

FII Project R04058:

***Land Management Planning Methods to Maximize  
Environmental, Societal and Economic Benefits***

Technical Report:

**A Review of Criteria and Indicators for  
Sustainable Forest Management:  
Indicators Obtainable from GIS Mapping and Production  
Modeling for use in Operational Planning**

*An analysis for Slocan Forest Products and Tembec Industries Inc. in the  
Invermere Timber Supply Area*

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### **Format of this Report**

This report starts with a brief review of the CCFM Criteria and Indicators and a discussion of their relevance for use in the planning model and their availability in the GIS database. It next reviews the 25 criteria developed by UBC Researchers for the Arrow IFPA. It concludes with a recommended set of criterion and indicators to be used in this project.

## **Background**

In 1992 Canada developed its National Forest Strategy, in which it committed to develop a set of criteria and indicators for sustainable forest management. In 1993 the Canadian Council of Forest Ministers formed a task force and launched a public process to develop a science based set of criteria and indicators that can be used to measure progress toward sustainability in the management of forests. Three years later the CCFM agreed to a set of 6 criteria encompassing 83 indicators (Canadian Council of Forest Ministers 1997).

The 1992 United Nations Conference on Environment and Development was held a few months after the National Forest Strategy was released. This conference led to an international seminar on sustainable development of temperate and boreal forests that was held in Montreal. This international initiative, known as the Montreal Process (1995), endorsed a system of 7 criteria and 67 indicators for the conservation and sustainable management of temperate and boreal forests.

In both initiatives, each criterion represents a category of desirable conditions that society would like to promote. The criterion contains a numbers of indicators by which one can judge progress in meeting the principles embodied in the criterion.

The CCFM criteria and indicators were designed for the purpose of reporting on the state of Canada's forests at a national level. In a recent research project at the University of British Columbia, researchers designed a set of performance based criteria to be used for adaptive management in a local timber supply area (Robinson, 1997). The project conducted an extensive review of the CCFM criteria by provincial experts in wildlife biology, forest ecology, hydrology, economics, recreation and visual quality. The result is a set of 9 criteria and 25 indicators organized 3 types of values: Ecological Values, Economic Values and Social Values.

## **Indicators for Strategic & Tactical Planning**

This report is background information relevant to developing an operational planning model that would provide guidance to forest managers to meet the criteria for sustainability. The model is designed to evaluate factors of the economic performance of the firm and the progress in sustainable management. The model output will provide information useful to managers and constituents to guide decision making - *it is not intended to provide exact schedules & solutions.*

Effective criteria for management planning must be practical and simple – in short, they must make common sense. The planning model at this stage of development will obtain the bulk of its input concerning the land base from GIS databases. The indicators chosen for inclusion in the model must meet the standards listed below (adapted from Bunnell 1997).

1. Accessible:

To meet this standard for the purposes of this project the indicator must currently exist in an available GIS database or it must be obtainable from filtering overlays in the database to create a new field.

2. Measurable:

To meet this standard the indicator must be a metric that is clearly understood, measurable on the ground, and verifiable. It also must be something with which success can be measured.

3. Operable:

To meet this standard the indicator must be usable in the planning model. This means that the mathematical relationship between the indicator and management decisions made on the ground must be clearly understood. It is anticipated that at first this standard will be strongly restrictive; as the model evolves, and is peer-reviewed, more and more indicators will be useful in the model.

4. Credible & Relevant:

To meet this standard, the indicator must be pertinent to the intent of the original criteria adopted by the Canadian Council of Forest Ministers. Ideally it is either identical to or strongly related one of the specific indicators listed in the technical report.

This standard is applied to new indicators that are created to replace the original indicators developed by the CCFM that failed to meet one or more of standards 1-3 (above).

Operability is clearly the most restrictive of the 4 standards. To make appropriate use of the performance metric it must be clearly understood how the factor is affected by land management decisions in the planning model framework. It is expected that new indicators will be developed and found useful as the planning model evolves and is used by more people. Therefore, the purpose of this report is to present a useful starting point.

## The CCFM Criteria and Indicators

### Criterion 1: Conservation of biological diversity

#### *Background*

A simple definition of biodiversity is the diversity or variety in life forms that exist at three levels of understanding: the *ecosystem* level, the *species* level, and the *genetic* level. At each level we seek to understand the compositional, structural and functional components of biodiversity. The compositional component refers to collection of distinct items within a defined area, such as the number of species within a stand or the number of different ecosystems within a landscape unit. The structural component explains how these items are arranged in the landscape both spatially (where they exist) and temporally (their age or size class distribution). Finally, the functional component describes the constraints on the development of biodiversity.

It becomes increasingly important to monitor and preserve biodiversity as more and more of the planet's natural landscapes are coming under mankind's active management. In their paper on forestland classification schemes, Pregitzer et al (2001) recognize 5 forest classification schemes.

- *Vegetative* classifications provide data on predominate forest cover types including the tree species composition, size, and age class structure.
- *Soil* classifications provide information on the physical and chemical properties of predominate soil types.
- *Land type association* classifications focus on the differences in the climatic, physiographic and topographic characteristics in the land.
- *Habitat type* classifications extend the basic vegetation classification schemes to include indicator species that infer the potential climax stage of succession, which itself is a good indicator of the productive capability of the site.
- *Ecosystem* classifications attempt to describe the interaction between all of the above classifications and put them into a single scheme. Good examples would be the Biogeoclimatic zones approach (Krajina 1965), and the EcoRegion approach (Bailey 1995).

