

Lower Nicola Indian Band Sustainable Forest Management Strategies for Natural Disturbance Type 3

November 16, 2006

Prepared for: LNIB Chief and Council and Membership

Prepared by: Lower Nicola Indian Band Natural Resource
Department

Project Funding Provided by:

First Nations Forestry Program





Vision Statement

We, the people of the Lower Nicola Indian Band, commit ourselves to being a peaceful, prosperous and secure community made up of healthy individuals rooted in the Nlaka'pamux culture, respecting ourselves, each other, the environment and all of Creation. We will honor and protect our children, the sacred gifts from the Creator, and our elders, the wisdom keepers.

Together as one, we will take responsibility to regain control of our own destiny and rebuild our relationships with other people on a firm footing of respect and justice.

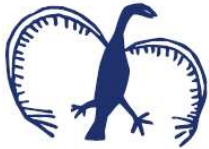
We will possess our traditional territories and defend our hereditary and Aboriginal rights as Nlaka'pamux people, and promote the unity and strength of the Nlaka'pamux Nation as a whole.

We will be a sovereign community with a government based on traditional values, guided by leaders who know and respect the language, culture, and people.

We recognize that injustices have been committed against our people: our lands have occupied, our culture eroded, and our sovereignty denied. We will not allow this to continue and will ensure that it never happens again.

In this, the Lower Nicola Indian Band will be a model community that others look to for direction and inspiration. We will realize true power, fulfill our responsibility to our ancestors, and create peace and prosperity for future generations.

Shulus, BC
December 1996



LNIB Sustainable Forest Management Vision Statement

Following the ways of the Old Ones, the Lower Nicola Indian Band promotes a holistic approach to sustainable forest management, preserving all of nature's plants and animals for future generations.

Executive Summary

It is estimated that 30% of the Nlaka'pamux traditional territory is impacted by the current mountain pine beetle (MPB) infestation (LNIB 2006). The MPB infestation is expected to impact more than 60% of the traditional territory by the year 2011. To address the MPB impacts in Merritt Timber Supply Area (TSA), the chief forester determined an allowable annual cut (AAC) of 2,814,171 m³.

The Lower Nicola Indian Band (LNIB) expressed concern over the elevated harvest level required to manage the spread of MPB and its impact on First Nations traditional values. A funding request was made to the First Nations Forestry Program (FNFP) to review current forest practice legislation and propose strategies that protect LNIB's natural resource interests.

A majority of the land base impacted by MPB is classified as Natural Disturbance Type 3 (Biodiversity Guidebook 1995). The review focused on Natural Disturbance Type 3 to incorporate the influences of wildfire as well as controlled burns initiated by the Nlaka'pamux Nation. The strategies are intended to support decision making by Chief and Council and the Band's Natural Resource Department. In addition, the strategies are proposed for consideration by resource planners.

Resource values that were reviewed included: water/riparian, biodiversity, wildlife, visual quality objectives, cultural heritage resources, timber and range. In better keeping with First Nations traditional values a more holistic, biodiversity approach was recommended. A workplan was completed to identify knowledge gaps, research priorities as well as future goals and objectives.

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1.0 Introduction

The concept of sustainable development incorporates the needs of the present without compromising the needs of future generations. Sustainable forest management (SFM) is a critical component of sustainable development. The original concept rose out of international pressures or agreements to demonstrate the sustainability of forest practices. Furthermore it included the use of natural regeneration, restoring or enhancing native woodlands and the structural diversity of the forest.

More recently the concept of sustainable forest management has expanded to include non-timber resources such as water, habitat and esthetic values. The expanding scope of sustainable forest management has required the selection of indicators to evaluate the effectiveness of management strategies for non-timber resources. However identifying meaningful indicators presents a challenge considering the qualitative aspects of non-timber resources.

First Nations input to sustainable management has been primarily restricted to consultation around the effectiveness of “*pre-determine*” developments or strategies. The Nlaka’pamux Nation have lived in their traditional territory for thousands of years. Over that time the Nlaka’pamux applied their inherent Traditional Ecological Knowledge (TEK) in co-existence with the nature. While the sustainability of current practices may be challenged, the Nlaka’pamux’s TEK may provide a meaningful foundation. Sustainable management can only improve to include Nlaka’pamux philosophies, strategies and indicators.

