Ontario's Forestry Research Partnership: Progress and next steps

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ABSTRACT

This paper provides a synthesis of a 2-phase approach used by the Canadian Ecology Centre – Forestry Research Partnership (CEC-FRP) to implement adaptive management on 6 forest management units in northeastern Ontario. It also provides a summary of a self evaluation of the partnership using a set of attributes deemed necessary to successfully implement adaptive management (i.e., leadership; alignment with organizational goals; commitment, will, and capacity to act; and formal and explicit documentation). We conclude that the adoption of the 2-phase approach, rather than direct implementation of adaptive management, provided the partners with the means to identify and address critical uncertainties related to intensifying forest management on Crown lands in Ontario, focus research and transfer activities, develop and test new landscape- and stand-level models, and adjust forest management policies and practices.

Key words: adaptive management, intensive forest management, knowledge transfer

RÉSUMÉ

Cet article présente une synthèse d'une approche en deux étapes utilisée par le Centre écologique du Canada – Partenariat pour la recherche forestière (CEC-PRF) visant à implanter un aménagement adaptatif dans 6 unités d'aménagement forestier du nord-est de l'Ontario. Il constitue également un sommaire de l'auto-évaluation d'un partenariat effectuée au moyen d'un ensemble de caractéristiques identifiées comme essentielles au succès de l'implantation d'un aménagement adaptatif (par ex. : leadership; conformité avec les objectifs organisationnels; engagement, volonté et capacité d'agir; et documentation formelle et explicite). Nous concluons que l'adoption d'une approche en deux étapes, plutôt que l'implantation directe de l'aménagement adaptatif, permet aux partenaires d'avoir les moyens d'identifier et de répondre aux principales incertitudes reliées à l'intensification de l'aménagement forestier sur les terres publiques de l'Ontario, de concentrer les activités de recherche et de transfert, de développer et d'évaluer de nouveaux modèles au niveau de l'écosystème et du peuplement et d'ajuster les politiques et les pratiques d'aménagement forestier.

Mots clés : aménagement adaptatif, aménagement forestier intensif, transfert de connaissances

Introduction

Research can be defined as an organized and systematic way of finding answers to questions. An appropriate question is thus a central tenet of Ontario's Canadian Ecology Centre – Forestry Research Partnership (CEC-FRP) among Tembec, the Ontario Ministry of Natural Resources (OMNR), and Natural Resources Canada (NRCan). That question combined with a goal was and continues to be the partnership's focus. The goal was to achieve a 10% increase in wood supply in 10 years (10/10 goal) and the associated question relates to the uncertainty of achieving the goal while sustaining other values (CEC-FRP 2000; Bruemmer 2008, this issue).

The partnership adopted an adaptive management framework to provide a systematic and organized approach to answering the question: Is the 10/10 goal achievable and sustainable? Both the goal and the question emerged from the Ontario Forest Accord following the increase in protected areas resulting from Ontario's Living Legacy commitments. The intent was to intensify forest management on the landbase that remained available for timber production.

This paper provides a brief synthesis of topics discussed in the preceding series of papers devoted to the CEC-FRP. In it, we draw some conclusions from the research and transfer activities described in those papers and outline next steps for the partnership.

The Adaptive Management Process

Adaptive management is a process for continual learning in a structured framework that explicitly outlines the steps—set goals/objectives, assess sustainability, design plan, implement, monitor, and evaluate—to progress towards adjusting goals and objectives (Fig. 1). The adaptive management framework described in Bell *et al.* (2008a, this issue) and in Fig. 1 provides the context for research and transfer activities undertaken by the CEC-FRP. At the outset, the partners recognized that although considerable knowledge was available that

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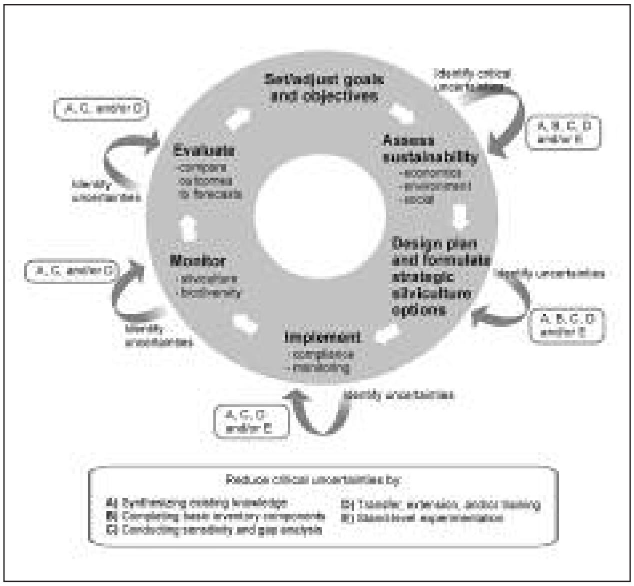

