Ecosystem Representation in Tree Farm License #30

Final Report
March 31, 2006

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Executive Summary

The purpose of this study is to describe how the ecosystems of TFL30 are distributed within non-harvestable areas. Maintaining ecosystem representation in non-harvestable areas is a strategy for protecting the array of species that we have no knowledge of and preserving unmanaged benchmarks for monitoring the ecological effects of human activities. This analysis supports the Sustainable Forest Management and certification initiatives adopted by the licensees taking part in this study

Wells and Haag (2006) provided the coarse filter ecosystem groups, in which the site series of the Prince George timber supply area were aggregated based on relative similarities of their indicator plant communities. Using a netdown modified from the timber supply review netdown, the forested land base was divided into the Non-Harvestable Land Base (NHLB) and the Timber Harvesting Land Base (THLB). The proportion of each ecosystem group in the Non-Harvestable Land Base was measured. Other analyses include an assessment of interior NHLB (the amount of the NHLB that is at least 50m from the THLB), representation by Natural Disturbance Unit/merged biogeoclimatic variant, and comparisons of the attributes of the NHLB and THLB (pine leading stands and site index). Companion maps are included with this report that show the spatial distribution of the ecosystem groups and the harvesting constraints of the NHLB.

The Non-Harvestable Land Base occupies 15% of the forested land base of TFL30. Of this percentage, 1% occurs in parks, 3% in caribou range, 2% in Riparian Reserve Zones, 3% in sensitive soils and difficult regeneration, and 6% in physically and economically inoperable areas.

The results of this study were integrated into a preliminary rating of relative ecological risk associated with ecosystem representation. The risk rating only incorporates measures of the quantity of representation (NHLB representation and ecosystem abundance). Ways of incorporating measures of quality and certainty into the relative risk index are discussed. Ecosystem abundance is an important moderator of ecosystem representation in the determination of relative ecological risk.

This report provides a base of information and theory that will help forest managers prioritize their conservation efforts. The development of an ecological risk index is recommended because it would provide a means of integrating ecosystem representation results into a larger Sustainable Forest Management framework by allowing assessment of trade-offs with other ecological, economic, and social indicators.

Acknowledgements

The author would like to thank Craig Delong (MoF), Kerry Deschamps (Canfor), and Ralph Wells (Centre for Applied Conservation Biology) for contributing their expert advice through all stages of this project. I am indebted to Dave Huggard and the Weyerhaeuser Adaptive Management Working Group, who pioneered many of the methods employed here. The publications of Weyerhaeuser BC's Forest Project provided substantial scientific rationale for the approaches used in this study.

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Table of Acronyms

BC	British Columbia
BEC	Biogeoclimatic Ecosystem Classification
ERA	Ecosystem Representation Analysis
ESA	Environmentally Sensitive Area
FESL	Forest Ecosystem Solutions Ltd.
GIS	Geographic Information Systems
MoF	British Columbia Ministry of Forests
MP	Management Plan
MSRM	British Columbia Ministry of Sustainable Resource Management
NCBr	Non-Commercial Brush
NCLB	Non-Contributing Land Base
NHLB	Non-Harvestable Land Base
PEM	Predictive Ecosystem Mapping
RMZ	Riparian Management Zone
RRZ	Riparian Reserve Zone
SBFEP	Small Business Forest Enterprise Program
SFM	Sustainable Forest Management
SFMP	Sustainable Forest Management Plan
THLB	Timber Harvesting Land Base
TFL	Tree Farm Licence
TSA	Timber Supply Area
TSR	Timber Supply Review
VRI	Vegetation Resources Inventory
WTP	Wildlife Tree Patch
WTR	Wildlife Tree Retention

1 Introduction

1.1 Background

Canadian Forest Products Ltd. (Canfor) initiated the process for obtaining certification in early 2000 (Canfor Technical Working Group *et al*. 2002). To meet the biodiversity criteria of the Canadian Council of Forest Ministers Criteria and Indicators, Canfor is adopting a three-tiered approach to conservation developed by Dr. Fred Bunnell and the Weyerhaeuser Adaptive Management Working Group (Bunnell et al. 2003). Ecosystem representation in the Non-Harvestable Land Base is the first tier in this approach. This Ecosystem Representation Analysis (ERA) of TFL30 follows from the 2003 TFL 30 ERA pilot project and is one of four components of a more comprehensive analysis of the Prince George TSA.

1.2 The Study Area

TFL 30 is located on the McGregor Plateau, in the Southeast portion of the Prince George TSA, and is about 30 km northeast of Prince George. The TFL is predominantly in the SBS biogeoclimatic zone, with small areas of the Interior Cedar-Hemlock zone in the eastern portion and the Engelmann Spruce-Subalpine Fir zone at higher elevations. The total land base of TFL 30 is 180 km^2, of which 141 km^2 is productive forest. TFL30 has been managed by Canadian Forest Products Ltd. since 1999.

1.3 Ecosystem Representation Analysis

Maintaining representation of a full range of ecosystem types is a widely accepted strategy to conserve biodiversity in protected area networks (e.g., Margules and Pressey 2000; A) and is suggested for landscapes managed for forestry (e.g. Lindenmayer and Franklin 2002). Managing for ecosystem types rather than for individual species is often called the “coarse-filter approach” (Noss 1987). This approach is based on the assumption that a representative array of ecosystems will encompass the vast majority of species present on the landscape (Hunter, Jacobsen, and Webb 1988).

Maintaining ecosystem representation in non-harvestable areas is a coarse filter approach that is intended to manage for the array of species that we have no knowledge of, provide a buffer for species that are managed for within the harvested land base, and preserve unmanaged benchmarks for monitoring the ecological effects of human activities (Wells, Haag, and Braumandl 2003). Knowledge of the state of representation of individual ecosystems allows managers to set habitat priorities within the Timber Harvesting Land Base.

The approach to evaluating ecological representation that we used was originally developed by Dr. Fred Bunnell and the Weyerhaeuser Adaptive Management Working Group (Bunnell et al. 2003), as a component of a monitoring framework for maintaining biodiversity in managed forested landscapes. This framework is based on a criterion (goal) of maintaining biological richness and a set of three indicators (ecological representation, habitat elements and types, species-based monitoring) to assess the success in attaining the criterion. Therefore, representation is not intended as a stand-alone strategy, but rather as a forest-level complement to conservation efforts at the stand and species level.

This study adopts an approach to representation analysis developed by Dave Huggard and the Weyerhaeuser adaptive management group. (Huggard 2000; Bunnell et al. 2003). Bunnell et al.

(2003) summarize this approach in a progression of questions that a conservation biologist would ask when evaluating a reserve system, paraphrased below:

1. How much of the land base is set aside in reserves or lightly managed areas?
2. Are these reserves just rock and ice, or do they represent all forest types?
3. Are the reserves small and fragmented, or are there larger areas?
4. Are they long, thin areas, or is there some interior forest, away from edges?
5. Are the areas in reserves less productive or aberrant in some other way not captured by the forest classification system?

The objective of this study is to answer these questions for the area of TFL30, and to integrate the answers into an assessment of ecological risk. The following analyses are performed to answer Questions 1 through 5:

1. **The Netdown**: determining the Non-Harvestable Land Base (NHLB), which is the system of reserves to be evaluated in this study.

2a. **Classification**: classifying the forested land base into coarse-filter ecosystem groups, evaluating how these ecosystem groups are distributed within the Non-Harvestable Land Base.

2b. **Representation Analysis**: evaluating how the coarse-filter ecosystem groups are distributed within the Non-Harvestable Land Base.

3 & 4. **Interior NHLB analysis**: determining how much of each ecosystem group is greater than 50m distance of THLB areas.

5. **Attribute Comparisons**: comparing the attributes of the ecosystem groups within the Non-Harvestable Land Base and the Timber Harvesting Land Base.

Step 2b is the core analysis in this study. Steps 1 and 2a are the prerequisites to representation analysis, and steps 3, 4 and 5 are designed to qualify the results of representation analysis. These qualifying analyses can be useful for evaluating which ecosystem groups should become priorities for management actions or further analysis. Step 3 was addressed by patch size analysis in previous representation analysis in the Vanderhoof Forest District (Forest Ecosystem Solutions Ltd. 2004). However, patch size analysis was dropped from the methodology because it doesn't tend to provide meaningful interpretations (Dr. Dave Huggard, personal communication, 2004).

2 Provincial Context

The overall provincial distribution of the ecosystems of TFL 30 is an important consideration in ecosystem representation analysis. This type of assessment is an index for the responsibility that Canfor has over coarse filter conservation of the ecosystems of TFL 30 in the provincial context. Special attention needs to be given to ecosystems that have a large proportion of their total provincial area within TFL 30.

