone (Table 2). The condition of protected and unprotected mature/old forest in each zone was assessed using distance to road and natural disturbance impacts as indicators (Figures 3 and 4). Mature/old forest impacted by both mountain pine beetle and fire is reported in the appropriate fire category (2000-2016 or 2017).

All of the mature/old forest in the MS, SBPS and SBS zones, and the majority in the ESSF and IDF zones, (93% and 97%, respectively), is protected from harvest. Mature/old forest is the least protected in the CDF zone (10%), followed by the MH zone (29%) and the CWH zone (32%). Approximately half of the unprotected mature/old forest within the CWH zone is roadless, whereas in the CDF zone, only 6% is roadless, which is consistent with the substantial amount of alienated forest in this zone. The condition of mature/old forest is not impacted by mountain pine beetle or fire in this region.

Table 2. Hectares and percentage of mature/old forest protected from harvest by biogeoclimatic zone in the West Coast Region.

Biogeoclimatic Zone	Mature/Old Forest Protected from Harvest	
	Hectares (rounded to nearest 1000 ha)	Percentage
Coastal Douglas-fir (CDF)	8,000	10%
Coastal Western Hemlock (CWH)	1,200,000	32%
Engelmann Spruce – Subalpine Fir (ESSF)	142,000	93%
Interior Douglas-fir (IDF)	33,000	97%
Mountain Hemlock (MH)	160,000	29%
Montane Spruce (MS)	17,000	100%
Sub-Boreal Pine – Spruce (SBPS)	50,000	100%
Sub-Boreal Spruce (SBS)	68,000	100%
ALL ZONES	**1,674,000**	**36%**

In summary, the underlying data indicates that within the West Coast Region, high value mature/old forest is most concentrated within the Great Bear Rainforest, less concentrated on Haida Gwaii, and the least concentrated on Vancouver Island (Figure 1).

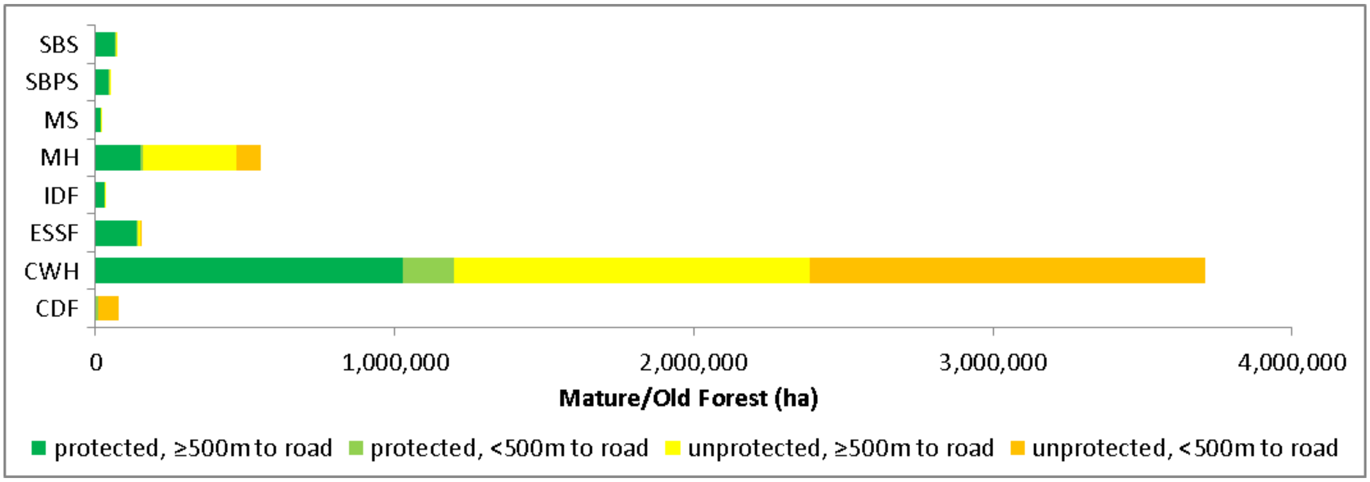

Figure 3. Hectares of protected roadless, protected roaded, unprotected roadless, and unprotected roaded mature/old forest by biogeoclimatic zone in the West Coast Region.

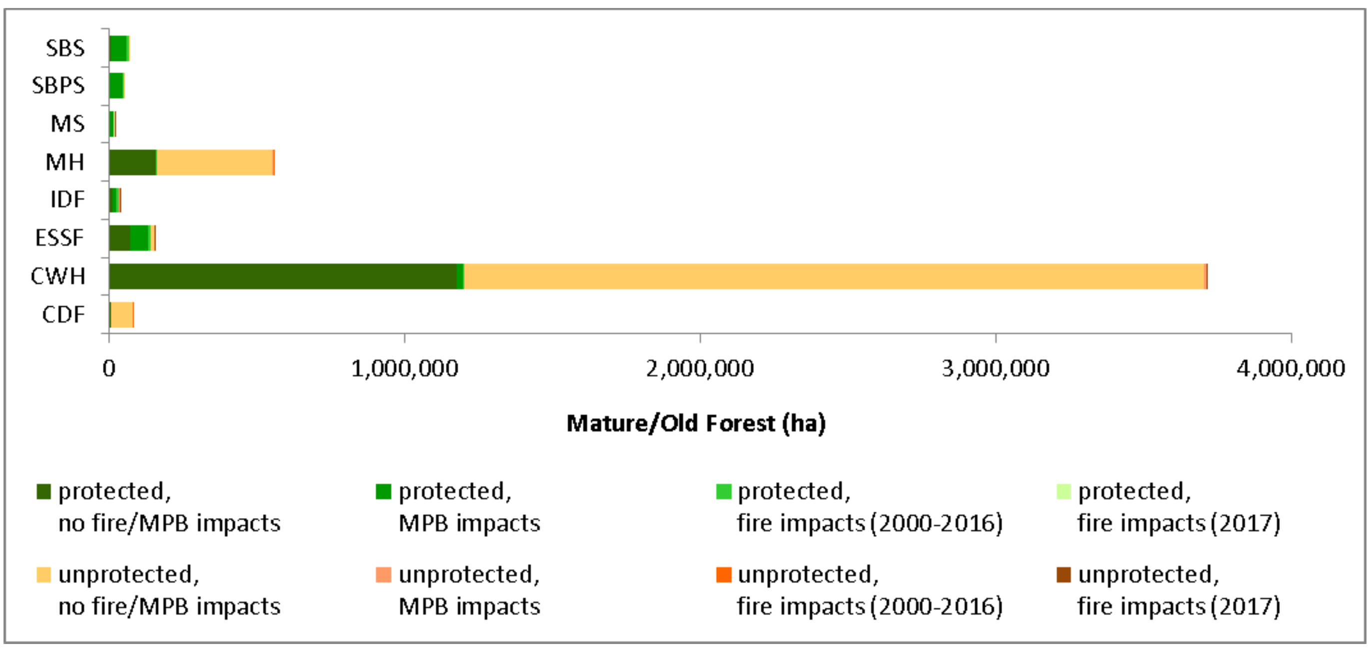

Figure 4. Hectares of protected and unprotected mature/old forest impacted by mountain pine beetle and/or fire by biogeoclimatic zone in the West Coast Region.

