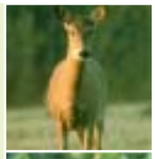
Canadian Council of Forest Ministers (CCFM)

As steward of 10% of the world's forests, Canada has a global responsibility to keep its forests in good health by ensuring that they are managed sustainably.

CCFM is a forum for discussion that unites Canada's provincial, territorial, and federal forestry ministers to work on areas of common interest related to Canada's forests, including sustainable forest management.



Criteria and indicators for sustainable forest management (SFM)

In 1995, CCFM publicized a framework comprising 6 criteria and 85 indicators (''C and I''). This framework provided a scientific footing for defining and measuring Canada's progress towards SFM of its forests.

The criteria correspond to forestry values that the population of Canada hopes to improve or sustain.

The indicators are scientific factors used to evaluate the state of the forests and measure the progress towards SFM that has been achieved over time. Each indicator should have a reference value and should be:

- pertinent,
- measurable,
- comprehensible, and
- reliable.

Review of the framework

In 2001, CCFM undertook a re-examination of the framework. The revised version retained 6 criteria, but now has 46 indicators. The criteria have not changed, but they have been reformulated. The number of indicators has been reduced. The 6 SFM criteria relate to the:

1- conservation of **biological diversity**;
2- maintenance and improvement of the **productivity of forest ecosystems**;
3- conservation of **soils and water**;
4- contribution of forest ecosystems to **global ecological cycles**;
5- maintenance of the **economic and social benefits** that forests provide for society;
6- responsibility of society: accounting for the values and needs expressed by affected populations in the choice of development strategies.

Use of indicators in the field

The SFM indicators defined by CCFM are **designed** to describe a **national situation** and help evaluate the country's progress in this context. However, the same indicators may sometimes be **inappropriate** for evaluating and comparing the state of the forest at **regional, local, and operational scales**.

From the perspective of a forestry manager, an SFM approach should not have the direct goal of contributing to national objectives, but should instead help to identify:

- practices that risk interfering with ecosystems and the species that live in them; and
- methods of adapting practices so as to minimize their impacts on the forest system.

SFM: a priority for the Canadian Forest Service

The goal of SFM guides the work of many Canadian Forest Service researchers from the Laurentian Forestry Centre, where many researchers work on the development of SFM indicators suitable for different scales.

An approach to forestry planning and the types of SFM indicators

Forestry planning

In Quebec's public forest, the beneficiaries of Timber Supply and Forest Management Agreements are responsible for creating the forest management plans (Table 1).

Indicator types

An evaluation of forest management activities shows that there are two distinct stages where SFM indicators are required at the operational scale, namely during the planning and monitoring stages.

Planning indicators define the targets that must be attained to meet an SFM objective. These indicators are thus applicable at the landscape scale and at the level of the General Forest Management Plan, but also at the stand scale within the framework of developing the Annual Plan.

Monitoring indicators are used to confirm whether the goals defined during planning have been met and whether the operations are providing the expected results. Monitoring indicators are required both in the short term and in the long term (after many decades) to ensure that the forest management is truly sustainable.

Table 1: Relationships between forestry planning and SFM indicators

Stage of forestry planning	Scale of planning: spatial / temporal	Level of forestry planning	Example of SFM indicator	
General Forest Management Plan: Forest management strategy to sustain the forest's yield	Forest management unit or landscape / 25 years	Strategic	Landscape-scale planning of the amount of old-growth forest	See the Gauthier poster
5-year Forest Management Plan: Scheduling activities for each year of intervention	Intervention sectors / 5 years	Tactical	Planning at the scale of the intervention sector. For example, preservation of large forest tracts.	
Annual Plan: Description and location of activities over the course of a year	Stands or cutovers / 1 year	Operational	Planning at the scale of the site Vulnerability of sites to various silvicultural practices in terms of soil fertility	See the Paré poster
Annual Intervention Report: Summarizes the forest management activities performed during the year and evaluates the quality and quantity of silvicultural treatments	Area of intervention	Retroactive	Regional-scale monitoring	See the Beaudoin poster

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Examples of SFM indicators developed by the Canadian Forest Service – Laurentian Forestry Centre

Development of an indicator to determine the quantity of old-growth forests that must be preserved at the landscape scale

Sylvie Gauthier, Ph.D., CFS
In collaboration with **Alain Leduc, Dan Kneeshaw** (UQAM)
Yves Bergeron, Brian Harvey (UQAT)

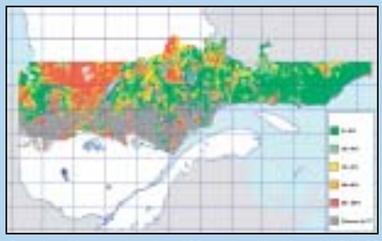
Associated with the following criteria:
1 Conservation of **biological diversity;**
2 Maintenance and improvement of the **productivity of forest ecosystems**;

The problem

Many researchers believe that the development of forest management strategies aimed at maintaining a variety of forest habitats similar to those created by a region's regime of natural disturbance should generally ensure preservation of the essential functions of the forest's ecosystems and of biodiversity.