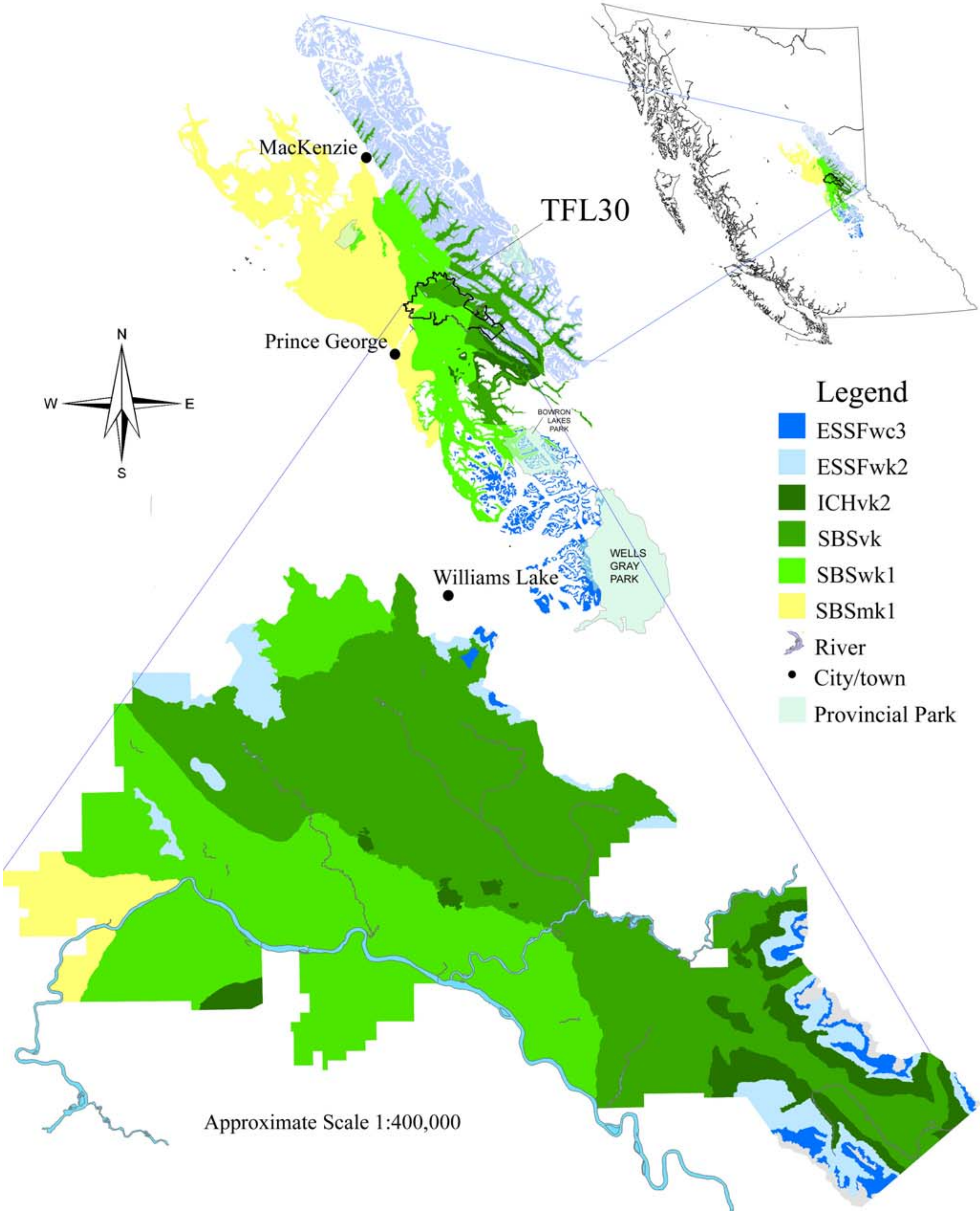
Table 1 and Map 1 show the area distribution of TFL 30 BEC variants in the provincial context. TFL 30 is composed of eight BEC variants, six of which contain forested site series: ESSFwc3, ESSFwk2, ICHvk2, SBSmk1, SBSvk, and SBSwk1 (see Map 1). TFL 30 contains a substantial portion of the ICHvk2, SBSvk, and SBSwk1, indicating that the responsibility for effective coarse filter biodiversity conservation is relatively high in these variants. It is notable that 14% of the SBSvk occurs within TFL30, even though the TFL is a relatively small management unit. The TFL 30 responsibility is relatively low for the ESSFwc3, ESSFwk2, and SBSmk1 because these variants are distributed almost entirely outside the boundary of the TFL.

Table 1: Responsibility for biogeoclimatic variants of TFL 30 in the context of the Prince George TSA and the province as a whole.

Biogeoclimatic Variant	Total Area (ha)			TFL 30 Responsibility		% of TFL 30 Area
	BC[1]	PG TSA	TFL30	BC	PG TSA	
ESSFwc3	915,322	235,033	2,933	0%	1%	2%
ESSFwk2	604,915	280,554	9,920	2%	4%	7%
ICHvk2	164,014	134,972	9,204	6%	7%	7%
SBSmk1	1,414,963	1,005,674	6,505	0%	1%	5%
SBSvk	458,128	433,468	62,162	14%	14%	44%
SBSwk1	785,845	574,469	50,294	6%	9%	36%

[1]Assessing the provincial distribution of ecosystems is only possible at the BEC variant level because this is the finest unit of ecosystem mapping at the regional scale. The provincial BEC spatial database (aBEC: map scale 1:20,000 to 1:250,000) was used to estimate the provincial area of BEC variants. The localized BEC variant mapping (map scale 1:20,000) is used to derive areas of each variant within the study area.

Map 1: Representation of Biogeoclimatic Variants in TFL 30



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3 Methods

This section summarizes the methods that were used to answer the 5 key questions of Ecosystem Representation Analysis that were posed in the introduction.

3.1 Defining the Non-Harvestable Land Base

This analysis is designed to answer question 1 in the introduction: *"How much of the land base is set aside in reserves or lightly managed areas?"*

Ecosystem Representation Analysis examines the proportion of each ecosystem unit that is expected to remain unharvested. The process of determining this non-harvestable area is a netdown procedure very similar to a timber supply netdown, in which stands ineligible for harvest are sequentially removed from the Timber Harvesting Land Base (THLB) and transferred to the Non-Harvestable Land Base (NHLB). Where the Timber Harvesting Land Base is of primary importance in a timber supply netdown, the primary goal of the SFM netdown is to create land bases that have distinct management implications. The netdown for Ecosystem Representation Analysis divides total study area into four main land bases:

Exclusions from study area—Urban, private, and agricultural lands were not included in the study area. These exclusions comprise private land, woodlots, crown land plan exclusions, and community leases. These areas were not included in the study area primarily because there is no ecosystem mapping, but also because government and licensees do not have substantial influence over management for biodiversity values in these areas.

Non-Contributing Land Base (NCLB)—The non-forested portion of the land base. The NCLB includes non-forested areas such as lakes, rock outcrops, wetlands, and roads. It also includes non-commercial brush (NCBr), which is potentially productive land that is in a relatively stable non-forested state.

Non-Harvestable Land Base (NHLB)—The portion of the forested land base where harvesting will not occur according to current forest practices. The NHLB includes parks, caribou range Riparian Reserve Zones, stands with sensitive soils or poor regeneration potential, and stands that are inoperable for reasons of worker safety or merchantability.

Timber Harvesting Land Base (THLB)—Forested land that is harvestable according to current forest practices. In addition to unconstrained areas, the THLB also includes areas where partial harvesting will occur (such as in riparian management zones) and areas where the spatial location of constraints is currently not known (such as wildlife tree patches and some recreation areas). These latter areas are called the "Constrained THLB."

3.2 Coarse-Filter Classification

This classification exercise defines the "forest types" referred to in question 2 in the introduction: *"Are these reserves just rock and ice, or do they represent all forest types?"*

Classification of the landscape into units that represent the diversity of ecosystems is fundamental to representation analysis. Representation studies worldwide have used various classification systems based on landform-vegetation classes (Awimbo, Norton, and Overmars 1996), climate-physiography-soil-vegetation interactions (Lapin and Barnes 1995), breeding bird communities

(Saetersdal and Birks 1993), and physiography alone (Wessels, Freitag, and van Jaarsveld 1999). The Biogeoclimatic Ecosystem Classification (BEC) (Pojar, Klinka, and Meidinger 1987) integrates climate, soils, and vegetation into a hierarchal scheme that lends itself well to representation analysis for forest ecosystems of British Columbia.

Definition of ecosystem types requires classification at an ecologically appropriate scale (Pregitzer, Goebel, and Wigley 2001). Existing provincial BEC mapping is commonly used for coarse filter management using the variant level. This information is often too general since variants describe climate and may contain a wide range of ecosystems that may respond differently to forest management. Conversely, representation at the BEC site series level is not appropriate for a coarse filter approach for practical reasons (too many groups) and because there is limited evidence that organisms are linked to this level of detail (Huggard 2000; Bunnell et al. 2003).

The goal for *the ecosystem classification portion* of this project is to identify a level of site series aggregation that recognizes the uniqueness of individual sites while providing logical ecosystem units for coarse filter management. Devon Haag and Ralph Wells (Centre for Applied Conservation Research) created groups of site series for this analysis using statistical methods and expert review. Expert review was provided by Craig Delong (MoF Prince George Regional Ecologist). The methodology and results of this classification exercise are provided in Wells and Haag (2006).

3.2.1 Naming conventions

The coarse-filter ecosystem classification for the Prince George TSA divided the TSA in three Areas with different climatic and ecological implications. In a few cases, the Area boundaries divide individual biogeoclimatic variants into separate units for ecosystem classification. The numeric IDs assigned to the ecosystem groups in Wells and Haag (2006) are used throughout this report. The classification Area in which the group occurs is assigned as a prefix to this ID. For example, Group 12 in Area 1 would be called “Group 1-41”.

3.3 Ecosystem Representation Analysis

This analysis combines the results of the netdown and the coarse-filter classification to answer question 2 in the introduction: *“Are these reserves just rock and ice, or do they represent all forest types?”*

The locations of the ecosystem groups and the netdown reductions (e.g. riparian reserves) were maintained as polygons in a spatial database (resultant). Reporting area representation of ecosystem groups within the Non-Harvestable Land Base is therefore a spatial exercise. The main limitation on the spatial accuracy of the results is the scale of the predictive ecosystem mapping.

3.3.1 PEM scale and decile accuracy

There can be up to three site series in the label for each Terrestrial Ecosystem Mapping (TEM) polygon. The proportion of each site series in the polygon is specified in increments of one-tenths, and so these subunits of the polygon are called “deciles”. Analysis methods ensured that area totals are accurate to the decile level, which is a more precise approach that using only the leading site series. However, deciles are inherently non-spatial, so the spatial accuracy of results is limited to that of the TEM polygon (1:20,000), rather than the much smaller size of the resultant polygons.

3.4 Assessment of Interior NHLB

This analysis is designed to answer question 4 in the introduction: *"Are the reserves long, thin areas, or is there some interior forest, away from edges?"*

Fragmentation of unmanaged areas can compromise their effectiveness in coarse filter conservation of biological diversity. The forest adjacent to roads and cutblocks is ecologically different from interior forest, due to changes in microclimate, the structural complexity of vegetation, the abundance of predators and/or nest parasites, the presence of edge-associated species, and possible invasion of exotic species. These edge effects may reduce the ability of those areas to supply habitat to a full complement of species. An ecosystem unit represented in the NHLB by many small, unmanaged patches may require special management in the THLB, even if its representation in the NHLB is large. Therefore, an assessment of interior condition is an important part of Ecosystem Representation Analysis (Bunnell et al. 2003)

Kremsater and Bunnell (1999) have found that most microclimatic or biological edge effects occur within 50m from the physical edge of western forests. Landscape Biodiversity Objectives for the Prince George Timber Supply Area (BC MSRM 2004) measure interior old forest beyond 200m from boundary between young and old forests. Previous representation analysis for the Vanderhoof Forest District used both 50m and 200m in the assessment of interior NHLB. For simplicity, the proportion of the NHLB that is 50m from the THLB is used as the measure of interior in this analysis. This measurement was accomplished using GIS by buffering the THLB by 50m and calculating the percent of NHLB polygons covered by this buffer. Edges between the NHLB and non-productive land such as lakes, wetlands, and NCBr were not buffered because they are within the natural range of habitat types.

