A Guide for Incorporating Environmental Values Into Silviculture Strategic Planning

April 2008

Prepared for the Ministry of Environment and the Forests for Tomorrow Program

Mike Fenger, Scott McNay, Greg Utzig, Andrew Fall, Rachel Holt and Tanis Douglas

Mike Fenger and Associates
mfenger@pacificcoast.net
511 Foul Bay Road
Victoria, BC V85 4G9

Recommended citation.

Fenger, M., G. Utzig, S. McNay, R. Holt, A. Fall and T. Douglas. 2008. A Guide for Incorporating Environmental Values Into Silviculture Strategic Planning. Prepared for Ministry of Environment. Forest For Tomorrow Program pp 28.

Cover photograph shows Ponderosa Pine mortality in a Douglas fir –Ponderosa Pine stand near Kamloops. This image belongs to the Mike Fenger.

Table of Contents

1.0 Introduction 0
2.0 Development of the Approach 2
2.1 Key Concepts 2
3.0 Steps to Incorporate Environmental Values into Silviculture Strategies 4
3.1 Step 1 – Review and summarize existing information for the MU 6
3.2 Step 2 - Identify and summarize environmental values potentially at risk 7
3.2.1 Identify environmental values for conservation emphasis areas 10
3.3 Step 3 - Identify threats to environmental values and potential action 12
3.4 Step 4 - Identify information gaps 13
3.5 Step 5 – Complete environmental trends and habitat supply analyses 13
3.5.1 Projecting environmental trends and assessing risks 13
3.5.2 Habitat supply modelling in Type 2/3 Silviculture Strategies 14
3.5.3 Utilizing timber supply models to assess environmental trends 16
3.5.4 Standards for Type 2/3 analysis 17
3.6 Step 6- Rank environmental values for consideration in silviculture strategies 17
3.7 Step 7 - Develop silviculture options 17
4.0 Producing the final report 17
5.0 Bibliography 19
Appendix One: Proposed Environmental Trend and Habitat Supply Analyses for Type 2 Silviculture Strategies 23
Appendix Two: Limitations of Projecting Environmental Trends and Habitat / Timber Supply Modelling 29
Appendix Three: Review of FFT Environmental Provisions 30

Index of Tables

Table 1. Steps to incorporate environmental values into silviculture strategies 4
Table 2. Template for analysis of Habitat Elements in Type 2/3 Silviculture Strategies. .. 8
Table 3. Conservation Emphasis Areas (CEAs) 11
Table 4. Selected forest dependent species and ecosystems in MU. 12
Table 5. Threats to environmental values. 12

Acknowledgements

Funding to develop this document was supplied by the Forests for Tomorrow Program, and this project was overseen by Colene Wood of the Ministry of Environment.

Mike Fenger and Associates created this document by revising the original habitat supply modelling guide (Province of BC 2005), with efforts by Mike Fenger, Tanis Douglas, Andrew Fall, Rachel Holt, Scott McNay and Greg Utzig. Further improvements were made to this guide based on the experience gained in applying it to various Type 1 Silviculture Strategies and Type 2/3 Silviculture Strategies, by team members Laurence Turney, Scott McNay, Cris Guppy, Dave Jones, Rachel Holt, Alison Peatt and Mike Fenger.

1.0 Introduction

Silviculture strategies are used as a tool for identifying silviculture opportunities to [1]improve timber supply in the mid and long term and to review issues and trends for environmental values, which also might be improved by applying silviculture techniques. The objective is to select the suite of silviculture activities, over time, that will have the largest positive effect on the largest amount of values, both timber and non-timber. Positive effects include biological, social and economic.

Silviculture strategies are presently being revised and updated in Timber Supply Areas (TSAs) and Tree Farm Licenses (TFLs) significantly affected by mountain pine beetle (MPB) and by recent catastrophic wildfires. These disturbances have changed not only timber supply forecasts, but also the future supply of other forest attributes necessary for sustaining environmental values. These updated strategies will help inform industry, government agencies and other stakeholders on how to select activities and manage the impacts of MPB and catastrophic fires, and speed the recovery of affected timber and environmental values.

The Forests for Tomorrow (FFT) program plan is currently funding silviculture strategies. The FFT program plan focuses on silviculture interventions in an effort to offset the anticipated drop in timber supply and to mitigate impacts to environmental values/habitat. The Environmental provisions of this program are summarized in Appendix 3. The FFT program is an integral part of the government's action plan on MPB.[2]

The Canada – British Columbia Mountain Pine Beetle Program[3] (FMPB) - provides a portion of its funds to protect forest resources and communities from impacts of MPB epidemic and measures to reduce wildfire risk. Silviculture Strategies and Regional Restoration Plans[4] (ENAR ESDE Inc. 2006a, b, c) together provide the full spectrum of opportunities to mitigate impacts to environmental values from the effects of major wildfires and MPB.

The steps described in this guide provide a consistent approach to identifying environmental values at risk due to MPB and catastrophic fires, and on incorporating them into the Silviculture Strategy development process Type 1. The approach helps to identify gaps in inventory and research, and to identify where there is a need for detailed environmental modelling and trend analysis that might be undertaken as part of a Type 2 analysis.

The standards for conducting Silviculture Strategies[5] are applicable to projects funded under the Forest Investment Account Land Base Investment Program. They apply to other funding sources as directed by the MOFR.

[1] http://www.for.gov.bc.ca/hfp/fft/FFT_Mgt_Plan_2007.pdf
[2] British Columbia's Mountain Pine Beetle Action Plan 2005–2010.
[3] http://mpb.cfs.nrcan.gc.ca/index_e.html
[4] Regional Restoration Plans are available from FFT reports
[5] http://www.for.gov.bc.ca/hcp/fia/landbase/silviculture.htm

The information flowing from this approach can also provide background needed by the Ministry of Environment (MOE), Ministry of Forests and Range (MOFR), the forest industry and other stakeholders for developing silviculture priorities, budgets and projects specific to sustaining environmental values.

This guide builds on and replaces the earlier draft document "Habitat Supply Modelling – A Guide for Silviculture Strategic Planning" (Province of BC 2005). Rather than "non-timber values", we are using the term "environmental values" to encompass forest values related to biodiversity, habitat, individual species and domestic/irrigation water supplies. Other values that are outside the mandate of MOE are not explicitly included in core indicators but could be adapted to management unit level assessments, for example values related to aesthetics, tourism and botanical forest products.

2.0 Development of the Approach

This document is the result of experiences gained during participation in the 2005-06 Type 1 Silviculture Strategies for 100 Mile, Williams Lake, Okanagan, Cranbrook, Merritt, Kamloops, Prince George, Quesnel, TFL 42 (Tanizuil) and Type 2/3 Silviculture Strategies for Quesnel, Merritt and Kamloops. There have also been many helpful comments from MOE and MOFR staff, and the MOFR contractors carrying out the silviculture strategies. There are government supported technical documents on habitat modelling[6] and environmental risk assessment[7] on the web and listedare listed in the bibliography of this document.

For Type 2/3 strategies, we have built on experience gained in two previous pilot projects: habitat supply modelling for Tree Farm Licence 14 in Rocky Mountain Forest District (Wilson *et al*. 2002; Utzig and Holt 2002) and the Arrow Innovative Forest Practices Agreement Plan Area in Arrow Forest District (Wilson *et al.* 2003), as well as environmental states and trends reporting done for the Queen Charlotte Islands (Holt 2004). The TFL14 reports provide a contrast between using broad coarse filter assessments (Utzig and Holt 2002) and more detailed assessments based on modelling specific stand level factors and attempting to correlate those with species-specific requirements (Wilson *et al*. 2002).

2.1 Key Concepts

Silviculture, as defined by the Ministry of Forests and Range[8], is:

> *"…the art and science of controlling the establishment, growth, composition, and quality of forest vegetation for the full range of forest resource objectives. Successful silviculture depends on clearly defined management objectives. However, silviculture is often confused with managing stands and forests purely for timber. Remember that silviculture is also used to manage forests for wildlife, water, recreation, aesthetics, or any combination of these or other forest uses."*

Silviculture Strategies[9] are key to determining priorities and budgets for on-the-ground projects, research, and inventory for MOE, MOFR, and the forest industry. Information on silviculture strategies can be found at the following website

A **Type 1 Silviculture Strategy** identifies management objectives and provides predictions regarding the effects of various silviculture regimes on timber quantity, timber quality, and selected environmental values (e.g., Caribou habitat supply). Type 1 strategies rely on pre-existing information such as timber supply reviews, previous silviculture strategies, relevant studies and expert advice, local knowledge, and stakeholder input. Key issues are identified (both

[6] http://www.for.gov.bc.ca/hfp/silstrat/habitat/habitat-docs.htm.
[7] http://www.agf.gov.bc.ca/clad/strategic_land/econ_analysis/seea_methods.html#era_report
[8] http://www.for.gov.bc.ca/hfd/pubs/SSIntroworkbook/meansilv.htm
[9] http://www.for.gov.bc.ca/hfp/silstrat/overview.htm

for timber supply and environmental values), and then opportunities to ameliorate these through silviculture investments are sought.