Operationally, vegetation structure is currently widely used as an indirect indicator of biodiversity (Pregitzer et al 2001) as it represents a surrogate measure of habitat structure (McCoy and Bell 1991). Using GIS mapping, new

multi-factor measures of diversity can be developed by combining information from different data layers in the database, zeroing in on the specific requirements of indicator species that represent the health and resilience of the ecosystem. Many forest products companies are already using this technique in their planning (Pretzinger and Goebel 2000).

Developing workable indicators for biodiversity is challenging due to the many disparate sources of GIS data for the same region, the generally poorly documented database fields, and the constantly changing structure of the database and information provided. Clearly, an overseeing body is needed to bring structure and order to the GIS databank.

The CCFM criterion for biological diversity consists of 8 indicators in 3 elements pertaining to the three levels of diversity described above. Four of the 8 indicators are obtainable from GIS mapping data and would be usable in an operational planning model.

#### *Element 1.1: Ecosystem Diversity*

##### The Indicators

##### 1.1.1 *Percentage and extent, in area, of forest types relative to historical condition and to total forest area*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

With GIS mapping it is possible to obtain the extent of forest types, although it is not possible to learn about the historical context. Operationally, a baseline condition can be established and used measure against future changes in the forest condition.

##### 1.1.2 *Percentage and extent of area by forest type and age class (ref. 2.2.1)*

Available	Measurable	Operable	Relevant
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

It is possible to obtain the extent of forest types and seral stages in the forest. This measure can be used operationally, for example, by ensuring the sustainability of forest types and seral stages related to threatened or indicator species. The indicator meets all four standards for inclusion in the model.

### 1.1.3 *Area, percentage and representativeness of forest types in protected areas*

Available	Measurable	Operable	Relevant
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

This can be obtained by overlaying forest cover types with ownership status. This is especially an important indicator of the sustainability of those forest types related to threatened or indicator species. It is also an important reason why the non-timber harvesting land base should be considered in measuring sustainability of a forest products company. The indicator meets all four standards for inclusion in the model.

### 1.1.4 *Level of fragmentation and connectedness of forest ecosystem components*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

This indicator is difficult to measure directly from GIS mapping. It may be possible to infer connectedness from analyzing the forest type and seral stage of adjacent polygons in the database. More research is needed to determine if the resulting index would be a good measure of connectedness of forest ecosystem components. Spatial planning and optimization techniques exist to make good use of this indicator (Gustafson and Crow 1996, Hof and Joyce 1992).

## *Element 1.2: Species Diversity*

### The Indicators

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

These indicators fail to meet standards 1 and 3: they are not currently obtained from GIS mapping data, and they would not currently be usable in an operational planning model.

However, they could be estimated by a careful analysis of the area of a professional team of observers. The resulting information would not be directly usable in an operational planning model other than as input into the desired changes in the forest condition required to achieve species diversity.

- 1.2.1 *Number of known forest-dependent species classified as extinct, threatened, endangered, rare or vulnerable relative to total number of known forest-dependent species*
- 1.2.2 *Population levels and changes over time of selected species and species guilds*
- 1.2.3 *Number of known forest-dependent species that occupy only a small portion of their former range*

**Element 1.3: Genetic Diversity**

The Indicator

- 1.3.1 *Implementation of an in situ/ex situ genetic conservation strategy for commercial and endangered forest vegetation species*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

This indicator fails to meet standards 1 and 3: it cannot currently be obtained from GIS mapping data and it would not currently be usable in an operational planning model. Other indicators are possible that would indicate the success in implementing the strategy. These should be considered for future research.

**Criterion 2: Maintenance and Enhancement of Forest Ecosystem Condition and Productivity**

*Background*

The philosophy behind criterion 2 is to measure the overall health and productive capability of the forest. It is recognized that ecosystems are constantly changing as a result of stresses. Criterion 2 emphasizes the ability to distinguish between natural stresses and those caused by human activity. The intent of these indicators is to provide a baseline from which future changes can be measured (CCFM 2000).

*Element 2.1: Incidence of disturbance and stress (biotic and abiotic)*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

This element consists of 8 indicators that relate to the frequency and severity of major stresses which can affect the forest condition over time. All 8 are discussed here. While these indicators are measurable and relevant, they are

not currently available in the GIS and it is unclear how they could be used in the planning model. At the present time it is important that a baseline of the current condition is established for the operational area. Research should be conducted on how these indicators could be monitored and measured against the baseline.

#### The Indicators

2.1.1 *Area and severity of insect attack*

2.1.2 *Area and severity of disease infestation*

2.1.3 *Area and severity of fire damage*

2.1.4 *Rates of pollutant deposition*

2.1.5 *Ozone concentrations in forested regions*

2.1.6 *Crown transparency in percentage by class*

2.1.7 *Area and severity of occurrence of exotic species detrimental to forest condition*

2.1.8 *Climate change as measured by temperature sums*

#### *Element 2.2: Ecosystem resilience*

This element consists of 2 indicators that relate to the ability of the forest to recover from major stresses by monitoring the percentage of area by forest cover type and age, and the status of regeneration.