"Interior NHLB" is defined as the area of forest that will never be less than 50m from managed stands. At any given time, the THLB will contain stands at various stages of development. Consequently, there will often be more interior forest in TFL30 than indicated by the interior NHLB.

3.5 Attribute Comparisons

This analysis is designed to answer question 5 in the introduction: *"Are the areas in reserves less productive or aberrant in some other way not captured by the forest classification system?"*

A comprehensive comparison of the attributes of ecosystem groups in the NHLB and THLB is outside the scope of this study. Nevertheless, average site index and percentage of pine-leading stands in the NHLB and THLB were compared for each ecosystem group. Site index and species distributions were taken directly from the Vegetation Resources/Forest Cover Inventory in the analysis dataset.

3.6 Source Data

The TSR2 resultant was obtained from Canfor and processed by staff at Forest Ecosystem Solutions Ltd. This resultant database contains the Vegetation Resources Inventory (VRI), Terrestrial Ecosystem Mapping (TEM), and all other spatial information required to conduct this

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analysis[1]. The VRI is mapped at a scale of 1:20,000 and is current to the year 2000. The TEM is mapped at a scale of 1:50,000 and is current to the year 2000. An updated road coverage was provided by Canfor and overlaid onto the resultant. The resultant was processed in ArcInfo to remove unnecessary coverages. FESL's Polygon Manipulation Tool (PMT) was used to remove very small (<0.1 ha) polygons while preserving important linework. Polygons within riparian reserve and management zones are smaller than on the rest of the land base, and were processed to a tolerance of 0.01 ha.

[1] A detailed description of all inventories used to create the TSR2 resultant is given in the data inputs and assumptions report for the TFL 30 Management Plan No. 9 Timber Supply Analysis (Voros and Lynch, 2001).

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4 Results

This section gives answers to the 5 key questions of Ecosystem Representation Analysis that were posed in the introduction. Section 4.1 describes how the total area of TFL30 breaks down into different land bases, most importantly the Non-Harvestable Land Base (NHLB) (question 1). Section 4.2 gives the proportion of each ecosystem group in the Non-Harvestable Land Base, which are the core results of the Ecosystem Representation Analysis (question 2). Sections, 4.3 and 4.4 give the results of the interior NHLB and attribute comparisons (questions 4 and 5). Section 4.5 provides representation results for NDU-merged BGC units, which is a broader scale climatic classification.

Two 1:200,000 companion maps are included with this report that shows the spatial distribution of the coarse-filter ecosystem groups and the Non-Harvestable Land Base. Mapping assumptions are documented in Appendix D.

4.1 Results of the Netdown

The netdown is designed to answer question 1 in the introduction: *"How much of the land base is set aside in reserves or lightly managed areas?"* The netdown for Ecosystem Representation Analysis in TFL30 is shown in Table 2.

Table 2: The netdown for Ecosystem Representation Analysis in TFL30, showing the determination of the Non-Harvestable Land Base and the Timber Harvesting Land Base.

Reduction to THLB	Gross Area (ha)[1] ERA	TSR2	Net Area Transferred (ha) To NCLB	To NHLB
Total land base	180,471	182,298		
Private land	502	429	502	
TFL 30 Working Area	179,970			
Unclassified lands	16	2,046	16	
TEM Non-productive	27,157	17,993	27,141	
Rivers	1,849		100	
Existing Unmapped landings	1,072	1,036	1,072	
Existing Roads and Trails	3,505	1,836	2,934	
Non-commercial Brush	10,239	10,589	7,641	
Total Non-Forested Land (NCLB)			**39,407**	
Forested Land Base (combined NHLB and THLB)	141,065			
Full Removals				
Giscome Portage Trail (Class A Park)	90	93		84
Horseshoe recreation area	577	649		328
Tri-lakes recreation area	676	675		461
Woodall recreation area	1,735	1,734		1,038
Recreation sites (113m circular buffer)	11	12		6
Seebach riparian zone	1,205	1,196		298
McGregor river management zone	3,198	3,182		954
Riparian reserve zones	2,191	2,821		1,153
Unstable Terrain (Class V)	4,409	5,111		3,064
Caribou High value habitat	8,317	8,312		4,247
Difficult regeneration	4,498	8,061		1,304
Non-merchantable stands	21,578	18,529		8,507
Non-Harvestable Land Base (NHLB)				**21,442**
Timber Harvesting Land Base (THLB)	**119,623**	122,080		
Partial Retention				
Caribou medium habitat (70% retention)	2,063			1,238
S1-S3 riparian management zones (50% retention)	1,831			1,092
Lake and wetland RMZs (25% retention)	3,271			2,326
Net Area of Partial Harvesting				**4,656**

[1] Total Area of the TFL 30 working area covered by a given land classification

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4.2 Ecosystem Representation in the NHLB

The area and NHLB representation of the coarse-filter ecosystem groups are shown in Table 3. Area totals are for the NHLB/THLB area of the ecosystem group exclude non-commercial brush, since these areas are considered to be in a stable non-forested state and do not contribute to ecosystem representation in the NHLB. The NHLB representation range from 0% (ecosystem group 2-3) to 100% in groups of the ESSFwc3 variant. The total representation level of 15% is consistent with the results of the netdown: 15% of the forested area of TFL30 is in the Non-Harvestable Land Base.

Table 3: Representation of coarse-filter ecosystem groups in the Non-Harvestable Land Base (NHLB)

Coarse-Filter Ecosystem Group			Area (ha)	Representation in the NHLB
Area 2	3	Xeric-subxeric BWBS/SBSmk	11	0%
	7	Subxeric-submesic SBS mk1	141	16%
	11	Submesic-mesic SBS mk1	849	9%
	14	Circum-mesic SBS	1,321	7%
	17	Circum-mesic SBS mk1/wk	1,983	6%
	23	Mesic-subhygric SBS mk/wk2	995	7%
	30	Subhygric-hygric SBS mk1	303	7%
	36	Hygric-subhydric SBS mk/wk2	762	18%
Area 3	2	Xeric ICH wk3	184	39%
	4	Xeric-subxeric ICH/SBS	621	10%
	6	Xeric-subxeric SBS wk	15	33%
	7	Subxeric ICHvk2/wk3	480	39%
	8	Xeric-submesic ESSF wc3	478	100%
	10	Subxeric-submesic SBS wk1	2,419	12%
	11	Subxeric-submesic SBS vk	1,553	22%
	12	Subxeric-submesic ESSF wk2	872	68%
	15	Submesic-mesic ICH vk2/wk3	2,098	21%
	16	Submesic SBS vk	7,140	10%
	17	Submesic-mesic ESSF wc3	2,121	100%
	20	Circum-mesic SBS wk	29,187	7%
	21	Circum-mesic SBS vk/wk	49,324	7%
	22	Submesic-hygric ESSF wk2	7,247	44%
	23	Mesic-subhygric ESSF wk2	139	47%
	24	Mesic-hygric ESSF wc3	334	100%
	25	Subhygric SBS wk1	3,660	7%
	27	Subhygric ESSF wk2	1,662	39%
	30	Subhygric-hygric ICH vk2/wk3	4,838	11%
	31	Subhygric-hygric ICH/SBS	8,009	19%
	34	Subhygric ICH vk2	1,359	14%
	38	Hygric ICH/SBS	1,943	34%
	39	Hygric ICH vk2	197	7%
		Subhydric (unclassified)	9,086	32%
TFL30 Total			141,331	15%

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The results above are shown in more detail in Figure 1. Figure 1 shows the total area of each ecosystem group in the upper graph (NHLB plus THLB), and the NHLB representation in the lower graph. NHLB representation is divided into the main categories of constraints: parks and reserves; caribou range, riparian reserve zones; sensitive soils; and physically/economically inoperable.

As noted previously, the area distribution shows that zonal sites dominate the landscape, while ecosystems on drier and wetter sites are relatively uncommon. The general pattern of representation is that ecosystems at the moisture extremes have high NHLB representation relative to zonal sites.

