Babine Watershed Monitoring Trust

Babine Watershed Monitoring Trust 5-year Activity Report and Project Summaries

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Introduction

The Babine Watershed Monitoring Trust (BWMT) is a registered charity that prioritises and independently funds the monitoring of government-approved land-use plans in the Babine Watershed. The monitoring aims to ensure that planned resource management strategies are successful at achieving publicly-defined objectives.

An integral part of the Trust's governance structure is its Monitoring Framework. This is an analytical tool for identifying strategic monitoring priorities. Trustees are appointed in a volunteer capacity to administer the Trust in accordance with the Trust Agreement and the Monitoring Framework. These legal mechanisms oblige Trustees to distance themselves from their individual value preferences in favour of cooperation and collaboration. The Monitoring Framework permits the Trust to focus its scarce financial resources on those factors most critical to sustainable resource management in the Babine watershed, in accordance with the objectives of current land-use plans. This approach has successfully reduced longstanding conflict among stakeholders in the area.

The Monitoring Framework points to where monitoring matters most: where risk to an objective is highest, where uncertainty about risk level is highest, and where there's simply not enough information to assess risk. It fulfills these functions in a multi-stage process that culminates in an annual ranked set of priorities for monitoring. It directly ties monitoring options to objectives contained in land-use plans. For the dozens of objectives contained in the plans, the Monitoring Framework summarises the essential scientific information in a Knowledge Summary, and analyses the risk and uncertainty. It thereby enables Trustees to decide, with impartiality and transparency, on monitoring priorities from among competing resource values.

The Monitoring Framework permits Trustees to select and fund monitoring projects in a logical and efficient, cost-effective manner. The results of these studies feed back to validate or improve the land-use plans that direct government’s management of the Babine Watershed's resources. The work has garnered formal recognition from the local community for the Monitoring Framework's unprecedented contribution to sustainable resource management, as well as considerable interest among the wider resource management community.

This document summarises the results from projects completed to February 2010. Final reports for all projects as well as the Monitoring Framework and BWMT Annual Monitoring Plans are available at www.babinetrust.ca.

BWMT Projects

The following table lists all completed, ongoing and approved projects. Monitoring results can confirm existing management direction, suggest the need for further study, or suggest that strategies may not achieve objectives. The follow-up column indicates the actions taken based on study results. See study summaries for more information.

#	*Project Name*	*Contractors*	*Partners*	*$*	*Status*	*Follow-up*
--	Monitoring Framework	Karen Price, Dave Daust	BWMT	23,100	Completed	Updated every 5 years
2005-1	Riparian Ecosystems and Fish Habitat: Nichyeskwa	Ruth Lloyd, Karen Price	Phil Burton (CFS), Steve Gordon (MoE), Tom Pendray (DFO), Dave Wilford (MoFR), PIR (data and helicopter time), MoFR (data)	15,519	Completed	Not needed
2005-2	Stream Crossing Quality: Nichyeskwa	Pierre Beaudry		11,798	Completed	PIR
2005-3	Water Quality in Relation to Stream Crossings	Ian Sharpe	Multi-partner FSP project to Ian Sharpe (MoE)	5,000	Completed	Not needed
2005-4	Wilderness Value of Babine River Corridor: Background Methodology	John Shultis	Real Estate Foundation Partnering Fund ($5,000)	5,000	Completed	2006-3
2005-5P	Stand-level Biodiversity in Natural Stands	Ruth Lloyd, Karen Price, Phil Burton	FSP ($63,000), CFS ($11,500 in-kind), UNBC ($10,000 in-kind), MoFR (data)	776	Completed	2007-2
2006-1	Stream Crossing Quality: Upper Babine	Pierre Beaudry		13,972	Completed	PIR
2006-3	Wilderness Value of Babine River Corridor: Design and Data Collection	To be determined	To be determined	15,000	Approved	--
2007-1	Human/bear Interaction and Open Road Density	Debbie Wellwood, Johanna Pfalz		10,000	Completed	BVCRB
2007-2	Stand-level Biodiversity in Managed Stands	Ruth Lloyd		7,000	Completed	BVCRB
2007-3P	Mountain Goat Habitat: Background Review	Megan D'Arcy	Darren Fillier (MoE)	2,000	Completed	2008-3
2007-4P	Spatial Distribution of Mature and Old Forest	Dave Daust	Doug Steventon (MoFR)	5,000	Completed	BVCRB

2008-1	Update Knowledge Base and Monitoring Priority Tables	Karen Price, Megan D'Arcy,		12,300	Contract let	--
2008-2	Framework Manual and Extension	Liz Osborn, Karen Price		5,125	Contract let	--
2008-3	Mountain Goat Habitat: Data Analysis	Megan D'Arcy	Darren Fillier (MoE)	7,278	Completed	BVCRB
2008-4	Bull Trout Habitat	Ralph Kossman	Jeff Lough (MoE)	10,250	Completed	BVCRB
2008-5	Visual Quality in Babine River Corridor	Ralph Kossman, Megan D'Arcy	Glen Buhr (MoFR), MoFR ($5,000)	5,125	Contract let	--
2009-1	Rare Ecosystems	Paula Bartemucci, Patrick Williston	To be determined	10,250	Contract let	--
2009-2	Human/bear Interaction and Education: Baseline Data	Debbie Wellwood	Brandin Schulz (BC Parks), Scott MacMillan (BC Parks)	10,250	Approved	--
2009-3	Grizzly Bear Habitat	Johanna Pfalz, Debbie Wellwood	To be determined	10,250	Contract let	--
2010-1	Timing of Industrial Activity	To be determined	To be determined	4,100	Approved	--
2010-2	Recreation Opportunity Spectrum Analysis	To be determined	To be determined	5,125	Approved	--
2010-A3	Data Management	Johanna Pfalz		6,150	Approved	--
	Project Total			**$200,357**		
	Administration	Bulkley Valley Research Centre		54,412		
	Technical Support	Karen Price		22,475		
	Fundraising	Various		4,050	Approved	
	Banked for 2011			16,193		
	Total Funding			**$304,309**		

Project Summaries

The following section provides an abstract of each completed study as well as details about funding, partners, and consequences of the study for the Knowledge Summary, for future monitoring and for management. Projects are generally listed in by project # (i.e. by year of initiation) unless they monitor the same strategy.

