

Sustainable Forest Management Plans: Standards for Monitoring

Project Report for

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Sustainable Forest Management Plans: Standards for Monitoring

1.0 Introduction

The preparation of Sustainable Forest Management Plans (SFMPs) and supporting studies has been funded under the Land Base Investment Program (LBIP) of the British Columbia Ministry of Forests and Range (MOFR) Forest Investment Account (FIA) since fiscal 2002/03. A criteria and indicator approach to planning is encouraged, where measurable indicators of sustainable forest management are defined within broader criteria. Monitoring of indicators is needed to assess progress towards sustainability and to provide feedback to management practices. Agencies can propose monitoring projects under FIA, in the category of Information Gathering and Management – Monitoring. A prioritization scheme for monitoring projects is needed as monitoring can cover broad subject areas and can be costly. The objectives of this study are to:

- Review current Provincial-level monitoring initiatives.
- Prepare a consolidated list of indicators used for SFM planning under FIA.
- Prepare a list of indicators eligible for monitoring under FIA LBIP funding.
- Assign priority to the indicators for monitoring.
- Identify associated monitoring methodologies.

2.0 Provincial Natural Resources Monitoring Initiatives

British Columbia Government Forest and Range Evaluation Program

The Forest and Range Evaluation Program (FREP) involves the Ministry of Forests and Range and the Ministry of Environment in a program to assess practices under FRPA (Forest and Range Practices Act). Under FREP, the effectiveness of FRPA in achieving resource stewardship is evaluated. As well, issues concerning implementation of forest policies, practices and legislation affecting FRPA resource values are addressed and continuous improvement of forest management is implemented.

The Forest & Range Practices Act identifies 11 forest and environmental values that must be maintained. Indicators and protocols, which include data collection methods, for these values are completed or under development. Effectiveness evaluations will be carried out using seven high priority resource evaluation questions and other tools to provide information (Ministry of Forests and Range 2007a).

The BC Forest Practices Board

The BC Forest Practices Board is an independent agency that has the legal mandate to audit forest practices of both industry and government. It must deal with complaints from the public. It carries out special investigations, and may appeal government-imposed enforcements and penalties. The Board uses criteria and indicators in assessments of forest practices. Previously developed criteria and indicators are used where possible. The Board is developing custom criteria and indicators for audits and conducts pilot audits to ensure they have complete tools to audit agency commitments to FRPA values. (Forest Practices Board 2006).

FORREX Forest Research Extension Partnership

A Common Ground for Criteria and Indicators of Sustainable Forests for British Columbia

In 2004 FORREX Forest Research Extension Partnership was engaged by the Province of BC via the Forest Practices Board to work with key organizations, including forest industry representatives, on development of scientifically sound, commonly accepted criteria and indicators for BC's forests.

Descriptions of projects for 2004/05 through 2006/07 can be found online at <http://www.forrex.org/bcci/projects.asp>.

One of the current projects is the development of a searchable on-line database containing the BC-specific indicators matrix prepared by the Sustainable Forest Management Lab at UBC (FORREX 2007).

Sustainable Forest Management Research Group, Faculty of Forestry, UBC

The Sustainable Forest Management Laboratory at UBC was established in 2000 to encourage inter-disciplinary research into sustainable forest management. All aspects of management, from physical through biological to social issues are considered. This group has collaborated with FORREX to prepare a matrix of indicators applicable to BC, and to analyze how they are being used in the field. The reviews are available on the website at UBC: <http://sustain.forestry.ubc.ca/>

Ministry of Forests and Range State of the Forest Reporting

State of the Forest reporting in BC provides an overview of progress towards sustainable forest management. Indicators are based on existing international and national frameworks for assessing sustainable forest management, adapted to emphasize issues of importance to BC. Six of the 24 indicators are assessed in the 2004 report. The state of progress towards sustainable forest management, trends, and adequacy of information is evaluated for each indicator. (Ministry of Forests 2004).

Ministry of Environment State of the Environment Reporting

The Ministry of Environment reporting program releases regular reports, which analyze trends in environmental conditions, assess progress towards sustainability, and provide scientific information about the environment. Recent reports include “British Columbia’s Coastal Environment 2006” and “Environmental Trends in British Columbia 2002” (Ministry of Environment 2006 and 2002).

3.0 Consolidated Indicators

In this phase of the project a consolidated list of indicators for monitoring under FIA funding was prepared.

Indicators used in 2004/2005 SFM projects formed a basis for the consolidated list. These are available in the report “Sustainable Forest Management Plans: Review of the 2004/2005 Forest Investment Account Program Deliverables: List of Criteria, Indicators, and Measures” (LM Forest Resource Solutions 2006). Only nine of the 2004/2005 projects contained indicators. Therefore indicators from the 16 SFMPs completed in 2005 and 2006 (found online) were reviewed, and the indicators from these SFMPs that were not already on the list were added. This list was reduced by grouping similar indicators under broader more general indicators where possible. Indicators were edited where needed to make them more widely applicable. The resultant list of indicators is presented in Appendix 1.

The Canadian Council of Forest Ministers (CCFM) has developed a framework of criteria and indicators based on six criteria representing forest values to be sustained, each with a set of indicators for assessing the criteria (Canadian Council of Forest Ministers 2003). Many of the completed SFMPs reviewed use this framework or show linkages to it. This framework is used for categorizing the indicators identified in this project.

Indicators in the SFMPs are selected by recipients (participating licensees and BCTS representatives) through planning exercises, which often include public participation. Indicators chosen therefore reflect public concerns and priorities.

The following definitions are found in “Working Paper: Developing a Sustainable Forest Management Plan” (SFMP Working Group 2002):

- “A goal is a broad statement describing a defined forest area’s desired future state or condition.
- An indicator is a variable that measures the state or condition of a goal for a defined forest area.
- A target is a specific statement describing a desired future state or condition of an indicator.”

During the review of completed SFMPs it was found that definitions and terminology varied. Other terms including “value”, “strategy” “objective”, and “measurable” were used, and this posed some challenges for consolidating indicators. However these other terms were defined in the individual SFMPs and there is no need to standardize them further.

4.0 Indicators for Monitoring

To prepare a list of indicators eligible for FIA project funding in the component Information Gathering and Management – Monitoring Values for SFM, the standards for the FIA-eligible activities water quality/quantity monitoring, terrestrial aquatic biological and physical monitoring, aquatic biological and physical monitoring, and carbon sequestering were reviewed (Ministry of Forests and Range 2007 b). Any indicators that did not fit the eligibility standards were removed from the list of consolidated indicators. For example, none of the indicators in the group CCFM Criterion 5: Economic and Social Benefits: Timber and Non-timber Benefits fit the eligibility criteria, so none were included. Thus the consolidated list of indicators (as presented in Appendix 1) was reduced to a list of indicators eligible for monitoring (Appendix 2).

It is important to note that indicators on this list were included in one category only, and not repeated, however, indicators can be used to assess more than one value or forest condition. For example, the indicator “Number of known species classified as vulnerable, threatened or endangered in the planning unit” is included under Species Diversity but can also be an indicator of genetic diversity. It is the suite of indicators used in an SFMP that are used together to measure progress towards sustainable forest management on a management unit.

Appendix 2: Priorities and Methods for Monitoring includes the list of indicators for monitoring.

5.0 Priorities for Monitoring

Indicators eligible for monitoring were assigned priority for monitoring based on the following questions:

- Is monitoring of the indicator an eligible activity under FIA?
- Is the activity essential for assessing progress towards sustainable forest management?
- Is the monitoring of interest and value to government and LBIP?
- Is monitoring of the indicator affordable?
- Is indicator required to be monitored under other legislation/plans/programs already in place?
- Are there other funding sources available for monitoring the indicator?
- Are there clear methodologies for monitoring?
- Is development of new monitoring tools or techniques needed?
- Will data collected be consistent with government approved standards?
- Does there appear to be a high level of interest from recipients in monitoring the indicator?

