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Lakes North Sustainable Resource Management Plan

Integrated Land Management Bureau

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PART 1. INTRODUCTION AND OVERVIEW

The Lakes North Sustainable Resource Management Plan (SRMP) outlines biodiversity objectives and strategies for resource management in the northern half of the Lakes Timber Supply Area (TSA) in the Nadina Forest District. The plan area includes seven landscape units (Babine East, Babine West, Bulkley, Burns Lake East, Burns Lake West, Fleming, Taltapin - see Map 1) encompassing 451,105 ha, of which approximately 404,556 ha is Crown forest land.

This plan is consistent with the provisions of the Lakes District Land and Resource Management Plan (LRMP), January 2000.

In June 2003 the former Ministry of Sustainable Resource Management – now the Integrated Land Management Bureau (ILMB) under the Ministry of Agriculture and Lands (MAL) – completed the Lakes South SRMP, which provides resource management direction for biodiversity for the southern half of the Lakes TSA. Collectively the Lakes North SRMP and the Lakes South SRMP will address the entire plan area of the Lakes LRMP.

1.1 Plan Scope

The Lakes North SRMP objectives apply to Crown forest land outside of protected areas and relate to management of biodiversity values in forested ecosystems. The biodiversity values addressed in this plan relate to landscape level or “coarse filter” biodiversity objectives. These objectives include:

- Seral stages
- Old growth
- Wildlife tree retention
- Connectivity
- Patch size distribution
- Wild young forests
- Species composition

These biodiversity objectives are complementary to, and consistent with, the Lakes LRMP direction.

The Lakes North SRMP does not directly address the following issues:

- Species specific, or fine filter, management objectives. The Lakes LRMP provides objectives for caribou and other ungulates. The Lakes North SRMP considered these objectives in the drafting of spatial Old-Growth Management Areas (OGMA) and landscape connectivity corridor objectives and is therefore consistent with the LRMP.
- Non-biodiversity related objectives such as wilderness tourism, enhanced forestry, and settlement/agriculture.
- Management within provincial parks. It should be noted that Crown forest land within protected areas is included when assessing the status of current and future seral stage, patch size distribution, and species composition.

Lakes LRMP objectives reflect social choices that have been approved by government for consideration in plans. Accountability for the implementation of these "non-legal" components rests with resource professionals and their professional accounting bodies.

1.2 Purpose of this Plan

Implement Lakes LRMP:
The Lakes North SRMP is needed to provide more operationally clear direction to implement objectives in the Lakes LRMP. The LRMP provides the direction of how the local residents and stakeholders in the plan area want the land and resources used and managed. The LRMP, however, is a strategic level plan and requires more specific watershed scale interpretation before resource planners can understand what its objectives mean to the management of resources in the area. The Lakes North SRMP provides this specific watershed scale direction.

Manage Mountain Pine Beetle infestation:
The very large infestation of Mountain Pine Beetle (MPB) in the central interior of the province is now the driving force behind both ecological processes and forest management in the area. Most of the mature and old pine trees in the Lakes North plan area have been killed by this infestation. Harvesting is now almost entirely driven by mountain pine beetle salvage objectives.

The Lakes North SRMP is needed to ensure that LRMP objectives to protect forest and biodiversity values are implemented in a way that also considers the effects and needs created by the MPB infestation.

Respond to Allowable Annual Cut Determinations:
The allowable annual cut (AAC) in the Lakes TSA was increased in 2001 to 2.962 million cubic meters from 1.5 million cubic meters. In 2004, the AAC was increased to 3.162 million cubic metres. This AAC will remain in effect until a new AAC is determined, expected by October 2009.

The AAC in the Lakes TSA was more than doubled to allow for MPB management operations. As the MPB infestation passes through the TSA, the number of forest licensees operating in the northern portion of the Lakes TSA has increased. New Non-Replaceable Forest Licences, Community Forests Licences, and other Forest Licensees in existing tenures have placed pressure on the resources in the Lakes North plan area. Planning for the management of non-timber values is complicated by the fact that individual landscape units and watersheds may have multiple forest licensees operating in them.

The Lakes North SRMP is required to provide clear direction to forest licensees and the Ministry of Forests and Range (MOFR) on how to manage for biodiversity values at the landscape scale.

Support *Forest and Range Practices Act* implementation:
The Lakes North SRMP establishes legal land use objectives for biodiversity established in order to support the implementation of the *Forest and Range Practices Act* (FRPA).

1.3 Benefits of this Plan

Conserve Biodiversity:
This plan provides clear objectives to ensure that a diversity of forest habitats is retained on the landscape. The plan does this by:

- Maintaining a range of age classes, including old-growth forest, appropriately distributed across the landscape.
- Providing connectivity, to allow for the movement of organisms across the landscape by providing key "stepping stones".
- Maintaining species diversity and wildlife trees through time at both the stand-level and landscape-level.

The above objectives contribute to providing a range of habitat types that are intended to support a wide diversity of animals and plants.

Create Certainty:
The clear measurable objectives, some of which are spatially located on maps, remove uncertainty on how management for biodiversity will affect timber management objectives. This plan accomplishes the following:

- Provides certainty for government agencies and forest licensees regarding biodiversity values in the face of increased MPB-killed stands and increased harvesting.
- Provides Ministry of Forests and Range with the information to aid in the allocation of forest licensees and awarding new tenures to salvage mountain pine beetle infested stands.
- Provides Ministry of Agriculture and Lands with information to aid in the adjudication of crown land referrals.
- Permits calculation of available timber volumes in any area of interest to determine levels of investment in infrastructure required for forest management objectives.

Support Forest Professionals:
This plan will assist forest professionals with forest planning and forest management activities by:

- Providing guidance to forest professionals involved in operational and strategic planning. The strategies provide implementation suggestions, and the appendices provide scientific support.
- Providing guidance on how to implement the Chief Foresters *Guidance on Landscape- and Stand-level Structural Retention in Large-Scale Mountain Pine Beetle Salvage Operations.*
- Providing the District Manager of the Nadina Forest District with guidance on the legal biodiversity objectives.

Provide Flexibility:
Forest managers require flexibility to respond to the MPB infestation and to the shelf-life constraints that such an infestation creates as time goes on. Flexibility is also required to meet biodiversity objectives as the post-beetle forest characteristics become known. This plan provides flexibility by:

- Allowing for harvest of pine-leading stands in connectivity corridors, while deferring harvest of non-pine-leading stands in the short-term.

- Allowing for management of a substantiated forest health factor (non-MPB) within OGMAs and Wildlife Tree Retention (WTR) areas, where harvesting constitutes an appropriate and effective control action.
- Maintaining consistency with the regional Old Growth Management Area Amendment Policy – Skeena Region, which provides direction on amendment and replacement of OGMAs.
- Providing an early seral stage requirement in the short-term that will allow salvage harvesting of dead pine stands.

1.4 Development of this Plan

The following process was followed to create this plan:

- A project scope combining the Lakes North and Lakes South plans was created in the spring of 2004. The Lakes North portion was revised in December 2004, and work commenced on the project in the spring of 2005 through a partnership between ILMB and the Innovative Forest Practices Agreement (IFPA) group.
- A "Technical Working Group" made up of forest licensee representatives, and staff members from the Ministry of the Environment (MOE), Ministry of Forests and Range (MOFR), and the Integrated Land Management Bureau (ILMB) was created. This working group provided operational direction on objectives, strategies and spatial locations of OGMAs and connectivity corridors.
- First Nations who had asserted traditional territory in the Lakes North area were consulted on objectives, strategies and spatial location of OGMAs and connectivity corridors, with special consideration given to locations that overlap with cultural areas.
- Both a computer modelling exercise conducted by Ardea Biological Consulting and a field assessment of proposed OGMAs conducted by Gartner Lee Limited helped determine the location of OGMAs.
- ILMB drafted objectives and strategies which were reviewed on an ongoing basis by the Technical Working Group and the First Nations whose territory is affected.
- The final SRMP document was advertised for public comment for 60 days from September 3 to November 2, 2008.
- A public Open House was held on November 6, 2008 in Burns Lake, BC.
- Four submissions were received during the public review and comment period and at the open house. Appendix 6 summarizes the comments received and the responses from ILMB.
- The Regional Executive Director, Northern Interior Region of ILMB approved the Lakes North Sustainable Resource Management Plan on XXXX.

PART 2. OBJECTIVES AND STRATEGIES

The Lakes North SRMP objectives and strategies listed in this section provide clear management guidance on maintaining biodiversity values while retaining flexibility to manage for timber harvesting.

Two different types of objectives occur in this plan:

1. Legal objectives: the order establishes objectives 1 through 4 of the SRMP as legal objectives. These objectives are: seral stage distribution, old growth forest retention through OGMA establishment, stand structure through wildlife tree retention, and connectivity.

2. Non-legal objectives: objectives 5 through 7 are not established as legal objectives at this time, in consideration of uncertainties created by the mountain pine beetle infestation, and also in consideration of risk and necessity. These objectives are included to provide guidance to current management. These objectives are: patch size distribution, retention of wild young forest, and coniferous and deciduous tree species diversity.

In addition, strategies are provided for most of the objectives to indicate the intent of how consistency with the objective could be best achieved. The strategies provided are not legal direction and are not intended to limit options on how to be consistent with the objectives. Appendices are also included to provide further support to forest professionals implementing the plan.

2.1 Seral Stage Distribution

The goal of the following seral stage distribution objective is to maintain the range of forest stand ages that were historically found within the various Biogeoclimatic zones within the Lakes North SRMP area.

A seral stage analysis of both the current state and the targets is found in Appendix 1.

Objective 1: Maintain a range of forest seral stages by Biogeoclimatic zone within each landscape unit shown on Map 1 and in accordance with Table 1.

Table 1: Seral Stage Distribution for the Lakes North SRMP area

Landscape Unit / BEC Zone / Biodiversity Emphasis Option	Early[a]	Mature plus Old[b]	Old[c]
Burns Lake East – BEO Low			
SBS	NA	>11%	>11%
ESSF	NA	>14%	>9%
Burns Lake West – BEO Low			
SBS	NA	>11%	>11%
ESSF	NA	>14%	>9%
Taltapin Low – BEO Low			
SBS	NA	>11%	>11%
ESSF	NA	>14%	>9%
Babine West -- BEO Low			
SBS	NA	>11%	>11%
ESSF	NA	>14%	>9%
Babine East – BEO Intermediate			
SBS	<54%	>23%	>11%
ESSF	<36%	>28%	>9%
Bulkley – BEO Intermediate			
SBS	<54%	>23%	>11%
ESSF	<36%	>28%	>9%
Fleming – BEO Intermediate			
SBS	<54%	>23%	>11%
ESSF	<36%	>28%	>9%

[a] Early seral targets will be applied to man-made disturbances. Early forest is defined as < 40 years for SBS and ESSF.
[b] Mature forest is defined as >100 years for SBS and >120 years for ESSF
[c] Old forest is defined as >140 years for SBS and >250 years for ESSF

2.2 Old growth Forest Retention through OGMA Establishment

Old Growth Management Areas (OGMAs) are identified primarily for the purposes of retaining or restoring the ecological attributes associated with old forest, and maintaining areas that are subject to natural forest succession. They may also contribute to the retention of other features important for biodiversity or other values. OGMAs function to provide reserves for old growth forest-dependent species across the landscape. The areas were selected to meet old seral criteria over time, while minimizing impacts on timber supply.

The goal of the old growth forest objective is to manage for the retention of areas that are appropriately sized, contain, or can recruit specific structural old growth forest attributes, and represent the range of ecosystem types found across the Lakes North planning area. It is important to note that where other objectives overlap with OGMAs, those objectives continue to apply.

The old growth forest objective in this document takes direction from the LRMP. Specifically, Objective 43 from the LRMP states, “Maintain biodiversity at the ecosystem, species, and genetic levels through the application of ecosystem management principles”. Relevant management strategies state:

- 43.7 Develop and implement an old growth management strategy which establishes, throughout the district, OGMAs dominated by old tree cover and containing most of the structure, function, microclimatic conditions and biota associated with old forest, including interior forest conditions. Within OGMAs, maintain old growth and interior forest conditions, and provide a representative cross-section of ecosystem types occurring in the District.
- 43.8 Generally, the old growth management strategy will take advantage of existing old forest within special resource management areas, habitat linkages, riparian and lakeshore reserves, and forest harvesting land base exclusions. Where sufficient old forest is not available, OGMAs may be recruited from other age-class and/or resource management categories.

The old forest establishment targets in Appendix 2 specify the proportion of the old seral target that must be met in spatial OGMAs. These establishment targets were identified by the expert panel involved in the original Lakes South SRMP process. The members of the expert panel modified the targets found in the Biodiversity Guidebook (BG). This step was taken in an effort to ensure that the targets could be met both spatially and aspatially across the land base, and also to recognize the contribution to biodiversity from wildlife tree retention associated with cutblocks and/or riparian zones.

Objective 2: Preserve Old Growth Management Areas as identified on Map 2.

a) Despite the above, timber harvesting is allowed for one or more of the following purposes, provided an alternate area or areas is identified and reserved from harvesting in the same Landscape Unit/BEC variant unit as in the original OGMA and the overall effectiveness of old forest conservation will not be diminished:

i. New road development and maintenance where no practicable alternatives exist, and subject to these roads being deactivated once operational activities are complete.

ii. To address a substantiated forest health factor within an OGMA where this poses a significant and substantiated forest health risk to forests outside the OGMA and where harvesting constitutes an appropriate and effective control action.

iii. To address a public or industrial safety concern, or an environmental hazard where no practicable alternative exists.

b) Boundary adjustments to the OGMAs are allowed, provided that an alternate area or areas is identified and reserved from harvesting in the same Landscape Unit/BEC variant unit as in the original OGMA, and that old growth attributes of the replacement OGMA meet or exceed the attributes of the original OGMAs.

Strategies

1) Ensure that over time, the old forest establishment target for each LU/BEC variant unit as noted in Appendix 2 is achieved and maintained.

2) Within OGMAs the following activities will be allowed:

   - First Nations traditional uses;
   - cone gathering and tree topping;
   - fire suppression;
   - existing grazing leases;
   - hunting, fishing, trapping;
   - commercial or non-commercial recreational use;
   - subsurface resource uses, including exploration for and development of oil and gas, mineral, and aggregate resources, and including incidental tree cutting for these purposes;
   - harvesting and collecting botanical forest products (other than timber);
   - any other use for which an existing lease or licence has been issued under the *Land Act*.

Persons engaged in these uses are encouraged to avoid or minimize disturbance to OGMAs. Disturbances within OGMAs that occur as a result of these uses will be assessed on a landscape unit basis.

3) Public and industrial safety concerns may include the presence of danger trees in an OGMA near hiking trails, campsites, roads, cutblocks or landings. A forest licensee may need to remove these trees for safety reasons. Fire may pose a threat to safety, and a forest licensee may have to harvest, build temporary roads or perform other fire suppression activities inside an OGMA to address this threat.

4) Environmental hazards may include windthrow events or reclamation work related to landslides.

5) Amendments to OGMAs will be consistent with the *Old Growth Management Area (OGMA) Amendment Polcy – Skeena Region.*

2.3 Stand Structure through Wildlife Tree Retention

The goal of retaining wildlife trees is to promote healthy functioning ecosystems that provide wildlife habitat elements at the forest stand level. This will be promoted by maintaining forest stand structural attributes[1] of natural forests, within managed stands, through wildlife tree retention areas[2].

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[1] Forest stand structural attributes include, but are not limited to, living and dead standing trees; coarse woody debris; large living trees; tree species diversity; a variety of layers and opening sizes in the forest canopy, and a full range of above- and below-ground flora and fauna.

