Extension Note

BC Journal of Ecosystems and Management

Arrow IFPA Series: Note 1 of 8

A framework for sustainable forest management

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Abstract

This extension note is the first in a series of eight that describes a set of tools and processes developed to support sustainable forest management planning and its pilot application in the Arrow Timber Supply Area (TSA). Conducted under the Arrow Innovative Forestry Practices Agreement (IFPA) Sustainability Project, and initiated by an interdisciplinary team of academics and practitioners, the "Sustainable Forest Management Framework" offers a comprehensive approach to forest management planning that is also applicable in other parts of British Columbia. Throughout the planning to monitoring process, it uses criteria and indicators as a means of developing and implementing forest management strategies with clear goals and objectives. In this way, forest practitioners can achieve measurable and effective results for identified forest resource values. The framework also incorporates a hierarchical planning process to address these goals and objectives at various spatial and temporal scales, and is supported by a suite of decision-support tools and procedures, including scenario planning, integrated modelling, public multi-criteria analysis, and trade-off analysis. Within this framework, public participation is integrated throughout the planning process.

During the life of the IFPA, aspects of this framework were tested in the Arrow TSA and it has been used operationally as part of Canfor's certification effort. Although this approach has received strong support from academic and management circles and promises to provide an objective approach to sustainable forest management, some features have not yet been implemented. The proposed framework is a work-in-progress that evolves as more components of the framework are tested and outcomes evaluated.

KEYWORDS: *criteria and indicators, decision support, forestry planning, sustainability, sustainable forest management.*

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Introduction

British Columbia's provincial government has implemented forestry policies in response to a wide range of external pressures. Often the outcome of these policies is unknown. Current policies place considerable responsibility in the hands of forest companies to manage resources appropriately. Forest certification systems are continually evolving to support market acceptability based on sustainability. Therefore, a need exists for an objective framework that will evaluate the long-term effects of forest practices, planning, and policy on important ecological, economic, and social values, and that will also guide the development of forest resource management strategies to achieve the short-, medium-, and long-term goals of sustainable forest management.

A robust, credible, and comprehensive framework for forest management is required to clearly and quantitatively demonstrate to local communities, and to national and international interests, how British Columbia's forests are managed. In particular, how will a balance be struck between competing values, and how will uncertainties (due to complexity or lack of knowledge) be addressed? This framework should not be a prescriptive, global set of rules. Instead, it should provide a flexible structure for developing regionally suitable and innovative approaches that will achieve satisfactory performance in forest management.

A robust, credible, and comprehensive framework for forest management is required to clearly and quantitatively demonstrate to local communities, and to national and international interests, how British Columbia's forests are managed.

From 1999 to 2003, an interdisciplinary team of scientists from the University of British Columbia was involved in the Arrow Innovative Forestry Practices Agreement (IFPA) Sustainability Project (see sidebar). The Project's goal was to work towards a scientifically defensible, collaborative, and comprehensive approach to developing a sustainable forest management (SFM) framework for use in British Columbia. This framework, initiated jointly by scientists and practitioners, responded to a need for scientific credibility, social acceptability, and operational feasibility. It reflects the input of professionals from various provincial and local government agencies, multiple licensees, local specialists, and stakeholders.

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) 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.

* 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.