2.0 Objectives

The objective of this document is to identify SFM priorities and propose strategies for consideration by resource planners. The document will also identify knowledge gaps in SFM as well as research priorities.

On July 1, 2005, the Chief Forester determined an allowable annual cut (AAC) of 2, 814,171 m³ for the Merritt TSA to address the growing impacts of MPB infestation. A majority of the landbase in the Merritt TSA impacted by MPB is classified as NDT 3 (Biodiversity Guidebook, 1995). The increased harvest level to manage the impacts of MPB is expected to continue for the next 5-7 years. The SFM strategies (SFMS) identified in this document are focused on the NDT 3 where planning is most immediate.

The proposed strategies are intended to protect LNIB’s natural resource interests as well as enhance or protect biodiversity and SFM. In addition, the strategies are proposed to minimize overall impact on timber supply by identifying alternative plans which provide greater or more efficient access to timber.

The strategy document is intended to support decision making by Chief and Council as well as the Band's natural resource department. The strategy document is also expected to be the starting point for LNIB in its future forest management endeavors and promote discussion with neighboring First Nations.

3.0 Background

3.1 Lower Nicola Indian Band

The Lower Nicola Indian Band belongs to the Sewemx ("People of the Creeks") branch of the Nlaka'pamux Nation of the Interior Salish peoples of the British Columbia. The band has 10 reserves totalling greater than 17,500 acres located throughout the Nicola Valley. The LNIB population is nearly 1000 members. A majority of the on-reserve membership resides on Nicola Mameet IR#1.

Nicola Mameet IR # 1 – 11,350 acres, located approximately 8 km west of Merritt.

Joeyaska IR# 2 – 320 acres, located east of Merritt between hwy. 5A and Coldwater Rd.

Pipseul IR# 3 – 220 acres, located North of Mameet Lake on hwy 97C.

Zoht IR# 4, 5, 14 – 937 acres located 9 km northeast of Merritt on hwy 5A near Nicola Lake.

Logans IR# 6 – 45 acres located on Quilchena Creek.

Hamilton IR# 7 – 4400 acres located 8 km upstream of Quilchena Creek.

Speous IR # 8 – 280 acres located 7 km's off hwy. 8 via Sunshine Valley Rd.

Hihium IR # 6 78 acres located on the west end of the Hihium Lake, shared with Kamloops, Bonaparte and Upper Nicola Band.

The map shown in figure 1 identifies LNIB reserve lands in relation to MPB impacts as of 2005.