Project 2005-1: Riparian Ecosystems and Fish Habitat

Objectives listed in land-use plans: Legislation and planning documents pertinent to this project include: 1) FRPA, which establishes objectives for conservation of ecological values associated with riparian areas, 2) The Kispiox LRMP, which includes an objective (within the goal of maintaining biodiversity) to maintain riparian areas, and 3) The Bulkley LUP, which include objectives (within goals of maintaining fish habitat) to retain structure within riparian management zones. Both the Bulkley LUPs and Kispiox SRMP include maps of Landscape Riparian Corridors.

Why is monitoring a priority? Collecting indicator data about riparian forest allows assessment of risk to riparian ecosystems and fish habitat. Monitoring will also reduce uncertainty about whether leaving riparian buffer strips is an effective strategy or whether strips are lost due to windthrow

Abstract: This project examined the status of riparian forest ecosystems adjacent to fish-bearing and non-fish-bearing streams within the Bulkley portion of the Nichyeskwa watershed. A group of experts designed the project in 2005. The project included analysis of existing remote data, new air photo data and limited field checks to assess the status of riparian forest around unmanaged and managed streams.

Classification by biogeoclimatic subzone, size and gradient captured the variation in 302 stream reaches in 6 study sub-basins. Unharvested riparian forest was mostly old (91% > 140 years in the ESSFmc and 73% > 140 years in the SBSmc2), with relatively open canopies. Deciduous trees were rare.

Forest harvesting has affected a small portion of the riparian forest within a 60-m ribbon in the study area. Sixty-metre strips provide an ecologically precautionary estimate of the extent of riparian forest. In the ESSFmc, harvesting primarily affected forest around small, gentle streams. In the SBSmc2, harvesting affected all stream types. The highest proportion of harvested riparian forest within a 60-m ribbon was 15% (11 – 27% by sub-basin) for small streams with a gentle slope in the SBSmc2.

Streams containing fish were somewhat disproportionately harvested, although only 8% of riparian forest within 60 m of fish-bearing streams have been harvested. Field work next to five fish streams found that buffers ranged from 20 – 50m. Hence, much of the harvested forest was likely beyond these buffers.

Field work in buffers and paired unmanaged riparian forest corroborated the observation from the air that blowdown poses little risk in the Bulkley portion of the Nichyeskwa watershed.

Status: Complete

Geographic scope: Bulkley portion of Nichyeskwa watershed

Contractors: Ruth Lloyd and Karen Price

Partners: Ministry of Forests (provided data), Pacific Inland Resources (shared helicopter time and provided data), Canadian Forest Service (time for Phil Burton to assist with remote data collection); Research design participants: Phil Burton (CFS), Steve Gordon (MoE), Tom

Pendray (DFO), Karen Price (consultant), Dave Wilford (chair, Bulkley Aquatic Resources Committee).

Funding: $15,000

Consequence for knowledge base: In the Bulkley portion of the Nichyeskwa watershed, current levels of harvesting pose low risk to ecological function or fish habitat. Exceptions to low risk were due to a rare stream type or to low levels of natural old forest in sub-basins. Forest within 60m of moderately-sized, steep streams in the SBSmc2 covered only 25ha. Almost half of this area lay within a single cutblock, posing moderate risk.

In addition, buffers in this area have very low susceptibility to windthrow, reducing associated uncertainty.

Consequence for management: This project supports current strategies of riparian retention.

Recommendations for further monitoring: The low levels of harvesting next to streams means that further projects of this type are currently not a high priority. As harvesting increases within sub-basins, risk to riparian ecosystems and fish habitat should be monitored for increased levels of risk. Existing databases, modified by silvicultural prescriptions, should be sufficient for coarse-filter monitoring in accordance with the indicators included in Babine Watershed land-use planning. A similar project in the Nilkitkwa watershed, and in other watersheds over time, would be useful to assess risk and uncertainty levels elsewhere in the Babine watershed. Unless blowdown is more prevalent elsewhere, field work should not be necessary for coarse-filter monitoring.

Project 2005-2 / 2006-1: Stream Crossing Quality

Objectives listed in land-use plans: The Kispiox SRMP includes an objective to maintain water quality within its natural range, and presents specific targets relating to sediment introduction at stream crossings within the Nichyeskwa, Shelagyote and Babine mainstem watersheds. The Bulkley LRMP includes an objective to maintain existing levels of water quality.

Why is monitoring a priority? Collecting indicator data about potential sediment sources allows assessment of hazard to water quality, one component of a risk assessment.

Abstract: Roads are a dominant source of sediment introduced into riparian systems, particularly where they cross streams. This project examined the quality of stream crossings in the Nichyeskwa Watershed (2005-2) and Upper Babine River Corridor (2006-1), using a Stream Crossing Quality Index developed by Pierre Beaudry. The index assesses the hazard level of accelerated erosion and sediment delivery associated with roads. It does not assess the impacts of changed sediment regimes on the aquatic ecosystems (see Project 2005-3; Water Quality in Relation to Stream Crossings).

The project sampled 60 streams in the Nichyeskwa in 2005 and 103 in the Upper Babine in 2006. In the Nichyeskwa, 17% of streams had a water quality concern rating of high to very high; in the Upper Babine, only 4% had this rating. At these levels, sediment potentially impairs fish habitat. Larger streams generally fared better than small streams: all crossings of streams greater than 5m wide had low or nil concern ratings; in the Nichyeskwa, about two-thirds of crossings of streams between 0.5 and 5m had low or nil concern ratings and in the Upper Babine, about 85% had low or nil concern ratings.

The project provided maps of the location of each sampled streams, with associated concern rating.

Status: Complete

Geographic scope: Nichyeskwa watershed and Upper Babine River Corridor

Contractor: Pierre Beaudry

Partners: None

Funding: $12,500 in 2005; $15,000 in 2006.

Consequence for knowledge base: This project assessed current hazard associated with individual stream crossings.

Consequence for management: This project assessed each crossing for its potential to produce sedimentation, and ranked them into hazard groups (nil, low, moderate, high, very high concern). These rankings have been used by forest managers to mitigate hazard through appropriate processes which are separate from the BWMT.

Recommendations for further monitoring: Based on the results from two watersheds, monitoring of stream crossings elsewhere within the Babine watershed is not a high priority at this time. However, future monitoring of crossings with high to very-high concern ranking, particularly following any efforts at mitigation could be useful.

Project 2005-3: Water Quality in Relation to Stream Crossings

Objectives listed in land-use plans: The Kispiox SRMP includes an objective to maintain water quality within its natural range, and presents specific targets relating to sediment introduction at stream crossings within Nichyeskwa, Shelagyote and Babine mainstem watersheds. The Bulkley LRMP includes an objective to maintain existing levels of water quality.

