# Planning and monitoring forest sustainability: an Australian perspective

O. Chikumbo[1,2], R.D. Spencer[1], B.J. Turner[2] and S.M. Davey[1, 3]

[1] Bureau of Rural Sciences, PO Box E11, Kingston, ACT 2604.
[2] Department of Forestry, School of Resource Management and Environmental Science, The Australian National University, Canberra, ACT 0200.
[3] Department of the Prime Minister and Cabinet, 3-5 National Circuit, Canberra, ACT 2600.

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## Summary

Misunderstandings have arisen in the Comprehensive Regional Assessments (CRA) leading up to the Regional Forest Agreements (RFA) on the utilisation and management of Australian native forests, due to different perceptions held by stakeholder groups on what constitutes forest sustainability. In the CRA process, terms such as 'sustained yield', 'sustainable yield', 'sustainable forest management', 'multiple-use forestry', 'ecologically sustainable forest management' and 'adaptive forest management' have been used indiscriminately, adding to the confusion. This paper attempts to define forest sustainability in the contemporary usage. It is hoped that the paper will help clarify related policy issues and the processes required to plan and monitor forest sustainability. These processes address goals over a long time horizon, and these goals in turn provide a framework for guiding and constraining detailed short-term planning.

*Keywords*: strategic planning, operational planning, ecologically sustainable forest management, adaptive ecosystem management.

## Introduction

Australia's forests are currently the subject of intense debate that encompasses wide-ranging issues of forest tenure, land use, and management. Under the federal system of government, powers relating to land use and management are vested primarily in the states and territories. Federal jurisdiction, vested in the Commonwealth, is restricted to matters relating to international treaties, international trade, and policy co-ordination for the states and territories. For example, the Commonwealth Government has endorsed the Global Statement of Principles on Forests and signed a number of conventions relating to Biological Diversity and Climate Change at the United Nations Conference on the Environment and Development in Rio de Janiero in June 1992. Australia also has played an active role in the development and consideration of 'Criteria and Indicators' under the Montreal Process (Commonwealth of Australia 1998).

Nationally, the Commonwealth Government coordinated the preparation of a National Forest Policy Statement (Commonwealth of Australia 1992), which was agreed to by the Commonwealth, State and Territory Governments to provide a long term framework for balancing the competing demands of conservation and industry. This policy, *inter alia*, established a process for joint Commonwealth/State Comprehensive Regional Assessments (CRAs) of forests to underpin Regional Forest Agreements (RFAs). The RFAs, covering selected areas of public forests, consider resource, economic, social, national and world heritage values, 'sustainable yield', 'ecologically sustainable forest management', environmental impacts, and obligations relating to international conventions such as those for protecting endangered species and biological diversity. RFAs commit the Commonwealth and respective State Governments on strategic directions for managing public forests over the next 20 years (Commonwealth of Australia 1992).

The Commonwealth of Australia (1995) identified five principal aims of the RFAs:

(1) to use an integrated cooperative assessment and planning process to reduce uncertainty about outcomes and to reduce duplication between government requirements and processes in land use decision-making;

(2) to produce durable, long-term decisions that meet the requirements of the governments involved, the community and industry, and are consistent with the principles of ecologically sustainable development;

(3) to equitably balance competing sectoral objectives and coordinate the policies and activities of governments;

(4) to maintain regional environmental, heritage and social values; and

(5) to provide secure access to resources for forest-based industries.

Benefits to be derived from these aims include the establishment and management of a comprehensive, adequate and representative forest reserve system; ecologically sustainable forest management; and the development of an efficient, internationally competitive timber industry (Commonwealth of Australia 1995).

The establishment of 'ecologically sustainable forest management' takes into account the existing regulatory framework in the states and territories, and builds on existing forest management strategies and practices. The guidelines include planning and monitoring 'sustainable yield', the application and reporting of codes of practice, and the protection

of rare and endangered species and national estate values (Commonwealth of Australia 1992).