Traditionally, it was believed that the boreal forest was characterized by a relatively short fire cycle and that the vast majority of forest stands were even-aged. This justified an approach to management of these ecosystems based on clearcutting over short rotations. However, recent work has shown that in many parts of the boreal forest of eastern Ontario and western Quebec, more than 50% of the area is covered by forests that burned more than 100 years ago, and 20% of the area has a fire cycle of more than 200 years. The longer fire cycles in these areas thus permit the development of old-growth forests with a composition and structure that are very different from those of forests subject to a higher frequency of fires. It is thus important to preserve this older component of the forest. To do so, it is necessary for a given region to evaluate the quantities of even-aged and old-growth forest required to set conservation targets in SFM.

Spruce stand older than 100 yrs.



Quantity of forests older than 100 yrs. (modified from MNRW, 2000)

Elements that must be defined to determine the required quantity of old-growth forest

To define the quantity of old-growth forests that must be preserved in a region, it is necessary to determine two things: (1) the age at which the stand begins to achieve the status of an old-growth forest and (2) the regional quantity of stands that have attained this state.

When does a forest become "old"?

A forest achieves the old-growth stage when the canopy trees, established after a fire, begin dying and being replaced in the canopy by a second generation of trees. In the boreal forest, it is estimated that the old-growth stage begins 80 to 125 years after the passage of a fire (Table 1).

Table 1: Longevity and senescence of the most common tree species in the boreal forest

Species	Tree longevity (years)	Stand senescence (years)
Aspen	50-100	90-100
Jack pine	70-130	90-110
White birch	70-140	90-110
Black spruce	100-200	110-160
Balsam fir	60-100	70-80

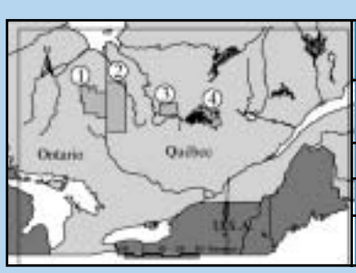
May be different from region to region

How much old-growth forest is there in a given area?

The recurrence of fire in a region is the defining factor that determines the quantity of old-growth forest in a region. The recurrence of fire has changed in the past, often rapidly. Over the past 300 years, the interval between fires has increased. However, the mean time since the last fire has changed more slowly. This time can be determined by constructing a fire history for an area.

By combining these two facts, it is possible to establish targets for the quantity of old-growth forests that should be preserved in a region (Table 2). This criterion thus serves as a planning indicator at the landscape spatial scale and on a long temporal scale.

Table 2: Mean time since fire



Region	Mean age (years)	Target >100 years
1) Lake Abitibi Model Forest	172	78%
2) Abitibi (W)	139	57%
3) Abitibi (E)	111	54%
4) Central	127	56%

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Development of an indicator for preserving soil fertility

David Paré, Ph.D., CFS
In collaboration with **Alison Munson, Évelyne Thiffault, François Marquis** (Université Laval)
Nicolas Bélanger (UQAM)

Associated with the following criteria:
2 Maintenance and improvement of the **productivity of forest ecosystems**
3 Conservation of **soils and water**

The problem

Preserving the quality of soils after forestry operations represents a significant challenge in SFM. In addition, the forestry manager has only a few tools for evaluating what is good or bad in terms of maintaining soil fertility, and the indicators associated with criterion 3 of the CCFM only deal with physical damage such as rutting, erosion, and compaction.

Nutrient budgets

CFS researchers have developed a tool based on an accounting approach that helps to identify the situations that pose the greatest risk of damaging soil fertility in the boreal forest. This approach estimates the gains and losses of nutrient elements associated with different types of forest and for two types of forestry intervention. The tool also identifies the risk of nutrient losses exceeding nutrient gains.

Development of a soil fertility indicator

It has been determined that the richness of soils and the atmospheric inputs of nutrient elements are the main factors associated with nutrient gains. The capacity of soils to generate nutrients was estimated for four main types of deposit: S, thin soils; F, glaciofluvial sands; T, tills; and C, clays.

The magnitude of the losses of nutrient elements is determined by the characteristics of the forest stand and the type of harvesting. The species composition, age, density, and site index are the factors that most affect the quantity of nutrient elements in forest biomass. The type of harvesting (full-tree or tree-length) affects the losses, but the magnitude of this effect also depends on the type of stand.

