Babine Watershed

Indicator Data Summary Report

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Executive Summary

The Babine River has been subject of much interest regarding land management due to its high value resources. This project was commissioned by the Babine Watershed Monitoring Trust, as part of its mandate to monitor the effectiveness of land management plans covering the Babine Watershed. These management plans are focussed on either the Bulkley Timber Supply Area in the east or the Kispiox Timber Supply Area in the west.

The Babine Watershed Monitoring Trust looks at whether strategies in the land use plans are effective at meeting plan objectives and goals. The effectiveness indicators being analyzed are: for Biodiversity objective - deciduous stands, tree species and stand structure; for Maintain Timber Supply objective - timber salvage, and for Maintain Water Quality objective - equivalent clearcut area.

For stand structure, in the Bulkley TSA 13.6% of cutblock area was reserved and in the Kispiox, 7.7%. The amount reserved varied by subzone, generally with greater percent in reserves in the higher elevation ESSFmc subzone than in the lower elevation SBSmc2 and ICHmc subzones.

The area with deciduous tree species in the young seral stage was below natural amounts in several landscape units, especially in the SBSmc2 subzone. The cause of these findings requires further analysis.

Mountain pine beetle has attacked 79,000 ha of forest in the Babine Watershed, most of it in the Bulkley Timber Supply Area. Salvage timber harvesting has occurred on 2,600 ha, or 4.3 percent of the attacked area.

The Equivalent Clearcut Area (ECA), in the Kispiox TSA the Cataline watershed was over the trigger level of 20% by 15%, when the ECA was calculated in 2004, and the Gail watershed was approaching the ECA limit. With the low level of harvesting in the Cataline and Gail watersheds since the ECA was completed and the hydrological recovery through tree growth the ECA has likely decreased. None of the watersheds in the Bulkley TSA are over the ECA triggers or limits, even with the current level of MPB killed trees added as equivalent to clearcut. An analysis of ECA done for the Bulkley TSA in 2011, found that none of the identified sensitive watersheds in the Bulkley portion of the Babine Watershed exceed ECA targets.

There are issues with the methods used for several indicators. The tree species analysis appears to have been subdivided into units that are too small to effectively represent landscape scale patterns. Differences in mountain pine beetle mapping methods in by the BC Forest Service and the forestry company leads to some uncertainty about the area attacked by mountain pine beetle.

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1.0 Introduction

The Babine Watershed is located 65 km north of Smithers and 30 km north of Hazelton BC, with the Babine River being a tributary to the Skeena River. The Babine River has been subject of much interest regarding land management due to its high value resources, including excellent steelhead angling, large sockeye salmon run, excellent river rafting and timber resources. This project was commissioned by the Babine Watershed Monitoring Trust, as part of its mandate to monitor the effectiveness of land management plans covering the Babine Watershed. These management plans are focussed on either the Bulkley Timber Supply Area in the east or the Kispiox Timber Supply Area in the west, each of which cover a portion of the Babine Watershed (Figure 1). The Babine Watershed covers 402,435 ha.

The Babine Watershed Monitoring Trust looks at whether plan strategies are effective at meeting plan objectives and goals (Price and Daust 2005). This indicator data summary project is looking at indicators for the goals of Biodiversity, Maintaining Timber Supply and Maintaining Water Quality. The specific were selected because the Babine Watershed Monitoring Trust has insufficient data to assess the risk to the objectives. Most of these indicators are mentioned in the Babine Landscape Unit Plan (1999), Nilkitkwa Landscape Unit Plan (1999) and the Xsu gwin lik'l'inswx: West Babine Sustainable Resource Management Plan (SRMP) (Ministry of Sustainable Resource Management 2004).

Specifically the indicators being analyzed are: for Biodiversity - deciduous stands, tree species and stand structure (reserve area); for Maintain Timber Supply - timber salvage, and for Maintain Water Quality - equivalent clearcut area (Table 1).

Table 1. Relationship of Indicators to Goals, Objectives and Strategies

Objective	Strategies	Indicator
Goal – Maintain Biodiversity		
Maintain a diversity of coniferous and deciduous species, across the Nilkitkwa Landscape Unit and throughout the rotation, that represents the natural species composition of each biogeoclimatic subzone.	1. Where hemlock and balsam are not planted but are a primary or secondary species, as per the *Establishment to Free Growing Guidebook for the Prince Rupert Forest Region,* facilitate natural regeneration by ensuring these species are a component of wildlife tree patches scattered throughout larger openings. 2. Incremental silviculture activities should ensure that all existing ecologically acceptable species on site will be represented. 3. Where the preharvest stand has a major component (greater than 20%) of deciduous species, retain a portion of these species as either wildlife tree patches and/or reserve patches (wildlife tree patches can include the retention of single trees). 4. Where the preharvest stand had little or no deciduous component, but deciduous species have invaded naturally, design control measures so the presence of deciduous species will not be eliminated from the site while also recognizing that free-growing requirements must be achieved. Preferably, retain deciduous in a clumpy distribution. 5. Do not assist conversion of natural deciduous stands to coniferous species.	deciduous stands—natural amounts and % of natural by appropriate ecosystem and natural disturbance estimates tree species - natural amounts and % of natural for each species by appropriate ecosystem and seral stage

Table 1. Relationship of Indicators to Goals, Objectives and Strategies		
Objective	**Strategies**	**Indicator**
Provide structural diversity within managed stands by retaining attributes of old forests such as coarse woody debris, standing dead trees, and standing live trees	1. Retain wildlife tree patches (WTP) containing suitable wildlife trees at the time of harvest and during silviculture activities. Locate wildlife tree patches to provide a range of old forest stand structural attributes such as standing dead trees, standing live trees, coarse woody debris, and root wads. Patches should be distributed throughout the block with distances between patches (or other suitable leave areas outside the block) not normally exceeding 500 metres. 2. Retain wildlife tree patches with each block, independent of silviculture system, and approximately in the percentages in **Error! eference source not found.** 3. Allow natural processes to occur within wildlife tree patches unless infestations or infections threaten to spread to non-wildlife tree patch areas. Where intervention is required, treatment will retain a diversity of structural attributes or a suitable replacement wildlife tree patch will be located. 4. Where possible, plan wildlife tree patches: - to retain deciduous as well as coniferous trees, - to retain some large, old trees, - to provide connectivity within the cutblock, - to provide structure in riparian management areas, and - in areas already constrained. 5. Retention of coarse woody debris outside identified wildlife tree patches, core ecosystems and riparian reserve zones should not exceed utilization standards.	% retention, and % of various structures by ecosystem
Goal – Maintain Timber Supply		
Maintain the health and productivity of the timber resource	Salvage of damaged or diseased timber should occur as soon as possible in an economic and efficient manner according to objectives of the area	% of disturbed stands salvaged
Goal – Maintain Water Quality		
To maintain water quality and quantity within the range of natural variability	None	Equivalent clearcut area (ECA) within each mid-sized watershed

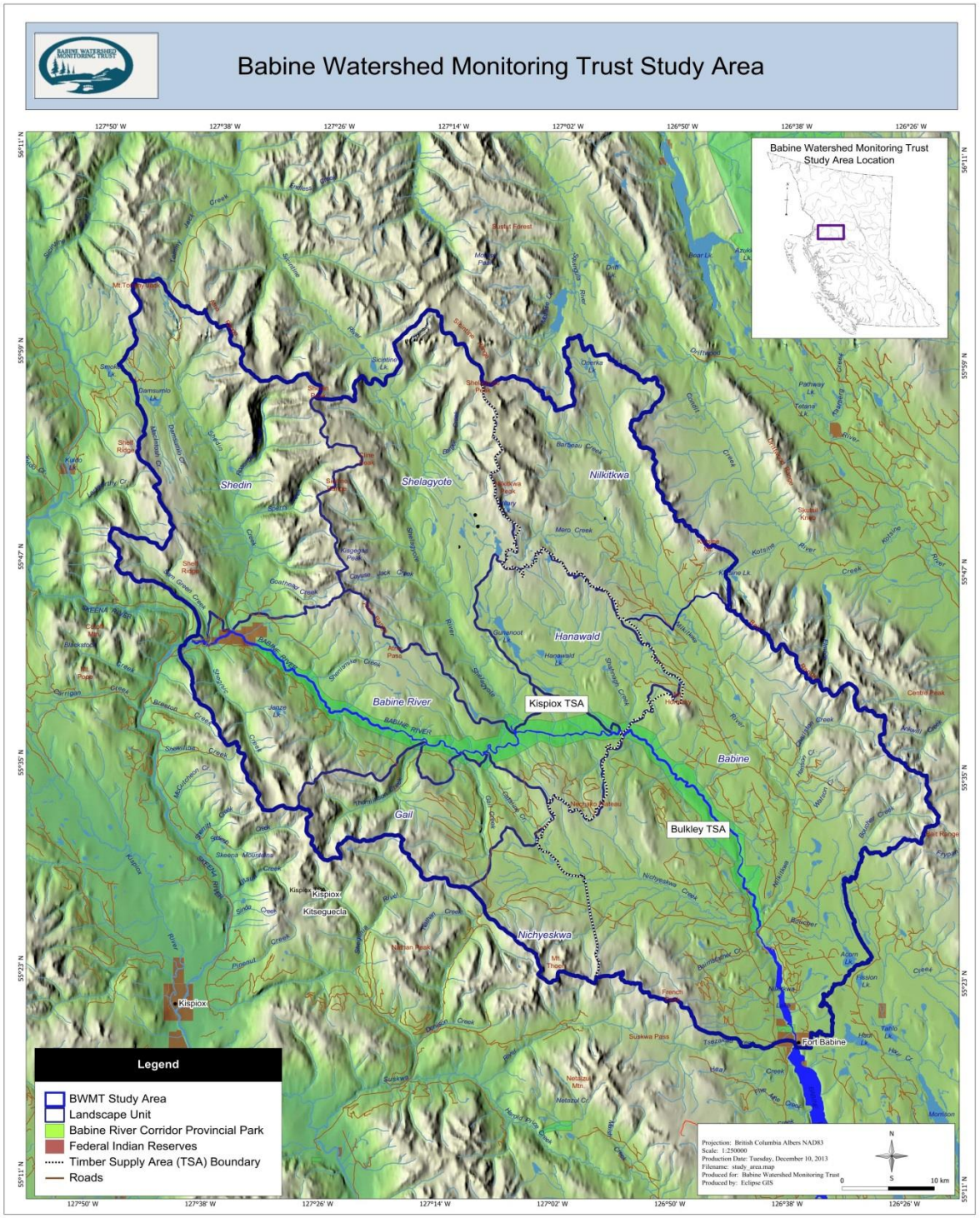


Figure 1. Location of Babine Watershed and land use plan boundaries

1.1 Study Area Overview

The Babine Watershed is dominated by the SBSmc2 and ESSFmc Biogeoclimatic Ecosystem Classification (BEC) subzones in both total area and area in the Forest Management Harvesting Land Base (FMLB) (Figure 2, Table 2).