In this paper we seek to understand the meaning of forest sustainability and to identify a complete process for planning and monitoring sustainability that could underpin the implementation of RFAs. This could provide a foundation for development of 'ecologically sustainable forest management' in Australia for the 21st century.

## Definitions of forest sustainability

### Sustained yield

Forest sustainability has been traditionally defined as 'sustained yield', a European management concept that related to a perpetual maximum production of wood. It implied managing the forest age class or size class distribution to approximate the classical normal forest (McKinnell 1994, Turner 1993). A normal forest is a collection of evenaged stands ranging in age from one year to the rotation age. The stands are so distributed and growing in such a way that they provide equal annual volumes of produce which can be harvested continuously without detriment to future production (Clutter *et al*. 1983, Brasnett 1953). The assumptions are that all stands in a normal forest are growing on equi-productive sites and that the age class distribution is balanced, that is, each age class has an equivalent area allocation.

The traditional concept of sustained yield focussed on timber values and did not ensure that conscious steps were taken to address the conservation, management and use of all values (e.g. wildlife habitat, water quality, water quantity, recreation, etc) of the forest ecosystem. It also ignored critical issues relating to the scale of timber harvesting operations that are feasible at stand or landscape levels (McKinnell 1994). However, McKinnell does not seem to make any distinction between sustained yield and sustainable yield because he recognises the changing nature of the sustained yield concept, over the years, in more explicitly catering for non-wood values.

### Sustainable yield

A definition of sustainable yield applied by the Commonwealth of Australia when considering accreditation of State processes is the long-term estimated wood yield from forests that can be maintained from a given region in perpetuity under a given management strategy and suite of sustainable use objectives (see Ritman *et al*. 1997). This definition recognises that non-wood values are part of the main objective and have to be simultaneously met with the desired wood yields, although it is unclear about the condition in which the forest ecosystem should be maintained.

Sustainable yield is about maintaining a capacity for continuing flows of products from a system in ways that maintain the functioning of the whole system (Turner 1993). The products include a range of forest goods and services such as water quality, water quantity, wildlife, recreation, biodiversity and wood.

Whether the capacity to maintain a constant flow is a maximum or directed to one or a number of products, is still problematic. The concept of sustainable yield can embody a range of products and scales of production but it is optional whether the scales of production could or should be maintained at constant levels. It would seem more realistic to infer fluctuations of the scale of production over time but within defined levels.

### Multiple-use forestry

The sustained yield concept was extended to include other material and non-material products and uses of forests - an approach to forest management that became known as multiple-use forestry during the 1960s and 70s. Glück (1994) viewed multiple-use forestry as embodying an economic primacy in that it involved determining a maximum continuing non-declining wood yield subject to the maintenance of the forest resource and other forest uses (Glück 1994). Usually, however, as concluded by Behan (1990), the multiplicity in forest-use was based on adjacency, that is, for a given forest, wood was harvested in one place, recreation services provided somewhere else, and multiple-use claimed overall.

The concept of multiple-use forestry has now evolved into the concept of sustainable forest management, an ecosystem approach based on the principle of ecological sustainability and sustainable yield. Implicit in an ecosystem management approach is the objective of improvement or maintenance of the ecological vitality' or condition of the ecosystem. According to the Helsinki Resolution H1, "sustainable forest management means the stewardship and use of forests and forest lands in a way and at a rate that maintains their biodiversity, productivity, regeneration capacity, vitality, as well as their potential to fulfil now and in the future, relevant ecological, economic and social functions at local, national and global levels, and that does not cause damage to other ecosystems." (ISCI 1996).