Post-harvest Condition of Stand-level Biodiversity in the West Coast Region

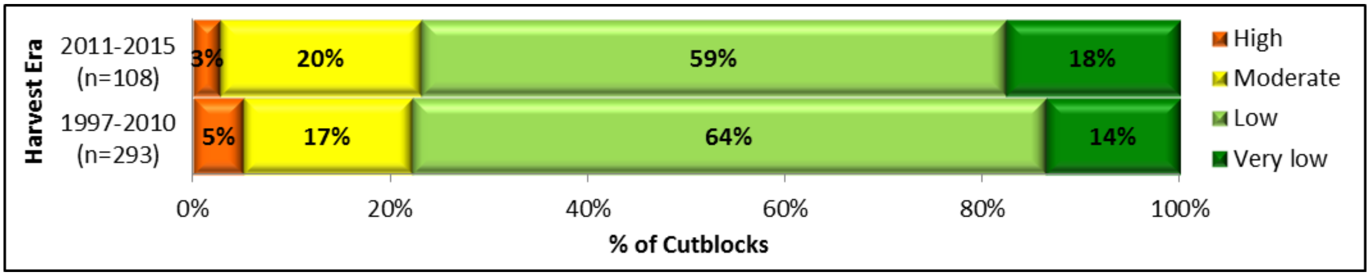

Figure 1. Quantity and type of retention by harvest era: Percentage of cutblocks in high, moderate, low, and very low impact categories.

Table 1. Quality of tree retention compared to pre-harvest benchmark by harvest era.

	Large Live Tree Density	Large Snag Density	Tree Species Diversity
2011-2015 (n=108)	Less	Comparable	Comparable
Quality Trend	No change	***Improving***	***Improving***
1997-2010 (n=293)	Less	Less	Less

Table 2. Quality of coarse woody debris (CWD) retention compared to pre-harvest benchmark by harvest era.

	Large Piece Volume	Large & Long Piece Density
2011-2015 (n=108)	Comparable	Not Comparable
Quality Trend	No change	No change
1997-2010 (n=293)	Comparable	Not Comparable

Data Source

Assessments were conducted by trained personnel from 2006 to 2016 using the FREP stand-level biodiversity (SLBD) monitoring protocol to evaluate whether retention of wildlife tree patches and riparian reserves is achieving the desired levels and types of structures to maintain species diversity. The sample population consists of randomly selected cutblocks harvested from 1997 to 2015. A total of 319 SLBD samples have been collected in the West Coast Region, of which 100 represent recently harvested blocks.

Summary

Quantity and Type of Retention: The impact rating for each cutblock with respect to quantity and type of retention was determined by assessing percent of within-block retention, patch size, presence of within-patch ecological anchors, and presence of dispersed retention. If a cutblock scored greater than 80 out of 100 points, it was rated as very low impact. If a cutblock scored between 45 and 80 points, it was rated as low impact. If a cutblock scored less than 45 points, it was rated as moderate impact. If a cutblock had less than 3.5% retention (regardless of total score), it was rated as high impact.

Sixty-six percent of recently harvested cutblocks were in the low and very low impact categories compared to 74% of the sites harvested before 2011 (Figure 1). The average score has not changed significantly over time (Figure 2). The average percent of within-block retention, median patch size, use of ecological anchors, and use of dispersed retention did not differ significantly between harvest eras (Figure 3).

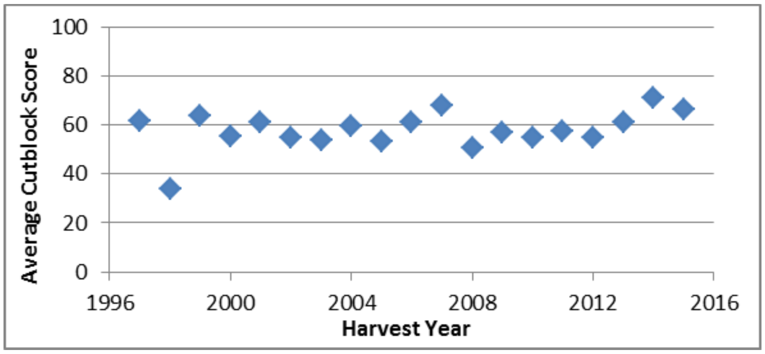

Figure 2. Average cutblock score with respect to retention quantity and type by harvest year.

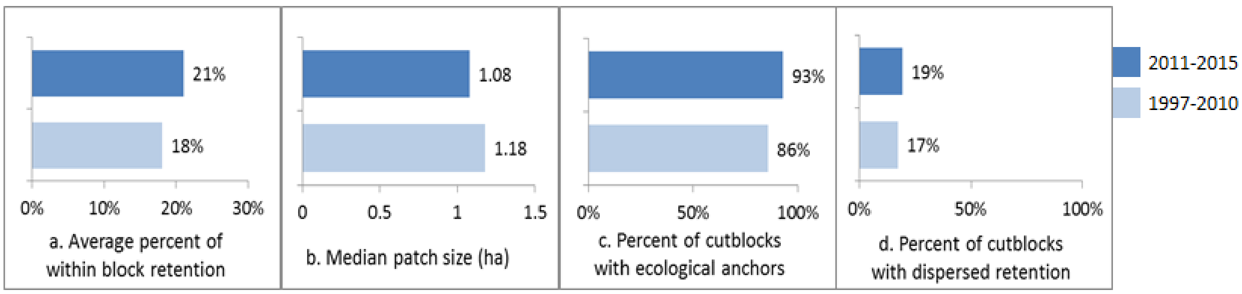

Figure 3. Quantity and type of retention by harvest era.