2.2.1 *Percentage and extent of area by forest type and age class (ref. 1.1.2)*

Available	Measurable	Operable	Relevant
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

This indicator differs from 1.1.2 in its intent. Here, age classes and forest types are monitored to ensure sustainability in forest the condition and productivity as opposed to ecosystem diversity.

This indicator meets all four criteria for inclusion in the model.

2.2.2 *Percentage of area successfully naturally regenerated and artificially regenerated*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

This indicator is not currently available in the GIS database. It would be usable in the planning model. Future research should explore how this indicator could be included in the database.

*Element 2.3: Extant biomass (biota)*

The intent of this element is to ensure that the productive capability of the ecosystem is maintained. A good indicator of the ability of the ecosystem to support and maintain life is the biomass production of tree species. This can be measured as the mean annual increment.

The intent of the CCFM is to measure the mean annual increment in permanent research plots located in the full variety of forest types found every 5 or 10 years. The planning model could make use of this indicator by ensuring that MAI does not decline in the model as predicted by growth and yield models based on harvesting and regeneration occurring over the planning period. The data is not currently available on the GIS database, but may be possible to predict the MAI based on data available from the GIS Database (such as aspect, elevation, forest cover type and age class).

*2.3.1 Mean annual increment by forest type and age class*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

This indicator is not currently available in the GIS database. It would be usable in the planning model. Future research should explore how this indicator could be included in the database.

*2.3.2 Frequency of occurrence within selected indicator species (vegetation, birds, mammals, fish)*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Although it would depend on the species chosen, this indicator is not currently available in the GIS database. It would not currently be usable in the planning model. Further research would have to be conducted to determine the appropriate indicator species.

**Criterion 3: Conservation of soil and water resources**

This criterion focuses on the maintenance of forest soils for future productivity and the provision of potable water for human and wildlife use, and for maintenance of suitable aquatic habitats.

*Element 3.1: Physical environmental factors*

These indicators measure changes to the state of physical factors of the forest over time. For these to be workable, a baseline of existing conditions would have to be established, and then a sampling program instituted to track changes. For

planning purposes, a method would have to be developed to predict changes in these indicators from typical management decisions like harvest method, road building activities and regeneration.

3.1.1 *Percentage of harvested area having significant soil compaction, displacement, erosion, puddling, loss of organic matter, etc.*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

This indicator is not currently available in the GIS Database. It is measurable, and can be reported through appropriate sampling. It is not currently usable in an operational sense until it is better defined. Future research should determine how to relate soil properties to management decisions.

3.1.2 *Area of forest converted to non-forest land use, for example, urbanization (ref. 4.2.1)*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

This indicator is measurable and can be reported. It would not be usable in an operational sense as the planning model would not be making decisions that would remove land from the forest base.

3.1.3 *Water quality as measured by water chemistry, turbidity, etc.*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

This indicator is not currently available in the GIS Database. It is measurable, and can be reported through appropriate sampling. It is not currently usable in an operational sense until it is better defined. Future research should determine how to relate water quality to management decisions.

3.1.4 *Trends and timing of events in stream flows from forest catchments*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

This indicator is not currently available in the GIS Database but it might be available through other reporting agencies for selected streams. It is measurable, and can be reported. It is not currently usable in an operational sense until it is better defined. Future research should determine how to relate water flows to management decisions.

### 3.1.5 *Changes in distribution and abundance of aquatic fauna*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

This indicator is not currently available in the GIS Database though it could be determined by sampling. It is measurable, and can be reported. It is not currently usable in an operational sense until it is better defined. Future research should determine how to relate water flows to aquatic fauna.

### *Element 3.2: Policy and protection forest factors*

Whereas element 1 monitors changes in soil and water conditions from management practices, this element is concerned with conserving soil and water resources by protecting riparian areas and steep slopes.

#### 3.2.1 *Percentage of forest managed primarily for soil and water protection*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

It is unclear whether this indicator is currently available from the GIS database as it could possibly be obtained from combining a number of fields from different databases. A baseline should be established of current conditions, and the planning model could influence future progress. Further research is needed on the operability of this indicator in a planning model framework.

#### 3.2.2 *Percentage of forest area having road construction and stream crossing guidelines in place*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

This indicator is a measure of protection guidelines that are in place and is not an operable planning measure. This information could be collected and reported as a measure of overall sustainability, but is not considered usable in a planning model framework.

3.2.3 *Area, percentage and representativeness of forest types in protected areas (ref. 1.1.4)*

Available	Measurable	Operable	Relevant
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

This indicator, which is actually 3 indicators in one, should be available from the GIS database. Currently there are no guidelines in place to determine the target values for this indicator. However, a baseline of the existing condition can be established and the planning model could be used to ensure that this level is retained throughout the planning period.

**Criterion 4: Forest ecosystem contributions to global ecological cycles**

Forests contribute significantly to the earth's carbon and water cycles, and Canada contains approximately 10% of the world's forests. Therefore, Canada's forests have an important role in the earth's ecological cycles. Criterion 4 attempts to measure the nationwide contributions to these important cycles.