‘Ecosystem vitality’ refers to the ability of a system to recover from anthropogenic or natural disturbances. Any forest ecosystem is made up of sub-ecosystems that interact as a functioning whole. For example, if one cuts a tree, it may influence wildlife habitat, scenic beauty, water yield, fuel loading, forage production, energy flow and nutrient cycling, but over time the effect may be imperceptible. Maintaining the vitality of the functioning whole would mean ensuring (over many years) that there is an increase or, at least, no decline (in function) of any of the sub-ecosystems that may jeopardize the functioning of the whole ecosystem. Functioning of the whole implies that the forest is dynamic, that is, self-sustaining and self-repairing in the face of fires, insect attack, frost, harvesting and other disturbances.

At the same time that the Helsinki resolutions on 'ecologically sustainable forest management' were being passed in Europe a new philosophy of forest sustainability called, 'ecosystem management', was being introduced into the USDA Forest Service. Ecosystem management is based on the 'ecosystem approach', a concept with an objective to amend or maintain ecological stability of forest ecosystems subject to the production of minimum periodic quantities of wood and non-wood products and services (Glück 1994, Maser 1994). Such an approach for Australian native forests is outlined by Davey and Norton (1990).

While multiple-use forestry is output-oriented, ecosystem management focuses on the state of the ecosystem components such as biodiversity, forage, water, game, fish and wood which

should not be decreased over the long term but maintained or increased by forest management (Glück 1994). Ecosystem management treats these components as being interrelated in an interactive system, rather than as independent and isolated (Maser 1994). This ecosystem approach became synonymous with sustainable forest management as an outgrowth of the international focus on sustainable development (World Commission on Environment and Development 1987).

**Ecologically sustainable forest management**

There is frequently a degree of overlap between what is ecologically feasible through ecosystem management, and the supply of what society desires in terms of goods, services and condition of the forest ecosystem. Society tends to use economic analysis as a tool to evaluate the trade-offs between utility and maintenance of the forest ecosystem in a healthy state. In making decisions about how to use or not to use the forest, economic values are necessarily implied in terms of the forgone opportunities. Consequently, a decision to preserve some element of a forest ecosystem indicates a willingness to forgo the benefits that otherwise could have arisen from its development. Because such decisions may not be based on exact valuation, they inescapably indicate a judgement that the value of the forest ecosystem is greater in some sense than the value of the opportunities, which have been forgone (Hodge 1995, Sinden and Worrell 1979). In this way, the current generation influences social, economic and ecological options for the future.

Sustainability of social, economic and ecological components in the Australian context is referred to as ecologically sustainable forest management (Raison *et al.* 1997). Davey *et al.* (1997) define ecologically sustainable forest management as involving the integration of commercial and non-commercial values of forests so that the welfare of society (both material and non-material) is improved, whilst ensuring that the values of forests, both as a resource for commercial use and for conservation, are not lost or degraded for current and future generations.

Primary goals for ecologically sustainable forest management may be listed as follows:

(1) maintaining the vitality of the forest ecosystem (ie. ecological processes within forests, including the formation of soil, energy flows, and the carbon, nutrient and water cycles);

(2) maintaining the biological diversity of forests; and

(3) managing the net social benefit derived from the mixture of forest uses within ecological constraints for many years.

Davey *et al.* (1997) and Raison *et al.* (1997) outline how assessments are undertaken of ecologically sustainable forest management and the need to link such assessments to performance measures, targets and indicators. As Raison *et al.* (1997) point out, the Montreal Process (1995) criteria can be used to measure ecologically sustainable forest management. Several countries have jointly agreed to produce 'Criteria and Indicators[1]'. These will be used by that particular group of countries to measure 'sustainable forest management', for example, the Montreal Process used by 12 non-European temperate countries, the Pan-European Process (Helsinki Process) of 40 European countries, and the Tarapoto treaty partnership of a group of Latin American countries (Glück 1994).