[2] Wildlife Tree Retention is an area specifically identified for the retention and recruitment of suitable wildlife trees. It can consists of a group reserve, or of a group of single trees dispersed over the harvest area.

Objective 3: Maintain stand level structural diversity by retaining wildlife tree retention (WTR) areas in the Lakes North plan area, as shown on Map 1, and as per (a), (b) and (c).

(a) Where an agreement holder completes harvesting in one or more cutblocks during any 12 month period beginning on April 1 of any calendar year, the holder must ensure that, at the end of that 12 month period, the total area covered by WTR areas that relate to the cutblocks is a minimum of 10% of the total area of cutblocks.

(b) An agreement holder who harvests timber in a cutblock greater than 3 hectares must ensure that, at the completion of harvesting, the total amount of WTR areas that relate to the cutblock is a minimum of 5% of the cutblock area.

(c) An agreement holder must ensure that high wildlife value trees/areas are retained after harvest. Where there are few trees with high value wildlife attributes available, locate retention on a priority basis as follows:

(i) in areas most suitable for long-term wildlife tree recruitment, and
(ii) in areas that are representative of the pre-harvest stand.

Strategies

1) Refer to the following paper prepared by the Ministry of Forests and Range and the Ministry of Environment: *Wildlife Tree Retention: Management Guidance*[3]. Table 3 below is an excerpt from that paper that lists the attributes of a high-value wildlife tree.
2) Establish a higher percentage of retention for cutblocks that are greater than 100 hectares in size and give consideration to increased retention in larger openings.
3) Refer to *Guidance on Landscape- and Stand-level Structural Retention in Large-Scale Mountain Pine Beetle Salvage Operations*[4] prepared by the Chief Forester.
4) Maintain old growth and wildlife tree values within wildlife patches by allowing natural processes to occur within wildlife tree patches unless:
    a. New road development and maintenance is required where no practicable alternatives exist, and subject to these roads being deactivated once operational activities are complete and replacement of WTR of greater or equal value.
    b. A substantiated forest health factor within a WTR must be addressed, where this poses a significant and substantiated forest health risk to forests outside the WTR and where harvesting constitutes an appropriate and effective control action.

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[3] *Wildlife Tree Retention: Management Guidance.* Ministry of Forests and Range and Ministry of Environment. May 2006. http://www.for.gov.bc.ca/hfp/values/wildlife/WLT/Publications/policies/WT-Guidance-05-2006.pdf

[4] *Guidance on Landscape- and Stand-level Structural Retention in Large-Scale Mountain Pine Beetle Salvage Operations. December 2005.* Ministry of Forests and Range. http://www.for.gov.bc.ca/hfp/mountain_pine_beetle/stewardship/cf_retention_guidance_dec2005.pdf

c. There is a public or industrial safety concern, or an environmental hazard where no practicable alternative exists and where harvesting constitutes an appropriate and effective control action.

d. The timber on the net area to be reforested that relates to the WTR has grown to a mature age class.

5) Include trees that are more open grown or have current defects (e.g. stem scars, broken tops) or larger branches in the definition of areas suitable for long-term wildlife tree recruitment.

6) In light of the current mountain pine beetle epidemic, and increased Allowable Annual Cut (AAC) in the Lakes Timber Supply Area, the Chief Forester of British Columbia has provided guidance regarding the amount of forest that should be left standing within a harvested area (retention). This guidance states that the amount of retention should increase with the size of the cutblock, and should be in the range of 10-25% for a given cutblock. It is in this context that direction is provided here as to how and where the increased retention levels could be most effectively implemented, with consideration given for non-timber forest values, risks, and best science.

   With this in mind,
   If stand level retention is to occur in excess of the wildlife tree retention targets established in the wildlife tree retention objective, retain forests according to ecological and/or hydrological resource values and/or risks within the planned cutblock.

   In addition,
   Where values and risks have not been determined, locate retention in the oldest available forest types located on hydro-riparian sites.

   For further direction, refer to the document, *Proposed Objective for "Retention" for the Lakes (North) Sustainable Resource Management Plan,* Rick Heinrichs, Ministry of Environment, Environmental Stewardship Division, July 15, 2006 in Appendix 3.

Table 3: Attributes of High-Value Wildlife Tree Retention Strategies[5]

Attributes of a high-value wildlife tree	Attributes of a high-value wildlife tree patch	Attributes of high-value, dispersed wildlife tree retention	Attributes of high-value wildlife tree retention at the cutblock level
• Internal decay (heart rot or natural/excavated cavities present). • Crevices present (loose bark or cracks suitable for bats). • Large brooms present. • Active or recent wildlife use. • Tree structure suitable for wildlife use (e.g., large nest, hunting perch, bear den). • Large trees for the site (height and diameter) and veterans. • Locally important wildlife tree species.	• Trees with valuable wildlife tree attributes, including large dead trees. • Potentially dangerous trees have been assessed. • Large patches with no harvest-related modifications. • Patches anchored on high-value trees/habitats, and/or other biodiversity criteria (e.g., around raptor nests, cave entrances), and/or operationally difficult areas (e.g., wet areas). • Retention of uncommon species, stand characteristics, and other elements of stand-level biodiversity. • Designed in consideration of windthrow risk. • Designed to balance valuable wildlife tree habitat attributes (e.g., heart rot, brooms, insects) and forest health issues. • Considers how individual tree species and site conditions affect stand structure. • Patches distributed throughout the cutblock. • Undisturbed forest floor.	• Wildlife trees that can be safely worked around during current and near future forest operations. • Retained trees have the potential to achieve the desired stand structure attributes (e.g., tall, large diameter trees). • Considers the susceptibility to windthrow. • Includes deciduous trees, vets, "wolf trees" and other trees of generally lower economic value.	• Based on a pre-harvest field assessment that identifies best opportunities for retaining wildlife trees in the most ecologically and operationally appropriate locations. • Contains a diversity of wildlife tree retention strategies (e.g., a range of patch sizes combined with dispersed trees). • Captures a diversity of habitat types. • Any fallen trees within reserve areas are left in place to function as coarse woody debris, unless they pose a significant forest health or other concern. • Considers tree windfirmness. Patch and individual tree retention considers the site, stand and individual trees during layout (e.g., low height/diameter ratio). • Ecological interpatch distance has been incorporated into design. • Identifiable on a map for long-term tracking and evaluation/monitoring. • Higher levels of retention on cutblocks with high ecological values, and lower levels of retention on cutblocks with low ecological values. However, ideally some retention on every cutblock. • Increased retention levels where there are exceptional wildlife tree or other stand-level biodiversity values that can be retained.

Note: In general, no single retention strategy is appropriate for all sites. Factors, such as stand type and condition, tree species, and windthrow hazard, create unique conditions for each stand.

2.4 Connectivity

In order to provide opportunities for the distribution of species, populations and genetic material, the Lakes LRMP includes an objective to maintain or enhance habitat connectivity at the landscape level. One method to achieve this objective is to establish a network of landscape corridors.

Landscape ecologists distinguish between two types of connectivity: functional and structural (D'Eon 2007). The focus of functional connectivity is based upon species' requirements where they are known. Conversely, structural connectivity considers the physical structure of habitat within a landscape, independent of any measure of species' movement (i.e. coarse filter). Since habitat requirements for movement are known for very few species (e.g. ungulates and marten) the approach to managing connectivity described here should be considered a hybrid between functional and structural connectivity.

A new landscape connectivity matrix (LCM) was developed for the Lakes North SRMP through improved mapping. The LCM is derived from an earlier connectivity strategy known as the Biological Ecosystem Network (see Lakes LRMP). The LCM is overlaid with three Ecosystem-Based Structural components. The components and the matrix are defined below:

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[5] *Wildlife Tree Retention: Management Guidance.* Ministry of Forests and Range and Ministry of Environment. May 2006. http://www.for.gov.bc.ca/hfp/values/wildlife/WLT/WT Guidance_May 2006.pdf

1) Vegetative Cover important for biodiversity (VC):
These are comprised of 42 different non-pine-leading coniferous and deciduous forest stand types.

2) Potential Hydro-Riparian ecosystems (HR):
These are derived from Predictive Ecosystem Mapping (PEM) and constitute potential high value structure for terrestrial and aquatic ecosystem and hydrological functions due to their association with streams and groundwater.

3) Potential Rare or Endangered Plant Communities (RE):
These are derived from Predictive Ecosystem Mapping (PEM) where there is a good chance of finding rare or endangered plant communities.

4) Landscape Connectivity Matrix (CM):
This consists of the above three components as well as all other areas within the connectivity network which could be comprised of immature conifer, non-forest, pine-leading stands, or other.

The first three components represent habitats most important for terrestrial and aquatic wildlife, areas of rare or special significance, and focal points for ecological processes (e.g. watershed hydrology). Appendix 4 summarizes the amount of area in each network component by landscape unit.

The pattern of these components on the landscape may be indicative of natural disturbance patterns, biogeoclimatic influence, or edatopic conditions which provide valuable information for a landscape level retention strategy. However, due to the history of anthropogenic disturbances on these landscapes (logging and agriculture), the current distribution and size of the component patches may also be indicative of a highly fragmented landscape, with only remnant structure. Either way, there is ecological justification for retention of a significant amount of this structure through time.

The landscape connectivity network has been located in areas with linear assemblages or complexes of various Ecosystem-Based Structural (EBS) components. Based on the continuity of these assemblages, habitat structure, and known species' use within them, and other known ecosystem functions (e.g. hydrological), this network is intended to represent the best scientific approximation of ecosystem-based, functional landscape connectivity. The network provides:

- a continuum of representative habitat for species that prefer mature or old forest habitat (goshawks, marten, red-backed voles, most woodpeckers and raptors, many passerines, plants, etc.) for movement, hunting, and breeding,

- areas of refuge for wildlife (habitat for living) during periods of disturbance on nearby sites, as well as acting as centres and corridors of dispersal for the re-colonization of historic ranges, and

- terrestrial, aquatic, and hyporheic (ground water) connectivity.

In general, the desired condition for VC, HR, and RE is to retain a mature or old forest structure. By managing for the desired condition of the Ecosystem-Based Structural components within the network through selection of appropriate silviculture systems, the intended function and integrity of the network is most likely to be achieved. Overlaps between VC, HR, and RE constitute areas of higher value and therefore should be given higher priority for retention. Harvesting should be avoided in RE. Attributes in Appendix 5 are identified as a potential measurable methodology for achieving the desired condition.

The EBS components provide valuable habitat structure and ecosystem services regardless of *whether or not they are inside or outside the designated Landscape Connectivity Network* (LCN). Species differ in their ability or willingness to cross areas of early seral forest to access other patches. For some species the early successional forests of the *landscape* matrix (outside LCN) may provide adequate connectivity or present no obstacle to accessing patches outside the corridor (i.e. some birds). The suitability of the early successional *landscape* matrix for movement of other species depends on the structural make-up of the matrix with elements such as CWD, and other landscape matrices such as distance to the patch, or inter-patch distance. For example, pine marten generally avoid use of any sized clear-cut unless there is abundant CWD structure and adequate residual forest structure. EBS components outside the LCN are also important for species such as grizzly bears which generally do not forage more than 100 meters from cover. Therefore forage supplies that exist between patches which are more than 200 meters apart may not be available to grizzly bears.

Note: In light of the MPB epidemic within and around the planning area and the uncertainty around the impacts it will create on future timber supply, future biodiversity supply, social choices and economic impacts, it is prudent to defer harvesting in the corridors in the short-term. It is difficult to make choices now regarding management within landscape corridors when the outcomes of the MPB epidemic are not yet fully realised. This objective will therefore be revisited within 7 years, during which time it is expected that an appropriate management strategy for connectivity will be developed.

The following objective is consistent with the Chief Forester’s *Guidance on Landscape- and Stand-level Structural Retention in Large-Scale Mountain Pine Beetle Operations*, where he stresses the importance of focussing harvest operations towards pine-leading types in the short-term.

Objective 4: Maintain habitat connectivity within the landscape connectivity matrix (LCM) shown on Map 3 and in accordance with (a), (b) and (c).

(a) Defer the harvest of the following stands for a period of 7 years following the effective date of the order:

(i) Stands listed in Table 4 if they are made up of less than 70% pine.

(ii) Stands in hydro-riparian areas if they are in the site series listed in Table 5 and are made up of less than 70% pine.

(b) Avoid harvesting in rare and/or endangered plant communities[6].

(c) Despite (a), timber harvesting is permitted in the deferred areas for the following reasons:

(i) Where required for new road development and maintenance and where no practicable alternative exists, and subject to these roads in the deferred areas being deactivated once forestry operational activities are complete.

(ii) Where required to address a substantial forest health factor other than Mountain Pine Beetle where it poses a significant forest health risk to forests outside of the deferred areas and where harvesting constitutes an appropriate and effective control action.

Table 4. Vegetative Cover Important for Biodiversity Criteria

1.	Deciduous – leading		
2.	ESSF	> 140 years	Balsam leading
3.	ESSF	> 140 years	Spruce leading
4.	SBS	> 140 years	Douglas-fir leading
5.	SBS	> 140 years	Balsam leading
6.	SBS	> 140 years	Spruce leading

Table 5. Hydro-Riparian Ecosystems Criteria

SBS dk – 07, 08, 09, 10
SBS mc2 – 07, 09*, 10, 12
ESSF mc – 07, 08, 09, 10*
ESSF mv1 – 04, 05
ESSF mv3 - 07

*These site series were not mapped, but may be found on the ground.

[6] Rare and endangered plant communities are defined as the Conservation Data Centre's Red List and Blue List ecological communities.

Strategies

1) Overlaps between VC, HR, and RE constitute areas of higher value and therefore should be given higher priority for retention.
2) Wherever possible, licensees should also endeavour to retain the function of the EBS components *outside* the landscape connectivity network, through stand-level retention or selection logging.
3) Avoid new permanent access in corridors.
5) Orient development in landscape corridors to minimize impacts on connectivity.

2.5 Patch Size Distribution: Temporal and Spatial Distribution of Cutblocks

This element of biodiversity is often referred to as "patch size distribution". The pattern and timing of forest harvesting are the dominant factors that determine the size and spatial distribution of similarly-aged forest patches in managed landscapes. The goal of this objective is to create and maintain a pattern of forest seral stages distributed across the landscape that reflects the natural disturbance regime. The shape and pattern of cut blocks following timber harvesting should resemble an opening that would result from a natural disturbance.

Objective 5: Attain a harvest pattern that, over time, reflects the natural disturbance patterns as described in Table 6.

The targets in Table 6 represent a vision of desired future conditions. It is understood that these conditions will not be immediately achieved in the Lakes North area.

Table 6. Percent of Forested Area by Natural Disturbance Type (NDT)

NDT	Patch[7] Size	Patch Size	Patch Size
	<40 ha	40-80 ha	>80 ha
2	30-40%	30-40%	20-40%
	<40 ha	40-250 ha	>250
3	10-30%	10-30%	40-80%

2.6 Retention of Wild Young Forest

"Wild Young Forest" refers to naturally-created, young seral forests, such as young unmanaged post-fire stands and beetle-killed stands. These forests, while classified as

[7] A patch is defined as any new harvesting and any harvested or disturbed areas 20 years of age or younger that have a common boundary edge, and are greater than 1 ha in size.

young seral forests, have significantly different characteristics than young plantations, and have become increasingly rare in our forests due to fire suppression, salvage harvesting, and widespread spacing and thinning of naturally regenerated young stands.

The goal of the following wild young forest objective is to ensure retention of representative naturally created young seral forest types across the Lakes North planning area. It is assumed that, due to the extent of the mountain pine beetle infestation, large areas of wild young forest are being created. Therefore, in the short term, there is little risk associated with the decision to not designate specific wild young forest stands for retention.