It was found that priorities could be assigned to groups of indicators. Priorities are presented in Appendix 2: Priorities and Methods for Monitoring and are summarized in Table 1.

Table 1. Summary of Priorities for Monitoring

Indicator Group	Priority
CCFM Criterion 1: Conservation of Biological Diversity Ecosystem Diversity (15 indicators)	Med – High. Monitoring of indicators in this group is important for providing information on biodiversity. The low number of monitoring projects funded by FIA to date may reflect low priority by recipients in these types of projects, or that information is available from other sources.
Ecosystem diversity: Protected areas (5 indicators)	Variable. Depends on the type of protected area and the degree of protection required.
Species Diversity (20 indicators)	High. Monitoring of indicators in this group is essential for assessment of SFM. There is a high level of interest by recipients in monitoring these indicators. Standardized approaches to species inventories are available through RIC CBCB manuals and other resources.
Genetic Diversity (3 indicators)	Low. Few FIA monitoring projects to date may reflect complexity and cost of assessing. Work is more research-oriented than monitoring. Could potentially become a greater public issue.
CCFM Criterion 2: Ecosystem Condition and Productivity Ecosystem resilience (9 indicators)	Medium. These are important indicators of SFM. Agencies may be monitoring them, however there have been no FIA monitoring projects in this category to date. Basic information is available from other sources and through monitoring of other indicators.
CCFM Criterion 3: Soil and Water (24 indicators)	High. This category had the highest number of FIA monitoring projects reflecting a high level of interest from agencies in monitoring these indicators. They are essential indicators of progress towards SFM. Monitoring is of interest to government and LBIP. Standards are in place for data collection and storage for most of these indicators.
CCFM Criterion 4: Role in Global Ecological Cycles Carbon Cycle (6 indicators)	Low. Innovative projects only eligible at this time. Standards are not in place. Low interest level from recipients. However, refinement of monitoring tools is needed, and this indicator may become higher priority with recent BC government interest in carbon monitoring. Eligibility may need to be reconsidered as this develops.
CCFM Criterion 5: Economic and Social Benefits Sustainability of Benefits (5 indicators)	Medium. Indicators can be tracked through existing management information systems.
CCFM Criterion 6: Society's Responsibility Fair and Effective Decision-making (1 indicator)	High. It is important to identify objectives, procedures, standards, and results through monitoring plans and reports.

6.0 Monitoring Methodologies

Steps taken to identify methodologies in use for assessing the indicators were as follows:

1. A list of all recipient monitoring projects from 2005/06 and 2006/07 was obtained from the Forest Investment Reporting System (FIRS) website in the component Information Gathering and Management – Monitoring Values for SFM (Price Waterhouse Coopers 2007). Projects in the areas of water quality/quantity monitoring, terrestrial aquatic biological and physical monitoring, aquatic biological and physical monitoring, and carbon sequestering are eligible. All innovative and standard projects and all levels of project status (completion approved, cancellation approved, project plan rejected – not eligible, project plan pending, project plan declined) were selected.
2. Projects were grouped according to the CCFM criteria and indicators (CCFM 2003).
3. Methods associated with the projects stated on the FIRS website were listed. Where clarification was required the project reports were consulted, if available.
4. Some additional methods were obtained from “Indicators of sustainable forest management: Review of potential indicators” (McHugh et al 2005).

Methods are presented in Appendix 2: Priorities and Methods for Monitoring.

Project numbers and titles are presented in Appendix 3: FIA Land Base Investment Program, Information Gathering and Management Component, Monitoring: Agency Projects, 2005/06 and 2006/07.

7.0 Conclusions

A list of indicators of sustainable forest management that could be eligible to be monitored with funding from the Forest Investment Account is presented. Indicators are based on a roster of the indicators found in sustainable forest management plans and projects completed to date under FIA, and grouped by CCFM criteria. The list of indicators is expected to change as more SFMPs are completed and agency priorities evolve.

Priorities for monitoring are assigned to groups of indicators, based on a series of evaluation questions. Priorities will also change as indicators change and as monitoring becomes more routine.

Methods listed for monitoring indicators are based on methods planned by agencies with completed SFMPs, and others. Methods and tools for some aspects of monitoring will change as their development proceeds.

The SFMP activity under FIA LBIP supports sustainable forest management planning such as the development of objectives or indicators and targets for a management unit or subset but does not include monitoring. Monitoring is an eligible activity area under the FIA LBIP for specific activities, such as repeated inventories of wildlife species, ecosystems, water quality, fish species, and carbon monitoring. The current list of eligible monitoring activities under FIA LBIP will satisfy only a portion of the broad range of the forest industry's monitoring needs outlined in the SFMPs. Funding of SFMP monitoring could be a significant issue given the wide variety and number of potential indicators and costs associated with capturing the monitoring information.

The MOFR needs to review the monitoring activity under FIA LBIP to consider expanding the list with monitoring activities that would provide value to government and possibly satisfy a wider range of SFMP monitoring needs.

Acronyms

AAC	Annual Allowable Cut
BCTS	British Columbia Timber Sales
CBCB	Components of British Columbia's Biodiversity
CWD	Coarse Woody Debris
FIA	Forest Investment Account
FIRS	Forest Investment Reporting System
FRPA	Forest and Range Practices Act
GIS	Geographic Information Systems
HDM	Hemlock Dwarf Mistletoe
LBIP	Land Base Investment Program
MAI	Mean Annual Increment
MAMU	Marbled Murrelet
MOFR	Ministry of Forests and Range
NSR	Not Satisfactorily Restocked
PEM	Predictive Ecosystem Mapping
RIC	Resources Inventory Committee
RISC	Resources Information Standards Committee
SFMP	Sustainable Forest Management Plan
THLB	Timber Harvesting Land Base
TSA	Timber Supply Area
VRI	Vegetation Resource Inventory
VR	Variable Retention

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Appendix 1. Consolidated Indicators from 2004/05 and 2005/06 Sustainable Forest Management Plans and Projects

Consolidated Indicators from 2004/05 and 2005/06 Sustainable Forest Management Plans and Projects

CCFM Criterion 1: Conservation of Biological Diversity

Ecosystem Diversity

Indicator
<p>Area of forest, by type and age class, and wetlands in each ecozone</p> <p>Percent change in area of forest land/water bodies, measured at each Timber Supply Analysis period</p> <p>Species composition by age class/seral stage by planning unit by Biogeoclimatic Ecosystem Classification (BEC) zone/Wildlife Value Class</p> <p>Area of Old Growth by BEC zone</p> <p>Area of “Old Interior” forest conditions</p> <p>Area of non-forested types converted to forest</p> <p>Percent forest in each patch type by patch size class</p> <p>Average shape index of young patches in a landscape unit</p> <p>Area harvested by silvicultural system</p> <p>Percent openings that meet the large opening design criteria</p> <p>Area and distribution of stand-level retention</p> <p>Area of shrub habitat</p> <p>Number, spatial distribution, characteristics and type of significant habitat features in riparian areas</p> <p>Area of new riparian, restoration, or maintenance</p> <p>Area of forest, by type and age class, wetlands, soil types, and geomorphological feature types in protected areas in each ecozone</p> <p>Area of total land base/forest in protected areas by type, age class, and BEC zone</p> <p>Area of and strategies for:</p> <ul style="list-style-type: none"> • Landscape-level biodiversity reserves • Rare Landscape Units • Sites of special biological significance • Rare, uncommon and under-represented ecosystem clusters • High Conservation Value Forests <p>Percent forest management commitments completed on time resulting from consultations re: Non-timber features and interests</p> <p>Species composition by age class/seral stage by planning unit by BEC zone in protected areas/Wildlife Value Class/riparian ecosystems</p> <p>Government designated protected areas and sites of special biological significance are sustained at the site and sub regional level</p> <p>Percent personnel trained to identify sites of special significance</p> <p>Road density by BEC zone/Wildlife Value Class</p> <p>Area of harvesting or roads within Class A parks, ecological reserves, LRMP designated protected areas, rare ecosystems contained within OGMAs, landscape-level biodiversity reserves</p>