The questions asked are:

1. what are the key issues;
2. what is of most concern; and
3. what opportunities exist today to alter unacceptable expected future trends and events?

Type 1 Silviculture Strategies[10] direct the selection of options and actions through a workshop format. There is no re-analysis of information in a Type 1 strategy, so assessments of environmental trends have to be derived from interpretation of pre-existing information such as age class projections from TSR, existing reports (e.g., Recovery Action Plans) and expert knowledge. Results may be qualitative rather than quantitative. Despite this limitation, there is a need to identify and select the environmental values that are at highest risk and that are linked to mitigating factors that can be achieved through silviculture investments. Specific Type 1 standards were developed in 2001 by government for TFL holders [11]

A **Type 2/3 Silviculture Strategy**, like a Type 1, also begins by identifying key issues - normally done by updating those identified in a Type 1 strategy. Type 2 strategies provide an opportunity to delve into timber,and habitat supply issues, and environmental trends in more detail, and to evaluate potential costs and benefits of various silvicultural investment options. Unlike Type 1 strategies, Type 2 strategies offer the opportunity for further analysis, and it may be possible to quantify trends for selected environmental indicators. The scope and values to be analysed should be determined by stakeholders at the initial Type 2 meetings.

The goals of environmental trends analyses for silviculture planning are to project and anticipate environmental impacts associated with forest health (e.g., MPB), potential catastrophic fires and associated harvest levels, and then seek means by which to mitigate those impacts and sustain environmental values. Using this information, the silviculture strategies derived from this process will identify areas where silvicultural treatments would be effective in restoring and/or maintaining environmental values, along with improving timber supply.

Further analysis (originally referred to as a Type 3[12]) provides opportunities for significant increases in the extent of forecasting and the type of data used for projections of future conditions. The analysis recommended in this guide applies the framework outlined in the BC Ministry of Water, Land and Air Protection 2000 report entitled "Environmental Risk Assessment (ERA): An Approach to Assessing and Reporting Environmental Risk,"[13]

[10] http://www.for.gov.bc.ca/hfp/fft/committees/sswg/type1analysis.htm
[11] http://www.for.gov.bc.ca/hfp/silstrat/admin/admin-docs/FS1A.doc
[12] As the FFT program expanded in 2005/06, the term Type 3 was dropped. Type 2s are assumed to include some level of environmental analysis, particularly habitat supply analysis.
[13] http://www.env.gov.bc.ca/wld/documents/era.pdf. or
http://www.agf.gov.bc.ca/clad/strategic_land/econ_analysis/seea_methods.html#era_report

3.0 Steps to Incorporate Environmental Values into Silviculture Strategies

The following sections outline the basic steps for the identification and prioritization of environmental values that are potentially at risk due to MPB or catastrophic wildfires (including accelerated harvesting and road building associated with these occurrences). The steps then outline how to identify silviculture activities that may mitigate impacts to those values and/or restore habitat.

The approach advanced here is intended to integrate the priorities of actions and budgets for sustaining environmental values with those for sustaining timber values.

These steps form the basis for reporting on the process and outcomes for each management unit followed in 2005-06.

Table 1. **Steps to incorporate environmental values into silviculture strategies**

Step #	Description of Tasks	Application
1	**Review and summarize existing information for the MU, including.** • Timber Supply Review (TSR) documents (emphasize identified environmental risks and measures to protect environmental values). • Species and ecosystems at risk within the management unit, from the Conservation Data Centre's provincial red/blue list, Identified Wildlife, and species listed by COSEWIC as nationally Endangered, Threatened or of Special Concern. • Local studies on species, habitats and values impacted by catastrophic events and forest development (i.e., harvesting and access). • Habitat modelling. • Expert opinion of wildlife managers or conservationists regarding species, habitats and values like to be impacted by MPB and/or MPB harvesting.	All strategy types
2	**Identify and summarize environmental values potentially at risk from MPB, wildfires and/or harvesting in the MU.** • May include species or habitat already at risk or potentially at risk due to other factors, and where MPB and/or MPB harvesting will likely increase the background risk. • Based on input from stakeholders (i.e., input from the initial	All strategy types

	meetings/workshops).	
3	**Identify the threats (i.e., human and biological) that contribute to the risk, and potential actions to reduce and/or mitigate those threats.** • Place emphasis on mitigation activities that could be implemented through silviculture treatments. • Identify other non-silvicultural forestry-related actions that may reduce or mitigate risk.	All strategy types
4	**Identify information gaps.** • Information gaps could include: species-habitat relations, future trends in habitat supply, outcomes of planned harvesting and/or silvicultural treatments and activities, range of natural variability (i.e., "natural conditions"), etc. • Prepare a list of potential modelling, environmental trend analyses, inventory and/or research projects that would fill the high priority gaps, and could be conducted as part of the Silviculture Strategy development and elsewhere (e.g., as part of retention planning for MPB affected areas).	All strategy types
5	**Complete environmental trend analyses and habitat modelling.** • Identify indicators - may include coarse filter and/or fine filter indicators. • Define baselines and thresholds, including use of the range of natural variability (RONV) for species/values and use of economic thresholds for commercially important species/values. • Interpret results and discuss in terms of their implications to silviculture strategy planning, and other actions that may reduce identified threats and risks	Types 2
6	**Rank environmental values for consideration in silviculture strategy planning, based on existing information (Type 1) or analyses (Type 2).** • Factors to consider may include: overall level of risk, sensitivity to MPB-related activities, likelihood of silvicultural treatments ameliorating risk, etc. • Consider anticipated funding levels for treatments.	All strategy types
7	**Develop silviculture options/scenarios for improving timber supply and environmental values.** • May include silviculture treatments specifically aimed at maintaining and/or restoring environmental values as well as	All strategy types

	timber supply, or modifications of timber-based silviculture treatments to reduce their impact on environmental values. • Consider landscape level effects and cumulative effects of the silviculture regime over time.	

In essence, every timber supply review is a trend analysis for timber supply, and many of them have included the potential benefits of various silvicultural treatments as the base case. The effects of the scenarios selected in the Silviculture Strategies will be modelled to show the potential benefits of further silviculture activities. This work related to timber values has evolved over the past two decades.

Assessment of the benefits of silviculture on environmental values has a much shorter history. Significant preparation prior to engaging in the Silviculture Strategy process is needed. There is more uncertainty associated with projections, however, the focus is to concentrate on scenarios and combinations of activities that benefit both timber supply and environmental values. This requires a spatial representation of environmental values that in many MUs is not available. Surrogates and assumptions of how treatments will be spatially applied may be necessary as part of the analysis of the benefits of treatments.

3.1 Step 1 – Review and summarize existing information for the MU

Step 1 begins immediately, and a preliminary draft of steps two to four, six and seven must be completed prior to entering the formal process (i.e., the first meeting/workshop).

Consultation with local MOE staff is needed prior to the workshop to ensure their knowledge is incorporated, and that the approach is consistent with their understanding of values, risks, and options in the MU.

Existing information can be found in a variety of locations. Environmental concerns /issues /objectives may have been addressed in earlier silviculture strategies and can be found at the Silviculture Strategies home page[14] and earlier timber supply reviews found at the Timber Supply Reviews home page [15]. Non-timber issues noted in these documents should be reviewed and brought forward into the current strategy as appropriate.

The TSR data package, the TSR analysis report and the allowable annual cut (AAC) rationales may also provide insight into some environmental issues. Environmental concerns/issues/objectives may also be addressed in strategic overviews associated with land use planning and forest stewardship certification, and these can also be used as sources for information on environmental conditions in the management unit. Species and ecosystems at risk should be considered, including those on the Conservation Data Centre's provincial red/blue

[14] http://www.for.gov.bc.ca/hfp/silstrat/map/region-home.htm
[15] http://www.for.gov.bc.ca/hts/tsr.htm

list[16] and species listed by COSEWIC [17],and Forest and Range Practices Act Identified Wildlife [18].