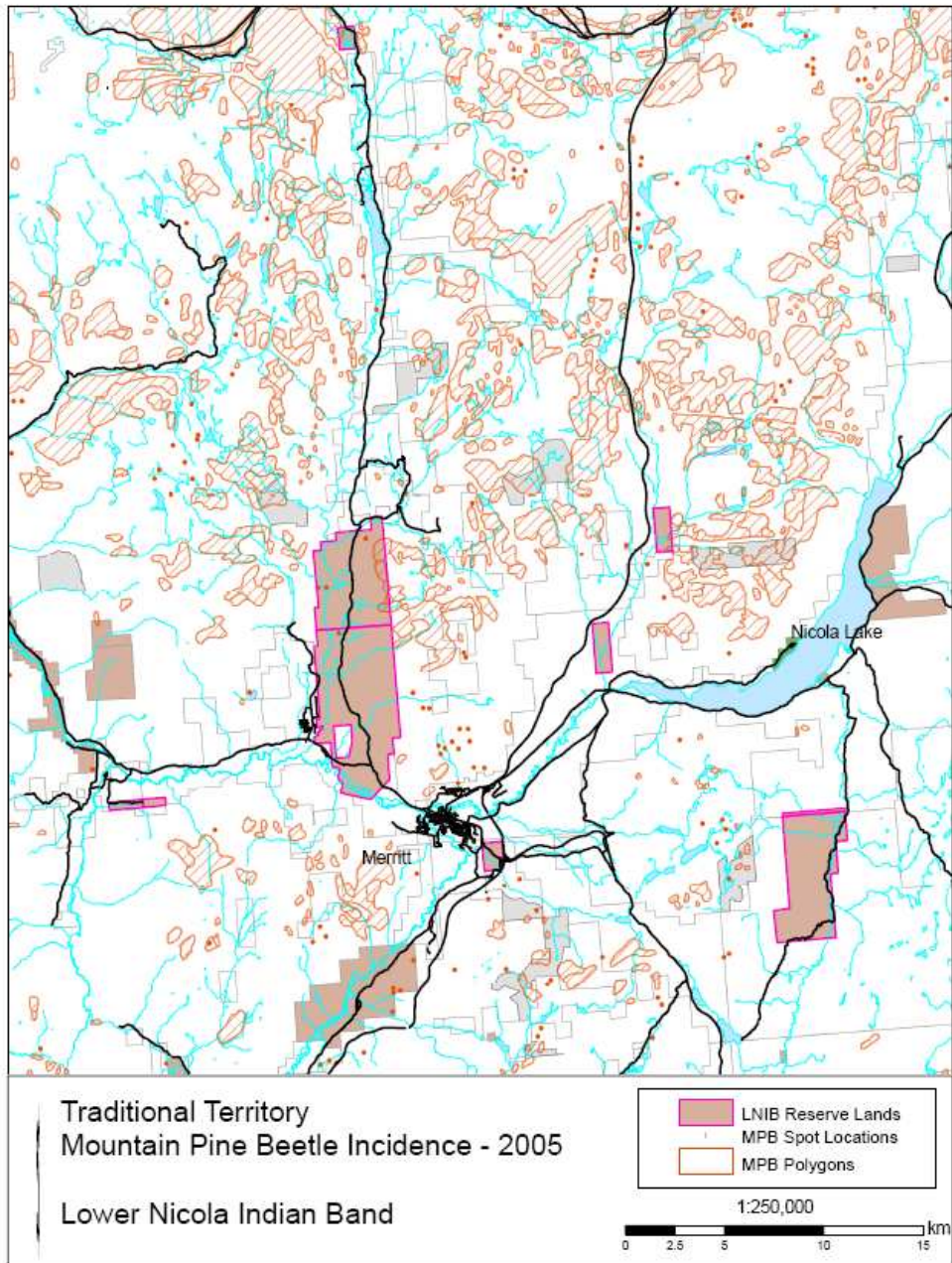


Figure 1. Mountain Pine Beetle Incidence in LNIB Reserve Lands 2005.

3.2 Nlaka'pamux Traditional Territory

The Traditional Territory of LNIB covers the Cascades as well as portions of the Kamloops, Chilliwack and Okanagan Forest Districts. The territory extends to the Bonaparte plateau in the north to Pyramid Peak in the west into Washington State (USA) in the south and Okanagan Lake to the east.

The map outlined in Figure 2 shows the MPB incidence in the Nlaka'pamux Traditional Territory as of 2005.