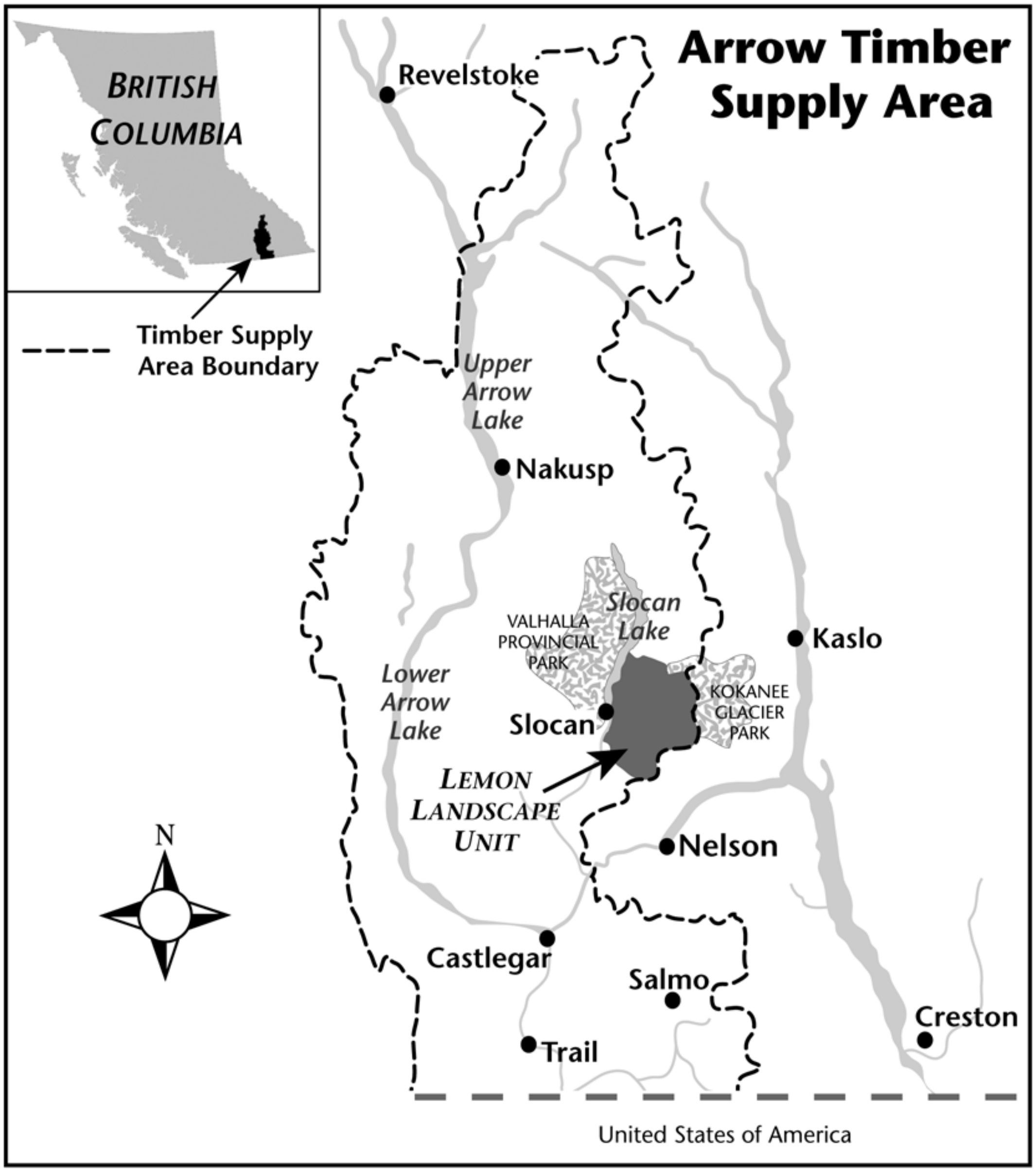

FIGURE 1. The Arrow Timber Supply Area in southwestern British Columbia.

This extension note, the first in a series of eight, sets out the rationale and assumptions for the SFM framework. The framework uses criteria and indicators (C&I) of sustainability that are systematically integrated into the process from planning to monitoring. The planning elements of the framework are built around three concepts:

1. a clearly integrated hierarchical planning structure,
2. a suite of decision-support and public-participation approaches that can be used at the most appropriate planning level, and
3. an overarching adaptive management system.

Various aspects of this conceptual framework have been tested in the Arrow Timber Supply Area (TSA).

The accompanying extension notes in this series serve to outline the application of the framework's principles and to provide details of a case study undertaken in the Arrow TSA's Lemon Landscape Unit (see Figure 1). The notes describe the generation of performance-based C&I for use in:

- the design of forest management strategies (Extension Note 2);

- the design of innovative approaches to public involvement processes (Extension Note 3);
- the design and analysis of an SFM scenario in the Lemon Landscape Unit through an integrated computer-modelling approach (Extension Note 4); and
- the analysis of selected indicators of sustainability under the SFM scenario, including biodiversity (Extension Note 5), ecosystem productivity (Extension Note 6), timber economics (Extension Note 7), and quality-of-life benefits (Extension Note 8).

These extension notes are intended to introduce resource managers, public advisory groups, First Nations, and the general public to the rationale behind the SFM framework.

Context

The original concept behind the framework was to describe a process for developing SFM-related management activities, regardless of existing legislation or certification requirements. When the IFPA's Sustainability Project began, no comprehensive mechanisms for SFM existed at the operational and tactical planning levels. Since its development, divisions of Canfor and BC Timber Sales have used the framework to refine their SFM plans for Canadian Standards Association (CSA) certification. As well, a Memorandum of Understanding was established with the [former] British Columbia Ministry of Sustainable Resource Management to use the framework approach in revising the broader Kootenay Boundary Land Use Plan. Both of these uses are a start at integrating the conceptual framework with existing management and legislative needs. Further work is needed to build linkages between the framework, land use planning, tactical analysis, and operational implementation.

