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Integrating socio-economic and ecological indicators of sustainability: Bridging boundaries between groups and fields of expertise

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Integrating socio-economic and ecological indicators of sustainability: Bridging boundaries between groups and fields of expertise

S.H. Yamasaki, D.D. Kneeshaw, and A.D. Munson

Preamble

A meeting on criteria and indicators (C&I) of sustainable forest management (SFM), organized by the Sustainable Forest Management Network (SFMN) was held in Trois-Rivières, Forestry Capital of Canada for the year 2001. The meeting began on Sunday, February 11th and carried on through Monday the 12th. The conference was scheduled to coincide with a regional (Québec and eastern Ontario) Canadian Model Forest Network (CMFN) Workshop, and events of the 12th were organized collaboratively between the SFMN and CMFN. CMFN events continued through to the 13th. The meeting involved presentations followed by questions and discussion (on the 11th and 12th), as well as workshops (on the 13th) [1]. Simultaneous translation was provided by the Canadian Forest Service (CFS) and CMFN and to the benefit of many participants. Over the course of the meeting,140 people attended.

In all, 21 talks were presented to participants[2]. The topics covered included the development of biophysical, social, and economic indicators of SFM; frameworks and tools for the application and monitoring of indicators; and institutional challenges for the implementation of C&I and SFM in general. The diversity and experience of participants ensured a well-balanced and pointed discussion on the many aspects of each of the topics. In this report, we summarize conference presentations, identify challenges for C&I development and solutions proposed by participants, and present some institutional, societal, and technological obstacles that impede our evolution towards SFM made evident by the discussions that occurred during the meeting.

Introduction

Initiatives at the national and international level have encouraged Canadian forestry researchers to elaborate frameworks for the development and implementation of C&I (Riley, 1995). The importance of achieving sustainability in forestry and the complexity of human and ecosystem interaction has led to many diversified approaches to the development of C&I. For this reason, the SFMN organized a meeting for researchers, the forest industry, and other interested parties in order to promote communication and collaboration among those involved in C&I research and development. The principal objective of the meeting was to stimulate discussion on the development of C&I of SFM, on their integration and modelling. Three themes were addressed: biodiversity, the biophysical environment, and society. A second important objective of the conference was to promote linkages among research groups involved in the development of C&I and

[1] A detailed program of events is included as appendix A to this document.
[2] Abstracts from these presentations are provided in appendix B.

the CMFN. The conference was organized in close collaboration with the CMFN and attracted participants from universities, government, industry, and model forests from across Canada. Presentations and discussions brought forward many key challenges and potential solutions for the development of SFM in Canada. The highlights of the presentations and discussions are presented here.

Highlights from the presentations

It is becoming evident that the development of effective SFM requires a multidisciplinary approach (Côté et al. 2001). The following sections present highlights of presentations addressing issues relating to (i) biophysical ecosystem components, (ii) society and economic, and (iii) tools and frameworks for the implementation of C&I.

(i) Biophysical ecosystem components and the development of C&I

The presentations dealing with biophysical indicators exhibited a diversity of approaches and perspectives ranging from the genome to forested watersheds. Several themes emerged from these presentations, themes that reflected the perspectives of research, government and industry.

a) Characteristics of "ideal" indicators

Some of the most desirable characteristics of indicators identified include ease of measurement, the ability to be linked to management, and scalability (Williams, Fyles, Dorion, Cantin). Fyles invoked the "pick-up truck test", (which became a popular image for most of the workshop), illustrating the idea that the forest manager should not have to go beyond the truck door to verify if he/she is meeting thresholds associated with an indicator. Williams presented the process he used to screen indicators for the Lake Abitibi Model Forest; criteria used for retaining indicators (57 as a final total) included understandability, relevance and response to management, cost, measurability, predictability, early warning capability, scientific soundness and that indicator values should be comparable to known threshold values. These latter three criteria may be where the SFMN has the largest role to play.

Two elegant examples of indicators and approaches to monitoring were presented by Joyce (genetic diversity) and Plamondon (hydrological processes). Ontario has put in place a Genetic Resource Management Program, that includes principles for conserving genetic diversity, and combines population management and considerations of landscape ecology. Other provinces looking to develop a coherent strategy for conserving genetic diversity could examine this model. At the other end of the biophysical spectrum, Plamondon presented a simple photo-interpretable indicator, the "equivalent harvest area", which represents a threshold of harvest on a watershed basis, that should not be surpassed if one wants to avoid flooding and associated sedimentation beyond the normal limits of water courses in that watershed. Having tested this indicator in the experimental forest of Forêt Montmorency, Plamondon is now examining how green-up will affect this indicator after harvest, so that an hydrologically sound harvest potential can be projected over time for a particular watershed.

b) Integration of indicators

Biophysical indicators are perhaps more strongly linked than our current approaches would suggest. This general observation was made by Williams, following his indicator screening process for the Lake Abitibi Model Forest. Fyles presented some pertinent examples of how these linkages could take place: 1) linkage of terrestrial and aquatic indicators; 2) linkage of ecosystem productivity to soil indicators; 3) linkage of indicators of ecosystem function to biodiversity (most often treated separately). The integration should evolve as we define and validate the indicators in various processes of certification and case studies across Canada.