Objective 6: Ensure retention of naturally-created wild young forest by monitoring establishment of stands with wild young forest attributes[8] and assessing options to ensure retention of up to one percent of the Crown forested land-base across the Lakes North planning area in representative[9] wild young forest stands.

Strategies

1) Identify unmanaged age class one and two stands from the forest cover inventory or other sources. Assess risk of these stands losing wild young forest attributes through forest management activities. If forest management threatens to reduce area of these stands to less than one percent of the Crown forested land-base across the plan area, consider selecting a representative cross-section of these stands, not less than one percent of the Crown forested landbase in the planning area, and designating them as Wild Young Forest reserves. Where less than one percent of the Crown forested land-base in the planning area is identified, all the available stands meeting the above criteria should be considered for designation as Wild Young Forest reserves.
2) Minimize timber impacts by locating suitable and representative Wild Young Forest reserves in areas that are constrained or non-contributing to timber supply before locating reserves in the timber harvesting land base.
3) No harvesting, salvage operations, silvicultural activities, or any other forest management activities are permitted in Wild Young Forest reserves unless necessary to protect resource values in adjacent areas.
4) Once a stand in a Wild Young Forest reserve exceeds age forty years, it will be removed from the reserve and the associated management constraints will be removed. In spite of their change in status, however; these areas should be considered for their potential as recruitment Old growth Management Areas.
5) A review of the available wild young forest stands (as per strategy 1) should be conducted every 5 years or following significant new natural disturbance events.

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[8] Wild young forests are unmanaged stands created by natural disturbance events such as fire, beetle infestations and catastrophic windthrow and in which dominant tree species are less than 40 years old.

[9] Retained wild young forest stands should represent the range of BEC variants and tree species inventory type groups in which wild young forests occur.

2.7 Coniferous and Deciduous Tree Species Diversity

Objective 7: Maintain a diversity of coniferous and deciduous species across each Landscape Unit and throughout the rotation that represents the natural species composition[10] of each biogeoclimatic subzone.

Strategies

1) Where spruce and subalpine fir 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 trees located in a clumpy distribution.
5) Do not assist conversion of natural deciduous stands to coniferous species.
6) Rare forest stand types within the landscape unit (that is, those accounting for less than 2% of the area, such as birch, cottonwood, and Douglas fir) should be maintained over the rotation.

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10 Natural species composition for the purposes of this plan are the species present, in their relative proportions on the landscape, in 2002.

PART 3. IMPLEMENTATION AND MONITORING

The Provincial Government has updated the provincial monitoring framework to ensure alignment with the new direction[11]. This strategy integrates SRMP and LRMP monitoring. In addition, there are other monitoring processes being undertaken by Ministry of Forests and Range, and also the Morice and Lakes Innovative Forest Practices Agreement.

Implementation of the SRMP will be done by staff at various government agencies, and also by licensees. Below are some roles and responsibilities for both implementation and monitoring of this plan.

3.1 Roles and Responsibilities

SKEENA REGION MANAGERS COMMITTEE

The Skeena Region Managers Committee provides overall coordination of the implementation and monitoring of strategic land use plans between government agencies. The committee endorses project charters, prioritises monitoring projects, and funds implementation and monitoring activities.

INTEGRATED LAND MANAGEMENT BUREAU

The Integrated Land Management Bureau is responsible for developing new strategic plans for the management of Crown land and natural resources as well as maintaining BC's existing land use planning legacy. ILMB undertakes strategic-level monitoring; the Lakes LRMP Resource Monitoring Framework will include monitoring of objectives in the Lakes North SRMP. ILMB is responsible for coordinating amendments to the plan.

MINISTRY OF FORESTS AND RANGE

The Ministry of Forests and Range will retain responsibility for approval of Forest Stewardship Plans that are in compliance with legislation. MOFR also enforces compliance with results and strategies in approved Forest Stewardship Plans (FSP). MOFR will monitor operational practices as related to the legal objectives of this plan.

LICENSEES (INCLUDING BC TIMBER SALES)

Licensees are responsible for implementation of the Lakes North SRMP. The legal objectives will be implemented through approved results/strategies in individual licensee's FSP. A forest licensee who expects approval of a FSP will need to include results and strategies in their FSP that are consistent with objectives set by government for zones located in the area encompassed by the plan. In some cases, licensees will need to collaborate (example – Morice and Lakes Innovative Forest Practices Agreement partnership) to ensure that their results and strategies are consistent with the broad biodiversity objectives for specific zones or landscape units.

It is incumbent upon licensees to consider the non-legal elements of the Lakes North SRMP through the realm of professional reliance. The non-legal components included in the plan provide guidance to forest professionals regarding operations and practices around the

[11] See *Implementation of the New Direction for Strategic Land Use Planning in BC: Framework for Monitoring of Strategic Land Use Plans in BC, ILMB, December 2007.* Currently in IAMC review, and awaiting approval by ADMCILM.

management of biodiversity values, and are based on a thorough review of up-to-date scientific knowledge.

Monitoring actions taken by licensees will demonstrate that they are duly diligent in minimizing their exposure to risk and associated liability. In addition, monitoring actions, such as those done through the Morice and Lakes IFPA, contribute to the operational monitoring of this plan.

PUBLIC

Public involvement in the Lakes North SRMP implementation is through review and comment on FSPs, and through the Lakes Plan Implementation and Monitoring Committee. The monitoring committee may make recommendations to the Skeena Region Managers Committee with respect to plan implementation, monitoring and amendment.

3.2 Adaptive Management

This plan was developed using the best available information and knowledge. There is, nonetheless, some uncertainty, both in the information and knowledge used, and in the effectiveness of management recommendations. To allow continual improvement of management policies and practices, the monitoring activities referred to in the above section will provide information on the outcomes of the management practices associated with the objectives of this plan. This knowledge may lead to changes as plans can be amended throughout their implementation as outlined in Implementation of the New Direction for Strategic Land Use Planning in BC: Reviewing and Amending Strategic Land Use Plans (2007).

In order to address concerns around the definition of man-made disturbances in the seral stage distribution objective, government agencies and major forest licensees will develop strategies that address aquatic values and timber values through the Morice and Lakes IFPA FIA landbase investment program. To assist in development of strategies, an analysis of the current hydrological condition will be undertaken in the Lakes North SRMP area in consideration of the MPB epidemic.

List of Acronyms

AAC	Allowable Annual Cut
BCTS	British Columbia Timber Sales
BEC	Biogeoclimatic Ecosystem Classification
BEO	Biodiversity Emphasis Option
BG	Biodiversity Guidebook
CWD	Coarse Woody Debris
EBS	Ecosystem-Based Structural
ECA	Equivalent Clearcut Area
ESSF	Englemann Spruce Subalpine Fir BEC zone
FIA	Forest Investment Account
FRPA	*Forest and Range Practices Act*
FSP	Forest Stewardship Plan
HLP	Higher Level Plan
HR	Hydro-Riparian
IFPA	Innovative Forest Practices Agreement
ILMB	Integrated Land Management Bureau
IWAP	Interior Watershed Assessment Procedures
LCM	Landscape Connectivity Matrix
LCN	Landscape Connectivity Network
LRMP	Land and Resource Management Plan
LU	Landscape Unit
LUPG	Land Use Planning Guide
MAL	Ministry of Agriculture and Lands
MOE	Ministry of Environment
MOFR	Ministry of Forests and Range
MPB	Mountain Pine Beetle
OGMA	Old Growth Management Area
PEM	Predictive Ecosystem Mapping
RE	Rare and/or endangered plant communities
SBS	Sub-Boreal Spruce BEC zone
SRMP	Sustainable Resource Management Plan
TSA	Timber Supply Area
VC	Vegetative Cover
WTR	Wildlife Tree Retention

PART 4. APPENDICES

Appendix 1. Seral Stage Analysis Report

Seral Stage Analysis Report (February 7, 2006 version)

Landscape Unit (biodiversity emphasis option)	BEC Variant	Crown Forested	Early Seral			Mature Plus Old Seral			Old Seral		
		Ha.	age/ %target	Max target (ha.)	Current state (ha.)	age/ %target	Min target (ha.)	Current state (ha.)	age/ %target	Min target (ha.)	Current state (ha.)
Babine East	SBS dk	14729	<40/<54%	7954	973	>100/>23%	3388	10575	>140/>11%	1620	6117
(BEO - Interm.)	SBS mc 2	16806	<40/<54%	9075	1224	>100/>23%	3865	8651	>140/>11%	1849	5483
	ESSF	12328	<40/<36%	4438	147	>120/>28%	3452	7748	>250/>9%	1110	617
L.U. TOTAL		**43863**		**21467**	**2344**		**10705**	**26974**		**4578**	**12217**
Babine West	SBS dk	7383	N/A	N/A	1779	>100/>11%	812	4193	>140/>11%	812	1423
(BEO - Low.)	SBS mc 2	37275	N/A	N/A	8491	>100/>11%	4100	24482	>140/>11%	4100	13359
	ESSF	14722	N/A	N/A	1246	>120/>14%	2061	12857	>250/>9%	1325	1284
L.U. TOTAL		**59380**			**11516**		**6973**	**41532**		**6237**	**16066**
Bulkley	SBS dk	26992	<40/<54%	14576	6287	>100/>23%	6208	16875	>140/>11%	2969	10594
(BEO - Interm.)	SBS mc 2	18383	<40/<54%	9927	5436	>100/>23%	4228	9125	>140/>11%	2022	4874
	ESSF	15515	<40/<36%	5585	3610	>120/>28%	4344	9332	>250/>9%	1396	502
L.U. TOTAL		**60890**		**30088**	**15333**		**14780**	**35332**		**6388**	**15970**
Burns Lake East	SBS dk	36128	N/A	N/A	4264	>100/>11%	3974	13803	>140/>11%	3974	7917
(BEO -Low)	SBS mc 2	28573	N/A	N/A	3521	>100/>11%	3143	9050	>140/>11%	3143	7107
	ESSF	11997	N/A	N/A	953	>120/>14%	1680	3632	>250/>9%	1080	423
L.U. TOTAL		**76698**			**8738**		**8797**	**26485**		**8197**	**15447**
Burns Lake West	SBS dk	26825	N/A	N/A	5118	>100/>11%	2951	17146	>140/>11%	2951	10825
(BEO – Low)	SBS mc 2	19077	N/A	N/A	4351	>100/>11%	2098	13797	>140/>11%	2098	9742
	ESSF	1732	N/A	N/A	159	>120/>14%	242	1467	>250/>9%	156	14
L.U. TOTAL		**47634**			**9628**		**5292**	**32410**		**5205**	**20581**
Fleming	SBS dk	2588	<40/<54%	1398	374	>100/>23%	595	1874	>140/>11%	285	1501
(BEO -Interm.)	SBS mc 2	36244	<40/<54%	19572	8581	>100/>23%	8336	23448	>140/>11%	3987	13275
	ESSF	9965	<40/<36%	3587	398	>120/>28%	2790	9118	>250/>9%	897	841
L.U. TOTAL		**48797**		**24557**	**9353**		**11722**	**34440**		**5168**	**15617**
Taltapin	SBS dk	3307	N/A	N/A	724	>100/>11%	364	2064	>140/>11%	364	1639
(BEO – Low)	SBS mc 2	44291	N/A	N/A	11665	>100/>11%	4872	27293	>140/>11%	4872	21661
	ESSF	20985	N/A	N/A	3008	>120/>14%	2938	13395	>250/>9%	1889	1941
L.U. TOTAL		**68583**			**15397**		**8174**	**42752**		**7124**	**25241**
GRAND TOTAL		**405845**		**76112**	**72309**		**66442**	**239925**		**42898**	**121139**

Note: Current state as of end of April 2004.
All harvesting and approved blocks to the end of April have been accounted for (these areas have been included in the early seral category).
Forest cover file used for analysis was projected to 2004.

Appendix 2. Old Forest Establishment Target and OGMA Area Analysis

Lakes North OGMA Area Analysis (March 29, 2007 version)

Landscape Unit (biodiversity emphasis option)	BEC Variant	Crown Forested	Old age	Old target		Old establishment target)		Candidate OGMAs			
								Crown Forest in COGMAs		*Old in COGMAs*	
		Ha.	*yrs*	*%*	*Ha*	*%*	*Ha.*	*%of est. target*	*Ha.*	*%of est. target*	*Ha.*
BABINE EAST	SBS dk	14729	>140	11%	1620	75%	1215	101%	1225	75%	908
Intermediate	SBS mc 2	16806	>140	11%	1849	75%	1386	96%	1334	66%	912
	ESSF	12328	>250	9%	1110	75%	832	25%	206	17%	142
L.U. TOTAL		**43863**			**4578**		**3434**	**81%**	**2765**	**57%**	**1962**
BABINE WEST	SBS dk	7383	>140	11%	812	50%	406	101%	412	6%	24
Low	SBS mc 2	37275	>140	11%	4100	50%	2050	92%	1895	60%	1221
	ESSF	14722	>250	9%	1325	50%	662	96%	634	55%	364
L.U. TOTAL		**59380**			**6237**		**3119**	**94%**	**2941**	**52%**	**1609**
BULKLEY	SBS dk	26992	>140	11%	2969	75%	2227	98%	2193	64%	1427
Intermediate	SBS mc 2	18383	>140	11%	2022	75%	1517	96%	1454	85%	1292
	ESSF	15515	>250	9%	1396	75%	1047	40%	424	32%	340
L.U. TOTAL		**60890**			**6388**		**4791**	**85%**	**4071**	**64%**	**3059**
BURNS LAKE EAST	SBS dk	36128	>140	11%	3974	50%	1987	111%	2196	78%	1547
Low	SBS mc 2	28573	>140	11%	3143	50%	1572	54%	852	40%	628
	ESSF	11997	>250	9%	1080	50%	540	84%	453	58%	313
LU TOTAL		**76698**			**8197**		**4098**	**85%**	**3501**	**61%**	**2488**
BURNS LAKE WEST	SBS dk	26825	>140	11%	2951	50%	1475	92%	1361	83%	1228
Low	SBS mc 2	19077	>140	11%	2098	50%	1049	139%	1460	103%	1084
	ESSF	1732	>250	9%	156	50%	78	0%	0	0%	0
LU TOTAL		**47634**			**5205**		**2603**	**108%**	**2821**	**89%**	**2312**
FLEMING	SBS dk	2588	>140	11%	285	75%	214	99%	211	57%	122
Intermediate	SBS mc 2	36244	>140	11%	3987	75%	2990	97%	2900	76%	2267
	ESSF	9965	>250	9%	897	75%	673	19%	128	15%	98
L.U. TOTAL		**48797**			**5168**		**3876**	**84%**	**3239**	**64%**	**2487**
TALTAPIN	SBS dk	3307	>140	11%	364	50%	182	86%	157	74%	135
Low	SBS mc 2	44291	>140	11%	4872	50%	2436	88%	2154	53%	1282
	ESSF	20985	>250	9%	1889	50%	944	101%	953	93%	874
L.U. TOTAL		**68583**			**7124**		**3562.215**	**92%**	**3264**	**64%**	**2291**
GRAND TOTAL		**405845**			**42898**		**25483**	**89%**	**22602**	**64%**	**16208**

Appendix 3. Proposed Objective for "Retention"

<u>Retention</u>

<u>for the Lakes North Sustainable Resource Management Plan</u>

Submitted by:

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Ministry of Environment
Environmental Stewardship Division

For consideration of:

The Lakes (North) SRMP Table Members

July 15. 2006

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Introduction

The Lakes (North) Sustainable Resource Management Plan (SRMP) is currently under development and will provide resource management for biodiversity over the northern half of the Lakes Timber Supply Area (TSA). In keeping with the Lakes South SRMP, objectives are being planned for seral targets (including old growth), wildlife tree retention, landscape connectivity, patch size, and coarse woody debris. Unlike the Lakes South SRMP, the Lakes North SRMP planning table must also consider the increased potential for environmental impacts resulting from an accelerated rate of timber harvest for the salvage of Mountain Pine Beetle (MPB) damaged timber. Since the Chief Forester's (CF) determination to provide an uplift to the Annual Allowable Cut (AAC) for the Lakes Timber Supply Area (TSA) he has also provided direction for a "conservation uplift". Specifically, the current CF, Jim Snetsinger, has provided licensees with guidance to increase stand level retention into the range of 10 to 25% .