Fig. 1. An active adaptive management cycle indicating points of critical uncertainty and means by which uncertainties can be reduced (adapted from Bell and Baker 2006).

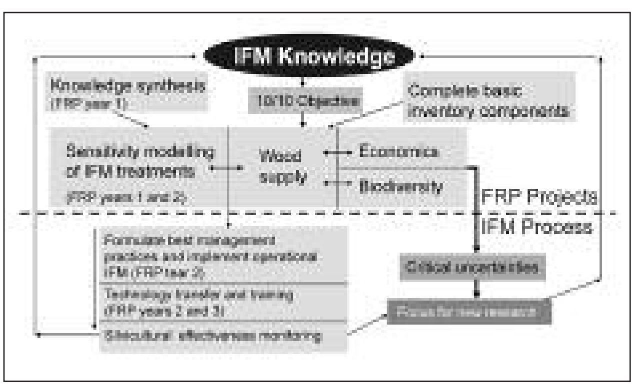

Fig. 2. Research strategy applied by the CEC-FRP (CEC-FRP 2000).

could assist in achieving the 10/10 goal, it was necessary to identify critical uncertainties at each step throughout the cycle.

This general adaptive management cycle was then modified to describe more specific sets of research and transfer activities to be undertaken by the CEC-FRP as described in Fig. 2. These activities more fully articulated the uncertainties and technical issues requiring improved knowledge and technical competence. This framework included a series of feedback loops to update existing knowledge of intensive forest management (IFM) that included knowledge synthesis, basic inventory, sensitivity modelling, wood supply analysis, economics of IFM, biodiversity considerations to identify critical uncertainties, formulate best management practices, technology transfer, and silviculture effectiveness that would focus new research.

The adaptive management process as first described by Holling (1978) and Walters (1986) recommends a series of guided workshops using modeling to define the problem in relation to ecosystem function and potential management actions. These workshops and modelling exercises are to be conducted in a short time frame to maintain enthusiasm and commitment (Walters 1986). However, given the legal and policy context within Ontario, it was necessary to develop and deliver a foundation of knowledge and information to enable a series of simulation modelling and sensitivity analysis projects (Bruemmer 2008, this issue) as described in Fig. 2. Thus, between 2000 and 2005 Phase I of the partnership was devoted to this overall task. Phase II began in 2005 with emphasis on implementation, monitoring and evaluation, to begin to move the CEC-FRP to the "implement" stage of Fig. 1.

The Forests

As discussed in Bruemmer (2008, this issue) and Bell *et al.* (2008a, this issue), the CEC-FRP anticipated that the available knowledge would be primarily applied to intensifying forest management. To be cost-effective, intensive forest management (IFM) is applied only on the most productive sites. Thus, one of the first initiatives of the partnership was to assess the potential of each forest management unit for IFM. As described by McPherson *et al.* (2008, this issue), this assessment showed that 4 of the 6 forests contributing to Tembec's wood supply in Ontario have potential for increased volume gains through the application of more intensive silviculture. These forests are more amenable to intensive management based on criteria that include tenure, potential productivity, protection from fire, insect and disease, and are managed under a suitable enabling planning and legislative environment.

The degree to which IFM is applied depends on the amount of risk that industry is willing to assume based on future world markets and the associated cost/benefits. Proposed potential futures, related to the level of intensification, include high value end product (>25% of area managed using intensive or elite practices as defined by Bell *et al.* 2008b, (this issue), bet hedging as per senate sub-committee (20% protected, 60% managed using extensive or basic practices, 20% managed using intensive practices), bet hedging as per Ontario Forest Accord Advisory Board (12% protected, 76% managed using extensive or basic practices, 12% managed using intensive practices), and conservation (12% protected and 88% extensive) (for details see McPherson *et al.* 2008, this issue). For partnership forests, one of these potential futures could be chosen for each forest or each of the forests could be zoned such that one or more of these potential futures are applied within each forest.