c) Defining "acceptable" within the range of natural variability (RNV)

If we use the range of natural variation to understand natural limits associated with disturbance, we still need to define (and generally on a regional basis) what is an acceptable amount of change from the natural reference condition (Fyles). This will require both sound science and open discussion, bringing value judgements to the table along with science. In some situations, we may set specific operational goals for emulating natural disturbance, in others we may be restoring ecosystems towards the reference condition, after long-term degradation. These objectives, then, will be specific to the local biophysical and socio-political context. Bélanger proposed that public participation forums, in which participants identify the specific regional issues that need to be addressed to attain sustainable forest management, could facilitate the definition of common regional objectives. When both the public and the industries involved "buy in" to these issues and the pertinent indicators, it is more likely that a monitoring framework will endure over time.

d) Indicators should not be fixed in time

We should view the C&I framework and indicators as part of adaptive management (Dorion). With this in mind, continuous integration of new knowledge with practices, and development of new measures and monitoring approaches will mean that C&I will evolve over time.

(ii) Society, economics, and the development of C&I

Many of the presentations dealt with the social, economic and political aspects of sustainable forestry and C&I. These presentations developed three broad topics: (a) changes necessary to attain sustainability, (b) the roles of stakeholders in the evolution towards sustainability, and (c) the implementation of C&I of sustainability.

(a) Changes necessary to attain sustainability

Reform of social, political, and forest management systems is needed to allow for the development of sustainable forestry practices. According to Englemark, the principal role for leadership in sustainability lies in providing a vision for the future; governments must move beyond their current regulatory role and take a proactive stance in developing a vision of forests of the future. Meanwhile, political will originating from a grass roots level could ensure that momentum develops in the movement towards sustainability (Englemark). To maintain this grass roots support, action must take place once commitments are made (Englemark, Bélanger, and Bouthillier). Reform should involve the development of institutions through which commitments are translated into action and results as well as mechanisms of accountability.

Managers and scientists must develop a more constructivist view of forest ecosystems to allow for a more inclusive and holistic approach (Bouthillier). The positivist view (based on the assumption that reality can be objectively known) limits experts in their interactions with other stakeholders, who have a more experience-based understanding of the forest (Bouthillier). From the point of view of economic analysis for policy study, there is a need for economic indicators to reflect environmental change in order to ensure that benefits of policy outweigh costs. For example, indicators must be developed to measure the maintenance of the value of the natural capital of landscapes (Adamowicz). Uncertainty must be addressed in establishing objectives for forest management. Since no level of harvest is sustainable with complete certainty, objectives of sustainability must be qualified by measures of probability (Armstrong).

Management systems that include adaptive management, or feedback loops to incorporate knowledge gained through the collection of C&I data, can greatly benefit the sustainability of forestry (Johnson). Bélanger proposed that efforts to develop sustainable practices must shift away from looking for solutions, and move towards the identification and acceptance of problems. Stakeholders must essentially identify and agree on the most relevant problems before beginning to find solutions (Bélanger).

(b) Roles of stakeholders in the evolution towards sustainability

Public participation processes must go beyond the legitimization of current practices towards the empowerment of forest dependant communities (Bouthillier). Inclusiveness, representativity, freedom from condescending and pedagogical attitudes, and freedom from excessive cost and time constraints are all essential elements of any successful public participation process (Bouthillier). Within a successful participation process, stakeholders must understand problems in order to commit to the process of sustainable development (Bélanger). Scientists then play a key role in demonstrating to the public the importance of maintaining forest values such as biodiversity. These principles link back to the importance of grass roots involvement. Also, scientists can play a role in developing closer links with actors, in order to foster the harmonization of indicators and more generally, of mechanisms of sustainable development (Englemark, Johnson).

(c) Implementation of sustainability

The implementation of C&I and sustainable practices in forestry raises many social, economic, and political questions. Bélanger expressed that it was important that strategies be developed regionally and that stakeholders identify, agree on, and accept problems at a local scale before attempting to find solutions. While a nation-wide adoption of indicators is unlikely, regional consensus is perhaps possible (Johnson). In developing indicator sets, there appears to be an upper limit to the number of indicators (57) that could be applied within a given management system in a given area, though some integration of indicator data occurs during the measurement and analysis phase of management (Williams). While data for social indicators is generally available (not the case for economic indicators) many of the indicators appear to be open to interpretation (Williams).

(iii) Tools and frameworks for the development of C&I

The use of computer simulation tools in sustainable forest management permits us to ask questions about indicators over temporal and spatial scales that are difficult for the human mind to evaluate easily.

The presentation of these different models highlighted their use or potential use in a number of different areas important to successful SFM. Fortin and Fall, for example, demonstrated a modelling tool (SELES) in which C&I from multiple fields can be integrated at the landscape scale. The use of models in integrating research from multiple fields has perhaps been under-exploited in the past and represents an important direction for SFM research.