Why is monitoring a priority? Collecting indicator data on the effects of sediment on water quality is a priority because data are insufficient to assess the risk to water quality posed by stream crossings.

Abstract: Changes in benthic invertebrate communities are frequently used to indicate water quality. This project investigated the relationship between stream crossing quality (as measured by project 2005-2; Stream Crossing Quality) and water quality by looking at benthic communities. It used a multi-variate index to compare communities in unharvested reference streams with those below stream crossings.

Thirteen streams were sampled 100m below stream crossings in the Nichyeskwa watershed. Three of these streams had a moderate or high concern rating based on the Stream Crossing Quality Index. All streams, including those with sediment hazards, had unstressed communities of benthic invertebrates.

Data are currently insufficient to relate the two indices—the sample of three streams with concerns for sedimentation is too small. In addition, sedimentation impacts might be visible only at certain times (e.g. prolonged periods of heavy rain).

Status: Complete

Geographic scope: Nichyeskwa watershed.

Contractor: Ian Sharpe (MoE)

Partners: FSP (funded a larger, multi-year project of which the BWMT contribution is part—the BWMT contribution allowed more sample sites to be located in the Babine Watershed than would otherwise be possible), MoE.

Funding: $5,000

Consequence for knowledge base: This project has confirmed that, at least for the period of study, risk to water quality in relation to stream crossings is low. Uncertainty remains because of the potential for seasonal effects.

Consequence for management: This project supports current management direction.

Recommendations for further monitoring: Future monitoring should focus sampling during periods of heavy rain. Collecting sufficient information to detect an effect would require a large sample collected at an appropriate time.

Project 2005-5P: Stand-level Biodiversity in Natural Stands

Objectives listed in land-use plans: Both the Bulkley LUPs and the Kispiox SRMP include objectives to maintain structural attributes and diversity within managed stands. Indicators include wildlife tree patches (both Forest Districts) and amounts of specified attributes (Kispiox)[1]. The Bulkley LUPs also include an objective, and associated indicators, to maintain a diversity of tree species.

Why is monitoring a priority? Collecting indicator data related to amounts of stand structure remaining following natural disturbances provides a baseline for comparison and risk assessment.

Abstract: Forest management prescribes retention of structural attributes in harvested stands, but questions remain about the amount of each attribute to retain. This study documented the range of natural variability in the number of standing and dead trees, and the volume of downed wood, remaining after fire, insects and wind disturbances in and around the Babine watershed, to allow risk assessment of management options relating to structural attributes.

The project measured structural legacies in 140 plots in 27 sites that had been disturbed by fire, wind and insects over the past 50 years. In the study area, fire caused the most extensive catastrophic disturbances; beetles were extensive, but often not catastrophic; wind disturbance was least common. Salvage of disturbed stands severely reduced the number of potential sites.

Overall, the range of natural variability was large, and covered all possible values of retention. However, the mean and standard error of numbers of snags and volume of downed wood left after disturbance can guide risk analyses (Table 1). Analyses found very few significant effects of biogeoclimatic subzone or site productivity on the amounts of structure retained. The only exception for standing live and dead trees was in stands disturbed by balsam bark beetles: this effect was related to the proportion of subalpine fir in the stand. For downed wood, the only pattern detected was that mesic-rich sites had a higher proportion of larger-diameter downed wood.

Table 1. Structural legacies of natural disturbance (mean ± standard error) for disturbances within the past 10 years.

	Live trees (#/ha)	*Dead trees (#/ha)*	*Downed wood (m^3/ha)*
Fire (n=2)	55 ± 11	1140 ± 94	216 ± 62
Beetles (n=6)	422 ± 59	328 ± 59	165 ± 35
Wind (n=4)	281 ± 29	172 ± 48	632 ± 28

Wind and beetles left more large than small snags and downed wood. Size-class distribution of snags following fire initially was negatively exponential, but became unimodal over time as the smallest snags fell. This size-class distribution suggests that within-stand retention guided by natural patterns should either leave snags in a size distribution that matches the

[1] See Knowledge Base for details and rationale for indicator (www.babinetrust.ca)

pre-disturbance distribution of live trees (to mimic fire) or should bias retention towards larger snags and downed wood (to mimic beetles and wind).

Status: Complete. Proposal development funded in 2005. Project funded by FSP.

Geographic scope: 1:250,000 NTS sheet 93M (which includes the Babine Watershed), but expanded to include sheet 93L and parts of 93E

Contractors: Ruth Lloyd, Phil Burton, Karen Price

Partners: FSP ($63,000 funding), CFS ($11,500 in-kind funding), University of Northern BC ($10,000 in-kind funding), MoFR (data).

Funding: $776 from proposal development budget

Consequence for knowledge base: To estimate the risk to biodiversity associated with different levels of stand retention, it is necessary to compare retention in managed stands with retention following natural disturbance. Before this study, no data existed to estimate stand-level retention following natural disturbance and hence it was not possible to estimate risk to biodiversity. This project thus provides the natural baseline for in-stand retention. It allows for assessment of future risk and associated uncertainty based on targets included in land-use plans. In combination with project 2007-2 (Stand-level Biodiversity in Managed Stands), it allows for assessment of current risk and associated uncertainty to stand structure in relation to forest harvesting activities.

Consequence for management: This project provided the natural baseline for Project 2007-2.

Recommendations for further monitoring: No further estimation of natural retention levels in the area is necessary: improving the power to detect trends would require a vast investment.

Project 2007-1: Human/bear Interaction and Open Road Density

Objectives listed in land-use plans: The Babine LUP (Bulkley) and the Kispiox SRMP include objectives and associated strategies relating to road use and forest harvesting, for reducing the number of human-bear interactions. The SRMP includes specific road density targets for two watersheds. The Babine LUP includes a strategy for temporary roads to remain beyond 300m from the protected area.

Why is monitoring a priority? Collecting indicator data allows assessment of the risk posed to grizzly bears by open roads (where "open" roads are accessible by motorised vehicle of some type, including ATV).

Abstract: Open road density is a strong indicator of the risk to grizzly bears posed by human/bear interactions. This project conducted a preliminary GIS analysis of road density by type (i.e. primary, secondary) and status (i.e. active, deactivated, proposed) by sub-watershed and resource management zones within the Babine Watershed.