Snetsinger (2005) further states that collaborative, multi-stakeholder, long-term landscape-level planning is the best option for managing increased retention that is balanced between the landscape and the stand and suggests that this planning be carried out as part of established regional strategic planning processes.
It is in the context of these recommendations that this report has been prepared: **to provide recommendations for an SRMP objective that will provide direction as to how and where the additional recommended retention levels (10 - 25%) could be most effectively deployed with consideration for non-timber forest values, risks, and best science – a "retention" objective.**

It is not the intent of this paper to re-emphasize existing legislation. Nor is it intended to replace other guidance given by authors such as Eng (2004) and Snetsinger (2005). That guidance should still be considered as important general mitigation strategies for;

- -wildlife trees
- -coarse woody debris
- -retaining non-pine and mixed species types
- -patch size
- -access planning
- -peak flow and sediment reduction

Although it is generally acknowledged that informative research regarding the effects of MPB on non-timber resources is limited, I have conducted an extensive review of available existing literature to determine the potential impacts of accelerated timber harvest and to identify opportunities for mitigation of impacts to environmental values and ecological processes. This should be considered an interpretation paper.

The **Retention Objective** that I am proposing will direct planners to prioritize the placement of retention targets (10-25% as per CF guidance) based on the environmental values (aquatic, terrestrial, hydrological, ecological) and potential risks to those values that may result from accelerated timber harvest where it can be determined through assessment. Where these values are undetermined I recommend an ecosystem-based management approach that focuses on retaining live forest over those portions of the landscape that provide the maximum value for area retained, namely, ***hydro-riparian sites***.

The need for this objective is clear given that the "results-based", "professional reliance" management regime that we currently operate within still creates a lot of uncertainty regarding "on the ground" performance. As an example regarding riparian management, White (2005) notes the following in regard to an evaluation of riparian practices under the Forest and Range Practice Act, for the legislative assembly:

> "Eight forest stewardship plans were analysed for their approaches to riparian management. Licensees opted largely for familiar practices, with few plans exhibiting notable deviation from Code-level practices, and limited innovation in results and strategies. Lack of clarity around proposed alternatives was common. Preliminary observation indicates that licensees have a fundamental understanding of FRPA with some continued misunderstanding around the development of proposed alternatives. Many licensees are hesitant to develop new approaches to riparian management."

I will begin with the objective itself, followed by strategies, and finally a rationale based on the following six perspectives:

1. Ecosystem based management – presents rationale based on natural disturbance patterns, and landscape ecosystem stratification and prioritization. Presents the merits of variable width riparian buffers.
2. Terrestrial vertebrate species - the importance of riparian areas to vertebrate species.

3. Hydrology and stream morphology – the importance of riparian areas with respects to watershed hydrology and stream morphology.
4. Stream Temperature – how changes in temperature affect the aquatic community.
5. Timber management and silviculture.
6. Restoration

The rationale will generally explain why, where information regarding values and risks are absent, a retention objective focused on hydro-riparian sites is the most effective approach from the ecological, hydrological, and operational standpoints.

Proposed Objective: **Retention**

Plan the retention of forests according to the highest known ecological and hydrological *values and risks* (*) in the stand or landscape. Where values and risks have not been determined locate retention in the oldest available forest types located on *hydro-riparian sites* (**).

*****known nest sites (i.e. goshawks), sensitive soils, fisheries sensitive watersheds, etc.

**Hydro-riparian sites potentially include:
- alluvial aquifers (hyperheic groundwater, phreatic groundwater)***
- fans and floodplains
- wet ecotypes (ecosystem-based) - SBSdk-07, 08, 09, 10
SBSmc-07, 09, 10, 12
ESSFmc-07, 08, 09, 10
-areas with high water tables, or projected high water tables.

*** Definitions:

Alluvial Aquifer – underlies both the stream channel and the riparian zone (or floodplain). Water is exchanged in both directions; to and from the stream channel.

Hyperheic groundwater – water that enters the alluvial aquifer from the stream, travels along localized subsurface flow pathways for relatively short period of time (minutes to months), and re-emerges into the stream channel downstream without leaving the alluvial aquifer. Ground water/surface water ecotones.

Phreatic groundwater – water derived from the catchment aquifer. Phreatic groundwater feeding a river enters the bottom of the alluvial aquifer and, as it moves towards the stream, mixes with hyporheic groundwater.

Intent

In any given industrial forest landscape where values and risks are unknown, and retention targets are limited, additional riparian protection likely provides the best over-all mitigation of negative impacts to aquatic and terrestrial habitat, and ecological and hydrological function.
This objective does not advocate equal representation of all ecotypes through retention but rather over-representation of highest value landscape features as a mitigation strategy and as the beginning of a restorative approach to Nadina ecosystems following the next 5-10 years of intensive timber harvest.
The value of the habitat structure that riparian areas provide to fish is assumed to be well known and the scientific rationale is exhaustive. Therefore it is not discussed directly in this paper. The intent is to provide scientific validation of this objective for less recognized riparian values and processes. Stream temperature as it relates to fish is discussed separately.
This objective is intended to be used for deployment of the 10-25% retention recommended by the CF (Snetsinger 2005), and is therefore incremental to the legal retention requirements of FRPA and the Old Growth targets of the Lakes LRMP/SRMP.

Strategies

1.Combine wildlife tree attributes with riparian sites where ever possible.

2. When planning block boundaries, they should be located at edge of hydro-riparian or non-pine type.

3. Where retention occurs within the block boundaries, this area will credit towards the 10-25% target. Partial cutting (removal of pine) can occur in appropriate portions of the hydro-riparian RMA, and could be a credit to the 11-25% based on basal area removed.

4. It is particularly important to provide more riparian protection in basin headwaters.

5. Avoid road construction within hydro-riparian areas.

6. Retain large enough areas that they can constitute a future timber harvesting opportunity.

7. Include hydro-riparian sites that have old growth attributes as part of the spatial old growth strategy.

8. Identify hydro-riparian sites at the strategic or operational planning level.

9. Describe known values and risks in the Forest Stewardship Plan.

Rationale

1. Ecosystem Based Management (EBM)

Summary of literature.

- *protection of hydro-riparian sites is an ecosystem-based management approach to riparian management because it recognizes the essential connectivity of the entire drainage system and it's importance to ecological and hydrological function.*
- *some ecosystems are more important for landscape function than others and should be protected to a higher degree, especially when negative impacts to seem imminent.*
- *hydro-riparian sites exist throughout watersheds and are readily identifiable.*
- *legislated riparian requirements follow arbitrary boundaries with limited ecological consideration. This causes numerous challenges related to logging on wet sites, silviculture, and windthrow, often providing justification for the removal of much riparian forest.*
- *fixed width riparian buffers need to be reconsidered as an effective method for managing riparian areas. Stream width does not appear to be a good predictor of the riparian flood plain width.*
- *riparian areas are areas that can be skipped by fire, be a barrier to fire, or at the very least respond differently to wildfire. Therefore they may be sites with longer fire disturbance intervals.*
- *because of their predominantly non-pine or reduced pine component they are certainly the ecotype most likely to remain as living forest following an MPB epidemic.*

- *if riparian areas burned less frequently or were attacked by MPB with less frequency than uplands, they should be represented on the landscape with more frequency and managed to retain their disproportionately high inherent ecological and hydrological value.*
- *the fact that wildfire commonly burns through some riparian areas more than others certainly makes the case for variable width riparian buffers as opposed to fixed width buffers..*
- *although not always continuous a hydro-riparian objective, by default, contributes to the mutual objectives of hydrological, aquatic, and terrestrial landscape connectivity. Hydro-riparian and deciduous retention could comprise the SRMP objective for connectivity.*

Eng (2004). Innovative or non-traditional (non-clearcut) silvicultural systems should be encouraged, where appropriate, to maintain some biological legacies.

Church and Eaton (2001). Forest management in British Columbia has for some time included some form of special management or protection for stream channels, streamside habitat as shore zones. The principal basis for specifying management procedures along streams is a simple classification of the stream channel and characteristics of fish population in the streams (cf. Forest Practices Code of British Columbia). In an ecosystem-based approach to land management these criteria are neither sufficient nor logical as a basis for managing aquatic and riparian ecosystems because they do not recognise the essential connectivity of the entire drainage system, hydrologically, sediment-ologically, and ecologically. A classification and operational rules that recognise the ecosystem units themselves, including the stream channel and the adjacent terrestrial surface to the limit of riparian influence, is more appropriate. Such a classification was developed by the Clayoquot Sound Scientific Panel (Report 5, 1995; Appendix II).
The Scientific Panel recommended that the entire hydroriparian zone be designated a special management zone. Within the special management zone, it is recommended that the entire "active floodplain" be a reserve. For streams that do not have an active flood plain, it is recommended that reserves be extended for 20 to 50 m horizontal distance into the forest from each channel bank, according to the size of the channel. These recommendations, which are intended to apply to all perennially flowing channels, are to secure the ecological function of the hydroriparian system.

Wilford, et al (2002). This paper pertains to "fans" small floodplains on forestry landscapes. "The forest stand component of riparian vegetation plays two hydrogeomorphic roles (on fans): enhancement of sediment deposition and reinforcement of the soil mass." Where forestry prescriptions fail to recognize the footprint left by these hydrogeomorphic signatures, stream channels and fan surfaces are often destabilized. This can lead to impacts to growing sites, roads, drainage structures and other investments. Forestry staff can be trained to identify the zone of riparian forest stand influence.

It is well known that biodiversity is non-randomly distributed. Certain sites teem with life, whereas other are relatively species poor. The Nature Conservancy (TNC) have pioneered an approach to identify sites with exceptional biodiversity on private lands. The approach involves collection of site data and scoring of sites based on their global and state-level biodiversity values. The strength of this approach is that it recognizes the importance of certain sites (NCASI, 2005).

Riparian zones are an unusually diverse mosaic of landforms, communities, and environments within the larger landscape, and they serve as a framework for understanding the organization, diversity, and dynamics of communities associated with fluvial ecosystems (Naiman and Decamps, 1997). The riparian zone encompasses the stream channel between the low and high water marks and that portion of the terrestrial landscape from the high water mark toward the uplands where vegetation may be influenced by elevated water tables or flooding and by the ability of the soils to hold water (Naiman et al, 1993; Naiman et al 1997).

Macdonald et al. (2003). The Forest Practices Code of British Columbia legislation specifies riparian management areas widths of 20-30 m for streams with bank-full widths of less than 3 m without fish and streams less than 1.5 m with fish, respectively. The application of these objectives is flexible and subject to various interpretations and frequently results in the removal of all commercial vegetation. Consequently, they have proven to be controversial, and their effectiveness for protecting aquatic ecosystems has been questioned.

Richardson et al. (2002b). Other approaches to managing riparian forests need to be evaluated besides fixed width buffers. Innovative solutions beyond narrow, linear strips of trees and narrow machine-free zones are necessary, but regulatory frameworks and lack of long-term funding make tests of alternatives difficult to pursue.

Delong (1999). The underlying assumption is that the biota of a forest is adapted to natural disturbances and thus could cope more easily with the ecological changes associated with timber harvest if the patterns created resemble those of natural disturbances (Hunter 1993, Swanson et al. 1993, Bunnell 1995, as cited in Delong 1999).

Recent studies in the Klamath region and eastern Cascades have found that fire return intervals in riparian reserves are more variable than in adjacent uplands and tend to be longer (Poage 1994; Everett et al. 2002; Skinner 2003 as cited in NCASI 2005).

Weather, fuel moisture, width of stream, topography, orientation of riparian areas relative to prevailing wind, fire intensity in upslope areas and other factors will affect the probability of fire crossing over riparian areas (Agee 1993 as cited in NCASI 2005).

NCASI (2005)– Modeling management after natural disturbance.
Adaptations to recovering from natural disturbances are common. In recent years, a number of books (see Kohm and Franklin 1997; Hunter 1999; Lindenmayer and Franklin 2002), papers (e.g., Atwill 1994), and special features in the journal of Ecological Applications (Roberts and Gilliam 1995) have addressed the topic of biodiversity in forests managed for fiber production. They have all concluded that management should attempt to deviate less from the historic disturbance regimes in order to better maintain biodiversity. The premise is that organisms are not as well adapted to disturbance regimes that did not occur in the past and/or that substantially diminish various legacies upon which resilience apparently depends. Silviculture based on models of natural stand development following disturbance is now increasingly used where goals are both economic and ecological (Franklin et al. 2002).

(Andison and McCleary 2004). We found no evidence of either the age-class distribution, or percentage of old forest of riparian zones differing from the rest of the landscape at very coarse scales. However, at finer-scales, patterns began to emerge. For example, we found evidence that small, partially burnt residual islands tend to form at or near riparian zones more often than expected. Such islands tend to survive the fires relatively intact, form at wide streams and on wetter sites, and chances are good that the surviving trees will be white spruce. We also found evidence that fires tend to stop at riparian zones more than expected, and particularly so on large streams with steep slopes. However, in all cases, the relationships were weak, and highly variable. Overall, fire burnt through the majority of riparian zones.
Heinrichs – However, the question is not whether fire does or does not burn through riparian zones. The question is with what frequency, and, how does it behave?

Gyug (1996). Topographic effects on fire behaviour were the sole sources of this diversity (i.e. differences between upland and riparian forest) in only 20% of the riparian sites. Gullies deeper than 28 m and floodplains wider than 50 m appeared to deflect or reduce the intensity of fires leaving older stands in these riparian sites. Tree Species diversity in the remaining 80% of the riparian stand resulted mostly from the establishment and growth of trees in the post-fire stand. Stream width was not a good predictor of the extent of riparian floodplain in the first and second order streams studied.

Gyug(1996) (*in the MSdm1)* believes that current riparian (FPC) guidelines set up a situation which is the opposite of what is found in nature: upwards branching pattern of linear forest patches along the lower reaches of streams that will lack any connection near the headwaters. "…. fires would often have burned across lower stream reaches where there will be reserves of trees." He recommends two options for headwaters;

- Add the forested subhydric site series to the definition of stream riparian zone width (Note that the FPC *wetland boundary* definition already includes the subhydric site series)
- Increasing forest buffer zone widths for floodplain sites where forest are generally shallow rooted and prone to windthrow.

Variability closer to natural conditions along lower stream reaches might be added by retaining only enough trees to achieve the overall survival levels naturally found in typical drainages. Table 1. The FPC guideline will benefit wildlife on S1-S3 streams where cycles of wildlife trees and CWD may more closely mimic natural cycles with tree reserves along streams. Wildlife tree and CWD cycles on S6 headwater streams will be well below natural levels.

Schellhaas et al (2001). Fire frequency did not seem to be affected as much by aspect as it was by localized land characteristics such as wet areas and rocky outcrops on open slopes and ridge tops. Remnant Pl and Sx survived where stand densities and fuels were lower and where fuel moisture was higher. Post-fire remnants seemed to be most common on rockier portions of ridgelines where pre-fire fuels and stand density were probably less. Some of the largest fires they discovered occurred in areas with low and moderate topographic deviation.
Riparian areas often provided significant barriers to fire spread in the subalpine community. When fires did manage to burn into riparian forests the rate of spread and intensity was often either stopped or reduced, allowing much of the over story to survive. 70% of all riparian areas were either unburned or had significant remnant overstory survive the latest fires, characteristic of lower fire intensity.