**Adaptive ecosystem management in order to achieve forest sustainability**

Ecologically sustainable forest management should be viewed as 'adaptive ecosystem management'. The word 'adaptive' is added for the following reasons:

(1) Although we want to sustain the ecosystem, we only have a rudimentary concept of how to take its pulse, especially about non-timber values. We are trying to develop new forest practices but are severely constrained by our limited understanding of a landscape laboratory that has been modified by past practices. Planners and decision makers will never have complete knowledge on which to base strategic decisions. Forest managers will never have fully adequate knowledge on which to base operational decisions (Maser 1994);

(2) Management is a continuous process based on planning, acting, information gathering, evaluation and adjustment (Tolle and Czaplewski 1995). Such processes are fundamental to improving management systems and processes to realise ecologically sustainable forest management;

(3) Rapid social and ecological changes are likely to occur with increasing population demands; and

(4) The evolution towards ecosystem management is likely to be gradual as it is dependent on the rate of learning, along with the acceptance and application of new knowledge. Kuhn (1970) argues that normal science progresses slowly, painstakingly, and only at the margins by building on existing data and ideas, but that occasionally there is a quantum advance from a current fundamental perception to an entirely new one.

Even if scientists and forest policymakers do not agree on the use of appropriate terminology to define forest sustainability, there appears to be a general acceptance of the ecosystem approach. Because sustainability is a central element of the ecosystem approach, we will concentrate on how to develop and implement a process for planning and monitoring forest sustainability as a basis for defining what needs to be accredited in the RFA processes.

## Regional Forest Agreement accreditation and sustainable forest management

We now turn from a general consideration of forest sustainability to its incorporation in the RFA process. In doing so we look at operational and strategic planning and its relationship to sustainable forest management. In developing each RFA the Commonwealth had a responsibility to ensure that the principle of forest sustainability will guide the States implementation of forest management in the post-RFA era

[1] A criterion is a category of conditions or processes by which sustainable forest management may be assessed. The indicators that relate to the criterion, are objective and in some cases, quantifiable (Wijewardana 1996).

(Commonwealth of Australia 1999). The procedure for this involved a process of Commonwealth 'accreditation' of state planning and management systems and processes, including sustainable yield systems, plus requirements for five-yearly examinations of how RFAs were being implemented. Commonly the current systems and processes have been accredited with the expectation that they will be enhanced over time to fully achieve ecologically sustainable forest management.

Current accreditation of forest sustainability focuses on the design and quality of processes used to derive wood yield over time considering ecologically sustainable principles (Ritman *et al*. 1997). Monitoring for sustainability will be assessed every five years over the next twenty years using sustainability indicators that are yet to be fully developed. It remains unclear how these reviews will be carried out, in spite of their crucial role in determining the ultimate success or failure of the RFA process. For the purposes of sustainability Ferguson (1996) recommends five to ten yearly reviews for long term plans (50-100 years) of forest sustainability. It would be important to link such reviews with each five yearly RFA review.

The design of a generic process for determining forest sustainability, subject to periodic reviews (or monitoring), needs to be considered.

**A view of strategic and operational planning**

To understand the design of the process for planning and monitoring forest sustainability we need to introduce two terms widely used by managers to formalise the planning and monitoring approach to sustainable resource allocation; strategic and operational planning. The word 'planning' in this context connotes a process for exercising favourable influence over future events (Head 1982). It is an active rather than a passive exercise, as contrasted to forecasting/prediction, which is concerned with estimating the future rather than influencing it through actions and decisions. As adapted from military vocabulary, strategic planning has to do with the overall conduct of large-scale operations whereas operational planning concentrates on the immediate problems of operations in the field that achieve specific objectives (Head 1982). Planning is necessary at these two levels: the operational, to ensure that there is sufficient capacity including funding, personnel and other resources to continue to get the recurring work done; and the strategic, to anticipate future conditions of a system and what the future work/resources are likely to be.