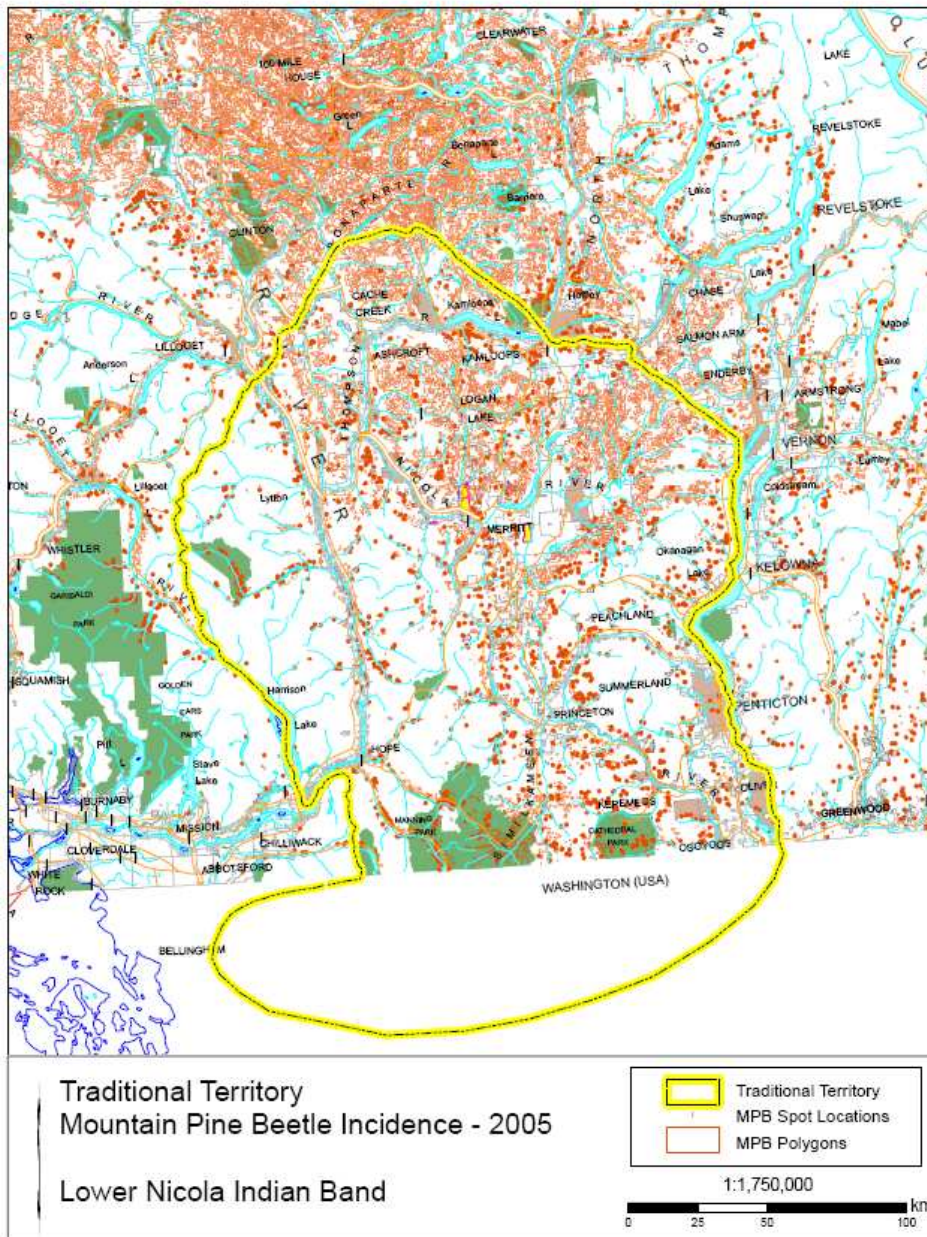


Figure 2. Incidence of MPB in Nlaka'pamux Traditional Territory as of 2005.

3.3 Traditional Ecological Knowledge

The Nlaka'pamux First Nations have lived in the traditional territory for thousands of years; preserving a way of life built on spirituality and respect. Furthermore, it was the inherent application of TEK passed on by the elders that provided the foundation for future generations. Today the understanding of the interrelationship between the plants, animals and the creator remains paramount.

Significant changes have occurred over the past two hundred years. The evolution of natural resource "management" is a prime example of differing philosophies. However, using TEK to drive management strategies would restore a more holistic approach to resource management.

At first hand, the incorporation of TEK into management strategies may be considered an additional constraint on industry. However, a first step would consider natural disturbance with TEK to re-evaluate existing constraints. It is expected that a more holistic, biodiversity approach would offset any additional constraints.

4.0 Process and Linkages

A land and resource management plan (LRMP) has yet to be initiated in the Merritt TSA. A formal LRMP would provide a higher level plan with enforceable measures around timber values, livestock grazing, recreation, biodiversity and cultural heritage resources. In lieu of an LRMP, a combination of provincial legislation and local guidelines are currently in place to oversee a range of SFM values (Cascades Forest District 2006).

Unfortunately, First Nations participation in policy development has been insignificant and limited to consultation of existing strategies (Merkel, 2003). As a result, there is considerable distrust among First Nations communities as to the effectiveness of the management strategies and their compliance and enforcement.

4.1 First Nations Forestry Program

The FNFP was initiated in 1996/97. The purpose of the program is to: *"improve economic conditions in status First Nation communities with full consideration of the principles of sustainable forest management."* Since its inception, more than 1600 projects involving more than 80 First Nations communities have been completed. The key objectives of the FNFP are to enhance the capacity and knowledge of First Nations communities in the areas of sustainable forest management, forest based developments and the economy.

