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A NETWORK OF CENTRES OF EXCELLENCE
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CONFORMANCE OF ONTARIO'S FOREST MANAGEMENT PLANNING MANUAL TO CRITERIA AND INDICATORS OF SUSTAINABLE FOREST MANAGEMENT

WORKING PAPER

By

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Abstract:

Sustainable forest management (SFM) cannot be achieved just by developing national level criteria and indicators (C &I). An understanding of the gaps between existing forest management institutions and C & I, at the given level, is critical. Hence, a gap analysis framework is developed, and used to analyze gaps between the Canadian Council of Forest Ministers C & I and the provisions of the Forest Management Planning Manual (FMPM) for Ontario's Crown forests. The examination is aimed to establish gaps and highlight forest management planning aspects requiring gap-bridging interventions at the forest management unit (FMU) level. The three levels (parts) of the FMPM - Management Planning, Annual Operations, and Reporting & Monitoring – are examined. Gaps are categorized in three groups – major, intermediate, and minor gaps. Major gaps are recorded for 5 out of 22 elements of the CCFM C & I framework, and these gaps indicate inadequate prescriptions for the corresponding elements at all the three levels. Minor gaps are also recorded for 5 elements, and these gaps indicate inadequate prescriptions at the monitoring level. Intermediate gaps are recorded for 11 elements, and depending on the specific element and indicator, inadequacy of prescriptions may only be for operations, reporting & monitoring, or may also include the planning level. On the basis of the gap-category of the majority of the elements in a criterion, we are inclined to rank the six criteria in this order - Global Ecological Cycles, Society's Responsibility, Soil and Water Conservation, Multiple Benefits, Biological Diversity, and Ecosystem Productivity (highest to lowest gaps). Hence, reforms in forest management institutions have been good on biological aspects, poor on social aspects, and worst on global ecological cycles. The dominant features of the gap analysis are that none of the six criterion of SFM has been fully incorporated in the FMPM; the Part C (Reporting and Monitoring) has the highest degree and Part A (Plan Contents) has the lowest degree of non-conformity with respect to CCFM C & I framework; at the criterion-level the Global Ecological Cycles has major gaps while three criteria - Soil and Water Conservation, Multiple Benefits, and Society' Responsibility – have intermediate gaps; and the changes in the FMPM have been incremental while the shift in the concept of forest management from Sustained Yield Timber Management to SFM was a drastic change.

Key words: Biological diversity, Canadian Council of Forest Ministers, criteria, indicators, institutional arrangements, ecological cycles, forest management planning, multiple benefits, society's responsibility, sustainable forest management.

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List of Acronyms

C & I	Criteria and Indicators
CCFM	Canadian Council of Forest Ministers
CFSA	Crown Forest Sustainability Act
CSA	Canadian Standards Association
FMP	Forest Management Plan
FMPM	Forest Management Planning Manual
FMU	Forest Management Unit
FMNCP	Forest Management Native Consultation Program
MAI	Mean Annual Increment
NBIR	Native Background Information Report
NPP	Net Primary Productivity
NVMs	Native Value Maps
PCP	Public Consultation Program
SFL	Sustainable Forest License
SFM	Sustainable Forest Management

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1.0 Introduction

In 1992, the Canadian Council of Forest Ministers (CCFM) released a national Forest Strategy that indicated Canadian response and commitment to the globally evolving paradigm of Sustainable Forest Management (SFM). In this strategy SFM is defined as "forest management to maintain and enhance the long-term health of forest ecosystems, while providing ecological, economic, social, and cultural opportunities for the benefit of present and future generations" (CCFM 1992). As a follow up to the strategy, the council has developed a framework of criteria and indicators (C & I) to define and measure SFM in a national context (CCFM 1995; 2000). The C & I of SFM reflect wide-ranging values that ought to be enhanced and sustained in Canadian forests. The six criteria contain twenty-two elements that refine their scope (Table 1), and eighty-three indicators whose state can be assessed periodically to determine Canada's progress in SFM (CCFM 2000).

In order to have creditable SFM systems, the implementation and measurement of sustainability must start at the forest management unit (FMU) level. Various forest policies, Canadian Standards Association (CSA) certification system, and local level C & I initiatives in Canada draw from the CCFM framework. Subsequently, forest practices at the FMU-level must be adjusted accordingly to conform to the CCFM C & Is of SFM[1]. To make this possible, the forest management prescriptions must conform to the values defined in the C&I framework, while accommodating locally defined values. The Forest Management Planning Manual (FMPM) for Ontario's crown forests (OMNR 1996) provides such prescriptions. The FMPM describes the management approach for SFM of Ontario's forests as a follow up to the 1995 Ontario's Crown Forest Sustainability Act

[1] Since, all the provincial governments have representation in the Canadian Council of Forest Ministers (CCFM), our assumption is that the provincial governments will incorporate CCFM C & I in their forest management planning. Hence, we have chosen the CCFM C & I for this gap analysis, and not the forest management standards of certifying agencies such as Forest Stewardship Council (FSC).

and other provincial, regional and local policies and strategies[2]. The manual prescribes the process and product requirements for forest management planning at the FMU level, and provides directions for operations, and reporting and monitoring of the forest management plans (OMNR 1996).

Under the directives of the Crown Forest Sustainability Act (CFSA), the Minister of Natural Resources issues Sustainable Forest Licenses (SFLs) to forestry companies. The terms and conditions to a licensee include compliance with the FMP, and independent forest audits are conducted every five years in order to evaluate the effectiveness of plan implementation by individual management units (Burckardt 1999). However, these audits can monitor the effectiveness of forest management operations with respect to the provisions of the FMPM, and not with respect to the Canadian goal of SFM unless the provisions of the FMPM are in total conformance with the framework of SFM. Hence, an examination of the extent to which the provisions of the FMPM meet the requirements of the elements of CCFM, C & I is necessary to uncover the gaps and highlight the areas of intervention, in the FMPM, to achieve SFM at the FMU level. Furthermore, the goals of SFM cannot be achieved just by development of C & I at different levels. Comprehensive forest management institutional reforms, that are responsive to C & I at all the three stages - planning; operations and; reporting & monitoring - of forest management, are essential ingredient for SFM. Hence, an understanding of the gaps between existing forest management institutional arrangements and C & I, at the given level, is critical to strengthen the process of SFM.

The main objective of this study is to conduct this gap analysis - between forest management institutions, as reflected in the FMPM, and the CCFM C & I - and highlight the areas, which require different-levels of policy intervention to become in conformance with the CCFM C & I. Hence, first we develop a framework for gap analysis between forest management institutions and C & I. Second, we demonstrate the use of this framework by using the case of the Ontario province, Canada, where forest management on Crown land is regulated by the Forest Management Planning Manual (FMPM)

[2] Key documents that provide direction in forest management activities include: the Crown Forest Sustainability Act; Direction 90's and Moving Ahead 1995; MNR statement of environmental Values; Ontario's Living Legacy, an approved Land Use Strategy; and the decisions of the Class Environmental Assessment for Timber Management on Crown Lands in Ontario (Burckardt 1999).

(OMNR 1996). In the next section we describe the methodology for gap analysis. In Section 3, we first present the outcomes of the gap analysis at the element-level. The discussion in Section 3 is somewhat mechanical in the sense that we discuss each indicator of the element and the relevant prescriptions to each indicator in the FMPM. In Section 4, we comprehend the gap analysis into a criterion-wise discussion and include references from a scientific literature. Finally we conclude with some dominant features of the gap analysis and policy suggestions – including the suggestion that provinces in Canada, which aim to achieve SFM in the near future, should initiate the process of gap analysis and reform the forest management institutions accordingly. A summary of key recommendations made in the discussion is provided in appendix 1.