Strategic planning is a long-range process that provides a framework for guiding and constraining short-range planning (ie. operational planning)[2]. In other words, strategic planning is concerned with long-range activities and broad 'goals', leaving the specific 'objectives' to be articulated through operational planning. Goals are "...enduring statements of purpose..." often not attainable in the short run (Head 1982) and objectives are derived from them. Goals specify what constitute desired outcomes for resources or returns and since outcomes depend on the interactions with and between components of a system, strategic planning really represents a scheme to control a process of interactions (Lane and Maxfield 1996). Objectives are associated with target dates or milestones for accomplishment and an identification of resource requirements necessary for their achievement.

**Strategic and operational planning in forest management**

In the context of forest planning, strategic planning incorporates decisions that have the potential to cause great changes, including demands on resources either directly by affecting major actions, or indirectly by triggering significant chain reactions among related activities. Therefore, the concept of inter-relatedness between issues is a characteristic which, perhaps more than magnitude can make decisions strategic (Spencer 1985). Strategic planning can be forest-wide and is used to gain understanding of the broad relationships between animals, sediment movement, water, management regimes, land strata (large aggregates of operational land units), wood prices, activity costs, yields, harvesting methods and so on. It reflects the availability of resources within specified environmental and resource constraints over many years, usually 50 to 100 years (Ferguson 1996). Because of this long time horizon, it is possible to assess the impact on non-wood values and the adequacy of conservation reserves. Policy makers are the primary users of strategic planning. Strategic planning is fundamental to the realisation of sustainability; without strategic planning, managers cannot comprehend the appropriate direction and consequent risks or limitations that may be experienced.

Operational planning is carried out with the benefit of a more detailed specification of alternatives within the context of established strategic decisions (Spencer 1985). It is area-specific with land units and their associated attributes as the planning units. The information at an operational level may be overwhelming and the modelling tends to be computationally cumbersome. The time horizon for operational planning can be anything from one to ten years. Land unit relationships cover adjacency (framework to include/exclude vegetation treatments on adjacent land units), security areas (restriction of management activities at certain periods in specific areas), corridors (connected land units between source and destination), and resources to initiate road construction (road segments included/excluded if a particular management regime is selected for a certain land unit), (Zuuring *et al*. 1995). Forest planners and managers are the primary users of operational planning.

The relationship of strategic and operational plans in forest management is illustrated in Figure 1 as a hierarchical pyramid with strategic planning at the apex and operational planning at the base. The concept of Figure 1 is taken from the Hierarchy Theory, where the high level hierarchy behaves at a lower frequency (longer time cycle) than the levels below it (Allen *et al*. 1984). The arrows inside the pyramid signify control.

Based on the foregoing concepts, an appropriate design for strategic and operational planning for forest sustainability should have:

(1) a strategic tool for assessing the vitality of the forest under different environmental protocols and proposed reserves;

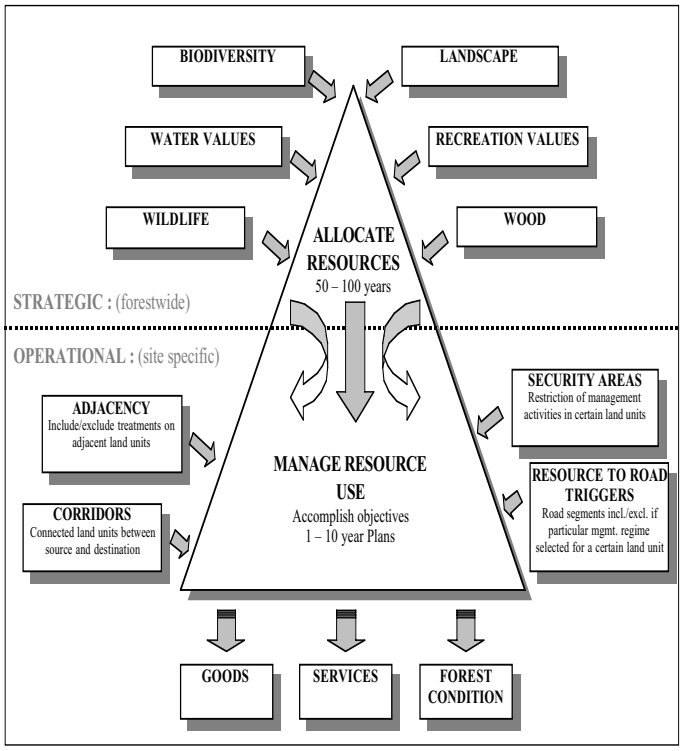
[2] Some might argue that there is an intermediate process called tactical planning. This may be appropriate, depending on the needs and unique managerial approaches to planning. Tactics determine how the actions in which an organisation intends to engage will actually be executed (Lane and Maxfield 1996). The level of detail in forest strategic plans tends to blur the distinction between strategic and tactical planning and therefore tactical planning will not be considered in this paper.