Stuart-Smith and Hendry (1998) – Residual Trees Left by Fire in Invermere– Thirty Percent of all *clumps* (O.3 – 12.3 ha and burned through) were adjacent to streams for all or part of their length. There was no relationship between clump placement and aspect. Almost all *islands* (2 -100 ha and burned through) were located adjacent to a fire boundary. 66% of islands were located next to streams. Islands displayed a stronger relationship to aspect than did clumps, with 36% of islands found on cool slopes and 64% on warmer ones. Many skips (larger unburned areas) were located on steep rocky slopes with low tree density and little or no CWD or understorey.

2. Terrestrial Vertebrate Species

Summary of literature.

- *riparian areas provide unique habitat structure that is predictably depended on and used by the majority of species.*
- *although riparian areas are a small component of landscape they represent a value to wildlife and fish species disproportionate to their degree of occurrence.*
- *FRPA default Riparian Management Areas, in many if not most cases, are likely ineffective in terms of accurately classifying riparian areas but also insufficient in the amount retained. The size of the river or stream is one consideration.*
- *deciduous stands are a predictor of species richness.*
- *if riparian areas are harvested (hydro-riparian in particular) vertebrates will be more severely impacted than if only uplands are harvested.*
- *there is a general lack of preference for lodgepole pine among the vertebrates of the Lakes TSA.*
- *avoiding harvest of riparian areas is critical to mitigating negative responses on a wide range of species.*
- *the effects of the removal of riparian vegetation are largest in relatively small, narrow, and shallow water bodies, such as headwater streams.*
- *Headwaters are source areas of food for downstream, fish-bearing stream food webs (headwaters comprise 70-80% of most watersheds).*
- Reserving riparian habitat and non-pine species from harvest will permit more rapid re-colonization of salvaged areas by many species including some listed species.

Note: the value of the habitat structure that riparian areas provide to fish is assumed to be well known and is not generally discussed in this paper. It is probably sufficient to add however, that fixed width riparian buffers provided through FRPA are frequently of insufficient width to encompass some fisheries sensitive zones.

(Kauffman et al. 2001). The high degree of association between riparian habitats and mammalian species can be explained in part by riparian areas having predictable sources of water, abundant streamside insects, favourable microclimates, and high plant composition and structural diversity.
Although riparian zones make up only 1-2% of western landscapes, they provide breeding habitat for more species of birds than any other vegetation type.

Buffer width influences bird community composition. In western Washington and Oregon, buffers >30 m wide retained similar bird communities compared to those present prior to harvest and unlogged controls, where as more narrow buffers (<30m wide) experienced higher species turnover (Hagar 1999 as cited in NCASI 2005).

In a comparison of bird communities between large and small rivers in western Washington, Lock and Naiman (1998 as cited in NCASI 2001) found that bird species richness and total abundance was higher in riparian areas of large rivers than smaller rivers. They also found that the ratio of deciduous to coniferous cover was a good predictor of bird species richness, which increased with deciduous cover, and that large rivers had a higher number of unique species not found in riparian habitats of the smaller rivers. Riparian habitat adjacent to large rivers appeared to be particularly important for raptors, neotropical migrants, and deciduous-associated species.

Bunnell et al (2004)

> -p7-Because there is no literature dealing with events at this scale, and because it is too early to know the pattern of harvesting, our predictive efforts can be no more than reasoned estimates based on the natural history of vertebrates in the area. Consequences likely will be quite different if riparian areas are harvested along with upland areas or if all tree species are harvested instead of harvest being limited to lodgepole pine.
>
> p.7-The lack of preference for lodgepole pine among most species derives partially from the fact that lodgepole pine forests are specifically adapted to stand-initiating fires and do not represent a community with long-term stability (Davis et al. 1980; Fischer and Clayton 1983; Smith and Fischer 1997, as cited in Bunnell et al. 2004).
>
> -p.7-Only three vertebrates present in the study areas are known to seek lodgepole pine as a preferred forest cover and none are restricted to it.

-caribou – sometimes for winter ranges
-black-backed woodpecker
-3-toed woodpecker

p.8-These species are likely to respond negatively to salvage and the large amount of cutting planned. Some vertebrate species can be expected to respond neutrally or positively to large-scale removal of lodgepole pine forests.
Predominantly negative effects can result from practices with regard to riparian habitat, deciduous stand, cavity sites, and older seral stages.

p.8- 116 of 182 vertebrate species in the study area either prefer early successional habitat (32) or are insensitive to age of forest cover (84) at the broad scale, or prefer mixtures of stand ages. However, less than half of these 116 species would flourish if large tracts of forest were completely denuded of forest cover. There are four reasons**.** First, 73 of these species (63%) of the invertebrate species in the study areas are riparian associates. Riparian areas must be retained relatively intact. Second, a significant portion of both early seral associates and generalists respond positively to forest edge. Third, among these species, some that show no strong affinity for edges will not venture into the middle of larger clearcuts. Fourth, an additional number of species noted as early seral associates or generalists required only a few additional trees within expansive clearcuts to do well.
p.9-Retaining species other than lodgepole pine during logging will help retain about 60% of the terrestrial vertebrate species present as well as bryophytes, lichens, and non-pest invertebrates**,** provided the riparian areas are maintained.

p.9-It is important to note that, in the provisions for uplift in AAC to accommodate salvage operations, it is assumed that stand-level retention will average 20% rather than the 7% assumed for normal forest operations. That level of retention should accommodate retention of patches of other tree species and riparian areas.

Data suggest that most dead lodgepole pine will be on the ground within 10 years.

p.12-Within the three TSAs, 92 of 182 species (50.5%) are more abundant or productive within riparian areas. Avoiding harvest of riparian areas is critical to mitigating negative responses on a wide range of species.

p.12-A total of 45 vertebrate species within the three TSAs show marked preferences for hardwood trees or stands. Most of these (32) are birds. Of the 45 species, 31 (69%) also show marked preferences for riparian areas where hardwoods are more abundant. The other 14 species use primarily upland hardwoods away from riparian areas, but often will be found in riparian areas as well.

p.13-Although there are 32 cavity-nesting birds within the area, only six are large, strong primary excavators capable of excavating holes that other bird, bat and other small mammal species use. Of those six, five preferentially excavate in hardwood species (the exception is the pileated woodpecker). These large primary excavators are sometimes referred to as keystone species, because so many other species depend upon the holes they excavate, including rodents and bats. In the three TSAs, these keystone species (and those that depend on them) rely largely on hardwood trees as nest sites. That alone makes the maintenance of hardwood components critical to sustaining biological diversity. Provision of riparian buffers will accommodate many of these species, but if deciduous trees become restricted only to riparian sites, the abundance of these species and the secondary cavity nester dependent on them will be reduced. In short reservation of riparian areas and upland hardwoods from harvest is critical. In addition to vertebrates, their reservation will help to maintain many other species of lichens, bryophytes and invertebrates.

p.17-Listed species.
<u>Great Blue Heron</u>-provided that riparian areas are left unharvested and species other than lodgepole pine are retained, large-scale salvage should have little impact on the heron.
<u>Fisher</u>-Forestry practices negatively affect fisher habitat in several ways. Habitat is lost due to logging of old forest and removal of larger-diameter trees, particularly from riparian sites – both streams and wetlands; creation of large openings and habitat fragmentation may restrict movement; lack of structural complexity in recently logged stands makes habitat less favourable; and increased access for trappers result in increased mortality (Canning et al. 1999; Powell and Sielinski 1994; Thompson and Harestad 1994; Weir 2003, as cited in Bunnell 2004).
Reserving riparian habitat and non-pine species from harvest will permit more rapid recolonization of salvaged areas.

P.27-The effects of the removal of riparian vegetation are largest in relatively small, narrow, and shallow water bodies, such as headwater streams, which are used for spawning by many species, especially salmonids.

Because they produce fewer secondary compounds than do conifers, hardwoods host abundant herbivorous insects.

Reeves, Everest, and Sedell (1993 – as cited in NCASI 2005) determined that diversity of juvenile salmonid assemblages was directly related to the proportion of the watershed that had been harvested, and diversity decreased when >25% of the basin had been harvested. Furthermore, basins that experienced a high level of harvest were more frequently dominated by a single salmonid species. Instream habitat heterogeneity was also directly related to level of harvest, and streams in low-harvest basins had significantly more pieces of wood per 100m and more pools per 100m than streams in high-harvest basins.

M.S. Wipfli et. al. , Concluded that the amount of detritus and invertebrates exported from headwaters through out the year ……..enough to support 100-2000 young-of–the year salmonids per kilometre of fish-bearing stream. Also said that alder (red) sites exported over four times more invertebrates than did young-growth conifer sites

3. Hydrology and Stream Morphology

Summary of literature:

- *beetle epidemics increase water yield.*
- *logging generally increases water yield.*
- *increased snow accumulations in clear-cuts and increased (earlier) melt rates due to increased exposure to sun and wind increase water discharge and change discharge timing.*
- *forestry activities within the riparian areas will have a disproportionately high influence on freshet hydrology relative to activities in the rest of the watershed*
- *failure to recognize and protect hydro-riparian areas can cause stream channels and riparian areas to become destabalized.*
- *riparian vegetation may use more water*
- *diurnal streamflow oscillations are reduced when riparian vegetation is removed (indicating reduced transpiration on the site).*
- *clearing riparian vegetation causes greater water yield than upland harvesting.*
- *there are generally higher water tables following logging.*
- *roads constructed through hydro-riparian areas intercept water through ditches, accelerating delivery to streams.*
- *most flood events are generated in the zone of soil saturation (hydro riparian areas).*
- *the alluvial aquifer, which includes the hyperheic aquifer and the phreatic aquifer is an invisible zone within which critical hydrological processes occur (including nutrient exchange). The function of this zone can be negatively affected by increased peak flow.*
- *increased peak flows can affect channel morphology through removal of LOD, channel simplification, sedimentation, and stream widening and shallowing.*
- *riparian vegetation can offset increases in stream transport power associated with increased peak flows.*
- *Changes in timing and magnitude of peak flows associated with logging can alter floodplain recharge and the subsequent release into stream channels.*
- *Because headwater systems comprise 70% to 80% of the total catchment area headwater systems are important sources of sediment, water, nutrients, and organic matter for downstream systems.*

Pike and Scherer (2004). Three studies that address low flow changes associated with beetle epidemics and (or) wildlfire (Bethlahmy 1975; Cheng and Bondar 1984; Potts 1984 as cited in Pike and Scherer 2004) all report increases in water levels after disturbance.

With regard to interception, evaporation, and transpiration within a watershed, it is thought that management activities that occur within low flow source areas (i.e., riparian areas) will have a greater influence than those occurring in non-source areas (Pike and Scherer 2004). Pike and Scherer (2004) cited three studies to demonstrate the influence of riparian vegetation on streamflow, though none of these studies were conducted in snow-dominate catchments. Hicks et al (1991) attributed reductions in low flows 8 to 15 years after logging to changes in riparian vegetation to species that used more water. Berndt (1971) documented that prior to wildfire, streamflow oscillated daily due to transpiration from vegetation rooted in the streamside capillary fringe, whereas after the fire, only minor daily oscillation were observed. Scott (1999) found that clearing riparian vegetation caused a disproportionately greater gain in water yield than would have resulted from harvesting vegetation in non-riparian areas in the study areas.

Pike and Scherer (2004) discuss that one may expect that this would reduce flows in the low flow period. However, this expectation not supported by numerous North American studies completed in snowmelt-dominated watersheds. Troendle and

Stednick (1999) and Toendle et al. (2001) (as cited in Pike and Scherer, 2004) have shown that the primary effect of harvesting is an earlier start to the freshet period, with higher flows on the rising limb and peak of the snowmelt hydrograph, and little or no effect on the recession limb.

Pike and Scherer (2004) discuss that lower losses of water (lack of evapotransporation and increased snow accumulation, etc), generally lead to higher moisture levels in the soil matrix due to a higher proportion of precipitation reaching the ground. The result is typically higher water tables in cleared areas, although the upper layers of the soil may appear drier due to increased exposure to evaporation.

If connected to the natural drainage network of a watershed, roads may lead to quicker delivery of runoff (Wemple 1996 as cited in Pike and Scherer 2004). Conceptually, if ditch lines and road surfaces interrupt natural flow paths that result in accelerated water delivery to streams, this could lead to lower low flows (and higher peak flows) due to some water bypassing the normal routing pathways (Pike and Scherer, 2004). However combining most of the literature to date on the subject of timber harvest (in general) and low flows indicates that, in most forest types, the overriding suggestion is for streamflow to increase during the low flow period after forest harvesting.

Wilford, et al (2002). The forest stand component of riparian vegetation plays two hydrogeomorphic roles (on fans): enhancement of sediment deposition and reinforcement of the soil mass. Where forestry prescriptions fail to recognize the footprint left by these hydrogeomorphic signatures, stream channels and fan surfaces are often destabalized. This can lead to impacts to growing sites, roads, drainage structures and other investments. Forestry staff can be trained to identify the zone of riparian forest stand influence.

(Hibbert and Troendle 1988). The central precept of the variable source area concept as applied to forested land is that water generally infiltrates undisturbed forest soils, migrates down slope, and maintains saturation or near-saturation at lower slope positions. These lower slope positions readily contribute subsurface flow to storm flow as the zone of saturated soil surface expands laterally and longitudinally. Given that storm flow is primarily generated from areas of shallow water table close to the stream it is reasonable to retain forest on these sites to retain transpiration as well as other functions.

Chen et al. (2006). Found that the average diameter, length, volume and biomass of individual LWD pieces increased as a function of increasing bank-full width. The large majority of LWD pieces in the smallest sized streams was orientated perpendicular to stream-flow and was located in spanning the channel. Conversely, most LWD pieces in intermediate sized streams were orientated parallel to the direction of flow and were situated below the bank-full height of the channel. With a difference in the orientation of and position, LWD pieces within different sized streams are expected to have varying potentials to affect stream-low and channel habitats. These results highlight the need to recognize spatial variation of in-stream LWD loading and function through channel networks when maintaining suitable LWD pieces and making riparian management decision at watershed scales.

Gibert et al (unknown year). Groundwater/Surface water ecotones, are transition zones, the limits between very contrasted systems. At different space and time scales they provide, favour, filter or stop exchanges and they can also modify interactions between ecosystems.
They are sites where intense hydrological changes exist and where the biogeochemical activity is higher than in the adjacent systems that influence the quality of the water flowing through the interface.
The main characteristics of these interfaces are their great variety of elasticity, permeability, biodiversity and connectivity. The ecotone, a temporary or permanent sink of organic matter from the drainage basin, is determined by such diverse and interactive external factors as riparian vegetation, channel and bank morphology, flood regime of the surface water, with seasonal variations of retention and storage. Moreover the field ecotone produces additional nutrient fluxes, for example DOC increases, resulting in a rise in microbial nitrate and oxygen consumption. The distribution of bacteria indicates a very high metabolic rate. The soil/vegetation system and macrophytes act as a self-purification filter for the surface and groundwater. The importance of the deposition function in the ecotone has been emphasized in this process of self-purification.
Malfunctioning of these ecotones can occur due to hydraulic stress, loads of particulate and dissolved matter, and excessive leaching of substances from catchment areas.
Studies carried out across different space scales have revealed that two of the key factors for protection of both surface and underground systems are water exchanges and the biological properties of the interface.