The Role Of "Science"

Academic and consultant researchers have played an important role in developing the rationale behind the various components of the SFM framework and in establishing scientific rigour within each project. The extension notes mention the role of science as an important component of the framework. Essentially, resource managers are looking to "science" to provide a transparent and independently designed basis for the framework's components and to establish credible rationales for the choice of criteria, indicators, measures and their associated targets, and monitoring approaches in advance of their implementation.

Criteria and Indicators of Sustainable Forest Management

Based on existing definitions (Canadian Council of Forest Ministers 1997; Natural Resources Canada 2001), sustainable forest management is defined as:

> *Balanced, concurrent sustainability of forestry-related ecological, social and economic values for a defined area over a defined time frame.*

Criteria and indicators of sustainable forest management are used to provide a strategic and systematic means of evaluating forest management and policy options, and to foster the development of adaptive management programs (Canadian Council of Forest Ministers 1997; Prabhu *et al.* 1999). This approach differs from previous management approaches in that it is explicitly results-based and comprehensive, and focusses on clearly defined performance criteria (management objectives) and indicators (which determine whether objectives are met). Monitoring that uses indicators and their measures is a results-based approach, as opposed to compliance monitoring, which is a rules-based approach.

The SFM framework incorporates a set of C&I that will measure and demonstrate the sustainability of economic, ecological, and social values in a forest management unit (i.e., the Arrow Timber Supply Area) (see Extension Note 2). Criteria represent important management goals, the achievement of which is proven through the repeated, long-term measurement of associated indicators. Indicators assess the success of meeting SFM criteria across a balance of ecological, economic, and social dimensions. These C&I are preliminary and their development is an evolving and iterative process that is shaped by testing and application in forest management planning, and by public review processes.

Setting Thresholds

To create an SFM plan, estimates are required of the levels and quality 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 in relation to thresholds. Initial thresholds are estimated by various methods (see Figure 2; Extension Note 2).

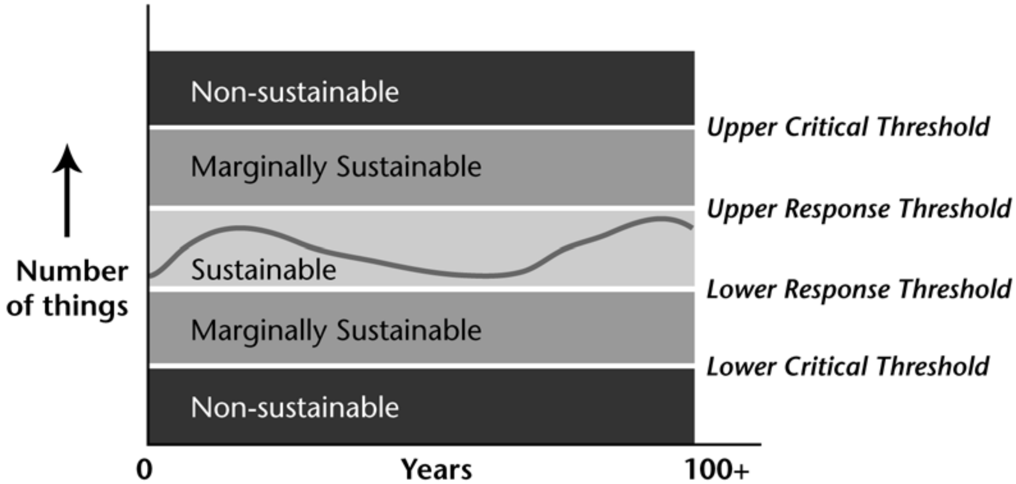

FIGURE 2. Definition of indicator thresholds and (or) targets applies to the individual measures under each indicator. The current condition for each indicator is first quantified; this provides a baseline, or starting point, for formulating thresholds or targets for each measure (Source: Jeakins *et al.* 2004).

The goal of sustainable forest management is to achieve desired future conditions in which all established criteria are met. Under the framework, desired future conditions are defined as sets of thresholds established for multiple indicators. Initial thresholds can be modified to reflect public values or tolerance of risk. The upper or lower thresholds for each indicator create a range of acceptable conditions within which we actively manage to maintain the status of the indicator. Defining explicit and meaningful measures or thresholds calls for some experimentation; this is particularly true for social indicators, given the province's limited experience with social C&I (see Extension Note 8).

Because SFM is a process and not an endpoint in itself, thresholds, and therefore desired future conditions, will change with evaluation and shifting social values. The concept of desired future conditions is useful because it provides "goalposts" or target ranges (reflecting current best scientific knowledge) for which forest managers must aim.

Application of Criteria and Indicators

Criteria and indicators provide a comprehensive set of targets for SFM and are used at three main stages in forest planning and management.