Species Diversity

Indicator
<p>The status of forest-associated species at risk</p> <p>Number of known species classified as vulnerable, threatened or endangered in the planning unit</p> <p>Area by ecosystem and wildlife value class in the planning unit</p> <p>Area of species at risk habitat in the planning unit</p> <p>Percent personnel trained to identify species at risk</p> <p>Percent plans reviewed by a person trained in species at risk</p> <p>Number of management strategies developed, implemented and monitored for species at risk/riparian sensitive species/legally identified wildlife species/regionally important species</p> <p>Percent forest operations consistent with species at risk, Ungulate Winter Range, Wildlife Habitat Areas Notices/Orders, Wildlife Habitat Features, and/or retention of structural habitat elements</p> <p>Number of incidences of non-conformance with government direction on recover plans for regionally significant species</p> <p>Population levels of selected forest-associated species</p> <p>Species composition by age class/seral stage by planning unit by BEC zone/Wildlife Value Class</p> <p>Km of fish habitat created, restored, or maintained</p> <p>Number of fry released annually</p> <p>Populations of recommended vertebrate species</p> <p>Plant Species Diversity Index for site association groups in the planning unit</p> <p>Number of Effectiveness Monitoring Plans developed and implemented for selected indicator species (wildlife), critical species</p> <p>Km new main summer road developed adjacent to harvested areas within identified major river corridors where visual screening is present</p> <p>Distribution of selected forest-associated species</p> <p>Age class/seral stage distribution by planning unit by BEC zone/Wildlife Value Class</p> <p>Area of Old Growth by BEC zone</p> <p>Number, spatial distribution, characteristics and type of significant habitat features in hardwood areas</p> <p>Distribution of selected habitat elements by BEC zone:</p> <p>Percent stems in large live tree diameter class</p> <p>Number of snags per hectare on the planning unit by age class</p> <p>Volume of Coarse Woody Debris per hectare on the planning unit</p> <p>Area of wildlife/biodiversity corridors in the planning unit</p> <p>Riparian connectivity corridors</p> <p>Percent stand level retention/Wildlife Tree patches in harvested areas</p> <p>Number of invasive, exotic forest-associated species</p> <p>Percent prohibited and primary noxious weeds and known invasive weed species of concern in seed mix analysis</p>

Genetic Diversity

Indicator
Genetic Diversity of Reforestation Seedlots
Percent of seed collected and seedlings planted in accordance with the Forest and Range Practices Act
Status of in situ and ex situ conservation efforts for native tree species within each ecozone
Area of natural regeneration
Use of mixed (natural and artificial) regeneration techniques
Age class/seral stage distribution by planning unit by BEC zone
Number of known species classified as vulnerable, threatened or endangered in the planning unit
Population levels of selected forest-associated species

CCFM Criterion 2: Ecosystem Condition and Productivity

Ecosystem resilience

Indicator
Total growing stock of both merchantable and non-merchantable tree species on forest land
Age class/seral stage distribution by planning unit by BEC zone
Volume of timber harvested annually based on TSR and cut-control requirements
Dollars invested in enhanced forestry
Area Weighted Ave Min Harvest Age MAI by BEC zone
Species composition by NDU by BEC zone
Site index by BEC zone
Additions and deletions of forest area, by cause
Percent of the timber harvest land-base in permanent access structures
Area of catastrophic natural disturbance events
Area of forest disturbed by fire, insects, disease and timber harvest
Area of operational related fires
Percent of operating area managed under a Fire Preparedness Plan
Volume of timber salvaged due to forest insect outbreaks
Area of the THLB and non-contributing forest by beetle hazard type
Percent high windfall risk edges treated
Compliance with disease control measures for cutblocks
Area of forest with impaired function due to ozone and acid rain
Proportion of timber harvest area successfully regenerated
Area of NSR
Amount A class stock planted annually
Area fertilized at time of planting
Percent weevil resistant spruce planted in high weevil hazard areas
Percent of harvested blocks meeting or ahead of the regeneration delay date
Percent of harvested areas meeting free growing requirements

CCFM Criterion 3: Soil and Water

Indicator
Rate of compliance with locally applicable soil disturbance standards
Percent of blocks meeting soil conservation targets after harvesting and silviculture activities
Percent road-related soil erosion events identified in annual road inspections and satisfactorily treated
Percent of the agencies' forest operations employees and primary contractors trained in Spill Preparedness and Response Procedures
Number of legally reportable spills
Rate of compliance with locally applicable road construction, stream crossing and riparian zone management standards
Percent compliance with Access Management Plans
Effectiveness Monitoring Plans are developed and implemented for selected access management areas to continually improve access points (M
Road density by BEC zone/Sensitive Watershed
Percent permanent status roads with risk assessments and plans developed based on assessments
Percent high hazard structures with action plans
Compliance of operational plans with terrain stability assessments
Compliance with road revegetation requirements
Percent slides seeded and/or planted
Percent stream crossings installed or removed consistent with erosion/sediment control plans or procedures/legal requirements
Percent stream crossings that maintain natural stream flow
Stream crossing density by watershed
Percent permanent crossings that are adequate for fish passage
Percent surveyed stream crossings with a high Water Quality Concern rating
Percent forest operations consistent with stream and riparian management requirements
Percent area less than 3m ht in stream RMAs by sensitive watershed
Percent conformance with karst management prescriptions
Proportion of watersheds with substantial stand-replacing disturbance in the last 20 years
Percent compliance with Coastal Watershed Assessment Procedures (CWAP)
Interior Watershed Assessment Procedures (IWAP) are completed and regularly updated by a Qualified Registered Professional (QRP) in designated Community Watersheds
Percent watersheds with Peak Flow Index (PFI) calculations completed (with Equivalent Clearcut Area calculations)
Watershed review where PFI targets exceeded
Drainage Management Indicator (DMI) used for select watersheds of concern
Dollars spent on watershed restoration

CCFM Criterion 4: Role in Global Ecological Cycles

Carbon Cycle

Indicator
Net change in forest ecosystem carbon
Carbon Monitoring Plan is developed and implemented for forest ecosystem biomass and carbon pools
Ave time to meet regeneration delay date
Percent seed orchard seedlings planted
Area broadcast fertilized to accelerate growth
Areas with stand damaging agents will be prioritized for treatment
Forest ecosystem carbon storage by forest type and age class
Age class/seral stage distribution by planning unit by BEC zone
Estimated amount of carbon stored in trees in planning unit (converted from TSR M3/ha)
Estimated carbon in non-tree vegetation (above ground biomass and roots)
Percent of blocks where a portion of the residual wood is left on-block
Percent harvested areas where operational guidelines have been applied to retain structural habitat elements
Percent of harvested areas meeting free growing requirements
Net change in forest products carbon
Forest sector carbon emissions

Forest Land Conversion

Indicator
Percent of cutblock area occupied by total permanent access structures
Area lost per year due to landslides attributable to harvesting or road building
Percent of the timber harvest land-base converted to non-forest

CCFM Criterion 5: Economic and Social Benefits

Timber and Non-timber Benefits

Indicator
Contribution of timber products to the gross domestic product
Total value of the timber harvest (amount of harvest related to purchase price of logs based on MPS system)
Volume of timber harvested annually based on TSR and cut-control requirements
Area Weighted Ave Min Harvest Age MAI by BEC
Value of secondary manufacturing of timber products per volume harvested
Local and/or value-added processing
Production, consumption, imports, and exports of timber products
Contribution of non-timber forest products and forest-based services to the gross domestic product
Percent forest management commitments completed on time resulting from consultations re: non-timber features and interests
Forest management operations comply with conservation of agriculture resources
Consistency with action plans for guides, trappers, and other known non-timber commercial interests
Area harvested within the Agricultural/Settlement RMZ
Value of unmarketed non-timber forest products and forest-based services
Species composition by age class/seral stage by planning unit by BEC zone
Age class/seral stage distribution by planning unit by BEC zone/Wildlife Value Class
Percent area in suitable forage opportunity class
Area of arable land converted to agricultural lease
Number of range improvements damaged by participants' activities
Percent compliance with Visual Quality Objectives
Recreation opportunities are maintained or enhanced
Kilometers of forest road maintained for public use
Percent plans conserving unique or significant identified cultural features/spiritual sites/subsistence uses
Percent blocks that follow recommendations in Archeological Impact Assessments
Percent forest management commitments completed on time resulting from consultations re: Non-timber features and interests
Maintenance of the natural diversity of fish species and fish habitats