Table 2. Biogeoclimatic subzones present in the Babine Watershed

Timber Supply Area	BGC Unit	BGC code	Area (ha)	Area in FMLB (ha)
Bulkley	Boreal Altai Fescue Alpine unclassified	BAFAun	12,370	89
	Engelmann Spruce Subalpine Fir moist cool	ESSFmc	61,879	52,638
	Engelmann Spruce Subalpine Fir moist cool parkland	ESSFmcp	9,572	2,549
	Sub-Boreal Spruce moist cold Babine variant	SBSmc2	81,273	68,918
		Sub-total	**165,094**	**124,194**
Kispiox	Boreal Altai Fescue Alpine unclassified	BAFAun	46,535	510
	Engelmann Spruce Subalpine Fir moist cold	ESSFmc	44,203	38,323
	Engelmann Spruce Subalpine Fir moist cold parkland	ESSFmcp	720	19
	Engelmann Spruce Subalpine Fir wet very cold	ESSFwv	54,990	46,602
	Engelmann Spruce Subalpine Fir wet very cold parkland	ESSFwvp	17,347	7,033
	Interior Cedar Hemlock moist cold Nass variant	ICHmc1	31,598	27,921
	Interior Cedar Hemlock moist cold Hazelton variant	ICHmc2	2,310	2,027
	Sub-Boreal Spruce moist cold Babine variant	SBSmc2	39,640	34,207
		Sub-total	**237,341**	**156,642**
		Total	**402,435**	**280,836**

Within the Babine Watershed, the Kispiox TSA is larger in both total area and in the area in the Forest Management Land Base (Table 3, Figure 3). However, the Bulkley TSA has had much more area harvested, and as a result has more cutblock reserve area and more roads.

Table 3. Area in depletions, reserves and road buffers by Timber Supply Area

Land designation	Area (ha)		
	Bulkley TSA	**Kispiox TSA**	**Total**
Total area	165,094	237,341	402,435
Forest Management Land Base	124,194	156,642	280,836
Depletions (cutblocks)	16,917	5,205	22,122
Cutblock reserve Areas	2,656	433	3,089
Road buffer	1,855	803	2,658

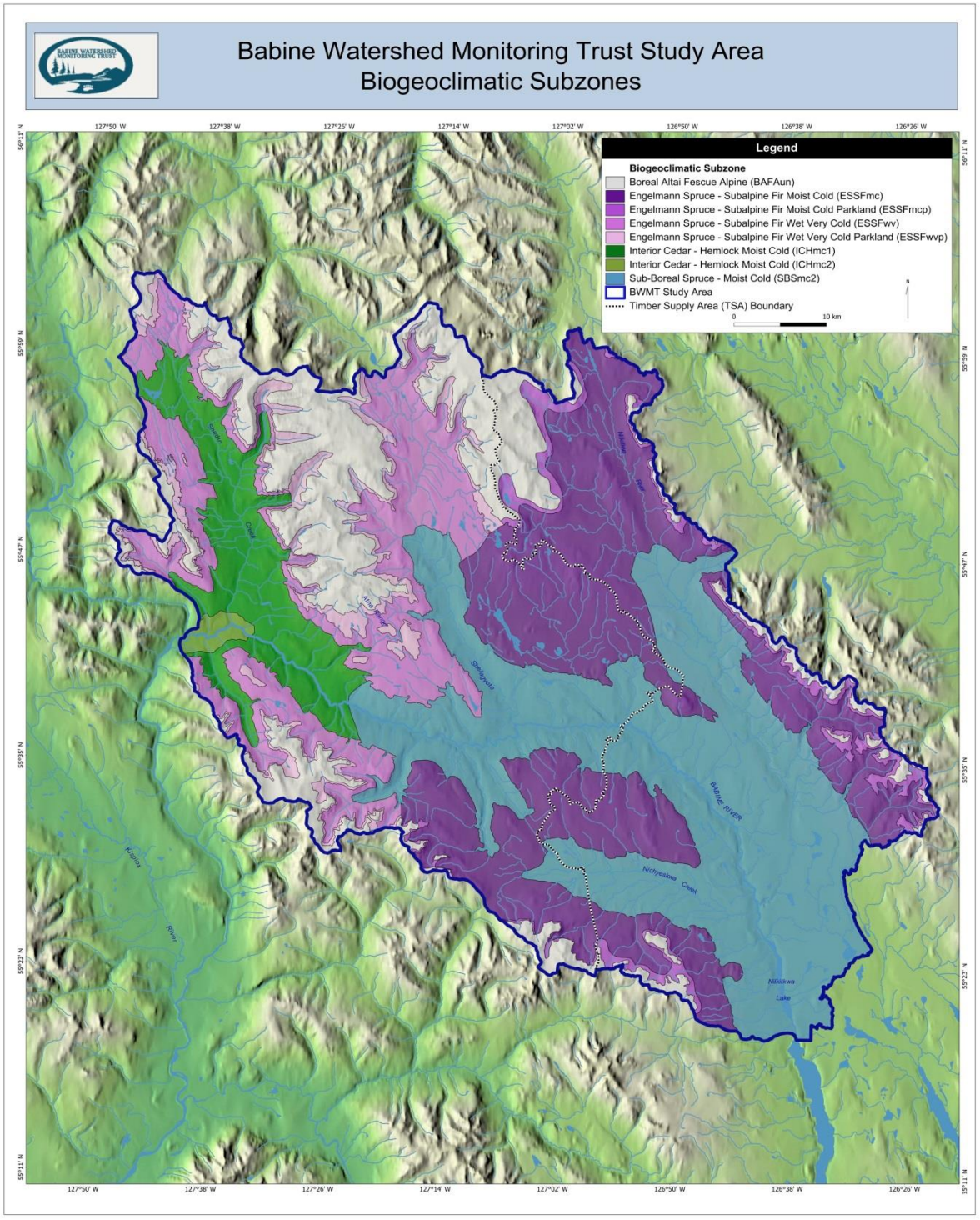


Figure 2. Biogeoclimatic Ecosystem Mapping subzones in the Babine Watershed area

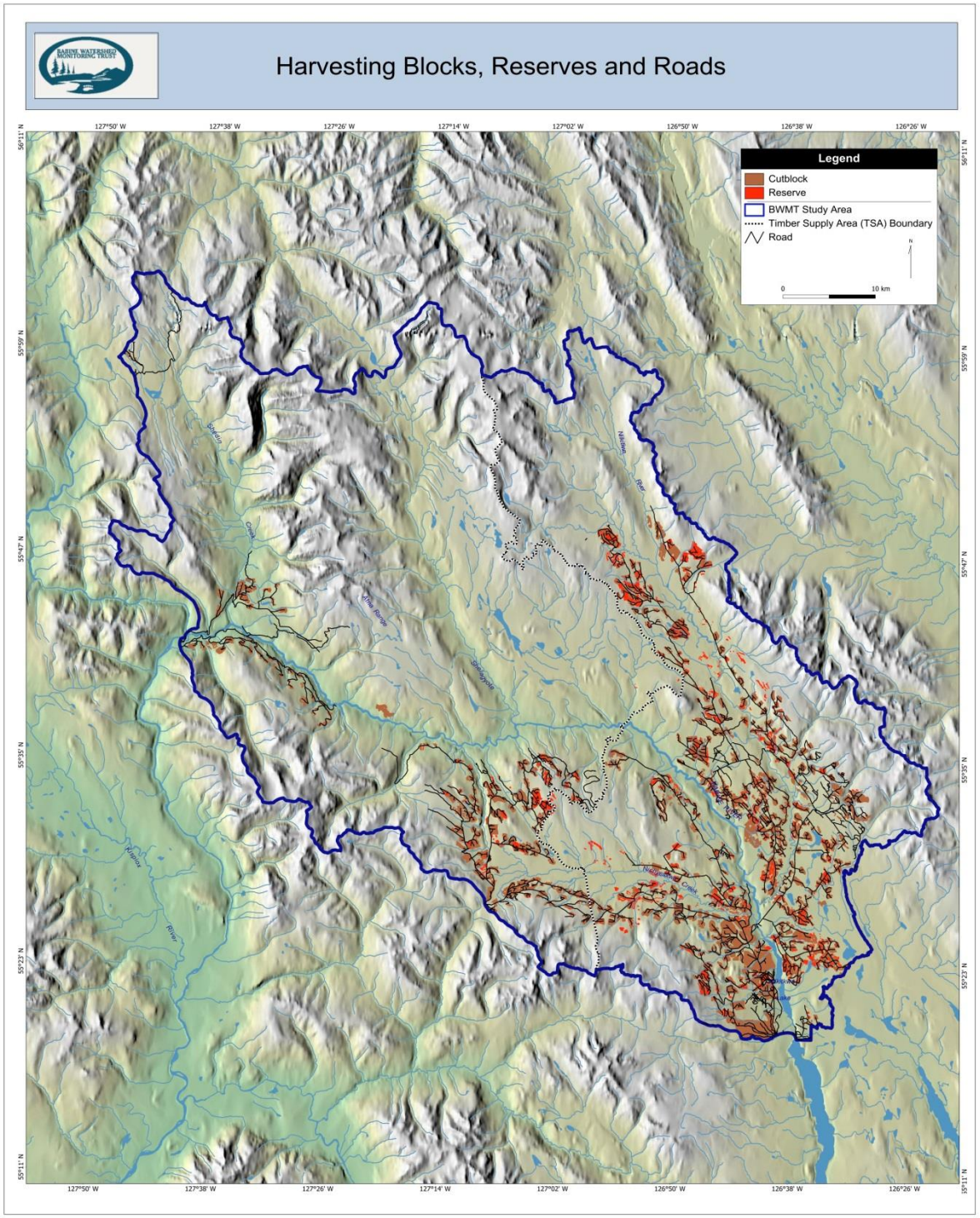


Figure 3. Location of cutblocks, reserve area and roads in the Babine Watershed

2.0 Data Sources and Data Issues

2.1 Data Sources

Data was obtained from many sources for this analysis (Table 4), with attempts made to get the most current information on harvesting, roads, wildlife tree patches and forest health.