Throughout the entire Babine Watershed, an area of 4,024km^2, a total of 1,260km of road has been built or proposed, for a total road density of 0.32km/km^2 and active road density of 0.29 km/km^2. The two watersheds with target road densities (<0.6 km/km^2 over 80% of Hanawald and Shedin watersheds) currently are well within the target levels (Table 1). Risk to grizzly bears is estimated as low for these watersheds, although uncertainty remains high. The Gail-Thomlinson, Nichyeskwa and Babine River watersheds approach or meet the 0.6 km/km^2 threshold included in the Knowledge Summary[2]. Risk to grizzly bears associated with human-bear conflict is estimated as moderate, and approaching high, with high uncertainty, for these areas. These watersheds were red-flagged for further investigation.

Table 1. Active road density (km/km^2) in sub-watersheds of the Babine Watershed.

Sub-basin	*Active road density (km/km^2)*	*Total Road Density (km/km^2)*[1]
Kispiox		
Hanawald	0.08 (96% has density < 0.6)	0.08
Shedin	0.08 (95% has density < 0.6)	0.11
Babine River	0.22	0.31
Gail-Thomlinson	0.53	0.59
Nichyeskwa	0.6	0.68
Shelagyote	0	0
Bulkley		
Babine River	0.53	0.55
Upper Nilkitkwa	0.22	0.22

[1] As a conservative measure until interviews and ground investigations can be conducted to identify *open roads* (i.e., those that are accessible by any type of motorized vehicle), Wellwood and Pfalz (2009) focus their discussion on total road density

The report also calculated road density in other relevant management zones around the Babine River (Table 2). Some zones are noted as red flags for future investigation. For example, land-use strategies note restricted access where all temporary access is intended to remain at least 300 m from the park (a linear zone around Babine River Corridor Park). However, preliminary analyses indicate that this 300-m buffer has an active road density of 0.43 km/km^2

[2] See BWMT Knowledge Summary for description of the indicator and rationale for thresholds.

and total road density of 0.50 km/km^2. These preliminary analyses were unable to determine the history of these roads—future investigation would classify road density by date of construction to allow for a better estimate of implementation monitoring, as well as by current status to reduce uncertainty about the risk to grizzly bears. It is likely that most of these roads were constructed prior to the implementation of the strategy—but if they remain accessible, they still pose risks to bears.

Table 2. Active and total road density (km/km^2), based on preliminary GIS analysis, in management zones in Babine Watershed.

Management Zone	*Active road density (km/km^2)*	*Total Road Density (km/km^2)*[1]
Babine River Corridor Park	0.13	0.14
Babine Special Management Zone	0.3	0.40
300-m Buffer Outside Park Boundary	0.43	0.50
Landscape Corridors	0.16	0.17
Core Ecosystems	0.04	0.05
Atna-Shelagyote Special Management Zone	0.01	0.01
Shenismike Corridor	0	0.00
High Value Grizzly Bear Habitat	0.13	0.16

[1] As a conservative measure until interviews and ground investigations can be conducted to identify *open roads* (i.e., those that are accessible by any type of motorized vehicle), Wellwood and Pfalz (2009) focus their discussion on total road density.

All areas with densities approaching moderate risk levels, or otherwise flagged, should be further investigated. The critical factor for assessing risk to grizzly bears is to determine whether roads are "open" to any type of motorised access, regardless of classes defined in GIS datasets (i.e., active, deactivated, proposed). Deactivated roads (i.e., defined as not accessible by four-wheel drive vehicle) may still be accessible by ATV which would pose a greater threat to bears than roads that are inaccessible to all motorised vehicles. Identifying open roads and classifying them by motorised vehicle type and level of use would support a better estimation of risk and reduce uncertainty considerably.

Specific recommendations for further monitoring to reduce the uncertainty related to road density and risk to grizzly bears from human-bear conflict include

- identifying open roads and classifying them by type of vehicle and level of use,
- improving road database to include date, purpose and rationale for road construction,
- updating Bulkley roads data to match the Kispiox standards, and
- determining the effectiveness of access controls.

The project also proposed a conceptual design for a broader grizzly bear risk assessment framework, including cumulative effects modelling and analyses of open road density and core security areas. It proposes a survey process for acquiring expert knowledge and opinion to support various aspects of the study design. Within this framework, risk to grizzly bears associated with road-related mortality could be explored through investigations of habitat value in relation to roads, screening and access control, based on available information and expert input. The report also provides a preliminary study design for future implementation and effectiveness monitoring work.

Status: Phase 1 complete. Proposal to complete broader risk assessment framework to support the completion of Phase 2 initiated in 2010.

Geographic scope: Sub-watersheds within Babine watershed

Contractors: Debbie Wellwood and Johanna Pfalz

Funding: $10,000

Consequence for knowledge base: GIS analysis indicates that no sub-basins have crossed the identified high-risk threshold within the Babine Watershed, but that some are approaching this threshold. These sub-basis and other identified zones should be subject to further investigation. Uncertainty remains high because road status is not clear, particularly in the Bulkley.

Consequence for management: Current levels of risk are estimated as low in the two sub-basins with targets, confirming management direction. Road densities, however, are approaching high risk levels in other areas, and there are roads defined as "active" within zones intended to be free of roads. This information will be passed to appropriate decision-making bodies.

Future monitoring: This project provides a comprehensive plan for future monitoring. Short-term priorities are to improve the classification of road use and to improve the Bulkley road database. Long-term priorities include development of a cumulative effects model and analysis of open road density and core security areas to support the completion of an expert-based mortality sub-model to better assess the risk of road-related grizzly bear mortality.

Project 2007-2: Stand-level Biodiversity in Managed Stands

Objectives listed in land-use plans: Both the Bulkley LUPs and the Kispiox SRMP include objectives to maintain structural attributes and diversity within managed stands. Indicators include wildlife tree patches (both Forest Districts) and amounts of specified attributes (Kispiox)[3].

Why is monitoring a priority? Collecting indicator data related to stand structure in managed stands allows assessment of the risk posed to stand-level biodiversity. This study compared the amount remaining in managed stands with the natural baseline estimated in study 2005-5P.

Abstract: This project measured stand structure in young managed stands. Project 2005-5P estimated the range of natural variability in stand structure following fire, beetle and wind disturbance in three productivity classes of the SBSmc2 and ESSFmc. This project compared remnant structure in managed stands (the number and size-class distribution of standing live and dead trees and the volume of downed wood) with the range of structure found in the natural baseline, and hence allowed for assessment of current risk.