Distribution of Benefits

Indicator
Forest area by timber tenure
Distribution of financial benefits from the timber products industry
Stumpage/revenues/taxes/payments made to the appropriate federal/provincial/regional/municipal governments and contractors as a result of timber harvesting
Percent volume advertised for sale through open competitive bid
Volume of private wood purchases
Volume of timber made available annually for local community processing

Number of contracts and total contract value issued to local contractors by contract type
 Number of small scale salvage requests granted per year
 Procurement of local goods and services
 The level of First Nations employment, contracting, business activities and delivery of goods and services
 Employment opportunities advertised locally
 Donations to the local community

Sustainability of Benefits

Indicator
<p>Annual harvest of timber relative to the level of harvest deemed to be sustainable</p> <p>Total projected long term timber supply (m3/year)</p> <p>Volume and species of timber harvested annually based on TSR and cut-control requirements</p> <p>Species composition by age class/seral stage by planning unit by BEC zone</p> <p>Percent of harvested blocks meeting or ahead of the regeneration delay date</p> <p>Percent of harvested blocks meeting the free growing assessment date</p> <p>Percent thinning and spacing treatments that specify a post-treatment density greater than original planting density</p> <p>Non-recoverable volume loss due to stand damaging agents</p> <p>Management strategies in place and implemented to reduce the impact of damaging events or agents (including plans, suppression, salvage)</p> <p>Percent of harvest area in MPB attacked stands</p> <p>Percent of blocks and roads assessed in which avoidable waste and residue levels are within the target range</p> <p>Ratio of mill consumption to AAC apportionment</p> <p>Annual harvest of non-timber forest products relative to the levels of harvest deemed to be sustainable</p> <p>Age class/seral stage distribution by planning unit by BEC zone by non-timber tenure</p> <p>Public survey of non-timber uses in the planning unit</p> <p>Mushroom picking</p> <p>Number and variety of non-timber forest products/resource operations/businesses that exist/have potential in the management unit</p> <p>Return on capital employed</p> <p>Earnings before interest, taxes, depreciation, and amortization</p> <p>Cash Return on Capital Employed</p> <p>Return on Capital Employed</p> <p>Return on Shareholder's Equity</p> <p>Percent of earnings reinvested in capital</p> <p>A competitive primary milling facility is sustained</p> <p>Competitiveness of delivered log costs as established under MPS, compared to prices for adjacent TSAs</p> <p>Area harvested by harvest method</p> <p>Productivity index</p> <p>Direct, indirect and induced employment</p> <p>Percent of direct employment and number of person years derived from the forest industry in comparison</p>

to other sectors
 Employment in each forestry sub-sector locally
 Indirect/Induced Employment and Income Estimates
 Percent of local residents employed
 Local people are provided training and other services
 Level of First Nations employment, contracting, business activities and delivery of goods and services
 Promotion of future employment and development of the local First Nation through education, training and capacity building initiatives
 Number of hauling days
[Average income in major employment categories](#)
 Average income of forest sector workers compared to provincial average
 Income from jobs in NTF Sector

CCFM Criterion 6: Society's Responsibility

Aboriginal and Treaty Rights

Indicator
Extent of consultation with Aboriginals in forest management planning and in the development of policies and legislation related to forest management Forest management planning incorporates and seeks to accommodate local First Nation interests and values at the administrative, strategic and operational planning levels The PAG Terms of Reference will be reviewed annually to recognize that Aboriginal participation in the public process will not prejudice Aboriginal treaty rights Number of (culturally appropriate) Aboriginal participation opportunities by type Number of First Nations partnerships Survey of the level of Aboriginal satisfaction with forest management First Nations are provided with detailed reciprocal knowledge pertaining to forest use as well as forest management plans prior to governmental approval and implementation Number of responses to information requests by First Nations List of First Nations values and indicators Number of plans, maps, visual simulations and Archeological assessments made available to First Nations Percent of plans, maps and/or visual simulations which show baseline cultural uses of local forest resources, recognizing First Nations' concern for privacy for specific features Participation in Implementation of Treaty & Use Rights Strategies Issues raised by Aboriginal Chief & Council/Aboriginal people developed into agreed strategies Appropriate mechanisms established through written documents/memoranda on the methods and procedures to resolve disputes over treaty and customary use rights Percent disputes resolved (i.e. accepted by both parties) on legally established treaty or legally established customary use rights established through written documents Forest management plans demonstrate consideration and accommodation of First Nations' rights and interests in known non-timber forest products No unauthorized forestry activities within legally recognized treaty areas Area of forest land owned by Aboriginal peoples

Aboriginal Traditional Land Use and Forest-Based Ecological Knowledge

Indicator
<p>Area of forested Crown land with traditional use studies</p> <p>Reciprocal demonstration of knowledge exchange (i.e. local community expresses increased knowledge of SFM and forest managers express increased knowledge of culturally relevant forest use)</p> <p>Forest management plans demonstrate consideration and accommodation of known First Nations cultural issues by protecting/or enhancing culturally sensitive areas/features</p> <p>Sites and activities of special significance to First Nations are identified and recognized through an effective collaborative process</p> <p>The relationship between forest management and First Nations culture is acknowledged and respected as important</p> <p>Percent of forest operations consistent with the Heritage Conservation Act</p> <p>The number of Aboriginal forest based Traditional Use Studies (TUS) or knowledge information used in the planning processes</p> <p>Percent of forest operations consistent with cultural heritage requirements as identified in operational plans</p> <p>Percent of blocks (id'd through the aboriginal input process) where archeological assessments were requested, undertaken, and completed on time</p>

Forest Community Well-Being and Resilience

Indicator
<p>Economic Diversity Index of forest-based communities</p> <p>Employment and income sources and their contribution to the local economy continue to be diversified</p> <p>Education attainment levels in forest-based communities</p> <p>Employment rate in forest-based communities</p> <p>Incidence of low income in forest-based communities</p> <p>Worker and Public Safety is maintained</p> <p>Number of safety incidences occurring in the bush related to forest management strategies (i.e. not related to machinery or human error)</p> <p>Percent observance of recognized safety standards in forest engineering and operations</p> <p>Written safety policies in place, are being implemented and are effective</p> <p>Percent of the operating area managed under a Fire Preparedness Plan</p> <p>Number of company related forest management operation accidents each year (Lost Time Accidents)</p> <p>Percent of road inspections meeting defined safety standards</p> <p>Percent of prescribed burns that follow the smoke management guidelines</p> <p>Percent of fires burning during poor or fair air quality conditions</p>