Table 4: Data sources used in the analysis

Feature	Name	Source	Current	Acquired
Biogeoclimatic ecosystem classification (V8)	BWMT_BEC	DataBC	Feb 2012	February 2012
Vegetation Resources Inventory (VRI)	Vege_clip	DataBC	Jan 2013	April 2013
Existing blocks and openings	Depl_Bulk_to2009	MFLNRO	2009	February 2013
	Depl_Kisp_to2006	MFLNRO	2006	February 2013
	Cut_BulkLic_to2011	MFLNRO	2011	February 2013
	PIR_Harvest_Jan1_11_to_Mar31_13	PIR	2013	March 2013
	BMT_Blocks	BCTS – Bulkley	2013	March 2013
	RESULTS	MFLNRO	2013	January 2013
Existing roads	Rds_Bulk_Bab	MFLNRO	2011	February 2013
	Rds_Kisp_Bab	MFLNRO	2009	February 2013
	PIR_perm_roads_Jan2011_to_Mar2013	PIR	2013	March 2013
	BMT_roads	BCTS - Bulkley	2013	March 2013
Reserves	WTR_BulkLic_to2011	MFLNRO	2011	February 2013
	PIR_Reserves_Jan1_11_to_Mar31_13	PIR	2013	March 2013
	BMT_SUt	BCTS – Bulkley	2013	March 2013
	RESULTS – Reserves (for Kispiox TSA)	MFLNRO	2011	December 2012
Forest Health	Forest_Health_poly	MFLNRO	2012	January 2013
Fire History	BWMT fire Polygons	DataBC	2012	December 2012
Watersheds	dki_4th_wsheds (for Kispiox TSA)	MFLNRO		February 2013
	Bulkley portion 4th order watersheds	MFLNRO		February 2013

2.2 Forest Management Land Base Definition

The forest management land base (FMLB) is the portion of the total area within a TSA with forest cover that contributes to Crown forest management objectives for timber supply, such as landscape-level biodiversity or visual quality objectives. The FMLB excludes:

- private land
- federal reserves
- long-term leases
- area-based forest tenures
- non-forested lands.

The definition of the Forest Management Land Base (FMLB) used by the Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) for the 2013 Bulkley TSA Timber Supply Review (TSR) was followed for this project (Table 5).

Table 5. Description of non-forested areas removed from the Forest Management Land Base (FMLB)

Attribute	Description
Bulkley VRI BCLCS level 1 equal to 'N' and no logging history	Removes non-vegetated areas
BCLCS level 2 = 'N' and no logging history	Removed non-treed areas
BCLCS level 3 = 'A' and no logging history	Removes alpine areas
Projected Height < 5 m and no logging history OR Crown Closure Layer 1+2 < 20% and no logging history	Forested but does not contribute to biodiversity and habitat objectives
Existing roads, trails and landings	Removes roads, trails and landings based on Right-of-Way buffer width by road class: • Paved roads – 40 metres • 2 Lane Gravel roads – 30 metres • 1 Lane Gravel roads – 20 metres • Unimproved roads – 10 metres • Trails – 10 metres

To define the FMLB, the roads layer used for the Bulkley and Kispiox timber supply reviews was obtained from MFLNRO and was updated with information provided by PIR and BCTS. Buffer width coding was applied to the new roads following protocols in Table 5. The road buffer width was applied to these additional roads and to the new roads based on information supplied by Pacific Inland Resources – West Fraser Timber (PIR) and BC Timber Sales (BCTS), and by analysis of the Kispiox roads. The Bulkley TSR data package description of the road buffers does not include a 15m buffer; however, many roads in the database obtained from MFLNRO had a 15m buffer. To be consistent with that database the 15m buffer was used for similar road types in the Kispiox TSA. The roads layer contained many roads that were inactive historical roads or trails and could not reasonably be considered roads needing a buffer and removal from the FMLB. Most of these problematic roads were in the Kispiox TSA.

2.3 Cutblock Data

Information on cutblocks was obtained from several sources. Harvested areas were identified using the so-called "depletions layer" used in the Bulkley and Kispiox timber supply reviews. This layer contains all silvicultural openings, which includes areas such as burns that have been treated silviculturally. For the Bulkley TSA the depletions layer used in the 2012 Bulkley Timber Supply Review (Forest Analysis and Inventory Branch 2012) was obtained and updated with additional harvest information from PIR and BCTS. For the Kispiox TSA, the depletions layer used in the 2006 Timber Supply Review was obtained; no harvesting has occurring in the area since 2006.

The cutblock boundaries in the Vegetation Resource Inventory (VRI) database does not exclude reserves, instead it includes the entire cutting permit area which includes reserved areas. As a result using the VRI to obtain harvested area will result in an inflated cutblock area. The spatial cutblock information in the RESULTS database also includes all silvicultural openings; as such it includes cutblocks and other areas that have been treated silviculturally such as burns. A field that was effective to filter out these different opening types was not found in RESULTS. Information on non-logging disturbances, such as burns, is included in the VRI database, but the VRI database was not the most current for harvest data.

The projected age of cutblocks does not always reflect the post-harvest status of the stand. The tree species may also be incorrect if they are updated when age data are

updated. This may be partly due to the process used to update the depletions layer with new cutblock information received from PIR.

2.4 Seral Stage Data

The Vegetation Resources Inventory (VRI) database was used for several analyses. The VRI was clipped from the provincial database using the BWMT boundary and divided into the Kispiox and Bulkley TSA's. A seral age attribute was added following guidelines in the Biodiversity Guidebook (Table 6).

Table 6. Age ranges used to define seral stages in different Biogeoclimatic Zones

Seral Stage	SBS	ESSF	ICH
Young	0 – 40	0 – 40	0 – 40
Pole	41 – 100	41 – 120	41 – 100
Mature	101 – 140	121 – 250	101 - 250
Old	141 +	250 +	250 +

2.5 Tree Species Data

Information on tree species was obtained from the VRI database. Up to six tree species can be recorded for one polygon, with percentage estimates for each species in each polygon given. The area containing each tree species was calculated using the percentage estimates for each tree species in each polygon.

For the tree species and deciduous tree species indicators, the natural amount was calculated using the pole seral stage as the reference natural amount. The pole seral stage was used as it was unlikely to have been targeted for harvesting or have been produced as a result of harvesting. The hectares in each seral class of each tree species in each polygon was determined using Vegetation Resource Inventory data. Only tree species with >500 ha in a subzone in a landscape unit are included in the analysis. The deciduous tree species are grouped together as individually the species may not cover enough area to allow meaningful analysis.

The area in the young seral class was adjusted for the number of years in the seral class. For example, in the ICHmc the young seral class spans 40 years and the pole seral class spans 60 years. The area in the young seral class was adjusted upwards to compensate for the recruitment time-span differences. The ESSFwv subzone was not included in the deciduous analysis because of the small amount of deciduous forest in this subzone.

2.6 Stand Structure Data

Stand Structure is maintained by establishing Wildlife Tree Patches (WTP) also called reserves. Reserves can be established for a variety of reasons (Table 7). Reserve data includes all reserve types except Timber and Other, which are not full rotation reserves. The data obtained from MFLNRO were updated with data from PIR, BCTS – Bulkley, and DataBC. These reserves are often called Wildlife Tree Patches (WTP). It does not include Core Ecosystems, Landscape Corridors or Old Growth Management Areas (OGMA).

Obtaining spatial data on the location, purpose and duration of reserved areas is difficult. The cutblock boundaries in the VRI database does not exclude reserves, instead it includes the entire cutting permit area which includes reserved areas. As a result using the VRI to obtain harvested area will result in an inflated cutblock area.

Table 7. Reserve Types in the RESULTS database

Reserve Objective Code	Reserve Description
BIO	Biodiversity
BOT	Botanical Forest Products
CHR	Cultural Heritage Resources
CWD	Coarse Woody Debris
FH	Forest Health
FUE	Fuel Management
OTH	Other
REC	Recreation
RMA	Riparian Management Area
SEN	Sensitive Site
TER	Terrain Stability
TIM	Timber Management
VIS	Visual
WTR	Wildlife Tree Retention Goals

The RESULTS database separates reserve area from cutblock area, but conflicting information was received from the BC Forest Service and PIR as to the permanence of reserve areas with different codes. Ministry of Forests, Lands and Natural Resource Operations indicated that all reserve types except Timber were full rotation (G. Buhr *pers. comm*.), whereas PIR indicated that those designated "Other" were also not full rotation (T. Penninga *pers. comm*.). In this report reserves coded timber and other were not included.

2.7 Forest Disturbance Data

The provincial pest overview database has records of 16 different disturbance factors occurring in the Babine Watershed from 1979 to 2012. The database is updated each year, with the data from the present year being added to that of all the previous years. The result is that there are many overlapping polygons, even within one type of disturbance. These overlaps can occur as a disease or pest progresses through the forest killing more trees each year thus becoming more severe, or by stands becoming reattacked perhaps after a period of inactivity. The result is that the total area disturbed is overestimated if the sum of all the data from different years is used. For example, the area mapped as being disturbed by Western Balsam Bark Beetle is nearly three times the area of the Babine Watershed. For the major disturbances, these overlaps were removed with the most severe disturbance code for the overlap area used.