1. **Formulating comprehensive forest management plans –** The use of criteria serves to facilitate explicit recognition of aspects of each value the plan is intended to sustain and to communicate the intent of the plan concisely.
2. **Decision support in selecting preferred plans –** The use of models, expert evaluation, and public input serves to design future scenarios, predict their consequences over time, and thus inform decision making.
3. **Ongoing monitoring and adaptive management –** The appraisal of success in meeting management objectives leads to changes in management practices and helps to define indicators and thresholds.

Hierarchical Planning

An important component of an SFM framework is the implementation of hierarchical planning. As defined by Barber *et al.* (1996): "[a] hierarchical approach is based on a sequential and iterative process, rather than [a] simultaneous one for solving [an] integrated forest planning problem." A hierarchical approach encourages resource managers to organize information for each management level, ensuring that the levels are linked, integrated, and efficient (see Figure 3). Levels are defined temporally and spatially, where the scope of the higher level fully encompasses the scope of the lower level (Connelly 1996).

The various levels of planning must be clearly related to each other; the appropriate decisions must include an apt level of detail and must be supported by suitable data and procedures. Overarching regional priorities, as provided in Higher Level Plans for example, provide direction for local management units. The scientific results of monitoring at the operational level feed back to the policy level where changes are made

FIGURE 3. From strategic to operational, the nested interactive levels of hierarchical planning (Source: Jeakins *et al.* 2004).

(Oliver *et al.* 2001). Although certain issues, such as timber supply for mills or networks of wildlife corridors, are best handled at the tactical level, others are unique to local circumstances. For the purpose of SFM in the Arrow IFPA, three levels of planning were:

1. Strategic (e.g., at the management unit or regional level, such as the Tree Farm Licence [TFL] or TSA level [usually 200 000 ha or more])
2. Tactical (e.g., at the level of one or more landscape units)
3. Operational (e.g., at the day-to-day planning level for licensees involved in management activities, such as harvesting layouts, silviculture, and road design)

Starting at the strategic level, the tasks and information at each planning level result in the definition of progressively more specific management outcomes. In the SFM framework, strategic planning sets out broad, long-term objectives or desired future conditions for a number of indicators in single or multiple management units. Tactical planning supports both the strategic level and the operational level by generating alternative scenarios based on strategic direction, identifying a preferred alternative, and then translating strategies to achieve the desired conditions through best management practices at the operational level. The operational level then provides direction for on-the-ground, annual, and day-to-day forestry activities.

The following sections describe how the SFM framework conceptualizes the relationship of C&I to these various planning levels.

Strategic-level Forest Management Planning

According to Barber *et al.* (1996), the primary function of strategic-level planning is "to analyze forest-wide issues, concerns and opportunities, allocate lands, adopt standards and guidelines, establish production levels for outputs and describe environmental effects." Strategic planning thus establishes broad goals and priorities over a larger area and a longer time frame than the other levels of planning. These broad goals and priorities can be interpreted as the criteria, or management goals, that establish the appropriate regional or local balance of resource values. They also define the management emphasis to be followed at the next level of forest management planning in the various landscape units or planning zones (areas suitable for a particular resource emphasis). Public participation processes are critical at this level (see Extension Note 3). The strategic level is often associated with provincial and regional land use planning efforts, such as Land and Resource Management Plans (LRMP) and Land Use Plans (LUP).

Tactical-level Planning

The primary functions of tactical-level planning, according to Barber *et al.* (1996), are:

- to spatially disaggregate or allocate the strategic plan;
- to adjust or reschedule the strategic plan if local thresholds are exceeded; and
- to analyze connected actions and cumulative effects on an area that may extend beyond the boundaries of the designated tactical planning area.

Tactical planning units are linked with each other to meet the broad goals of the strategic plan. Some indicators are best developed and refined at this level.

Under the proposed SFM framework, the development of tactical-level plans leads to the delineation of:

1. a timber harvesting land base (THLB), in which timber harvesting is allowed under certain conditions, and
2. a non-harvesting land base (NHLB), in which reserves are dedicated for non-timber uses and resource values.

The definition of THLB and NHLB areas is an iterative process. The initial NHLB is comprised of inoperable