2.0 Methodology of Gap Analysis

The proposed gap analysis framework has two components. The first is vertical gap analysis - analyzing hierarchical complementarities (national to local level) of C & I as well as of institutions. The second is horizontal gap analysis - gaps between C & I and the corresponding institutions at any given level. The details of the framework are given in Table 2. However, due to non-availability of C & I at the local-level in Ontario, we could not demonstrate the use of the first component. For the horizontal gap analysis we use the CCFM C & I, as a proxy for local C & I - the best approximation of such values at the FMU level in the given circumstances, and the Ontario's FMPM. The horizontal gap analysis involved scoring each Criterion and its elements of SFM on the basis of the adequacy of the information/prescription content in the three parts of the FMPM.

Normally, forest management consists of three stages – management plan preparation, management plan implementation, and reporting and monitoring. Accordingly, the FMPM of Ontario has three parts – Part A (Management Plan), Part B (Annual Operations), and Part C (Reporting and Monitoring). Part A provides direction for the preparation of forest management plan, and includes the provisions for management planning organization and process, plan contents, public consultation, plan review, approval, amendments and renewal. Part B provides direction for the scheduling of forest management operations on an annual basis, and describes requirements for: forest operations prescriptions; annual work schedule, and use of prescribed burns, herbicide and insecticide, and insect pest management. Part C provides direction for

monitoring, reporting and evaluation of forest management operations, as well as the condition of the forest, at regular intervals. Hence, in order to achieve the goal of SFM, the criteria, elements, and indicators of CCFM C & I framework should be incorporated, in appropriate form, at all the three levels or the three parts of the FMPM.

In order to gather the evidence for conformity or non-conformity, in each part of the FMPM, the sections/ sub-sections relevant to each indicator of the twenty-two elements of the CCFM C & I framework were identified. In each part (A, B, and C) of the FMPM, the provisions/prescriptions, in the relevant sections/sub-sections, for each indicator were examined for the adequacy of prescriptions with respect to the concerned indicator. For example, one of the four indicators for the element of ecosystem diversity is the level of fragmentation and connectedness of forest ecosystem components. Hence, the provisions of part A were examined for the adequacy of management prescriptions for fragmentation and connectedness, the part B was examined for the adequacy of provisions for annual operations with respect to fragmentation and connectedness; and part C was examined for adequate provisions for reporting and monitoring of fragmentation and connectedness. Each element, of all the six criteria of CCFM C &I, was scored based on the inadequacy of the prescriptions in the three parts of the FMPM. Gaps were grouped into major, intermediate and minor gaps.

Major Gap indicates lack of explicit provisions for planning (documentation and assessment), operations, reporting and monitoring for the majority of the indicators of an element of the C & I framework, which means lack of adequate provisions through all three Parts, A, B, and C, of the FMPM**.** *Intermediate gap* means many indicators of the element in question are adequately prescribed throughout the FMPM, but there is lack of prescriptions for some indicators of that element, particularly at the annual operations and reporting and monitoring sections (part B & C) of the FMPM, but in few cases also at the Planning (Part A) level of the FMPM. *Minor Gaps* include findings which indicate that documentation of the information pertinent to indicators of the element in question is generally well prescribed in management plan and operations sections (part A & B) of the FMPM; however, for some indicators, there are no corresponding prescriptions in

sections that deal with reporting and monitoring (part C of the FMPM**).** The details of the conceptual framework used are provided in Table 3.

3.0 Gap Analysis & Results

A summary of the outcomes of gap analysis with respect to the elements of the CCFM C & I framework is presented in Table 4. Only one element – forest land conversion (under Global Ecological Cycles criterion) – out of the total twenty-two elements has enough prescriptions through all the three parts of the FMPM. Five elements, spread over three criterion, have major gaps indicating inadequate prescriptions for indicators of these elements at all the three levels - the management planning, operations, and reporting & monitoring. Out of these five elements, three elements are in the criterion of Global Ecological Cycles, and hence, the majority of the elements of this criterion (three out of five) have major gaps. Eleven elements, spread over four criterion, have intermediate gaps. All the four elements of Multiple Benefits criterion and four out of five elements of Society's Responsibility criterion are in this category of intermediate gaps. Minor gaps were also recorded for 5 elements; spread over three criteria, indicating inadequate prescription for monitoring of the indicators of these elements. Criterion & element-wise details of these gaps are analyzed next. Before identification of the gaps a brief description of the elements of each criterion is provided based on CCFM C & I framework (CCFM 2000).

3.1 Criterion 1: Conservation of Biological Diversity

Element 1.1 Ecosystem Diversity: It depicts the mixture of ecosystems found in the landscape. Assessment of ecosystem diversity includes measure of their dimensions, composition and spatial arrangement. Indicators that measures this element are: (1) Percentage and extent in area of forest types relative to the historical condition and total forest area; (2) Percentage and extent of area by forest type and age class; (3) Area, percentage and representation of forest types in the protected areas and; (4) Level of fragmentation and connectedness of forest ecosystem components (CCFM 2000).

Section 2 of the Planning Process and Planning Content Requirements (part A) in the FMPM, deals with Management Unit descriptions, which requires assessment of historic and current forest condition. There are specific prescriptions for documentation

of forest types and disturbance patterns, forest types by age class, forest diversity, protected areas, and landscape and forest diversity indices. The examination of these prescriptions indicated that, except for one indicator; "Assessment of representation of forest types in protected areas", there are no significant gaps in requirements for documenting the relevant information in the sections, which deals with management planning process.

An examination of the Monitoring and Reporting section (part C of the FMPM) indicated that indicators used in the assessment of forest sustainability falls short of those in the CCFM framework. Indicators used in the FMPM are landscape pattern indices, forest diversity indices, and frequency and distribution of clear-cut and wildfires. The Gap observed for this element was therefore considered to be minor as it is possible to incorporate the missing indicators in the assessment of sustainability as the relevant information is prescribed in other sections of the FMPM.

Gap (Minor): In the FMPM, specifications for the assessment, reporting and monitoring of *ecosystem diversity* incorporate limited information of indicators defined by the CCFM C & I framework. There are no particular prescriptions for the *Assessment of representation of forest types in 'protected areas'*.

Element 1.2 Species diversity: It describes the number and variety of species in the ecosystems. This element is concerned with the status of forest dependent animal and plant species and determining possible threats to their survival. Assessment and monitoring of the status of species is important because loss of species can threaten long-term ecosystem productivity and stability. The following indicators measure this element*:* (1) Number of known forest dependent species classified as extinct, threatened endangered, rare or vulnerable relative to the total number of known forest-dependent species; (2) Population levels and changes over time of selected species and species guilds; and (3) Number of known forest dependent species that occupy only a small portion of their former range (CCFM 2000).

The FMPM has prescriptions that cover documentation of indicators of species diversity in sections 1 and 2 of part A, while documenting forest resource inventories and

other forest resources. However the section that deals with monitoring, reporting and evaluation of forest conditions overtime (Part C) lacks prescriptions, which require independent assessment of indicators of species diversity. Analysis of sustainability is aggregated under the assessment of indicators of biodiversity. This gap is considered minor, as there are adequate prescriptions for the management of species diversity in the Planning Process and Planning Content Requirements - the deficiency occurs only in corresponding prescriptions for monitoring and reporting. Thus while the management plan may have objectives for management of forest dependent animals and plant species, monitoring will not be possible without assessment of what is achieved overtime.

Gap (Minor): There is lack of a separate monitoring and reporting of indicators of *species diversity.* The evaluation of the status of forest dependent animal and plant species and determination of their survival over time is not prescribed for.

Element 1.3 Genetic diversity: It includes the range of genetic characteristics found within the species and among different species. The indicator specified for the measurement of this element is the implementation of an "in situ/ex situ genetic conservation strategy for commercial and endangered forest vegetation species" (CCFM 2000). Examination of the sections of the FMPM indicated lack of prescriptions for genetic conservation strategies. This is therefore considered to be a major gap.