FNFP provide funding for LNIB natural resource department to review forest legislation and policy. The review was used as a starting point to develop SFM

strategies that better incorporate LNIB's natural resource interests. As described the strategies are focused on the NDT3 to incorporate the impacts of MPB. The initial focus has been at the strategic level. The future goals include incorporating NDT2 and 4 as well as developing stand level plans that support strategic objectives.

4.2 Nicola Similkameen Innovative Forestry Society (NSIFS)

In March 1998, the five major forest licensees (Weyerhaeuser Company Ltd., Tolko Industries Ltd., Aspen Planers Ltd., Ardeu Wood Products Ltd., Riverside Forest Products) along with the Nicola Tribal Association (NTA), the Upper Similkameen Indian Band (USIB) and BC Timber Sales signed an Innovative Forest Practices Agreement and formed the NSIFS. One of the major accomplishments of the society has been the issuing of a new First Nations forest license and a sixth IFPA to Stuwix Resources Ltd.

The NSIFS has made a considerable investment in the area of SFM, in which the local First Nations communities have played a major role in developing. Using predictive ecosystem mapping (PEM), habitat capability and suitability models are made incorporating First Nations elders accounts and traditional use knowledge. The NSIFS is in the process of developing a web based SFM platform. The SFM platform will integrate plant and wildlife models with forest development plans (FDP), site plans (SP) and MPB information to produce habitat supply scenarios.

The LNIB have developed 20 habitat models for species of interest in the Merritt TSA. The completed models are ready to be integrated in the NSIFS SFM platform. One of the next steps will be to develop and incorporate management strategies into the SFM platform.

It is anticipated that strategies proposed in this document will be integral in developing the SFM platform.

5.0 Values and Strategies

5.1 Water and Riparian

Water is a fundamental resource in the Merritt TSA and has been identified by membership as a primary concern in light of the current MPB outbreak and subsequent salvage harvesting.

It is understood that natural disturbance had a major influence on riparian and wetland habitats. Based on average fire return intervals combined with recent riparian management practices it is assumed that higher stream classes (S1-S3) experience less disturbance than what may have historically occurred. On the other hand, stream classes (S4-S6) likely experience more disturbance than may have occurred historically.

Water demands in continue to increase exponentially making management strategies that better reflect natural disturbance. In addition, the impacts of MPB combined with potential influences of global warming make water conservation a major priority.

Water conservation and riparian management objectives are often identified as being highest priority. However, a majority of guidelines and best management practices were drafted without consideration for catastrophic impacts such as MPB. Limitations in past riparian management may be identified by the recent focus on temperature sensitive stream management (Teti 2000).

There are concerns that the current level of clearcut harvest will increase peak stream flows, surface and stream bank erosion; leading to wasting events. In addition, concerns exist around impacts to water chemistry as well as nutrient uptake from regenerating forests (Helie *et al.* 2005). To reduce potential for negative impacts the following recommendations are made to better conserve water and riparian resource values:

Riparian Reserve and Management Zones.

Table 1 outlines recommended riparian reserve and management zones. The table follows legislation outlined in the *Forest Planning and Practices Regulation* (MOF 2006). Increases in riparian management area have been recommended for stream classes S4 to S6.

Table 1. Riparian Reserve and Management Zones.

Riparian Class	Riparian Management Area (meters)	Riparian Reserve Zone (meters)	Riparian Management Zone (meters)
S1 – A	100	0	100
S1 – B	70	50	20
S2	50	30	20
S3	40	20	20
S4	40	20	20
S5	40	20	20
S6	40	20	20

Table 2 outlines recommended wetland reserve and management zones. The table follows legislation outlined in the *Forest Planning and Practices Regulation* (MOF 2006 a.). Increases in reserve zone boundary have been recommended for all wetland classes.

Table 2. Wetland Reserve and Management Zones.

Wetland Class	Wetland Management Area (meters)	Wetland Reserve Zone (meters)	Wetland Management Zone (meters)
W1	50	20	30
W2	40	20	20
W3	40	20	20
W4	40	20	20
W5	50	20	30

5.2 Biodiversity

A number of events have occurred over the past several decades to impact biodiversity. Fire suppression activities, combined with improvements in suppression technology have disrupted natural fire disturbance regimes. These objectives have likely contributed to decreases in the availability, quality and distribution of old growth, early seral grassland and deciduous habitats. Following fire suppression, the hi-grade logging practices of the 1950's also impacted old growth features (Marcot et al. 1998).