Structural legacies in terms of live and dead standing stems and downed dead wood were measured in 30 plots in 8 sites that had been harvested between 1992 and 2000. Results were compared to equivalent data collected previously in young stands originating from natural disturbance (wildfire, beetle attack and windthrow) within the same general area. Six of eight study blocks included reserve areas accounting for 4-13% of the total area.

Overall, timber harvesting left fewer standing stems than fire, beetle attack or windthrow. In particular, timber harvesting retained significantly fewer snags than any form of natural disturbance, and no snags were retained in cutblocks without reserve areas. The abundance of "functional" snags (>20cm dbh) was much lower after timber harvest than after natural disturbance. Residual live stems were less abundant after timber harvest than after beetle attack or windthrow, but more abundant than after wildfire; however, nearly all the residual live trees encountered after timber harvest were in the smallest diameter class, and cutblocks without reserves did not include any large (>20cm dbh) live trees at all.

Downed dead wood was somewhat less abundant after timber harvest than after any form of natural disturbance, although differences were statistically significant only with windthrow. Diameter class distribution and decay class distribution were comparable between all forms of disturbance, but timber harvesting resulted in significantly shorter pieces than any form of natural disturbance.

The project showed that structural legacies following clearcut logging (with or without reserves) do not fall within the range of natural variability of structural legacies following natural disturbance, especially as regards "functional" snags and large live trees (Table 1). Clearcut timber harvest follows the distribution pattern of wildfires (clumped) as far as large live trees are concerned, but the low numbers and limited distribution of snags is unlike any natural disturbance. Downed wood volume and attributes present a lesser issue in the first two decades following harvest, but are expected to deviate markedly from that left by natural

[3] See Knowledge Base for details and rationale for indicator (www.babinetrust.ca)

disturbance within three or four decades after harvest unless provision is made for downed wood recruitment from standing stems at the time of harvest.

Table 1 Percent of natural structure retained in managed stands in the first decade after disturbance, calculated using mean values in each case. Large standing trees are those > 17.5 cm dbh; long downed wood are those > 10m.

Disturbance	Live	Dead	Downed wood	Large live	Large dead	Long downed wood
Fire	262	3	68	69	3	32
Beetles	33	9	52	9	7	14
Wind	51	17	18	21	13	4

Status: Completed 2008

Geographic scope: Available funding limited field work to easily accessible sites.

Contractor: Ruth Lloyd

Funding: $7,000

Consequence for knowledge base: By reducing uncertainty surrounding the amounts of residual structure present, this study enables a more accurate assessment of risk associated with current levels of retention during timber harvest. Based on the risk curve included in the stand structure section of the Knowledge Base, showing a sigmoidal increase in risk to biodiversity related to the % of natural amount of structure retained, current levels of retention within cutblocks pose a high risk to biodiversity (i.e. are below 30% of natural levels), particularly in relation to snags (small or large). Amounts of large live trees (> 17.5 cm dbh) and long downed wood pose moderate risk when compared with fire (the most prevalent natural disturbance in the area).

A finding of high risk requires consideration of other questions. First, stand level retention is only one of several strategies designed to maintain biodiversity. The first task is to examine the landscape context. If sufficient levels of forest are retained within the landscape, stand-level retention is less crucial. Currently, landscape levels of old forest are sufficient to pose low risk to biodiversity. However, the clear trend to preferentially harvesting high productivity sites means that these ecosystems might be poorly represented on the landscape in the future. Unfortunately, very little work anywhere has investigated the interaction between stand-level and landscape-level retention to determine how much increased stand-level retention can decrease risk due to low levels of landscape-level representation.

Another avenue of consideration was to re-examine the risk curves in the Knowledge Base to determine if there was any new evidence to improve the hypothesis. A recent meta-analysis of the effectiveness of stand structure in maintaining biodiversity provided an alternative risk curve based on the absolute amount of retention. This study found that in general, absolute retention levels below 15 – 20% provide little benefit to forest-dwelling specialists, whereas levels between 30 – 50% can increase the value of a stand significantly for some organisms. This new analysis confirms that the risk to biodiversity posed by current retention strategies is high.

Consequences for management: It is not possible for commercial timber harvesting to approach levels of structural elements found after natural disturbance, because harvesting removes much of the biomass of the original stand from the site. However, to approach more closely the natural levels and distribution, the following priorities are recommended:

1. Increase the number and size (> 20cm diameter) of standing live trees across the cutover area, particularly in larger cutblocks (even when part of the opening consists of a developing stand several decades old). These trees will recruit into the snag population over time.
2. Increase the size (particularly length) of downed dead logs across the cutover area.

Determining consequences to management will require consideration of the importance of the stand-level objective. An objective to "lifeboat" species requires higher levels of retention than an objective to increase the rate of recovery of old forest structure. Discussion with the BV Community Resources Board should clarify this point within the Bulkley portion of the Babine.

The BWMT will pass these results to decision-making bodies.

Recommendations for further monitoring: The sample size in this project was relatively small. Further monitoring would be useful, particularly if management practices or natural disturbance patterns change. For example, the current MPB disturbance is changing the landscape context, decreasing the amount of old forest, but increasing snags. This disturbance could change optimum retention from snags (currently at highest risk) to live trees.

Project 2007-3P/2008-3: Mountain Goat Habitat

Objectives listed in land-use plans: Bulkley LUPs include Mapped Habitat and specific objectives for goats. New Ungulate Winter Ranges for mountain goats have been created in the Kispiox subsequent to the SRMP.

Why is monitoring a priority? There is uncertainty about the indicators associated with mountain goats. This study looked at disturbance within a range of distances from goat habitat to facilitate assessment of risk.

Abstract: These projects summarised existing work on harvesting near to goat habitat. Project 2007-3P documented new targets for the Kispiox in the form of Ungulate Winter Ranges (UWR) and an associated legal Order, summarised data on harvesting exist for the Kispiox (Table 1), and designed Project 2008-3. In conjunction with the Ministry of Environment, Project 2008-3 refined data and developed a database relevant to mountain goats in Babine watershed. The database includes UWR (Kispiox), mapped goat habitat (Bulkley), forest cover, harvested area, harvested patch size, roads and access. GIS buffers were used to analyse activities (harvesting and roads) within mapped habitat, and within 200m, 500m, 1,000m and 2,000m buffers around the habitat.

Currently, with the exception of the Gail Canyon UWR, less than 10% of the forest within 200m of goat habitat has been harvested (Table 1), putting these habitats at low risk based on the risk curve included in the Babine Watershed Knowledge Base.