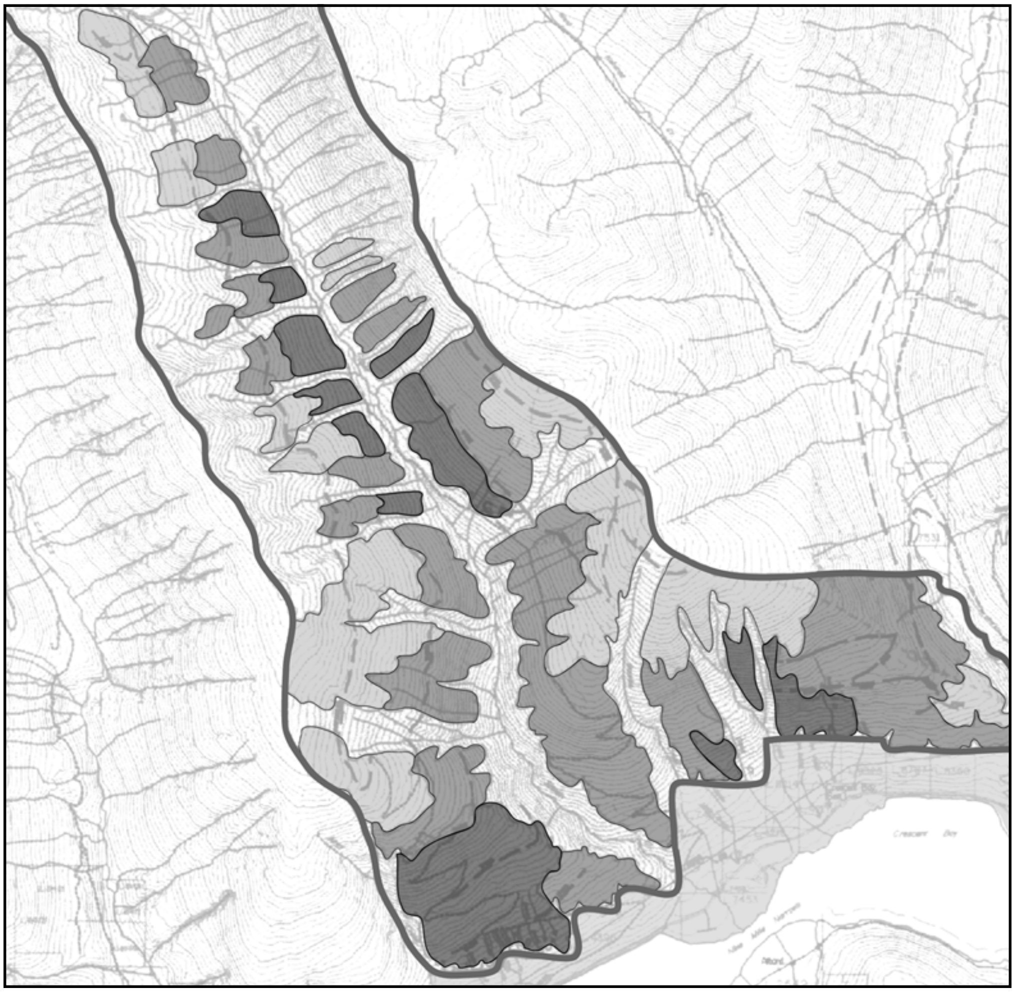

FIGURE 4. Operational sustainable forest management map, Kootenay Lake Forest District. The different shades of gray indicate different best management practices for the THLB.

areas, operable areas in which only salvage harvesting would be permitted, parks and other reserves, and areas of concern (e.g., areas with highly unstable slopes). Indicators are used to define additional areas or the conditions under which clear or unacceptable risks exist of exceeding thresholds due to management activity. From the outset, therefore, these critical environmental and social resource values set the "footprint," or the maximum limit of sustainable harvesting, and form the first level of resource protection, effectively restricting harvesting to the least damaging and most suitable areas.

Once the NHLB and THLB are established, the contribution of each toward meeting sustainability targets can be analyzed. Understanding the contribution of the NHLB towards meeting targets allows managers to quantify target deficits and thus to develop best management practices in the THLB as the second level of resource protection, or to modify the THLB boundaries, if necessary. This, in turn, means that not all strategic requirements may need to be met on every cutblock. Thresholds must be met within the management unit and be based on contributions from both the NHLB and THLB over time. Figure 4 shows a map of the NHLB and THLB for an operational chart area in the Kootenay Lake Forest District. The major considerations for the development of the NHLB included community watersheds, visuals, fish and grizzly bear habitat, and a growing Douglas-fir bark beetle population.

As at the strategic level, tactical-level planning involves forecast modelling to test management options across time and space (see Extension Note 4).

Stakeholders and area residents must be closely involved at the tactical level to identify local information and concerns that may not be emphasized at the strategic level (see Extension Note 3). Although strategic-level plans need not be changed frequently in response to tactical-level planning decisions, management emphasis and practices may require modification to take local issues into account.

Operational-level Planning

The operational-level planning reflects the on-the-ground imprint of all strategic management policy and tactical-level planning and has the shortest planning horizon. Resource managers have the most input at this planning level and usually guide the detailed location of roads and cutblocks in relation to other resource value needs.