Gap (Major): Lack of prescriptions and reference guidelines for the implementation and monitoring of an *in/ex-situ genetic conservation strategy for commercial and endangered forest vegetation species.*

3.2 Criterion 2: Ecosystem Condition and Productivity

Element 2.1 Incidence of Disturbance and Stress: It defines the frequency and severity of major stressors affecting forest ecosystems. Biotic stressors originate from living source such as insects, disease, and direct human impact. Abiotic stresses are originating from non-living sources such as fire, pollution, and temperature. The element is measured by the following Indicators: (1) Area and severity of insect attack; (2) Area and severity

of disease infestation; (3) Area and severity of fire damage; (4) Rates of pollutant deposition; (5) Ozone concentration in forested regions; (6) Crown transparency in percentage by class; (7) Area and severity of occurrence of exotic species detrimental to forest conditions; (8) and Climate change as measured by temperature sums (CCFM 2000).

Examination of the FMPM indicated sufficient prescriptions for the assessment, reporting and monitoring of natural disturbances/depletions (fire, disease, and insects). This assessment represents the first three indicators of the element. There are no prescriptions found to ascribe to any of the remaining indicators. Such indicators are largely attributable to human induced disturbances – such as deposition of pollutants, and introduction of exotics - in the forest eco-system. Hence, this gap was categorized as an intermediate gap.

Gap (intermediate): The assessment of sustainability of the forest eco-system lacks specific prescriptions for monitoring *disturbance and stress* ascribed to *anthropogenic impact* on the forest ecosystem. No gaps were observed in monitoring and reporting *disturbance and stress* ascribed to natural depletions (insect, disease and fire).

Element 2.2 Ecosystem Resilience: *It* captures the ability of forest ecosystems to recover from stress. Resilience (return time) is a measure of an ecosystems ability to maintain its integrity against disturbances, for instance, regeneration of a forestland following harvesting. Indicators of ecosystem resilience include: (1) Percentage and extent of area by forest type and age class and; (2) Percentage of area successfully regenerated naturally and artificially (CCFM 2000).

The FMPM requires assessment of planned and successful renewal both annually and on the five-year planning period. The manual also requires assessment of forest types by age class in every five-year plan. The information gap observed for this element was therefore categorized as minor. This gap was registered due to the fact that the assessment of forest sustainability for the criterion in question (ecosystem condition and productivity) uses Net Primary Productivity (NPP) as the sole indicator for the criteria. Such assessment may indirectly reflect that forest renewal and change in age class affect

NPP. However as NPP is also affected by other factors, inclusion of indicators specified for ecosystem resilience will provide more elaborate assessment of sustainability.

Gap (Minor): No major Gap in information recording and reporting indicators for *ecosystem resilience*. However the use of Net Primary Productivity (NPP) as a measure of sustainability for ecosystem condition and productivity does not take into account all indicators of *ecosystem resilience*.

Element 2.3 Extant of Biomass: It indicates net performance of a forest ecosystem as measured by forest biomass productivity and accumulation. If a forest is managed in a sustainable manner it will show evidence of constant or improving condition - health and vitality of all species and types. Indicators of extant of biomass include: (1) Mean annual increment by forest type and age class and; (2) Frequency of occurrence within selected indicator species (CCFM 2000).

Gap analysis indicated no specific mention of the term Mean Annual Increment (MAI). However, there are prescriptions that require assessment of variables that are conceptually equivalent or convertible to MAI. Such variables include Available Harvest Volume, Net Merchantable Volume, Forest by Age Class, and Total Productive Crown Forest. There are prescriptions in the FMPM which require reporting on habitat management for provincially and locally featured species including site protection for rare, vulnerable, endangered and threatened species. Gap analysis indicated lack of prescriptions for management, assessment, and monitoring of *indicator species* per se with respect to reporting and monitoring of extant of biomass of the forest.

Gaps (minor): Monitoring of *extant biomass* lacks specific requirement for the assessment of occurrence within selected indicator species and for *continuous assessment of Mean Annual Increment (MAI).*

3.3 Criterion 3: Soil and Water Conservation

Element 3.1 Physical environmental factors: It defines the relationship between forest management practices and physical aspects of the environment and the protection of soil

and water resources in forest ecosystem. Forest management practices should therefore protect sensitive terrestrial sites as well as aquatic systems e.g. protection of steep slopes, stream crossings and riparian areas. Another important factor is watershed management to maintain water flow patterns, water levels and water quality. The indicators of this element include: (1) Percentage of harvested area having significant soil compaction, displacement, erosion, pudding, loss of organic matter etc.; (2) Area of forest converted to non-forest land use; (3) Water quality as measured by water chemistry, turbidity etc; (4) Trends and timing of events in stream flows from forest catchments; (5) Changes in distribution and abundance of aquatic fauna (CCFM 2000).

The planning and monitoring sections of the FMPM consists of prescriptions for creation of protection forest including riparian reserves, soil and water conservation, and assessment of forest conversion to non-forest uses, as well as assessment and monitoring of non-compliance of forest operations to physical constraints. Indicators used for the assessment of sustainability include water yield, riparian reserves, and soil and water conservation. Two main gaps were recorded for this element. The first is lack of prescriptions for direct assessment and monitoring of water quality. Water is assessed in terms of quantity (yield). The second gap is lack of explicit prescriptions for management and monitoring the dynamics of aquatic fauna.

Gaps (intermediate): Lack of assessment of water quality as an indicator of *Physical environmental factors* for the purpose of *soil and water conservation*. Water is assessed only in terms of quantity (water yield). There is also lack of specific management directives for monitoring the *Dynamics of aquatic fauna.*

Element 3.2 Policy and protection forest factors: It entails the role of guidelines and management objectives for the protection and maintenance of soil and water resources in forest ecosystem. Policies directed to institute appropriate management practices will protect soils against erosion and compaction. Similarly water resources should be protected against siltation, flooding, and increased temperatures. The following indicator*s* measure sustainability for this element: (1) Percentage of forest managed primarily for soil and water protection; (2) Percentage of forested area having

road construction and stream crossing guidelines in place and; (3) Area percentage and representation of forest types in protected areas (CCFM 2000).

Prescriptions in the FMPM that can be ascribed to this element include those dealing with "protected areas" and "areas of concern". In spite of the general directives for the protection and maintenance of soil and water resources in forest ecosystem there is deficiency in specific guidelines/factors for appropriate management practices to be taken into account in management of protected areas/areas of concern in the context of the national and provincial legislative framework.

Gaps (intermediate): Lack of *specific Policy and protection factors* for soil and water conservation including protection of areas of concern (protected areas).

3.4 Criterion 4: Global Ecological Cycles

Element 4.1: Global carbon Budget: It considers the role of forests as sinks or sources of atmospheric carbon. It takes into account the impact of natural (e.g. pests, disease and fire) and anthropogenic (e.g. harvesting) disturbances on the atmosphere, trees, and soils. Carbon budgets estimate the balance between carbon storage and carbon release from forests and forest products. Such estimates indicate nation's contribution to atmospheric enhancement as indicated by: (1) Tree biomass volumes; (2) Vegetation (non-tree) biomass estimates; (3) Percentage of canopy cover; (4) Percentage of biomass volume by general forest type; (5) Soil carbon pools; (6) Soil carbon pool decay rates; (7) Area of forest depletion; (8) Forest wood product life cycles and;(9) Forest sector carbon dioxide emissions (CCFM 2000)[3].

Element 4.2 Forest Land Conversion: This determines the amount of forestland being converted to for other uses such as agriculture. This assessment is crucial because removal of forest cover alters land's capacity to absorb and store carbon. Indicators used to measure this element include: (1) Area of forest permanently converted to non-forest land use; (2) Semi-permanent or temporary loss or gain of forest ecosystem (CCFM 2000).

[3] All the indicators of this criterion are discussed together at the end of element 4.5.

Element 4.3 Carbon Dioxide Conservation: It deals with the impact of types of fuel-energy used by the forest sector in harvesting, transporting and converting timber into products on the global carbon budget. The element also takes into account the energy efficiency initiatives of the forest industry. Indicators of this element are: (1) Fossil fuel emissions; (2) Fossil carbon products emissions and; (3) Percentage of forest sector energy usage from renewable sources (CCFM 2000).