Although these futures are discussed within the context of the 10/10 goal for the 6 forests (McPherson *et al.* 2008, this issue), they may also be realistic potential futures for the forest industry elsewhere in Canada. The viability of intensifying forest management practices such as harvesting, protection, and silviculture is generally correlated with soil productivity and growing season (Bell *et al.* 2008b, this issue), with the latter having a north–south gradient. As a result, more intensive silviculture practices are more likely to be implemented on the 4 southern forests with more extensive silviculture applied on the 2 northern forests (McPherson *et al.* 2008, this issue).

In addition to being used to increase wood volume and/or quality, intensive silviculture can also be used to improve habitat for wildlife (Thompson *et al.* 2008, this issue). So, consideration of implementing more intensive practices should not be restricted to providing for future wood volumes but also include other values. Tradeoffs for cost/benefits to wood and other values will need to be considered in forest planning futures and will be a challenge considering current market conditions and silviculture costs. However, intensive silviculture need not be expensive provided costs are offset with bioproducts, treated stands are close to mills, and when treating fully stocked plantations, the cost per seedling is reduced (Jeff Leach, Silvicultural Specialist, Tembec, 2008 personal communication).

To date, the partners have identified potential areas for implementing more intensive forest management and identified potential futures to apply to those areas. Next steps are to implement the practices, monitor results, and assess tradeoffs.

Intensifying Forest Management: NEBIE

The potential futures identified for the Tembec forests involve implementing various intensities of forest management. To assess and apply silviculture options, it was necessary to explicitly define and quantify a range of silvicultural intensities. These were categorized as natural, extensive, basic, intensive, or elite (NEBIE) (Bell *et al.* 2008b, this issue) to provide a common and standard set of criteria for planning, evaluating silviculture effectiveness, and ultimately predicting expected composition of tree species for precommercial thinning, commercial thinning, and optimum harvest rotation as well as wood volumes. These standards also explicitly recognize the need for tending to reduce competition for resources such as light on rich soils. As Hearnden *et al.* (1992) pointed out in their report on the status and future of forest renewal in Ontario, post-harvest renewal of spruce-dominated stands would require better silviculture knowledge and tools. As described by Allen and Hoekstra (1992) in their contribution to understanding the union of hierarchy theory in ecology and its application to resource management, it is almost an axiom of resource management that where and when management alters one or more components of a connected system, that management must substitute for what nature would have done. In the boreal forest, fire, insect, disease, and severe weather caused disturbances would normally drive the renewal process. The range of NEBIE options provide a range of silviculture interventions that substitute for these disturbances and renewal in post-harvest even-aged systems depending on the objectives of management. To manage spruce-dominated systems on rich soils, for example, the CEC-FRP recognized the need to invest in high-cost renewal options on some portion (10-20%) of the landbase to increase the probability that, over the long-term, these forests remain on the landscape both for their high-value forest products and as habitat for wildlife (Thompson *et al.* 2008, this issue).

The NEBIE framework has been applied in the 2009 Romeo Malette Forest (McPherson *et al.* 2008, this issue) plan that is in development. Variables critical to applying these silviculture intensities include desired future species composition and density, return on investment relative to expected product demand as well as contribution of habitat for wildlife and other values, and an assessment of appropriate site conditions for applying each intensity level. The first 2 require knowledge about the current forest management unit and the desired future landscape, and an assessment of investment risk based on estimated future product demand. The third variable requires knowledge about the expected growth response of species on different site conditions and how to minimize cost of implementing the selected silviculture intensity, which is well established. Current NEBIE experiments being conducted across the province, described in Bell *et al.* (2008b, this issue), will, in time, inform improved practices and predictions of wood quantity and quality and habitat quantity and quality.

Current forest resource inventory mapping provides only a coarse assessment of site conditions. Consequently, as Bell *et al.* (2008b, this issue) point out, forest planners often submit a list of potential silviculture options for each planned harvest operation because silviculture decisions depend on a final assessment of site conditions based on field observations of soil type, depth, and moisture. This rather coarse planning analysis does not lend itself to accurate forecasts of future conditions and investment options. So, a remaining challenge and research question is to determine if more accurate predictions of site conditions can be made *a priori* to better inform planned investments in silviculture both for desired forest products and other values.