Quality of Tree Retention: Assessment of tree retention quality was conducted in aggregate for the entire region because pre-harvest condition is unknown for the vast majority of the blocks assessed. Assuming that timber cruise data is an appropriate surrogate for pre-harvest condition, a benchmark was adopted for each harvest era to reflect that the characteristics of the harvested stands differ between the two eras. The density of large live trees and snags (>40 or >70 cm dbh, dependent on biogeoclimatic subzone) and the diversity of tree species retained for each harvest era were compared to cruise data from approximately the same harvest era and for the same biogeoclimatic subzone (Table 1). Large live tree density was less than pre-harvest conditions for both harvest eras. Large snag density and tree species diversity increased to reflect pre-harvest conditions on recently harvested blocks.

Quality of Coarse Woody Debris (CWD) Retention: Assessment of coarse woody debris retention quality was also conducted in aggregate against a pre-harvest benchmark for each harvest era. The volume of large pieces (>30cm diameter) and density of large and long pieces (>20 cm diameter, >10 m long) in harvested areas were compared to retention patches (Table 2). For both harvest eras, large piece volume reflected pre-harvest conditions whereas large and long piece density was not comparable to the benchmark.

Opportunities for Improvement and/or Continuation of Practices to Manage Stand-level Biodiversity

- Continue to include ecological anchors within patches when available.
- Continue to leave dispersed retention throughout harvested areas.
- Continue to retain large snag densities and tree species diversity comparable to pre-harvest conditions.
- Improve tree retention quality by leaving densities of large live trees representative of pre-harvest conditions.
- Continue to retain large piece volumes similar to pre-harvest conditions.
- Improve CWD retention quality by leaving densities of larger and longer pieces that reflects pre-harvest conditions.

Post-harvest Condition of Streams and Riparian Areas in the West Coast Region

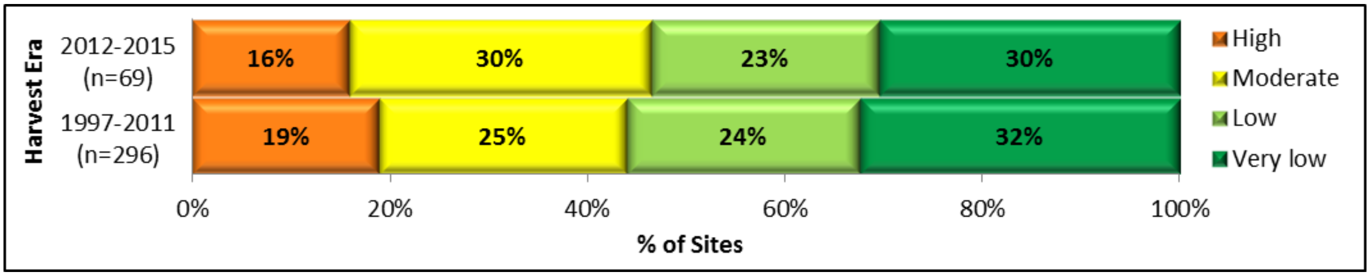

Figure 1. Percentage of sites in high, moderate, low, and very low impact categories by harvest era.

Data Source

Assessments were conducted by trained personnel from 2006 to 2016 using the FREP riparian monitoring protocol to evaluate whether riparian forestry and range practices are effective in maintaining the structural integrity and functions of stream ecosystems and other aquatic resources. The sample population includes randomly selected cutblocks with streams within or adjacent to them. A total of 365 riparian samples have been collected in the West Coast Region, of which 69 represent stream reaches harvested since 2012. Because the protocol requires a time lag of one to two winters to allow for impacts such as windthrow to manifest, there is little or no data for blocks harvested within the last two years.

Summary

Fifty-three percent of the recently harvested sites were in the low or very low impact categories compared to 56% of the sites harvested before 2012 (Figure 1). Of the 69 recently harvested sites, 32 were in the high or moderate impact categories. Of these, 22 were S6 streams, four were S5 streams, and six were S3 streams (Table 1). Five S3 streams and two S6 streams were located adjacent to the block. The remaining streams were in the block.

Table 1. Number of recently harvested sites by stream class and impact category.

Stream Class	Impact Category				Total
	High	Moderate	Low	Very Low	
S1	0	0	0	0	0
S2	0	0	0	3	3
S3	1	5	5	4	15
S4	0	0	1	1	2
S5	2	2	4	2	10
S6	8	14	6	11	39
Total	**11**	**21**	**16**	**21**	**69**

Causal Factors

The largest causal factors of impacts were logging (52%) and natural events (26%) at sites that had been recently harvested (Figure 2). The average number of logging-related impacts per year ranged from 1.4 to 5.1 (Figure 3). There is no statistical trend when considering all data points over time; however, if sites harvested before 2007 are not included, then impacts caused by harvesting have been in steady decline (Pearson's r = -0.79).

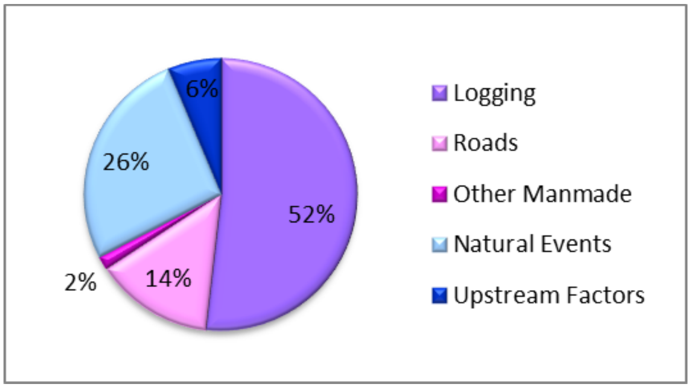

Figure 2. Percentage of impacts by causal factor at recently harvested sites.