Terrestrial ecological restoration priorities have been summarized for the six former MOF regions using a biogeoclimatic framework to describe landscape and stand level issues. These Terrestrial Ecological Restoration Assessments can be found at Ecosystem Restoration Program Regional Restoration Plans (MOE 2006) [19] includes stakeholder identified values needing mitigation. Evidence of environmental degradation and areas in need of restoration are found in these reports. Further ecosystem restoration prioritization planning is found in Fenger *et al.* 2006.

In addition to previously noted paper sources, local biological experts (MOE staff, biologists, ecologist, hydrologists, and local naturalists) with understanding of the ecology of the area can provide insights to issues/concerns.

Use these existing sources of information to develop steps 2 through 7 and prepare for the workshops. The report format to be used for describing the work done for each management unit and its outcomes (see section 4.0) is based on the steps described here.

3.2 Step 2 - Identify and summarize environmental values potentially at risk

The identification of forest-dependent species and ecosystems at risk will assist in the identification of issues that may potentially benefit from silviculture activities flowing from the silviculture strategies. MPB or catastrophic fire may increase the risk for many of these species in the short term and mid term. In the latter case, improvements to timber supply in the mid term may reduce the potential mid term risk to the species, and such opportunities should be identified.

There are a number of indicators that can be used to indicate trends in environmental values and where the most serious habitat supply problems may occur. Type 1 analyses use an intuitive, expert opinion approach to selecting indicators, assessing values and risks, and identifying ecosystem components that may respond to silviculture activities. Conversely, the Silviculture Strategy could use indicators the licensees have developed as part of their Sustainable Forest Management Planning (SFMP). The MOFR have summarized the indicators developed by licensees [20].

Table 2 below provides a list of potential environmental values and indicators, compiled during the 2005/06 Type 1 Silviculture Strategies development, which may assist in the selection of indicators relevant to a particular management unit. Subsequent Type 2/3s indicated a need for a consistent management unit level assessment. Table 2 therefore provides an updated habitat template for all Type 2/3s silviculture strategies where the fifteen numbered indicators form the

[16] http://srmapps.gov.bc.ca/apps/eswp/)
[17] http://www.cosewic.gc.ca/eng/sct5/index_e.cfm
[18] http://www.env.gov.bc.ca/wld/identified/index.html
[19] http://wlapwww.gov.bc.ca/wld/fia/ecosystem_restoration.html.
[20] http://www.for.gov.bc.ca/hcp/fia/landbase/list_of_indicators_2004_05.pdf.

core environmental indicators. Appendix 1 provides some more detail on indicators, natural baselines, risk and option development for use in Step 5.

The Canadian Council of Forest Ministers (CCFM) provides information on the use of sustainable forest management criteria and indicators [21]. The CCFM indicate that trends and risks to biodiversity can be informed using measures of diversity at various levels, including ecosystem, species and genetic diversity.

The criteria and indicators report on the CCFM site has suggested the following measures to forecast biodiversity:

1. Percentage and areal extent of forest types relative to historical condition and to total forest area;
2. Percentage and areal extent by forest type and age classes;
3. Area, percentage and representation of forest types in protected areas, and;
4. Level of fragmentation and connectedness of forest ecosystem components.

An indicator approach (Table 2) is recommended for assessment of environmental values. Indicator analysis is based on: 1) risk assessment where risk is the current condition of the indicator compared to proper functioning condition of the indicator (an environmental base case), 2) the ability of the ecosystem to respond and 3) the duration of the benefit achieved by the FFT investment. More information on assessing environmental risk is provided at the Strategic Land Policy and Legislation Program Home Page[22].

For each indicator a comparison is made between expected natural baseline and the current and expected future condition. The degree of risk to the indicator and to the environmental value is based on how far the indicator deviates for expected natural condition. This provides a strategic assessment of the condition of an indicator within a MU. Reporting on indicators for the purposes of planning and scheduling investments mean that assessment units such as Landscape units and BEC level assessments or 3rd order watersheds will need to be used, to see the variation in indicator conditions across the Management Unit.

Table 2 provides a consistent approach to address these values described in legislation/ regulation.

Table 2. Template for analysis of Habitat Elements in Type 2/3 Silviculture Strategies and the core environmental indicators.

Value	Indicators	Indicator and measure (core indictors are in bold and numbered and form the standard habitat template for all SS)	Baseline and Risk Threshold	Report Current Condition and Trend
Terrestrial Coarse Filter Landscape				
Landscape level	Landscape level diversity	**1. Seral stage distribution LU/BEC variants** Current condition relative to expected historic baseline.	% deviation	

[21] http://www.ccmf.org/current/ccitf_e.php
[22] http://www.agf.gov.bc.ca/clad/strategic_land/econ_analysis/seea_methods.html#era_report

biodiversity		**2. Current condition of OGMAs** spatial and non spatial in LU/BEC variants relative to expected natural	% not old	
	Ecosystem representation	**3. Protected area representation** Mature and old forest representation BEC zones/variants/LU	% BEC/Variant	
		4. Current condition of Parks and Protected Areas (PPAs)	% Seral stage	
	Landscape Connectivity/ fragmentation	Road density Opening sizes Degree and extent of intactness (interior forest conditions) Stand structures across landscapes BEC zones/variants/LU	Species specific density thresholds (suitable and unsuitable)	
		5. Forest riparian condition (Lakes/Streams/wetlands) Current condition relative to expected natural condition	% seral stage/LU/BEC variant	
	Species and plant communities at risk	Change in historic distribution Total number of listed species	Historic species ranges (%) change	
		6. Current condition of listed forested ecosystems (CDC listed forested ecosystems)	Seral stage	
Aquatic Coarse Filter Watershed Level				
Aquatic and riparian biodiversity (i.e., aquatic habitat - fish and other; riparian habitat) Water for human use (changes in flow regime and water quality)	Changes in flow regime (quantity and timing)	**7. Clearcut equivalency (ECA)** Hydrologic recovery estimate of all 3rd order watersheds Flow interception/ diversion	% > 30, >50	
		8. Condition of 3rd order watersheds i.e. CWS FSW based on ECA	% > 30, >50	
	Flow interception / diversion	Road density (indicator for more detailed analysis of water)		
	Stream temperature	Riparian cover (enabled if needed through 10)	% Seral stage	
	Fish passage	Stream crossings (enabled if needed through core indicator10) Riparian/ channel condition	# per stream class/3rd order watershed	
	Sediment	Terrain stability/ erodibility Development on unstable/ erodible soils Channel condition Bank stability	% area unstable % erodable soils/ 3rd order watershed	
	Riparian condition	**9. Forest cover (seral stage) based on buffer along on all streams, wetlands and lakes/landscape unit** Large organic debris sources Litterfall sources	% Seral stage mature + old Relative ranked entire MU.	
		10. Forest cover (seral stage) on	% Seral stage	

		riparian Reserves and management zones/ landscape unit	mature + old	
Terrestrial Coarse Filter Stand Level				
Stand level biodiversity - Dead wood	Wildlife trees	**11 Standing dead >30 cm/BEC variant.**	% deviation for expected natural	
	Downed dead wood	**12. Coarse woody debris in cubic meters/hectare/BEC variant**	% deviation from expected natural	
Aquatic or Terrestrial Fine filter*				
Species diversity	Forest-dependent species at risk	Trend in the total number of listed Species Changes in single species distributions	% change	
Single species (listed, regionally important, identified or focal)	Species range/ Habitat supply	**13. Single species** Base line of distribution of a species preferred habitat and current condition. Could be a number of listed species and ecosystems (Conservation Data Centre) Select up to 10.	% suitable compared to base case suitable LU/variant	
	Wildlife Habitat Areas	**14. Wildlife Habitat Areas and Wildlife Habitat Features current condition.** Compared to proper functioning condition for WHAs and WHFs	% in proper functioning condition	
Ungulate Winter Ranges	Habitat condition	**15. Current condition of ungulate winter ranges.** Compared to proper functioning condition baseline.	% in proper functioning condition	
Indicator Summary				
Total Indicators		15. non timber indicators plus an additional 10 for listed species and ecosystems, regionally important species		

* as determined by local threats and values analysis in each Management Unit. Species/ecosystems from the fine filter list are 'required' in each analysis, with the highest priority single species/ecosystems based on the specifics of the MU.

The key is to identify indicators that can be influenced by silviculture activities, in order to focus the analyses.

3.2.1 Identify environmental values for conservation emphasis areas

Land use plans and forest management planning define areas where conservation objectives have an emphasis, sometimes including areas outside of the timber harvesting land base. Assessing the condition of these conservation emphasis areas helps to determine whether these will benefit

from silviculture treatments[23]. Natural disturbances operate independently of land use zones, so these areas may be affected and in sub-optimum condition (or conversely, management exclusion of natural disturbances may also adversely affect ecosystems – e.g., exclusion of low intensity fires). The extent to which the presence or absence of natural disturbances have compromised these areas should be identified, as should opportunities to maintain, enhance or restore these areas through silviculture treatments. Table 3 shows the list of areas that may benefit from silviculture treatments.