Computer simulation tools are also extremely useful in exploring questions that can only be resolved over long-term temporal horizons and large spatial scales. In fact, all of the models presented during the meeting addressed questions of scale. Planning for an indicator at only one scale or at the wrong scale can lead to unsustainable practices. Rempel, for example, indicated that the planning moose habitat at only one scale can lead to an over-simplification of the landscape. In a temporal context, Armstrong's modelling suggests that failing to account for long-term temporal variability in fire regimes could lead to the establishment of AAC's that most likely exceed the long-term sustainable harvest volume.

The above examples demonstrate the usefulness of spatio-temporal models in comparing different scenarios in environments composed of complex interactions. An important caveat is that each model is designed to respond to a specific question or type of question, and cannot provide responses for all potential management problems. Thus like all tools, computer models are best used in the circumstance for which they were designed.

Doyon, based on his experience with the Biodiversity Assessment Project (BAP) project, suggested a number of different ways in which computer tools may be useful in forest management planning. They can be useful in (1) the identification of a preferred forest management scenario, (2) the detection of critical forest conditions, (3) designing biodiversity-sensitive practices or practices sensitive to other indicators (both biological and economic), (4) selecting appropriate monitoring indicators, (5) evaluating the effects of forest management activities on multiple indicators, (6) evaluating long-term and multiple scale effects, (6) comparing different scenarios and (7) integrating the public in the decision-making process. This final point is important because, ultimately, forest management decisions are social decisions. These decisions will only improve forest management (*i.e.*, move towards sustainability) if they are based on the best information of the day.

Challenges for the development and implementation of C&I

The discussions that followed meeting presentations brought forth many important and timely observations on the development and implementation of C&I in Canada. Throughout these discussions, five themes emerged: (i) the lack of leadership and vision in matters of SFM, (ii) the need to link top-down initiatives (such as legislation and international agreements) with bottom-up movements (community groups and vehicles for public participation), (iii) the need to streamline initiatives for the development of SFM (certification, CFMN, and other public and private initiatives), (iv) the challenges involved in balancing uncertainty of knowledge and the urgency of applying knowledge in management, and (v) the need for integration and collaboration amongst those working in different fields and institutions. The diversity and experience of participants ensured that a very balanced vision emerged from the exchanges.

(i) The development of leadership and vision in matters of SFM

Currently, ninety-four percent of Canadian forests are public (Natural Resources Canada, 2000). Since provinces are responsible for the long-term sustainable management of forests, provincial governments must play leadership roles in the evolution of forestry towards sustainability (Lapierre, Dorion). Governments must play a key role in developing a vision of the sustainable forest ecosystem; without such a vision, plans for sustainability are doomed to failure (Englemark). The provinces' participation in the CCFM has lead to a strong initiative for SFM, but these initiatives must be translated into effective concerted action in the field. Since the provincial governments regulate all levels of forestry operations, these governments should be able to link C&I to long and short term management plans. Also, since governments are already involved in social and economic as well as natural resource matters, these institutions are best positioned to create links among society, economics, and forest management. Participants also expressed the view that governments should play a stronger role in training forestry workers.

> ● Provincial governments as managers of the forest resource must provide greater leadership and vision

(ii) Linking top-down initiatives with bottom-up movements

Concerns were expressed that a top-down approach to implementing SFM (any approach where objectives and constraints originate from international, national, or provincial institutions) will lead to a loss of local support, from both forestry workers and communities. It is widely accepted that grass roots support is essential for the implementation of social reform. It will be individuals in the field carrying out interventions that will lead to the sustainability of forestry. The harvester operator is the ultimate decision-maker (Englemark). It is for this reason that Sweden has implemented a mentor programme for forestry workers. Also, it was suggested that the public should address criteria only, since understanding indicators requires extensive and detailed technical knowledge. In terms of developing C&I, social context is crucial for the proper implementation and follow-up of monitoring programs. The "pick-up truck test" approach, referred to many times over the course of the meeting, suggests that forestry workers should be able to evaluate the status of indicators without having to open the pick-up truck door. From a political point of view, leaders must keep in mind all levels of government at once (international, national, provincial, and local) in order to develop effective procedures and guidelines for SFM that are suited to the complexities of society (Englemark).

- Formal links between public involvement processes (such as FSC certification) and government can narrow gaps
- Initiatives such as the CMFN and the Tembec/WWF partnership can promote grass roots involvement

(iii) Streamlining initiatives for the implementation of SFM

There are many certification vehicles currently generating interest in Canada (CSA, ISO, FSC, and SFI). As resources and political will are limited, some participants felt that too many concurrent processes would exhaust these resources. Government could play a leadership role in these matters and co-ordinate approaches (Dorion). While integration is important, it is simplicity and cohesion that will reduce workload for forestry workers. The Ontario government has promoted simplicity in certification by formalizing linkages between government regulations and FSC certification. Some amount of simplification could be reached through regional agreement on locally appropriate indicator sets. From a research and development perspective, implementation of C&I could also be facilitated by defining indicators in terms of forest condition. In this way, forestry practitioners can establish objectives in terms of elements over which they have some amount of control.