During more recent harvest history cutblock sizes in the Merritt TSA have averaged slightly greater than 20ha (Cascades Forest District, 1996). However, the recent MPB outbreak and subsequent harvesting have resulted in larger cutblock sizes. In addition road densities associated with smaller cutblocks and the accelerated harvest has increased. The combination of these activities has resulted in some degree of ecosystem fragmentation and considerable impact to biodiversity (Biodiversity Guidebook 1995; Bunnell et al. 1999; D'eon 2002).

Extensive work and review has gone into development of forest retention strategies (DeLong and Tanner, 1996; Bunnell et al. 2004; Eng 2004). Similarly, forest retention strategies compose a majority of wildlife management guidelines. While considerable effort has been made to develop forest retention guidelines at a strategic level; the evaluation of operational practices is less understood. Recent work would suggest that forest retention at the operational level is not meeting higher level strategy objectives in terms of protecting desirable habitat attributes (Machmer and Steeger 2004).

There are a number of limitations in the evaluation and development of forest retention strategies. Desirable habitat features are rarely identified in pre-harvest inventories, making the evaluating post harvest conditions challenging. In developing enforceable measures, criteria such as retention area and age class are identified. However establishing measurable criteria around habitat quality is more complex.

Harvest and Retention Recommendations

The Cascades Forest District's policy: Interim Large Cutblock Harvesting Strategy – October 16, 1996; describes a sound approach to managing the impacts of MPB in addition to many opportunities for habitat enhancement and recruitment. Approval of large cutblocks should consider the following recommendations.

Cutblock Size: There is no maximum size recommendation for cutblocks. It is assumed that operational capacities will limit cutblock sizes below those which may have occurred in natural disturbance regimes. The large areas of even aged Lodgepole pine forest strongly indicate the large areas of historical disturbances.

The following rationale supports larger cutblock development:

Lower road densities (compared to small cutblocks) reducing: wildlife and habitat disturbance, pathways for introduction of invasive plants, development and reclamation costs.

Greater stand level diversity: Large cutblocks should be laid out to cross the greatest range of moisture and topographical diversity. The rate of change following harvest will vary based on moisture and topography resulting in greater stand level diversity over time.

Retention Strategies:

The following considerations should be included in strategic and stand level retention development:

Emphasis is placed on retention of limiting habitat types and structural stages such as old growth, early to mature seral/deciduous.

In mixed age class stands, variable veteran retention is encouraged to promote: forest health, recruitment of co-dominant stems for future old growth features, understory development of forb and shrub features (Zielke et al. 2003).

In even aged stands, forest retention should reflect the size and shape of residual stems consistent with natural disturbance regimes (Heinrich and Lewis 2005; Klenner 2006).

Stocking:

The following stocking standards should be considered to support the harvest and retention biodiversity objectives:

In general lowered stocking standards are encouraged to promote early seral features.

In variable veteran and seed tree retention systems, natural regeneration is preferred followed by minimum stocking standards. It is expected that a majority of these stands will occur on xeric to sub-xeric conditions as well as sub-mesic conditions.

The range of ministry stocking standards can be applied to clear cut areas with minimum stock standards preferred. It is assumed that a majority of these areas will be on prime growing conditions.

Prescribed Fire

Fire is a natural process that supports the health, diversity and productivity of the forest ecosystems. Harvesting activities that attempt to mimic fire disturbance may be an effective management strategy to restore biodiversity at a landscape level. However it may not be as effective at the stand level. Many wildlife and plant species have evolved to depend on regular fire disturbance. Furthermore, many plant species that require fire to promote germination do not respond well to harvesting alone. Many traditionally used and endangered species are dependant on fire associated ecosystems.

Re-introducing fire to the ecosystem is a necessary step to restoring biodiversity. It is anticipated that the extent of salvage harvesting that has occurred to manage MPB will provide opportunity for prescribed burns. The scale of the harvesting will reduce fuel loads and distance from at risk stands. Site level burn plans need to be developed and monitored to evaluate the effectiveness of prescribed fire on enhancing habitat for traditionally used, identified and endangered species (Snyder 1991; c.MOFR 2006).