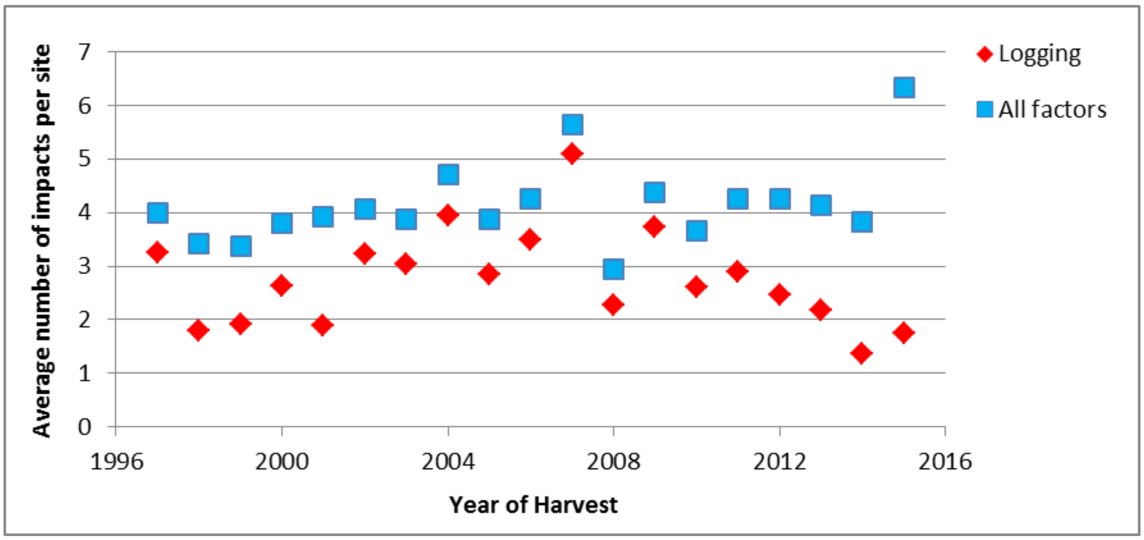

Figure 3. Average number of logging-related impacts and average number of impacts caused by all factors by year of harvest.

Specific Impacts

The most common logging-related activities that contributed to impacts observed at recently harvested sites include falling/yarding and low retention. Other harvest-related factors contributing to impacts at a lesser scale were windthrow and old logging. These activities have been linked to: reduced riparian vegetation vigour and structure, blockages to aquatic connectivity, impaired in-stream large woody debris (LWD) function, and reduced LWD supply/root network (Table 2). Although old logging is not a result of recent management decisions, it remains a logging-related causal factor in the protocol. However, if all other indicator questions are given positive responses and there is retention of second-growth forest in the riparian area, historical logging alone will not be enough to downgrade the stream from properly functioning condition. Second-growth forests are potentially less resilient and more susceptible to disturbance because the dense canopy of second-growth stands often limits understory growth. Thus, removing riparian timber in these stands could have a greater effect on stream bed/bank stability than harvesting older stands with more complex root networks.

Natural events that contributed to impacts observed at recently harvested sites include high background sediment levels and wind. These events lead to decreased moss abundance/condition, high levels of in-stream fine sediments, and blockages to aquatic connectivity (Table 2).

Table 2. Causal factors and related impacts for recently harvested sites.

% of All Factors	Most Common Specific Impacts
Logging (52%) *Falling/Yarding* *Low Retention* *Windthow* *Old Logging*	Riparian vegetation form/vigour↓ In-stream blockages ↑ In-stream LWD function↓ LWD supply/root network ↓
Natural Events (26%) *High background sediment levels* *Wind*	Moss abundance/condition ↓ In-stream sediments ↑ In-stream blockages ↑
Roads (14%) *Running surface eroding into stream* *Ditches eroding into stream* *Fill or cut slopes eroding into stream*	In-stream sediments ↑ In-stream blockages ↑ Soil disturbance/bare ground ↑
Upstream Factors (6%)	In-stream sediments ↑
Other manmade (2%)	Riparian vegetation form/vigour↓

Opportunities for Improvement and/or Continuation of Practices that Protect Stream and Riparian Conditions

- Recognize the risk of erosion in areas that are naturally high in fine sediments. Apply strategies related to the timing of harvest and methods to minimize compaction and exposure of bare ground in the riparian area. Plan, maintain, and deactivate roads to minimize the transport of sediments to stream channels.
- Account for the reduced resiliency of second-growth forests by maintaining a treed buffer where riparian logging has previously occurred.
- Reduce windthrow by increasing buffer widths or use more selective harvest practices for windthrow-prone timber.
- Increase retention width and complexity around small streams, especially wider perennial streams that make significant contributions of water, sediment, debris, and nutrients to downstream fish habitats, and contribute to watershed function.
- Fall and yard away from the stream whenever possible. Establish yarding corridors where this is not possible to limit the introduction of broken stems and branches to the stream.
- Provide training to equipment operators about the importance of streams and best practices in riparian areas. Monitor harvesting to ensure operators are utilizing methods that will minimize disturbance.

Water Quality in the West Coast Region

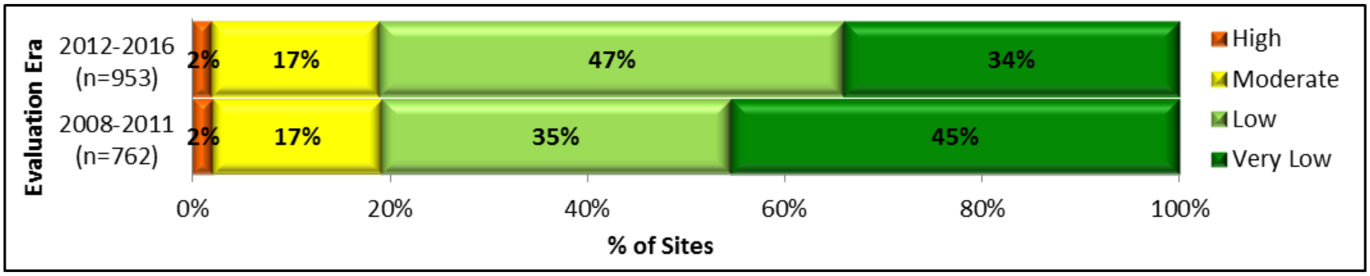

Figure 1. Percentage of sites in high, moderate, low, and very low impact categories by evaluation era.

Data Source

Assessments were conducted by trained personnel from 2008 to 2016 using the FREP water quality monitoring protocol to evaluate the potential for fine sediment transfer into streams. The sample population consists of roads and/or mass wasting sites connected to fish habitat and/or drinking water sources originating at randomly selected recently harvested cutblocks. A total of 1715 samples have been collected in the West Coast Region, of which 953 represent recently evaluated sites. The number of sites sampled each year ranged from 50 to 297.

Summary

Nineteen percent of recently evaluated sites had moderate or high potential for fine sediment transfer into streams compared to 19% of sites evaluated from 2008 to 2011 (Figure 1). The annual percentage of sites in the moderate and high impact categories ranged between 10% and 24%, with no strong statistical trend (Figure 2). This suggests water quality impacts from roads are not increasing or decreasing.