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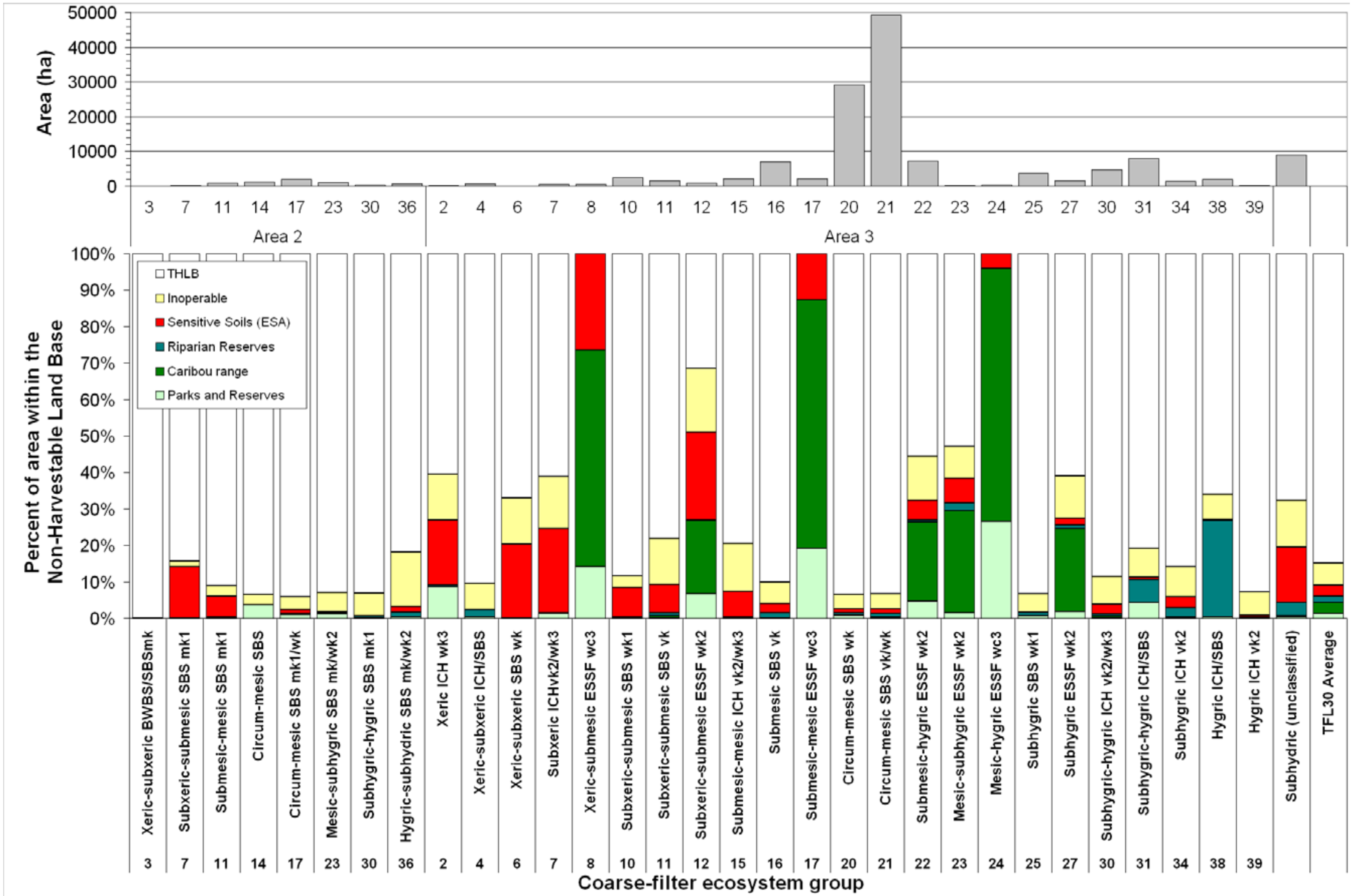

Figure 1: Representation of coarse-filter ecosystem groups in TFL30, showing the total area of each ecosystem group (THLB plus NHLB) and proportion of the total area that is in the NHLB.

4.2.1 Representation in parks and protected areas

Certain reserves are more important to some ecosystem groups than to others. Figure 2 shows the contribution of individual parks and reserves to the representation of each ecosystem group. The Woodall Recreation Area is the largest overall contributor to representation.

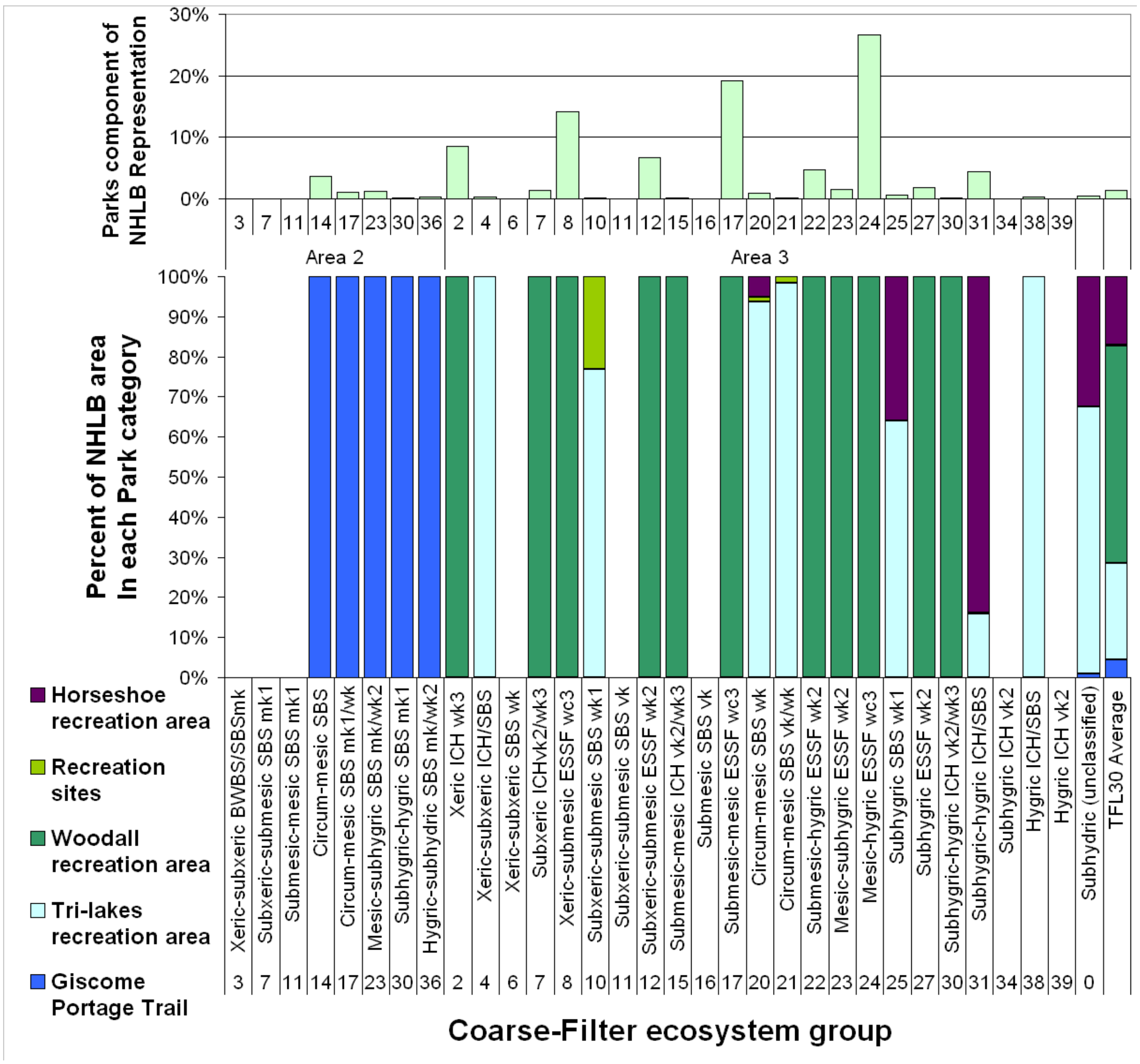

Figure 2: Contribution of individual parks to NHLB representation of each ecosystem group. The upper graph shows the total representation in parks and reserves, while the lower graph shows the proportion of this representation in individual parks.

4.2.2 Representation within riparian reserves

Riparian Reserve Zones (RRZs) are an important contributor to ecosystem representation in TFL30, comprising one-fifth of the NHLB. However, there is considerable variation in the RRZ representation of individual ecosystem groups, as shown in the upper graph of Figure 3. RRZ representation is highest in the moister ecosystem groups. The lower graph of Figure 3 shows the breakdown of Riparian Reserve Zone representation levels into different riparian-oriented reserves.

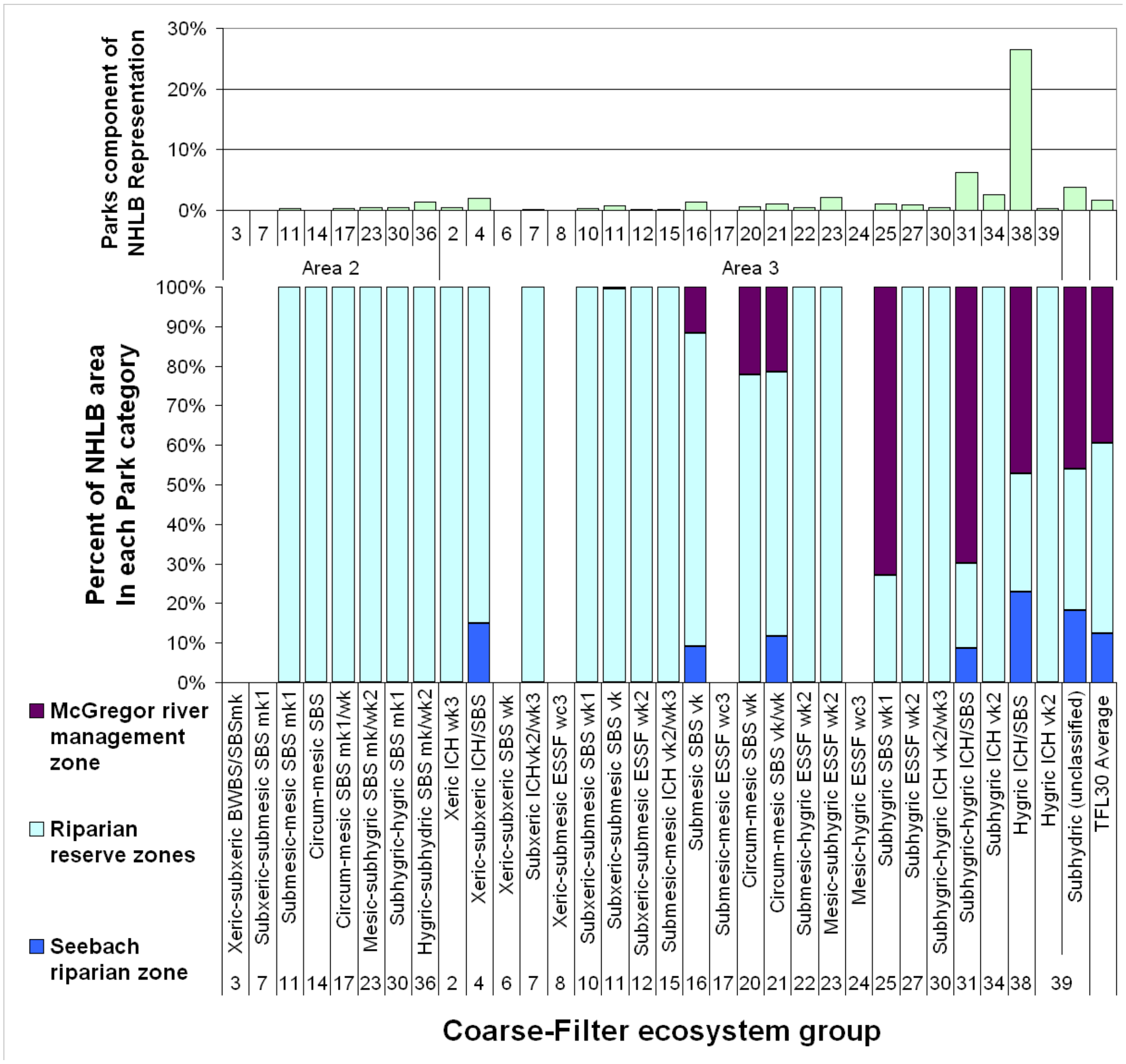

Figure 3: Representation of coarse-filter ecosystem groups in Riparian Reserve Zones (RRZs). The graph on top shows the component of overall NHLB representation in RRZs. The graph on the bottom is the breakdown of this representation in RRZs for streams, lakes, and wetlands.