2.8 Biogeoclimatic Ecosystem Classification

Current BEC subzone maps do not show the recently mapped woodlands of the high elevation forested subzones, despite the upper operability line being defined by the lower elevational edge of the woodlands, and Predictive Ecosystem Mapping (PEM) using the woodlands designation (Ministry of Forests, Lands and Natural Resource Operations. 2012).

Harvest Method Mapping, originally completed in 1998, is used to identify operable areas. An update completed in 2010 considers an upper operability line defined by the lower elevational edge of newly mapped "woodlands" Biogeoclimatic Ecosystem Classification (BEC) subzones. Woodlands BEC subzones were recently mapped and have yet to be incorporated into the Land and Resource Data Warehouse (LRDW) BEC layer.

3.0 Results

3.1 Biodiversity Indicators

3.1.1 Stand Structure Indicator

The only indicator with measureable targets for stand structure is the percentage of cutblock area retained as wildlife tree patch (WTP) reserves (Integrated Land Management Bureau 2006). Additional strategies for maintaining stand structure are provided in landscape unit plans, but measurable targets are not provided. For this report, the percent cutblock area in WTPs is the main indicator. A comparison of the site index of reserves to cutblocks was also done, to indicate if the forests in WTP were of a similar productivity to that in cutblocks.

In the Bulkley TSA 13.6% of block area was in reserves and in the Kispiox 7.7 % (Table 8). The amount reserved varied by subzone, generally with greater percent in reserves in the higher elevation ESSFmc subzone than in the lower elevation SBSmc2 and ICHmc subzones.

Table 8. Comparison of reserve area to harvested area by Timber Supply Area and subzone

Landscape Unit / Subzone	Area (ha)			% of total area in reserves
	Harvested	Reserved	Total	
Bulkley TSA				
Babine				
ESSFmc	1,876.3	408.8	2,285.1	17.9
SBSmc2	13,553.4	1,710.4	15,263.8	12.6
Nilkitkwa				
ESSFmc	979.0	449.8	1,428.8	31.5
SBSmc2	508.0	87.3	595.3	14.7
Bulkley Total	**16,916.7**	**2659.2**	**19,575.9**	**13.6**
Kispiox TSA[1]				
Babine River				
ESSFmc	491.6	94.0	585.6	16.1
ESSFwv	7.7	0	7.7	0
ICHmc	542.5	0	542.5	0
SBSmc2	115.1	0	115.1	0
Gail				
ESSFmc	1,289.4	217.5	1,506.9	14.4
SBSmc2	681.0	43.2	724.2	6.0
Hanawald				
ESSFmc	63.9	0	63.9	0
SBSmc2	64.1	6.7	70.8	9.5
Nichyeskwa				
ESSFmc	1,242.8	65.3	1,308.1	5.0
ICHmc	177.0	0	177.0	0
Shedin				
ESSFwv	23.8	0.6	24.4	2.5
ICHmc	497.2	3.6	500.8	0.01
Kispiox Total	**5,204.9**	**433.1**	**5638.0**	**7.7**
Total	**22,121.6**	**3,089.3**	**25,210.9**	**12.3**

1 - No harvesting has occurred in the Shelagyote watershed

The site index[1] of reserves was slightly lower than that in cutblocks in all subzones in both the Kispiox and Bulkley TSAs (Table 9). The average difference was 0.6m in the Bulkley and 2.5m in the Kispiox, indicating that reserves tend to be located in lower productivity forests than harvested areas.

Table 9. Comparison of site index in reserve areas and harvested areas

Subzone	Average Site Index (m tall @ 50 yrs. old)		Difference
	Reserve Area	Harvested area	
Bulkley TSA			
ESSFmc	10.1	10.8	+0.7
SBSmc2	12.6	13.2	+0.6
Bulkley total	**12.2**	**12.8**	**+0.6**
Kispiox TSA			
ESSFmc	9.6	10.8	+1.2
ESSFwv	7.9	12.0	+4.1
ICHmc1	8.0	14.4	+6.4
ICHmc2	n/a	17.4	n/a
SBSmc2	12.2	12.5	+0.3
Kispiox total	**10.0**	**12.5**	**+2.5**
Total	**11.9**	**12.7**	**+0.8**

3.1.2 Tree Species Indicator

The analysis of all tree species and deciduous tree species is presented together. Analysis of data for tree species changes is most relevant in the SBSmc2 and ESSFmc subzones where most of the forest harvesting in the Babine Watershed has occurred. In both the Bulkley and Kispiox TSAs subalpine fir and interior spruce are the leading tree species (Table 10, Figure 4). The Bulkley TSA has lodgepole pine as the third leading species, with hemlock being the third leading species in the Kispiox TSA. The Kispiox TSA also has more area containing deciduous stands (6.3%) than the Bulkley (3.6%).

[1] Site index is the height of the largest diameter (at breast height) site tree on a 0.01 ha plot at age 50.

Table 10. Summary of the area occupied by each tree species based on % of area occupied in each species in each polygon

		Bulkley		Kispiox	
Tree type	**Tree Species[1]**	**Area**	**Percent**	**Area**	**Percent**
Deciduous	Black Cottonwood	264	0.2	2,450	1.6
	Paper Birch	140	0.1	745	0.5
	Trembling Aspen	4,035	3.3	6,519	4.2
	Total Deciduous	**4,439**		**9,714**	
Coniferous	Subalpine fir	66,868	54.7	102,931	66.6
	Black spruce	1,203	1.0	27	0.0
	Hemlock	130	0.1	15,227	9.8
	Interior Spruce	28,593	23.4	19,709	12.7
	Lodgepole Pine	20,940	17.1	7,062	4.6
	Western Redcedar	0.1	0.0	3	0.0
	Total Coniferous	**117,734**		**144,958**	
	Total	**122,173**		**154,972**	
	Total forested	**276,845**			

1- Codes lumped due to ambiguity or overlaps are Black Cottonwood (AC & ACT), Subalpine Fir (B, BA & BL), Hemlock (H, HM & HW), Lodgepole Pine (PL & PLI) and Interior Spruce (S, SE, SW, SS & SX).

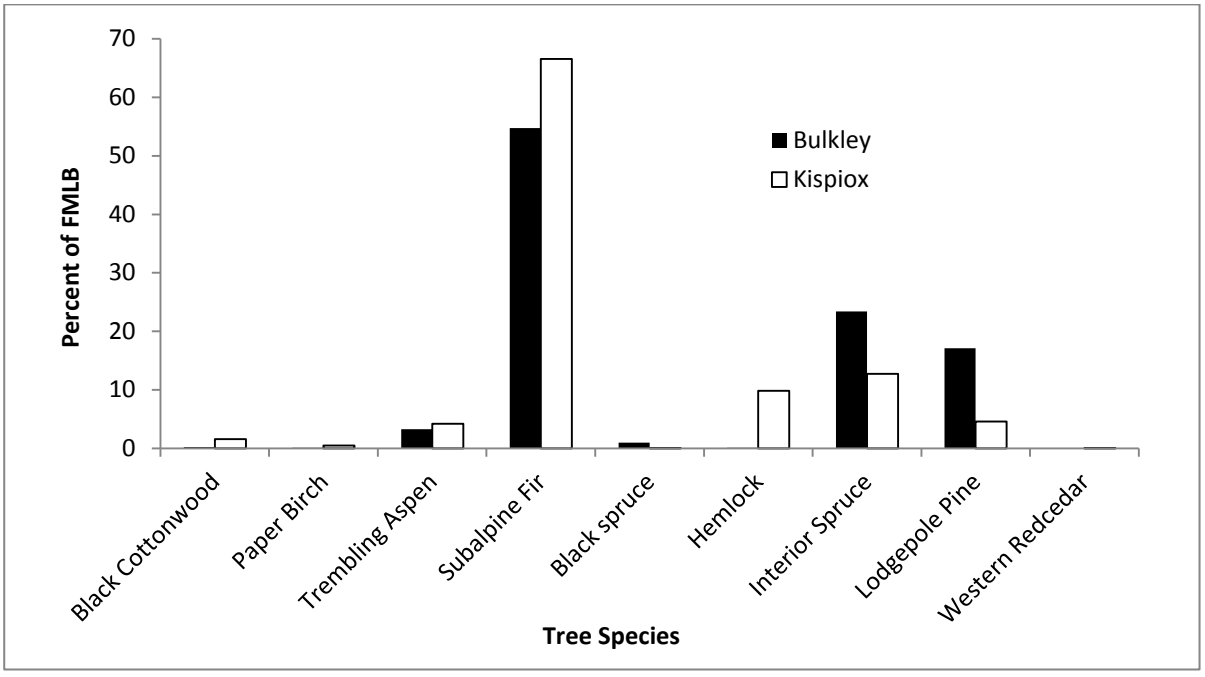
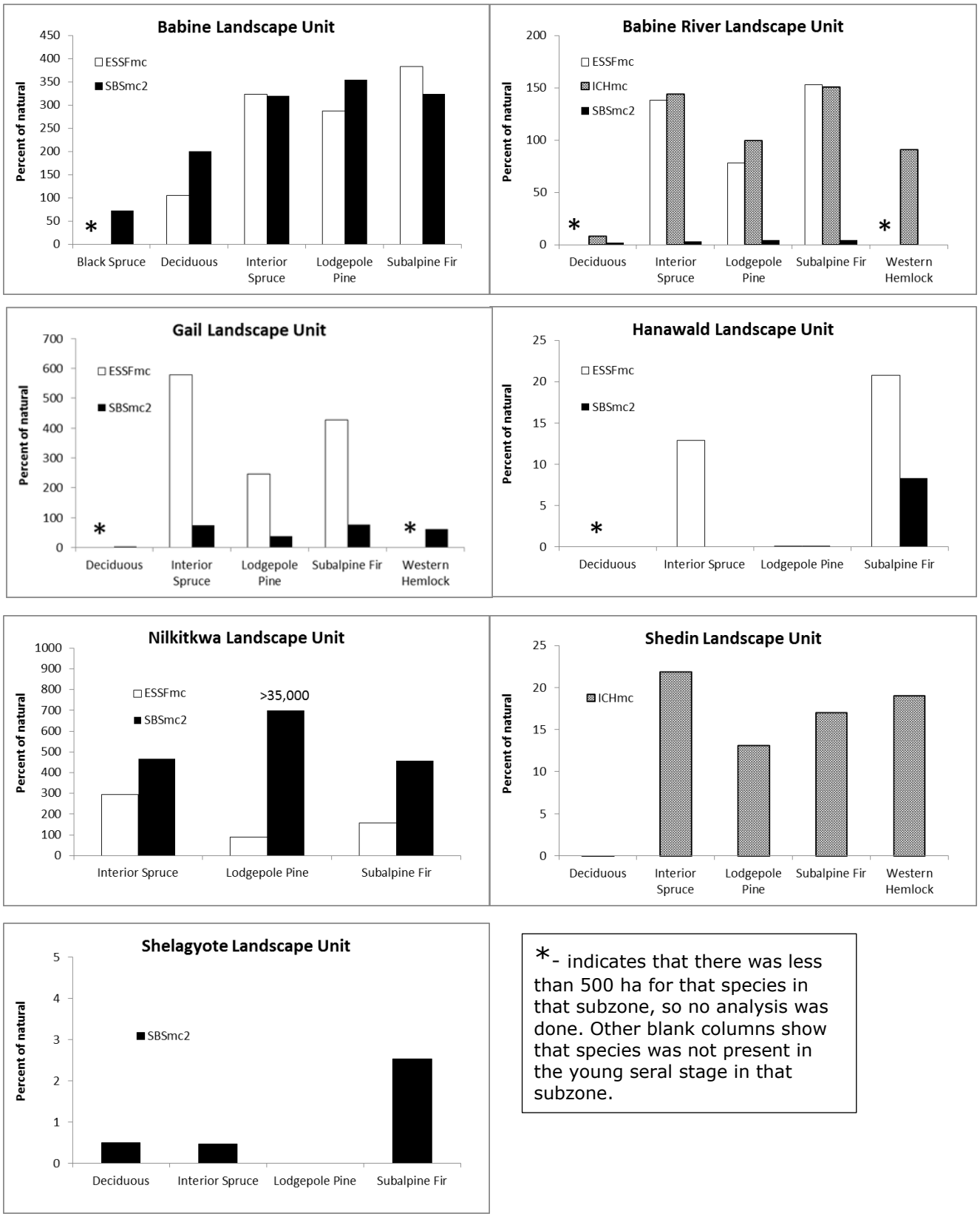


