

# Developing criteria and indicators of sustainable forest management in the Arrow Forest District

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## Abstract

This extension note is the second in a series of eight that describes a set of tools and processes developed to support sustainable forest management (SFM) planning and its pilot application in the Arrow Timber Supply Area (TSA). It outlines the development of criteria and indicators (C&I), which focus on explicitly defined goals and an objective means of determining success in meeting these goals. Criteria and indicators are used to evaluate the long-term sustainability of forest management through decision support in planning processes and through monitoring and adaptive management activities. The C&I for the Arrow TSA were based on the Canadian Council of Forest Ministers framework and were refined to address specific local issues through an iterative process that included input and review by professionals, academics, and forestry practitioners, and evaluation by stakeholders. The development process was guided by two directives: that performance-based indicators be emphasized and that these indicators should be credible, measurable, cost-effective, and connected to forestry. The resulting C&I are preliminary—their evolution is shaped by testing and application in forest management planning, and by continuing public review.

**KEYWORDS:** *criteria and indicators, local level, sustainable forest management, thresholds.*

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## Introduction

Criteria and indicators (C&I) of sustainable forest management (SFM) are intended to provide a strategic and systematic means of evaluating forest management and policy options. Criteria are meant to represent broad management objectives that can be validated through the repeated, long-term measurement of associated indicators. In turn, indicators serve to assess progress towards meeting SFM criteria. The C&I approach differs from current management approaches in that it is explicitly goal-based; that is, it focusses on clearly defined performance criteria (management objectives) and indicators (which determine whether objectives are met) as part of the adaptive management cycle.

This extension note describes the development of a set of C&I, under a framework for SFM, that will be used to measure and demonstrate the sustainability of economic, ecological, and social values at the local level, specifically the Arrow Timber Supply Area (TSA; see sidebar). It outlines the characteristics considered important in designing indicators that will effectively evaluate the long-term sustainability of forest management. The role of thresholds in assessing the efficacy of meeting SFM targets is also described.

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## Distinguishing Between Values, Criteria, and Indicators

The terminology used by SFM practitioners often varies. To facilitate discussion and comparison with other systems, we have defined values, criteria, indicators, and measures as follows:

- **Value:** A standard or principle considered as desirable (Pollard 1994).
- **Criterion:** A category of conditions or processes that constitutes one of the bases for sustainable forest management; is characterized by a set of indicators that are monitored periodically to assess change (Montreal Process Working Group 1995).

## The IFPA Sustainability Project

The Arrow Innovative Forestry Practices Agreement (IFPA) was established as a co-operative effort between the five licensees\* in the Arrow Timber Supply Area (see Figure 1, Extension Note 1) and the B.C. Ministry of Forests' Nelson Forest Region. The Sustainability Project was an important initiative of the Arrow IFPA that partnered forest practitioners and academic researchers to develop a comprehensive approach to planning and implementing sustainable forest management.

The result of this work has been the Sustainable Forest Management Framework, which is now being used by Canfor\* to guide certification and

sustainable forest management planning in their British Columbia operations. For further background, refer to: <http://www.sfmportal.com>

### Disclaimer

The ideas presented in this extension note form part of a project (outlined in a series of eight notes) that was initiated to develop a system for evaluating management options under a criteria and indicators framework. These ideas do not represent real management options for the Lemon Landscape Unit, or the Arrow TSA, although they could form the basis of such options.

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\* The Arrow Forest Licensee Group was comprised of Slocan Forest Products, Kalesnikoff Lumber, Atco Lumber, Riverside Forest Products, and Bell Pole. In 2004, Slocan Forest Products Ltd. was acquired by Canadian Forest Products Ltd.

- **Indicator:** A “second order” criterion that adds meaning to a criterion without itself being a direct measure of performance; indicators are the intermediate points at which the information provided by measures (see below) can be integrated and interpreted within the context of its criterion (Prahbu *et al.* 1999)
- **Measure:** A quantitative or qualitative variable that, when observed periodically, demonstrates trends in an indicator (Montreal Process Working Group 1995); a specific metric of an indicator.

## Criteria and Indicators of Sustainable Forestry

Criteria and indicators have formed part of the sustainable forest management model since the 1992 United Nations Conference on Environment and Development’s Convention on Biological Diversity, which was designed to conserve the biological diversity of temperate and tropical forests around the world. International initiatives resulting from this convention committed countries to sustaining biological diversity at a national level through the use of C&I which defined and ensured sustainability and through the provision of a common understanding of sustainable forest management (Woodley *et al.* 2000). These initiatives included the 1994 Montreal Protocol and subsequent 1995 Santiago Declaration (for non-European nations). In Canada, the result was a set of C&I, developed by the Canadian Council of Forest Ministers (CCFM), that provided a framework for reporting on the state of Canada’s forests at the national level and to serve as guideposts for SFM planning (Canadian Council of Forest Ministers 1995, 2003).