Element 4.4 Forest Sector Policy Factors: It measures Canada's policy initiatives related to global ecological cycles. This is achieved by looking at Canada's international forestry commitments, the national policy frameworks that are in place for forest management, and the existence of forest inventories. Indicators of this element include: (1) Recycling rate of forest wood products manufactured and used in Canada; (2) Participation in the climate change conventions; (3) Economic incentives for bio-energy use; (4) Existence of forest inventories and; (5) Existence of laws and regulations of forestland management (CCFM 2000).

Element 4.5: Hydrological Cycles: *It* is concerned with the movement of water from the atmosphere to the soil, vegetation, water bodies and back to the atmosphere. The impact of forest practices on hydrological cycles can be assessed by estimating changes in the area of water surfaces within forested landscapes. The sole indicato*r* specified for this element is "the Surface area of water within forested areas" (CCFM 2000).

The FMPM has prescriptions that require the assessment and reporting of *forestland conversion*. There are however no explicit directives in the FMPM for recording, assessment and monitoring of the forest ecosystem contributions to Global Ecological Cycles at the FMU level. There is, therefore, lack of monitoring of the impacts of forest management practices at the FMU level to ecological cycles. Although the criterion deals with global ecological cycles, the forest practices at a FMU level and their impact on the ecological cycles, will cumulatively add to the broader scale (provincial or national) impacts on *global ecological cycles*. Lack of such prescriptions is considered to be a major gap. Even though some indicators of this criterion are not measurable at the local level, there are many indicators of this criterion for which it is possible to scale measurable variables at the FMU level.

Gaps (Major): Except for *forestland conversion*, there are no explicit directives in the FMPM for recording, assessment and monitoring of indicators of other critical elements that relates impact of forest management practices at the Defined Forest Area (FMU) to measures of *global ecological cycles*.

3.5 Criterion 5: Multiple Benefits

Element 5.1 Productive capacity: *It* evaluates the capacity of the forest to sustain a flow of timber and non-timber benefits by comparing current rates of removal with quantities determined to be sustainable. Indicators of productive capacity of the forest include: (1) Annual removal of forest products relative to the volume of removals determined to be sustainable; (2) Distribution of and changes in the land base available for timber production; (3) Animal population trends for selected species of economic importance; (4) Management and development expenditures; and (5) Availability of habitat for selected wildlife species of economic importance (CCFM 2000).

The FMPM Planning Process and Plan Content Requirement sections have specific prescriptions whose contents can be attributed to indicators 1, 2, 4 and 5 of the element 5.1. Specific sections of the manual are those which deal with the descriptions of: other forest resources, development of management alternatives, analysis of management alternatives, and selection of management alternatives. Other prescriptions are those dealing with analysis of available harvest area, eligibility for harvest renewal along with tending, and operational planning. In monitoring and reporting sections, information related to assessment of depletions and expenditures is applicable to indicators 1, 2, and 4. Assessment of sustainability takes into account; forest area available for timber production and the percentage of which is actually utilized, habitat for selected wildlife species, and value added.

The gap observed in this element is the predominance of timber/trees in the assessment of the productive capacity of the forests. In this assessment forest depletion is assessed in terms of timber but not animal species. Assessment of sustainability takes into account indicators 1, 2 and 5. Animal population trends (indicator 4) are not explicitly accounted for.

Gaps (intermediate): In the assessment of *productive capacity of the forest* depletions is assessed in terms of timber/fiber/trees. There is no specific requirement for assessment of other forest products/values including animal population trends.

Element 5.2 Competitiveness of Resource Industries: It considers the ability of forest industries to maintain or expand the flow of economic benefits as measured by the following indicators: (1) Net profitability; (2) Trends in global market share; (3) Trends in research and development expenditures in forest products and processing technologies (CCFM 2000). The analysis required for indicators of this element as specified by CCFM may fall out of the context of planning at the FMU level, as the indicators suit analysis of the forest industry at a higher scale. Notably, each FMU is a self-operating resource management and business unit. The FMU is thus ought to sustain a competitive resource management and business environment, including assessment and monitoring of such competitiveness over time. This entails the need of local indicators, scaled from the general indicators specified by the CCFM.

Gaps (intermediate): No requirements for assessing, monitoring, and sustaining competitiveness at the FMU level.

Element 5.3 Contribution to the National Economy: It deals with the quantification of forest-generated wealth, which flows to Canadians both through the market economy and subsistence economy that involves in-kind income. Indicators used to measure contribution of the forest sector to the national economy include: (1) Contribution of timber and non-timber sectors to gross domestic product (GDP); (2) Total employment in all forest related sectors; (3) Utilization of forests for non-market goods and services, including forest land use for subsistence purposes; and (4) Economic value of non-market goods and services.

Element 5.4 Non-timber Values: It looks at the importance of Canadian forests for non-timber goods and services and determination of their availability. Such values include recreation, tourism, and existence & option values. Indicators for non-timber values are: (1) Availability and use of recreational opportunities; (2) Total expenditures

by individuals on activities related to non-timber use; (3) Membership and expenditures in forest recreation-oriented organization and clubs and; (4) Area and percentage of protected forest by degree of protection (CCFM 2000).

The Planning Process and Planning Content Requirement section of the FMPM requires analysis and documentation of *Socio-economic Profile of the area, Socioeconomic Impact (SEI) analysis of the management alternatives, and socio-economic evaluation and ranking of management alternatives*. Such analyses provide necessary baseline information for indicators of these two elements (5.3 and 5.4). There are also sections of the FMP which deal with *"protected forest"* that include prescriptions requiring documentation of value maps e.g. old growth sites, areas of concern and other kinds of protected areas. However, such kind of analysis is limited to evaluation of how optimization of different timber management alternatives will impact on the socioeconomic and environmental values of the forest rather than looking at how such values could be optimized as equally important entities of SFM.

Non-market and non-timber values are evaluated during the assessment and ranking of the impact of timber management alternatives in which case they are treated as constraints in the timber optimization models. The sections of the FMPM that deals with reporting and monitoring of forest sustainability lack requirements for assessment, reporting, and monitoring sustainability of *Non-market* and *non-timber values* and their *contribution to economy*.

Gaps (intermediate): The prescriptions for reporting and monitoring of forest sustainability lack requirements for assessment, reporting, and monitoring sustainability of *non-market* and *non-timber values* and their *contribution to economy.* Such values are evaluated only when assessing and ranking the impact of timber management alternatives where they are treated as constraints in the timber optimization models

3.6 Criterion 6: Societies Responsibilities for Sustainable Development

Element 6.1 Aboriginal and Treaty Rights: This examines compliance to Aboriginal and treaty rights in forestry planning and management in the context of the current legislation, policies and practices. The Indicator specified by CCFM for assessing this

element is the "Extent to which forest planning and management process consider and meet legal obligations with respect to Aboriginal and treaty rights" (CCFM 2000).

The FMPM requires involvement of Native communities in or adjacent to the management unit in management planning through the Forest Management Native Consultation Program (FMNCP). This consultation is intended to allow the native communities to raise concerns, issues, and values of interest, which they want to be addressed in managing the forest. Assessment of sustainability as prescribed by the FMPM specifies that the percent of Native communities involved in management planning be used as one of the indicators for measuring "*Accepting Societies Responsibilities in Sustainable Development*"

Native issues can also be addressed through the standard public consultation process, during management planning. In spite of the presence of prescriptions in the FMPM that require consideration of *Aboriginal and Treaty rights*, there is lack of specific guidelines and mandatory terms of reference to facilitate the commitment to actions aimed to meet *Aboriginal and Treaty Rights.*

Gaps (intermediate): Lack of specific guidelines and mandatory terms of reference to facilitate the commitment to actions aimed to meet *Aboriginal and Treaty Rights*.

Element 6.2 Participation by Aboriginal Communities in SFM: It focuses on the degree to which forest management plans and practices integrate the recognition of the Aboriginal people's connections to the land and to the resource-based economy. The element evaluates the share of timber and non-timber benefits from the forest accruing to Aboriginal people, and consideration in forest management plans for the protection of their cultural and spiritual heritage. *Indicators* of this element include: (1) The Extent of Aboriginal participation in forest based economic opportunities; (2) Extent to which forest management planning takes into account the protection of significant aboriginal sites; (3) Number of aboriginal communities with a significant forestry component in the economic base and the diversity of forest use; (4) Area of forestland available for subsistence purposes; (5) Area of Indian reserve lands under integrated management

plans (CCFM 2000). Incorporation of these indicators in the FMPM is discussed with the next indicator.