(Ebersole, 2003). The associations that we observed are suggestive of potential linkages between the characteristics and occurrence of cold water patches in streams and channel and riparian structure. Channel configuration and structural complexity can influence the degree to which cold water inflow is intercepted and stored. Numerous authors have suggested that floodplain isolation and channel simplification associated with channelization, logging, and other land uses in general disconnect desirable stream-land interactions including groundwater-stream water interchange (Bilby 1984; Pringle and

Triska 2000; Fernald et al. 2001). As channels became wider and shallower among our study sites, distances of cold water patches from the main channel increased and frequency of cold water patches declined.

Helie et al. (2005). The hydrological cycle is principally driven by solar radiation and gravity. The hydrological processes that affect the quantity and timing of water available for streamflow generation include precipitation, interception, evaporation and transpiration and changes in water storage within a watershed.

The variable source area concept suggests that forestry activities within the riparian areas will have a disproportionately high influence on freshet hydrology relative to activities in the rest of the watershed (Hewlett and Hibbert 1967)

Macdonald et. al 2003 found an increase in peak flow and mean daily freshet discharge following harvesting. There was no sign of hydrologic recovery in the 5-year post-harvest period. *This work was done in the central interior.*

Hydrologic recovery is not expected until the new trees are about 9 meters tall (B.C. Min of For. 2001). Until then, there is a significant risk of hydrological problems.

Snetsinger (2005). The accelerated risk of harvest represents a departure from what is normally considered acceptable in watersheds, thus increasing the risk of stream instability, sedimentation and loss of biodiversity. I believe increased retention is likely the best option for minimizing these risks, particularly until these watershed have reached hydrologic recovery. Retention may be particularly effective around sensitive areas (e.g., areas with high water tables) – maintaining an undisturbed forest floor with large amount of deadwood and, where possible, live trees.
The CF is mindful of the hydrological risks associated with accelerated timber harvest as he cites the following research:
-Both harvesting and beetle infestation may result in increased peak flows and water yields, leading to elevated risks for streambank instability and sedimentation (Cheng 1989).
-Increased water yields are less likely to produce adverse effects if roads and other ground disturbance are absent (e.g., areas retained from harvesting) (Hetherington 1987).
-Hydrologic recovery is sped up by leaving live species to transpire water (e.g., understory shrubs, advance regeneration or non-pine mature trees (B.C. Min. of For. 2001)

Land uses may also influence groundwater – stream water inter-change rates and temperatures. Logging or other vegetation removal can lead to increases in shallow groundwater temperature (Hewlett and Fortson 1982; Holtby 1988 as cited in Ebersole 2003). Changes in timing and magnitude of peak flows associated with logging or river regulation may alter floodplain recharge and the subsequent release into stream channels (Sheperd et al. 1986 as cited in Ebersole 2003). Coarse sediments from roads, grazing, or logging may induce channel aggradation, widening , and structural simplification, thereby increasing surface-water exposure to solar radiation (Beschta et. Al 1986 as cited in Ebersole 2003). Our observation that maximum temperatures within cold water patches were higher in reaches with lower frequencies of large wood and fewer pools is consistent with hypotheses linking channel simplification, straightening, and widening to increased fragmentation of cold water refuges.

What are the risks?

-coarse sediments can induce channel aggradation, widening, and structural simplification, thereby increasing surface-water exposure to solar radiation. This is directly in keeping with other findings that temperatures are higher in reaches with lower frequencies of large wood and fewer pools.
-stream temperature associated with removing vegetative shade (logging) causing warming of shallow groundwater.
-Changes in timing and magnitude of peak flows associated with logging may alter floodplain recharge and the subsequent release into stream channels (Sheperd et al. 1986 as cited in Ebersole et al 2003).
Increased bank resistance provided by riparian vegetation is required to offset increases in stream transport power associated with increased peak flows.

Because the spatial extent of headwater systems composes a major portion (70% to 80%) of the total catchment area headwater systems are important sources of sediment, water, nutrients, and organic matter for downstream systems. (Sidle et al. 2000, Meyer and Wallace 2001 as cited in Takashi et.al.),

4. Stream Temperature

Summary of literature.

- *stream temperature is directly related to watershed hydrology and stream morphology (i.e. increases to peak flow), as well as riparian shading and air temperature.*

- *groundwater inputs cool stream water.*
- *water temperature effects fish species presence.*
- *stream temperature influences metabolic rates, physiology, and life-history traits of aquatic species and helps to determine rates of important community processes such as nutrient cycling and productivity.*
- *given that an adequately rigorous assessment of streams for temperature sensitivity is unlikely to occur on time, a precautionary approach is justified.*
- *stream warming can be cumulative with several tributaries.*
- *smaller streams heat up faster than large streams.*
- *wide, shallow streams heat up more than deep, narrow streams.*
- *deep narrow streams can be changed to wide shallow streams due to the impact of increased peak flows and associated channel simplification and sediment deposition.*
- *streams generally warm in a downstream direction.*
- *riparian vegetation reduces stream warming by shading the stream and areas of shallow ground water (hydro-riparian areas).*
- *stream roughness and meandering forces flow into the hyperheic area where it generally cools; if channels are smoothed and straightened this process is reduced.*
- *stream shading is more important on small streams than large streams.*
- *the physical structure of streams influences how water temperature in stream channel will respond to a given heat load and flow regime.*
- *the only practical tools available for mitigating stream warming in the industrial forest are road management and riparian management.*
- *stream temperatures in northern sub-boreal forests may require greater recovery periods, due to the slower growth of under- and over-story vegetation.*

Danehy et al (2004). Groundwater inputs moderated thermal conditions in streams but did not subsume the predominant temperature range controls of insulation and air temperature.
(follows that the degree to which ground water can moderate temperature is largely dependent on the degree of forest shade provided over areas of shallow groundwater).

Ebersole et al (2003). Heterogeneity in stream water temperature created by local influx of cooler subsurface waters into geomorphically complex stream channels was associated with increased abundance of rainbow trout (Oncorhynchus mykiss) and chinook salmon (Oncorhynchus tshawytscha) in northeastern Oregon.

Allen (1995). Stream temperature directly influences the metabolic rates, physiology, and life-history traits of aquatic species and helps to determine rates of important community processes such as nutrient cycling and productivity (Allen 1995)

Another argument that can be made for being precautionary about riparian protection at this time of accelerated timber harvest is that temperature sensitive streams have not been identified, and it is likely that an adequately rigorous process will not be initiated or completed within the period of the AAC uplift (the next 5-10 years), at any rate it will not be done on time given that increased salvage harvest are already underway. Ideally this should be done prior to timber harvest. Assessment could include potential impacts to:

-timing of fish migration
-timing of spawning
-timing of emergence from eggs and egg survival
-invertebrate community
-growth
-resistance to disease

A forest manager or habitat manager would then need to define an acceptable level of impact and tradeoffs relative to the thermal thresholds of this variety of factors (values).

Nelitz (2004). The influence of roadbeds on stream temperature may be driven by changes to groundwater flow and exchange across a watershed and not just the localized effects of roads.

Teti (2000). The removal of riparian vegetation can increase mean daily stream temperature and if it does so on several tributaries, the increases can be cumulative downstream.

While external factors (drivers) determine the net heat energy and water delivered to a stream, the internal structure of a stream determines how heat and water will be distributed within and exchanged among a stream's components (channel, alluvial aquifer, and riparian zone/floodplain). Therefore, the interaction between external drivers stream temperature and the internal structure of integrated stream system ultimately determines channel water temperature (Poole and Berman 2001).

Often, channel water temperature trends away from baseline temperature and toward atmospheric temperatures in downstream direction (Sullivan et al 1990 as cited in Poole and Berman 2001).

Riparian vegetation blocks solar radiation from reaching the channel and reduces the stream's heat load (Davies and Nelson 1994, Hostetler 1991, Naiman and others 1992 as cited in Poole and Berman 2001)). Vegetation also reduces near-stream windspeed and traps air against the water surface. This action reduces heat exchange with the atmosphere by decreasing convection and advection of heat energy to the water surface (Naiman and other 1992 as cited in Poole and Berman 2001). Channel width influences channel surface area across which heart is exchanged; a greater surface areas allows for more rapid heat conduction and radiation. Under the same climatic conditions, narrower, deeper channels will not absorb as much heat as shallow, wide channels. Similarly, riparian vegetation more effectively shades a narrower channel.

Stream roughness, and meander influence degree of hyperheic flow. Therefore channelization and simplification of stream structure reduce hyperheic flow.

Stream characteristics (riparian shade, stream discharge, tributaries, phreatic groundwater, hyporheic groundwater) have different degrees of influence on temperature depending on stream size. The physical structure of stream channels, riparian zones, and alluvial aquifers changes along the continuum from headwaters to river mouth (Naiman and others 1992 as cited in Poole and Berman 2001). As stream structure changes, the processes that drive and mediate stream temperature vary in their relative importance:
Riparian shade – most important in stream order 1-2, moderate in 3-4, low in 5+
Stream discharge- most import. in order 5+, moderate influence in 3-4.
Tributaries – High in 3-4 moderate in 1-2, low-mod in 5+
Phreatic gw – high in 1-2, mod in 3-4, low-mod in 5+
Hyperheic gw – mod-high in 3-5+, low mod in 1-2.
(Poole and Berman 2001)
Thermal inertia of large water volumes (large streams) allows the stream to resist changes in temperature.
Hyperheic influence can be strong in larger streams due to more extensive floodplains (alluvial aquifers are well developed).
Generally speaking, as streams become larger, insulating processes become less effective and buffering processes (which are driven by stream morphology) become more important.
In streams where flood spates occur during winter and spring months, the highest aquifer recharge period occurs while the stream channel is coldest. In these systems, hyporheic exchange and floodplain storage of floodwaters may be an especially effective buffer against stream channel warming because the aquifer is recharged predominantly with cold water. This cold water is discharged to the stream during baseflow periods when the highest stream temperatures are apt to occur.

Poole and Berman 2001 (Key conclusions)

1. Human activities that alter the ecological drivers of stream temperature can affect water temperature in stream channels by changing the timing or magnitude of the amount of heat energy delivered to the channel (heat load) or the amount of water delivered to the channel (flow regime).
2. The dominant mechanism controlling water temperature differs among stream systems with different structural characteristics. Therefore, streams with different structural characteristics will differ in their sensitivity to specific human activities that alter ecological drivers and/or stream system structure.
3. the physical structure of streams influences how water temperature in stream channel will respond to a given heat load and flow regime. Changing the physical structure of a stream system has the potential to influence both the heat load to the channel and the stream's and the stream's ability to withstand a given heat load without substantive increase in channel water temperature (i.e. the stream's assimilative capacity for heat).

Removal of forest vegetation has the tendency to increase sediment delivery, warm lateral water inputs, alter the relative amount of surface runoff (and therefore, peak flows), and alter upland water infiltration and groundwater recharge (Naiman and others 1992).

Land uses may also influence groundwater – stream water inter-change rates and temperatures. Logging or other vegetation removal can lead to increases in shallow groundwater temperature (Hewlett and Fortson 1982; Holtby 1988 as cited in Ebersole 2003). Changes in timing and magnitude of peak flows associated with logging or river regulation may alter floodplain recharge and the subsequent release into stream channels (Sheperd et al. 1986 as cited in Ebersole 2003). Coarse sediments from roads, grazing, or logging may induce channel aggradation, widening , and structural simplification, thereby increasing surface-water exposure to solar radiation (Beschta et. Al 1986 as cited in Ebersole 2003). Our observation that maximum temperatures within cold water patches were higher in reaches with lower frequencies of large wood and fewer pools is consistent with hypotheses linking channel simplification, straightening, and widening to increased fragmentation of cold water refuges.

What are the risks?

-coarse sediments can induce channel aggradation, widening, and structural simplification, thereby increasing surface-water exposure to solar radiation. This is directly in keeping with other findings that temperatures are higher in reaches with lower frequencies of large wood and fewer pools.

-stream temperature associated with removing vegetative shade (logging) causing warming of shallow groundwater.

-Changes in timing and magnitude of peak flows associated with logging may alter floodplain recharge and the subsequent release into stream channels (Sheperd et al. 1986 as cited in Ebersole et al 2003).

Increased bank resistance provided by riparian vegetation is required to offset increases in stream transport power associated with increased peak flows.

Poole and Berman (2001). At least three integrated and inter dependent components determine stream structure: the channel, riparian zone, and alluvial aquifer. Thus, the edge of a river is not its channel margin, but the edge of the riparian zone. Similarly, the bottom of a river is not the streambed, but the bottom of the alluvial aquifer. Interaction between external drivers of stream temperature and the internal structure of the integrated stream system ultimately determine channel water temperature. The relative importance of various drivers and structures varies spatial. Together, drivers and structures interact to produce heterogeneity in stream temperature at a variety of spatial and temporal scales.

The primary determinants of stream temperature are climatic drivers, stream morphology, groundwater influences, and riparian canopy condition.

<u>Mechanism and influence of human influence on channel water temperature</u> (Poole and Berman 2001)

1. Reduced phreatic groundwater discharge results in reduced assimilative capacity – Removal of upland vegetation decreases infiltration of groundwater on hillslopes and reduces baseflow in streams.
2. Reduced stream and tributary flow during low-flow periods reduces assimilative capacity – Removal of upland vegetation results in flashy stream flow.
3. Simplified alluvial system structure reduces assimilative capacity by reducing hyporheic flow – Removal of upland vegetation increases fine sediment load which clogs gravels and reduces hyporheic exchange. Channelization severs subsurface flow pathways. Riparian management may remove large woody debris (and it sources) that contributes to streambed complexity.
4. Simplified channel morphology reduces hyporheic flow thereby reducing assimilative capacity; wider, consolidated channels are less easily shaded and have greater surface areas leading to increased heat load. Removal of upland vegetation increases peak stream power and/or increases sediment volumes altering the interaction between water and sediment regimes and changing channel morphology. Riparian management may remove large woody debris (and it sources) that contributed to streambed complexity.
5. Reduced riparian vegetation reduces shade and increases heat load. Riparian management may reduce shade to the channel and may reduce the amount of air trapped by the vegetation, increasing convective and advective heat transfer from the atmosphere to the riparian zone and stream surface.

When considering stream channel temperature, perhaps the most pervasive and best studied effect of upland land use is the changes in channel morphology (usual widening and shallowing of channels) in response to increased sediment load (Poole and Berman 2001). Wider channels have greater surface areas and are not as easily shaded by riparian vegetation, thereby facilitating the exchange of heat with the atmosphere.

Regarding peak flows Poole and Berman 2001 state that when stream power is altered, the historical channel morphology is likely to be disrupted, altering the physical structure of the stream and therefore the dynamics of heating, cooling, and temperature buffering.

Where shallow phreatic groundwater systems are important sources of stream water, removal of vegetation in the catchment can alter upland groundwater temperatures, increasing the temperature of water delivered to the stream (Hewlett and Fortson 1982 as cited in Poole and Berman 2001).

The primary mechanism by which riparian vegetation controls temperature is through insulation (i.e. shading the stream and trapping air next to the stream surface). However, riparian vegetation removal can also destabilize stream banks, thereby facilitating erosion, increasing sediment loads, and ultimately changing the physical structure of the stream. These actions may alter the rate of heat exchange with the atmosphere and restrict hyporheic flow by reducing streambed permeability. Loss of riparian vegetation may have major consequences for forested streams since riparian vegetation is the primary source of large wood to the channel. This may have important ramifications for channel morphology (and therefore temperature) over time.

Moore and Miner (1997). In general streams with smaller volumes of water change temperature faster than streams or rivers with larger volumes of water.
A wide, shallow stream receives more energy (and therefore increases in temperature faster) than a stream of the same volume that is narrow and deep.