5.3 Wildlife

A majority of wildlife management strategies focus primarily on retention. Retention criteria such as landbase area and age class compose the primary measures for wildlife management. However, there continues to be increasing concern regarding planning requirements, fragmentation and the effectiveness of retention strategies for wildlife (Machmer and Steeger 2004; JS Thrower & Associates 2006). In order to adequately meet the needs of future habitat supply more emphasis should be placed on habitat recruitment strategies.

In light of the MPB impacts and salvage harvesting, the precautionary principle should be adopted for the management strategies of Species at Risk and Identified Wildlife (BC Ministry of Water, Land and Air Protection 2004).

Mule Deer Winter Range Guidelines

Current management guidelines for mule deer have been based on research conducted in the Cariboo Forest Region and as such may not be directly applicable to the dry forest ecosystems of the Southern Interior (Armleder *et al.* 1986). In the dry ecosystems of the Southern Interior mule deer are often observed in “non-typical” habitats than those described elsewhere in the province (Nyberg and Janz 1990; Armleder *et al.* 1986). Retention of forest cover has been identified as the primary management recommendation aimed at reducing energetic costs of moving through snow as well providing additional thermal and security cover (Parker *et al.* 1984, 1990; Kirchhoff and Shoen and 1987). However, forest cover may not be a limiting habitat feature in the Southern Interior where winters are generally characterized by lower snow packs and milder temperatures than the Cariboo region. In addition the retention of forest cover may be at the detriment to forage availability. Recent work on Rocky Mtn. Elk (*Cervus elaphus*) found no positive effect of thermal cover on animal condition. Furthermore, dense cover was observed to have the

highest energetic costs, which was attributed to low availability of forage (Cook *et al.* 1998).

The selectivity of mule deer for browse of the highest nutrient content and palatability is well documented (Swift 1948, Tucker *et al.* 1976). It is possible that fire suppression activities have resulted in the in-growth of coniferous forest to the exclusion of many deciduous shrub species preferred for forage by deer. It is likely that a reduction of preferred browse species has resulted in a shift in diet composition with a greater reliance on Douglas-fir foliage. Recent studies in the Merritt TSA suggest that Douglas-fir may comprise as much as 57% of mule deer winter diet (Simpson and Simpson, 2000). It has been demonstrated that reduced availability of quality forage can negatively impact animal health and herd productivity (Ozaga and Verme 1982; Pederson and Harper 1978).

These findings would suggest that management strategies that promote forage opportunity may be favourable to mule deer. However the relationship between forage and cover in dry ecosystems is not well documented. In addition, the impact of the landscape level, salvage harvesting is unknown. Additional work in this area may be invaluable to resource managers planning catastrophic salvage activities such as pine beetle salvage or wildfire.

5.4 Visual Quality Objectives

Visual quality objectives protect scenic values in areas designated by District Managers or higher level plans. The effectiveness of visual quality guidelines are regularly evaluated to determine if practices and policies are meeting objectives (MOF 2005).

In general the public prefer natural forests to those modified by timber harvesting. Furthermore, the public approval is positively correlated with amount of forest retention, preferring selective harvesting over variable retention and clearcutting. Tourists are generally less accepting of forest harvesting than residents of British Columbia. Industry professionals are generally more accepting of forest harvesting than those outside of the industry (MOF 2006 b.).

Visual quality objectives have been developed to accommodate a number of purposes, such as: the tourism industry, protection of forest industry in multi-national markets and public opinion. Visual quality objectives have considerable economic impact on the forest industry. Furthermore, visual quality guidelines limit opportunities to manage for biodiversity objectives. However, variances in visual quality have been accepted to allow for the salvage of infected pine. More work is needed to incorporate biodiversity values into harvest plans that meet visual quality objectives.

Considerable effort is made to determine public opinion around visual quality. However little or no attempt is made to gauge First Nations perspective on visual quality objectives. Based on work within the community it is assumed that LNIB membership would generally be less accepting of forest harvesting visuals than general public. It may be assumed that a significant contributing factor is the lack of meaningful consultation around the development of forest management guidelines. Considerable work is necessary to clearly demonstrate how First Nations values may be used to drive management guidelines.