This level of planning provides flexibility for resource managers to ensure efficient field operations. Tactical-level planning defines the THLB area, best management practices to achieve desired future conditions, and management objectives that were set at the strategic level. Operational implementation allows licensees to harvest sustainably where and when markets and efficiencies dictate, within the confines of the tactical plan and in a manner consistent with the strategic-level plan. The operational planning level adheres to all required legislation, but acts more as a reporting function than as a mechanism to approve operations. Licensees still collect site-specific information for harvest areas and show how roads will be developed and how regeneration will occur. The operational level is where much of the monitoring of sustainable performance occurs, although some indicators must be measured at both the tactical and strategic levels.

It is often assumed that the three SFM planning levels proceed in a linear temporal sequence. In reality, however, some degree of activity must proceed simultaneously at all three levels. With integrated resource modelling systems, which can operate across geographic scales, it is increasingly feasible to track the interactions between levels for key indicators and to support adaptive management by providing linkages from the strategic level down or from the operational level up. One of the major advantages of hierarchical planning is that it permits the disaggregation of certain actions that would confuse each other when aggregated in the same level; for instance, some resource management objectives can be addressed at the strategic level and others can be left until the tactical or even operational level.

The most successful participatory methods engage the public in a collaborative dialogue from the earliest stages of planning, and provide a fully transparent decision-making process.

Public Participation

An important component of sustainable forest management is that public participation must be more fully integrated into planning systems for public forest land (Hamersley Chambers and Beckley 2003). The most successful participatory methods engage the public in a collaborative dialogue from the earliest stages of planning and provide a fully transparent decision-making process. One of the first steps is the stakeholder analysis—that is, explicitly identifying groups that should be involved in whatever type of planning is done for a particular geographic area.

Work undertaken in strategic- and tactical-level planning is intended to provide assurances to government, stakeholders, and residents that timber removal and road construction will not affect the protection or maintenance of other significant forest-related resource values and attributes. If greater design flexibility at the operational level is to be acceptable to the public, then in-depth communication and participatory planning is required. Public access to monitoring information derived at the operational level is crucial to maintaining public support for SFM (Sheppard 2003).

A set of participatory methods is available to suit different levels of planning, stages in the process, and the local context (Sheppard and Achiam 2004). Some of these methods have been tested under the Arrow Sustainability Project (see Extension Note 3); however, the design and implementation of the SFM framework as a whole has not yet been tested against public opinion. Implementation in other regions of British Columbia should provide that opportunity.

Decision-support Approaches

At each planning level, a suite of decision-support tools and procedures is required. These include scenario planning and design, integrated modelling and scenario analysis, and some form of multi-criteria analysis to combine the potentially numerous analyses of multiple resource values into a single decision (i.e., to modify, approve, or not approve a plan). The SFM framework incorporates the systematic development and assessment of alternative forest management scenarios against C&I. The following sections outline some of the decision-support tools and procedures applied and tested under the Sustainability Project.

Scenario Planning and Development

Forest management scenarios represent different potential plans for future management of the forest land base, and enable prediction and analysis to determine preferred (or legally required) solutions for SFM. These comparative analyses aim to clearly demonstrate sensitivities to certain forest management proposals or assessment criteria, both to experts and to the public. Scenarios can range from theoretical concepts with general zoning at the strategic level, in which specific spatially located targets are *not* set, to detailed variations that use spatially located targets resulting from carefully designed analyses at the tactical and operational levels.

In the Sustainability Project, alternative scenarios for analysis were developed through informal group workshop techniques (e.g., applying operational local knowledge to identify suitable management zones) and through more comprehensive processes of C&I-based tactical-level planning. Extension Note 4 in this series describes the SFM pilot basecase analysis, a project designed to evaluate how indicators can be applied to guide decision makers in developing sustainable forest management plans.

Integrated Modelling for Scenario Analysis

Modelling tools are required to undertake scenario analyses to support planning at both strategic and tactical levels (Nelson 2003a). These analyses will then guide operations. Selection of the appropriate spatial scales will depend on the indicator in question. For example, timber supply analyses are appropriately applied to large areas (e.g., TSA) over long time periods (two rotations), whereas projections of visual characteristics of different harvesting methods might best be applied at the small watershed or cut-block scale and only over a relatively short time period.

> *The SFM framework incorporates the systematic development and assessment of alternative forest management scenarios against criteria and indicators.*

The Sustainability Project used several models, including:

- ATLAS, a model for spatial allocation and harvest scheduling (Nelson 2003b);
- FORECAST, a model for growth and yield predictions (Kimmins *et al.* 1999); and
- SIMFOR, a model for predicting wildlife habitat dynamics (Wells and Moy 2002).

These tools were applied in the SFM pilot basecase analysis. This analysis explored tactical-level questions in which indicators defined management objectives and thresholds (see Extension Note 4). Computer-generated landscape visualizations, which provided realistic views of future landscape conditions, were also used to demonstrate modelling results more understandably (see Extension Note 8). This exercise represented the first time that these specific decision-support tools were used to comprehensively investigate the spatial and temporal analysis of forest management planning.