Natural Resources Canada is currently working to develop an overall carbon budget for the country (CCFM 1997). Further research is needed to determine how these important goals could be used operationally.

*Element 4.1 Contributions to the global carbon budget*

Models are the way to estimate the overall carbon budget from operational decisions made in forest management. Future research should identify the key indicators that can be used operationally, and methods for modeling these indicators. Such a model could be used in within the planning model framework.

4.1.1 *Tree biomass volumes*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

4.1.2 *Vegetation (non-tree) biomass estimates*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

4.1.3 *Percentage of canopy cover*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

4.1.4 *Percentage of biomass volume by general forest type*

Available	Measurable	Operable	Relevant
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	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
4.1.5	<i>Soil carbon pools</i>			
	Available	Measurable	Operable	Relevant
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
4.1.6	<i>Soil carbon pool decay rates</i>			
	Available	Measurable	Operable	Relevant
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
4.1.7	<i>Area of forest depletion</i>			
	Available	Measurable	Operable	Relevant
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
4.1.8	<i>Forest wood product life cycles</i>			
	Available	Measurable	Operable	Relevant
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
4.1.9	<i>Forest sector CO2 emissions</i>			
	Available	Measurable	Operable	Relevant
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

#### *Element 4.2 Forest land conversion*

Carbon budgets can be adversely affected by removals from the forest land base. This element tracks the net change in the amount of forestland. It is an important indicator of net changes to carbon balancing but these are not considered operable indicators in the planning model framework. The model will not be used to plan or track removals from the forest land base.

4.2.1	<i>Area of forest permanently converted to non-forest land use (for example, urbanization) (ref. 3.1.2)</i>			
	Available	Measurable	Operable	Relevant
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
4.2.2	<i>Semi-permanent or temporary loss or gain of forest ecosystems (for example, grasslands, agriculture)</i>			
	Available	Measurable	Operable	Relevant
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

#### *Element 4.3 Forest sector carbon dioxide conservation*

This information could be collected and reported as a measure of overall sustainability for the country, but is not considered usable in a planning model

framework for an individual operation. The data could be collected and reported as parts of Canada's overall forest strategy.

#### 4.3.1 *Fossil fuel emissions*

These indicators are discussed together:

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

These indicators are discussed together:

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

#### 4.3.2 *Fossil carbon products emissions*

These indicators are discussed together:

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

#### 4.3.3 *Percentage of forest sector energy usage from renewable sources relative to total sector energy requirement*

### *Element 4.4 Forest sector policy factors*

This information could be collected and reported as a measure of overall sustainability for the country, but is not considered usable in a planning model framework for an individual operation. The data could be collected and reported as parts of Canada's overall forest strategy.

#### 4.4.1 *Recycling rate of forest wood products manufactured and used in Canada*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

#### 4.4.2 *Participation in the climate change conventions*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

#### 4.4.3 *Economic incentives for bioenergy use*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

#### 4.4.4 *Existence of forest inventories*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

#### 4.4.5 *Existence of laws and regulations on forest land management*

##### *Element*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

##### *Element 4.5 Contributions to hydrological cycles*

This information could be collected and reported as a measure of overall sustainability, but is not considered usable in a planning model framework.

#### 4.5.1 *Surface area of water within forested areas*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

### **Criterion 5: Multiple benefits of forests to society**

#### Economic sustainability indicators

The purpose of this criterion is to measure the social and economic contribution of the forest on a sustainable basis. The intent of the CCFM is to measure the contribution to Canada as a whole; we look at this criterion from the perspective of the regional economic and social welfare. This is an important distinction of scale. Strategic and tactical management decisions made on the ground can impact in the local economy. Decisions such as the focus on timber vs. non-timber benefits in a particular area are important management decisions in which the regional economy must be considered paramount.

There are four elements in Criterion 5. The first looks specifically at the productive capacity of the landbase to provide a continue flow of benefits from both timber and non-timber sources. The second is related to the continued competitiveness of the industry. If the industry is not competitive it cannot continue to provide economic benefits. The third is concerned with the potential to of the forest company to provide a steady stream of economic benefits. Again, we will look specifically at the economic benefits provided to the region, rather than the Canadian economy. The last element pertains to the non timber benefits such as outdoor recreation and the value that Canadians place on the environmental values of natural forests.

##### *Element 5.1 Productive capacity*

A critical ingredient of SFM is to maintain the productive capacity of the forest to provide a flow of benefits to society. The element includes 5 key indicators to ensure that the productive capacity is not being diminished. Two of these are usable in the planning model.

5.1.1 *Annual removal of forest products relative to the volume of removals determined to be sustainable*

Available	Measurable	Operable	Relevant
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

This is a relevant indicator which could be tracked for a Timber Supply Area. Additional research should be conducted to determine the volume of removals that are sustainable for each region.

5.1.2 *Distribution of, and changes in, the land base available for timber production*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

This indicator could be tracked and reported for each Timber Supply Area but it would not be immediately useable in the planning model as the model's scope would not include decisions on removals from the land base.

5.1.3 *Animal population trends for selected species of economic importance*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

This indicator is neither available nor useable in the planning model. Population trends could be tracked and reported, and further research is needed in each timber supply area to determine the appropriate indicator species and threshold levels.

5.1.4 *Management and development expenditures*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

This indicator could be tracked by the company but is neither available nor useable in the planning model.