Figure 4. Tree species dominance in each Timber Supply Area

The analysis of tree species relative to natural amount is intended to determine if regenerating stands in the young seral stage are of a similar composition to natural stands; i.e. the pole seral stage.

The results by Landscape Unit (LU) (Figure 5) are below:

- In the Babine LU, in both the ESSFmc and the SBSmc2 subzones, all species except black spruce are above natural levels.
- In the Babine River LU, in the SBSmc2 subzone all species are well below natural levels, with deciduous species also well below, and lodgepole pine slightly below natural levels in the ICHmc.
- In the Gail LU, in the SBSmc2 subzone all species, but especially deciduous species, are below natural levels.
- In the Hanawald LU, all species in both the ESSFmc and SBSmc2 subzones are below natural levels.
- In the Nilkitkwa LU, lodgepole pine is slightly below natural levels.
- In the Shedin LU, all species are well below natural levels.
- In the Shelagyote LU, all species are well below natural levels.



*- indicates that there was less than 500 ha for that species in that subzone, so no analysis was done. Other blank columns show that species was not present in the young seral stage in that subzone.

Figure 5. Relative abundance of tree species in the young seral class using the pole seral class as the natural amount (i.e.: 100%)

3.2 Timber Supply Indicators

3.2.1 Timber Salvage

The timber salvage indicator is intended to monitor how much salvage of disease or damaged timber is occurring on the landbase. Western Bark Beetle and Mountain Pine Beetle are the two leading disturbances in the Babine Watershed (Table 11, Figure 6, Figure 7), with Aspen leaf miner and two-year budworm also very prominent.

Table 11. Disturbance types and area disturbed in the Babine Watershed

Disturbance Code	Disturbance Description	Total Ha Disturbed[1]
IBB	Western Balsam Bark Beetle (*Dryocoetes confusus*)	297,258
IBM	Mountain Pine Beetle (*Dendroctonus ponderosae*)	78,997
ID6	Aspen Leaf Miner (*Phyllocristis populiella*)	44,502
IDB	Two-year Budworm (*Choristoneura biennis*)	36,939
IBS	Spruce Beetle (*Dendroctonus rufipennis*)	15,514
DLV	Aspen-Poplar Twig Blight (*Venturia* spp.)	12,817
ID	Defoliators – unknown species	2,549
DFS	Dothistroma Needle Blight (*Dothistroma septosporum*)	1,030
IB	Bark Beetles – unknown species	1,007
IDX	Large Aspen Tortrix (*Choristoneura conflictana*)	823
IDF	Forest Tent Caterpillar (*Malacosoma disstria*)	747
NF	Flooding	326
ID2	Bruce Spanworm (*Operophtera bruceata*)	42
AP	Porcupine (*Erethizon dorsatum*)	21
NW	Windthrow	10

1 – the area for IBB, IBM, IDB and ID6 has been calculated with all polygon overlaps resulting from mapping of disturbances in different years removed, all other disturbances may have overlaps resulting in an inflated total area.