5.5 Cultural Heritage Resources

Under the Forest Practices and Planning Regulations, cultural heritage resources (CHR) are defined as resources that are the focus of traditional use and are of continuing importance to aboriginal people. Examples of CHR include non-timber forest products, medicinal plants and post 1846 culturally modified trees (pre 1846 culturally modified trees are considered under the Heritage Conservation Act) (MOFR 2001; Cultural Heritage Resources Working Group 2006).

The provincial ministry considers the following when developing strategies to conserve or protect CHR:

- Value or importance of traditional use to aboriginal person/community.
- Relative abundance of the resource.
- Historical extent of the resource.
- Impact on timber harvesting rights
- Mitigation strategies to protect resources.

The following considerations and concerns should be addressed in the management of CHR:

The identification of CHR priorities within LNIB membership would be a challenge to First Nations holistic approach to the land and natural resources. Prioritizing certain resources over others is contrary to First Nations Traditional Values.

As described the landscape of the traditional territory has changed significantly, resulting in changes in traditional use. The resulting changes in traditional use do not diminish their resource values. Restoring landscape through a biodiversity / holistic approach will promote traditional use and reduce pinch points where resources are limited.

In addition to relative abundance, the availability and quality of the resource also need to be considered. A specific resource may be relatively abundant, or available but considered poor in quality. Site factors such as soils and aspect may have a significant influence resource quality. It is important to consider that the best growing conditions may not yield the highest resource quality in terms of Traditional Use.

In developing mitigation strategies for rare Traditional Use species, a precautionary approach similar to species at risk should be implemented. In general, emphasis should be placed on habitat recruitment using a holistic biodiversity approach. Inventory and monitoring programs similar to those for identified plants and wildlife need to be initiated to assess the effectiveness of management strategies.

5.6 Timber

Many of the values and objectives under the Forest Practices Code and Forest and Range Practices Act (FRPA) impact timber resource values. An evaluation program has been developed to assess the impacts of FRPA of health, productivity and diversity of future forests.

To protect or enhance resource values, recommendations have been made to increase retention around riparian areas and lower stocking. It is anticipated that any proposed impacts on timber supply will be offset by additional access to timber. In addition, refinements in site index information and use select seed use may provide opportunity to improve timber values (Aird 2004).

5.7 Range

Domestic livestock grazing is managed under the authority of Forest and Range Practices Act. Grazing occurs on native communities throughout the range of ecosystems in the traditional territory. A considerable portion of grazing occurs in the NDT 3 forests. The level of grazing or animal unit month (AUM) is determined by the amount of available forage (MOFR 2000; Fraser 2004).

Fire suppression and development have reduced that amount of available range for livestock grazing. However, timber harvesting activities have contributed grazing opportunities. It is anticipated that the impact of MPB and subsequent salvage harvest will provide additional landbase for grazing. However, while forage opportunities are expected to increase, water resources are considered threatened. In addition salvage harvesting will provide greater access of livestock to riparian areas through the reduction of natural range barriers (BC Gov 2005).

To improve range management and reduce impact on other resource values it is recommended that AUM's are based on available water resources over forage. In addition, priority should be placed on maintaining or replacing natural range barriers lost during MPB harvest.

6.0 Workplan

6.1 Future Objectives

The following objectives have been identified as priorities for SFMS supporting LNIB's natural resource interests.

- Develop SFM strategies for NDT 2 & 4.
- Develop stand level plans to support higher level SFM strategies.
- Develop stand level plans to protect or enhance Traditional Use species.
- Work on operational pilot / harvest trial opportunities.
- Develop monitoring programs to assess the effectiveness of SFM.
- Maintain LNIB SFM committee to support the development and communication of strategies.

6.2 Knowledge Gaps

The following knowledge gaps are identified as research priorities to support SFMS.

- The relationship of surface to ground water; information on how surface development and wells interact.
- Hydrologic impacts in terms of water chemistry through live retention, dead standing retention and secondary structure. In addition examining impacts of forest regeneration and subsequent nutrient uptake on water chemistry.
- Use PEM to determine the predictability of old growth and understory features.
- Develop best management practices around stocking for non-timber objectives.
- Development of protocol to use water to determine AUM.

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