Fair and Effective Decision-making

Indicator
<p>Proportion of participants who are satisfied with public involvement processes</p> <p>Forest management planning adequately reflects the interests and issues raised by the public (stakeholders, residents and interested parties) through an effective and meaningful (to the group members) PAG</p> <p>Number of Public Advisory Group (PAG) meetings per year</p> <p>PAG Participant Satisfaction Survey</p> <p>Annual review of the SFMP PAG TOR</p> <p>Endorsement of the SFMP by the PAG</p> <p>Frequency that the SFMP and associated annual reports will be communicated to the public for review and comment</p> <p>Development and implementation of a communication plan</p> <p>Number and types of opportunities given to stakeholders to express forestry related concerns and be proactively involved in planning processes, summarized annually</p> <p>Number of public educational opportunities by educational type, number of participants</p> <p>Adequate notification of participation opportunity is published</p> <p>Percent of comments receiving response</p> <p>Documented results of how plans have been informed by the concerns of affected parties</p> <p>Demonstration of reciprocal knowledge exchange (i.e. local community expresses increased knowledge of SFM and technical expert incorporates local knowledge into forest management decisions/plans)</p> <p>Stakeholder Survey: Annually measure the level of residents, stakeholders, and Aboriginal satisfaction with forest management</p> <p>Rate of compliance with sustainable forest management laws and regulations</p> <p>Number of legislative infractions</p> <p>Management Systems are in place and functioning in a manner that ensures compliance with applicable laws, corporate policy and contractual agreements</p> <p>A functioning Environmental Management System that allows for reporting and monitoring by independent third party auditors</p> <p>A functioning Health and Safety Program that provides for independent third party reporting auditing and monitoring</p> <p>Compliance and audit records performed by government and other agencies</p> <p>Management Systems are in place and functioning in a manner that ensures compliance with applicable laws, corporate policy and contractual agreements</p> <p>Number of registrations to a recognized third party certification</p> <p>An effective monitoring plan for the SFM program or indicators is developed, updated, and reported on</p>

Informed Decision-making

Indicator
Coverage, attributes, frequency and statistical reliability of forest inventories
Availability of forest inventory information to the public
Percent PAG satisfaction with amount and timing of information presented for informed decision-making
Number of written communications
Percent of comments receiving response
Investment in forest research, timber products industry research and development, and education
The number of research and development projects
Maintain involvement and sponsorship in research and educational initiatives (e.g., summer students, post graduate research projects, volunteer sites for studies, association support)
Percent of active research plots protected from harvesting and silviculture activities
Status of new or updated forest management guidelines and standards related to ecological issues

Appendix 2. Priorities and Methods for Monitoring

Priorities and Methods for Monitoring

CCFM Criterion 1: Conservation of Biological Diversity

Ecosystem Diversity

Indicator	Priority
Area of forest, by type and age class, and wetlands in each ecozone	Med - High. Monitoring of indicators in this group is important for providing information on biodiversity. The low number of projects funded by FIA in the “Information Gathering & Management Component, Monitoring” category to date may reflect low priority by recipients in these types of projects, or that information is available from other sources.
Percent change in area of forest land/water bodies, measured at each Timber Supply Analysis period	
Species composition by age class/seral stage by planning unit by Biogeoclimatic Ecosystem Classification (BEC) zone/Wildlife Value Class	
Area of Old Growth by BEC zone	
Area of “Old Interior” forest conditions	
Area of non-forested types converted to forest	
Percent forest in each patch type by patch size class	
Average shape index of young patches in a landscape unit	
Area harvested by silvicultural system	
Percent openings that meet the large opening design criteria	
Area and distribution of stand-level retention ¹	
Area of shrub habitat	
Number, spatial distribution, characteristics and type of significant habitat features in riparian areas	
Forest management operations comply with conservation of agriculture resources	
Road density by BEC zone/Wildlife Value Class	
Area of forest, by type and age class, wetlands, soil types, and geomorphological feature types in protected areas in each ecozone	Variable. Depends on the type of protected area and the degree of protection required by policy or legislation.
Area of and strategies for: Landscape-level biodiversity reserves Rare Landscape Units Sites of special biological significance Rare, uncommon and under-represented ecosystem clusters High Conservation Value Forests	
Percent forest management commitments completed on time resulting from consultations re: Non-timber features and interests	
Species composition by age class/seral stage by planning unit by BEC zone in protected areas/Wildlife Value Class/riparian ecosystems	
Government designated protected areas and sites of special biological significance are sustained at the site and sub regional level	

¹ Innovative projects for monitoring have included: 6453005 (Windthrow monitoring), 6453008 (Forest structure).

Methods from agency project plans and SFMPs

Work plan “Monitoring Forest Structure: A Component of Weyerhaeuser’s adaptive management and monitoring program”

Scenario analysis

Work plan: “Windthrow Monitoring for Variable Retention”

Methods from McHugh et al, 2005

VRI

GIS

Satellite imagery

Ground surveys

Roads analysis

Species Diversity

Indicator	Priority
The status of forest-associated species at risk	High Monitoring of indicators in this group is essential for assessment of SFM. There is a high level of interest by recipients in monitoring these indicators. Standardized approaches to species inventories are available through RIC CBCB manuals and other resources.
Number of known species classified as vulnerable, threatened or endangered in the planning unit	
Area of species at risk habitat in the planning unit	
Number of management strategies developed, implemented and monitored for species at risk/riparian sensitive species/legally identified wildlife species regionally important species	
Percent forest operations consistent with species at risk, Ungulate Winter Range, Wildlife Habitat Areas Notices/Orders, Wildlife Habitat Features, and/or retention of structural habitat elements ²	
Number of incidences of non-conformance with government direction on recover plans for regionally significant species	
Population levels of selected forest-associated species	
Maintain or restore the natural diversity of fish species and fish habitats	
Populations of recommended vertebrate species ³	
Plant Species Diversity Index for site association groups in planning unit ⁴	
Number of Effectiveness Monitoring Plans developed and implemented for selected indicator species (wildlife), critical species	
Km new main summer road developed adjacent to harvested areas within identified major river corridors where visual screening is present	
Distribution of selected forest-associated species⁵	
Age class/seral stage distribution by planning unit by BEC zone/Wildlife Value Class	
Number, spatial distribution, characteristics and type of significant habitat features in hardwood areas	
Distribution of selected habitat elements by BEC zone: ⁶ Percent stems in large live tree diameter class Number of snags per hectare on the planning unit by age class Volume of CWD per hectare on the planning unit Area of wildlife/biodiversity corridors in the planning unit	
Riparian connectivity corridors	
Percent stand level retention/Wildlife Tree patches in harvested areas	
Number of invasive, exotic forest-associated species	

² Innovative projects for monitoring have included: 6564004 (VR Windthrow Monitoring).

³ Innovative projects for monitoring have included: 2411001 and 2420015 (Northern Goshawk), 6408004 (Goshawks & MAMU), 6557005 (Marbled Murrelet), 6453009 (Summer Breeding Birds), 6453010 (Birds and VR), 2420011 (Caribou – Terrestrial Lichen), 2418011 (Pine Lichen Winter Range), 4452012 and 4600012 (Skull Mtn), 4492004 and 4647004 (Mt Tom caribou).

⁴ Innovative projects for monitoring have included: 2424017 and 2538026 (Plant Diversity Benchmarks).

⁵ Innovative projects for monitoring have included: 2434001 (Cyanolichens).

⁶ Innovative projects for monitoring have included: 2421003, 2536005, and 4594008 (CWD).

Percent prohibited and primary noxious weeds and known invasive weed species of concern in seed mix analysis (Method)	
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Methods from agency project plans and SFMPs

1. Wildlife

Group Selection Silviculture Systems For High Elevation Forests (ESSFwc3) To Maintain Caribou Habitat in the Cariboo Forest Region, EP1104.02, Phase 3.

Initial work plan completed in 2001 and titled "Adaptive Management of Forestry Practices in Pine-Lichen Winter Range for Northern Caribou in North-Central British Columbia" (Sulyma and Wawryszyn, 2001).

Monitor area of Ungulate Winter Range Habitat.

Mule deer tracking along permanent survey transects.

Track transect methodology follows the RISC standard: Using snow-track surveys to determine deer winter distribution and habitat by Robert D'Eon, Wildlife Society Bulletin Vol. 29, No. 3, Fall 2001.

Ground-based inventory methods for selected ungulates (moose, elk, and deer). Version 2.0 (Mar. 1998)

Work plan entitled "Providing for Marten in Managed Forests in the Okanagan Shuswap LRMP Area: Phase 3 Completion - Development of Long Term Monitoring Program"

Field Manual for Describing Terrestrial Ecosystems; Land Management Handbook Number 25 ISSN 0229-1622, 1998.