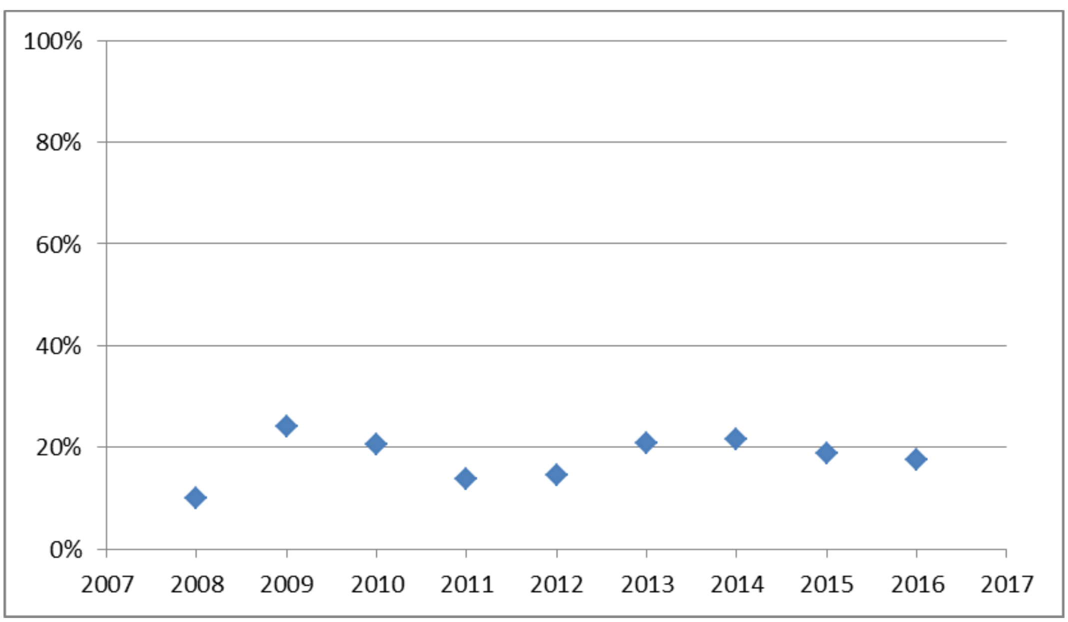

Figure 2. Percentage of sites in the moderate and high impact categories.

Causal Factors

The potential for fine sediment transfer into streams may be caused by several factors, including road location, road materials, maintenance techniques, resource road traffic, recreational activities, and storm damage.

Opportunities for Improvement of Practices to Minimize Fine Sediment Transfer to Streams

- Remove any berms present during road management.
- During road and cutblock design, ensure there are a sufficient number of properly sized and located culverts.
- Install strategically placed cross ditches, water bars, and ditch blocks to disperse storm flow when deactivating roads.
- When designing roads and cutblocks, avoid deep ditches near streams.
- Prevent storm flow incision into native soil by armoring areas of concentrated flow during harvesting.
- Design bridge decks to be placed higher than road elevations.

Road license holders should be promptly informed of sites with moderate or high impact ratings so that they can remediate these sites.

Post-harvest Condition of Cultural Heritage Resources in the West Coast Region

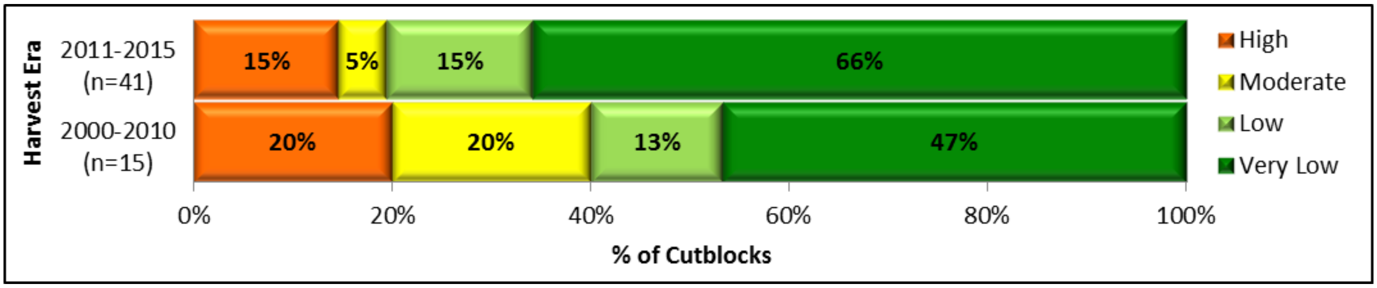

Figure 1. Percentage of cutblocks in high, moderate, low, and very low impact categories by harvest era.

Data Source

Assessments were conducted by trained personnel, often with the assistance of local First Nations and licensee forestry professionals, from 2009 to 2016 using the FREP cultural heritage resource (CHR) monitoring protocol to evaluate the conservation or protection of site-specific First Nations' CHRs. The sample population consists of randomly selected cutblocks with known CHR features as well as targeted cutblocks of special importance to First Nations. A total of 56 samples have been collected in the Campbell River, Haida Gwaii, North Island-Central Coast, and South Island Natural Resource Districts, of which 41 represent recently harvested cutblocks. A cutblock may present more than one CHR feature – up to 11 features have been found on a single cutblock in the West Coast Region. Of the 200 features monitored to date, 111 features were assessed on recently harvested cutblocks. Features were located prior to harvest, predominantly through archaeological impact assessments (41%) and pre-harvest CHR surveys (31%).

Summary

The impact rating for each cutblock is determined by assessing the overall management of CHRs and protection of individual cultural features. Eighty percent of recently harvested cutblocks were in the low or very low impact categories compared to 56% of cutblocks harvested before 2011 (Figure 1). The most common features monitored on recently harvested cutblocks were culturally modified trees (41%), archaeological resources (23%), and traditional use/spiritual/ceremonial sites (23%) (Figure 2).

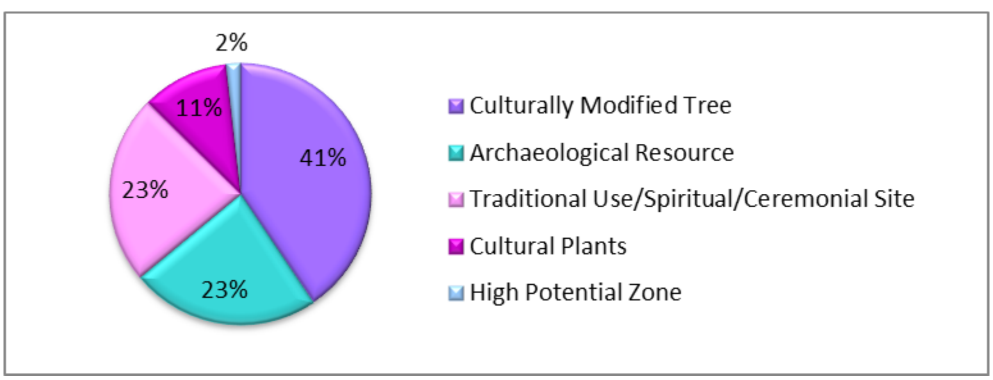

Figure 2. Percentage of CHR feature types located on recently harvested cutblocks.