Five years after the completion of harvesting treatments, temperature remained four to six degrees warmer, and diurnal temperature variation remained higher than in the control streams regardless of treatment. They speculate that late autumn reversals in the impacts of forest harvesting also occur. Temperature impacts in this study remained within the tolerance limits of local biota. However, even modest temperature changes could alter insect production, egg incubation, fish rearing, migration timing, and susceptibility to disease, and the effects of large changes to daily temperature range are not well understood (Macdonald et. Al 2003). *BC central interior study.*

Classical hydrology does not account well for water temperature processes because it does not accurately estimate the surface areas of a watershed that is available for heat exchange. Most of the precipitation that falls on the land passes through the soil before entry into the stream network. Much of this soil water moves into temporary storage in groundwater aquifers or shallow soil groundwater paths. Water stored in these compartments is susceptible to warming following shade removal and drainage alteration. Thus, a map of watershed heat transfer potential needs to include shallow groundwater aquifers and chronically saturate soils (Hudson 2003).
As forest harvesting proceeds in a watershed, changes in heat transfer occur through loss of shade and physical changes to the stream network. Canopy density reductions bring the heat transfer zone down to ground level reducing or eliminating the cool micro-climatic zone. Site preparation strategies that reduce soil porosity and produce surface ponding (mounding and disking) can be expected to increase thermal effects (Hudson 2003).
On the longer term, physical changes to the stream network can produce more warming effects. Stream channel disequilibrium produces wider and shallower channels that increase heat transfer. Groundwater interception by ditchlines extends the stream network into the road system adding additional areas for heat transfer. Predicting changes to watershed temperature following forest development involves estimating the added heat load from un-shaded areas and ditchlines (Hudson 2003).

Riparian vegetation blocks solar radiation from reaching the channel and reduces the stream's heat load (Davies and Nelson 1994, Hostetler 1991, Naiman and others 1992 as cited in Poole and Berman 2001)). Vegetation also reduces near-stream windspeed and traps air against the water surface. This action reduces heat exchange with the atmosphere by decreasing convection and advection of heat energy to the water surface (Naiman and other 1992 as cited in Poole and Berman 2001). Channel width influences channel surface area across which heart is exchanged; a greater surface areas allows for more rapid heat conduction and radiation. Under the same climatic conditions, narrower, deeper channels will not absorb as much heat as shallow, wide channels. Similarly, riparian vegetation more effectively shades a narrower channel.

Stream roughness, and meander influence degree of hyperheic flow. Therefore channelization and simplification of stream structure reduce hyperheic flow.

Often, channel water temperature trends away from baseline temperature and toward atmospheric temperatures in downstream direction (Sullivan et al 1990 as cited in Poole and Berman 2001).

(Herunter et al 2004). Showed significant increases in stream water temperature after forest harvesting events. Data suggested that the variable-retention buffers provided some mitigation from clear cutting but did not fully protect the streams from thermal impacts. Thermal regimes in the 3 riparian treatments did not recover to pre-harvest levels, even 7 year after harvesting. In contrast, most studies of stream thermal recovery predict return to pre-harvest levels within five to seven years of harvest. In the absence of comparable research from northern sub-boreal forests, we can speculate that stream temperatures in this type of ecozone may require greater recovery periods, due to the slower growth of under- and over-story vegetation.

5. Timber Management and Silviculture

Hydro-riparian sites are known for their challenges related to logging on wet soils, windthrow, soil compaction, surface erosion, re-stocking, frost damage to seedlings, brush competition, often requiring mounding, large planting stock, cluster planting, and reduced stocking to bring sites back into timber production. Many of these areas should be permanently reserved as "true riparian" reserves. Others will provide relief for mid-term timber supply short falls and could be reserved until watershed hydrological and ecosystem function return to these heavily logged landscapes. Others can feasibly be selectively logged.

With respect to high windthrow risk this retention objective advocates widening of riparian management areas to the extent of the identified windthrow risk zone, or light selective logging, as opposed to narrowing them, or logging them. Hydro-riparian areas are typically sensitive to soil compaction and erosion

With respect to silviculture systems this retention objective advocates no timber harvest or partial harvest especially given the risks to environmental resources associated with silviculture practices such as mounding and treatment of competitive brush. It would seem beneficial from a logistics and possible an economic standpoint that the extra costs associated with the above treatments could be avoided as well as costs associated with planting larger stock or replanting areas of plantation failures common to these sites. This may be particularly relevant on sites that have poor natural regeneration due to moss and heavy shrubs.

6. Restoration

Existing minimum retention targets under FRPA (landscape and stand-level) and LRMP objectives, in themselves, will likely contribute to an extended recovery period as a result of intensive timber extraction. Based on the science demonstrated here, the additional forest retention of 10 to 25% recommended by the CF, if executed on the ground with regard to values, risks, and enhanced riparian strategies will likely provide Nadina ecosystems with a shorter restorative period.

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Appendix 4. Landscape Connectivity Area Network Summary

Landscape Connectivity Network Area Summary (May 28, 2007 version)

Landscape Unit	BEO	Network Component	Total CF	Total CF in Networks		Total THLB in Networks		Non-Contributing, Priority A and Priority B in networks	
			Ha.	%	Ha.	%	Ha.	%	Ha.
		VC	15761	49%	7730	5%	771	48%	7531
		HR	4026	43%	1717	9%	380	37%	1495
		RE	969	91%	878	5%	53	91%	878
		Other	25646	20%	5020	8%	1992	12%	3010
Babine East	Int	**Total**	**43844**	**32%**	**13886**	**7%**	**3137**	**9%**	**4138**
		VC	19188	28%	5358	10%	2007	16%	2992
		HR	6045	29%	1757	17%	1007	18%	1092
		RE	171	93%	158	22%	37	93%	158
		Other	36375	11%	4101	7%	2390	4%	1283
Babine West	Low	**Total**	**59164**	**17%**	**10304**	**9%**	**5600**	**8%**	**4520**
		VC	11722	29%	3431	11%	1273	21%	2477
		HR	7909	40%	3156	23%	1820	25%	1938
		RE	111	43%	48	23%	25	40%	45
		Other	43274	8%	3605	6%	2398	2%	975
Bulkley	Int	**Total**	**60635**	**15%**	**9272**	**10%**	**5906**	**9%**	**5675**
		VC	15543	38%	5972	6%	879	36%	5594
		HR	6048	30%	1833	18%	1060	28%	1665
		RE	533	30%	161	23%	123	30%	161
		Other	56162	11%	6287	8%	4525	3%	1457
Burns Lake East	Low	**Total**	**76519**	**18%**	**13587**	**9%**	**6864**	**14%**	**10395**
		VC	9213	14%	1303	3%	283	11%	1056
		HR	5562	25%	1383	13%	750	14%	775
		RE	113	2%	2	0%	0	2%	2
		Other	33611	7%	2194	4%	1269	2%	592
Burns Lake West	Low	**Total**	**47467**	**10%**	**4652**	**6%**	**2840**	**5%**	**2357**
		VC	20551	21%	4357	6%	1230	18%	3610
		HR	6912	45%	3097	23%	1573	37%	2534
		RE	90	65%	58	50%	45	59%	53
		Other	23998	11%	2610	6%	1521	4%	881
Fleming	Int	**Total**	**48627**	**18%**	**8680**	**9%**	**4517**	**10%**	**4747**
		VC	16388	19%	3153	10%	1641	14%	2359
		HR	5592	33%	1836	21%	1158	16%	916
		RE	341	60%	203	31%	105	55%	188
		Other	48056	15%	7026	10%	4896	4%	1728
Taltapin	Low	**Total**	**68297**	**17%**	**11414**	**12%**	**8038**	**11%**	**7668**
GRAND TOTAL			**404553**	**18%**	**71796**	**9%**	**36901**	**10%**	**39500**

Notes

1. Landscape Unit: Draft LUs as per the RLUP.
2. Network Component: 1) VC - vegetation cover important for wildlife; 2) HR – hydroriparian; 3) RE - rare and endangered ecosystems, and; 4) other.

3. Total CF: Total Crown Forest land includes THLB designations; contributing (C), partially (P) and non-contributing (NC).
4. Non-Contributing - includes that part of the Crown Forested land base that does not contribute to the Timber Harvesting Land Base.
5. Priority A = Areas highly constrained for timber harvesting and include: Backcountry Lakes, ESA 70 and 90, Recreation Areas, Deer and Goat ranges, Grizzly and Significant Visual Retention
6. Priority B = Areas moderately constrained for timber harvesting and include: ESA 60, Significant Visual Partial Retention, Visual Retention and Partial Retention

Appendix 5. Desired Condition for Components within the Landscape Connectivity Network (Post-Logging)

Component	**Ecosystem-Based Structure (VC or HR)**	**Connectivity Matrix**
Basal Area minimum	100% deferral of stands <70% pine for a period of 7 years from the effective date of the order	N/A
Re-entry	When existing non-pine, conifer basal area has been restored.	N/A
Tree Size	existing profile of stand diameter range of conifer	N/A
Maximum Opening Size	No unnatural openings wider than 1 tree length (0.1 ha)	As per patch size objective
Green-up Minimum	N/A	3 metres
Deciduous Retention	100% except as required to extract conifer	100% except as required to extract conifer
Non-merchantable retention	N/A	Maximize retention of understory, deciduous, and non-merchantable
Coarse Woody Debris	FRPA default	FRPA default

Appendix 6. Public Review Summary and Response

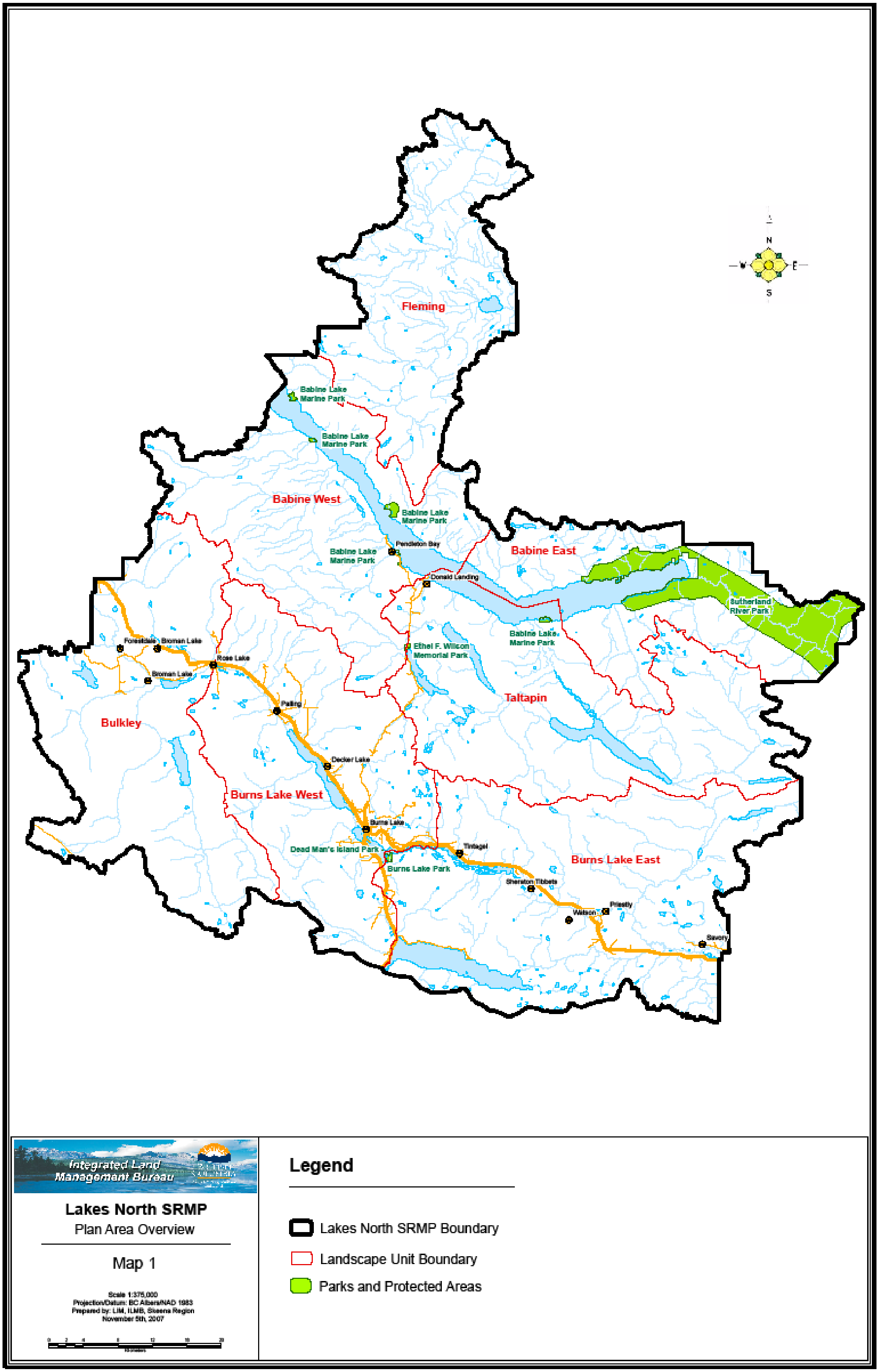
Official Public Review Period: September 3, 2008 – November 2, 2008
Public Open House: November 6, 2008 in Burns Lake, BC