Table 3. Conservation Emphasis Areas (CEAs)

1. Parks and Protected Areas.
2. Higher Level Plan conservation emphasis zones and sensitive management zones – includes areas designated in LRMPs for specific ecological objectives – some may have specific management objectives to guide restoration
3. Wildlife Management Areas
4. Old Growth Management Areas[24]
5. Seral Stage distribution (mature component)
6. Community Watersheds
7. Fisheries Sensitive Watersheds
8. Temperature Sensitive Streams
9. Important/Critical habitats identified by Species at Risk recovery teams
10. Wildlife Habitat Areas/Wildlife Habitat Features
11. Ungulate winter ranges
12. Habitat for regionally important species
13. Riparian Reserves and Management Areas
14. Wildlife Tree Patches

The Chief Forester's retention policy[25] emphasizes additional retention for environmental values where extensive harvest is taking place owing to MPB. These are areas where the objectives are to resemble natural disturbance with maintenance of stand structure through increased retention of wildlife trees, understory vegetation and coarse woody debris. Tree retention is expected to be higher than legislated defaults for standard size cutblocks. The increased retention will serve a variety of functions including but not limited to:

- increased protection for aquatic values through riparian areas,
- maintenance of non-pine species for biodiversity, seed source and future harvest opportunities,
- protection of sensitive soils (e.g., bank stability),
- increased maintenance of stand structure from either live or dead trees - with intact forest floor, and
- an allowance for cutblock design that more closely mimics natural disturbance patterns.

The location of these retained areas will help reduce the impact of increased short-term salvage harvest.

Table 4 shows an example form that could be used to summarize some of the results of Step 2.

23 Non timber projects under FFT funding are to be focused on speeding recovery of habitats at greatest risk. Risk is determined by deviation from an expected base case for the indicator based on proper functioning condition.

24 Landscape level biodiversity old growth, http://ilmbwww.gov.bc.ca/ilmb/lup/policies_guides/oldgrowth/index.html

25 http://www.for.gov.bc.ca/hfp/mountain_pine_beetle/stewardship/cf_retention_guidance_dec2005.pdf

Table 4. Selected forest dependent species and ecosystems in MU.

Species/ ecosystems	Forest attribute dependency	Habitat supply / environmental values implication	Silviculture options

3.3 Step 3 - Identify threats to environmental values and potential action

There are a number of non-forestry-related factors that affect environmental values, such as habitat loss through urban expansion and range practices. The cumulative effects of all pressures on a value influence its sustainability. We recommend that all identified pressures be noted, and that the focus be on those that are associated with forestry. Table 5 lists the types of pressures on environmental resources that are most closely related to forestry activities.

Table 5. Threats to environmental values.

1. Climate change is an overarching pressure on all ecosystems.
2. Fire suppression and its effects on landscape and stand characteristics.
3. Landscape level modification from harvesting and silviculture.
4. Rate of harvest and high levels of homogeneous early seral forests.
5. Harvest pattern, habitat fragmentation and loss of habitat connectivity.
6. Silviculture systems reducing old stand structures, reforestation decreasing species diversity, high density stands and loss of shrub and herb communities.
7. Loss of productive land and habitat fragmentation caused by roads.
8. Increased road access and impacts of displacement and hunting/poaching pressures (no refugia), road crossing impacts on fish passage, fishing pressure.
9. Riparian disturbance levels, loss of riparian habitat, increased stream crossings, disruption of wetland hydrology.
10. Increased soil erosion and sedimentation from road building and harvesting.
11. Change in runoff timing, high flows and low flows.
12. Increase of cattle disturbance in sensitive ecosystems.
13. Increase in spread of invasive and/or introduced species.
14. MPB and wildfires, though “natural”, are considered to be operating outside their natural range of variability and thus are an added pressure.
15. Cumulative effects of a number of pressures acting together over time.

Using the list of values (Step 2) and knowledge of threats to these values in Table 5, select those values that are considered to be at highest risk and that could potentially be assisted through silviculture activities. Knowledge of the state of the indicators described in Table 2 should be used to determine the environmental condition of fish, wildlife, water, and biodiversity values.

Quantitative assessment of some of these indicators is possible in Type 2 Silviculture Strategies, while decisions will have to rely on expert knowledge and qualitative information in Type 1s.

As well as looking at possible silviculture activities that may facilitate habitat recovery, there should be an assessment of possible silviculture activities that may mitigate the impacts of MPB, MPB harvesting and catastrophic fires on certain environmental values. For instance, if the MPB harvesting is mainly resulting in homogeneous pine plantations, there may be silviculture activities that focus on varied spacing and providing mixed species (including deciduous).

There are many factors that influence the sustainability of environmental values. Types of actions that contribute significantly to risk, but are outside the scope of a silviculture strategy, need to be noted, as they define the context in which the silviculture strategies will be applied. These other factors may affect the silviculture strategies' likelihood of success.

3.4 Step 4 - Identify information gaps

The previous 3 steps will likely have identified some information gaps. These need to be noted as they can be used to help focus funds on areas of greatest environmental uncertainty.

Information gaps could include: species-habitat relations, future trends in habitat supply, outcomes of planned harvesting and/or silvicultural treatments and activities, range of natural variability (i.e. "natural conditions"), etc.

List the gaps and potential modelling, inventory and/or research projects that would fill the high priority gaps. This information needs to be passed on to the people and through the processes defined for the various funding sources.

3.5 Step 5 – Complete environmental trends and habitat supply analyses

3.5.1 Projecting environmental trends and assessing risks

The following are some of the key terms used in environmental risk assessment:

1. **Indicator** is a parameter than can be measured, observed or derived, and that provides information about patterns or trends in the environment (e.g., % protected area by BEC/ecosection, seral stage distribution, number of listed species, changes in species distributions).

2. **Base Case** is the selected point of comparison against which changes in an indicator are assessed. For most environmental risk assessments, the base case consists of "natural" conditions. Because forested ecosystems are dynamic entities, a natural base case is usually described as the "range of natural variability" (RONV). Natural conditions can be described in terms of a long-term norm or mean and surrounded by a range (e.g., mean stream flows and historic maximums and minimums, or upper and lower 10% thresholds).

3. **Pressure or Threat** are terms used in Environmental Risk Assessment (MWLAP 2000) to refer to factors or activities affecting ecosystem functions or attributes. These most often refer to factors that are human-related (e.g., land use decisions, Workers' Compensation Board regulations, mountain pine beetle salvage).

4. **Risk** is the likelihood of an adverse outcome to the environment and the severity of that outcome. Risk is often described in classes (high, moderate, low), usually with definable class limits (e.g., low risk might be define as < 10% changes in an indicator or suite of indicators over the next 100 years). Note that an outcome may be low risk either because it is very unlikely or because the severity is low.

For a given management unit the environmental values, and the types and degree of threats to those values, will guide the selection of the most appropriate indicators. The MOE approach to environmental risk assessment (MWLAP 2000) provides a framework within which to evaluate trends of environmental values based on the use of indicators. State of Environment Reporting[26] and the report on the State of Forests[27] use indicators to report the current conditions of the environment and forests. These reports contain information that can be used to provide a context for a MU.

It is generally assumed that when ecosystems are maintained within the range of natural variability (RONV), risk to components of those ecosystems is minimized[28]. Therefore conditions that are within RONV are by definition "low risk," and ever-widening deviations from RONV are considered to be at increasing levels of risk (e.g., see MWLAP 2000 or Utzig and Holt 2002). The greater the deviation from the natural base case, the higher the risk and the greater the uncertainty of sustaining or recovering the value.

Ideally, a Type 1 strategy has been completed, and informs a Type 2 of values of highest ecological concern. In reality, the ability to undertake a meaningful Type 2 analysis will depend largely on available data (from TSR or other processes). If an additional environmental analysis is possible as part of the Type 2 Silviculture Strategy, it consists of identifying indicators of environmental values, determining a natural base case, estimating present and future deviations from the natural base case, and assessing present and future risks. Based such an analysis, one then formulates silviculture options to minimize risk, thereby maintaining the environmental values through time. An effective Silviculture Strategy outcome would be one that recommends silvicultural activities that mitigate and/or reduce risks to the identified environmental values that are presently or anticipated to be at moderate or high risk. Where environmental values are at high risk, recommendations could include a monitoring program involving such activities as periodic censuses of focal species or periodic inventories of key habitat components.