Element 6.3 Sustainability of Forest communities: It examines the number of forest dependent communities in Canada, their economic diversity, and the diversity of their forest use. Measurable *indictors* of this element are: (1) Number of communities with a significant forestry component in the economic base; (2) Index of the diversity of the local industry base; (3) Diversity of forest use at the community level; (4) Number of communities with stewardship or co-management responsibilities (CCFM 2000).

The Planning Process and Planning Content Requirement section of the FMPM has different prescriptions aimed at facilitating participation by aboriginal communities in SFM. These prescriptions require the consultation with the native communities in forest management planning either through a special Forest Management Native Consultation Program (FMNCP) or by the standard Public Consultation Program (PCP). This consultation is intended to document Native Background Information Report (NBIR), Native Value Maps (NVMs), and other issues of concern to the native people.

The FMPM also requires planners to undertake and document a socioeconomic profile of the communities within and around the management unit. This should also be accompanied by a Socioeconomic Impact analysis of the selected timber management alternative. Such analyses and other information obtained through FMNCP including NBIR, and NVMs, serve as important general baseline information (not specific to particular indicators) for the assessment of sustainability of forest communities.

Examination of the monitoring sections of the FMPM indicates that the monitoring process evaluates only the achievement level of the consultation process, but not how effective the participation process is and how the information obtained from the consultation is implemented. Also there are no prescriptions and/or specific guidelines that aid and require commitment for sustaining and monitoring forest economic base and subsistence base of native and forest dependent communities i.e. putting the information gathered during the consultation into practice, or empowering the communities as local actors and partners in SFM. The prescriptions provided for in the FMPM are mainly for facilitating the consultation process but do not guarantee commitment to address the issues raised during the public and native consultation process.

Gaps (major):In spite of the general directives, there is lack of explicit prescriptions and/or specific guidelines, to aid commitment in taking measures aimed at sustaining forest economic-base and subsistence-base of native and forest dependent communities (Note: the public and native consultation process which is prescribed in the FMPM does not necessarily ensure this commitment).

Element 6.4 Fair and Effective Decision Making: It is centered on public engagement in SFM process. The element deals with the assessment of the extent to which the public is involved in designing out a path toward SFM, the mechanisms used, and their effectiveness. Indicators of this element are: (1) Degree of public participation in the design of decision-making process; (2) Degree of public participation in the decision making process; (2) Degree of public participation in the implementation of decisions and monitoring (CCFM 2000).

As required by the FMPM, forest management plans will be prepared in an open and consultative fashion. In addition to interdisciplinary planning team, a local citizens committee (LCC) will be established to assist the plan author in the preparation of the plan. Interested and affected persons and organizations, and the general public can also participate in a formal public consultation process and public monitoring of implementation of the management plan. Additional consultation and negotiation may also be done with the native communities – through the FMNCP - outside of the standard consultation program. The manual also requires for public review of the management plans and public inspection of the Annual Working Schedules. This process prescribes for the *public participation in decision making*, *implementation and monitoring*. However the public consultation process doesn't prescribe for public participation in the *design of the decision making process.*

Gap (intermediate): Requirement for public consultation in management planning without involving the public in the *design of the decision making process* hampers the *fairness and Effectiveness of the Decision Making.*

Element 6.5 Informed Decision Making: It examines the current understanding of forests ecosystems and reports on the type of data currently being maintained in forest inventory databases. The element also takes into account the extent to which forest management planning is based on sound knowledge, and knowledge transfer from the forest sector to the general public. Indicators of the element are: (1) Percent of area covered by multi-attribute resource inventories; (2) Investments in forest-based research and development information; (4) Total effective expenditures on public forestry education; (5) Percent of forest area under management, including public participation; (6) Expenditure on international forestry; (7) Mutual learning mechanisms and processes (CCFM 2000).

The FMPM lacks explicit prescriptions attributable to the *indicators of informed decision-making*. Although various management practices - e.g. informed development, analysis and selection of management alternatives - are indications of conformance to some indicators of *informed decision making,* the lack of explicit requirement for monitoring indicators of this element undermines sustainability and makes it difficult or impossible to keep track of such practices. Practices such as, learning mechanisms, public education, research and development; multi-attribute (beyond timber/fiber) resource inventories are indispensable requirements for SFM. Although such programs may actually be taking place to different degrees at different FMUs, lack of reporting and monitoring of such programs hinders adaptive management in SFM.

Gap (intermediate): Full or partial lack of prescriptions for tracking and documenting *informed decision-making* programs (e.g. mutual learning mechanisms, public education, research and development etc.). This may act as a disincentive for improvement and innovativeness

4.0 Criterion-wise Discussion of the Gaps

The element specific gaps, discussed above, indicate that none of the criteria of SFM has been fully incorporated in forest management prescriptions in Ontario. In most cases prescriptions at the planning level have not been followed through at operations and

reporting & monitoring levels. In this section we provide a detailed criterion-wise discussion of the gaps while incorporating the current SFM Literature.

Criterion 1: Conservation of Biological Diversity

Biodiversity refers to the variability among living organisms and the biological complexes of which they are part. The Biological Diversity criterion has three elements - ecosystem, species and genetic diversity (CCFM 2000). The current FMPM prescriptions adequately cover the documentation of ecosystem diversity as specified by the C & I framework except for the assessment of representative forest types in protected areas within the FMU. Such assessment should be included in order to provide ecological benchmark information for comparative assessment of the impact of forest management practices on biodiversity. Furthermore the extent of forest types relative to historical conditions, and the extent of forest type by age class which are currently included only in the Part A of the FMPM, should be incorporated in the Part B and Part C.

Conservation of species diversity at the FMU requires evaluation of the status of forest dependent animal and plant species and determination of their survival over time. Currently such documentation is done during the planning process. This must be augmented by objectives-oriented prescriptions to ensure species survival (Part B) and the monitoring of their status relative to stated objectives (Part C). The FMPM prescriptions for Reporting and Monitoring (Part C) must include separate prescriptions for continuous assessment of the status of threatened, endangered, rare or vulnerable species and population levels and changes over time of selected species and species guilds.

Gene conservation is crucial for both ecological and utilitarian justifications - to safeguard the future evolutionary potential of species to new biotic challenges and for commercial genetic improvement programs. Leaving some ecologically representative wild forest stands to respond to natural evolutionary pressures in-situ is a desirable, cost-effective, feasible and long-term approach to gene conservation. This approach can supplement ex-situ collections made for breeding purposes (Yanchuk and Lester 1996). The sole indicator specified for the measurement of this element is: *the implementation of an in situ/ex situ genetic conservation strategy for commercial and endangered forest*

vegetation species. However, the FMPM totally lacks the prescriptions for genetic conservation at all three levels. It is thus important for the FMPM to prescribe for gene conservation activities as part of the forest management in Ontario's crown lands. This should include reference to guidelines for the implementation and monitoring of an in/ex-situ genetic conservation strategy for commercial and endangered forest vegetation species.

Criterion 2: Ecosystem Condition and Productivity

This criterion defines the forest condition, a measure of relative freedom from stress and relative level of physical and biological energy within forest ecosystem as indicated by forest health and vitality (CCFM 2000). For conservation of the forest ecosystem condition and productivity to be ensured the level and frequency of natural and human-induced forest disturbances and stresses should allow maintenance of ecosystem processes and conditions within the characteristic range for the succession stage of the ecosystem. Hence, forest management practices must emulate or compensate for the natural processes altered through management (Morris 1997).