Causal Factors for Recently Harvested Cutblocks
Logging activities were the main source of impacts on CHR features. Impacts were directly caused by machine disturbance and windthrow, often in association with non-windfirm buffers. Impacts were also commonly a result of insufficient marking of features in the field prior to harvest and incomplete mapping of culturally modified trees on site plans.

Opportunities for Improvements and/or Continuation of Practices to Manage for Cultural Heritage Resources
- Ensure operators and contractors understand the site plan and harvest/salvage instructions by holding a pre-work sign-off meeting.
- Clearly identify features in the field prior to harvest to improve visibility for machine operators.
- Include features in long-term (at least one rotation) windfirm reserves (e.g., wildlife tree retention areas) or exclude features from the harvest area by modifying cutblock boundaries.
- Ensure buffers intended to protect features are windfirm. Discuss management options and potential impacts with local First Nations prior to harvest.
- Select a management approach for culturally modified trees (e.g., preserving with a windfirm buffer or including in a reserve) based on discussions with local First Nations and consideration of the site context and tree species/condition.
- Improve "stop work procedures" when features are missed during the cultural feature identification survey and encountered during harvest.
- Use low impact harvest methods or harvest when ground is frozen and with sufficient snowpack to minimize soil disturbance to avoid damaging surface/sub-surface cultural features that may exist, where an archaeological impact assessment (AIA) recommendation states that these methods may be appropriate.

In addition, monitoring staff identified that the front-end process of offering harvested monumental trees to the Cultural Wood Access Program for the cost of logging contributed to establishing good relationships with First Nations. However, it was pointed out that there needs to be better tracking of those trees as there is currently no way of knowing if logs were accepted by the program.

Visual Quality in the West Coast Region

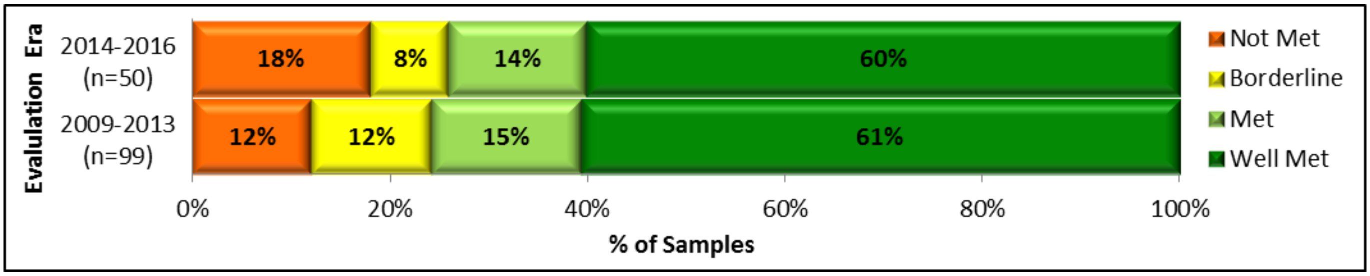

Figure 1. Percentage of landforms in each effectiveness evaluation rating category by evaluation era.

Data Source

Effectiveness evaluations were conducted by trained personnel from 2007 to 2016 using the FREP visual quality monitoring protocol to evaluate whether legally established visual quality objectives (VQOs) in designated scenic areas are being achieved. The sample population consists of landforms (distinct three-dimensional topographic features defined in perspective view) that include randomly selected cutblocks harvested under the *Forest and Range Practices Act*. A total of 149 samples have been collected in the West Coast Region, of which 50 represent recently evaluated landforms.

Summary

Seventy-four percent of recently evaluated landforms achieved *(met or well met)* the VQO compared to 76% of landforms evaluated from 2007 to 2013 (Figure 1). For the recently evaluated landforms, 36% of landforms with partial retention VQOs and 100% of landforms with retention VQOs did not achieve the objective *(borderline or not met)* (Table 1).

Table 1. Percentage of recently evaluated landforms by visual quality objective and rating category.

Landforms Evaluated 2014-2016		Rating Category			
		Not Met	**Borderline**	**Met**	**Well Met**
Visual Quality Objective	**Max Modification (n=3)**	0% (0)	0% (0)	0% (0)	**100%** (3)
	Modification (n=16)	0% (0)	0% (0)	**19%** (3)	**81%** (13)
	Partial Retention (n=28)	**25%** (7)	**11%** (3)	**14%** (4)	**50%** (14)
	Retention (n=3)	**67%** (2)	**33%** (1)	0% (0)	0% (0)
	Preservation (n=0)	-	-	-	-

Ocular Assessment Results for Recently Evaluated Landforms

Borderline/Not Met Ratings: For 85% of the landforms where the VQO was not achieved, the appearance, scale and visibleness of the alteration did not meet the criteria as defined in section 1.1 of the Forest Planning and Practices Regulation (FPPR) (Table 2).
Met/Well Met Ratings: For 100% of the landforms where the VQO was achieved, the appearance, scale and visibleness of the alteration met the criteria as defined in FPPR s.1.1 (Table 2).

Table 2. Achievement of criteria (appearance, scale and visibleness) defined in section 1.1 of the Forest Planning and Practices Regulation (FPPR) for recently evaluated landforms.

Landforms Evaluated 2014-2016		Criteria in FPPR Definition	
		Not Met	Met
Effectiveness Evaluation Rating	Borderline/Not Met	85%	15%
	Met/Well Met	0%	100%

Percent Alteration Assessment Results for Recently Evaluated Landforms

Borderline/Not Met Ratings: Initial percent alteration exceeded the upper limit of the range for the established VQO for 92% of the landforms (Table 3). Visual condition was negatively influenced by poor use of visual landscape design elements and by visual impacts of roads for 54% of the landforms (Tables 4 and 5). Additionally, in-block tree retention was not sufficient to improve visual conditions for 69% of the landforms (Table 6).

Met/Well Met Ratings: Initial percent alteration was below or within the range for the established VQO for 100% of the landforms (Table 3). Visual condition was positively influenced by good use of visual landscape design elements for 35% of the landforms (Table 4) and moderate/good in-block tree retention for 33% of the landforms (Table 6). Additionally, roads had no visual impacts for 76% of the landforms (Table 5).