Growth and Yield and Inventory

Investments by the CEC-FRP to improve growth and yield (G&Y) modelling, for example the Benchmark Yield Curve Project as described in Sharma *et al.* (2008, this issue) and its validation (Penner *et al.* 2008, this issue), have resulted in improved stand- and site-level models. Gaps in data for specific species groups and stand origin (natural disturbance versus post harvest), such as the lack of information about intensively managed plantations, have been identified and efforts to fill these gaps have been initiated (Sharma *et al.* 2008, this issue). These efforts will help to reduce uncertainties in predicting future wood supply in boreal and Great Lakes–St. Lawrence forests provided accurate inventory data is available for the areas to which the models are applied.

A recent study by Thompson *et al.* (2007) demonstrated that errors in the current inventory can potentially lead to errors in predicting wood volume. Since G&Y models are applied to inventory data to estimate long-term yields rather than relying on the plot data used to generate or validate those models, increased confidence in the models does not equate to an increase in prediction accuracy, which requires improved accuracy of the basic inventory data. At the outset of the CEC-FRP it was recognized that more accurate forest inventories were necessary and Tembec increased investments in developing a more accurate inventory on some of its licence areas. The OMNR is also currently investing considerable resources into improved forest resource inventory. An ongoing challenge for the CEC-FRP will be to decide where the optimum payoff will be for expected gains in the accuracy of predicting and achieving desired future forest conditions. How should investments be apportioned among improving growth and yield models, improving forest resource inventory accuracy, improving precision for wood quality and volume, and improving accuracy of identifying ecosite conditions to gauge the potential for species productivity?

Another valuable outcome of the investment in G&Y modelling has been the development of improved taper equations (Sharma *et al.* 2008, this issue) that will provide better estimates of product quality and mill recovery. Collaborative efforts are underway to combine these models with evaluations of product quality from natural and plantation grown trees to identify the best use of trees and perhaps portions of trees for a variety of forest products. This work is part of the vision of the newly formed Canadian Wood Fibre Centre.

The long-term value of this collaborative work would be to predict, from an inventory, the relative product value from each stand as well as the optimum harvest timing and processing facility. Development of a value chain from site to product would go a long way to improving Ontario's competitive position in world's wood product markets. One of the next steps for the CEC-FRP will be to identify best bet affordable silviculture options for deriving more value-added from current and future forests as outlined by McPherson *et al.* (2008, this issue).

Comparing Forest Planning Models

Computer models are a vital tool used in virtually all modern forest management planning processes. In Ontario, the Strategic Forest Management Model (SFMM) (Davis 1999) has been used since the late 1990s. During the past few years, emphasis on the development of spatial models has increased and the CEC-FRP has invested heavily in enhancing the Patchworks model (Rouillard and Moore 2008, this issue). An advantage of spatial modelling, and of Patchworks in particular, is the potential to find optimal solutions for a number of goals. The SFMM model (Davis 1999) and other aspatial strategic models have one overriding goal, usually maximizing wood volume, given constraints imposed by other goals. Ontario's forest management planning process is designed to accommodate multiple stakeholder values and incorporate public input to ensure that these values are considered in the planning process. Given that spatial models can accommodate multiple goals, their use provides an appreciable advance in decision-support tools that is consistent with this overall intent. A challenge for incorporating such a tool is an accompanying need for advanced technical knowledge on the part of planners and for modellers and analysts to become more informed about the planning process and how best to accommodate input from a variety of forest users (Rouillard and Moore 2008, this issue).

An outcome of spatial modelling appears to be much improved transparency in tradeoffs among multiple goals so that the public and stakeholders can more directly observe where and how the achievement of multiple goals are linked both spatially and temporally on the managed forest landscape. This process entails mutual learning and strongly suggests that the next steps for the CEC-FRP will be to incorporate these learning challenges into the adaptive management process. This will require linking to transfer and extension activities aimed at planning teams so that feedback and learning filters back through the whole process with the likely outcome being changes to how public input is obtained and accommodated in forest management planning.