- There are currently too many processes for certification
- Approaches to certification should be coordinated

(iv) Balancing uncertainty and the urgency of applying knowledge

The discussion on biodiversity indicators, and in particular on the relevance of planning and monitoring indicators (Doyon, Drapeau, Leduc), clearly highlighted the non-uniformity of opinion regarding the means necessary to maintain biodiversity. Models can only predict a few years into the future with an acceptable level of certainty (Bouthillier). Meanwhile, industry partners feel an urgent need for knowledge that will serve to change management practices to answer to the demands of society. Industry partners felt that even basic knowledge associated with moderate levels of uncertainty would help the forest industry take steps towards the maintenance of biodiversity. While such knowledge exists in universities, mechanisms for the transfer of this knowledge are few. Partners felt that this knowledge and expertise already exist within SFMN and CMFN, and that there is a need to share this with industry partners (Dorion). While some requested patience on behalf of the industry (Drapeau), others felt that knowledge will only result in action when there is sufficient political will to make this happen (Bélanger).

- There is a need for effective technology transfer mechanisms

(v) Integration and collaboration among fields and institutions

Integration of knowledge and collaboration among researchers in the various disciplines related to forestry have been identified as essential for the development of SFM. While ecology has begun to unite biologists from many disciplines, there remains a need to integrate fields outside the biological sciences, such as economics and sociology. While scientific research institutions (*e.g.*, universities and funding agencies) encourage specialization, there is a need to train multi-disciplinary researchers. Leadership on behalf of governments could help promote such multi-disciplinarity through funding initiatives and other incentives. There is a need for sociologists and economists that specialize in forestry. Sociology must be integrated into forestry research in order to better understand the processes that lead to the resolution of conflict and the development of profound and sustainable change. Furthermore, the impacts of forestry could be better estimated by assigning a value to non-timber values and elements of the environment (Adamowicz). Since specialist solutions lead to an incomplete resolution of problems (Bouthillier), multi-disciplinarity is essential. On a technological level, there is a need to integrate modelling approaches, frameworks, and methodologies for the success of SFM (Dorion).

- C&I researchers can develop common objectives and research agendas through institutional and multi-disciplinary integration

- The integration of disciplines can lead to more socially acceptable solutions

Conclusion

The SFM Network can continue to contribute to the development of SFM in many ways. By encouraging researchers to synthesize information and share understanding with industry, existing knowledge can be put into action. Information sharing efforts will be more effective if certain scientists (whether they are researchers or other specialists) are specifically charged with this task. The Swedish Institute for Ecological Sustainability, which seeks to "serve as a bridge between researchers and those who apply these theories" (IEH, 2001) through its information officers, could serve as a model for this. To generate knowledge that may be more easily applied on the field, the Network can encourage researchers to develop projects that are linked to existing decision-making frameworks. Multi-disciplinarity must also be enhanced. Finally, researchers with the Network can contribute to a more effective role of government by offering alternatives and complements to regulatory approaches to management, such as adaptive management, certification, and public participation for the definition of management objectives.

The SFM Network can also play an important role in providing direction for future research work. For biophysical research, there is an apparent need to develop a coherent vision and framework for the study of biodiversity and for the implementation of biodiversity-related knowledge in management. Also, indicators of long-term soil health and ecosystem productivity are lacking. For the development of decision-making tools, the integration of many fields of knowledge in the elaboration of landscape modelling tools must be promoted. Researchers from the different fields must be directly involved in the modelling process. These models must then be validated, with data from long-term research projects and through a process of monitoring and adaptive management. In order to develop socio-economic aspects of SFM, there is a need to train greater numbers of experts able to link forest management and the social sciences.

Multi-disciplinarity must be enhanced in order to develop a more holistic approach for the development of SFM. Institutions must strive to promote the training of multi-disciplinary researchers. In order to facilitate the development of such expertise, there is a need for models of multi-disciplinary study. Such programs of study could include, for example, diversified curricula, supervision committees composed of experts from many different domains, and study programs that link universities with strengths in different fields and technologies. Multi-disciplinarity will eventually build on itself. As more experience is gained and multi-discpilinarity permeates the scientific outlook, it will become easier to train new scientists. Meanwhile, research institutions must encourage multi-disciplinarity through the development of initiatives and evaluations that acknowledge the time and effort needed to develop truly multi-disciplinary work.

International collaboration can lead to a better understanding of forest ecology and of the links between society and the forest. Each country's forest management history can contribute to a global understanding of the impacts of various strategies on long-term forest health. Also, while forests may be structured and function very differently in the different regions of the world, important socio-economic issues relevant to forest management may be similar. Thus, important insight into potential solutions to conflict in forest management may be gained.

Scientists will generally agree that our knowledge of the forest, of its ecology and responses to management, is imperfect. Meanwhile, decisions about forest management that lead to long-term consequences are being made daily, often without the benefit of understanding derived from scientific knowledge. Forest managers require knowledge that can be applied in the field, while researchers are reluctant to commit to recommendations, given the imperfect state of knowledge. By defining a clearer vision of what we must pass on to future generations, by committing to a process of adaptive management, and accepting that our knowledge will continue to improve as we perfect our understanding, our interaction with the forest will continue to evolve towards SFM.