Inventory Methods for Raptors, Standards for components of BC's Biodiversity No. 11 (RIC October 2001) version 2.0.

Inventory Method for Marbled Murrelet in Marine and Terrestrial Habitats.

Guidelines and data forms for collecting data during Marbled Murrelet radar surveys: Recommendations for long term monitoring. March 2005.

RIC document: Upland Gamebirds, Grouse, Quail and Columbids, March 1997.

Ecology of natural history of forest dwelling birds in TFL 39.

Inventory Methods for Forest and Grassland Songbirds, Standards for Components of British Columbia's Biodiversity No. 15; March 16, 1999; Version 2.0.

Monitor fisher, wolverine and grizzly bear habitat.

Monitor moose winter range, mountain goat habitat.

Live Animal Capture and Handling guidelines for Wild Mammals, Birds, Amphibians and Reptiles - Standardized Inventory Methodologies RISC #3.

Wildlife Radio-Telemetry Standards for components of British Columbia Biodiversity No. 5.

Standards for Components of British Columbia's Biodiversity No. 1, Version 2.0 (1998) Errata No. 1.0 - March 2004. MSRM.

Standards for Components of British Columbia's Biodiversity No. 10; April 10, 2001 Version 2.0.

British Columbia Wildlife Habitat Rating Standards Version 2.0.

2. Vegetation

Work plan: "Cyanolichen Growth Rate Response in Innovative Harvesting Units of the Wet ICH".

"Changes in the relative growth rates of *Lobaria pulmonaria*, in the wet ICH forest subzone stands, will be assessed using a field enclosure (cage) technique (Renhorn and Esseen 1995). This technique provides for repeated fine-scale measures of lichen biomass (from which growth rates can be determined) using replicate thalli held within mesh enclosures, these placed in-situ within the canopy. Annual measurements of lichen

biomass will be used to assess lichen growth rates and assess the efficacy of various harvesting and silviculture treatments to conserve this important indicator of ancient forests”. From agency project plan, FIRS website.

Field Manual for Describing Terrestrial Ecosystems

- Update the plant diversity indicator protocol to include all forest licensees in the TSA, using recently completed PEM as a base inventory.
- Develop sampling strategy for determining plant diversity benchmark targets for managed stand plant diversity, based on naturally regenerating stands.
- Develop an integrated, cost-efficient strategy for monitoring plant diversity in managed stands.
- Pilot test a monitoring system using regen and free growing surveys.

3. CWD

Data on CWD from VRI phase II plot information, timber cruise and waste and residue surveys.

VRI – Ground Sampling Procedures, Version 4.5, March 2004: Sec 8 – CWD.

Line intersect sampling. (e.g. All CWD pieces crossed by the line transect with a top diameter greater than or equal to 10cm will be measured).

Methods from McHugh et al, 2005

Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and British Columbia Conservation Data Centre (CDC).

World Conservation Union classification.

Expert Knowledge.

Wildlife Species 2000.

BC Species and Ecosystems Explorer.

Gather basic natural history data on species (Bunnell et al (2005)).

Gather data on a wider range of things that affect the persistence of species (e.g. land use, alien species introductions, environmental contamination, etc.).

Look at historical ranges of species.

Species population surveys (Radio telemetry, ground surveys, pellet counts, aerial surveys, breeding bird surveys, etc.).

Aerial Photography.

NatureServe’s Central Databases for stand level occurrence and extirpation, Wildspecies 2000.

“A species historic range was defined as the sum of state areas where a species occurs and where a species has been (or is thought to have been) extirpated. A species current range was defined as the sum of state areas where a species now occurs. The percentage of the former range that is now occupied was calculated as: (area of current range /area of historic range) × 100.” Flather et al. (2003).

GIS queries.

Genetic Diversity

Indicator	Priority
Status of in situ and ex situ conservation efforts for native tree species within each ecozone	Low
Area of natural regeneration	Few FIA monitoring projects to date may reflect complexity

Use of mixed (natural and artificial) regeneration techniques	and cost of assessing. Work is more research-oriented than monitoring. Could potentially become a greater public issue (genetic diversity of planted forests).
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Methods

Ministry of Forests and Range tracks genetic diversity through its Tree Improvement Branch Gene Resource Management programs.

Area of planted vs. natural regeneration is available from agency databases, however, “the planted trees in many man-made stands are often supplemented by natural regeneration, and the natural regeneration may eventually dominate the stand. There has been insufficient survey to determine the extent of this” (McHugh et al, 2005).

CCFM Criterion 2: Ecosystem Condition and Productivity

Ecosystem resilience

Indicator	Priority
Total growing stock of both merchantable and non-merchantable tree species on forest land	Medium These are important indicators of SFM. Agencies may be monitoring them, however there have been no FIA monitoring projects specific to this category to date. Basic information is available from other sources and through monitoring of other indicators.
Area Weighted Ave Min Harvest Age MAI by BEC zone	
Additions and deletions of forest area, by cause	
Percent of the timber harvest land-base in permanent access structures	
Area of forest disturbed by fire, insects, disease, other catastrophic natural disturbances, and timber harvest	
Area of the THLB and non-contributing forest by beetle hazard type	
Percent high windfall risk edges treated	
Compliance with disease control measures for cutblocks	
Area of NSR	

Methods from McHugh et al, 2005

Basic forest inventory information

Annual insect and disease surveys

Agency silviculture databases

CCFM Criterion 3: Soil and Water

Indicator	Priority
Percent of blocks meeting soil conservation targets after harvesting and silviculture activities. <i>Eligible only when monitoring is in addition to requirement to monitor under FRPA, e.g. innovative projects.</i> ⁷	<p>High</p> <p>This category had the highest number of FIA monitoring projects reflecting a high level of interest from agencies in monitoring these indicators. They are essential indicators of progress towards SFM. Monitoring is of interest to government and LBIP. Standards are in place for data collection and storage for most of these indicators.</p>
Percent road-related soil erosion events identified in annual road inspections and satisfactorily treated	
Rate of compliance with locally applicable road construction, stream crossing and riparian zone management standards	
Percent compliance with Access Management Plans	
Effectiveness Monitoring Plans are developed and implemented for selected access management areas to continually improve access points	
Percent permanent status roads with plans based on risk assessments	
Percent high hazard structures with action plans	
Compliance of operational plans with terrain stability assessments	
Compliance with road revegetation requirements	
Percent slides seeded and/or planted	
Percent stream crossings installed or removed consistent with erosion/sediment control plans or procedures/legal requirements ⁸	
Percent stream crossings that maintain natural stream flow	
Stream crossing density by watershed	
Percent forest operations consistent with stream and riparian management requirements ⁹	
Percent permanent crossings that are adequate for fish passage	
Percent stream crossings with high Water Quality Concern rating	
Percent area less than 3m ht in stream RMAs by sensitive watershed	
Proportion of watersheds with substantial stand-replacing disturbance in the last 20 years ¹⁰	
Interior Watershed Assessment Procedures (IWAP) are completed and regularly updated by a Qualified Registered Professional (QRP) in designated Community Watersheds <i>Eligibility to be clarified</i>	
Percent compliance with Coastal Watershed Assessment Procedures (CWAP) <i>Eligibility to be clarified</i>	
Percent watersheds with Peak Flow Index (PFI) calculations completed (with Equivalent Clearcut Area calculations) <i>Eligibility to be clarified</i>	
Watershed review where PFI targets exceeded <i>Eligibility to be clarified</i>	
Drainage Management Indicator (DMI) used for select watersheds of concern <i>Eligibility to be clarified</i>	

Methods from agency project plans and SFMPs

⁷ Innovative projects for monitoring have included: 6431003 (STEMS II – VR (Soils and CWD)).

⁸ Innovative projects for monitoring have included: 2404001, 2420014, 2440006, 2505003, 2555002, 2576005 (Stream Crossings), and 6553003 (Sediment delivery).