At the time of development, the CCFM system of C&I used a procedural and descriptive approach to reporting on the condition of forest characteristics across Canada (Canadian Council of Forest Ministers 1995); however, many of the reporting elements were not relevant at the management unit level. Consequently, the national approach was found to be inappropriate for implementation at the local level.

After an extensive review of approaches employed to assess or implement sustainable forestry programs, the Arrow IFPA team decided to follow the CCFM C&I system as a general guide, but to adapt it for implementation at a more local level. The objective was to create a set of criteria, indicators, and associated measures and thresholds that were supported by scientifically credible data, that could be evaluated at a range of spatial and temporal scales, and that could be used to quantitatively assess the

effectiveness of forest management strategies in sustaining a range of forest-related values at the TSA level. The monitoring and assessment programs associated with these C&I would incorporate important components of the adaptive management process for the Arrow sustainability framework (see Extension Note 1). The following section outlines the guiding principles that were used to develop this set of local-level criteria, indicators, measures, and thresholds.

## Guiding Principles for Developing Robust Criteria and Indicators

The C&I developed under the SFM framework were designed to describe the basic elements of a sustainably managed forest and measure progress toward achieving that condition. Stakeholder or public involvement at the management unit level is an essential element in the design of C&I that reflect local preferences or priorities. In implementing an SFM plan that uses a C&I approach, the chosen indicators and their associated measures and thresholds are intended to address important local issues which characterize the specific management units; stakeholders, managers, experts, and decision makers decide how different factors should be weighed in a socially acceptable way (Kneeshaw *et al.* 2000).

Because the resources required for sustainable forest management activities are likely limited, operational implementation was a key objective in developing the Arrow C&I. It was recognized that not all forest-related values could be addressed by even an extensive list of C&I. The objective, therefore, was to create indicators that were effective and efficient in measuring progress toward achieving the goals set by each criterion. Two directives were adopted to guide this process.

First, a performance-based approach was emphasized. Indicators used in practice generally fall under two broad types:

1. **Procedural indicators:** These are more prescriptive indicators, where the criterion or indicator is deemed to be met if specified tasks or procedures have been satisfactorily carried out (e.g., riparian buffers were flagged during harvesting).
2. **Performance-based indicators:** These indicators try to determine whether the desired levels of sustainability have been achieved (e.g., stream water quality was measured and related to desired levels). The measurement can be quantitative, qualitative, or a combination of both.

Effective indicators should be primarily of the second type. Type 1 indicators on their own are not acceptable since they do not attempt to directly measure sustainability, but simply indicate whether certain practices believed to contribute to sustainability have been carried out.

Second, “quality criteria,” or characteristics, were identified with which the indicators had to comply (Bunnell 1997, 2000; von Mirbach 2000). These indicators had to be:

- **Credible:** The measures of the indicator reliably interpret indicator status (i.e., indicators are relatively free of factors that introduce ambiguity or “noise”). The indicator is sensitive to change in forest conditions and shows trends over time. Future indicator levels are forecast with reasonable accuracy.
- **Measurable:** The indicator is measurable at an appropriate scale and with sufficient accuracy to be useful. Data for the indicator should be available.
- **Cost effective:** The cost of measuring this indicator is justified by the value of the information it provides.
- **Connected to forestry:** The indicator is responsive to forest management actions or practices.

Using these two directives, a list of potential criteria and indicators was developed and reviewed by professionals, academics, and forestry practitioners. The development and forest planning application of selected C&I is documented in Extension Notes 5, 6, 7, and 8. Local practitioners provided detailed reviews at several stages. A subset of the draft C&I was also tested at the local level in a public involvement pilot for planning and evaluating SFM scenarios in the Lemon Landscape Unit (Extension Note 3: Public Involvement Processes). At each stage, the C&I were revised to incorporate various comments and concerns. For example, members of local stakeholder groups felt that some of the C&I required clarification and identified concerns over specific issues, such as defining forest productivity more broadly, considering geotechnical hazards, and addressing multiple water quality values. The identification of these issues resulted in substantive changes to the C&I.

The C&I developed for the Arrow IFPA were separated into three categories of values: ecological, economic, and social. Criteria, and their associated indicators, were assigned under each value (see Table 1). Although integration of indicators is desirable (and strong correlation existed between many of the

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*Local stakeholder or public involvement at the management-unit level is an essential element in the design of C&I that reflect local preferences or priorities.*

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indicators), the selection of the three categories was a practical decision—it served as a preliminary organizational tool, in that each criterion was developed by different teams in different research fields, and it also reflected the lack of integration that existed between disciplines when the C&I were developed.