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Appendix A: Schedule of the meeting

Sunday, February 11th

AM: Indicators of biodiversity, the biophysical environment, and human systems

Chair: Dan Kneeshaw

08:30h Registration
08:45h Welcome
08:55h The development of C&I for SFM in Québec, Michel Cantin
09:15h C&I needs of the Forest industry, Francine Dorion
09:35h Screening and Field Testing a Set of Local Indicators for SFM, Jeremy Williams
09:55h Indicators of forest nutrition for sustained ecosystem function, James Fyles
10:15h Break
10:35h The role of biodiversity indicators in Quebec to 2004 : Politics before monitoring, Louis Bélanger
10:55h Addressing genetic diversity as a critical element of biodiversity, Dennis Joyce
11:15h Harvested equivalent area, an indicator of hydrological equilibrium, André Plamondon
11:35h Discussion

12:15h lunch

PM: Integration of indicators and modelling forest landscapes for biodiversity and other values

Chair: Stephen Yamasaki

13:30h Inroduction
13:40h Using biodiversity indicator models to assess forest management strategies, Frédérik Doyon
14:00h Modeling wildfire impacts on timber supply: The role of uncertainty, Glen Armstrong
14:20h Signatures of Sustainability – A multiscale landscape approach to assessing habitat suitability, Rob Rempel
14:40h Break
15:10h Developing SFM indicators: On the relevance of distinguishing between performance and value indicators, Pierre Drapeau, Alain Leduc, and Sylvie Gauthier
15:40h Modeling forest dynamics and management for the evaluation of indicators in SELES, M.-J. Fortin
16:00h Discussion

17:00h Wrap-up

18:00h Supper with Alison Munson, for members of the C&I umbrella group of the SFM Network

Monday, February 12th (Overlapping day with Model Forest Network regional workshop)

- This day is dedicated to the memory of Dan Welsh -

AM: The big picture

Chair: Alison Munson

08:00h Registration Model Forest Network
08:30h Welcome
08:40h Elzéar Lepage, Introduction from the Forestry Capital 2001
08:45h Luc Bouthillier, Towards responsible forest management: public participation
09:20h Ola Englemark, Are there good or bad models of sustainable development?
09:55h Break
10:25h Vic Adamowicz, Integrating the environment into economic analysis
11:00h Peter Johnson, Local level indicators and certification
11:35h Discussion, with speakers
12:15h Lunch, speaker Yvan Hardy

PM, Part I: Local Level Indicators (LLI) of SFM: Putting Knowledge into Practice

Chair: TBA

13:30h Louis LaPierre, Purpose of LLI Workshop and LLI Programs
13:45h Martin von Mirbach, User's Guide to LLI of SFM
14:00h TBA, Initiating a Program on Local Level Indicators
15:30h Networking Break
15:45h Brian Kotak, Local Level Indicators: More than Just Monitoring

PM, Part II: Panel discussion : Identifying priorities

Chair: Luc Bouthillier

16:30h Identifying priorities for C&I work in the SFM and Model Forest networks in Québec (Panel: Ola Englemark, Louis Lapierre, Francine Dorion)
17:45h Wrap-up
18:00h Happy hour and poster session

Appendix B: Abstracts from meeting presentations

Integrating the Environment into Economic Analysis

Vic Adamowicz, Department of Rural Economy, University of Alberta

Traditional economic indicators (GDP-type indicators) have significant limitations especially in the context of measuring regional economic sustainability as a component of sustainable forest management. Emerging research has illustrated how traditional measures can be augmented by incorporating the depreciation of natural capital and the value of environmental goods and services. New indicators of this type will explicitly incorporate changes in environmental or ecological factors into economic measures of "sustainability." However, data are seldom available at appropriate scales for these new methods to be employed in regional forest management and policy analysis. New approaches for incorporating environmental elements into economic analysis will be presented and some of the challenges will be discussed.

Modelling wildfire impacts on timber supply: The role of uncertainty

Glen W. Armstrong, Department of Rural Economy, University of Alberta

The boreal mixedwood forest of Canada is an important timber producing region subject to highly variable annual disturbance by wildfire. Existing timber supply models do not adequately capture the variation in annual area burned.

A Monte Carlo simulation model that incorporates timber harvesting, forest fires, and replanting is developed. The output of the model consists of projected distributions of sustainable harvest levels generated by a timber supply model, in response to specified harvest volumes and randomly generated burn areas.

Because of the highly variable nature of the fire regime, it is difficult or impossible to set a harvest level that is perpetually sustainable with complete certainty. An alternative definition of sustainability incorporating probabilities and time is developed. At any point in time, a harvest level is considered sustainable if the probability of the harvest level exceeding the annual allowable cut is less than a specified probability level.

Using this definition, sustainable timber harvest levels usually decline as the acceptable probability of failure declines, or as the time period for which sustainability is required increases.

Le rôle des indicateurs de biodiversité au Québec d'ici 2004 : Un outil politique bien avant un outil de monitoring

Louis Bélanger et Hugues Lapierre, Faculté de foresterie et de géomatique
Université Laval

L'expérience douloureuse du projet pilote interministériel de Gestion intégrée des ressources forestières a démontré qu'il est impossible de s'entendre sur les solutions lorsque l'on ne s'entend pas sur les problèmes. La situation est tout à fait similaire en ce qui a trait à la conservation de la biodiversité. Avant de rêver mettre en place de nouvelles stratégies de conservation de la biodiversité et des systèmes d'indicateurs pour en faire le monitoring, nous devrons nécessairement répondre à une question fondamentale que nous poserons les gestionnaires forestiers : En quoi les pratiques forestières actuelles menacent-elles la diversité biologique et dans quelle mesure devrais t'ont les changer ?