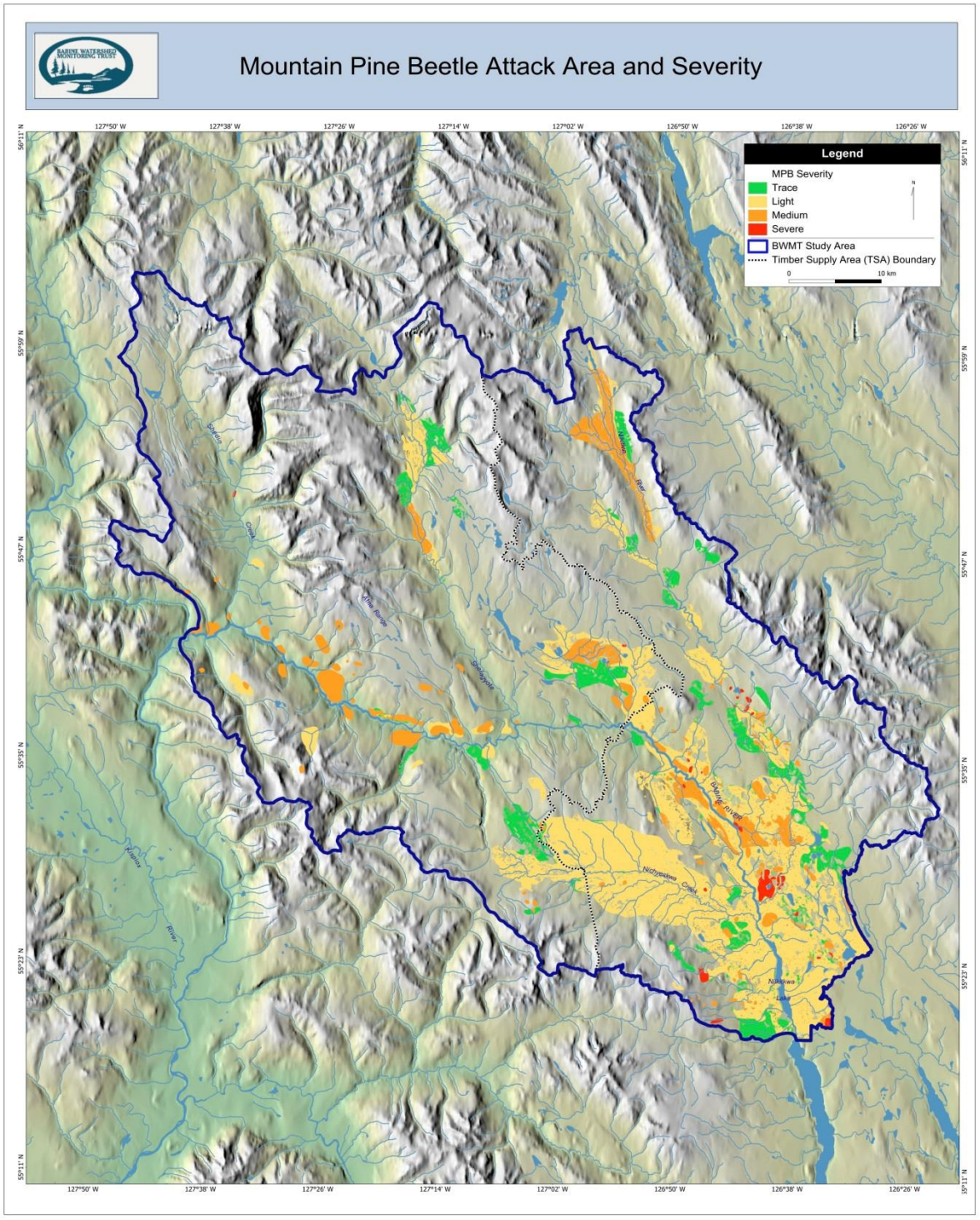


Figure 6. Distribution of mountain pine beetle attack in the Babine Watershed

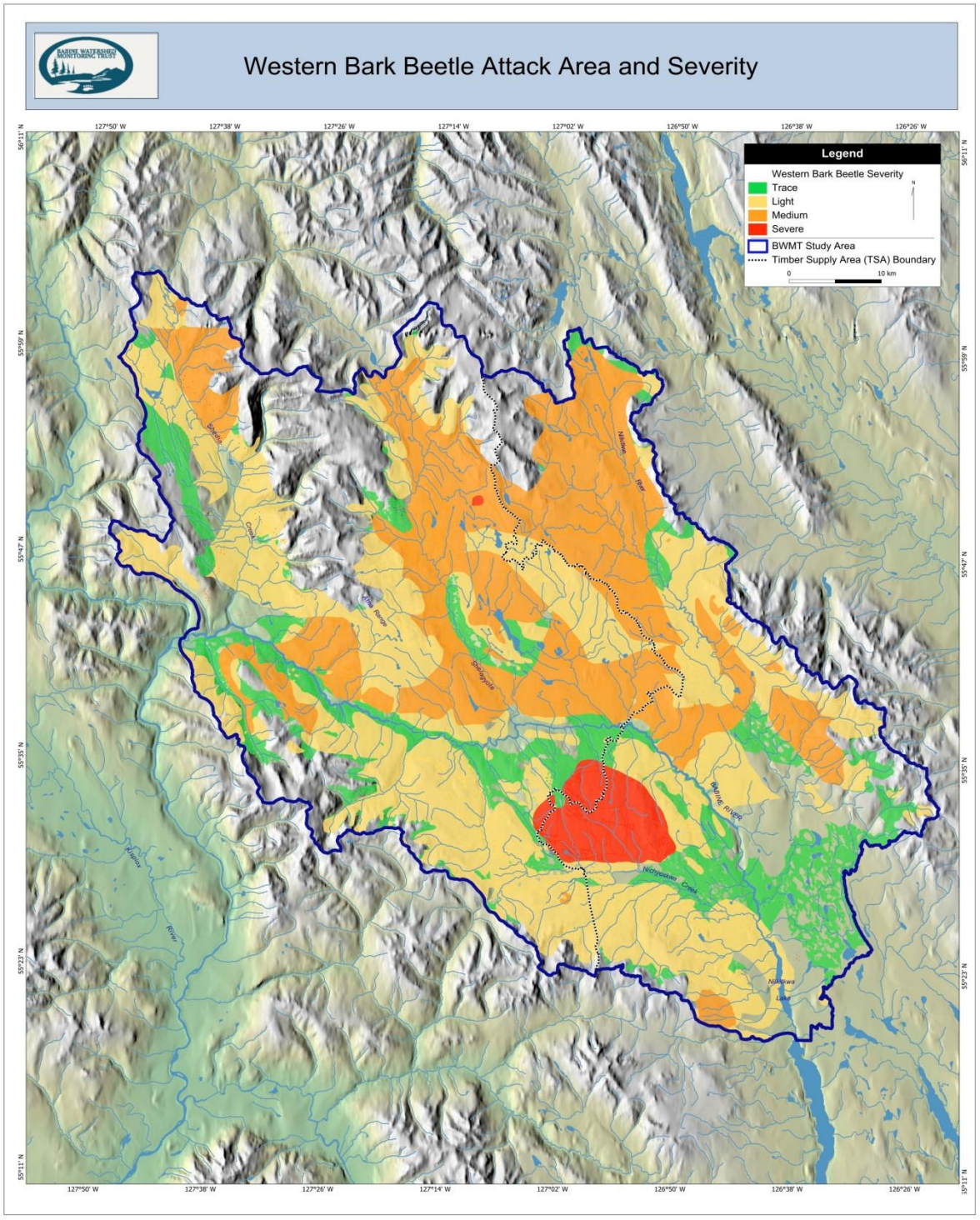


Figure 7. Distribution of western balsam bark beetle attack in the Babine Watershed

Additionally, twenty-four forest fires have been recorded in the BC Forest Service forest fire database in the Babine Watershed between 1922 and 2010, covering 17,581 hectares. Two fires accounted for 15,134 ha of this total with these fires occurring in 1958 and 1961. Sixteen of the fires were under 100 ha in size.

All of the forest harvesting Pacific Inland Resources (PIR), the main forestry company operating in the watershed, has done since 2005 has been salvage of Mountain Pine Beetle (MPB) attacked stands. Some cutblocks focussed on Western Balsam Bark Beetle have been laid-out but not harvested. The analysis of timber salvage was thus focussed on MPB attacked stands.

The mountain pine beetle was present at low population levels since mapping began in 1979 (Figure 8). The area attacked began greatly increasing in 2008, with the progression of the attack as more low, moderate and then severely[2] attacked area was mapped. Low attack has covered the most area to date, covering 51,621 ha, with moderate and trace attack covering similar amount of area, and severe attack covering 1,427 ha (Table 12).

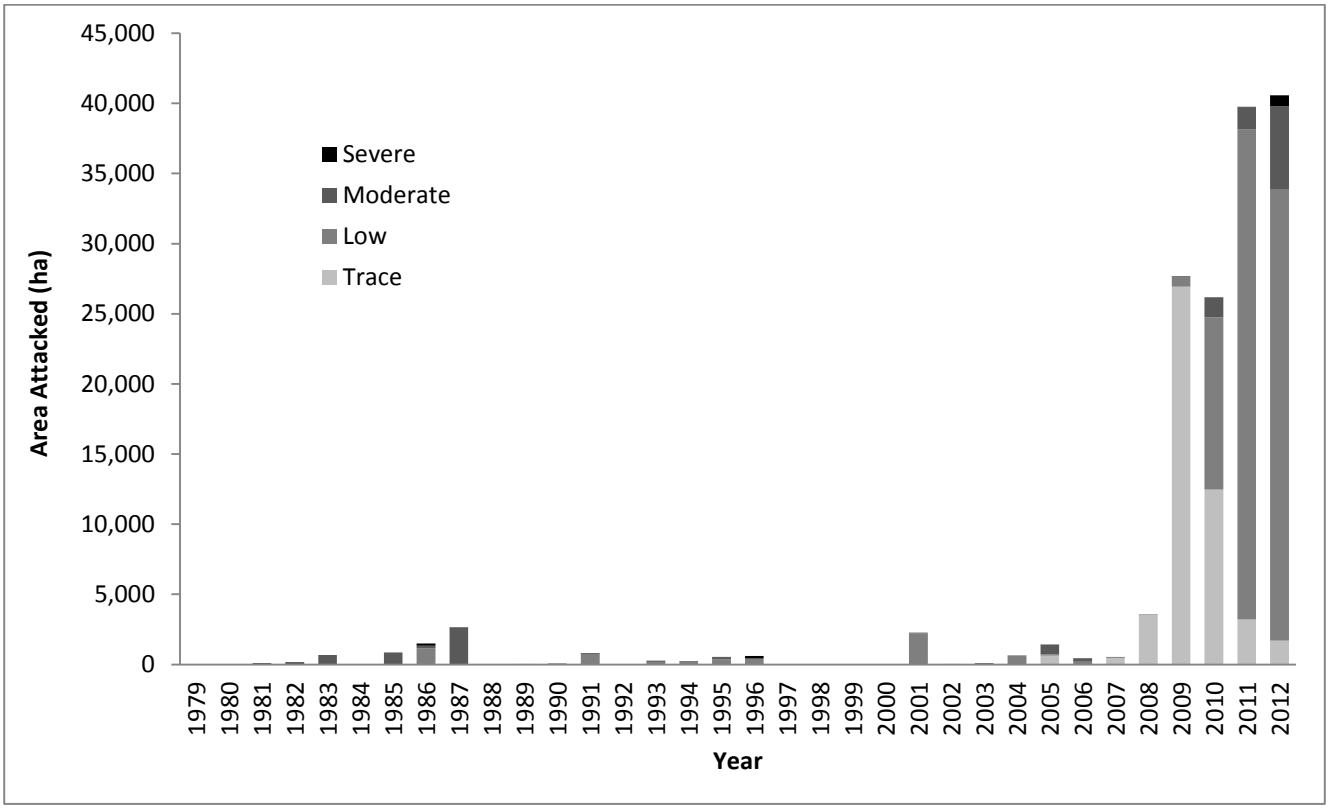


Figure 8. Area and severity of mountain pine beetle attack in the Babine Watershed by year (no inventory data for 1984, 1997-2000)

[2] Trace - <1% tree mortality, Low – 1-10%, Moderate – 11-30%, Severe – 31-50%, Very Severe >50%.

Table 12. Area (ha) with different severity classes of mountain pine beetle attack by Timber Supply Area

Timber Supply Area	Severity class of Mountain Pine Beetle attack (ha)				
	Trace	Low	Moderate	Severe	Total
Bulkley	7,792	43,222	7,513	1,389	59,916
Kispiox	4,787	8,399	5,857	38	19,081
Total	12,579	51,621	13,370	1,427	78,997

Salvage blocks were identified and overlaid on the MPB attacked area, and to determine the percentage of MPB attacked area that has been salvage logged. Not all salvage harvesting occurred in areas that had been mapped by the BC Forest Service as having been attacked by MPB. This is because PIR does not use BC Forest Service MPB mapping in planning its harvesting. Rather it uses low level photography and field surveys (Figure 9). Since 2005 PIR has harvested 2,604 ha in the Babine Watershed, all in the Bulkley TSA. This amounts to 4.3% of MPB total attacked area in the Bulkley TSA, but a somewhat larger portion of the area attacked since 2005.

Figure 9. Example of photo PIR uses to plan MPB harvesting (source PIR)

3.2.2 Seral Stage Indicator

The Seral Stage indicator for timber growth is intended to provide information on whether old slow-growing stands on productive sites are being harvested and replaced with young stands that are growing more quickly. The analysis for this indicator was not completed; however, discussion on how the analysis could be completed is provided. A

change in how site index is calculated from a normalized set of coefficients calibrated to reflect the range of heights for a given tree species, to a method that correlates site index for a given tree species with site series within biogeoclimatic ecosystem classification (BEC) units (SIBEC). To complete the analysis requires the identification of highly productive growing sites, the age distribution of stands are on these sites, and determining how much harvesting has occurred on these highly productive sites. The information required for this indicator includes identification productive sites (SIBEC), mapping of productive sites (PEM), location of existing cutblocks, and age of stand information (VRI).

3.3 Water Quality Indicator

3.3.1 Equivalent Clear-cut Area Indicator

Equivalent Clearcut Area (ECA) is an indicator that describes an area in terms of its hydrological equivalent as a clearcut. It is usually used to describe how much of a watershed is functioning as a clearcut, taking into consideration the growth of trees over the cutblock since harvesting. As second growth develops, the hydrological impact of tree removal from a site is reduced. The rate of reduction is measured by the height of the second growth trees. A cutblock with trees $\geq$9 m tall is considered to be 90% hydrologically recovered (BC Ministry of Forests 2001). A 100 ha cutblock with 10m trees on it would be recorded as a 10 ha cutblock for ECA calculation.