(2) an operational tool that will predict feasible plans that can be implemented within the environmental and resource limits identified by a strategic tool; and

(3) inventory and survey programs to measure the vitality of the forest ecosystem.

The operational tool would also make it possible to monitor forest sustainability on a periodic basis by setting up a feedback loop between operational ecosystem inventory and the resource-flow prediction from the operational tool. The operational plan can also feedback into the strategic framework to enable refining of the strategic plan.

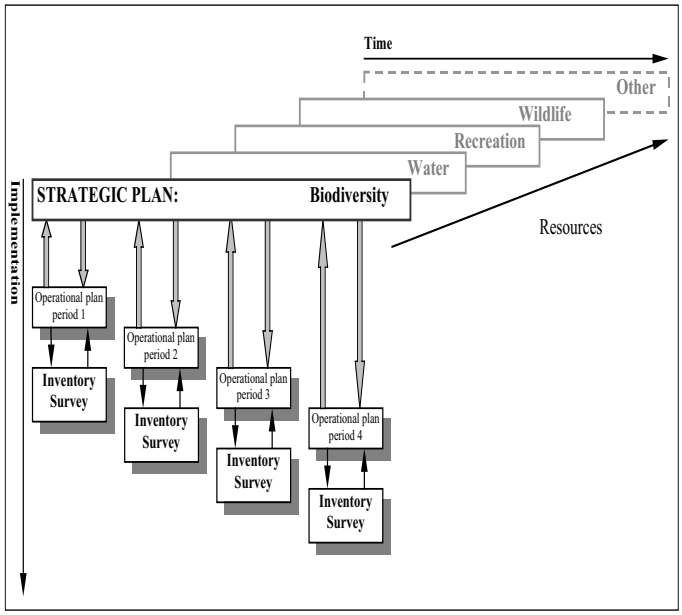
**Figure 1.** The hierarchical relationship between strategic and operational planning in forest management.




## Monitoring

The concept of monitoring needs to be elaborated in order to fully appreciate what needs to be accredited in the CRA process. Tolle and Czaplewski (1995) define two levels of monitoring, 'implementation' and 'effectiveness' monitoring. Implementation monitoring is about gathering data to answer the question, "Are you doing what you said you would?" It focuses on the standards and guidelines for achieving objectives. This monitoring is a top-down approach from a strategic plan to an operational plan and to the inventory/ survey. Figure 2 illustrates the linkage. Effectiveness monitoring determines the outcomes from implementing the plan, but does not guarantee that the expected outcomes will be achieved. Rather, it is a means for detecting unexpected consequences of the plan and providing information to update the future plan (Tolle and Czaplewski 1995). This is a bottom-up approach from the inventory to the operational plan and to the strategic plan. Therefore, a combination of implementation and effectiveness monitoring enables us to validate or refute, in a feedback loop, what we hypothesise in planning.

**Figure 2**. A monitoring process showing linkages from strategic planning to operational planning and inventory/survey programs.