Le ministère des Ressources naturelles s'est engagé, lors de la dernière mise à jour du régime forestier, à intégrer des objectifs de maintien de la biodiversité dans les nouveaux plans d'aménagement à être déposées en 2004. Dans ce contexte, nous pensons que le principal rôle d'un processus d'élaboration d'indicateurs de biodiversité est, 1) de présenter les enjeux régionaux de biodiversité d'une manière compréhensible et convaincante et 2) de schématiser les nouvelles stratégies de conservation en indicateurs de performance.

Nous illustrerons la démarche proposée à l'aide d'un projet pilote réalisée dans la région de Québec (03). Elle comprend quatre volets :

- Identifier les traits écologiques distinctifs qui déterminent la spécificité de la région naturelle ;
- S'entendre sur les enjeux de biodiversité de la région naturelle suite à son altération historique par la foresterie ;
- Développer des pistes de solutions et s'entendre conséquemment sur des pratiques sylvicoles, des stratégies de coupe et des mosaïques cibles ;
- Valider les stratégies de conservation par un suivi faunique.

Pour une gestion forestière responsable : La participation du public

Luc Bouthillier, Faculté de foresterie et de géomatique, Université Laval

La gestion durable des forêts signifie un engagement à mettre en œuvre des pratiques forestières qui s'adaptent avec l'évolution des connaissances. Cependant, les valeurs et les attentes envers les forêts changent elles aussi au gré des circonstances. La participation du public est donc un peu le pendant de la gestion adptative au plan social. La présentation visera à cerner la participation dans une optique constructiviste. Nous chercherons à caractériser les différents rôles de la participation dans un processus décisionnel. Cela suggérera certaines avenues institutionnelles. Les conditions de succès d'une telle démarche et les pièges qui la menacent mériteront aussi de l'attention. La place de l'interdisciplinarité pour nourrir une opération de participation sera examinée.

Enfin, l'exposé se clôturera avec quelques réflexions sur les critères utiles pour jauger l'impact de la participation du public.

Le dévelopement de critères et d'indicateurs pour une gestion durable des forêts au Québec

Michel Cantin, Ministère des Ressources naturelles du Québec

La présentation mettra en évidence quelques éléments historiques, contextuels et factuels qui, jusqu'à présent, ont limité l'usage d'indicateurs comme mesures de progrès en matière de développement durable. Les changements à la politique forestière qui seront apportés au cours des prochaines années ouvrent des perspectives intéressantes à la pratique d'un type de gestion beaucoup plus sensible à l'impact des pratiques forestières. L'utilisation d'indicateurs se présente comme un moyen parmi d'autres pour concrétiser ce changement.

Using biodiversity indicator models to assess forest management strategies

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Biodiversity values were assessed as part of the strategic forest planning of a publicly owned forest managed by Millar Western Forest Products Ltd. in Alberta, Canada. Our approach was to create and apply a set of models to predict the responses of indicators related to landscape patterns, ecosystem diversity, and wildlife habitat quality resulting from different forest management scenarios. These scenarios differed on silvicultural intensity and cutting spatial layout. Insight into determining favourable behaviour for the biodiversity indicators came from our use of a natural disturbance simulator (LANDIS). We used it to calculate limits of natural variability which define a realm of acceptable behaviour for the biodiversity indicators. Interpretation of the biodiversity assessment results allowed us to identify alternative practices that improve the performance of identified critical indicators and to design a final management-plan option. The paper provides details on our analyses and presents selected results. We conclude by arguing that landscape ecology will have its strongest influence on forest management only if landscape-ecological analysis is embedded directly within a real forest-management planning process.

Developing SFM indicators: On the relevance of distinguishing between performance and values indicators

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Within Canada and internationally, an increasing demand that forests be managed to maintain all resources has led to the development of criteria and indicators of sustainable forest management. There is, however, a lack of operational scale know how to evaluate and compare forest management activities to ensure the maintenance of all forest values. We have recently proposed an integrated approach to developing standards based on an ecosystem management paradigm, where the variability inherent in natural systems is used to define the limits within which forest management is ecologically sustainable. Standards for biodiversity were proposed and two types of indicators were developed: indicators of forest conditions (*Age structure and stand composition)* and indicators of forest values (*Songbird communities*). We focus on the rationale for this approach and discuss the importance of using both types of indicators in the assessment and continual improvement of sustainable forest management.

Are there good or bad models of sustainable development?

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Today, when sustainability is the key word for social reform, one mission is to integrate ecology, economy and social aspects. This was emphasized already in the Brundtland-report "Our common future" in 1987, and the UN conference on sustainable development in Rio de Janeiro in 1992. These gatherings are both milestones in the process of integrating science, policy and practical management. Although the pace of alteration towards sustainability is increasing, much remains to be done in the learning process.