Guidelines for recommended maximum ECA values without triggering a detailed watershed assessment for the Kispiox were set in the West Babine Sustainable Resource Management Plan (Ministry of Sustainable Resource Management. 2004), though no level was set for some areas around the Babine River. The watersheds identified in the West Babine Sustainable Resource Management Plan were subdivided into smaller units in the ECA analysis.

For the Bulkley TSA the detailed watershed assessment trigger levels were initially set in a letter from the District Manager for the Bulkley/Cassiar Forest District and the Regional Fish, Wildlife and Habitat Manager for the Skeena Region in a letter dated February 17, 2000. Some of these maximum ECA levels have since been adjusted as a result of detailed watershed assessments. The revised triggers or maximum ECA values range from 25 to 35%.

Equivalent Clearcut Area (ECA) calculations for the Kispiox (G. Buhr *pers. comm*.) and Bulkley (Forsite 2013) TSA's were available for use in this project. For the Kispiox TSA, ECA was completed in 2004, with calculated ECA based both on the existing cutblocks and on the existing an approved cutblocks. The map (Figure 10) shows the calculations using the existing cutblocks. With the limited harvesting occurring in the Kispiox portion of the TSA since that time it was deemed current enough. The ECA for the Kispiox will be an overestimate of the current conditions it does not reflect tree growth and hydrologic recovery since 2004. For the Bulkley TSA, the ECA was completed in 2013. It was calculated using existing cutblocks and the current level of MPB attack, and using existing cutblocks and all lodgepole pine stands considered dead (Table 13). This was done to provide inputs into risk calculations around the current MPB attack. The result of considering MPB in the ECA calculation is that some areas that have seen no harvesting have an ECA greater than zero. The map (Figure 10) shows the ECA with the current level of attack. The Bulkley ECA covers a portion of the Kispiox TSA; the newer Bulkley ECA was used in these overlap areas.

Table 13. Methods used for calculating ECA in the Bulkley TSA (from Forsite 2013)

Measurement	Formula	Comments
ECA as per 1999 Watershed Assessment Guidebook with full recovery at 12 m. Private land treated as clearcut with no recovery. MPB effects built into ECA calculation in two "runs". Applies to the entire reporting unit.	ECA / Reporting Unit Area * 100%	RUN 1 – Current MPB - All stands with a Pl component >50% and age >30 yrs. old, by MPB Severity: Trace & Light – apply 0% ECA proportional to the Pl component Moderate – apply 20% ECA proportional to the Pl component Severe – apply 40% ECA proportional to the Pl component Very Severe – apply 75% ECA proportional to the Pl component RUN 2 – Dead Pl – All stands with Pl component >50% and age >30 years considered dead. ECA applied proportional to the Pl component that is "killed."

In the Kispiox TSA the Cataline watershed was over the trigger level of 20% by 15%, when the ECA was calculated in 2004, and the Gail watershed was approaching the ECA limit (Table 14). With the low level of harvesting in the Cataline and Gail watersheds since the ECA was completed and the hydrological recovery through tree growth the ECA has likely decreased. In the Bulkley TSA, as a result of using the existing ECA calculations, the watershed boundaries do not match those in planning documents. However, none of the watersheds in the Bulkley TSA are over the ECA triggers or limits, even with the current level of MPB killed trees added in as equivalent to clearcut (Table 15). The Coyle Creek watershed had the highest ECA at 21.7%. An analysis of ECA done for the Bulkley TSA in 2011, found that none of the identified sensitive watersheds in the Bulkley portion of the Babine Watershed exceed ECA targets (Forsite 2011).

Table 14. Equivalent clearcut area percentages for the Kispiox TSA

Watershed	Existing cutblocks (%)	Existing and approved cutblocks (%)	Trigger (%)
Atna	1.1	9.3	n/a
Babine East	0	15.2	n/a
Babine North	2.3	2.3	n/a
Babine South	11.4	21.7	n/a
Babine Southwest	0.7	6.8	n/a
Big Slide	13.2	13.2	n/a
Cataline	35.6	38.9	20
Damsumlo	0	7.3	25
Gail	19.3	23.9	20
Goathead	4.4	8.9	25
Hanawald	0.7	5.8	30
Leclair	0.2	0.2	n/a
Lower Shedin	4.7	17.6	25
Lower Shelagyote	2.7	2.7	20
Rosenthal	0	0.1	25
Sam Green	0.7	1.9	25
Shahnagh	13.3	24.5	30
Shedin East	0	2	25
Shegisic	0.2	0.2	n/a
Shelly East	9.7	9.7	20
Shelly West	1.4	1.4	20
Shenismike	0.5	1.2	n/a
Sperry	0	0	25
Thomlinson	0.1	2.1	20
Upper Nichyeskwa	14	20.3	15
Upper Shedin	0.1	0.8	25
Upper Shelagyote	2.2	2.2	20

Table 15. Equivalent clearcut area percentages for the Bulkley TSA

Unit ID	Reporting Unit Name[1]	Area (ha)	ECA % with current MPB	ECA % all pine dead	Difference %
1000	Middle Nichyeskwa residual	3,746	5.7	11.9	6.3
1001	Lower North Babine residual	4,124	2.8	5.0	2.2
1002	Lower South Babine residual	5,691	2.5	4.7	2.2
1003	Babine Nilkitkwa residual	3,153	7.7	14.3	6.6
1004	Babine Nichyeskwa residual	3,023	8.9	17.4	8.5
1005	Middle North Babine residual	4,975	10.5	24.4	13.9
1006	East Nilkitkwa Lake residual	2,958	3.8	10.1	6.3
1007	Tsezakwa residual	512	15.2	15.2	0.0
1026	Nilkitkwa Coyle residual	6,819	11.0	18.9	7.9
1028	Central Nilkitkwa residual	8,283	5.1	5.5	0.4
1029	Nilkitkwa Charleston residual	7,679	12.4	20.2	7.8
1030	Nilkitkwa West Nilkitkwa residual	5,622	2.0	3.5	1.5
1031	Lower Nichyeskwa residual	6,955	11.5	14.7	3.2
1032	West Nilkitkwa Lake residual	4,255	5.8	37.3	31.5
5000	Barbeau Creek	8,615	3.4	3.9	0.5
5001	Upper Nilkitkwa River	6,213	5.2	6.1	0.9
5002	West Nilkitkwa River	17,036	2.9	3.2	0.3
5003	Coyle Creek	4,926	21.7	21.7	0.0
5004	Charleston Creek	7,417	4.7	7.9	3.2
5005	Lower West Nilkitkwa	3,939	6.9	8.0	1.1
5006	East Nilkitkwa	3,598	0.9	0.9	0.0
5007	North Nilkitkwa	2,394	1.1	1.1	0.0
5008	Lower Babine 1	3,389	0.8	1.2	0.4
5009	Lower Babine 2	2,262	8.0	12.0	4.0
5010	Lower Babine 3	2,664	7.6	8.2	0.6
5011	Bairnsfather Creek	2,667	8.6	11.6	3.0
5012	West Nilkitkwa Lake Creek	2,999	5.4	9.1	3.7
5013	East Nilkitkwa Lake Creek	2,101	4.5	8.4	3.9
5014	South Nichyeskwa	5,547	6.3	7.6	1.3
5015	Southwest Nichyeskwa	4,607	5.0	6.8	1.8
5016	North Nichyeskwa	2,428	0.3	2.3	2.0
5017	Boucher Creek	14,262	10.8	17.6	6.8
5083	West Nichyeskwa Creek	2,789	6.2	8.1	1.9
5084	Upper Nichyeskwa Creek	10,011	1.9	5.8	3.9

1. Residual areas are generally those areas that are within a given watershed but not a part of a defined basin/sub-basin (Forsite 2013).