⁹ Innovative projects for monitoring have included: 6405001 (VR/EBM (Riparian)/ small streams), 6447003 (Stream morphology), 6456001 (Soils Eco. Class (R. Reserves)), and 6503004 (Small Stream Study).

¹⁰ Innovative projects for monitoring have included: 4553001 (Baker Creek), 4602001 (Snow Pack Melt Study).

Soils Component: Soil disturbance surveys will be conducted as described in the "Survey methods for soil disturbance and forest floor displacement" and "Transect method for areas 10 hectares and smaller", sections (page 29-37) of the Forest Practices Code of BC, Soil Conservation Surveys Guidebook, Jan 1997.

Calibration and training in use of SCQI

Work plan #Y062128 for: Benthic Macroinvertebrate Sustainability Indicator Development for SFMP and LRMP Applications

Chronosequence study of allochthonous input into small streams over a one-year period compared to an old growth control area using litter collection traps. The litter traps are placed in predetermined segments of stream and are left in place for one year at which time the litter is collected for analysis.

Guidelines for Designing and Implementing a Water Quality monitoring program in British Columbia Version 1.0 (Cavanagh et al, May 1998).

Automated Water Quality Monitoring Field Manual (June 1999, ver 1.0).

Guidelines for Interpreting Water Quality Data - Version 1.0 created May 1998. Updated Aug 2001.

RIC Standard: Manual of Standard Operating Procedures for Hydrometric Surveys in BC (November 1998).

Weather Data Summary Standards for Hydrology Stations in Kamloops Forest Region.

WLAP Snow Monitoring Guidelines, MOE 1981.

Snow Survey Sampling Guide SS13-81, MOE, Aug. 1981.

Ambient Fresh Water and Effluent Sampling manual. March 1998.

“High spatial resolution imagery or large-scale aerial photography. Recently fine spatial resolution imagery collected from space-borne platforms has become a reality, offering the potential to map and monitor riparian vegetation and stream platform geomorphology. A 200km² image, acquired by Quickbird at both 2.8m multi-spectral and 60 cm panchromatic resolutions, centered over Clayoquot Sound, Vancouver Island, has been purchased. This project will examine the potential of the imagery to identify alluvial features, and develop methods to classify a range of stream types and other important features such as low bench flood plain, abandoned meanders and alluvial deposits. In addition, over a subset of the study area, LiDAR data is also available which can be used to develop a highly accurate digital elevation model.”

Methods from McHugh et al, 2005

British Columbia Watershed Assessment Procedures.

Total Length of road/ total basin area.

Peak flow index calculation: Ratio of Equivalent Clearcut Area to total area basin. Equivalent Clearcut Area is the area that has been cut, reduced by a factor to account for hydrologic recovery from forest regeneration.

GIS

CCFM Criterion 4: Role in Global Ecological Cycles

Carbon Cycle

Indicator	Priority
Net change in forest ecosystem carbon	Low Rationale: Innovative projects only eligible at this time. Standards are not in place. Low interest level from recipients. However, refinement of monitoring tools is needed, and this indicator may become higher priority with recent BC government interest in carbon monitoring.
Carbon Monitoring Plan is developed and implemented for forest ecosystem biomass and carbon pools	
Forest ecosystem carbon storage by forest type and age class ¹¹	
Estimated amount of carbon stored in trees in planning unit (converted from TSR M3/ha)	
Estimated carbon in non-tree vegetation (above ground biomass and roots)	
Percent of blocks where a portion of the residual wood is left on-block	

Methods from FIA LBIP (Ministry of Forests and Range. 2007 b)

“There are no provincial standards for carbon monitoring at this time. It is anticipated that in the near future, there will be a legal framework regarding carbon sequestration and accounting. The Intergovernmental Panel on Climate Change will be developing the best practices guidelines for measuring carbon sequestration, probably over the next 12 months. In lieu of these, proponents intending to use FIA Funding for forest carbon monitoring projects should be guided by the methodology outlined in 'Forest carbon accounting at the operational scale' (Kurz, W., M. Apps, E. Banfield and G. Stinson, 2002, Forestry Chronicle 78:672-679) and the publications listed below.” A detailed description of the work is to be included in the project plan.

Methods from McHugh et al, 2005

Canadian Forest Service carbon tool

Canadian Forest Service Carbon budget model: CBM-CFS2

Net Primary Productivity

CCFM Criterion 5: Economic and Social Benefits Sustainability of Benefits

¹¹ Innovative projects for monitoring have included: 2404005, 2424053, 6451011 (Carbon).

Indicator	Priority
Annual harvest of timber relative to the level of harvest deemed to be sustainable	Medium Indicators can be tracked through existing management information systems. Only two FIA projects to date in this category. Interest in developing new methods for damaging agents assessment may increase.
Percent of harvested blocks meeting or ahead of the regeneration delay date	
Percent of harvested blocks meeting the free growing assessment date ¹²	
Percent thinning and spacing treatments that specify a post-treatment density greater than original planting density	
Management strategies in place and implemented to reduce the impact of damaging events or agents (including plans, suppression, salvage) ¹³	

Methods from agency project plans and SFMPs

Regeneration delay and free growing dates: Agency databases, from field surveys.

Thinning and spacing: Project plan pending.

Damaging agents: HDM: Innovative work-plan: The models FORCEE and LLEMS at UBC incorporate features and data from TASS and other tree growth models, and are being upgraded to include HDM effects (Muir 2003). Data on the rate of spread and infection of young trees by HDM in retention-harvested forests are needed to initialize these ecosystem models.

Methods from McHugh et al, 2005

Annual harvest: BC Chief Forester's AAC Calculations

CCFM Criterion 6: Society's Responsibility

Fair and Effective Decision-making

Indicator	Priority
An effective monitoring plan for the SFM program or indicators is developed, updated, and reported on	High It is important to identify objectives, procedures, standards, and results through monitoring plans and reports.

Methods from agency project plans and SFMPs

Documentation of data management standards and procedures for collating and processing SFM indicator monitoring information.

In association with key industry personnel and members of the PAG, develop a scientifically sound, cost-effective program that utilizes existing operational programs to collect data where possible. Short and long-term monitoring requirements will be identified that will evaluate how effectively biodiversity is being managed.

Two components to the monitoring program: 1) GIS analysis and modeling; and 2) field data and inventories.

¹² Innovative projects for monitoring have included: 4488003 (Free Growing).

¹³ Innovative projects for monitoring have included: 6414002 (Hw Dwarf Mistletoe).

Standard operating procedures will be developed to gather measurements for specific criteria, indicators and measures required under the SFM plan.

Indicator mapping: Spatial Data Standards/Attribute Data Standards for Arc/Info; ArcSDE; Images/Air Photo; Other Data; Oracle; MOF Data (as of Oct. 30, 2003).

Create a strategy and sampling plan for monitoring site level habitat elements that contribute to biodiversity in second growth stands.