3.5.2 Habitat supply modelling in Type 2/3 Silviculture Strategies

[26] http://www.for.gov.bc.ca/hfp/sof/
[27] http://wlapwww.gov.bc.ca/soerpt/.
[28] Exceptions to this do exist, e.g., where species are near the edge of their natural range or occur in small numbers they may be inherently at high risk, even under natural conditions.

Stone (2000) defined habitat supply as:

> …simply the "quantity" of the habitat present. Habitat supply may involve a composite description of the "quantity" in terms of the organism of concern (e.g., habitat suitability rating for mule deer) or simply an individual component (e.g., number of standing dead trees over 25 cm dbh). A description may also be related to a seasonal, life stage or element habitat requirement of an organism (e.g., winter range, reproductive, food source). In some contexts (e.g., at a landscape or forest estate level) habitat supply has been considered to be the "sum" of habitat values generated at the stand level.

Page (2001) and Jones *et al*. (2002) defined habitat supply as:

> the quantity, quality and geographic distribution of habitat present, relative to an organism, organisms, or groups of organisms, and perhaps in relation to a season (e.g., winter range), life stage (e.g., reproduction) or habitat element (e.g., food source).

Habitat supply modelling starts with decisions of which habitat characteristics to project o r improve over the planning horizon. There are tools available to help guide this process. A timber supply model can provide information on the state of the forest at certain intervals in a planning horizon. Timber supply data can be used to estimate the supply of key forest characteristics that describe the abundance of habitat characteristics in different stand types and ages. The result is a series of supply projections for key habitat characteristics. Hence, habitat supply modelling is inherently temporal, and may be spatial or non-spatial. Characteristics used for habitat supply models are limited to the intersection of attributes with sufficient data and knowledge to support projection, attributes available as output from the timber supply model (or that can be derived from such output) and attributes desired for estimating habitat suitability.

Habitat projections should be examined for deficiencies based on thresholds and benchmarks where available. When deficiencies are identified, management interventions (e.g., silviculture treatments, deferred harvest) can be accommodated into additional scenarios by altering the assumptions in the timber supply model and/or the habitat database in collaboration with the timber supply analyst. An appropriate process for specifying and communicating new scenarios should be followed. These additional projections can lead to management recommendations to address future habitat supply issues. The final step is to design a monitoring and adaptive management program to determine whether the management recommendations and subsequent treatments are having the desired effect as operations are implemented, and to integrate monitoring results back into the strategic planning process.

Type 2/3 Silviculture Strategies provide opportunities to develop coarse and fine filter conservation provisions and trends. Where available, existing quantitative coarse filter and fine filter (single species) models can provide data to inform Type 1 and 2 strategies. Habitat modelling may have been conducted as part of forest development planning. See http://srmwww.gov.bc.ca/tib/fia/biowildlifehat.htm for FIA standards for habitat modelling.

3.5.3 Utilizing timber supply models to assess environmental trends

When selecting environmental indicators for more detailed analysis, it is necessary to ensure the habitat variables to be assessed can be linked to stand characteristics in the forest harvesting model being employed to track timber supply. In general, any model that generates stand-level characteristics at regular reporting periods is adequate, but each timber supply model has slightly different capabilities.

The following are features of timber supply models relevant to assessment of environmental trends:

1. Output should be produced at regular reporting periods (e.g., 10 year intervals over 250 years) to provide input for identifying environmental trends.
2. Output may be spatial (e.g., a time series of spatial outputs) or non-spatial (e.g., tables of outputs summarizing area in various strata, such as BEC variant, age class, analysis unit). Spatial output from a timber supply model is preferred, but not always necessary for habitat assessment. If knowledge of the specific locations of habitat, or the relative positions of two or more types of habitat are necessary for the assessment, then a timber supply model with spatial output will be required (see Page (2001) and Jones *et al*. (2002) for a review of models currently available.
3. Ideally, stand structure information (e.g., stand height, crown closure, tree diameter) derived from stand-level growth and yield models (e.g., TASS, SORTIE) used for timber supply would be provided as output through the landscape scale timber supply model.
4. Ideally, the timber supply analysis should accommodate natural disturbance and have the ability to consider a variety of silviculture treatments. However, in some cases, natural disturbance is limited to capturing effects important to timber supply (e.g., non-recovered loss) and is sometimes limited to the timber harvesting landbase.

The following are guidelines for using outputs of timber supply models to assess environmental trends:

1. Deficiencies in supply of environmental indicators can be identified by comparing supply against benchmarks and thresholds, where available (e.g., Biodiversity Guidebook, Range of Natural Variability, Land Use Plan objectives, etc.). Identify trends that lead to long-term deficiencies as well as short and mid-term bottlenecks.
2. Identify supply shortfalls and higher risk classes, and then management strategies or practices that could ameliorate or mitigate these.
3. Assess scenarios of alternative management regimes and practices, at different investment levels, designed to address habitat supply shortfalls (e.g., alternative silvicultural systems, deferred harvest, spacing program). These can be used for additional projections by changing parameters in the timber supply analysis and or in the environmental indicator database. To examine a range of alternative scenarios, interactions with the timber supply analyst will be necessary (to clearly specify the scenario, to run the timber supply analysis on that scenario, and to generate appropriate outputs).
4. Recommend management changes that ameliorate or mitigate projected habitat supply shortfalls.

5. In addition to suggesting management changes, recommendations should outline principal data gaps and field studies to address them.

3.5.4 Standards for Type 2/3 analysis

Standards for Type 2/3 are located at Silviculture Strategies Home Page[29] and Forest for Tomorrow Home Page.[30]

These standards reference this guideline and set the habitat analysis requirements for the core indicators identified in Table 2

3.6 Step 6- Rank environmental values for consideration in silviculture strategies

Prioritize environmental values for consideration in silviculture strategy planning. Factors to consider may include: overall level of risk, sensitivity to MPB related activities, likelihood of silviculture treatments ameliorating risk. In Type 1 strategies the priorities will have to be based on existing information and expert opinion. In Type 2 strategies the priorities will have the added information generated by further analysis and assessment.

3.7 Step 7 - Develop silviculture options

The silviculture options developed may include silviculture treatments specifically aimed at maintaining and/or restoring environmental values, or modifications of suggested timber-based silviculture treatments to reduce their impact on environmental values.

This is the most creative and challenging step in the development of a Silviculture Strategy, and relies on ongoing communication between the information provider and the analyst. Budgets will constrain the number of scenarios that can be developed and analysed, and it is critical that the chosen scenarios focus on silviculture treatments that improve timber supply and environmental values.

4.0 Producing the final report

Each management unit will have a report done describing the information gathered, process and outcomes. The basic approach will be similar for Type 1s and Type 2s. However Type 1 reports will not have a step 5 as no trend assessment and habitat modelling will be done. The recommended report outline below is based on the seven steps for incorporating environmental values into strategic silviculture planning, as described in Table 1.

[29] http://www.for.gov.bc.ca/hfp/silstrat/
[30] http://www.forestsfortomorrow.ca/

Chapter 1. Review and summary of existing information
Chapter 2. Summary of environmental values potentially at risk
Chapter 3. Threats contributing to risk and potential risk reduction strategies
Chapter 4. Information gaps
Chapter 5. Environmental trends analyses and habitat modelling (Type 2 only)
Chapter 6. Environmental values for consideration
Chapter 7. Silviculture scenarios for addressing timber supply and environmental values
Chapter 8. Environmental priorities, projects, scheduling and five-year budget forecast

5.0 Bibliography

BC Ministry of Forests. 1999. Coastal Watershed Assessment Procedure and Interior Watershed Assessment Procedure. Forest Practices Code of British Columbia. http://www.for.gov.bc.ca/tasb/legsregs/fpc/FPCGUIDE/wap/WAPGdbk-Web.pdf

BC Ministry of Environment. 2006. Ecosystem Restoration Program – Regional Restoration Plans. Draft in progress.