4.3 Interior NHLB

Interior NHLB analysis is designed to answer question 4 in the introduction: *"Are the reserves long, thin areas, or is there some interior forest, away from edges?"* Regions of the Non-Harvestable Land Base that are at least 50 meters away from the Timber Harvesting Land Base are considered to be in a long-term interior condition. Assuming no change in the distribution of the THLB, these areas will always be buffered from harvesting activities. The distribution of the NHLB interior amongst ecosystem groups is shown in Figure 4.

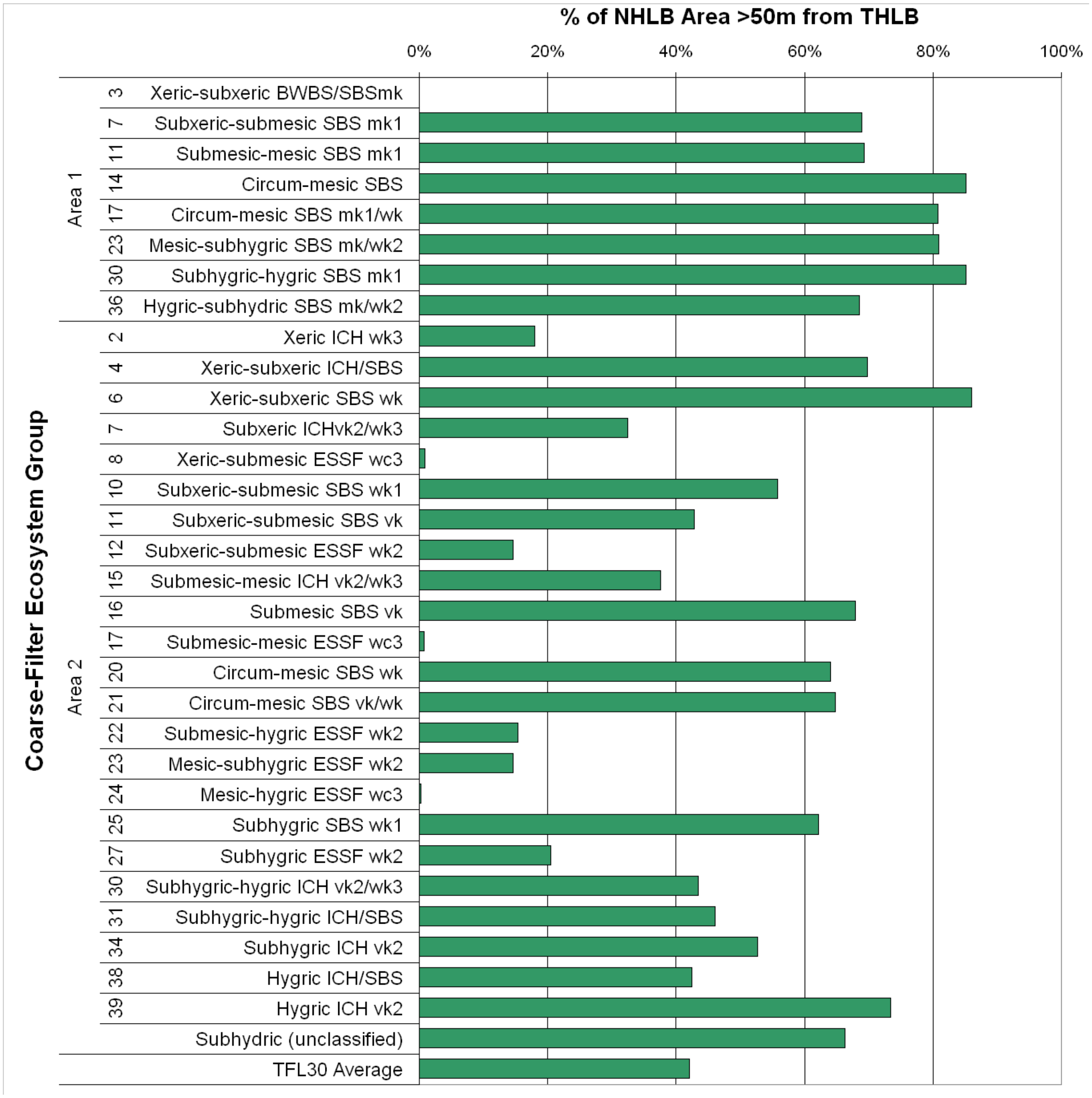

Figure 4: Proportion of the NHLB area that is interior NHLB (>50m from the THLB).

4.4 Attribute Comparisons

Attribute comparisons are designed to answer question 5 in the introduction: *"Are the areas in reserves less productive or aberrant in some other way not captured by the forest classification system?"* If there are substantial differences between the NHLB and the THLB for a given ecosystem group, then occurrences of that ecosystem group within the NHLB may not be representative of the ecosystem as a whole. While it is difficult to definitively characterize ecosystem state, attribute comparisons provide a "quick-and-dirty" assessment of whether the NHLB occurrences of the ecosystem groups are in a radically different state than their overall distribution in the productive forest land base.

The proportion of total area that is covered by pine-leading stands is the only attribute comparison provided in this analysis. Other representation analyses in the Prince George TSA also provide a site index comparison. This comparison was not included for TFL30 due to problems with the site index attribute in the available source data. A site index comparison may be provided at a future date if required.

4.4.1 Pine-leading stands

The mountain pine beetle infestation is one of the dominant ecological processes affecting the study area at present, and is a key forest management consideration. Although the current status of the forest is not meant to qualify representation as a measure of relative ecological risk, the role of the mountain pine beetle in the NHLB is a salient consideration, if only as peripheral information. The simplest measure of the potential of the mountain pine beetle to affect different parts of the landscape is the proportion of area covered by pine-leading stands. In many ecosystems, pine-leading stands represent an early- or mid-seral stage of stand development. The percent of pine-leading stands therefore also provides a simple indicator of the relative structural stage in different occurrences of some ecosystems. The pine-leading component of the NHLB and THLB are compared for each ecosystem group in Figure 5. Generally, the NHLB contains substantially less pine-leading stands than the THLB.

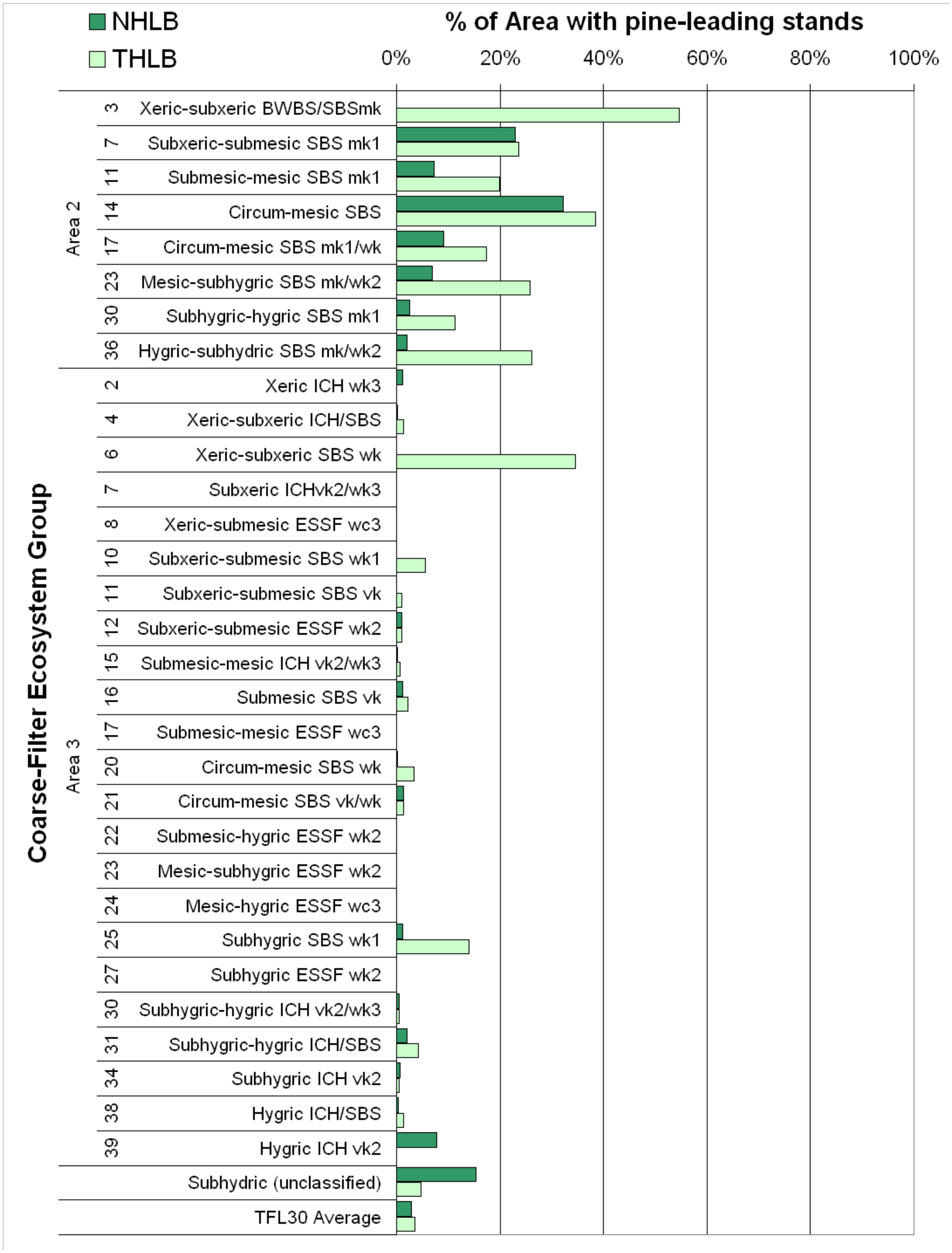

Figure 5: Proportion of Pine-leading stands in the NHLB and the THLB

4.5 Representation in NDU-merged BGC units

Delong (2002) has developed Natural disturbance units (NDUs) for the Prince George Forest Region. These units describe broad areas with distinct landscape-level natural disturbance regimes. The NDUs have been further subdivided into groups of biogeoclimatic variants (merged BGC units) that represent distinct climates. Together, the NDU-merged BGC units have gained widespread use throughout the Prince George Timber Supply Area as large-landscape-level units of management for biological diversity. These units do not capture ecological variation at the site level. Nevertheless, reporting NHLB representation within NDU-merged BGC units is useful because it provides a broader perspective of representation within the climatic units of the study area. NHLB representation within NDU-merged BGC units is shown in Figure 6.