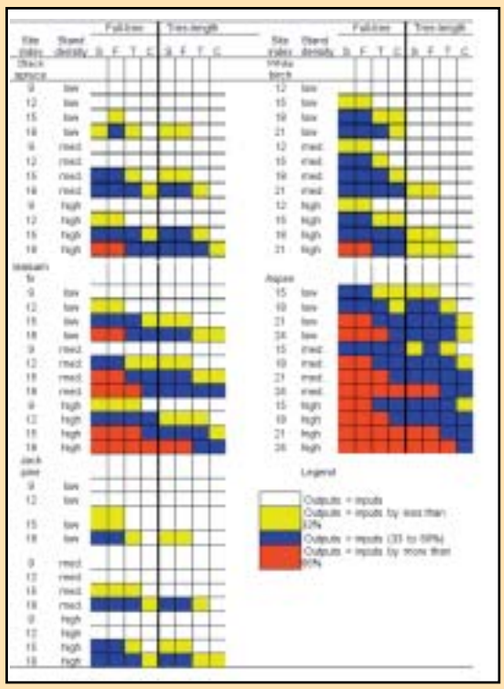
Full-tree harvesting

Tree-length harvesting

By comparing the gains and losses of nutrient elements for a given combination of stand type and harvesting type, it becomes possible to predict situations where the risks of removing too many nutrients from a site range from negligible to high (Table 1).

By determining the risks, this indicator becomes a suitable stand-scale planning tool.

Table 1. Risk of nutrient depletion for forests harvested at the age of economic maturity as a function of stand species composition, stand density, site index, type of harvesting, and soil deposit types (S, thin soils; F, glaciofluvial sands; T, tills; C, clays).



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An indicator for monitoring the state of a region's forest by means of remote sensing (Example: Abitibi-Témiscamingue)

André Beaudoin, Stephen Côté, and Guy Simard, CFS
In collaboration with **Olvaldo Valéria and Ahmed Laamrani** (UQAT)

Associated with the following criterion:
2 Maintenance and improvement of the **productivity of forest ecosystems.**

The problem

An overview of the forests of the Abitibi-Témiscamingue region is not available, even though this forestry region is subject to a range of significant problems related to both natural and anthropogenic disturbances.

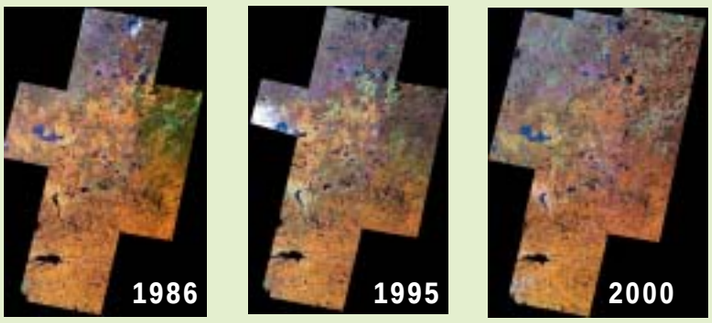
Remote sensing to provide indicators

Using remote sensing based on Landsat satellite imagery, this project permits monitoring of the state of the Abitibi-Témiscamingue forests at intervals of 5 years. The four indicators being used in the project can be monitored using this technology. Associated with criterion 2 of CCFM, these indicators are:

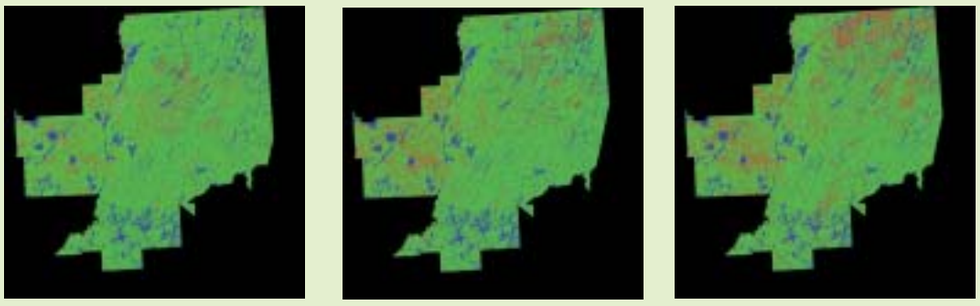
- The percentages of the area covered and not covered by forest;
- The percentages of coniferous, mixedwood, and hardwood forests;
- The proportions of juvenile and mature forests;
- The proportions of dense and open forest.

For a given year, an ensemble of Landsat images covering the entire region is processed and classified so as to map the area based on the cover-type classes. The indicators are calculated using these classes for spatial administrative units of particular interest, such as a regional municipality (MRC) or a forest management unit. Repeated every 5 years, this undertaking provides a dynamic portrait of the forest and of its evolution over time based on four indicators that are easily obtained by means of satellite imaging.

Land-cover maps from classified Landsat mosaics (22 classes)



Map of indicators: forest vs non-forest, MRC Val-d'Or



Tabulated indicator statistics: proportion of forest, MRC Val-d'Or

	1986		1995		2000	
	Hectares	% MRC	Hectares	% MRC	Hectares	% MRC
Forest	2076270	79	2008617	76	1866661	66
Non-Forest	229104	8	280145	10	459474	16
Water	323992	12	308797	11	311799	11

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