Table 1. Management activities within 200m of goat habitat. Harvesting and THLB (Timber Harvesting Land Base) are shown as a percent of the total amount of forest (given by the sum of the area of early, mid and old forest in the database created in project 2008-3).

Population	*Total forest area*	*Area harvested (% of forest)*	*Area old (% of forest)*	*Area in THLB (% of forest)*	*Road (km/km^2)*
Atna	2,347	<1	97	3	0.03
Babine	534	<1	97	5	1.6
Gail	1,383	11	46	27	2.6
Shegisic	204	3	100	21	0
Shelagyote	188	0	100	0	0
Shenismike	377	0	100	26	0
Thoen	363	<1	98	7	0
MH1	1,107	0	93	15	0
MH2	186	0	81	6	0
MH3	7,366	0	85	27	0
MH4	2,090	0	99	24	0

Gail Canyon has the highest amount harvested at all buffer width—with some harvesting within the UWR itself and about one quarter of the forest within 500m, 1,000m and 2,000m harvested (Table 2). This level of harvesting poses moderate risk with high uncertainty to Gail Canyon habitat. The patch size distribution of harvesting near to Gail Creek suggests that special management is not occurring—most of the area is in patches greater than 80ha, and very little in patches less than 5ha.

Table 2. Management activities in buffers around the Gail Creek Ungulate Winter Range.

Buffer (m)	*Total forest area*	*Area harvested (% of forest)*	*Area old (% of forest)*
0	816	3	62
200	1,383	11	46
500	2,262	21	56
1,000	3,834	27	58
2,000	7,222	25	64

As well as amount of unmanaged forest, amount of old forest in buffers around UWR is also a useful indicator, because natural disturbance impacts goat habitat as well as harvesting. All populations except for Gail Canyon have more than 80% of the forest in the old age class (over 120 years; Table 1). Gail Canyon has less than half of its forest over 120 years. Based on the amount of forest in the THLB, the amount of old forest in buffers will decline over time. Several populations have more than 20% of the forest within 200 m included in the THLB—these populations may be at higher risk over time and should be the focus of future investigations.

Road density within 200m is very low for all populations except for Babine and Gail Canyon (Table 1). Both of these populations have roads within the core UWR. Gail Canyon has a very high road density of 2.6 km/km^2 within the 200m buffer. Unfortunately, there is insufficient knowledge to estimate the level of risk this density poses to the goat population. High risk to grizzly bears begins at 0.6 km/km^2, but the relative sensitivity of grizzly bears and goats is unknown. The Babine population is likely at lower risk because access control points are intended to protect goats (West Babine SRMP). There is a high priority to reduce the uncertainty in this curve.

Both road density and harvesting indicators suggest that the Gail Creek population may be at high risk. Indeed this canyon population is known to have declined. Canyon populations are unusual in that escape terrain in down, rather than uphill.

Project 2008-3 also initiated the development of effectiveness indicators for mountain goats. Table 3 shows the status of key effectiveness indicators for goat populations. The project recommends that baseline data on evidence of use and movement are important to collect before interpreting the impact of harvest during the natal period. As a first phase, it would be useful to collect incidental observations from recreation or resource-related flights.

The project also recommends consideration of indicators relating to mining.

Table 3. Accepted effectiveness indicators for mountain goats.

Accepted Mountain Goat Effectiveness Indicators	*Status*
proportion of suitable or capable UWR habitat	completed for Kispiox as part of planning; could focus on improving knowledge for Bulkley Mapped Habitats by observing goat use
forest cover characteristics	completed (project 2008-3)
evidence of sustained winter use by mountain goats	not collected—first phase could be incidental observations from flights
evidence of movement between UWRs	not collected—first phase could be incidental observations from flights
snow depth and consolidation	not collected—requires field work

Status: Complete

Geographic scope: Babine watershed.

Contractor: Megan D'Arcy

Partners: Darren Fillier, Ministry of Environment

Funding: $2,000 (2007-3); $7,000 (2008-3)

Consequence for knowledge base: This project outlined new targets developed for the Kispiox and summarised old forest habitat, forest harvesting and road density for each goat population in the Babine watershed. These data can be used to update the risk for Babine mountain goats. All populations, except for the Gail Creek population are currently at low risk based on these indicators.

Consequence for management: Indicators suggest that the Gail Creek population may be at risk. This information will be passed to the appropriate decision-making body for consideration of appropriate action. Collaboration with Ministry of Environment will also facilitate feedback of results into management decisions. Over time, if forest in the THLB is harvested near to goat habitat, the amount of old forest will decline in buffers, road density will increase, and risk to goats will increase.

Recommendations for further monitoring: This project recommended monitoring to collect evidence of goat use of habitat and movement between habitats. These data could be collected initially through incidental observations from flights.

Project 2007-4P: Spatial distribution of mature and old forest Phase I

Objectives listed in land-use plans: Maintaining biodiversity is a general goal of all the land-use plans for the watershed and of legislation. Legislation and land-use plans also include objectives to create harvest patterns that reflect the spatial patterns of natural disturbance. The objective in the Kispiox SRMP specifically focuses on patch-size distribution while the objectives in the Bulkley LUPs and in legislation are more general (i.e., pattern).

Why is monitoring a priority? There is high uncertainty about the relationship between harvest pattern and resulting landscape pattern over time.

Abstract:

Forest management in the Babine River Watershed aims to "attain a natural landscape pattern" to maintain biodiversity. Strategies create harvested patch size distributions that are similar to natural-disturbance patch size distributions. Two uncertainties limit our understanding of the effectiveness of these strategies. First, uncertainty exists about the relationship between young forest pattern and old forest pattern. By creating patches of young forest within a matrix of older forest, harvesting alters the spatial arrangement of both young and old forest: Will a near-to-natural harvest pattern create a near to natural pattern of old forest? Second, uncertainty exists about the ecological merit of different patterns: Does pattern really influence biodiversity? This project examined two simulation studies that address these uncertainties.

The first study examined the influence of disturbance rate and type on old forest pattern. Disturbance rate was set to produce either the historical average (32%) or the recommended future target (11%) of old forest (>140 years) in the SBSmc. Patch size distribution resulting from natural disturbance was set to be typical for the SBSmc; the probability of natural disturbance did not vary with stand age. Four harvest patterns were examined: "checkerboard" harvesting with and without greenup rules; and "guidebook" harvesting with and without greenup rules. The checkerboard pattern used 80 hectare cutblocks; the guidebook pattern used the cutblock size distribution recommended in the Biodiversity Guidebook.