BC Ministry of Water, Land and Air Protection. 2000. Environmental Risk Assessment. Technical Bulletin #1 Habitat Branch. http://www.env.gov.bc.ca/wld/documents/era.pdf

BC Ministry of Water, Land and Air Protection. 2003. Watershed Restoration Planning and Priority Setting –An Emphasis on Fish Habitat. http://wlapwww.gov.bc.ca/wld/documents/fia_docs/wrp_guidelines_s.pdf

Beaudry, P.G. 2004. A water quality indicator for sustainable forest management: the SCQI experience. Pages 157-162 in G.J. Scrimgeour, G. Eisler, B. McCulloch, U. Silins and M. Monita. Editors. Forest Land–Fish Conference II – Ecosystem Stewardship through Collaboration. Proc. Forest-Land-Fish Conf. II, April 26-28, 2004, Edmonton, Alberta. http://www.tucanada.org/forestlandfish2/pdfs/abstracts/pages%20157-162.pdf

Carver, M. and G. Utzig. 2000. A GIS-based Hydrologic Decision-Support Tool for Strategic Planning in the Arrow Forest District. Unpubl. Report for Arrow Forest District, BC Ministry of Forests. Castlegar, BC. 37pp.

Cortex 2007a. Quesnel TSA Silviculture Strategy (Type 1). Prepared for the Quesnel TSA Strategic Forest Analysis Steering Committee.

_____ 2007b. Quesnel TSA Silviculture Strategy (Type 2) and Habitat Analysis (Type 3). Prepared for the Quesnel Strategic Forest Analysis Steering Committee.

ENAR ESDE Inc. 2006a. Cariboo Strategic Regional Restoration Plan Prepared for the Ministry of Environment, Ecosystems Branch, Victoria, BC

_____2006b. Northern Interior Strategic Regional Restoration Plan Prepared for the Ministry of Environment, Ecosystems Branch, Victoria, BC

_____ 2006c. Southern Interior Strategic Regional Restoration Plan Prepared for the Ministry of Environment, Ecosystems Branch, Victoria, BC

Environment Canada. 2004. The Management of Water – Water Quality. Case Study – Powell River, British Columbia (Community Watershed Planning, website viewed March 2006) http://www.ec.gc.ca/water/en/manage/qual/case/e_powell.htm

Fenger, M. 2001. Forecasting our way to a more certain future. A presentation to the habitat modelling workshop, Richmond BC. http://www.for.gov.bc.ca/hfp/silstrat/habitat/hsworkshop/presentation/1-04/1-04-Fenger.pdf

Fenger, M., T. Douglas, R. Holt, D. Jones, and B. Gray. 2006. Ministry of Environment Ecological Restoration Priorities. Priorities compiled through consultation with MOE staff in regions affected by Mountain Pine Beetle and catastrophic wildfire. Working Draft. Prepared for Ecosystems Branch, Ministry of Environment.

Forest Ecosystem Solutions Ltd., B.A. Blackwell and Associates Ltd. and Wildlife Infometrics Inc. 2006. Type 2 & 3 Silviculture Strategy Analysis Report for Tree Farm Licence #18

Forsite Forest Management Specialists, Symmetree Consulting Group and Mike Fenger and Associates Ltd. 2006a. 100 Mile Type 1 Silviculture Strategy. Prepared for the British Columbia Ministry of Forests and Range, Forests For Tomorrow Program.

_____2006b. Williams Lake Type 1 Silviculture Strategy. Prepared for the British Columbia Ministry of Forests and Range, Forests For Tomorrow Program.
_____2006c. Kamloops Type 1 Silviculture Strategy. Prepared for the British Columbia Ministry of Forests and Range, Forests For Tomorrow Program.
_____2006d. Merritt Type 1 Silviculture Strategy. Prepared for the British Columbia Ministry of Forests and Range, Forests For Tomorrow Program.
_____2006e. Okanagan Type 1 Silviculture Strategy. Prepared for the British Columbia Ministry of Forests and Range, Forests For Tomorrow Program.
_____2006f. Cranbrook Type 1 Silviculture Strategy. Prepared for the British Columbia Ministry of Forests and Range, Forests For Tomorrow Program.

Greenough, J.A., S.J. Beukema, D.C.E. Robinson, W.A. Kurz, N. Densmore, R. Winter and B. Snowdon. 2002. Prognosis EI: A detailed watershed-level environmental indicators model. pp.122-125. *In:* N.L Crookston, and R.N. Havis (comps.). Second Forest Vegetation Simulator (FVS) Conference; February 12-14, 2002, Fort Collins, CO. Proceedings RMRS-P-25. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 208 pp. Available at: http://www.fs.fed.us/rm/pubs/rmrs_p025.pdf

Holt, R.F. 2004. Environmental States and Trends for Haida Gwaii/ Queen Charlotte Islands. http://srmwww.gov.bc.ca/cr/qci/hgqci_env.htm

Johnson D. H. and T. A. O'Neil. 2001. Wildlife-habitat relationships in Oregon and Washington. Oregon State University Press, Corvalis.

Jones, K., R. Ellis, R. Holt, B. MacArthur and G. Utzig. 2002. A strategy for habitat supply modelling for British Columbia. Prepared for: Habitat Modelling Steering Committee, Victoria, BC. http://www.for.gov.bc.ca/hfp/silstrat/habitat/habitat-docs.htm

Machmer, M.M., G.F. Utzig, T.M. Gaines, and J. Dulisse. 2000. Development of a northern goshawk habitat suitability index for forest types of the Kootenay Region. Pp. 241-246 in L.M. Darling (ed.). Proceedings of a conference on the biology and management of species and habitats at risk. Kamloops, BC, 15-19 Feb., 1999. BC Min. of Environment, Lands and Parks, Victoria.

Fenger, M. and T. Douglas. 2008. Current and Proposed Approach to Addressing Environmental values through Silviculture Strategies and the Forests for Tomorrow Program. Prepared for the Ministry of Environment Forests For Tomorrow Program

Mike Fenger and Associates Ltd. 2006. 2006 Summary Report Habitat and Non-Timber Input to Type 1 and 2 Silviculture Strategies on Behalf of the Ministry of Environment.
_____ 2006b Assessing Implications to Kamloops Land and Resource Management Plan, Project Overview**.** A communications summary prepared for Integrated Land Management Bureau, Ministry of Agriculture and Lands, Kamloops.
_____ 2006c. Assessing implications to Kamloops Land and Resource Management Plan, Project Overview. Prepared for Integrated Land Management Bureau, Ministry of Agriculture and Lands, Kamloops.

Ministry of Environment Habitat Branch. 2000 Environmental Risk Assessment (ERA): An Approach for Assessing and Reporting Environmental Conditions. http://www.agf.gov.bc.ca/clad/strategic_land/econ_analysis/seea_methods.html#era_report

Ministry of Forests and Range (MOFR) 2007. Ministry of Forests and Range 2007. Forests For Tomorrow Program Plan pp 24.

Ministry of Water, Land and Air Protection, 2004. Accounts and Measures for Managing Identified Wildlife, Coast Forest Region.

Ministry of Water, Land and Air Protection, 2004. Accounts and Measures for Managing Identified Wildlife, Northern Interior Forest Region.

Ministry of Water, Land and Air Protection, 2004. Accounts and Measures for Managing Identified Wildlife, Southern Interior Forest Region.

Olivotto, G. 1999. Pine Mushrooms and Timber Production in the Cranberry Timber Supply Area - Prince Rupert Forest Region. Unpubl. report prepared for: Northwest Institute for Bioregional Research, Smithers, B.C. Olivotto Timber - Forest Modelling Consultants. Victoria, B.C. 12pp.

Page, R. 2001. Assessing the effects of forest management on wildlife: the models. Draft version 2.3. Prepared for: Forest Practices Branch, BC Ministry of Forests, Victoria. http://www.for.gov.bc.ca/hfp/silstrat/pdffiles/habitat-assessing-effects-of-fm.pdf

Province of BC. 1996 and subsequent updates. Caribou Chilcotin Land Use Plan Biodiversity Conservation Strategy. http://srmwww.gov.bc.ca/car/planning/cclup/biodiv/index.html

Province of BC. 1996, 1998, 2000, 2002. Caribou Chilcotin Land Use Plan, Caribou Strategy. http://srmwww.gov.bc.ca/car/planning/cclup/#caribou

Province of BC. 2001. Cariboo Chilcotin Land Use Plan, Grasslands Strategy. http://srmwww.gov.bc.ca/car/planning/cclup/grasslands_strat/index.html

Province of BC. 2002. Cariboo Chilcotin Land Use Plan. Regional Mule Deer Winter Range Strategy. http://wlapwww.gov.bc.ca/car/env_stewardship/ecosystems/mdwr_strat/mgmtplan.html

Province of BC. 2005. Habitat Supply Modeling – A Guide for Silviculture Strategic Planning. Draft for Testing and Review.

Province of BC. 1995. Biodiversity Guidebook. Ministry of Forests and Ministry of Environment, Queens Printer. http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/biodiv/biotoc.htm

Roberts, Anne-Marie. March 2004. Northern Woodland Caribou – Habitat Suitability Models. Prepared for the Morice and Lakes Innovative Forest Practices Agreement.