Appendix 3. FIA Land Base Investment Program, Information Gathering and Management Component, Monitoring: Agency Projects, 2005/06 and 2006/07

FIA Land Base Investment Program, Information Gathering and Management Component, Monitoring: Agency Projects, 2005/06 and 2006/07

CCFM Criterion 1: Conservation of Biological Diversity

Ecosystem Diversity

Project numbers and titles

6453005	Windthrow Monitoring (Innovative)	6564006	Forest Structure
6453008	Forest Structure (Innovative Project)		

Species Diversity

Project numbers and titles

2404004	Snag-CWD Indicators/Targets/Monitoring	4452012	Skull Mtn. Project Data Preparation (Innovative)
2404010	Vertebrate species monitoring plan (Project plan pending)	4480005	Pine Marten
2411001	Northern Goshawk (Innovative)	4480006	Caribou tracking
2418011	Pine Lichen Winter Range (Innovative)	4492004	Mt Tom Adaptive Mgmt (Innovative)
2420011	Caribou - Terrestrial Lichen (Innovative)	4503001	Breeding Bird Surveys
2420015	Northern Goshawk (Innovative)	4594008	CWD Indicator Monitoring Tool (Innovative)
2421003	CWD Biological Effectiveness Monitoring (Innovative)	4600012	Skull Mtn. Project Data Preparation (Innovative)
2421006	Tweedsmuir-Entiako Caribou	4600013	Skull Deer WR
2424017	Plant Diversity Benchmarks (Innovative)	4633005	Marten study (Project Plan Pending)
2434001	Cyanolichens (Innovative)	4647004	Mt Tom adaptive Mgmt (Innovative)
2505001	Songbird monitoring (Variance from Prov Standard)	6408004	Goshawks & MAMU - Heli-select (Innovative)
2531004	Goshawk (Variance from Prov Standard)	6430001	MAMU - Radar Monitoring
2536005	Coarse Woody Debris (Innovative)	6431003	STEMS II – Var Ret (Soils & CWD)
2538026	Plant Diversity Benchmarks & Monitoring (Innovative)	6451002	Owls (Variance from Provincial Standard)
2538054	Riparian Sensitive Species	6451005	Goshawks
2571005	Wildlife & Ecosystem Monitoring Strategy	6451005	Goshawks
4439010	Northern Goshawk Analysis	6451006	Songbirds/Salamanders
4452002	Skull Deer WR	6451009	MAMU Radar
		6453007	Blue Grouse Habitat
		6453009	Summer Breeding Birds (Innovative)
		6453010	Birds & VR: Summer Breeding Birds (Innovative)
		6512004	Goshawks

6557002	Owls (Variance from Prov Standard)	6561013	Breeding Success of Goshawks
6557003	Northern Goshawk	6564004	VR Windthrow Monitoring (Innovative)
6557004	Songbirds/Woodpeckers		
6557005	Marbled Murrelet (Project Plan Pending) (Innovative)	6564005	Summer Bird Surveys

CCFM Criterion 2: Ecosystem Condition and Productivity

Ecosystem resilience

No projects

CCFM Criterion 3: Soil and Water

Project numbers and titles

2404001	Stream Crossing Quality-Indicator Monitor (Innovative)	4495017	Sheridan & Dash Creeks
2420014	Stream Crossings (Innovative)	4497005	Stream Temperature Monitoring
2421005	Benthic IBI	4509003	Lambly and Whiteman
2424019	Snow Surveys	4510008	Channel Assessments
2440001	Water Quality/Quantity, Meadow Creek	4553001	Baker Creek (Innovative)
2440006	SCQI (Innovative)	4576003	Norns Creek
2453003	SCQI - TFL 48 (Project Plan Pending)	4579001	Wolverton Creek
2505003	SCQI assessments (Innovative)	4586001	Matthew Creek
2531016	Benthic Invertebrates	4592001	Skookumchuck/Sandown
2538001	Snow Surveys	4600003	Taweel Snow Sampling
2555002	SCQI (Project Plan Pending) (Innovative)	4602001	Snow Pack Melt Study (Thuya Lake) (Innovative)
2576005	SCQI (Innovative)	4602011	Snow Pack-Melt Study
4433001	Wolverton Creek	4602016	Water Quality/Quantity (Project Plan Pending)
4439002	Matthew Creek	4602017	Sampling Design - Tranquille/Paul/Heller
4443001	Skookumchuck / Sandown	4602018	Sampling Design - Russell/Haeshek
4452001	Taweel Water Quality	4606002	Bird Creek
4454001	Snow-Pack Study	4631001	Upper Penticton Creek Watershed
4454002	Clearwater - Monitoring	4634001	Chase / Charcoal Water Qlty/Qty
4454009	Snow pack- melt study (Thuya Lakes)	4634002	Chase/Charcoal meteorological station
4456001	Bird Creek	4634006	SNOWLINE Monitoring (Project Plan Pending)
4477001	Joe Rich WQT	4653006	Coho Escapement
4477002	Upper Penticton Creek Watershed	4653010	Water Quality
4482011	Water Quality / Snow measurements	4655012	Stream Temperature Monitoring
4482012	Meteorological & Snow Monitoring		
4483005	Upper Penticton Creek Study		

4668003	WTY Lambly & Whiteman	6456001	Soils Eco Class (R. Reserves) (Innovative)
4673002	Upper Penticton Creek Study	6457008	Site Maintenance
6401006	Hydrometric Monitoring	6457010	Equipment Replacement
6405001	VR/EBM (Riparian)/small streams (Innovative)	6457011	Renfrew GAP Stations
6405002	Correlational Study – Fish Habitat (Project plan pending)	6503004	Small Stream Study (EBM) (Innovative)
6408002	Hydrometrics - Gregory Creek	6512002	Hydrometrics
6431003	STEMS II - Var Ret (Soils & CWD) (Innovative)	6537001	Tsolum Hydrometric
6435001	Tsolum Hydrometric	6553003	Sediment Delivery - Russel Creek (Innovative)
6447003	Stream Morphology, Alluvial (Innovative)	6567004	Renfrew GAP Stations (Project Plan Pending)

CCFM Criterion 4: Role in Global Ecological Cycles

Carbon Cycle

Project numbers and titles

2404005	Carbon storage, sequestration (Innovative)	2538055	Carbon Phase 2
2424053	Carbon (Innovative)	6451011	Carbon (Innovative)

CCFM Criterion 5: Economic and Social Benefits

Sustainability of Benefits

Project numbers and titles

4488003	Free growing (Project plan pending) (Innovative)	6414002	Hw Dwarf Mistletoe - Development of Mon (Innovative)
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CCFM Criterion 6: Society's Responsibility

Fair and Effective Decision-making

Project numbers and titles

2420022	SFM monitoring data management & reporting user's guide (Innovative)	4442007	Monitoring Plan
2424033	Biodiversity Strategy for PGTA	4506018	Field Monitoring Plan
2538025	Biodiversity Monitoring & Mapping	4591005	Monitoring Plan
2538069	Habitat Elements Monitoring Strategy	4611004	Indicator Reporting
4435007	Field Monitoring Plan	6546001	Stand Structure & Eco Representation

Project numbers and titles, projects pending or cancelled, all categories

2424022	Cancellation approved
2510005	Patch size analysis. Project Plan Pending
2536003	Course Woody Debris. Cancellation Approved (Innovative)
2538045	Road, Landing, & Trail Indicator. Project Plan Declined (Innovative)
2548001	Cyanolichens. Project Plan Declined (Innovative)
2598007	Benthic Macroinvertebrate. Project Plan Declined
4495008	Quesnel River Chinook. Project Plan Rejected – not eligible
4553002	Watershed Overview. Project Plan Pending
4553002	Watershed overview. Project Plan Pending (Innovative)
4591007	Wildlife Tree Retention. Project Plan Pending
4604003	WADF. Cancellation Approved (Innovative)
4634003	Slamon River Cumulative MPB impacts. Project Plan Rejected (Innovative)
4634010	Road Crossing Monitoring. Project Plan Pending
4655005	Thermal Imaging - McKinley Cr. Project Plan Pending
4668009	Monitor Regen Stands. Project Plan Pending
4668011	NRLs. Project Plan Pending
6403001	Hydrological Recovery. Cancellation Approved. (Innovative)
6436002	Hydrological Recovery. Cancellation Approved. (Innovative)
6446002	Hydrological Recovery. Cancellation Approved. (Innovative)
6448001	Hydrological Recovery. Cancellation Approved. (Innovative)
6460004	Ecosystem representation. Cancellation Approved
6503005	Regen under VR (EBM). Project Plan Declined (Innovative)
6503006	HDM Monitor (EBM). Project Plan Declined (Innovative)
6503007	Development of N.Gr.Seed (EBM). Project Plan Declined (Innovative)
6528002	Bio-physical Model. Project Plan Declined (Innovative)
6544001	White pine trials. Project Plan Rejected (Innovative)