## Integrating the conceptual framework for forest sustainability

Figures 1 and 2 suggest a design for a management framework incorporating the strategic planning, operational planning and monitoring concepts. Such a framework requires decision support systems and appropriate information gathering which will be continuous over the planning horizon. An example of an appropriate tool which can be utilised for strategic and/or operational planning will be discussed using Eden Management Area, covering 200 000 ha of forest in southeast NSW, as a case study.

SPECTRUM is an LP matrix-generator specifically designed to schedule the management options of a forested landscape over time (USDA Forest Service 1997). It offers the capability to model/simulate management scenarios across landscapes through time, at a strategic planning level (Sleavin and Camenson 1994). SPECTRUM has an add-on called SPECTRAVISION, which is a GIS sub-system (Chikumbo *et al* 1999). It is an ArcView (ESRI 1996) extension designed to display SPECTRUM LP solutions. By interacting with SPECTRAVISION, the user can study the effects of a complex spatial optimisation problem in a visual manner. The SPECTRUM/SPECTRAVISION package presents an interactive, exploratory LP system with a capacity to visualise an LP solution in several dimensions by giving time-series pictorial representation of a solution.

Using SPECTRUM an Eden Management Area strategic plan can be derived from a linear programming (LP) formulation that uses information from: projected sawlog and pulpwood yields under different silvicultural options; water yields predicted from a water runoff model; sediment production from snig tracks, general harvested areas, crossbanks and trenches; wildlife yields; area statement of coupes (or operational management units) that are identifiable in the field; and a reserve design. In the Eden example, the LP problem was formulated with a present net worth objective function and specific constraints on

the sawlog production. SPECTRUM, the LP tool, was used for allocating management prescriptions and SPECTRAVISION to display SPECTRUM LP solutions (Chikumbo *et al*. 1999).

A commitment to developing decision support systems is required at strategic and operational levels if sustainability of land resources is to be realised. The Federal and State Governments have started positively with the CRA process which leads to the RFAs, by concentrating at the strategic planning level. The strategic plan should be used as a basis for developing operational plans to enable successful implementation and monitoring of sustainability in the post-RFA period.

SPECTRUM has been demonstrated as an integrative tool for strategic planning in the CRA process for northern and southern NSW and in Victoria. Another tool that has potential for operational planning is called MAGIS (*M*ulti-resource *A*nalysis and *G*eographic *I*nformation *S*ystem). The Bureau of Rural Sciences is currently reviewing it. MAGIS is a microcomputer-based spatial decision support system for planning land management and transportation-related activities on a geographic and temporal basis (Zuuring *et al*. 1995).

We believe that an appropriate monitoring framework would include:

(1) A strategic decision support system such as SPECTRUM and SPECTRAVISION. The example model described here for the Eden Management Area currently considers biodiversity, wildlife management, water values (quantity and quality), economics and timber harvesting; and

(2) An operational decision support system, such as MAGIS.

Post-RFA monitoring should include an assessment to determine whether the management framework (that integrates the strategic and operational planning levels) will appropriately address monitoring and implementing of ESFM concerns. The operational plan(s) will also be required to guide the nature and quality of appropriate surveys and inventories that will be required to keep this management framework dynamic and therefore viable at all times as a decision support system.

## Conclusion

In this paper we have shown how the concept of forest sustainability has grown in the last half century from a concern related purely to the provision of a perpetual wood supply to a primary concern for the preservation of the ecological vitality of the forest ecosystem. We have also suggested that the implementation of ecologically sustainable forest management, in order to achieve forest sustainability, will require an adaptive approach because in many ways this is new territory requiring an active learning mode derived from the monitoring process. Tools to implement this form of management are required at both the strategic and operational levels.

The Commonwealth Government, in accrediting ecologically sustainable forest management procedures of State forest services during the RFA process, has focused mainly on the strategic aspects. More thought needs to be given to developing better techniques for monitoring the implementation and effectiveness of the procedures for achieving forest sustainability through operational planning along the lines of the framework explored in this paper.

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