Table 3. Comparison of initial percent alteration to the range for the established VQO for recently evaluated landforms.

Landforms Evaluated 2014-2016		Initial Percent Alteration Compared to Range for Established VQO		
		Exceeded Range	Within Range	Below Range
Effectiveness Evaluation Rating	Borderline/Not Met	92%	8%	0%
	Met/Well Met	0%	49%	51%

Table 4. Use of visual landscape design elements for recently evaluated landforms.

Landforms Evaluated 2014-2016		Use of Visual Landscape Design Elements		
		Poor	Moderate	Good
Effectiveness Evaluation Rating	Borderline/Not Met	54%	23%	23%
	Met/Well Met	22%	43%	35%

Table 5. Visual impacts of roads on recently evaluated landforms.

Landforms Evaluated 2014-2016		Visual Impacts of Roads			
		Dominant	Significant	Subordinate	None
Effectiveness Evaluation Rating	Borderline/Not Met	0%	15%	39%	46%
	Met/Well Met	0%	8%	16%	76%

Table 6. In-block tree retention for recently evaluated landforms.

Landforms Evaluated 2014-2016		In-Block Tree Retention		
		Poor	Moderate	Good
Effectiveness Evaluation Rating	Borderline/Not Met	69%	31%	0%
	Met/Well Met	67%	28%	5%

Opportunities for Improvement and/or Continuation of Practices to Manage for Visual Quality

- Reduce the opening size to ensure the initial percent alteration is within the range for the established VQO.
- Increase in-block tree retention to reduce the amount of visible bare ground.

RANGELAND HEALTH IN BRITISH COLUMBIA

Data Source

Assessments were conducted by provincial range program staff in 2016 using the *Rangeland Health Field Guide*[33] to evaluate the effects of livestock grazing on upland sites, streams and wetlands. As livestock do not graze evenly across the land base, monitoring sites are not randomly selected. Selection of sites is targeted based on livestock use, tenure and operational plan renewals, complaints, and areas where land-based investments can improve range condition. By monitoring areas that are more affected by livestock, the range program can make necessary improvements or changes to operational plans or qualify for funding to improve the management of resources and livestock. This targeted sampling strategy, however, may contribute to a greater proportion of sites with poor condition ratings. In 2016, the majority of sites monitored were for range use plan renewals.

Summary

In 2016, field inspection reports were completed for a total of 501 sites (330 upland sites, 65 streams, 106 wetlands) in 10 districts across the province (Table 1). Of these, 48% were in properly functioning condition (PFC), 20% were slightly at risk, 15% were moderately at risk, 13% were highly at risk, and 4% were non-functional. Sites that are in properly functioning condition and slightly at risk are considered to be in good condition. Moderately at risk sites are considered to be in fair condition and should be re-assessed within a few years as this rating often indicates that the site is moving in either a positive or negative direction. Highly at risk and non-functional sites are considered to be in poor condition and should be assessed for management changes or improvements to reduce livestock impacts and allow the area to recover. Streams and wetlands are particularly susceptible to livestock impacts because these areas provide water, desirable forage and shade.

Table 1. Percentage and number of range monitoring assessments completed in 2016 by site type and functionality rating.

	Properly Functioning Condition (PFC)	Slightly at Risk	Moderately at Risk	Highly at Risk	Non-Functional
Uplands (330)	**45%** (149)	**19%** (64)	**15%** (48)	**17%** (55)	**4%** (14)
Streams (65)	**46%** (30)	**32%** (21)	**16%** (10)	**6%** (4)	**0%** (0)
Wetlands (106)	**57%** (61)	**17%** (18)	**15%** (16)	**7%** (7)	**4%** (4)
Total (501)	**48%** (240)	**20%** (103)	**15%** (74)	**13%** (66)	**4%** (18)

<u>Upland Sites:</u> Of the 330 upland sites assessed in 2016, 64% were in good condition (PFC and slightly at risk), 15% were in fair condition (moderately at risk), and 21% were in poor condition (highly at risk or non-functional) (Table 1). Four categories of parameters are considered when assessing the condition of upland sites: hydrologic and soils, biotic/vegetation, erosion/deposition, and mineral cycle. Average category scores for uplands sites assessed in 2016 are provided in Table 2.

[33] Fraser, D.A. 2007. Rangeland Health Field Guide. B.C. Ministry of Forests and Range, Range Branch, Kamloops, B.C. http://www.for.gov.bc.ca/hfd/pubs/docs/mr/Mr117.htm.

Table 2. Average scores for upland site condition assessment categories in 2016.

Uplands Site Condition Assessment Category	Average Score
Hydrologic and soils	**73%**
Biotic/vegetation	**55%**
Erosion/deposition	**90%**
Mineral cycle	**75%**

The biotic/vegetation and hydrologic and soils assessment categories scored the lowest overall. Although habitat structural diversity was good for 56% of the sites, plant communities did not have good vigour or fully occupy the root zone for 61% and 54% of the sites, respectively. Subsurface impenetrable layers or compacted soil layers did not support water infiltration at 48% of the sites, affecting root penetration and thereby contributing to poor plant vigour and a less than fully occupied root zone. Less preferred, shallow-rooted species (e.g., bluegrass) often increased where the root zone was not fully occupied.

Logging/silviculture, roads/ditches/culverts, ingrowth/encroachment of trees/shrubs, livestock grazing, and recreation were the most common causes of altered upland site dynamics. Where upland sites were located within transitional grazing areas (i.e., cutblocks), logging/silviculture may have increased soil compaction and reduced habitat structural diversity prior to livestock grazing, thereby negatively influencing the final condition ratings for these sites.

Streams: Of the 65 streams assessed in 2016, 78% were in good condition (PFC or slightly at risk), 15% were in fair condition (moderately at risk), and 6% were in poor condition (highly at risk) (Table 1). No streams were non-functional. Four categories of parameters are considered when assessing stream condition: channel structure, function, and diversity, biotic community, hydrology/soils, and nutrient inputs and water quality. Average category scores for streams assessed in 2016 are provided in Table 3.

Table 3. Average scores for stream condition assessment categories in 2016.

Stream Condition Assessment Category	Average Score
Channel structure, function, and diversity	**64%**
Biotic community	**84%**
Hydrology/soils	**67%**
Nutrient inputs and water quality	**76%**

The channel structure, function, and diversity assessment category scored the lowest overall. Increased embeddedness and sedimentation was observed at 50% and 74% of the sites respectively, which can impact fish spawning and the use of rock undersides by insects and other invertebrates.
Blowdown and flooding within riparian areas were the leading causes of altered stream dynamics. Livestock grazing along with land uses beyond the control of the range user, namely logging/silviculture and roads/culverts/ditches, also contributed to altering stream dynamics.