Identifying Core Areas

A key requirement for forest planning in boreal Ontario is the identification of core areas to protect from forest harvesting to ensure that other forest values, e.g., marten habitat (Watt *et al.* 1996), are sustained. Core areas contain large areas of contiguous forest predominantly of a preferred type but can include limited interspersion of other forest types or non-forest types (Moore and Tink 2008, this issue). In Ontario, an aspatial forest planning model (Davis 1999) is used that requires predefining locations of harvest deferrals as well as considerable effort to apply what is an iterative decision-making process. Predefining core area locations also negates the possibility of finding better solutions when other objectives are factored into the decision process (Moore and Tink 2008, this issue). Thus, development of an automated process using a spatial model was evaluated as a way to save time and optimize selection and allocation of core areas.

The CEC-FRP has invested in the use of the same spatial model used in the forest management planning process—Patchworks (Rouillard and Moore 2008, this issue)—to assist with optimizing forest harvest and deferral decisions by exploring alternatives for optimizing core area allocations (Moore and Tink 2008, this issue). The conclusion from this study was that patches of forest containing core area attributes can be automated, but only to the point of proposing areas that then require further evaluation by biologists and foresters to ensure regulatory requirements are met and other values adequately considered. This approach will assist in optimizing harvests to ensure wood supply and other values are explicitly and transparently accounted for in forest planning. A next step for the CEC-FRP will be to incorporate this type of analysis into public review of forest management plans with the intent of making options more transparent.

Transfer, Extension, and Training

The importance of sharing existing knowledge relevant to the 10/10 goal was recognized as the CEC-FRP was being formed (Bruemmer 2008, this issue). Also evident was that much of the available knowledge related to IFM (Bell *et al.* 2000) was not being used by operational practitioners or by policy and planning professionals. As described by Smith *et al.* (2008, this issue), traditional transfer activities such as workshops, field tours, and synthesis reports were undertaken initially. However, the partners soon recognized that it was necessary to go beyond traditional approaches and increase extension and training activities. The establishment of core teams of planning and operations staff within Tembec and the direct involvement of researchers from OMNR and NRCan with those teams accelerated the movement of knowledge as it was emerging from research activities (Smith *et al.* 2008, this issue).

Was it wise to transfer results before publication in scientific journals, i.e., before the broader science community had sanctioned the results and their interpretation, which from a scientist's perspective is the standard and "safer" approach? Researchers were encouraged to publish in the traditional manner and one objective of this special issue is exactly that. However, in an adaptive management process it is necessary to engage stakeholders and practitioners throughout the whole process, from the inception of studies through periodic progress updates to results and their interpretation for planning and operational implementation. This necessitated sharing of unpublished and sometimes interim results. However, critical results from some projects were also independently peer-reviewed. One example is the new G&Y models, which underwent extensive review and revision before they were approved for use in forest management planning and incorporated into forest management plans. In fact, all partnership activities and application of new knowledge have to comply with OMNR policies, guidelines, and the Crown Forest Sustainability Act (Statutes of Ontario 1994).

Results of projects other than those highlighted in this issue of *The Forestry Chronicle* are being published elsewhere. However, although it helps, peer review does not guarantee that knowledge is reliable. The only way of understanding the degree to which new knowledge is reliable for management decisions is to incorporate it into management decisions and assess its efficacy over the long term. Thus, an important part of the adaptive management process is to test results by implementing practices and monitoring and evaluating the outcomes. This "testing" not only assesses the response of the system to management but also the difficulties involved in implementing new knowledge. As part of the process, knowledge is constantly revised in light of changing contexts and new discoveries. This is the role of science and why a science methodology is embedded in the adaptive management process. Ongoing transfer and feedback is a fundamental component of the science process as it enables use and evaluation of new knowledge.

From the outset, the CEC-FRP has taken the long-term view that a transfer strategy that incorporates feedback from not only planning and operational professionals but also students and newly minted professionals was necessary and should be ongoing. Feedback from these individuals is important to learn what works and what does not, to support those who are responsible for implementing new knowledge in planning and operations to internalize and apply it. Given the importance of transfer and feedback, a challenge for the partnership will be to enable a dynamic and interactive transfer process with professionals involved in all aspects of forest management. This process will also need to embrace transfer and feedback to citizens involved in reviewing and commenting on forest management plans.