Roberts, Anne-Marie. 2004. Fisher Habitat Models Maternal and Natal Denning. Prepared for the Morice and Lakes Innovative Forest Practices Agreement.

Roberts, Anne-Marie. 2004. Marten Winter – Habitat Suitability Models. Prepared for the Morice and Lakes Innovative Forest Practices Agreement.

Roberts, Anne-Marie and Laurence Turney. 2004. Moose Habitat Model. Prepared for the Morice and Lakes Innovative Forest Practices Agreement.

Steeger, C., J. Dulisse, and M. M. Machmer. 2001. Wildlife-habitat relationships in the Columbia River Basin: a British Columbia database for terrestrial vertebrate species. Prepared for: Research and Forest Practices Branch, BC Ministry of Forests, Victoria.

Stevens, T. M. Fenger and J. Tantz. 2001. Habitat and Biodiversity in Modelling in Timber Supply Reviews. Robson Valley. http://www.for.gov.bc.ca/hfp/silstrat/habitat/hsworkshop/presentation/2-12/2-12-Stevens.pdf

Stone, J. 2000. Habitat Supply Modelling in British Columbia. Draft Report. Ministry of Forests, Timber Supply Branch. Victoria, BC. http://www.for.gov.bc.ca/hfp/silstrat/habitat/habitat-docs.htm

Timberline Forest Inventory Consultants Ltd. 2001. Information package. Arrow Innovative Forest Practices Agreement Forest Level Analysis 2001/2002. Draft report prepared for: The Arrow Forest License Group.

Turney, L. and Anne-Marie Roberts. 2004. Grizzly Bear Spring, Summer and Fall – Habitat Suitability Models. Prepared for the Morice and Lakes Innovative Forest Practices Agreement.

US Fish and Wildlife Service. 1981. Standards for the development of habitat suitability index models for use in the Habitat Evaluation Procedures, USDI Fish and Wildlife Service. Division of Ecological Services. ESM 103. http://www.nwrc.usgs.gov/wdb/pub/hsi/hsiintro.htm

Utzig, G. and R.F. Holt. 2002. Environmental Trends: Assessing the Environmental Effectiveness of the Kootenay Boundary Land Use Plan Higher Level Plan Order in TFL 14. Prepared for MSRM. ftp://nelftp.env.gov.bc.ca/pub/outgoing/misc/spatial_analysis_kb_hlp/

Utzig, G.F., and T.M. Gaines. 1998. Application of a habitat suitability index for the SIMFOR habitat model. B.C. Environment, Nelson, B.C. 20 p.

Wells, R. W., D. Haag, S. Paczek, I. Houde, and F. L. Bunnell. 2002. Habitat analysis of a sustainable forest management basecase in the Lemon Landscape Unit. Prepared for: Arrow IFPA.

Wells, R., E. Valdal. C. Steeger and P. Vernier. 1999. SIMFOR Habitat Analysis of Two FSSIM Harvest Scenarios in the Rocky Mountain Trench. Report for the Invermere Enhanced Forest Management Pilot Project (EFMPP). Available at: http://www.for.gov.bc.ca/drm/Pilot/simfor/simforhabitatanalysis.html

Wilford, D. and R. Lalonde. 2004. A Framework for Effective Watershed Monitoring. Streamline Watershed Management 8(1):5-10.

Wilson, S., C. Steeger, and D. Hamilton. 2002. Habitat supply modelling: TFL 14. Pilot Project report prepared for: BC Ministry of Water, Land and Air Protection, Victoria, and Tembec Industries. http://www.for.gov.bc.ca/hfp/silstrat/pdffiles/tfl14%2D%20final%2Dreport.pdf

Wilson, S. F., C. Steeger, and D. Hamilton. 2003. Habitat supply modelling for the Arrow Timber Supply Area. Prepared for the BC Ministry of Water, Land and Air Protection, Victoria, and Arrow Forest License Group. http://www.for.gov.bc.ca/hfp/silstrat/map/nelson-tsa-arrow.htm

Appendix One: Proposed Environmental Trend and Habitat Supply Analyses for Type 2 Silviculture Strategies

This appendix provides further detail on environmental trend analyses for Step 5 of Type 2 Silviculture Strategies.

Approaches to biodiversity management and habitat supply modelling can be generally divided into two approaches: coarse filter and fine filter. Coarse filter approaches assume that if a significant portion of a full cross-section of habitats and ecosystems are maintained in a fully functioning state, then the full complement of species present in those habitats will also be maintained. In contrast, fine filter approaches generally concentrate on managing or making assessments for individual species or groups of species with similar habitat needs.

Management or assessment approaches that focus on umbrella or keystone species[31] are somewhat of a hybrid, attempting to use an individual species as an indicator for broader ecosystem integrity. Assessments are also generally divided into terrestrial habitat assessments and hydrologic assessments or aquatic habitat assessments. Hydrologic assessments are generally coarse filter, while aquatic habitat assessments can be coarse or fine filter.

The following describes proposed minimum standards for assessments within Type 2/3 processes. The table below provides references to specific examples of assessments previously undertaken. The references also include descriptions of the methodologies employed. Practitioners can potentially use similar approaches or adapt them to their specific needs and/or data availability.

It is proposed that each Type 2 should include, at a minimum, 3 coarse filter analyses and 2 fine filter analyses :

Coarse Filter

1. An analysis of representation at the BEC variant/ Ecosection level - summary to include:

    a) local representation in Protected Areas for each BEC/Ecosection combination occurring in the management unit;

    b) total provincial representation for each BEC variant in the MU, and total provincial representation for each ecosection in the MU;

    c) possible risk classes VL >20%, L 16-20%, Mod 10-15%, H 5-10%, VH <5%. This could be augmented with Site Series or SS Group representation analysis if PEM/TEM data are available, one could also look at representation in other reserves (e.g., riparian, OGMAs,

[31] An umbrella species is one that has broad habitat requirements that if met, are assumed to also meet the needs of many other species; a keystone species is one that holds a critical functional role in an ecosystem, and thereby affects the survival and abundance of other species in that ecosystem.

etc. - the inoperable should be treated only as an insecure deferral area - it is not "protected".

2. An analysis of seral stage distribution based on:

    1. BEC unit by Landscape Unit or other relevant breakdown of the MU;

    2. risk classes should be determined based on deviation from a natural base case (i.e., range of natural variability - RONV; e.g. see Holt 2004 or Utzig and Holt 2002 below);

    3. make some assumptions about natural disturbance in areas outside the THLB - either model disturbance or, if necessary, just assume the non-THLB goes to RONV.

3. A coarse filter hydrologic/aquatic habitat analysis for all high value fisheries watersheds, and domestic and irrigation watersheds (not just Community Watersheds). The analysis should include indicators that represent the following variables at a minimum:

    a) weighted Equivalent Clearcut Area (ECA), density of road crossings, roads and harvesting on Class IV/V terrain, harvesting and roads in riparian habitats, and harvesting and roads within 200m of critical fish habitat (e.g. spawning/rearing areas), water intakes and key riparian habitat for terrestrial species (e.g., grizzly salmon feeding areas).

    There could be a minimum watershed size for the analysis (e.g., >500 ha). The base case for hydrologic assessment should either be assuming completely forested watersheds or a seral distribution based on RONV. (Note that riparian areas may have to be treated separately due to the preponderance of wet sites). Assessment of riparian areas should be emphasized, as these are likely to offer opportunities for silviculture activities to accelerate recovery and/or enhance habitat components. Risk classes can also be determined, based on deviation from a natural base case (or fully forested).

Additional coarse filter analyses could look at patch size distribution, the supply of specific stand structural components (e.g., snags, big trees) or other factors - see examples Table App 1-1 below.

Fine Filter Analyses

The two (or more) fine filter assessments should be selected based on focal species deemed most appropriate for the management unit. These could be red/blue listed species, species felt to be most sensitive or vulnerable to projected harvesting patterns, umbrella species, keystone species and/or species deemed critical due to public concerns. Species of national conservation concern (COSEWIC-listed) and those included in the provincial Identified Wildlife Management Strategy (see http://www.env.gov.bc.ca/wld/identified/index.html) should be specifically considered.

Risks should be assessed by comparing estimated capability or "natural suitability" compared to present conditions and projected future conditions (i.e., present condition should not be considered the benchmark/base case). See examples listed below in Table App. 1-1 for potential approaches.

Table App. 1-1. Examples of coarse and fine filter indicators and approaches to key aspects of environmental risk assessments.