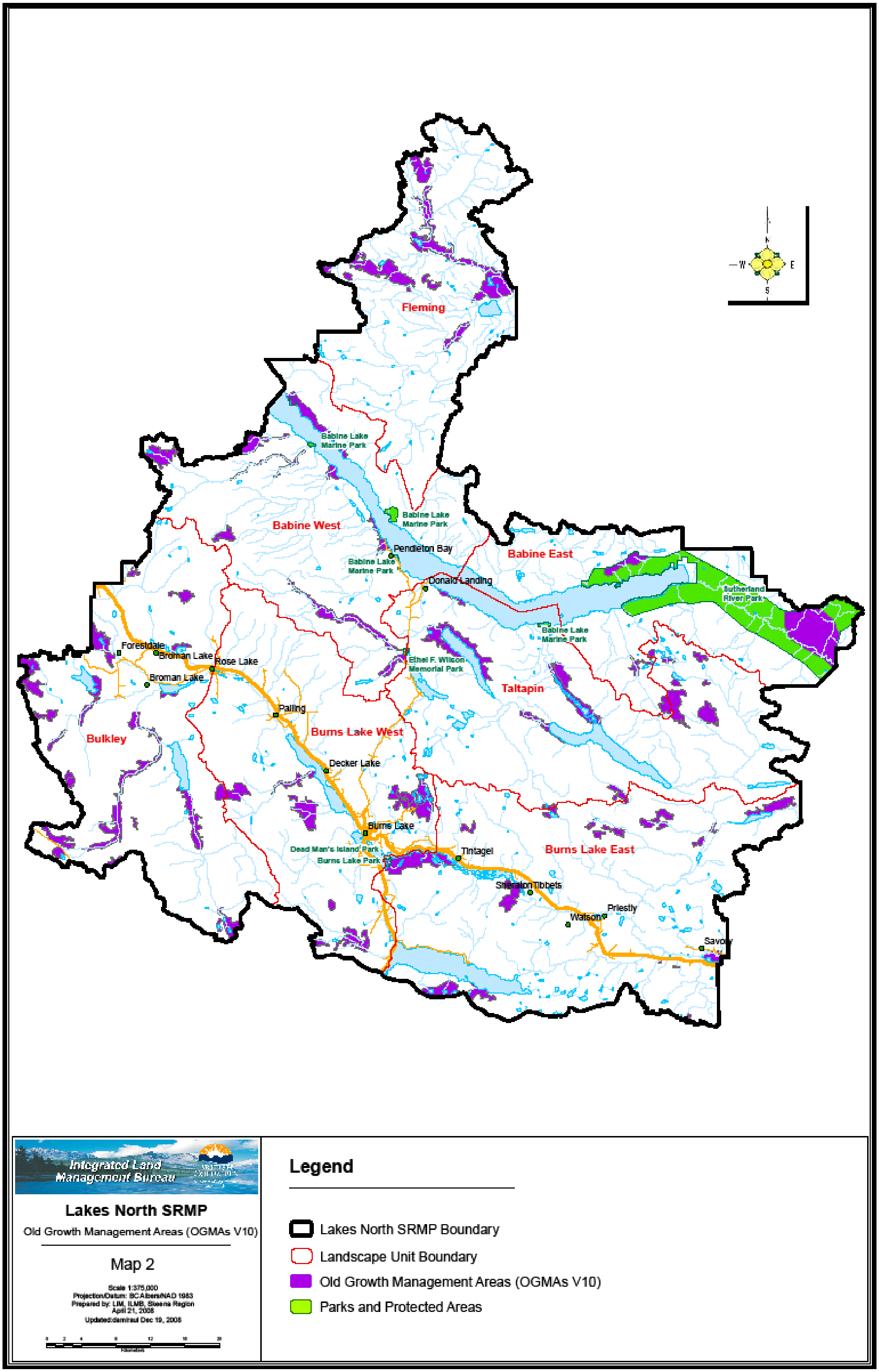
INPUT	ILMB RESPONSE/ACTION TAKEN
Cabins at Natowite Lake – inquiring as to whether these are in the plan area.	Natowite Lake is outside of the Lakes North SRMP plan area – it is within the Morice TSA/Morice LRMP plan area.
Recommend OGMA placement on the Sakeniche river corridor as it is an important salmon river.	The Sakeniche river flows out of Natowite Lake (in the Morice TSA) north-east into Takla Lake. The river is outside of the plan area (is within the Fort St. James plan area); therefore, no OGMAs can be placed on the corridor through this plan.
Recommend the south shore of Burns Lake within Canfor's operating area for an OGMA as it is a unique area.	Burns Lake extends from the town of Burns Lake east to Sheraton Tibbets. There is a large OGMA designated on the south shore of the lake between Burns Lake Park and Tintagel. There is another OGMA designated on the south shore of Burns Lake near Sheraton Tibbets. Due to lack of old forest, abundance of dead pine trees, private land, and aspen stands in the rest of the area on the south shore of Burns Lake, there are limited options for more OGMAs to be designated (OGMAs must meet certain criteria such as: forested area, old age, live trees, crown land not private land, etc). However, the LN SRMP requires additional retention in this area through the landscape connectivity matrix, which encompasses both the north and south shores of Burns Lake, and which defers harvest of non-pine stands for a period of 7 years.
In Appendix 6 the desired condition within the EBS (VC or HR) portion of the corridor is to retain 70% of existing non-pine. Part of the reason we went with a 7 year deferral on harvest in these types was because no one could agree on how to deliver the 70% retention. What was agreed to was a 100% deferral for 7 years which is what Objective 4 says. Appendix 6 should be consistent with Objective.	Changes made.
It was my understanding that there was supposed to be *no harvesting* in Rare Ecosystems. I haven't checked but I think this is right out of the LRMP or SRMP south. I believe most but not all are non-forested. Make no harvesting in Rare Ecosystems part of the objective, not just a strategy.	- The LRMP (s. 44.2) states that landscape connectivity corridors may include rare ecosystem types. It is implied that rare ecosystem types will not be harvested. There is no reference to rare ecosystems in Lakes South SRMP. - The potential location of Rare Ecosystems in the Lakes North SRMP is shown on Map 3, and the Rare Ecosystems are defined in the attributes for the spatial data. PEM was used to predict where Rare Ecosystems may potentially occur on the ground. The Conservation Data Centre's blue- and red-listed communities were the basis for defining the Rare Ecosystems. Rare Ecosystems that may potentially occur in the Lakes North SRMP plan area include: -SBSdk/02 - Pl-Common juniper-Rough leaved ricegrass (CDC blue-listed community) -SBSdk/04 - Fd-Red stemmed feathermoss-Step moss (CDC blue-listed community) -SBSdk/08 - Act-Dogwood-Prickly rose (CDC red-listed community) -SBSdk/81 - Saskatoon-Slender wheatgrass (CDC red-listed community) -SBSwk3/02 - Pl-Black huckleberry-Reindeer lichens (CDC blue-listed community) - "Avoid harvesting in rare and/or endangered plant communities" has been added to the objective, and defined as the CDC Red List and Blue List ecological communities.
Section 1.2, last paragraph should read "*Forest and Range Practices Act*"	Change made.
Section 1.4, third bullet. Will require revision to reflect revised timelines (i.e. First Nations *were* consulted)	Change made.

Section 2.3, strategies. Strategy 5) is the same as strategy 1) – including footnotes. Footnote 6 could be removed by rewording strategy 1) as follows: Refer to the following paper prepared by the Ministry of Forests and Range and the Ministry of Environment: *Wildlife Tree Retention Management Guidance*. Table 3 below is an excerpt from that paper that lists the attributes of a high-value wildlife tree.	Changes made.
Section 2.4. The text mentions twice that "harvesting should be avoided" in rare ecosystems. Discussions held by the Technical Working Group – and previous versions of the plan – stated that harvesting would not be allowed in rare ecosystems. This should therefore be reflected in the wording of Objective 4.	Change made. See above for related comments.
With respect to the objective for connectivity, I note that while the plan provides for flexibility in deferring harvest in some stands and areas for 7 years, the plan is silent as to what will happen at the end of the deferred period.	The preamble for this objective states that: "It is difficult to make choices now regarding management within landscape corridors when the outcomes of the MPB epidemic are not yet fully realised. *This objective will therefore be revisited within 7 years, during which time it is expected that an appropriate management strategy for connectivity will be developed.*"
I also note that section 3.1 refers to the "Lakes LRMP Resource Monitoring Framework" and the "Lakes Plan Implementation and Monitoring Committee". This committee has never been formed and ILMB is no longer coordinating plan implementation and monitoring committee. For this reason, I am concerned that the certainty and flexibility provided for by the plan for today may lead to uncertainty in the near future, especially without plan monitoring. To this effect, I would recommend that the coordination of an amendment to the plan should begin no later than in 2013.	- The Lakes Plan Implementation and Monitoring Committee (Lakes PIMC) was initiated from a public meeting held by the Integrated Land Management Bureau – ILMB on January 30, 2007. Three meetings were held in 2007. The PIMC had a Terms of Reference, and had selected a chairperson. There was some discussion about combining the Lakes PIMC and the Morice PIMC into one 'Nadina PIMC', but there was opposition to this from the PIMC members, so it didn't ever occur. While it is true that ILMB will no longer be coordinating the PIMC, the PIMC has the option of revising its TOR and continuing to provide a public advisory role. - Plans can be amended throughout their implementation as outlined in Implementation of the New Direction for Strategic Land Use Planning in BC: Reviewing and Amending Strategic Land Use Plans (2007). The connectivity objective will have to be reviewed and amended within 7 years. It would be timely to review the rest of the plan at that time as well.
I would also like to take this opportunity to point out that the 2000 Lakes Land and Resource Management Plan (LRMP) Order currently prohibits commercial harvesting in the Lindquist and Chikamin Mineral/Wildlife Management Zone. If the LRMP is cancelled according to ILMB's stated intent, then harvesting will be allowed in this zone. This zone should remain as a no harvest area. Therefore, I would like to suggest that rather than cancelling the Order, sections that are no longer relevant should be repealed.	All of the objectives *except for* the objective applying to the Chikamin Mineral/Wildlife Management Zone of the Lakes LRMP Order (2000) will be repealed.
Does the Lakes North SRMP address pipeline proposals? The village of Burns Lake wants to keep the pipelines in the same areas.	Lakes North SRMP applies to forestry activities, and will be implemented through the *Forest and Range Practices Act.*
Does the plan address community in view of the Mountain Pine Beetle epidemic and downturn in the forest industry?	- The very large infestation of Mountain Pine Beetle (MPB) in the central interior of the province is now the driving force behind both ecological processes and forest management in the area. Most of the mature and old pine trees in the Lakes North plan area have been killed by this infestation. Harvesting is now almost entirely driven by mountain pine beetle salvage objectives. - The Lakes North SRMP is needed to ensure that LRMP objectives to protect forest and biodiversity values are implemented in a way that also considers the effects and needs created by the MPB infestation. - Flexibility is required to meet biodiversity objectives as the post-beetle forest characteristics become known. This plan provides flexibility by: • Allowing for harvest of pine-leading stands in connectivity corridors, while deferring harvest of non-pine-leading stands in the short-term. • Allowing for management of a substantiated forest health factor

	(non-MPB) within OGMAs and Wildlife Tree Retention (WTR) areas, where harvesting constitutes an appropriate and effective control action. • Maintaining consistency with the regional Old Growth Management Area Amendment Policy – Skeena Region, which provides direction on amendment and replacement of OGMAs. • Providing an early seral stage requirement in the short-term that will allow salvage harvesting of dead pine stands.

PART 5. MAPS


Fleming
Babine Lake Marine Park
Babine Lake Marine Park
Babine West
Babine Lake Marine Park
Pendleton Bay
Babine Lake Marine Park
Babine East
Donald Landing
Sutherland River Park
Babine Lake Marine Park
Ethel F. Wilson Memorial Park
Taltapin
Forestdale
Broman Lake
Rose Lake
Broman Lake
Palling
Bulkley
Decker Lake
Burns Lake West
Burns Lake
Dead Man's Island Park
Tintagel
Burns Lake Park
Burns Lake East
Sheraton Tibbets
Priestly
Savory
N
W
E
S
Integrated Land Management Bureau
Lakes North SRMP
Plan Area Overview
Map 1
Scale 1:375,000
Projection/Datum: BC Albers/NAD 1983
Prepared by: LIM, ILMB, Skeena Region
November 5th, 2007
Legend
Lakes North SRMP Boundary
Landscape Unit Boundary
Parks and Protected Areas


Fleming
Babine Lake Marine Park
Babine West
Babine Lake Marine Park
Pendleton Bay
Babine East
Babine Lake Marine Park
Donald Landing
Sutherland River Park
Babine Lake Marine Park
Forestdale
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Broman Lake
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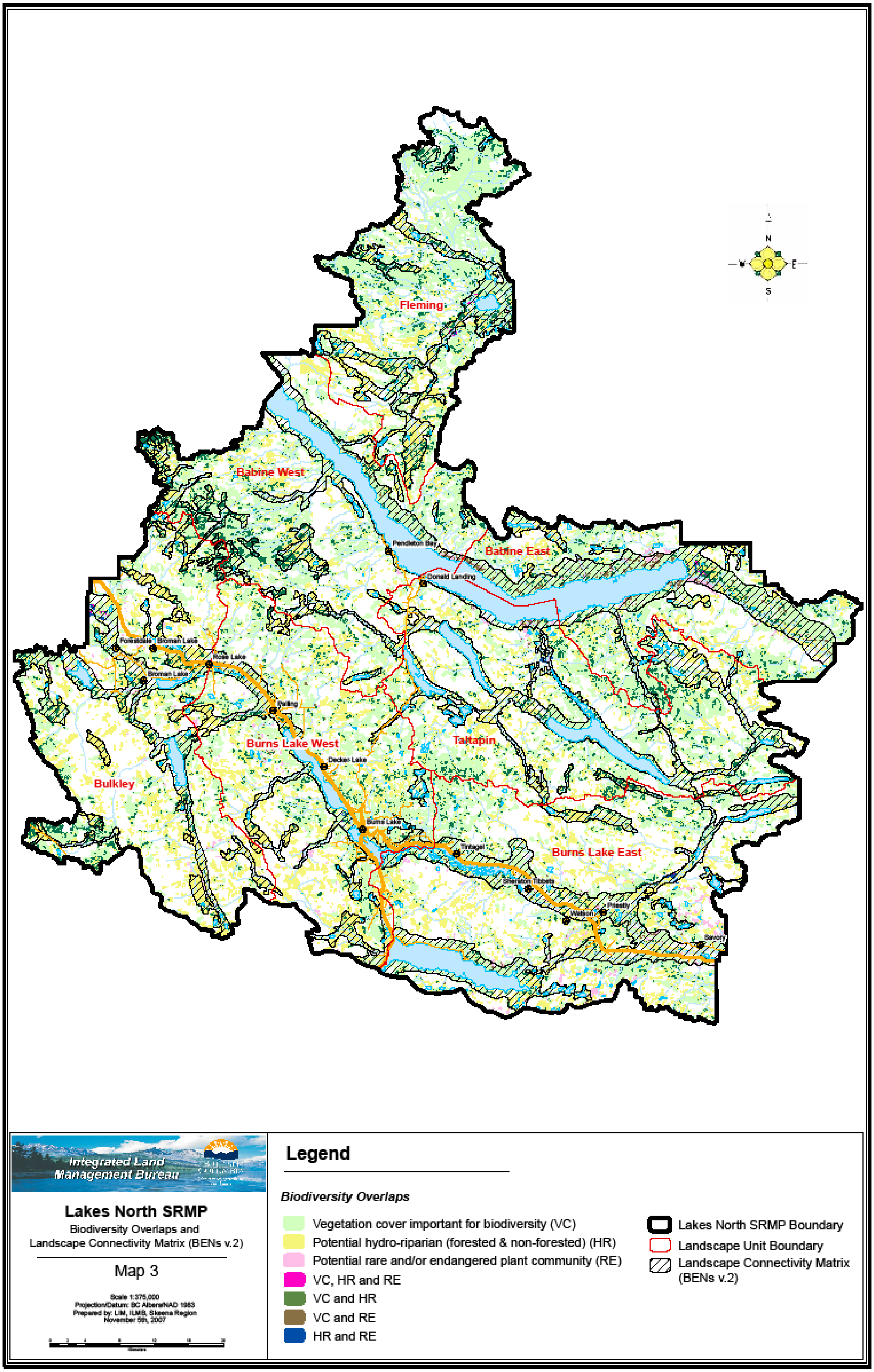
Taltapin
Palling
Burns Lake West
Bulkley
Decker Lake
Burns Lake
Dead Man's Island Park
Burns Lake Park
Tintagel
Burns Lake East
Sheraton
Tibbets
Priestly
Watson
Savory
Integrated Land Management Bureau
Lakes North SRMP
Old Growth Management Areas (OGMAs V10)
Map 2
Scale 1:375,000
Projection/Datum: BC Albers/NAD 1983
Prepared by: LIM, ILMB, Skeena Region
April 21, 2008
Legend
Lakes North SRMP Boundary
Landscape Unit Boundary
Old Growth Management Areas (OGMAs V10)
Parks and Protected Areas


Fleming
Babine West
Babine East
Pendleton Bay
Donald Landing
Bulkley
Burns Lake West
Tatlapin
Burns Lake East
Decker Lake
Burns Lake
Tintagel
Rose Lake
Palling
Priestly
Savory
N
S
E
W
Integrated Land
Management Bureau
Lakes North SRMP
Biodiversity Overlaps and
Landscape Connectivity Matrix (BENs v.2)
Map 3
Scale 1:375,000
Projection/Datum: BC Albers/NAD 1983
Prepared by: LIM, ILMB, Skeena Region
November 5th, 2007
Legend
Biodiversity Overlaps
Vegetation cover important for biodiversity (VC)
Potential hydro-riparian (forested & non-forested) (HR)
Potential rare and/or endangered plant community (RE)
VC, HR and RE
VC and HR
VC and RE
HR and RE
Lakes North SRMP Boundary
Landscape Unit Boundary
Landscape Connectivity Matrix (BENs v.2)