5.1.5 *Availability of habitat for selected wildlife species of economic importance*

Available	Measurable	Operable	Relevant
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

This indicator is available on the GIS database for certain species, such as woodland caribou, and ungulate winter range habitat.

These species are represented in the Arrow Criteria and Indicators discussed in the next section and these will be included in the planning model in place of 5.1.5.

### *Element 5.2 Competitiveness of resource industries*

Competitiveness is an important measure of the economic sustainability of the forest enterprise. For the enterprise to survive it must have access to capital markets to fuel investment. Companies must be profitable in order to pay taxes and thereby contribute to the economic well being of the region and the nation.

#### *5.2.1 Net profitability*

Available	Measurable	Operable	Relevant
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

This indicator can be determined from the planning model and is influenced by management decisions.

#### *5.2.2 Trends in global market share*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

This indicator is a global measure and is not appropriate at level of one company / one timber supply area.

#### *5.2.3 Trends in research and development expenditures in forest products and processing technologies*

This indicator is a global measure and is not appropriate at level of one company / one timber supply area.

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

### *Element 5.3 Contribution to the national economy*

In this project we will consider contributions to regional economy. This will also be a good indicator of global contributions, but it is deemed more appropriate to look at the sustainability of the local region.

5.3.1 *Contribution to gross domestic product (GDP) of timber and non-timber sectors of the forest economy*

Available	Measurable	Operable	Relevant
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

This is a more important indicator of SFM at the national level than for a specific company. Consequently it is not deemed operable in the planning model.

5.3.2 *Total employment in all forest-related sectors*

Available	Measurable	Operable	Relevant
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

This is a very important measure. At the present time it is only possible to obtain employment from forestry and manufacturing activities. Further research is needed to determine how to derive total employment from all sectors, and how to utilize this in the planning model.

5.3.3 *Utilization of forests for non-market goods and services, including forest land use for subsistence purposes*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Currently it is not possible to obtain this information from within the GIS database or from the planning model. Further research is needed to determine how to measure this and how it might be used in a SFM planning framework.

5.3.4 *Economic value of non-market goods and services*

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

This is a very important indicator that should be measured at the local level. Currently it is not possible to obtain this information from within the GIS database or from the planning model. Further research is needed to determine how to measure this and how it might be used in a SFM planning framework.

## Element 5.4 Non-timber values

### 5.4.1 Availability and use of recreational opportunities

Recreation site availability and potential can be obtained from the GIS database. This information can be used to track how forest operations affect recreation potential in the timber supply area. Further research is needed to identify how the key indicators can be used in the planning framework.

Available	Measurable	Operable	Relevant
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

### 5.4.2 Total expenditures by individuals on activities related to non-timber use

This is an important measure of non-timber values derived from the forest. However, this is not available from the any GIS database and it is not usable in the planning model framework. Further research should be done to determine how this should be quantified and tracked for reporting purposes. It is also possible to identify key recreation sites in the forest ranked by their potential to generate income in the region. This is a very important area for future research.

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

### 5.4.3 Membership and expenditures in forest recreation-oriented organizations and clubs

This indicator is not available or usable in the planning model framework.

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

### 5.4.4 Area and percentage of protected forest by degree of protection

This indicator is available in the GIS database and usable in the planning model.

Available	Measurable	Operable	Relevant
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

## **Criterion 6: Accepting Society's Responsibility for Sustainable Development**

Criterion 6 ensures that people are involved in the decision making process and the forests are managed in a way that benefits society as defined by society's own value system. Ultimately, Criterion 6 is about *listening* and *responding* proactively.

As valuable as these 19 indicators are, they are not available in a GIS database, and they are not usable in their current format in a strategic or tactical planning model concerned with local management decisions on the ground. For this reasons they are evaluated together in this section.

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Many of these indicators can be tracked and reported on an annual basis as a measure of sustainability, and this should be done. However, further research is needed to determine how the essence of these elements could be integrated into a planning model that would provide guidance and sensitivity analysis to planners. This remains for future research.

### **6.1 Aboriginal and treaty rights**

6.1.1 Extent to which forest planning and management processes consider and meet legal obligations with respect to duly established Aboriginal and treaty rights

### **6.2 Participation by Aboriginal communities in sustainable forest management**

6.2.1 *Extent of Aboriginal participation in forest-based economic opportunities*

6.2.2 *Extent to which forest management planning takes into account the protection of unique or significant Aboriginal social, cultural or spiritual sites*

6.2.3 *Number of Aboriginal communities with a significant forestry component in the economic base and the diversity of forest use at the community level*

6.2.4 *Area of forest land available for subsistence purposes*

6.2.5 *Area of Indian reserve forest lands under integrated management plans*

### **6.3 Sustainability of forest communities**

- 6.3.1 *Number of communities with a significant forestry component in the economic base*
- 6.3.2 *Index of the diversity of the local industrial base*
- 6.3.3 *Diversity of forest use at the community level*
- 6.3.4 *Number of communities with stewardship or co-management responsibilities*

#### *6.4 Fair and effective decision-making*

- 6.4.1 *Degree of public participation in the design of decision-making processes*
- 6.4.2 *Degree of public participation in decision-making processes*
- 6.4.3 *Degree of public participation in implementation of decisions and monitoring of progress toward sustainable forest management*