The current FMPM prescriptions adequately cover the assessment and monitoring of natural disturbances (insects, disease, and fire). However, there is a need for parallel assessment and monitoring of human-induced disturbances on the forest ecosystem (e.g. pollutants and, exotics) and indicators of ecosystem resilience (e.g. regeneration) in the assessment of ecosystem condition and productivity. Current measures of ecosystem condition and productivity are total productive crown forestland and net primary productivity (NPP), a measure of site productivity (kg ha^{-1} yr^{-1}). However, forest productivity refers to the growth and maintenance of all or any part of plants and animals that exist in a forested ecosystem (Morris 1997). Its assessment requires additional indicators - for disturbance and stress & ecosystem resilience (already discussed) and, indicators of extant biomass as discussed next. Mean Annual Increment (MAI) or related measurements, can be used to assess sustainability of commercially usable forest biomass (timber). As correlates to various elements of biodiversity, indicator-species can be used to assess sustainability of other forest species as they can indicate habitat changes overtime; specific features of the forest such as forest structure and age class; and the

impact of forest management operations on biological diversity. Such assessment is an important part of a monitoring and adaptive forest management program (Noss and Cooperrider 1994; McLaren et al. 1998).

Criterion 3: Soil and Water Conservation

The conservation of quantity and quality of soil and water resources as well as the physical environments of the forest ecosystems are important elements of SFM. They are needed to sustain the productivity of the ecosystem in its characteristic range (CSA 1996). Intensive disturbance by stand management operations may threaten long-term site productivity, particularly when poor practices are conducted in sensitive sites. An expert opinion survey in Ontario indicated concerns for harvest related nutrient removals and loss of organic matter, when black spruce is harvested on shallow soils and upland sites. Other concerns are altered hydrology and rutting for inherently shallow organic sites (Morris 1997). This criterion has two elements - physical environmental factors and policy and protection factors.

Physical environmental factors define the relationship between forest management practices and physical aspects of the environment and the protection of soil and water resources in forest ecosystem. Forest management practices should therefore protect sensitive terrestrial sites as well as aquatic systems e.g. protection of steep slopes, stream crossings and riparian areas. Another important factor is watershed management to maintain water flow patterns, water levels and water quality. The planning and monitoring sections of the FMPM consists of prescriptions for creation of protection forest including riparian reserves, soil and water conservation, and assessment of forest conversion to non-forest uses, as well as assessment and monitoring of non-compliance of forest operations to physical constraints. Indicators used for the assessment of sustainability include water yield, riparian reserves, and soil and water conservation. Two main gaps were recorded for this element. The first is lack of prescriptions for direct assessment and monitoring of water quality. Water is assessed in terms of quantity (yield). The second gap is lack of explicit prescriptions for management and monitoring the dynamics of aquatic fauna.

Policy and protection forest factors entail the role of guidelines and management objectives for the protection and maintenance of soil and water resources in forest ecosystem. Policies directed to institute appropriate management practices will protect soils against erosion and compaction. Similarly water resources should be protected against siltation, flooding, and increased temperatures. Prescriptions in the FMPM that can be ascribed to this element include those dealing with protected areas and areas of concern. In spite of the general directives for, the protection and maintenance of soil and water resources in forest ecosystem there is deficiency in specific guidelines/factors for appropriate management practices to be taken into account in management of protected areas/areas of concern in the context of the national and provincial legislative framework.

Management-induced changes in long-term site productivity can be evaluated and corrected by development of best practice guidelines; C & I of sustainability; and long-term field trials to provide feedback information for the best practices guidelines and C & I (Morris 1997). Additionally, the current assessment of water yield must be complemented by the assessment of water quality, and monitoring of the dynamics of aquatic fauna as per C & I framework. Equally important are site-specific soil and water protection factors and policy statements that contain commitment to SFM; and provide vision, mission, guiding principles and codes of good management practice (CSA 1996).

Criterion 4: Contribution to Global Ecological Cycles

Forests play a critical role in global ecological cycles, the complex and self-regulating processes responsible for recycling limited supplies of water, carbon, nitrogen and other life sustaining elements (CCFM 2000). Forest conditions and management activities at the FMU, must contribute positively to the health of global ecological cycles by maintaining such ecological processes as well as balancing and sustaining utilization and rejuvenation and protecting the forest lands from deforestation or conversion to other uses (CSA 1996). Five elements – global carbon budget, forestland conversion, carbon-dioxide conservation, forest policy factors, and hydrological cycles – are associated with this criterion.

The FMPM has prescription that require for the assessment and reporting of *forestland conversion*. There are however no explicit directives in the FMPM for

recording, assessment and monitoring of the forest ecosystem contributions to Global Ecological Cycles at the FMU level. There is therefore lack of monitoring of the impacts of forest management practices at the FMU to ecological cycles. Although the criterion deals with global ecological cycles, the forest practices at the FMU level and their impact on the ecological cycles, will cumulatively add to the broader scale (provincial or national) impacts on *global ecological cycles*. Lack of such prescriptions is therefore considered to be a major gap. It must be noted though that some indicators of this criterion are not measurable at the local level. However there are other indicators of this criterion for which it is possible to develop measurable variables at the FMU level.

Whereas indicators of forest utilization, rejuvenation and conversion are prescribed for by the FMPM (at least at the documentation level), there is a need for a parallel development for indicators related to water and nutrient cycling processes and other life sustaining elements of the ecological cycles, as well as the impact of forest management practices at the FMU to the ecological cycles in line with the CCFM C & I framework. It is also critical that the FMPM include explicit directives for assessment reporting and monitoring of such indicators over time. Furthermore, the complete inadequacy of management prescriptions for the criteria Global Ecological cycles, at all three management levels, suggests the need to scale the national C & I to the level of FMU, for example assessment of energy-use efficiency of harvesting practices, forest rotation based on the maximization of carbon sequestration, and management of forest biomass for carbon sequestration, and to make appropriate changes in forest management institutions at all the three components – planning, operations, and reporting & monitoring.

Criterion 5: Multiple Benefits to Society

Forest sustainability implies sustained flow of multiple goods and services for the current and future generations within limits of the productive capacity of the resource base and a competitively fair business climate (CSA 1996). The Criterion has four elements – productive capacity, competitiveness of resource industries, contribution to the national economy, and non-timber values. On the productive capacity element, the FMPM Planning Process and Plan Content sections have specific prescriptions related to

the indicators on timber volume, area available for timber harvest, expenditures, and habitat for selected wildlife species. In monitoring and reporting sections, information related to assessment of depletions and expenditures is applicable to indicators timber volume, forest area, and expenditures.

Assessment of sustainability takes into account forest area available for timber production and the percentage of which is actually utilized, habitat for selected wildlife species, and value added. The gap observed is the predominance of timber/trees in the assessment of the productive capacity of the forests. In this assessment forest depletion is assessed in terms of timber but not animal species. Assessment of sustainability does not incorporate animal population trends explicitly. The analysis required for the indicators of the Competitiveness of Resource Industries element may fall out of the context of planning at the Management Unit level. Each FMU is a self-operating resource management and business unit. The FMU is thus ought to sustain a competitive resource management and business environment, including assessment and monitoring of such competitiveness over time. This entails the need of local indicators, which can relate to the general indicators specified by CCFM.

Contribution to the national economy deals with the contribution of timber and non-timber sectors through the market economy and subsistence economy that involves in-kind contribution through goods and services. Non-timber values include recreation, tourism, and existence & option values. *Non-market* and *non-timber values* are evaluated during the assessment and ranking of the impact of timber management alternatives in which case they are treated as constraints in the timber optimization models. The sections of the FMPM that deals with reporting and monitoring of forest sustainability lack requirements for assessment, reporting, and monitoring sustainability of *Non-market* and *non-timber values* and their *contribution to economy.*

The growing value of non-timber resources refutes this timber-centered principle. As such SFM decision-making should include analyses of opportunities and constraints for both industrial forest uses and non-market/non-timber values i.e. production tradeoffs among a variety of jointly produced forest resources assessed in light of a common denominator. Some approaches to consider non-timber forest resources include: granting harvest rights to non-timber resources, collection of fees for non-timber resource by the

Crown, and public control in form of subsidies and/or requirements for forest resources with diffuse prices (Luckert 1997). Non-market Economic Valuation Models and Decision Support Systems can be used to evaluate non-market forest goods and services and to understand conflicts between industrial operations and other forest uses (Boxall et al. 1996a; Akabua et al. 2000). To facilitate considerations for multiple benefits, the FMPM should require assessment of competitiveness of forest resource companies in terms of innovation and investment into development of multiple forest products. As well, the assessment of productive capacity of the forest must include sustainability trends (including depletions) for non-market & non-timber values and their contribution to the economy.