The Challenge of Implementing the 10/10 Goal

Although some uncertainty remains about the response of post-harvest stands to various silviculture treatments, sufficient knowledge exists to be certain that more enhanced silviculture (application of NEBIE) will increase yields of desired species per unit area at reduced rotation periods compared to natural-origin and extensively managed stands. A major challenge is the cost and long-term uncertainty of competitiveness in world markets for forest products. New products will no doubt be developed, likely based on a combination of new technology and knowledge generated from within Canada with forest innovation initiatives such as the Canadian Wood Fibre Centre and from similar initiatives in other countries.

To some degree, an equally pressing concern is to provide evidence that increasingly intensive management will not adversely affect other values, in particular sustainability of biodiversity. Although projects conducted in whole or in part under the auspices of the CEC-FRP provide evidence that enhanced silviculture can provide and maintain habitat for some species such as American marten (*Martes americana*) and American toads (*Bufo americanus*), for other species, such as wood frogs (*Rana sylvatica*), it may not (Thompson *et al.* 2008, this issue). Evidence of use and/or lack of use of intensively managed stands by some species does not necessarily translate into evidence about larger spatial and long-term effects and/or gains in habitat quality and quantity. Issues related to the long-term viability of enhanced forest management and the tradeoffs, both positive and negative, for other values must be evaluated. Thus, a challenge for the CEC-FRP will be to design and implement a scientifically sound, cost effective study of the effects of implementing the 10/10 goal over large spatial scales and long time periods.

Given our current knowledge, some of which is presented in the companion papers in this issue, the 10/10 goal can likely be achieved on the basis of more accurate forest inventories and more reliable G&Y models that incorporate predicted variation in growth response for a range of post-harvest silviculture from extensive, basic, intensive, and elite treatments. A strategy of incorporating enhanced silviculture on optimum sites over 10 to 20% of the landscape will likely sustain long-term wood volumes. These are, however, predictions and have yet to be subjected to empirical tests. Thus, it will be some time before the outcomes can be fully evaluated.

The Challenge of Implementing Adaptive Management

The adaptive management framework applied in the CEC-FRP, as described by Bell *et al.* (2008a, this issue), has 2 phases: the first 5 years of short-term of knowledge synthesis and research projects—Phase I, and the second 5 years plus longer-term objectives—Phase II, to incorporate the various components of adaptive management, particularly monitoring and feedback for revision of policy and practices in forest management. As the partnership embarks on Phase II, it is therefore appropriate to briefly review the successes and challenges of the adaptive management approach.

Adaptive management was an integral part of the United States Northwest Forest Plan implemented in 1994. However, its track record has not been great, as documented by Stankey *et al.* (2005) and Stankey and Clark (2006) and, for a number of reasons, has not turned out to be the panacea envisioned by the authors of the plan. Application of an adaptive management framework within the CEC-FRP is at a more modest scale than that proposed for the Northwest Plan; however, some of the same challenges apply. Stankey and Clark (2006) provide a set of attributes necessary to successfully implement adaptive management. These are paraphrased below (in italics), each followed by a statement of how these were implemented within the CEC-FRP.

Leadership: *In challenging the status quo, enhance political and public understanding of the benefits and risks of adaptive management, support practitioners, and display leadership throughout all organizations and institutions and with external stakeholders.* The partners have provided strong leadership from the executive to the practitioner throughout all 3 organizations (Bruemmer 2008, this issue); however, the role of adaptive management and the benefits and risks need to be shared more widely with external stakeholders.

Alignment with organizational goals: *Adaptive management must become part and parcel of everyday business such that participating organizations have a goal of learning and improving resource management policies and practices*. Adaptive management has been explicitly adopted and is being applied in aspects of core business by all 3 organizations involved in the partnership (Bruemmer 2008; McPherson *et al.* 2008; Bell *et al.* 2008a; Smith *et al.* 2008, this issue).

Commitment and will to act: *Leaders within participating organizations must acknowledge that past behaviour may not have been adaptive and that current knowledge about resource management outcomes is often insufficient to "guide management actions."* As described by Bruemmer (2008, this issue), leadership by senior managers and staff of all 3 organizations provided the commitment to act with new and/or improved knowledge that built upon existing knowledge. Although the existing knowledge base was wide and deep, the CEC-FRP leaders expected that new knowledge would emerge and should be used to improve forest management.