#### *6.5 Informed decision-making*

- 6.5.1 *Percentage of area covered by multi-attribute resource inventories*
- 6.5.2 *Investments in forest-based research and development and information*
- 6.5.3 *Total effective expenditure on public forestry education*
- 6.5.4 *Percentage of forest area under completed management plans/programs/guidelines which have included public participation*
- 6.5.5 *Expenditure on international forestry*
- 6.5.6 *Mutual learning mechanisms and processes*

# The Indicators Developed by the UBC Sustainability Project and the Arrow IFPA

## Background

### Criterion 1 – Biological richness and its associated values are sustained

This pertains to criterion 1 of the CCFM C&I framework. The specific indicators below were developed by the sustainability project.

- 1) Caribou habitat types are represented in an unmanaged state.

Available	Measurable	Operable	Relevant
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

This indicator is available in the GIS database and it is usable in the planning model. However, caribou is not present in Slokan's operating area on the Invermere TSA so it will not be included in the planning model framework. Grizzly Bear habitat would be an important habitat type to include in the model – however, this is not currently available in the database.

- 2) Ungulate winter ranges are represented in an unmanaged state.

Available	Measurable	Operable	Relevant
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

This indicator is available and usable in the planning model. However, caribou is not present in Slokan's operating area on the Invermere TSA. The indicator is strictly yes/no. Further research is needed to determine the level of harvesting permitted in a Stewardship Unit (if any) before the winter range habitat is lost.

- 3) The amount, distribution and heterogeneity of habitat elements and landscape structure important to sustain biological richness are maintained.

Available	Measurable	Operable	Relevant
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

This indicator is available and usable in the planning model. An expert evaluation is required to determine the desired mix of ecological types, and seral stages. The model then could track management activities and ensure that the desired mix is maintained. It is equivalent to *CCFM 1.1.2*

- 4) Productive populations of these selected species are well-distributed throughout the range of their habitat.

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

This indicator is not available on the GIS database and not operable in the planning model. Sampling could be conducted to determine the extent to which selected populations are well distributed and this can be reported. Further research is needed to determine how the intent of this indicator could be included in a planning model.

## Criterion 2 – Productivity of forests and associated soil resources are sustained

This criterion pertains to criterion 2 of the CCFM C&I framework.

- 1) Areas disturbed in the timber harvesting landbase exhibit no net detrimental loss in productivity.

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

The planning model could determine the disturbed areas. It is not possible to determine if these areas have any loss in productivity. Further research is needed to determine how this can be implemented in the planning model.

- 2) Adequate regeneration on the timber harvesting landbase is assured.

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

This would likely be based on an expert developing a regeneration plan for each forest cover type. The model could track planned and actual activities based on user input. However, this information is not currently available on the GIS database, and further research is needed to determine how to implement it.

- 3) Soil productivity is sustained within the timber harvesting landbase.

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

This would likely be based on an expert evaluation. This information is not currently available on the GIS database, and further research is needed to determine how to implement it.

- 4) Soil resources associated with the resiliency of site productivity are maintained.

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

This would likely be based on an expert evaluation. This information is not currently available on the GIS database, and further research is needed to determine how to implement it.

- 5) No net detrimental loss in productivity as a result of forestry-related slope instability.

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Information on slope is available from the GIS database. However, it is not possible to determine the conditions under which productivity would be lost without an expert evaluation. Further research is needed to determine how to implement it and indicator based on slope instability into the model.

- 6) Environmentally sensitive areas are removed from the timber harvesting landbase.

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

This would likely be based strictly on an expert evaluation and reported. Areas removed from the harvesting database for this reason must be input into the GIS Database.

### **Criterion 3 – The flow of economic benefits from forests through the forest industry is sustained**

This criterion pertains to criterion 5 of the CCFM C&I framework.

- 1) Timber harvesting continues to contribute to economic well-being.

Available	Measurable	Operable	Relevant
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

This would be obtained from the planning model as direct employment and wages from the following activities:

- a. Development, including road building
- b. Silviculture
- c. Logging & Hauling
- d. Mill Activities

This indicator is usable in the planning model as is.

- 2) Citizens of the area continue to receive a portion of the benefits.

Available	Measurable	Operable	Relevant
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

This would be obtained from the planning model as an estimate of the municipal taxes paid by the company. This indicator is usable in the planning model as is.

- 3) The provincial government continues to receive a portion of the benefits.

Available	Measurable	Operable	Relevant
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

This would be obtained from the planning model as an estimate of the corporate taxes paid by the company and the income taxes paid by workers from the company. This indicator is usable in the planning model as is.

- 4) A strong, diversified forest sector exists.

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

This is a very important indicator for which the planning model will be able to provide information. Further research is needed to determine the definition of a diversified forest sector, and if it is required that the wood from the local forest must be used to diversify the sector. The model will be able to track the types of products made, and which ones are used in further manufacturing in the region. Currently this information is not available and not measurable.

**Criterion 4 – The flow of non-timber economic benefits from forests is sustained.**

This criterion also pertains to criterion 5 of the CCFM C&I framework.

- 1) Productive capacity for non-timber forest values and benefits does not decline.