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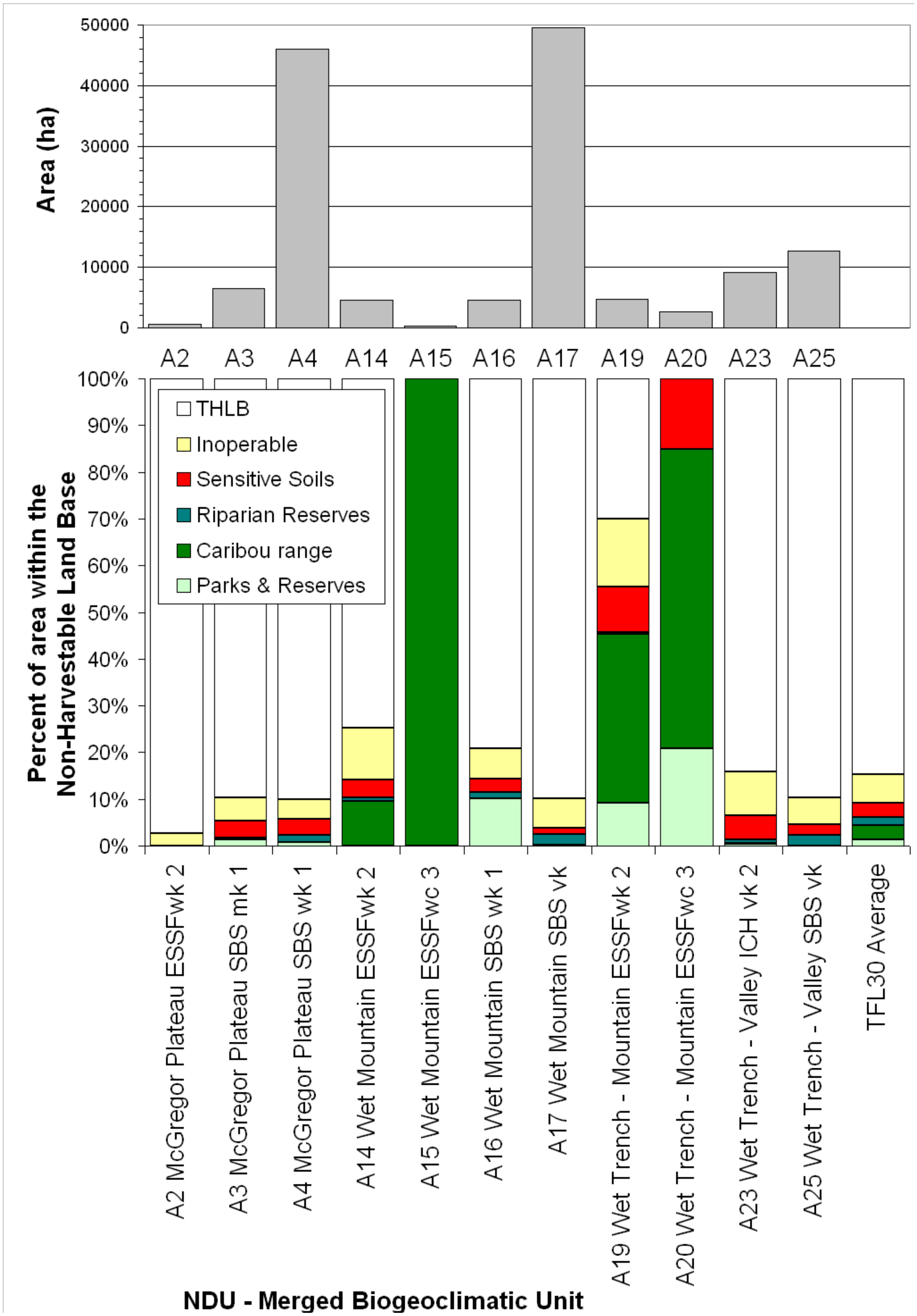

Figure 6: Representation of NDU-merged BGC units in the non-harvestable land base

5 Synthesis: Assessing Ecological Risk

The goal of ensuring ecosystem representation in the Non-Harvestable Land Base is to reduce the risk that timber harvesting activities have to biological diversity. The concept of ecological risk is therefore central to this study.

Ecosystem representation is a coarse filter conservation strategy: it is designed to sustain ecological elements and functions that we have little knowledge of. In this context of imperfect knowledge, the actual ecological risk cannot be assessed, and managers must rely on the concept of *relative risk* when prioritizing management actions. Assessments of relative risk synthesize available data and theory about the relationship between management actions and ecological risk.

This section discusses how the results of this study could be synthesized into an index of relative ecological risk associated with levels of ecosystem representation in TFL 30. The intent is not to provide a definitive assessment of relative risk, but rather to stimulate discussions and to provide a preliminary risk rating of the ecosystem groups.

5.1 Quantity, Quality, and Certainty of Ecosystem Representation

The effectiveness of the Non-Harvestable Land Base in reducing ecological risk is dependent not just on how much of each ecosystem group is in the NHLB, but also on the quality of that representation. There is also some uncertainty associated with our assumptions about what actually constitutes the Non-Harvestable Land Base. An assessment of ecological risk should therefore integrate the quantity, quality, and certainty of ecosystem representation in the NHLB.

Quantity of representation

<u>Representation in the Non-Harvestable Land Base</u>
This is the central variable being examined by the study. It is simplest to assume that the relationship between *NHLB representation* and risk is linear. However, Bunnell et al. (2003) note that representation in the NHLB and risk to biological diversity are likely not linearly related. Additions to the reserve network will likely have greater value for sustaining biological diversity in ecosystems with low representation than in ecosystems that already have high representation. This “diminishing returns” model of the relationship between representation and ecological risk should be considered when refining the methodology for risk assessment.

<u>Ecosystem abundance</u>
Widespread ecosystems are likely to be less sensitive to low levels of representation than uncommon ecosystems. The hypothesized robustness of common ecosystems is related to their tendency to occur in large connected patches that can better support viable populations of resident organisms (Lindenmayer and Franklin 2002). Uncommon ecosystems are thought to require higher representation in the Non-Harvestable Land Base to maintain ecological risk within acceptable levels (Wilson 2003). Abundance of an ecosystem group can be measured in many ways, none of which have received any rigourous assessment in the context of ecosystem representation. The simplest measure of abundance is the proportion of the total study area covered by the ecosystem group. This measure is not valid for ecosystems that occur primarily outside the study area

Quality of representation

The quality of representation is the extent to which the NHLB component of each ecosystem group is consistent with an ecological baseline (Noss 1990). Deviations from this baseline are considered to reduce the quality of representation.

<u>Interior NHLB</u>

Management activities occurring adjacent to non-harvestable areas compromise the "unmanaged" character of the NHLB. The proportion of ecosystem representation that is at least 50m from the THLB is an index of the quality of representation. The landscape in an unmanaged state would have no THLB, meaning the ecological baseline for this variable is 100% interior NHLB.

<u>Site Index Differences</u>

Unlike structural stage and species composition, site index is a measurable attribute of ecosystems that is thought to be relatively robust to management activities (BC MoF 1997). Site index therefore provides a reasonable measure of whether the Non-Harvestable Land Base is representative of the attributes of each ecosystem group. The average site index in the management unit as a whole can be used as the baseline for each ecosystem group.

Certainty of representation

The relative ecological risk to ecosystem groups is also related to the level of certainty in the ecosystem mapping and the distribution of the NHLB and the THLB.

<u>Certainty of the Ecosystem Mapping</u>

Predictive ecosystem mapping is a semi-automated process with inherent sources of error associated with the source data and the algorithms used to interpret the source data. The potential for error in mapping is compounded for rare ecosystems.

<u>Certainty of the NHLB</u>

There is some uncertainty associated with the spatial location of the Non-Harvestable Land Base. There are two main sources of uncertainty. First, the spatial resolution of the data used in this study is imperfect. For example, the boundaries of Riparian Reserve Zones and sensitive soil ESAs, and non-merchantable stands are estimated based on coarse assumptions and are expected to have higher levels of error than linework for parks and forest cover polygons. The second source of uncertainty is the potential of the NHLB to shrink or expand due to changes in management. For example, economical operability and merchantability is highly dependent on changes in technology and market demand. The future location of physically and economically inoperable NHLB will undergo unanticipated changes. The relative importance of these categories to representation of an ecosystem group will determine the overall NHLB uncertainty associated with that ecosystem group.

Variables not used for assessing ecological risk

A comparison of the proportion of pine-leading stands in the NHLB and the THLB was provided in this study as peripheral information of interest to managers at this point in time. However, this information, like structural stage and species composition are generally excluded from ecological risk assessment because ecosystem representation in the NHLB is intended as a state-independent measure (ecosystem state is accounted for explicitly by Indicator 2 of the Biological Diversity Criterion). Also, the state of ecosystems is directly influenced by forestry activities, and so it is difficult to determine an ecological baseline against which to measure the quality of representation.