### Assessing Sustainability Using Criteria and Indicators: Thresholds

Criteria and indicators are integral to the evaluation of the long-term sustainability of both forest management activities and the forest-related resources affected by those activities. To create an SFM plan, estimates are required of the levels of the various resources that will be sustained. The indicators described by the plan identify these resources. The term “threshold” is used to specify the amount or level of a resource that will trigger a management action aimed at attaining or maintaining SFM goals and objectives. Amounts or levels of resources are determined by “measures,” a set of variables that, when measured or monitored over time, provide quantitative information about the status and (or) trend of an indicator, which is then compared to some sustainability target or desired future condition.

Thresholds act as an early warning that forest management practices are compromising a given indicator of SFM; that is, when measures violate threshold boundaries, remedial actions should be considered. Reaching a threshold does not imply irreparable damage; rather, it indicates the need to identify, and possibly implement, corrective management action.

For example, if amounts of a particular resource (e.g., density of large snags) fall below a specified level or threshold, the trend should be verified and changes to forest planning and practices should be considered. Similarly, if a defined harvested area exceeds a particular level or threshold of soil disturbance, then causes should be identified and practices altered to mitigate the impact (Bunnell 2004).

**TABLE 1.** Draft criteria and indicators of sustainable forest management in the Arrow TSA

ECOLOGICAL VALUES	
<i>CRITERION 1.</i>	<i>Biological richness and its associated values are sustained within the Arrow TSA.</i>
Indicator 1	Ecologically distinct ecosystem types are represented in an unmanaged state in the Arrow TSA to sustain lesser-known species and ecological functions
Indicator 2	The amount, distribution, and heterogeneity of habitat elements and landscape structure important to sustain biological richness is maintained in the Arrow TSA
Indicator 3	Productive populations of selected species or species guilds are well distributed throughout the range of their habitat in the Arrow TSA
<i>CRITERION 2.</i>	<i>Productivity of forests and associated soil resources within the Arrow TSA are sustained.</i>
Indicator 4	Areas disturbed in the timber harvesting land base (THLB) exhibit no net detrimental loss in productivity
Indicator 5	Adequate regeneration on the THLB is assured
Indicator 6	Soil productivity is sustained within the THLB
Indicator 7	Soil resources associated with resiliency of site productivity are maintained
Indicator 8	There is no net detrimental loss in productivity as a result of forestry-related slope instability
<i>CRITERION 3.</i>	<i>Forest ecosystem contributions to global ecological cycles are sustained.</i>
Indicator 9	Ecological cycles: The total forest area and area of water bodies within the Arrow TSA are sustained
Indicator 10	Carbon: [indicator under development]
ECONOMIC VALUES	
<i>CRITERION 4.</i>	<i>The long-term flow of economic benefits derived from Arrow TSA forests through the forest industry is sustained.</i>
Indicator 11	Timber harvesting continues to contribute to economic well-being
Indicator 12	Citizens (locally, regionally, and provincially) continue to receive a portion of the benefits
Indicator 13	Governments continue to receive a portion of the benefits
Indicator 14	A strong, diversified forest sector exists
<i>CRITERION 5.</i>	<i>The flow of non-timber economic benefits derived from Arrow TSA forests is sustained.</i>
Indicator 15	Amount and quality of non-timber forest values and benefits does not decline
Indicator 16	Access to non-timber forest values and benefits does not decline
<i>CRITERION 6.</i>	<i>Forest management contributes to a diversified local economy.</i>
Indicator 17	Employment and income sources and their contribution to the local economy continue to be diversified
SOCIAL VALUES	
<i>CRITERION 7.</i>	<i>The quality and quantity of water for consumptive use in the Arrow TSA are sustained.</i>
Indicator 18	Water quality in monitored watersheds does not fall outside the range of natural variability with respect to Drinking Water Guidelines
Indicator 19	Changes in stream flows do not limit existing licensed withdrawals for domestic use
<i>CRITERION 8.</i>	<i>Decisions guiding forest management on the Arrow TSA are informed by a wide range of social and cultural values, including those of First Nations.</i>
Indicator 20	Forest management on the Arrow TSA responds to a wide range of social values through effective planning processes that involve inclusive consultation with stakeholders
Indicator 21	Collective understanding by forest managers and public (area residents, stakeholders, and local interested parties) is increased through a collaborative planning process and an adaptive management program where information is exchanged (with stakeholders and local interested parties) to facilitate capacity building in the community
<i>CRITERION 9.</i>	<i>Forest management sustains ongoing opportunities for a range of quality-of-life benefits.</i>
Indicator 22	Resources and opportunities for recreation (including quality of experience) are maintained or enhanced
Indicator 23	Visual quality of harvested/managed landscape is acceptable to a broad range of stakeholders/visitors
Indicator 24	Forest management conserves unique or significant places and features of social, cultural, spiritual importance
Indicator 25	Worker and community safety is maintained within acceptable levels

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Initial thresholds can be estimated in the following three ways (from Bunnell 2004).