A prime, overall challenge is to translate words into deeds and several models have been presented. This process requires both a multi-disciplinary and sector integrating approach for problem solving. It also requires so-called green industries and consumers preferring green products. To support this, research on natural resources sustainability needs to be reinforced. In the context of ecosystems, they have to be wisely managed but in some areas also restored. The forestry sector is successfully managing the forest resources more ecologically, and different models are used in different countries. There has been much scientific discussion as well as public debate supporting the improvement. Changes are definitely not straight-forward because attitudes, economy as well as policy control decisions. Such long-term sustainable use of the biosphere resources is however a necessity for society but is also a commercial challenge for all industries based on natural resources.

The improvements towards ecological sustainability made by the forestry sector could to some extent serve as role models to other sectors. Different examples of strategies and actions are discussed.

Modelling forest dynamics and management for the evaluation of indicators in SELES

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There is increasing pressure to manage forests for a variety of values, including economic production, ecological services and social. Since there is a tension between some forest values, the range of values will likely only be met over large areas. In addition, developing fully integrated and sustainable management plans requires information on likely long-term changes in landscape structure and function. This study is part of a larger study designed to explore interactions between natural disturbance and management regimes in the boreal forest with the goals of assisting with sustainable management of boreal forests and of integrating ecological and biodiversity management with timber management. This requires modelling forest regeneration over large spatial areas and long time-frames, exploring interactions and feedbacks between fire, succession and harvesting (variability and uncertainty), and evaluating the impact of various management scenarios. Our modelling effort specifically investigates management alternatives with a direct focus on the age class structure of the forest. We explored a variety of management options in the boreal forest of Québec in order to assess the costs and benefits at the landscape scale of ecosystem management proposals by Bergeron et al. (1998) and (Burton et al. (1999). In particular, we built and ran models using SELES that capture the essence of these models as well as the synergistic effects of fire at the landscape scale. Results indicates that planning forest management at the theoretical maximum harvest level poses a high risk to growing stock and future harvest levels and management plans should incorporate some flexibility to absorb natural disturbance.

Indicators of forest nutrition for sustained ecosystem function

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Many of the services society has come to expect from forests, including the production of fibre and non-fibre forest products, fixation and storage of carbon, and production of high quality water and habitats for a diversity of organisms, depend directly or indirectly on the processes that control the cycling of nutrients and carbon. Production of many forest values may be enhanced or reduced by management because of alteration the nutrient cycles that collectively represent the nutritional status of a forest. The development of indicators of forest nutrition presents several challenges. Indicators should be relevant to both stored nutrient capital and availability. Methodologies are often time-consuming and require intense sampling. Observations must be scaled up from point measurements to management areas. Standards, against which observed levels of indicators can be compared, must be relevant to a set of identified values and must be ecosystem specific. The forest condition to use as a reference must be chosen to meet societal values.

Four types of R&D activities are required to meet these challenges. First, broad discussion is required to identify the values we wish forest ecosystems to support, to decide on the 'reference state', and to establish the acceptable amount of deviation from the reference. Second, a set of benchmark sites should be monitored to increase knowledge of the reference condition. Third, research is required to establish relationships between variables that are closely linked to relevant ecosystem processes and variables that are more easily measured. Fourth, ecological classification systems should be expanded to allow knowledge to be extrapolated to forest sites across landscapes and regions.

Local Level Indicators and Forest Certification

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A critical piece to any credible forest certification mechanism is the indicators used to assess performance. Just as there is a variety for forest certification schemes available to forest owners and managers there are a variety of indicators to measure success. This paper examines the role of voluntary and mandatory local level indicators in four forest certification schemes - ISO, SFI, FSC and CSA. In particular, monitoring requirements, overlap and opportunities for harmonization are reviewed.

Addressing Genetic Diversity as a Critical Element of Biodiveristy

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Genetic diversity is widely acknowledged to be the ultimate source of biodiversity at all levels. Yet, the CCFM national status report 2000 on criteria and indicators does not include any discussion regarding the use of indicators for addressing the conservation of genetic diversity. This is, at least in part, because most discussion on this topic has focused on structural aspects of genetic diversity. In Ontario, the Genetic Resource Management Program has taken a functional rather that structural approach to setting goals for the conservation of genetic diversity. Principles from a number of scientific disciplines are being integrated to develop policy and planning guidelines for incorporating conservation concerns into the working forest. The local interbreeding population is recognized as the basic unit of conservation. The concern is that local populations have a finite life expectancy. Consequently, landscape-scale population management is the key to promoting the long-term persistence of a population from both a species and a genetic diversity perspective. The principles from population viability analyses can be generalized to evaluate types of species "of concern" because they are susceptible to extirpation from both an ecological and genetic perspective. The synthesis of these and other principles suggest that the key indicator for identifying species-of-concern is the distribution and abundance in the landscape. However, there is still a substantial amount of work remaining to establish regional planning guidelines for setting standards for evaluating the potential impact of human activities on species-of-concern. Resilience of tree species under both natural and artificial regeneration systems provide an example, of how standards might be established. An old growth management task team in the Ontario Ministry of Natural Resources is about to begin considering how to adapt the concept of distribution-and-abundance together with the coarse filter / fine filter approach to biodiversity conservation to develop ecosystem diversity conservation planning guidelines.