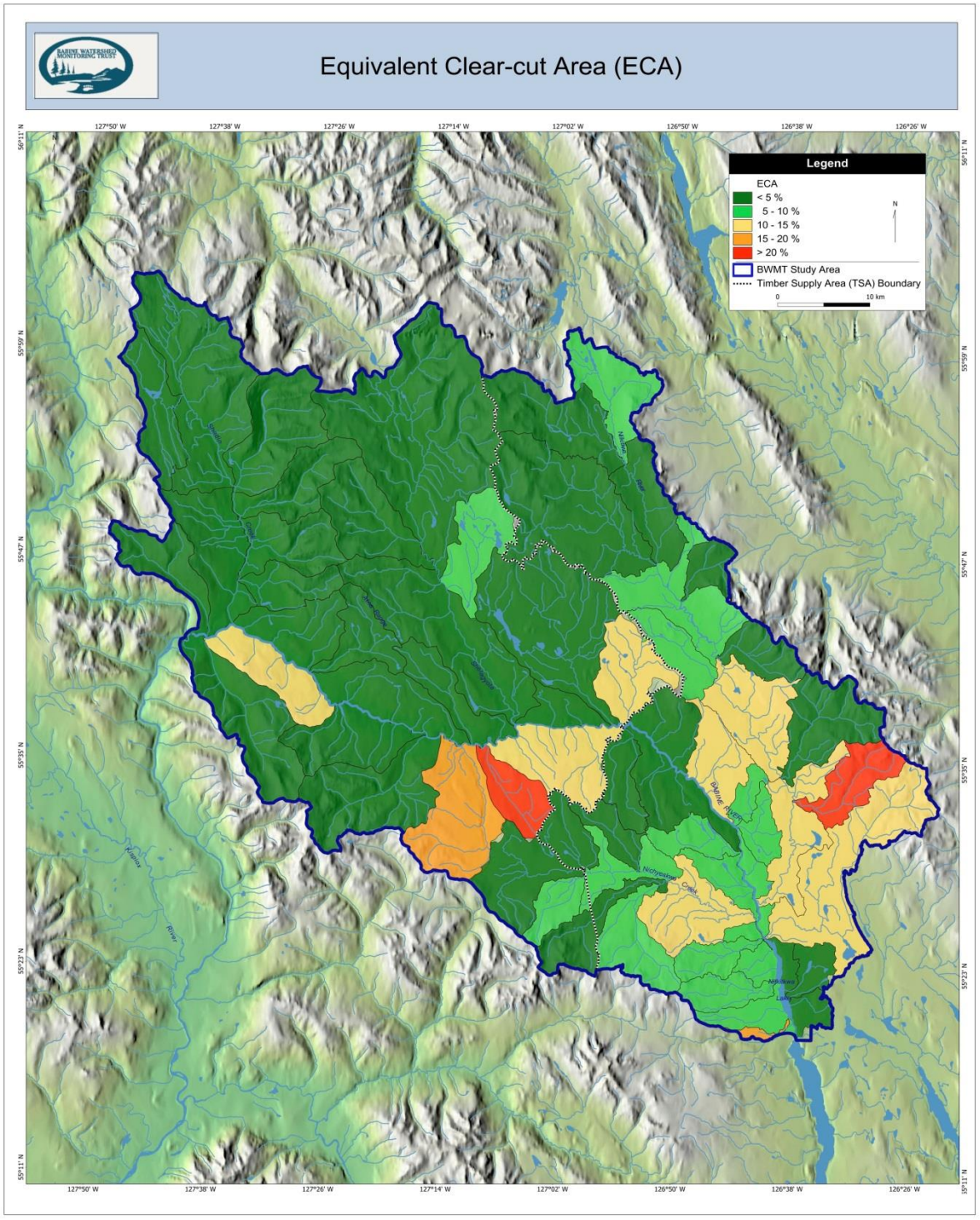


Figure 10. Equivalent clearcut area by watershed

4.0 Discussion

There are some issues with the data that are required to measure the indicators, as discussed in Section 2.0. These issues are not thought to be of a large enough magnitude to greatly alter the analysis presented for any of the indicators.

4.1 Stand Structure

The area in Wildlife Tree Patches (WTP) was generally well above that required in the land use plans. However, there is evidence that retention levels higher than those in land-use plans is required to be effective in maintaining biodiversity (Rosenvald and Löhmus 2007, Price and Daust 2010).

More detailed information and analysis of stand structure attributes in cutblocks and WTP would determine if non-legal stand structure objectives in the LUP were being met. Information that is available (Lloyd and Price 2008) indicates that cutblocks generally have fewer standing dead trees (snags), fewer long downed trees and fewer standing large live trees than naturally disturbed stands of the same age. The recruitment of coarse woody debris in cutblocks is required to emulate natural stand structure (Lloyd *et al*. 2007).

The lower site index of reserve areas than harvested areas indicates that reserve areas generally have less productive stands. There are two potential issues with this 1) reserve areas may not have the same biodiversity functions as the harvested areas, the biodiversity of which they are supposed to maintaining, and 2) reserve area could be comprised of areas that would not have been harvested due to low productivity, as a result calling them reserves could be inconsequential. Additional information on reserves and a more detailed analysis of the composition of reserve areas compared to harvested areas could clarify these potential issues.

4.2 Tree Species

In doing the analysis of tree species at the subzone within landscape unit level, the study area gets subdivided into relatively small areas. These areas may be too small for meaningful analysis of landscape level patterns. An example of this is in the Shelagyote LU where all species were below natural levels despite the absence of harvesting in the LU. The analysis may be showing a lack of recent disturbance on the landscape more than a lack of recruitment of specific species on the landscape. The usefulness of this analysis in determining natural amounts of deciduous and the deviation from this natural amount is thus problematic at the scale of the study area. Over a larger area the effects of single disturbance events would have less influence on the results.

There is some indication that there is a lack of recruitment of deciduous tree species, especially in the ICHmc, and potentially in the SBSmc2. In the SBSmc2, the area in the pole seral stage is also much higher than in the mature seral stage. On closer examination it was found that much of the pole seral stage in the SBSmc2 resulted from fires, with fires lacking in the time period that would have produced young deciduous seral stands. This could be the result of natural variability in disturbance factors that produce deciduous species, such as fire and flooding (Williams *et al*. 2001). For example, Steventon (1997) found that there were periods of higher than average disturbance in the late 1700s and most of the 1800's and again in the 1920's and 1930's in the SBS zone and ESSFmc subzone. Therefore, the cause of deviations from the abundance of tree species in the pole seral stage needs to be investigated to determine if they are caused by natural stand and disturbance dynamics, or if they are being driven by forestry practices.

All tree species were below natural levels in the Babine River, Gail, Hanawald, Shedin and Shelagyote Landscape Units. This widespread lack of trees in the young seral stage

likely reflects variation in the frequency of stand replacing disturbances, rather than changes induced by forest harvesting practices.

A more detailed analysis of the composition of stands pre and post-harvest is warranted, if cruise or harvest data are available. This analysis would look at deciduous and coniferous tree species to determine if deciduous species are being retained and if coniferous species diversity is being maintained.

The natural successional patterns and distribution of tree species must be considered when doing the tree species analysis. Deciduous tree species are much more common in the ICH and SBS zones than the ESSF zone (Banner *et al.* 1993). Also, lodgepole pine and deciduous species tend to be early successional and relatively short-lived species, with subalpine fir a long-lived species that is a later successional species that is more dominant in older forests. With deciduous species more common in the ICH and SBS, these zones could be priorities on future studies on changes in deciduous species abundance.

4.3 Timber Salvage

All of the recent harvest in the Bulkley TSA has been salvage of MPB attacked stands. The amount of salvage is quite low in proportion to the area mapped as being attacked by MPB. This is partly due to PIR harvesting MPB attacked stands in other areas where the MPB outbreak started earlier and was more severe than in the Babine. The discrepancy in methods used by the Forest Service to map MPB attack and PIR to identify and harvest MPN attacked stands means that using Forest Service MPB maps to determine the proportion of MPB attacked stands that have been harvested will be somewhat problematic. This issue is likely due to the BC Forest Service MPB mapping not being at a scale that can be used operationally.

Although western balsam bark beetle has attacked much more area than mountain pine beetle, no salvage of western balsam bark beetle stands has occurred in the Babine Watershed. This is the result of the focus on mountain pine beetle salvage and the less concentrated activity of the western balsam bark beetle. Western balsam bark beetle normally attacks less than 5% of a stand in a single season (Henigman *et al.* 2001).

4.4 Equivalent Clearcut Area

Equivalent Clearcut Area was above triggers or maximum limits in one watershed; Cataline in the Kispiox TSA. Hydrological recovery has likely occurred since the ECA was completed in 2004.

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References

B.C. Ministry of Forests. 2001. Watershed assessment procedure guidebook. 2nd edition, Version 2.1. Forest Practices Board, Ministry of Forests, Victoria, B.C. Forest Practices Code of British Columbia Guidebook.

Bulkley/Cassiar Forest District. 1999. Babine Landscape Unit Plan. Ministry of Forests, Smithers, BC.

Bulkley/Cassiar Forest District. 1999. Nilkitkwa Landscape Unit Plan. Ministry of Forests, Smithers, BC.

Daust, D. 2006. Methods for Calculating Indicators that Evaluate Legal Objectives in the Bulkley Timber Supply Area. *for* Integrated Land Management Bureau, Ministry of Agriculture and Lands, Smithers, BC.

Forest Analysis and Inventory Branch. 2012. Bulkley TSA Timber Supply Analysis Public Discussion Paper. Ministry of Forests, Lands and Natural Resource Operations, Victoria, BC.

Forsite Consultants Ltd. 2011. Bulkley Timber Supply Area Higher Level Plan Order Analysis. *for* BC Timber Sales - Babine Business Area, Canadian Forest Products Ltd., Ministry of Forests, Lands and Natural Resource Operations, Pacific Inland Resources – A Division of West Fraser Ltd. and Wetzin'kwa Community Forest Corporation.

Forsite Consultants Ltd. 2013. Bulkley TSA GIS-based Watershed Risk Analysis - Final Report. for BC Ministry of Forest, Lands and Natural Resource Operations, Skeena-Stikine District, Smithers, BC

Henigman, J., T. Ebata, E. Allen, J. Westfall and A. Pollard. 2001. Field guide to forest damage in British Columbia. Joint Publication Number 17. BC Ministry of Forests, Victoria, BC and Canadian Forest Service, Pacific Forestry Centre, Victoria, BC

Integrated Land Management Bureau. 2006. Bulkley LRMP, Objectives set by Government. Integrated Land Management Bureau, Smithers, BC

Lloyd, R., K. Price, P. Burton and D. Daust. 2007. Range of natural variation in structural attributes of young stands: Refining current indicators. Unpublished report to the Forest Science Program (FIA-FSP Project no. Y071269).

Lloyd, R. and K. Price. 2008. Range of Variation in Structural Attributes of Harvested Stands in the Babine Watershed: Refining Current Indicators. Babine Watershed Monitoring Trust, Smithers, BC.

Ministry of Forests, Lands and Natural Resource Operations. 2012. Bulkley Timber Supply Area Timber Supply Review Updated Data Package following completion of the timber supply analysis. Smithers, BC.

Ministry of Sustainable Resource Management. 2004. Xsu gwin lik'l'inswx:West Babine Sustainable Resource Management Plan. Ministry of Sustainable Resource Management, Skeena Region, Smithers, BC.

Price, K. and D. Daust. 2005. Babine Watershed Monitoring Framework. *for* Babine Monitoring Trust Governance Design Group, Smithers, BC.

Price, K. and D. Daust. 2010. Babine Watershed Monitoring Framework – Appendix 2 Knowledge Base. *for* Babine Watershed Monitoring Trust, Smithers, BC.

Rosenvald, R., and Löhmus, A. 2008. For what, when, and where is green-tree retention better than clear-cutting? A review of the biodiversity aspects. Forest Ecology and Management 255:1-15.

Steventon, J.D. 1997. Historic natural disturbance rates for Interior Biogeoclimatic subzones of the Prince Rupert Forest Region. Extension Note #26, Prince Rupert Forest Region, Smithers, BC.

Williams, H.J., K. Klinka, D. McLennan, and A. Banner. 2001. Field Guide to Identification and Interpretation of Hardwood-dominated Ecosystems in the SBSdk and ICHmc2 of the Prince Rupert Forest Region. Supplement No. 1 to Land Management Handbook No. 26: A Field Guide to Site Identification and Interpretation for the Prince Rupert Forest Region. Ministry of Forests, Victoria, BC.