The second study, led by Doug Steventon (MoFR Research, Smithers) simulated mountain pine beetle disturbance and a range of harvesting strategies and patterns in the Nadina Forest District. It modeled territory formation and dispersal, both a function of old forest pattern, for a wide range of "virtual" animals. Virtual animals varied in territory size (25 – 2,500 ha), affinity for old forest and dispersal ability.

The first study found that near-to-natural harvest patterns do not create near-to-natural patterns of old forest. First and most importantly, the amount of old forest had a large influence on old forest patch size distribution. Reducing old forest from 32 to 11% reduced the percent of large patches, greater than 1,000 ha, from 48 to 5%. Second, even with old forest amount fixed, harvesting generated different old forest patterns than natural disturbance. Furthermore, guidebook harvesting did not always produce more natural patterns than checkerboard harvesting, over the long term.

The second study found that harvest pattern had a minor effect on "populations" of virtual animals and that no harvest pattern emerges as clearly beneficial. The amount of old forest and life history traits were much more influential than harvest pattern. A second aspect of the

study showed that under specific conditions, old forest pattern could influence population size.

Together, these studies confirm that a very weak relationship exists between harvest pattern and old forest pattern and between harvest pattern and old forest habitat use.

Status: Complete.

Geographic scope: Simulations in SBSmc and in Nadina Forest District.

Contractor: Dave Daust

Partner: Doug Steventon

Funding: $5,000 (total for Phases I and II)

Consequence for knowledge base: Two premises underlie the use of harvest patch size as an indicator for biodiversity: that near-to-natural harvest size distributions produce near-to-natural patterns of old forest; and that some harvest patterns create patterns of mature and old forest that are beneficial to a range of species. This project rejects both premises. Hence, harvest patch size is not useful as an indicator of biodiversity. Better indicators would measure the pattern of mature and old forest directly. Another alternative is to not measure pattern at all, because amount of old forest is an important indicator of pattern.

Consequences for management: Current strategies to manipulate cutblock pattern pose a high risk to the objective of "attaining a natural landscape pattern" (similar wording in Kispiox SRMP Table 2 and Bulkley LUPs Table 5). This objective cannot be met by strategies that focus on harvest pattern without increasing the amount of old forest retained. Because the strategy and objective are inconsistent, one should be changed. The BWMT should initiate processes to pass this result to decision-making bodies.

Cutblock size targets derived from the Biodiversity Guidebook should still be used. Although they create old forest patterns that deviate considerably from natural, they still create a "more natural" old forest patch size distribution than do uniform 80-ha cutblocks or large cutblocks with no leave areas.

Recommendations for further monitoring: Future monitoring should focus on amount of mature and old forest. If pattern is to be monitored, indicators should measure pattern of mature and old forest directly.

Project 2007-4P: Spatial distribution of mature and old forest: Phase II

Objectives listed in land-use plans: Maintaining biodiversity is a general goal of all the land-use plans for the watershed and of legislation. The objectives of creating core ecosystems and landscape corridors are a large part of the strategy to fulfill this objective. However, to ensure sufficient representation, the land-use plans call for analysis over the entire landscape rather than just within core areas.

Why is monitoring a priority? There is high uncertainty in the amount of old and mature forest by ecosystem type because strategies are provided for BEC variant without distinguishing ecosystem productivity.

Abstract:

This project aimed to reduce uncertainty relating to the distribution of mature and old forest by quantifying the current distribution of mature and old forest relative to biogeoclimatic variant, site productivity class and leading tree species in the Babine Watershed. The project summarised the current area of each seral stage in each biogeoclimatic variant-site productivity combination (e.g., spruce-good in the SBSmc2), distinguishing between logging and natural disturbance. It then compared the current proportion of mature and old seral forest in each Variant-site combination to the natural proportion of mature and old seral forest in the Subzone in which the site occurs (based on the Biodiversity Guidebook).

Analysis showed that medium and high-productivity pine and spruce sites in the ESSFmc currently fall below the mean natural proportion of mature and old forest. Low pine sites in the ESSFwv and SBSmc2 also fall below natural. High pine sites in the ICHmc1 are entirely logged; in addition, high pine and spruce sites in the ESSFmc show the greatest difference from natural. However, because leading species may change following harvesting, site productivity alone may provide a more reliable, albeit coarser, classification of ecosystem variation. With this coarser approach, analysis found that no sites fall below the average natural proportion of mature and old forest (Figure 1).

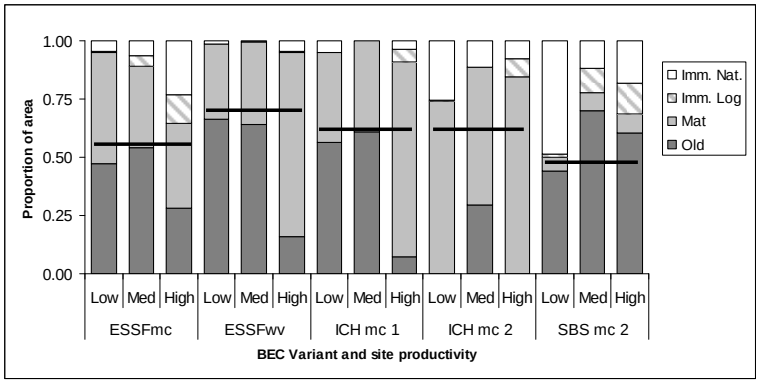

Figure 1. Proportion of each site productivity class within each BEC variant that is mature/old or immature (logged or natural). Horizontal bars show average natural proportion of mature and old forest in the variant.

Results showed that logging has preferentially target high productivity sites (Figure 2) and low elevation, more accessible variants (i.e. SBSmc2).

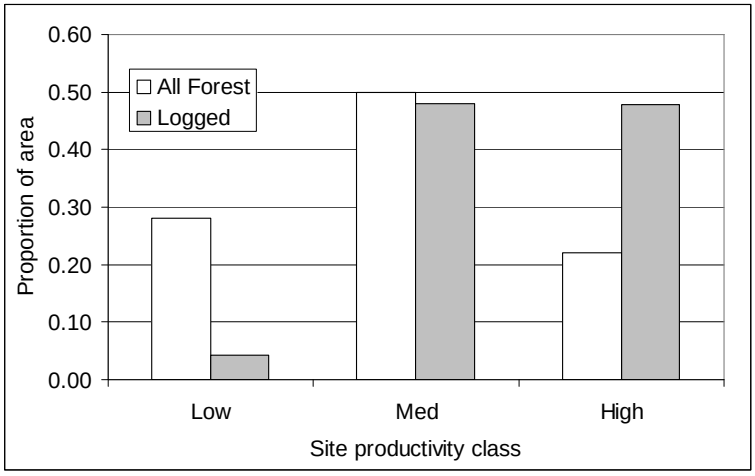

Figure 2. Proportion of forest area and of logged area in each site productivity class.