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

2) Access to non-timber forest values and benefits does not decline.

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

### Criterion 5 – Forest management supports a diversified local economy

This criterion pertains to criterion 5 of the CCFM C&I framework.

1) Employment and income sources and their contribution to the local economy continue to be diversified.

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

### Criterion 6 – The quality and quantity of water for consumptive use are sustained

This criterion pertains to criterion 3 of the CCFM C&I framework.

1) Water quality in monitored watersheds does not fall outside the range of natural variability with respect to Drinking Water Guidelines.

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

This indicator would have to be determined by a sampling scheme with expert analysis and reported on a regular basis. It is not available or measurable with GIS data. Further research could develop predictors of water quality based on slope, soils and harvesting practices.

2) Changes in stream flows do not limit existing licensed withdrawals for domestic use.

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

As indicator 1 above, this indicator would have to be determined by a sampling scheme with expert analysis and reported on a regular basis. It is not available or measurable with GIS data.

3) Within community watersheds, the green up height requirement is met.

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

This information is not currently available but it could be predicted based on site quality and growing period.

**Criterion 7 – Decisions guiding forest management are informed by a wide range of social and cultural values, including First Nations**

This criterion pertains to criterion 3 of the CCFM C&I framework.

- 1) Forest management in the Invermere TSA responds to a wide range of social values through effective planning processes that involve inclusive consultation with stakeholders.

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

This information is not available in a GIS database nor is it operable. The indicator would have to be evaluated by an expert on an annual basis

- 2) Collective understanding by forest managers and public is increased through a collaborative planning process and an adaptive management program where information is exchanged to facilitate capacity building.

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

This information is not available in a GIS database nor is it operable. The indicator would have to be evaluated by an expert on an annual basis

**Criterion 8 – Forest management sustains ongoing opportunities for a range of quality of life benefits**

- 1) Resources and recreation opportunities are maintained /enhanced.

Available	Measurable	Operable	Relevant
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Much of this information is available on the GIS database. The planning model could used to gauge the impact of land management decisions on recreational resources. The level of desired recreational opportunities would have to be determined by an expert, then the model could be used to suggest sustainable strategies.

- 2) Visual quality of the managed landscape is acceptable to a broad range of stakeholders.

Available	Measurable	Operable	Relevant
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

As in (1), this information is available on the GIS database. The planning model could used to gauge the effect of harvesting and management

practices on visual quality. The level of desired visual quality would have to be determined by an expert, then the model could be used to suggest sustainable strategies.

- 3) Forest management conserves unique/significant places and features of social, cultural, spiritual importance.

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Some of this information may be available however more research is needed to determine how to use it. For now, the indicator would have to be evaluated by an expert on an annual basis

- 4) Worker and community safety is maintained within acceptable levels.

Available	Measurable	Operable	Relevant
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

This information is not available in a GIS database nor is it operable. The indicator would have to be evaluated by an expert on an annual basis

## Recommended Criteria and Indicators for the Tactical Planning Model

### ***Criterion 1 – Biological richness and its associated values are sustained within the management unit (e.g., Invermere Timber Supply Area)***

Although they differ somewhat in content, the criterion and indicators for biodiversity that we present here are conceptually consistent with the Criteria and Indicators (C&I) model of the Canadian Council of Forest Ministers Framework (CCFM 2003). For this project, we propose indicators for a biological richness criterion and associated indicators initially developed by the Weyerhaeuser Adaptive Management Working Group for Weyerhaeuser's coastal tenure (Bunnell et al. 2003). These indicators, which are described in more detail in Wells (2004), are based on ecological representation, critical habitat elements and species-based effectiveness monitoring.

- 1) Ecologically distinct ecosystem types are represented in the non-harvestable land base of the management unit to maintain lesser known species and ecological functions.

Source: *Bunnell et al. (2003), Wells (2004)*

Data Availability: *Ecosystem groups are available in the GIS Database*

Description and Use: *For each ecosystem group, an expert will calculate the area required to achieve the target in the TSA, weighted by the responsibility of the TSA for that group. The model will track departures from the recommended levels*

Ecosystem group:

Field Name – AGROUPNUM2 (a combination of fields that will identify poorly represented groups)

Definition – Ecosystem group number

Range of values – text field

- 1 - subxeric-submesic IDF-PP
- 3 – cirum-mesic IDF/ICH/MS
- 7 – mesic MS/IDF dm 2a

- 2) The amount, distribution, and heterogeneity of stand and forest structures important to sustain biological richness is maintained over time (used as an old growth indicator)

Source: Bunnell et al. (2003), Wells (2004)

Data Availability: Old Growth Management Area rank and area are available in the GIS database

Description and Use: Area (hectares) in required forest types considered to belong to Old Growth Management Areas (OGMA) and their ranks. These will be weighted by a prioritization table linked to highest ranked OGMA's ('Excellent' and 'Good') for poorly represented ecosystem groups.

Forest Type:

Field Name – OGMA RANK

Definition – AI needs POGMA ranks - used in script generated OGMA selection process

Range of values – text field

- E            Excellent
- G            Good
- L            Low
- M            Moderate
- P            Poor
- XXXX       Nil

***Criterion II – Productivity of forests and associated soil resources are sustained***

- 3) Annual removal of forest products relative to the volume of removals determined to be sustainable.