Wetlands: Of the 106 wetlands assessed in 2016, 74% were in good condition (PFC or slightly at risk), 15% were in fair condition (moderately at risk), and 11% were in poor condition (highly at risk or non-functioning) (Table 1). Four categories of parameters are considered when assessing wetland condition: hydrology, biotic/vegetation, soils/erosion-deposition, and nutrient inputs and water quality. Average category scores for wetlands assessed in 2016 are provided in Table 4.

Table 4. Average scores for wetland condition assessment categories in 2016.

Stream Condition Assessment Category	Average Score
Hydrology	**62%**
Biotic/vegetation	**75%**
Soils/erosion-deposition	**79%**
Nutrient inputs and water quality	**82%**

The hydrology assessment category scored the lowest overall. Changes in water levels were observed at 35% of the sites. Low water levels directly affect the diversity and structure of riparian and emergent vegetation as well as indirectly contributing to bank shearing, soil compaction, and bare ground caused by livestock accessing water.

Seasonal drawdown was the leading cause of altered wetland dynamics. Seasonal drawdown is typically an annual occurrence and is increasing in some areas of the province because of changes in climatic conditions. Affected wetlands should be monitored and range improvements (e.g., point access or alternative watering locations) should be considered. These areas might be unsightly during years of low water levels but maintaining vigorous natural vegetation bands and limiting soil compaction will ensure a quick wetland recovery when higher water levels return. Livestock grazing along with land uses beyond the control of the range user, namely roads/ditches/culverts, logging/silviculture, wildlife, and recreation, also contributed to altering wetland dynamics.

***Upland Sites, Streams, and Wetlands in Community Watersheds*:** Of the 501 sites monitored in 2016, 38 sites (13 upland sites, 19 streams, 6 wetlands) were within a community watershed (Table 5). This may not reflect the total number of assessments conducted within community watersheds because the occurrence of a site within a community watershed is not always specified in the inspection report. Of the uplands sites, 77% were in good condition (PFC and slightly at risk), 8% were in fair condition (moderately at risk), and 15% were non-functional. Of the streams, 42% were in good condition (PFC and slightly at risk), 47% were in fair condition (moderately at risk), and 11% were in poor condition (highly at risk). All of the wetlands were in properly functioning condition.

Only 8% of the wetlands and streams within a community watershed were part of a beaver-influenced riparian system. Beavers regulate water levels and create habitat for many species, thus reducing potential livestock impacts. Beavers may cause water quality concerns, however, especially in community watersheds. As in previous years, the cumulative impacts of multiple land uses (logging, roads/culverts/ditches, and livestock grazing) have altered the dynamics within community watersheds.

Table 5. Percentage and number of range monitoring assessments completed within community watersheds in 2016 by site type and functionality rating.

	Properly Functioning Condition (PFC)	Slightly at Risk	Moderately at Risk	Highly at Risk	Non-Functional
Uplands (13)	**54%** (7)	**23%** (3)	**8%** (1)	**0%** (0)	**15%** (2)
Streams (19)	**26%** (5)	**16%** (3)	**47%** (9)	**11%** (2)	**0%** (0)
Wetlands (6)	**100%** (6)	**0%** (0)	**0%** (0)	**0%** (0)	**0%** (0)
Total (38)	**47%** (18)	**16%** (6)	**26%** (10)	**5%** (2)	**5%** (2)

Opportunities for Improvement and/or Continuation of Practices to Manage for Rangeland Health

Upland Sites:

- Leave residual cover (surface litter and live plant cover) after grazing to encourage germination of new grass seedlings and improve soil conditions.
- Build planned rest into the annual grazing plan for bunchgrass range (e.g., rest-rotation grazing systems – rest one-quarter of pastures from livestock use each year) to restore plant vigour.
- Adjust grazing use levels and stocking rates according to seral stage and rangeland health. Ideally, early-seral range should be used lightly (17 - 25% of annual forage production), whereas healthy mid- and late-seral range is best used moderately (30 - 40% of annual production).
- Allow dormant season (winter) grazing on low elevation bunchgrass range that has not been grazed during the growing season as this activity has less impact on grass plants and biological soil crusts than grazing during the growing season.
- Review the range carrying capacity using the approved procedure as capacity varies widely. If required, decrease livestock numbers based on the average available forage (as determined through forage clipping and analysis on a pasture and range unit basis) and a safe level of use.

Streams and Wetlands:

- Use exclusion fencing, woody debris barrier placement, and development of alternative water sources to protect streams, wetlands and non-classified drainages.
- Preserve natural range barriers (e.g., vegetation and downed woody debris) to limit livestock access to streams, wetlands, and lakes.
- Coordinate timber harvesting, road building, and range use to ensure that natural range barriers in riparian areas remain effective.

***Upland Sites, Streams, and Wetlands in Community Watersheds*:**

- Follow best management practices for livestock management in community watersheds where drinking water is the highest priority.

SUMMARY

As a regional-level summary of FREP monitoring results to date, this seventh annual report communicates continuous improvement perspectives and recommendations to natural resource professionals, land managers, and decision makers. This information is intended to support and promote dialogue necessary to achieve short- and long-term sustainable resource management goals in British Columbia. Natural resource professionals, land managers, and decision makers are strongly encouraged to consider this information along with other FREP reports (i.e., local multiple resource value assessment reports), extension notes, monitoring protocols, and other relevant data. Monitoring results should assist managing professionals to understand the outcomes associated with their plans and practices, and inform their recommendations and decisions, particularly where these need to balance environmental, social and economic values.

To ensure the resource management community gains the maximum value from FREP monitoring, natural resource professionals, land managers, and decision makers are encouraged to:

1. Carefully review this report in the context of their specific roles and responsibilities.
2. Contact their natural resource district to arrange a field visit to view local results and discuss outcomes and appropriate actions moving forward.
3. Request the data pertaining to their management area to conduct their own analysis and interpretation. Local data and support is available to individual licensees by contacting FREP@ gov.bc.ca.
4. Review the FREP monitoring protocols. These documents identify the best available information on key attributes and indicators of forest and range resource health and sustainability.
5. Visit the FREP website at: http://www2.gov.bc.ca/gov/content?id=F799814F5E004CA0A02A02D63CB69E55.
6. Send any feedback or questions relating to this report, or FREP in general, to FREP@ gov.bc.ca.