5.2 Preliminary ecosystem risk ranking

A basic ranking of ecosystem groups is provided in **Table 4** below. This ranking uses only NHLB representation and abundance. Further refinements to the ranking could include the other considerations of the quality and certainty of representation, as discussed above.

The equation for the relative ecological risk index is representation multiplied by abundance. The abundance of an ecosystem group is its area divided by the total forested area of the TFL. Abundance tends to override representation if it is weighted equally, so the cubed root of abundance is used to decrease its importance in the equation.

$$\text{Risk index} = \text{Representation x abundance}^{1/3}$$

The risk index provides a means of prioritizing ecosystems; the actual value of the index is not important. Ranking the ecosystems according to the index provides a means of focussing attention on ecosystems that may be at the highest risk.

.**Table 4: Preliminary risk ranking using representation in the NHLB and ecosystem abundance.**

Coarse-Filter Ecosystem Group		Area (ha)	Abundance	Representation in the NHLB	Risk Index	Risk Ranking
1-3	Xeric-subxeric BWBS/SBSmk	11	0.0%	0%	0.00%	1
1-39	Hygric ICH vk2	197	0.1%	7%	0.84%	2
1-30	Subhygric-hygric SBS mk1	303	0.2%	7%	0.91%	3
1-23	Mesic-subhygric SBS mk/wk2	995	0.7%	7%	1.39%	4
1-14	Circum-mesic SBS	1,321	0.9%	7%	1.43%	5
1-17	Circum-mesic SBS mk1/wk	1,983	1.4%	6%	1.44%	6
1-4	Xeric-subxeric ICH/SBS	621	0.4%	10%	1.60%	7
1-7	Subxeric-submesic SBS mk1	141	0.1%	16%	1.60%	8
1-6	Xeric-subxeric SBS wk	15	0.0%	33%	1.62%	9
1-11	Submesic-mesic SBS mk1	849	0.6%	9%	1.66%	10
1-25	Subhygric SBS wk1	3,660	2.6%	7%	2.02%	11
1-10	Subxeric-submesic SBS wk1	2,419	1.7%	12%	3.05%	12
1-34	Subhygric ICH vk2	1,359	1.0%	14%	3.08%	13
1-36	Hygric-subhydric SBS mk/wk2	762	0.5%	18%	3.26%	14
1-16	Submesic SBS vk	7,140	5.1%	10%	3.71%	15
1-30	Subhygric-hygric ICH vk2/wk3	4,838	3.5%	11%	3.79%	16
1-20	Circum-mesic SBS wk	29,187	21.0%	7%	3.90%	17
1-2	Xeric ICH wk3	184	0.1%	39%	4.43%	18
1-23	Mesic-subhygric ESSF wk2	139	0.1%	47%	4.82%	19
1-21	Circum-mesic SBS vk/wk	49,324	35.4%	7%	4.84%	20
1-11	Subxeric-submesic SBS vk	1,553	1.1%	22%	4.96%	21
1-15	Submesic-mesic ICH vk2/wk3	2,098	1.5%	21%	5.14%	22
1-7	Subxeric ICHvk2/wk3	480	0.3%	39%	5.99%	23
1-31	Subhygric-hygric ICH/SBS	8,009	5.8%	19%	7.49%	24
1-38	Hygric ICH/SBS	1,943	1.4%	34%	8.29%	25
1-27	Subhygric ESSF wk2	1,662	1.2%	39%	9.07%	26
1-12	Subxeric-submesic ESSF wk2	872	0.6%	68%	12.83%	27
	Subhydric (unclassified)	9,086	6.5%	32%	13.12%	28
1-24	Mesic-hygric ESSF wc3	334	0.2%	100%	13.66%	29
1-8	Xeric-submesic ESSF wc3	478	0.3%	100%	15.37%	30
1-22	Submesic-hygric ESSF wk2	7,247	5.2%	44%	16.75%	31
1-17	Submesic-mesic ESSF wc3	2,121	1.5%	100%	25.14%	32

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6 Recommendations

Future directions for implementing an ecosystem representation approach include identifying priority ecosystem groups, applying feedbacks to management, and periodically updating the analysis for new knowledge.

6.1 Establishing Priorities for Management

Within a criteria and indicators framework, thresholds are defined as "the amounts or levels of different resources that would trigger a management action" (Robinson 2003). Explicit representation targets are often cited as prerequisites for effective conservation planning (e.g. Noss 2003). However, coarse filter management is designed to address poorly understood systems, so ecologically meaningful thresholds for ecosystem representation are inherently difficult to determine. For this reason, representation studies in BC have avoided the formulation of thresholds. Rather than establishing thresholds for all ecosystem groups, forest planners could manage for ecosystem representation based on a prioritization system, where highest-risk ecosystems are managed first.

Several factors will contribute to the priority that a planner gives to specific ecosystem groups when managing for representation:

- **Relative ecological risk—**The assessment of relative ecological risk provided a rating of ecological risk that ordered ecosystem groups from highest risk to lowest risk. Once managers are comfortable with a methodology for calculating relative risk, they can use this rating as the basis for prioritization.
- **Responsibility—**The concept of responsibility was introduced in Section 2. Ecosystems that are primarily located within the TFL (high responsibility) may be given higher priority for management than ecosystems that are primarily located outside the TFL.
- **Cost—**Actions designed to meet representation objectives have a cost in that they may negatively impact other ecological, social, or economic goals. Certain ecosystems will have opportunities to immediately increase representation at low cost, while for other ecosystems the costs of increasing representation may be prohibitively high. The costs of managing for representation may be a factor in the priority given to one ecosystem over another.

6.2 Feedbacks to Management

Once priority ecosystems groups have been identified, there are several tools available to reduce ecological risk by increasing the quantity, quality, and certainty of representation.

Increasing the quantity of representation—Managers do not have control over the abundance of ecosystems, but they can increase ecosystem representation in the NHLB by:

- Establishing or reallocating reserves in high-risk ecosystems; and
- Prioritizing high-risk ecosystems in WTP and OGMA allocation.

Increasing the quality of representation—Even after the large quantities of NHLB representation have been achieved, ecological risk may still be high because the quality of this representation is poor. Very rare ecosystems provide a good example of this situation: even if the NHLB representation is increased to 100%, some rare ecosystems will remain a high-risk ecosystem group because they are in close proximity to managed area and can entirely altered by a single natural disturbance event. In order to further reduce risk, managers may choose to increase the quality of representation by establishing reserves adjacent to high-risk ecosystems in order to increase the amount of interior NHLB.

Increasing the certainty of representation—Some level of error is inevitable with any form of ecosystem mapping. However, the error associated with mapping of specific priority ecosystems can be reduced by targeted mapping of rare ecosystems (e.g. Predictive Rare Ecosystem Mapping, PREM), or through identification of these ecosystems during operational field work.

The Non-Harvestable Land Base is inherently dynamic, and there is inevitable uncertainty associated with our inability to predict the future. However some sources of uncertainty associated with the NHLB can be addressed:

- Spatialize the Non-Harvestable Land Base as much as possible—ESAs for soils and wildlife are accounted for through partial reductions to the Timber Harvesting Land Base. While partial reductions are sufficient for timber supply analysis, they confound Ecosystem Representation Analysis, which depends on knowing the spatial location of non-harvestable areas. Proponents of future mapping projects should be encouraged to be as spatially explicit as possible.

6.3 Monitoring and Adaptive Management

The analysis and results in this report are a first pass in assessment of indicator 1 in TFL30. The representation analysis should be periodically updated for improvements in methodology and inputs, such as:

- Refinement of ecosystem mapping due to field verification and changes to the PEM knowledge base;
- Increased spatial precision in the location and criteria of the NHLB;
- Changes in the NHLB due to shifts in policy and economic operability;
- Changes to the coarse-filter ecosystem groups based on expert opinion and field-checking.

6.3.1 Reviewing the ecosystem classification

The use of ecological classification schemes is a necessity in representation analysis. Nevertheless, the units created by these schemes are somewhat arbitrary surrogates for ecological diversity, which varies continuously across the landscape. Interpretations and management actions based on representation analysis are partially dependent on the classification system being used (Pressey and Logan 1994). The classification system should therefore be viewed with caution (Bourgeron 1988) and should be periodically evaluated as greater understanding of the ecosystems and ecological risk is developed.

6.3.2 Field verification of representation results

The results of this study are essentially reports on the interactions between two spatial data layers: predictive ecosystem mapping and land base (netdown) mapping. Both of these layers are derived data that share primary data sources (e.g. forest cover inventory). Consequently, the ecosystem groups and the Non-Harvestable Land Base are not independent of each other. This interdependence amongst derived data can lead to circular results: where an outcome of the study is hardwired into the input assumptions.

6.4 Linking to Other Indicators

Management decisions for increasing ecosystem representation in TFL 30 cannot be developed in isolation of other social, economic, and ecological priorities. This is the purpose of the integrated criteria and indicators framework that has been adopted by the licensees taking part in this study. Indexes of ecological, social, and economic risk should be developed that will allow assessment of trade-offs between indicators. A larger framework of relative risk assessment would allow managers to effectively implement objectives for ecosystem representation.

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Appendix A—Assumptions for Map Production

Ecosystem mapping in this study is not straightforward because predictive ecosystem mapping (PEM) is partly non-spatial: PEM polygons consist of up to three site series, the proportion of each being given in deciles (1=10% of the polygon, 2=20%, etc.). Consequently, each polygon can be composed of up to three ecosystem groups. Retaining this level of detail is impractical for the purposes of mapping, so each polygon was mapped using the ecosystem group with the highest decile area (majority rule). This can exaggerate the apparent area of common groups at the expense of less common groups that tend to occupy minority deciles.

This pattern is evident in Figure 7, which shows that generalization for mapping using the majority rule increases the apparent area of the circum-mesic ecosystem groups and decreases the mapped area of non-mesic ecosystem groups. The net change in area is zero, requiring a large proportional decrease in the mapped representation of the uncommon non-mesic groups for a small increase in the mapped area of the large mesic ecosystem groups.