The study concludes that, in comparison to the average natural amount expected, mature and old seral stages are currently well represented across the range of ecosystem types considered. Although five ecosystem types have less than 90% of natural (med- and high-spruce and med- and high-pine in the ESSFmc; high-pine in the ICHmc1), most of these calculated shortfalls appear to have limited reliability, for the following reasons. Spruce sites cannot be adequately distinguished from fir sites in the ESSFmc. Similarly, pine sites cannot be distinguished from hemlock sites in the ICHmc1. High pine sites in the ESSFmc cover very little area and most medium and high pine sites in the ESSFmc are nearing maturity (> 80 years old). With all coniferous species combined, mature and old seral stages are well represented across all site productivity classes.

There is a clear trend towards preferentially harvesting high productivity sites and the SBSmc2 Variant. Representing mature and old forest across a range of ecosystems requires harvesting in proportion to the amount of each ecosystem type on the entire landbase. Only a small proportion of the forest in the Babine River Watershed has been harvested to date. If the tendency to harvest high productivity sites and SBSmc2 sites continues, these sites will become poorly represented in the future.

Status: Completed march 2008.

Geographic scope: Babine watershed. Although a larger scale is required for calculation of the natural benchmark (these calculations already exist), it is acceptable to calculate current spatial distribution of mature and old forest at the watershed scale, particularly for a large watershed such as the Babine, for comparison with this benchmark

Contractor: Dave Daust

Partner: Doug Steventon

Funding: $5,000 (total for Phases I and II)

Consequence for knowledge base: This project reduced uncertainty about the amount of old and mature forest in the Babine Watershed. It determined that current levels of old and mature forest are sufficient to pose low risk to biodiversity within the Babine Watershed.

Consequence for management: This project supports current management in the short term, but suggests that, because harvest is not random with respect to productivity, risk to these ecosystems might increase in the long term following current management. The report recommends limiting harvesting of high productivity sites, particularly in the ESSFmc and SBSmc2. The BWMT should initiate processes to pass this result to decision-making bodies.

Recommendations for further monitoring: Future monitoring should focus on the amount of mature and old forest in high productivity sites. Monitoring should be completed every 5 years to track trends. This process takes about 1 day.

Project 2008-4: Bull Trout Habitat

Objectives listed in land-use plans: The Kispiox SRMP includes an objective to conserve critical bull trout habitat in the Shelagyote River and its tributaries. The MDS for Babine River Corridor Park includes objectives to protect bull trout.

Why is monitoring a priority? There is high uncertainty about the location of bull trout habitat in relation to management zones offering protection. This study is a necessary preliminary step to resolve this uncertainty.

Abstract:

This project estimated the amount of bull trout habitat protected within different zones (e.g. park, special management zone, riparian corridor). Bull trout habitat has not yet been delineated for the Babine, although work has been completed for spawning and rearing habitat in the Shelagyote. Because bull trout are highly mobile, their use of the Babine may be extensive. Bull trout are sensitive to activities upstream, particularly if water temperatures rise beyond their threshold. This GIS map-based approach provides a first approximation of the amount of habitat protected.

The project constructed a habitat model that classified habitat into "known critical habitat", "important habitat" (included known presence and very high probability of presence), and "other habitat" based on prior inventories and stream gradient. It then ranked existing management zones for their ability to protect bull trout habitat, and calculated the amount of habitat in each management zone. These data were synthesised to look at the proportion of well-protected habitat (within the top three ranked management zones) and the proportion of habitat with no protection.

Most of the critical habitat is well protected, and two thirds of important habitat is protected at some level (Table 1). Risk to bull trout over the entire area (based on the curve in the Knowledge Base) is low with moderate uncertainty. Uncertainty is higher in the areas not included within the considered management zones.

Table 1. Amount of critical and important bull trout habitat protected by management zones. Well-protected habitat is contained within large areas with no forest harvesting.

Habitat type	*Stream length (km)*	*Amount well-protected (%)*	*Amount protected in any zone (%)*
Known critical	79	73	100
Important	2,334	20	67

Useful future monitoring would determine bull trout presence in "important habitat" outside the well-protected zones, and particularly in the 33% not protected within any special management zone. A more detailed research project could examine the effectiveness of the less well protected zones at maintaining bull trout habitat.

Status: Complete.

Geographic scope: Babine watershed.

Contractor: Ralph Kossman.

Partners: Jeff Lough, Ministry of Environment

Funding: $10,250

Consequence for knowledge base: This project collected indicator data on bull trout habitat to facilitate risk analysis. It determined that current levels of protection through management zones are sufficient to low risk to most critical and important bull trout habitat. There is high uncertainty associated with populations in the streams not protected within any management zone.

Consequence for management: This project supports current management in the short term. Improved knowledge of bull trout presence in unprotected reaches, might suggest further actions. BWMT should pass on the information that one third of important habitat is not included within defined management zones to the decision-making body.

Recommendations for further monitoring: Future monitoring should focus on field documentation of bull trout presence in the unprotected and less-well-protected stream reaches.

Abbreviations

ATV ..... All Terrain Vehicle
BRC.....Babine River Corridor
BVCRB .....Bulkley Valley Community Resources Board
BWMT ..... Babine Watershed Monitoring Trust
CFS ..... Canadian Forest Service
DFO..... Department of Fisheries and Oceans
ECA.....Equivalent Clearcut Area
ETD.....Enhanced Timber Development Zones
FREP……Forest Resources Evaluation Program
FRPA..... The British Columbia Forest and Range Practices Act
FSP.....Forest Sciences Program
GIS .....Geographic Information System
LRMP.....Land and Resource Management Plan
LUP ..... Landscape Unit Plan
MoE..... Ministry of Environment
MoFR……...Ministry of Forests and Range
MDS.....Management Direction Statement
MPB .....Mountain Pine Beetle
PEM .....Predictive Ecosystem Mapping
SFM Network..... Sustainable Forest Management Network
SRMP..... Sustainable Resource Management Plan
THLB ..... Timber Harvesting Land Base
UWR .....Ungulate Winter Range