Source: CCFM 5.1.1

Data Availability: Annual removals would be determined by the planning model.

Description and Use: A sustainable annual allowable cut would have to be defined for the planning area. The model will track differences from the AAC.

***Criterion III – The flow of economic benefits from forests through the forest industry is sustained***

- 4) Net profitability is sustained (proxy tax revenues)

Source: CCFM 5.2.1

Data Availability: Net profitability is predicted from the planning model.

Description and Use: The exact indicator is not defined in the CCFM C&I framework. Net profitability is revenue net of all costs, but due to fluctuating markets it is not realistic that net profitability does not decline. The model will be used to track the difference between the net revenue that is possible without constraints and that actually obtained.

- 5) Total employment in all forest-related sectors / Timber harvesting continues to contribute to economic well-being

Source: Arrow 3.1, CCFM 5.3.2

Data Availability: Employment is predicted in the planning model; however we will use total wages. This would be obtained from the planning model as direct employment and wages from the following activities:

- a. Development, including road building
- b. Silviculture
- c. Logging & Hauling
- d. Mill Activities

Description and Use: The model will be used to track the difference between the wages that are possible without constraints and that actually obtained.

- 6) The provincial government continues to receive a portion of the benefits

Source: Arrow 3.3

Data Availability: The model can determine stumpage payments and other taxes to the Provincial Government.

Description and Use: This could be obtained from the planning model as an estimate of the corporate taxes paid by the company and the income taxes paid by workers from the company. This indicator is usable in the planning model as is.

**Criterion IV – Forest management sustains ongoing opportunities for a range of quality of life benefits**

- 7) Availability and sustainability of recreational opportunities

Source: CCFM 5.4.2; Arrow 8.1

Data Availability: *The GIS database lists both recreation features and primary recreational activities. It does not list the actual recreation sites or the use of sites. The Recreation Value Score, a measure of the recreational significance of a Decision Unit, was developed by experts (Harshaw 2004).*

Description of the Fields and Use:

This indicator identifies a score for each Decision Unit that describes the relative recreational value of that unit. The *Recreation Value* score is a function of a Decision Unit's recreational significance, sensitivity to development, and proximity to water weighted by the area of the Decision Unit.

The *Recreation Value* indicator will use 5 database fields:

- i. [Hectares] This field will provide information about the area of the Decision Unit; this will be used to weight the *Recreation Value* score. Value range: 1-100 (or actual minimum and maximum area values of Decision Units).
  - ii. [FEATURE\_SI] This field will provide information about the relative significance of recreation features contained within individual Decision Units. Value range: 1-4.
  - iii. [SENSITIVIT] This field will provide information about the relative sensitivity of recreation features to resource development within individual Decision Units. Value range: 0-3.
  - iv. [WATER] This field will provide information about the presence of hydrologic features within a Decision Unit. Value range: 0-1.
  - v. [TreatmentID] This field provides information about the harvest treatment that is to be applied to a Decision Unit; this will be used to weight the final value of the *Recreation Value* score. Value range: 1-3.
- 8) Visual quality of the managed landscape is acceptable to a broad range of stakeholders

Source: *Arrow 8.2, Picard (2004)*

Data Availability: *The GIS database lists scenic class, visual quality, and visual class, but not the Existing Visual Quality (EVC). Experts will calculate the EVC based on other database fields.*

*Description and Use: An expert would have to determine the desired level of visual class for the planning area. The model could then track the difference between the desired level and that obtained. The indicator will monitor the assessment of the Existing Visual Quality (EVC) and planned (or modeled) EVC based on the harvesting treatment and intensity within each Visual Sensitivity Unit (VSU).*

Field Name – EVC Final

Definition – Existing Visual Quality (EVC)

GIS database fields used in calculations:

- [VAC] - Visual absorption capability  
Field Values and Definitions:
  - H High
  - L Low
  - M Moderate
  - X No data
- [VQC] - Visual quality objective  
Field Values and Definitions:
  - M Modification
  - P Preservation
  - PR Partial Retention
  - R Retention
  - XX No VQO
- [VIEW\_DIST] - Viewing distance from major highways (<1, 1-5, 5-13, 13+ kms)  
Field Values and Definitions:
  - 0 <1 km
  - 1 1-5 kms
  - 12 13+ kms
  - 5 5-13 kms
- [AVE\_SLOPE] - Average slope of VQO polygons

9) Community and domestic watersheds are sustained and protected

*Source: Arrow 8.2*

*Data Availability: The GIS database lists community watersheds and domestic watersheds.*

*Description and Use: Community and domestic watersheds are identified and a forest cover requirement is implemented according to advice from*

*experts. The forest cover requirement will approximate a 30% equivalent clearcut area of max 30% < 6m ht within the crown forested area of each community and domestic watershed . The model could then this requirement.*

Field Names – CWS and DWS

Definition – Community watersheds and domestic watersheds

Range of Values – text field

- CWS Community Watershed
- DWS-1 Domestic Watersheds associated with small creeks
- DWS-2 Domestic Watershed < 500ha drainage area
- DWS-3 Domestic Watershed 500ha to 200,000 ha drainage area
- DWS-3s Domestic Watershed
- XXXX Not CWS or DWS

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