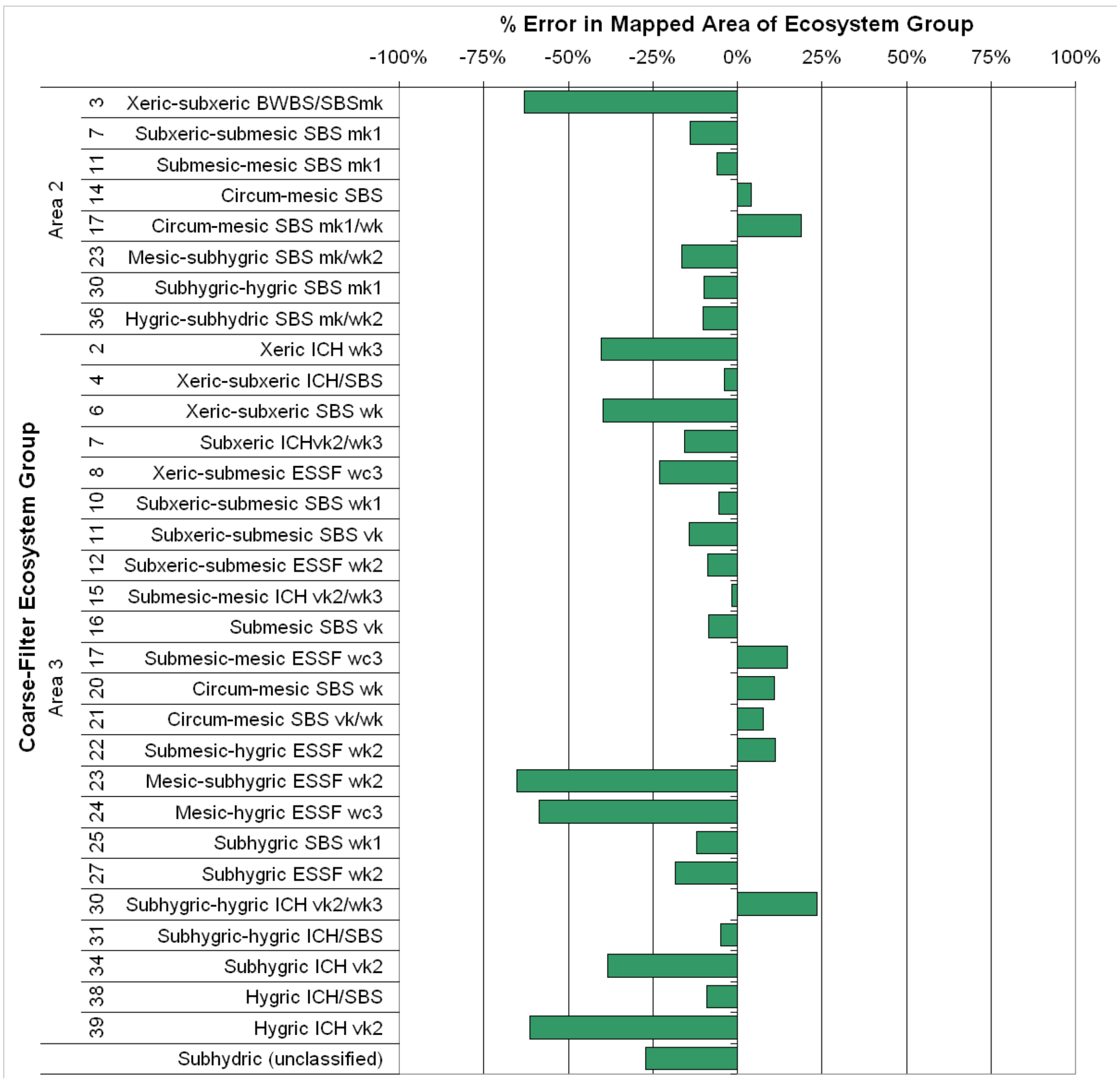

Figure 7: proportional error in the mapped area of ecosystem groups.

Appendix B— Differences Between the Netdowns for TSR2 and ERA

The objectives of ecosystem representation analysis are different from those of timber supply analysis. Consequently, the netdown procedure for ecosystem representation analysis differs from the netdown for TSR2. These differences are summarized in Table 5, and discussed sequentially below.

Table 5: Summary and Rationale for the differences between the TSR2 netdown and the netdown for this analysis (ERA)

Difference	TSR2	ERA	Rationale
Land Base Definitions	THLB/NCLB	THLB/NHLB/NCLB	TSR2 is concerned with timber supply from the harvestable land base, while ERA is concerned with habitat supply from the NHLB.
Netdown order	Various criteria	Reflects the relative certainty of the land base designation	The primary sensitivity analysis for ERA is the impact of changes in the distribution of the NHLB.
Deciduous-leading stands	Full removal from THLB	Not removed from THLB	Deciduous-leading stands are assumed to succeed to merchantable coniferous stands within one rotation.
S4-S6 RMZs	0-3% partial reduction	Not removed from THLB	The volume retention targets in S4-S6 RMZs are designed for riparian protection, but are not sufficient for coarse filter habitat supply.
Wildlife tree patches	Average 2% partial reduction to THLB	Not removed from THLB	Generally, WTPs are not large enough to contribute to forest-level representation. WTPs contribute to stand-level habitat supply.
Reduced Stability terrain	50% Partial area reduction to polygons	Not removed from THLB	The spatial location of reserved areas is uncertain and the size may be too small to contribute to forest level habitat supply.
Non-commercial Brush	Full removal from THLB	Transfer to NCLB dependent on patch size and location	Canfor currently rehabilitates NCBr patches smaller than 4ha within cutblocks.
Partial Harvesting	Partial area reduction to polygons	Retained in the THLB, and full reduction applied	The effect of partial harvesting on coarse-filter habitat supply is undetermined, and representation must be assessed separately.

6.4.1 Land Base Definitions

Timber supply analysis divides the land base into the THLB and the Non-Contributing Land Base, while representation analysis differentiates three land bases:

1. Non-Contributing Land Base (NCLB) – The non-forested portion of the land base. The NCLB is excluded from representation analysis
2. Non-Harvestable Land Base (NHLB) – The portion of the forested land base where harvesting will not occur according to current forest practices
3. Timber Harvesting Land Base (THLB) – Forested land that is harvestable according to current forest practices.

Where timber supply analysis is almost solely concerned with the THLB, the NHLB is the focal land base in ecosystem representation analysis. To facilitate the definition of the NCLB, all reductions for non-forested land are performed first.

6.4.2 Netdown Order

The most important sensitivity for ecosystem representation analysis is the potential for changes in the THLB/NHLB boundary. Therefore, the netdown reductions are ordered from greatest to least certainty that the reduction will persist in the future. Class A provincial parks and recreation areas are first in the order of full reductions because they are most likely to remain in the NHLB. Non-merchantable stands are placed last in the order of full reductions because market conditions can make harvest of these stands economically viable.

6.4.3 Excluded Netdown Factors

The purpose of a timber supply netdown is to determine the area of land from which timber volume can be removed. In contrast, the purpose of the ecosystem representation netdown is to determine the land base that can supply habitat to forest-associated species. Therefore, some timber supply netdown factors may not be appropriate for the ERA netdown and are not removed from the timber harvesting land base. Volume retention standards in S4 and S6 riparian management zones are 3% and 0%, respectively. Forest practices in S4 and S6 RMZs are designed for stream protection, but are insufficient for coarse filter habitat supply and are retained in the THLB. Likewise, wildlife tree patches are an important component of stand-level habitat supply, but are generally not large enough to contribute to ecosystem representation at the forest level. Deciduous leading stands are also retained in the THLB because, although they are not harvested according to current practices, it is assumed that they will eventually become harvestable coniferous stands through ecological succession.

6.4.4 Reduced Stability Terrain

On average, half of the areas mapped as reduced stability terrain are harvestable. However, the spatial location of these harvestable areas is not known. TSR2 accounted for this uncertainty by reducing the area of polygons with reduced stability terrain designation by 50%. The ERA netdown does not include a transfer to the NHLB for reduced stability terrain because the spatial distribution of this attribute is not known. The net THLB area of reduced stability terrain, after all other reductions, is 653 ha.

6.4.5 Non-Commercial Brush

NHLB/THLB status is reserved for forested sites or sites that are on a forest succession pathway. Non-commercial brush is assumed to be a dysclimax condition: it is assumed that low tree crown closure and high shrub cover will persist indefinitely. The methodology for clustering site series is based on climax vegetation communities and assumes that forests of the same site series will follow a similar succession pathway to the climax condition. NCBr sites violate this assumption, and so are not included in the population of clustered site series.

Canfor can successfully convert non-commercial brush into productive forest through intensive brushing treatments and planting. Currently, Canfor converts any patches of non-commercial brush less than 4 hectares in size that are in or adjacent to their cutblocks. To model this practice, any contiguous patches of non-commercial brush (NCBr) less than 4 ha in size were retained in the THLB. Patches larger than 4 hectares were transferred to the NCLB, because the crown closure of trees is too low to be classified as forest for the purpose of representation analysis. For the purposes of this study, NCBr of all site series and variants were clustered together and mapped as a single unit. The area of each cluster in NCBr condition is reported in the results section of this report.

6.4.6 Difficult Regeneration

Site series with a high risk of regeneration failure were transferred to the NHLB or the NCLB. Netdown transfers to the NHLB for difficult regeneration only included site series in ecosystem clusters. Site series not described in the MoF field guides to site identification are not in the population for hierarchal clustering, and so were transferred to the NCLB as non-productive. This approach decreased the net reduction for difficult regeneration relative to TSR2, but it increased the reduction for non-productive land.

Table 6: Land base designations for site series associated with difficult regeneration

Site Series	Transferred to:
ESSFwc3-all site series SBSmk1/10 SBSwk1/11-12	**NHLB**
ESSFwcp3-all site series SBSmk1/91 SBSwk1/92-94 SBSvk/96-98	**NCLB**

6.4.7 Partial Harvesting

Uniform retention harvesting was netted out of the THLB as partial reductions in TSR2 for Caribou medium habitat (70% retention) and riparian management zones (50% for S1-3 streams, and 25% for lakes and wetlands). Because of uncertainties around the role of partial retention harvesting in coarse filter habitat supply, these zones are considered marginally representative for the purposes of representation analysis, and are retained in the timber harvesting land base. In recognition that partial harvesting does contribute to habitat supply, representation of ecosystem clusters within RMZs and medium value caribou habitat is documented in the results of this study.