Trade-off Analysis and Multi-criteria Analysis

Scenario planning and analysis identifies priority issues in which conflicts exist among indicators or uncertainties in outcomes are large. Trade-offs between competing resource values, management objectives, or identified criteria are required when these values, objectives, or criteria cannot be simultaneously achieved through design or the spatial and temporal allocation of activities. Not all potential trade-offs are feasible or within the control of the forest manager; decision makers must choose among available options when resources are limited. Trade-off analysis is therefore fundamental to sustainable forest management. It can take place at various levels in the planning hierarchy, either as a formal process for deciding among often controversial strategic alternatives, or as a more informal activity undertaken by an interdisciplinary team to develop tactical SFM plans.

Multi-criteria analysis (MCA) is a decision-support tool developed for complex problems involving trade-offs between multiple objectives. It is used for situations in which both quantitative and qualitative aspects of a problem must be addressed (Mendoza *et al.* 1999). Multi-criteria analysis involves evaluation of alternative management scenarios across a range of C&I, and uses various methods of evaluating overall scenario performance. Its matrix format allows a clear and systematic comparison across scenarios and C&I. In its modern participatory form, MCA provides a structured and transparent process for combining multi-disciplinary expert evaluations (the technical component) and stakeholder priorities (public process) to support decision making. This process may also lead to increased stakeholder inclusion and acceptance of resource management decisions (Brown *et al*. 2001). In the Lemon Landscape Unit, experts assessed the relative sustainability of scenarios on fundamental criteria that were prioritized by stakeholders. This enabled the team to weigh different scenarios and identify an overall preferred scenario. Details of the MCA approach and criteria weightings used in the Sustainability Project are provided in Extension Note 3 (see also Sheppard and Meitner 2005). Its application was intended primarily to highlight and simplify general trade-offs for consideration and public engagement in planning. More in-depth forms of trade-off analysis are available for use in SFM, though their suitability for different purposes is still unknown.

Adaptive Management

The social, ecological, and economic forces operating in forest resource management are not static. As our management strategies affect forest resources over time, managers must be ready to adapt. This adaptation ensures that we continue to move toward concurrent sustainability of social, ecological, and economic values.

In planning, various elements of sustainable forestry must be evaluated at different scales and time steps, using predictive models wherever possible. Broad goals will not apply to each cutblock, but to the tenure as a whole. Assessments cannot occur everywhere; therefore, they must be designed so that they can be "scaled up" to larger areas. Although this process most often relies on computer projections, prediction is not consistently possible. Moreover, for large groups of organisms (e.g., invertebrates and fungi), too little is known to make useful predictions for more than a very small portion of the group. Undesirable conditions can often be identified, though no unequivocal target can be specified. For example, total commitment of an ecosystem type to harvest is undesirable, but the amount that should be reserved from harvest is equivocal. In these cases, thresholds used to provide early warnings must be considered heuristic rather than absolute.

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Active adaptive management experiments (Walters 1986), which are specifically designed by academics, government managers, or experts to better inform forest practices, are an integral part of SFM. As well, evaluations invoking retrospective sampling or computer simulation, termed *passive adaptive management*, are also used by resource managers. The term "passive" indicates only the absence of a designed experiment. The sampling still requires careful design. Adaptive management must also be applied to the results of monitoring social indicators including levels of public satisfaction or acceptability for forest management practices.

Monitoring of indicators and research activities are important components of the SFM framework's adaptive management program, and a crucial component of a science-based management model. Most monitoring will take place at the operational level, though some indicators (e.g., representation of ecological types) apply at all levels. Analysis, forecasting, and research should take place at the tactical level. An adaptive management panel, composed of researchers, government agency and licensee staff, and stakeholders, would ideally operate at the strategic level. Based on information received from tactical-level managers and on emerging priorities, such as natural disturbance and climate change, the panel would determine whether changes are needed to the SFM framework, C&I, thresholds, monitoring, or forecasting techniques.

Once the strategic and tactical components of the SFM framework are in place, resource managers can begin adapting their existing operational strategies. This will entail the development and implementation of best management practices that are designed to meet C&I thresholds and targets. Best management practices, developed by resource professionals and managers, will reflect the requirements and social priorities set out at the strategic and tactical levels to achieve the overall objectives of the SFM framework, as well as the different management priorities in various parts of a management unit. In an adaptive management framework, best management practices reflect the current best guesses, and are effectively hypotheses that can be tested through monitoring and adaptive management experiments.