Capacity to act: *Organizations must have the capacity in technical and social skills along with time and money. Appropriate regulatory authority to conduct management experiments is also required.* Each of the organizations has the necessary skill sets and resources (Bruemmer *et al.* 2008, this issue), although resources are currently a challenge given the financial situation of the forest industry over the past 3 years.

Linking words with deeds: *Promises of organizational change and intent to conduct and learn from management experiments must be followed through. Results of management experiments take time so it is vital to have all stakeholders involved throughout the process so that expectations are realistic and understood.* The act of establishing the CEC-FRP indicated that the 3 organizations were linking intentions arising from the Ontario Forest Accord to actual organizational change. The partnership is only now getting to where management experiments can be implemented at the cut-block scale with little controversy (McPherson *et al.* 2008, this issue). When experiments move to larger scales with potential for significant outcomes at the forest management unit scale, it may become more difficult to follow through on the concept of management experiments.

Clear, shared language and terminology: *The concept of adaptive management can be easily misinterpreted to mean incremental change up to and including active experimental management. What organization would not admit that it adapts and changes? However, this interpretation is not the same as an explicit statement and implementation of a process to manage, learn, and change by active experimental management.* The idea that passive adaptive management will lead to incremental change was common at the outset of the CEC-FRP, but this has changed and the partners are embracing the idea of active adaptive management (Bell *et al.* 2008a, this issue). This is exemplified in the adoption of revised growth and yield models (Sharma *et al.* 2008, this issue), new planning models (Rouillard and Moore 2008, this issue), the NEBIE framework (Bell *et al.* 2008b, this issue), active management experiments in the Nipissing, Romeo Malette, and Gordon Cosens forests to evaluate the use of intensive management (McPherson *et al.* 2008, this issue), and focused transfer, extension, and training (Smith *et al.* 2008, this issue).

Agreement on expectations: *All parties involved in adaptive management must be informed of and understand expectations. The parties include resource "managers, scientists, regulators, and citizens" to define "what will occur, what needs to be done to achieve desired ends and what are realistic outcomes."* To date, the CEC-FRP has made a sincere effort to involve all parties through inclusion on executive, management, and science advisory committees (Bruemmer 2008, this issue), in transfer activities through the core teams (Smith *et al.* 2008, this issue), as well as by involving the public through the forest management planning process and hosting local citizens committee member visits to management experiments (Smith *et al.* 2008, this issue). This is not to suggest that this has gone smoothly or without controversy about expectations. Lessons learned have included the importance of good communication and that nurturing mutual understanding is an ongoing activity.

Explicit roles and responsibilities: *It is important to be explicit about why, who, when, where, and how within and outside participating organizations.* In Phase I of the CEC-FRP, not all roles were clear but the partners are becoming better at defining roles and recognizing the need to be explicit. The fact that specific roles were not emphasized during Phase I was partly due to the need to initiate a number of projects within the research framework (Fig. 2), which focused more on the role of scientists and specialists.

Continuity: *Adaptive management is a long-term undertaking making it necessary for participating organizations to take a long-term view and ensure that staffing and organizational structure can absorb staffing changes and the ups and downs of budgets and organizational changes.* To this point, the CEC-FRP has acknowledged the long-term view but it is debatable to what degree the future staffing and organizational structure challenges are recognized. Certainly, senior Tembec forest management staff has recognized this need and mentoring of staff is ongoing. More attention to the importance of continuity is probably necessary within OMNR and NRCan.

Clear performance benchmarks: *It is necessary to establish criteria or at least an understanding of how evidence for changes in policy and/or practice will be judged by all participating organizations including stakeholders and citizens. Indeed, if clear questions and alternative hypotheses are established in the design of management experiments, the criteria for making changes become almost self-evident. Regardless, everyone must agree on what level of evidence is sufficient to accept and reject alternatives.* The 10/10 goal established a clear benchmark and the evidence for success/failure is understood (Bruemmer 2008, this issue). What is less clear are performance benchmarks for sustaining other values. Establishing such benchmarks will be a major component of the monitoring programs in Phase II.