	Examples										
Authors (see bibliography)	Utzig & Holt 2002	Holt 2004	Wilson *et al*. 2003	Wilson *et al*. 2002	Green-ough *et al*. 1999	Wells *et al*. 1999	Utzig & Gaines 1998; Machmer *et al*. 2000	Olivotto 1999	Carver & Utzig 2000	Wilford & Lalonde 2004	Beaudry 2004
Location	East Kootenays	Haida Gwaii	West Kootenays	East Kootenays	West Kootenay	East Kootenays	East Kootenays	Northwest BC	West Kootenay	Northwest BC	
Issue/Indicator											
Indicator Selection	X	X		X						X	
Threats/Pressures	X	X			X						
RONV Basecase	X	X									
Coarse Filter											
Representation	X	X									
Seral Stages Distribution	X		X		X						
Old Growth	X	X									
Patch Size Distribution	X				X						
Connectivity	X										
Watershed Condition		X			X				X	X	
Water Quality											
Riparian	X	X							X		
Large Trees				X	X		X				
Snags				X	X						
Downed Wood (CWD)			X	X	X						
Hardwoods			X								

	Examples										
Authors (see bibliography)	Utzig & Holt 2002	Holt 2004	Wilson *et al*. 2003	Wilson *et al*. 2002	Green-ough *et al*. 1999	Wells *et al*. 1999	Utzig & Gaines 1998; Machmer *et al*. 2000	Olivotto 1999	Carver & Utzig 2000	Wilford & Lalonde 2004	Beaudry 2004
Location	East Kootenays	Haida Gwaii	West Kootenays	East Kootenays	West Kootenay	East Kootenays	East Kootenays	Northwest BC	West Kootenay	Northwest BC	
Issue/Indicator											
Shrub Cover			**X**		**X**						
Thick-barked Tree Spp.				**X**							
Fine Filter											
Ungulate Winter Range	**X**				**X**						
Pileated Woodpecker			**X**		**X**						
Mountain Caribou			**X**								
Grizzly habitats	**X**				**X**						
Bat habitat					**X**						
Goshawk habitats		**X**					**X**				
Three-toed woodpecker						**X**					
Orange-crowned warbler						**X**					
Black Bear		**X**									
Marbled Murrelet		**X**									
Seabird Colonies		**X**									
Salmon		**X**									
Mushrooms								**X**			

Authors (see bibliography)	Turney Roberts 2004	BC Ministry of Forests 1999	Cortex 2007	Forest Ecosystem Solutions et a, 2007						
Location	Morice and Lakes	Provincial	Quesnel TSA	Canfor TFL 18	?	?	?	?	?	?
Issue/Indicator										
Indicator Selection			**X**	**X**						
Threats/Pressures			**X**							
RONV Basecase			**X**	**X**						
Coarse Filter										
Representation										
Seral Stages Distribution			**X**							
Old Growth			**X**							
Patch Size Distribution										
Connectivity										
Watershed Condition		**X**	**X**							
Riparian			**X**							
Large Trees										
Snags			**X**							
Downed Wood (CWD)			**X**							
Hardwoods										
Shrub Cover										
Thick-barked Tree Spp.										
Fine Filter										
Ungulate Winter Range										

Authors (see bibliography)	Turney Roberts 2004	BC Ministry of Forests 1999	Cortex 2007	Forest Ecosystem Solutions et a, 2007						
Location	Morice and Lakes	Provincial	Quesnel TSA	Canfor TFL 18	?	?	?	?	?	?
Issue/Indicator										
Pileated Woodpecker										
Mountain Caribou										
Grizzly habitats	**X**									
Moose	**X**		**X**	**X**						
Woodland Caribou	**X**									
Fisher	**X**									
Marten	**X**			**X**						
Black bear				**X**						
Mule deer				**X**						
White tailed deer				**X**						
Elk				**X**						
Critical fish habitat			**X**							

Appendix Two: Limitations of Projecting Environmental Trends and Habitat / Timber Supply Modelling

Analyses can clarify risks for decisions but cannot set acceptable thresholds as perception of risk is relative to individuals and institutions. Isolating risks can also be difficult as there is a range of natural variability within ecosystems, varying tolerances to stress and varying abilities to recover.

The follow points highlight potential issues related to projecting environmental trends and habitat/timber supply modelling:

1. Habitat supply models and timber supply models depend on many assumptions, some of which are virtually untestable due to the long time horizons of projections. Some uncertainty can be characterized through sensitivity analyses, but users should be prepared to accept more uncertainty for habitat supply analysis than is typically associated with timber supply analysis.
2. Timber supply data are some of the most reliable data available to characterize the abundance and supply dynamics of habitat elements important for wildlife, and to establish benchmarks or thresholds with respect to habitat supply in managed forests.
3. Timber supply analyses typically exclude important habitats for wildlife, e.g., riparian areas, from contributing to timber supply. Projections are often restricted to the timber harvesting land base and sensitivity analyses of the existing data may be necessary before habitat supply modelling is applied.
4. Available data are rarely based on consistent sampling protocols and therefore are difficult to integrate and use in habitat supply modelling applications. Ensure assumptions are well documented, and comparisons are made based on similar sample designs.
5. Fine filter (single species) habitat projections for viable populations rely on more than the provision of adequate habitat over time. Other biological effects (e.g., competition, predation, disease) and anthropogenic effects (e.g., mortality effects of roads, chronic disturbance, toxic substances) are difficult to account for in the silviculture strategic planning projections. However, anticipated trends in these other factors could be used as part of the interpretation of analyses. Silviculture strategies however, will help to reveal sources of uncertainty where either monitoring or research will be able to help inform how to sustain species and ecosystems.

Appendix Three: Review of FFT Environmental Provisions

From the Program Management Plan 2007 [32]

Program Drivers (Page 4)
"The strategic approach implemented in Forests for Tomorrow planning and expenditures address high-priority sites and ensure that resource values other than timber are considered and enhanced to restore the productivity of various forest resources."

" Secondary drivers for Forests for Tomorrow are based on predicted timber and habitat supply shortfalls, sustainable forest management, hydrological recovery, resource objectives and social values, …."

Government Strategic Planning (page 4)
"Forests for Tomorrow supports two of the provincial government's Five Great Goals. Through its reforestation initiatives, Forests for Tomorrow primarily addresses the fourth goal, "Lead the world in sustainable environmental management, with the best air and water quality, and the best fisheries management, bar none."

Ministry Service Planning (page 4)
"Ministry service planning begins with Goal 1: Sustainable Forest and Range Resources, under which lie eight objectives, the fourth of which is that forest resources are restored or improved"

Forest Stewardship Objective (Page 4)
"The fourth objective for forest stewardship from the ministry service plan is that forest resources are restored or improved".

Sustainable Forest and Range Resources (page 4)
"Appropriate practices are used to maintain and improve the long-term sustainability and health of the province's forest resources, both timber and non-timber."

Performance measures.
For objective 4, "forest resources are restored or improved," …. The three Internal Management Measures include tracking the percentage of Forests for Tomorrow project areas that are: (1) affected by fire or pests and assessed, and (2) treated compared to areas planned for treatment, as well as (3) the number of hectares declared free-growing in areas eligible for program funding".

Program Goals (Page 5).
"The immediate goal is to improve the future timber supply following the impacts of recent wildfires and the mountain pine beetle epidemic and to reduce risks to

[32] http://www.for.gov.bc.ca/hfp/fft/FFT_Mgt_Plan_2007.pdf

biodiversity, water, fish, wildlife, and habitat."

Objectives

"1. Accelerate the recovery of the timber supply, and biodiversity and other non-timber forest values, in forest management units affected by catastrophic mountain pine beetle infestations and recent large fires, through strategically planned reforestation and restoration activities. The ways in which this will be done are to:

• Revise silviculture strategies in impacted management units, and survey, assess, and plan the high-priority silviculture work not legally required of licensees;"

Guiding principles

5. Approved land use plans and land management objectives will provide direction to treatment priorities and site prescriptions.

6. Landscape- and stand-level biodiversity will be emphasized, and corresponding objectives reflected in site prescriptions.

10 Return on Investment is evaluated through the assessment of financial, timber supply, and non-timber values.

"The link to silviculture strategies is provided so strategic planning is clear

Page 9. **Management Unit Strategic Plans** provide the Forests for Tomorrow program with information to rationally and strategically allocate and deploy silviculture investments. These plans may be higher-level plans or Type 1 or 2 silviculture strategies.

"Silviculture strategies provide updated forest-level analyses for silviculture investments in management units across BC. The overall objective of the strategies is to provide program staff with information to enable rational and strategic allocation and deployment of silviculture investments."