Genetic resource management can be defined as the incorporation of genetic principles into forest practices in order to conserve genetic diversity in trees while promoting economic development through the maintenance and enhancement of productivity. The principles for using genetic resources under artificial regeneration are control of the seed source to ensure the stock is adapted to the planting site and the maintenance of a broad genetic base in tree breeding programs. The principles of genetic resource management under natural regeneration are the maintenance of a broad genetic base by ensuring that a large number of trees contribute to the regeneration and the avoidance of the genetic degradation that can result from uneven-aged management.

Although the management principles for conserving genetic diversity are less well defined they can be developed by integrating the principles from conservation biology and landscape ecology. The primary indicator of susceptibility to the genetic erosion associated with population decline is the distribution and abundance of a species in the landscape. Genetic resources can be conserved indirectly when a large population is maintained in the landscape by fostering rapid regeneration after both natural and human-caused disturbance. The primary species of ecological concern are those in fragmented landscapes or at the limits of their natural range. Achieving a dynamic balance between the conservation and use of genetic resources requires the integration of principles from landscape-mosaic and population management.

L'aire équivalente de coupe : Un indicateur de l'équilibre hydrologique

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Les caractéristiques morphologiques des cours d'eau sont façonnées par le débit de pleins bords dont la période de retour est de 1,5 ans. Une augmentation de la fréquence des débits ayant une période de retour d'environ 1,5 ans risque de rompre l'état d'équilibre dynamique du cours d'eau. Les débits de pointe de fonte et de pluie qui dépassent le niveau de pleins bords sont augmentés par la coupe totale avec protection de la régénération et des sols (CPRS) pratiquée sur plus de 50-60 % de la superficie d'un bassin. Cette superficie représente l'aire équivalente de coupe (AÉC) acceptable. Cependant, l'effet de la coupe sur le débit de pointe diminue avec la croissance de la végétation qui réduit le taux de fonte de la neige et augmente l'évapotranspiration en été. L'accélération du cheminement de l'eau par les fossés de chemins forestiers s'atténue aussi avec le temps. La prise en compte de l'atténuation des effets de la coupe permet de calculer à tout moment l'AÉC et de planifier la récolte forestière sur l'ensemble du bassin de façon à maintenir le régime d'écoulement. Un exemple basé sur les coefficients d'atténuation obtenus dans la forêt boréale est présenté.

Signatures of Sustainability: A multi-scale landscape approach to assessing habitat suitability

Robert Rempel, Centre for Northern Forest Ecosystem Research

Forest management operations change the pattern of forested landscapes from the natural condition. The extent to which they change landscape pattern is determined by the policies and guidelines under which the logging companies operate. Rules governing harvesting systems (e.g., clearcuts, shelterwood, variable retention), clearcut size and shape (e.g., dispersed block, progressive clearcut), and green-up delay all contribute to a resulting landscape pattern that is more or less similar to natural landscapes created through natural processes (e.g., wildfire, insect outbreaks, gap-phase succession). In Ontario, the Timber Management Guidelines for the Provision of Moose Habitat specify many of these legally binding requirements. The Moose Habitat guidelines were developed under the featured species policy, with the assumption that creating good moose habitat will ensure good habitat for about 75% of the endemic forest vertebrates.

Recently, forest ecologists have argued that the least risky strategy to maintaining endemic biodiversity is to maintain, to a degree that is economically feasible, natural patterns on the landscape. They argue that the entire suite of endemic plants and animals have adapted to these patterns, and therefore the maintenance of natural patterns will have less impact than the creation of artificial patterns. To this end, the province of Ontario is introducing new Fire Simulation Guidelines that will in large part supplant the Moose Habitat Guidelines.

The design of natural landscapes, however, is complex. Virtually all the current policies relating to landscape scale focus on a single scale, the clear cut. Rules define the extent of a clearcut based on the proximity of openings, and from there, define the allowable size, and size distribution of clearcuts. But natural landscapes are hierarchical in structure, with patterns occurring at two or more scales. To faithfully simulate natural disturbance, landscape design rules must incorporate multi-scale, spatially explicit guidance, and must be accompanied by similar tools for assessing compliance. The range or tolerance of landscape design compliance then becomes an indicator of overall habitat quality.

In my talk I will present a new approach to assessing landscape design, and our work to define quantitative, spatially explicit models of natural landscape pattern, which I call "landscape signatures". I argue that these signatures are indicators of habitat sustainability.

Screening and Field Testing a Set of Local Indicators for Sustainable Forest Management

Jeremy Williams, ArborVitae Environmental Services Ltd.

An initial set of 152 candidate indicators, developed at a series of workshops, was screened to identify the most effective and useful indicators under each of the six SFM criteria identified by the Canadian Council of Forest Ministers. The screening process involved determining the extent to which the indicators possessed the qualities of relevance, responsiveness to local management actions, measurability and predictability. A total of 72 indicators successfully passed through the screening process. These surviving indicators were then field-tested on two Ontario forests: Lake Abitibi Model Forest and the Spanish Forest. The intent of the field-testing was not to assess the sustainability of management on these forests but rather to determine whether the indicators were useful for making these assessments. At the end of the field tests, 52 indicators were judged to be useful and 5 deserved further research. The project was funded by the Forest Ecosystem Science Cooperative.