Formal and explicit documentation: *It is necessary to document the process, as well as successes and failures, for transparency and to ensure the information is available to all parties.* This was recognized at the outset of the CEC-FRP and the considerable time and effort devoted to establishing the framework, preparing project descriptions, and documenting transfer activities on an accessible Web site have helped to meet the need. The companion papers in this issue of *The Forestry Chronicle* are part of the documentation process. As the CEC-FRP progresses in Phase II, it is anticipated that additional research results will be published in articles and synthesis reports.

Of central importance to the next phase of the partnership is the identification of critical uncertainties and new areas of research and monitoring design. If adaptive management is to be successful as a learning framework to improve management practices and address uncertainties from a forest management perspective, the process needs to be driven from a management rather than a research perspective (Stankey and Clark 2006). This is the model followed by the CEC-FRP to date and will need to continue to ensure success. Thus, leadership for the partnership must continue to stem from a resource management perspective rather than a science perspective.

Another consideration is that the technical dimension was emphasized in the partnership's adaptive management framework with the assumption that this would sustain the social licence for management. However, to be transparent about existing uncertainties and address potential concerns, more attention to the social dimension is required. In Ontario, the forest management process is structured to incorporate public and stakeholder values and, as such, in addition to environmental, it is a social and economic undertaking due to the array of values in forests.

Technical uncertainties will emerge from further simulation modelling of current and future forest management plans. The social dimension will emerge from the forest management planning process through which uncertainties about outcomes for various values will be identified and the tradeoffs among goals for the range of values in forests recognized. The simulation studies described by Rouillard and Moore (2008, this issue) are illustrative of the types of trade-off analyses that bring realism to the forest management planning process. The partners have emphasized reducing uncertainties for wood supply and sustaining other values; however, questions remain about long-term effects on biodiversity because our collective understanding of large-scale effects is not mature. Other social dimension questions will likely revolve around issues with other forest values such as wildlife habitat, forest access, and the role of forests in dealing with expected effects of climate change. By openly embracing risk and uncertainty about the future, we assume that broader acceptance of the need to experiment with operational management trials rather than small-scale research projects will follow.

Next Steps for the Forestry Research Partnership

The adoption of the 2-phase approach, rather than direct implementation of adaptive management, provided the partners with the means to identify and address critical uncertainties related to intensifying forest management on Crown lands in Ontario, focus research and transfer activities, develop and test new landscape- and stand-level models, and adjust forest management policies and practices. This has positioned the partnership to proceed with implementation and evaluation under Phase II.

As this implementation and evaluation are undertaken, it is anticipated that emphasis will be on application of improved knowledge for intensive forest management, growth and yield models, taper function models, inventory methods, and spatial forest planning modelling with the goal of understanding of how to sustain other values and achieve the 10/10 goal. The CEC-FRP has successfully focused research and transfer on this goal by building a strong partner affiliation in Phase I, with links to many research institutions as well as other organizations. However, along with anticipated progress in these areas, the partners recognize that a number of uncertainties (as mentioned throughout this paper) remain to be addressed in Phase II. Adoption of an adaptive management cycle (Fig. 1) to guide the CEC-FRP provides a means to address these uncertainties and adjust management practices to account for unanticipated surprises and issues.

Potential areas of continued focus in Phase II include developing more accurate inventories and developing more robust and integrated planning models that can provide testable predictions of wood volume and value that are transparent and also consider other forest values such as wildlife habitat. Consistent focus on designing and maintaining a cost-effective monitoring process that is led by and benefits resource managers as well as stakeholders and the public is critical. Foremost in making progress will be the need for a mutual acceptance among resource managers, stakeholders, and the public that no one has all the answers and that the only means of adjusting management practices is to continually monitor in such a way that knowledge is obtained for the benefit of all forest users.

New areas of focus will likely involve integration of the social dimension in planning models. Emphasis will also be directed at knowledge management for planning and operational staff and obtaining their feedback to improve planning and operational issues. This feedback will provide new avenues for research and development leading to innovation, as demonstrated in other industries. For example, Miller and Morris (1999) reviewed and analyzed a number of case studies that accelerated innovation. A key driver was close interaction between researchers and users of existing products, which led to new insights and accelerated development of knowledge and products. Many parallels with the adaptive management process were apparent, especially related to inclusive interaction between scientists, managers, and practitioners. The CEC-FRP expects this interaction will fuel the development of new knowledge and technology leading to improved forest management that benefits all stakeholders.

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