Lessons Learned

The spatial-temporal modelling, combined with computer-generated visualizations, aided stakeholders with different levels of expertise to grasp the big picture on different SFM plans. These techniques generally helped to underpin the scientific credibility of the exercise, although only a limited range of values were addressed in the models. When a transparent and comprehensive approach is taken, the case study methods demonstrated that civilized public participation is possible even in highly polarized communities. In this case, it led to clear, shared preferences for certain scenarios and improved the awareness of both forest managers and the public. This study also demonstrated practical methods of quantifying and forecasting social sustainability indicators that had previously been considered "fuzzy" or impossible to integrate.

Furthermore, the C&I framework facilitates a science-based management model. In this framework, the indicators drive the decision-support approach, exposing conflicts among indicators. This, in turn, provides a clear focus for developing credible thresholds and incorporating science-based monitoring, adaptive management experiments, and MCA into the management framework.

Future Directions

The Lemon Landscape Unit case study detailed in Extension Notes 3–8 demonstrates that components of the SFM framework can be applied successfully to support a planning framework. The case study was limited in scope to a relatively small planning unit, and focussed on the tactical level of the planning hierarchy; however, it would be possible (and necessary) to scale up to the TSA level and to develop strategic objectives over the larger management unit based on the C&I framework (e.g., determining strategic biodiversity, economic, and social objectives for the TSA). These strategic objectives would drive the more detailed, tactical-level planning that was the focus of our example. Finally, the landscape-level results from the case study could guide the development operational-level plans.

The Lemon Landscape Unit case study demonstrates that components of the SFM framework can be applied successfully to support a planning framework.

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Considerable progress has been made towards outlining a critical and objective framework to evaluate the long-term effects of forest practices, planning, and policy on important ecological, economic, and social values. This approach should also guide the development of forest resource management strategies to achieve short-, medium-, and long-term goals. In using C&I to drive planning processes, we have moved much closer towards quantitatively assessing success in meeting goals identified through a scientifically defensible, transparent, and accountable process, as demonstrated in the MCA and the SFM pilot basecase analysis pilots.

Some aspects of the SFM framework remain largely conceptual, however. For example, the hierarchical planning process, which implements strategic goals in actual space within tactical planning units and informs operational practices, has not been tested. Versions of this framework are now undergoing tests in various locations in British Columbia; the framework's effectiveness should be documented as part of a continuous learning process. Further work is necessary to complete the C&I that will drive the planning process. A significant challenge exists in establishing the thresholds that will be required to set real management targets. Inevitably, public acceptance of the framework and proposed planning processes must be achieved.

Further collaborative projects are under way between the University of British Columbia and Canfor, including modelling approaches, MCA and trade-off studies, recreation user surveys conducted in the Arrow and northeast British Columbia, and a current (2006) series of community public opinion surveys adapted from the original survey mentioned in these extension notes.

Canfor has ongoing partnerships with public advisory groups, other licensees, and BC Timber Sales in the development of SFM plans using the framework as an overall guide. As well, Canfor used the framework to develop business cases for proposed project expenditures related to SFM. Canfor has worked with FORREX and the Common Ground Initiative partners in the analysis of existing C&I in British Columbia and the SFM framework was used as a case study in various fora.

As one of the first comprehensive interdisciplinary efforts between University of British Columbia scientists, forest managers, and other stakeholders, much can be learned from the experience of developing the SFM framework in the Arrow TSA. It serves as an important precedent for integrating science and management in the search for sustainability.

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Test Your Knowledge . . .

Arrow IFPA Series: Note 1 of 8 – A framework for sustainable forest management

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. The role of "science" is mentioned in this extension note. What do the authors suggest resource managers look to science for?

2. What are the criteria and indicators mentioned in the note meant to be used for?

3. What are the three levels of hierarchical planning?

4. How does the public participate in the proposed SFM framework?

5. What is the point of a trade-off analysis?

Answers

1. Resource managers are looking for "science" to provide a transparent and independently designed underpinning to the components of the SFM framework and to develop credible rationales for the choice of criteria, indicators, measures and their associated targets, and monitoring approaches in advance of their implementation.

2. The SFM framework has developed a set of criteria and indicators that will be used to measure and demonstrate the sustainability of economic, ecological, and social values in a forest management unit.

3. Strategic, tactical, and operational.

4. The work undertaken at the strategic and tactical levels of planning is intended to provide assurance to government, stakeholders, and residents that timber removal and road construction will not affect the protection or maintenance of other important forest-related resource values and attributes. If greater design flexibility at the operational level is to be acceptable to the public, then in-depth communication and participatory planning is required. Public access to monitoring information derived at the operational level will be crucial to maintaining public support for sustainable forest management.

5. Trade-offs between competing resource values, management objectives, or identified criteria are required when values, objectives, or criteria cannot be simultaneously achieved through design or spatial/temporal allocation of activities.