Criterion 6: Society's Responsibility in SFM

This criterion extends the role of SFM beyond trees to encompass forest communities**.** The criterion looks at social values of the forests and effectiveness of the participation of the broader society in SFM (CCFM 2000). The criterion has five indicators: Aboriginal and Treaty Rights, participation by Aboriginal communities, sustainability of forest communities, fair and effective decision making, and informed decision making. In spite of the presence of prescriptions in the FMPM that require consideration of *Aboriginal and Treaty rights*, there is lack of specific guidelines and mandatory terms of reference to facilitate the commitment to actions aimed to meet *Aboriginal and Treaty Rights,* and there are no monitoring mechanism to ensure the useful and meaningful consideration of these rights.

The current FMPM prescriptions require consultation with the local citizens, Aboriginal and other forest dependent communities, during management planning. This study observed gaps in the process, which must be addressed, in order to enhance public and Aboriginal participation in SFM. The current prescriptions facilitate the consultation process without guaranteeing commitment to address issues that are raised. Furthermore lack of public involvement in the design of the decision making process hampers the fairness and effectiveness of the process.

To make the process more effective, the monitoring process in the FMPM must not be limited to the evaluation of the number of consulted communities. Rather, the

evaluation of the effectiveness of the participation process and implementation of gathered information must also be done. Early involvement of the local citizens and communities in the consultation process and having their input on the design of the process by which local values are identified based on local situations; knowledge; perceptions; and resources are critical for successful, fair, and effective consultation and subsequent management planning and implementation. Implementation of this process requires locally adaptable guidelines.

The FMPM also requires planners to undertake and document a socioeconomic profile of the communities within and around the management unit. This is accompanied by a Socioeconomic Impact analysis of the selected timber management alternatives. Such analyses and other information obtained through Forest Management Native Consultation Program (FMNCP), including Native Background Information Report (NBIR) and Native Value Maps (NVMs), may serve as important general baseline information for the assessment of sustainability of forest communities.

The level of commitment to the concept of SFM must be established both in forest management policy statements and all aspects of forest operations (Rawlinson 1996). With respect to respecting Aboriginal and Treaty Rights, and Sustainability of Forest Communities, the FMPM must require clearly defined set of policy statements, which express and define commitments, including roles and obligations of all involved stakeholders. These commitment statements must be objective oriented i.e. can be linked to specific compliances in forest management procedures, operations and attitudes. Such policy statements will serve as monitoring schemes and will also minimize the risks involved in the venture.

Efforts must be made to inform and empower the general public and local communities as local actors and partners in SFM, which also implies preparedness to learn from them (mutual learning). This will enable them to know their position and take the necessary steps towards sustainable development (Nilsson and Gluck 2001). Finally, informed decision-making programs e.g. learning mechanisms, public education, research and development and multi-resource inventories should also be promoted. Monitoring of such programs will catalyze improvement and innovativeness leading to adaptive management.

5.0 Conclusions

The gap analyses, in the last two sections, have provided extremely valuable and detailed information regarding the conformance of the FMPM provisions with respect to each element of the CCFM C& I framework. The emergent features of this gap analysis can be summarized as given next.

First, twenty-one elements, out of twenty-two, spread over all the six criterion have some degree of gap, and this means that none of the criterion of SFM is being fully incorporated in forest management. Hence, the Canadian goal of SFM is far from sight.

Second, the Part C (Reporting and Monitoring) of the FMPM has the highest degree and Part A (Plan Contents) has the lowest degree of non-conformity with respect to CCFM C & I framework; while the degree of non-conformity in Part B (Forest Operations) is in the middle. The Parts A, B and C have adequate prescriptions for twelve elements, six elements and only one element respectively. This means that prescriptions in Part A have not been followed through Part B and C, and the government should make special efforts to develop forest management planning manuals which enforce consistency in three stages – planning, operations, and reporting and monitoring.

Third, on the basis of the gap-category of the majority of the elements in a criterion, the six criteria can be grouped in the same three categories – criterion with major, intermediate, and minor non-conformance. Based on this, the criterion of the Conservation of Biological Diversity and Ecosystem Condition and Productivity will fall in to minor category because two elements, out of three, are in the minor-gaps category. This means that the FMPM has been better on biological aspects of management. The Criterion of Global Ecological Cycles will fall in the major category because three elements out of five are in the major-gaps category. This criterion has not been dealt adequately at any level, and requires special attention from policy makers. The remaining three criteria - Soil and Water Conservation, Multiple Benefits, and Society' Responsibility – will fall in the intermediate category, but in the terms of conformance in Parts A, B, and C, the situations are different for these three criteria. All the five elements of the criterion of Society's Responsibility have non-conformance at all three-levels (Part A, B, and C), which indicates that this criterion has not been taken seriously

even at the Management Plan level. But, all the four elements of the criterion of Multiple Benefits have non-conformance only at two-levels (Part B and C). Hence, the prescriptions related to this criterion required at the management plan level have not been followed through at operational and monitoring level.

Fourth, in terms of degree of gaps, we are inclined to rank the six criteria in this order - Global Ecological Cycles, Society's Responsibility, Soil and Water Conservation, Multiple Benefits, Biological Diversity, and Ecosystem Health (highest to lowest degree of gaps). Hence, reforms in forest management institutions have been good on biological aspects, poor on social aspects, and worst on global ecological cycles.

Finally, the most critical result of this study is that there are huge gaps between the existing forest management institutions and C & I, which clearly indicates that C & I are not being transformed into management practices. Hence, it is necessary for all the provinces in Canada and other countries, aiming for SFM, to initiate similar gap analysis at the FMU level. The gap-analysis framework and analytical procedure of the study can serve as guiding tools for scaling national C & I to sub-national levels; analyzing institutional arrangements for the implementation of C & I; analyzing gaps for the purpose of improvement of policy and management practices; and increasing efficiency of data gathering and aggregation. The framework, used in this study, is flexible and can be used at any scale – local, provincial, and national. However, we have used only the horizontal component of the framework, but the outcomes clearly prove the utility of the framework. Outcomes demonstrate the need of scaling C & I from the national level to the FMU level and hence the utility of vertical component. The outcomes also demonstrate the need of comprehensive forest management institutional reforms to incorporate all the elements of C & I.

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Table 1

Canadian Council of Forest Ministers Criteria & Elements of Sustainable Forest Management

Criteria	Elements
1. Conservation of Biological Diversity	(1) Ecosystem diversity; (2) Species diversity; (3) Genetic diversity
2. Ecosystem Condition and Productivity	(1) Disturbance and stress: (2) Ecosystem resilience (3) Extant biomass
3. Soil and Water Conservation	(1) Physical environmental factors; (2) Policy and protection factors
4. Global Ecological Cycles	(1) Global carbon budget; (2) Forest land conversion; (3) Carbon dioxide conservation; (4) Policy factors; (5) Hydrological Cycles
5. Multiple Benefits	(1) Productive capacity; (2) Competitiveness; (3) Contribution to economy; (4) Non-timber values
6. Society's Responsibility	(1) Aboriginal and Treaty Rights; (2) Participation by Aboriginal Communities; (3) Sustainability of Forest Communities; (4) Fair and Effective Decision Making Informed Decision Making

Table 2
A framework for analyzing gaps in institutional arrangement for the implementation of C & I

Scale	SFM Values Definition		Institutional Arrangements	
National	National C & I framework	Context	Legislation	Context
	Criteria	Define broader values - basis for complementary sub-national values	Acts/Bills	Definitions, Purpose, Scope, Powers, Compliance, Penalties, Appeals, etc.
	Elements	Refine the scope of the criteria		
	Indicators	Assessment, reporting and monitoring		
	Scaling ↓ / Aggregation ↑	Compatibility/comparability	Institutionalization ↓ / ↑	Ensures complementary rules
Sub-National			Regulations	Enforcement
Provincial/ Regional	Criteria	Provincial/regional values	Guidelines	Acceptable codes of practice
	Elements	Refine the scope of the criteria	Standards	Acceptable levels of performance
	Indicators	Assessment, reporting and monitoring		
	Scaling ↓ / Aggregation ↑	Compatibility/comparability	Institutionalization ↓ / ↑	Ensures Complementary rules
Local	Criteria	Local values	Planning & Operational Manual + Local knowledge	Provisions & prescriptions for Forest Management Planning; Operational procedures; and Reporting & Monitoring
	Elements	Scope for implementation		
	Indicators	Assessment for reporting and monitoring		

Vertical Gap Analysis

Horizontal Gap Analysis

Table 3.
The conceptual framework used to analyze gaps between elements of CCFM C & I of SFM and the prescriptions of the FMPM for Ontario's Crown forests.