1. **Synthesizing the available data:** Data already collected by various groups, from government to consultants, can be synthesized and analyzed.
2. **Projecting known relationships:** Because the consequences of forest practices occur over long time periods and large areas, present conditions can have large future impacts. For example, the sustained provision of large snags 200 years from now requires that some trees be planted or designated to provide those future snags. Estimating sustained provision of a resource requires projecting relevant relationships using simulation models. In this example, relevant relationships include mortality rates, snag fall rates, and decay rates of trees.
3. **Formulating reasoned guesses:** Data are sometimes insufficient to permit reliable estimates of thresholds. For example, researchers relating coarse woody debris to forest-dwelling organisms have no agreed-upon protocols; therefore, studies are extremely difficult to summarize and compare. Although this makes extraction of a threshold difficult, it allows a reasoned guess to be made.

Thresholds should be estimated in such a way that corrective measures are still possible when the threshold is reached. As initial thresholds will be no more than estimates, continued monitoring may reveal that thresholds require adjustment. Some thresholds undergo continuous change (i.e., values held by different cultures) and, therefore, cannot be estimated adequately by any means. Several indicators relevant to Arrow IFPA Criterion 9 (Quality of Life) fall into this category. For example, some kinds of recreational activities, and the satisfaction gained from these activities, have shown consistent change and will continue to change. This prevents the specification of a threshold that will have long-term utility (Bunnell 2004).

Extension Note 4 describes the SFM basecase analysis, a project designed to evaluate how indicators can be applied to guide decision makers in the creation of SFM plans. In particular, it details the evaluation of initial thresholds developed for multiple indicators under a forest management scenario in a small geographic area in the Arrow TSA.

## Using Criteria and Indicators in Sustainable Forest Management Planning

Criteria and indicators provide a comprehensive set of measurable objectives for sustainable forest management. They are used during the following three stages of forest planning and management (Extension Note 1).

1. **Formulating comprehensive forest management plans:** The use of criteria helps to explicitly recognize aspects of each value the plan is intended to sustain and to concisely communicate the intent of the plan.
2. **Decision support in planning:** The use of models, expert evaluation, and public input supports the design of future scenarios that are intended to meet certain criteria, predict their consequences over time (expected success in meeting all criteria and indicators), and inform decision making.
3. **Monitoring and adaptive management:** The appraisal of success in meeting management objectives leads to changes in management practices and the refinement of indicators and thresholds.

This extension note series summarizes an example of the application of criteria and indicators in stages 1 and 2. As a sustainable forest management plan is implemented for the Arrow TSA, the indicators and their associated measures will be used to guide monitoring and adaptive management activities.

## Future Directions

The criteria and indicators developed for the Arrow IFPA Sustainability Project are preliminary. Their development is an evolving and iterative process that will be shaped both by their testing and application in forest management planning, and by public review processes. In testing the effectiveness and practicality of the indicators, locally relevant measures and thresholds will continue to be developed. Their application in decision-support processes, in monitoring, and in other adaptive management activities will determine the utility of the C&I system in evaluating the effectiveness of forest

management planning. Specifically, work will be required to establish relationships between the measurements collected through monitoring programs and assessments of the sustainability of given management strategies both in present and future terms. Predicting the effects of management decisions will be an important component to ensure that C&I inform sustainable forest management programs implemented at the local level.

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## Test Your Knowledge . . .

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### *Arrow IFPA Series: Note 2 of 8 – Developing criteria and indicators of sustainable forest management in the Arrow Forest District*

How well can you recall some of the main messages in the preceding extension note?

Test your knowledge by answering the following questions. Answers are at the bottom of the page.

1. How is the use of criteria and indicators different from previous approaches to setting management objectives for forest planning in British Columbia?
  - A) C&I use quantitative rather than qualitative measurements to assess progress towards meeting management objectives
  - B) C&I are used to set specific management objectives; progress towards meeting the objectives is assessed using performance-based indicators rather than a compliance or procedural approach to evaluating management practices
  - C) C&I are not related to any legislative or regulatory requirements associated with forest management
  
2. How might thresholds be used in assessing the effectiveness of forest management practices to achieve goals?
  - A) Thresholds reveal information about which measures can be considered procedural and based on performance
  - B) Thresholds are the basis for forecasting the temporal patterns of change in a measure under a given forest management scenario
  - C) When the level of a particular resource approaches a threshold, it indicates that current management strategies may not be effective in sustaining desired or target resources or forest conditions
  
3. What are the characteristics of good indicators and measures of sustainable forest management?
  - A) Measurable, credible, cost effective, connected to forestry
  - B) Measurable, can be forecast, available data, connected to forestry
  - C) Measurable, credible, can be mapped, connected to forestry

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**ANSWERS**

1. B 2. C 3. A