	FMPM prescriptions				Assumptions
	Management Plan (Part A of FMPM)	Annual Operations (Part B)	Reporting & Monitoring (Part C)	Gap category	Likelihood of conformance to SFM standards
Elements of the C & I framework	Inadequate	Inadequate	Inadequate →	Major	Lower
	Adequate for most indicators [a]	Adequate for many indicators; Inadequate for some indicators	Adequate for many indicators; Inadequate for some indicators →	Intermediate	Intermediate
	Adequate for most indicators	Adequate for most indicators	In adequate for some indicators →	Minor	Higher

[a] Some elements in this category may also have some of their indicators inadequately prescribed at Part A, in addition to the inadequacy at Part B & C of the FMPM

Table 4

Gaps ascribed to the Conformance of the FMPM for Ontario's Crown forest to the elements of the CCFM C & I framework of SFM

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Criteria	Element	GAPS BY FMPM CONTENT: MA = major; IN = intermediate; MI = minor LEVEL OF INTERVENTION: A = Forest Management Planning section of FMPM; B = Annual operations section of FMPM; C = Monitoring and Reporting section of FMPM	
			Missing/required content
Conservation of Biological Diversity	Ecosystem diversity	MI^{C}	Representation of forest types in 'protected areas'
	Species diversity	MI^{C}	Indicators of species diversity
	Genetic diversity	$MA^{A,B,C}$	In/ex situ conservation strategy for commercial and endangered species
Ecosystem Condition and Productivity	Disturbance and stress	$IN^{B,C}$	Anthropogenic disturbance & stress
	Ecosystem resilience	MI^{C}	Indicators of ecosystem resilience
	Extant biomass	MI^{C}	Indicator species, MAI
Soil and Water Conservation	Physical environmental factors	$IN^{B,C}$	Water quality, dynamics of aquatic fauna
	Policy and protection factors	$IN^{A,B,C}$	Best practice guidelines, policy statements
Global Ecological Cycles	Global carbon budget	$MA^{A,B,C}$	Local estimates/budgets
	Forest land conversion		Well covered
	Carbon dioxide conservation	$MA^{A,B,C}$	Energy conservation, forest industry emissions
	Policy factors	$MA^{A,B,C}$	Forest inventories, policy statements
	Hydrological Cycles	MI^{C}	The impact of forest practices
Multiple Benefits	Productive capacity	$IN^{B,C}$	Sustainability trends/depletion of non-timber resources
	Competitiveness	$IN^{B,C}$	Profitability, markets, R & D, innovation
	Contribution to economy	$IN^{B,C}$	Contribution of non-timber products/values
	Non-timber values	$IN^{B,C}$	Optimal utilization/sustainability
Society's Responsibility	Aboriginal and Treaty Rights	$IN^{A,B,C}$	Guidelines, terms of reference & policy statements to aid and ensure commitment, define roles and reduce risk.
	Participation by Aboriginal Communities	$IN^{A,B,C}$	
	Sustainability of Forest Communities	$MA^{A,B,C}$	
	Fair and Effective Decision Making	$IN^{A,B,C}$	Public involvement in the design of decision making process
	Informed Decision Making	$IN^{A,B,C}$	Mutual learning, public education, R & D; multi-resource inventories

Appendix 1

Summary of Recommendations:

- The complete inadequacy of management prescriptions for the criteria Global Ecological cycles, at all three management levels, suggests the need to scale the national C & I to the level of FMU, for example assessment of energy-use efficiency of harvesting practices, forest rotation based on the maximization of carbon sequestration, and management of forest biomass for carbon sequestration, and to make appropriate changes in forest management institutions at all the three components – planning, operations, and reporting & monitoring.
- There is a need for an earlier involvement of the local citizens and communities in the public consultation process in order to have local peoples input not only on identifying the local values but also on the design of the process by which such values will be identified based on local situations, knowledge, perceptions, and resources.
- There is a need to develop prescriptions that will allow forest managers to use the baseline information collected during forest inventorying to track the multi-attributes of the forest over time and document success or failure in their maintenance and/or improvement over time.
- There is a need to develop prescriptions for alternative genetic conservation strategies including: monitoring the safety of wild populations in existing protected areas, creating new reserves for *in- situ* management and *ex- situ* collections of various types for breeding purposes.
- There must be prescriptions and guidelines for making trade offs and ranking management alternatives for optimal combination of market (e.g. timber, fiber) and non-market goods and services. This involves local analyses of opportunities and constraints for both market values (goods and services).
- There is a need to develop explicit provisions and/or specific guidelines, including policy statements to aid commitment in taking measures aimed at sustaining forest economic-base and subsistence-base of native and forest dependent communities.

- Prescriptions for monitoring of soil and water conservation must include assessment of water quality – e.g. water chemistry and turbidity - as an indicator of *Physical environmental factors* for the purpose of *soil and water conservation*. There is also a need for specific management directives for monitoring the *Dynamics of aquatic fauna.*
- There is a need to develop *specific Policy and protection factors* for monitoring soil and water conservation including protection of areas of concern ("protected areas"). Forest management planning prescriptions must require policy statements and specified management objectives that provide vision, mission, guiding principles and codes of sound management practice.
- In the assessment of *productive capacity of the forest* addition to assessment of depletion of timber/trees, there must be requirement for assessment of other forest products/values including animal population trends.
- The is a need to prescribe for assessing, monitoring, and sustaining competitiveness at the FMU both in terms of profitability and investment in development of multi-resource values of the forest.
- The prescriptions for reporting and monitoring of forest sustainability should include requirements for assessment, reporting, and monitoring sustainability of *Non-market* and *non-timber values* and their *contribution to economy* rather than treating them as side effects of timber management.
- With respect to *Aboriginal and Treaty rights*, there is need to develop specific guidelines and mandatory terms of reference to facilitate the commitment - and minimize risks - to actions aimed to meet *Aboriginal and Treaty Rights*, enhance aboriginal forest based economic opportunities, protect significant aboriginal sites, and ensure participation during forest management planning and implementation.
- Forest management planning process should document and keep track of informed *decision-making* programs (e.g. learning mechanisms, public education, research, development etc.).
- The assessment of sustainability of the forest eco-system should specify provisions for monitoring *disturbance and stress* ascribed to *anthropogenic*

impact on the forest ecosystem in addition to those currently used to assess natural disturbances.

- The specifications for the assessment, reporting and monitoring of *ecosystem diversity* must include prescriptions for the *Assessment of representation of forest types in "protected areas"* and application of inventory data from protected areas in monitoring of forest management practices in managed forest lands, for biodiversity conservation objectives of forest management.
- There is a need for separate assessment of indicators of *species diversity* per se separate from the assessment of *forest diversity* in order to ensure and guide the evaluation and monitoring of the status of forest dependent animal and plant species and determination of their survival over time.
- Assessment of sustainability of ecosystem condition and productivity must include the assessment of other indicators of ecosystem resilience as specified in the CCFM framework – indicators of disturbance and stress and extant biomass - in addition to the current use of Net Primary Productivity.