NEW ZEALAND

FORESTRY

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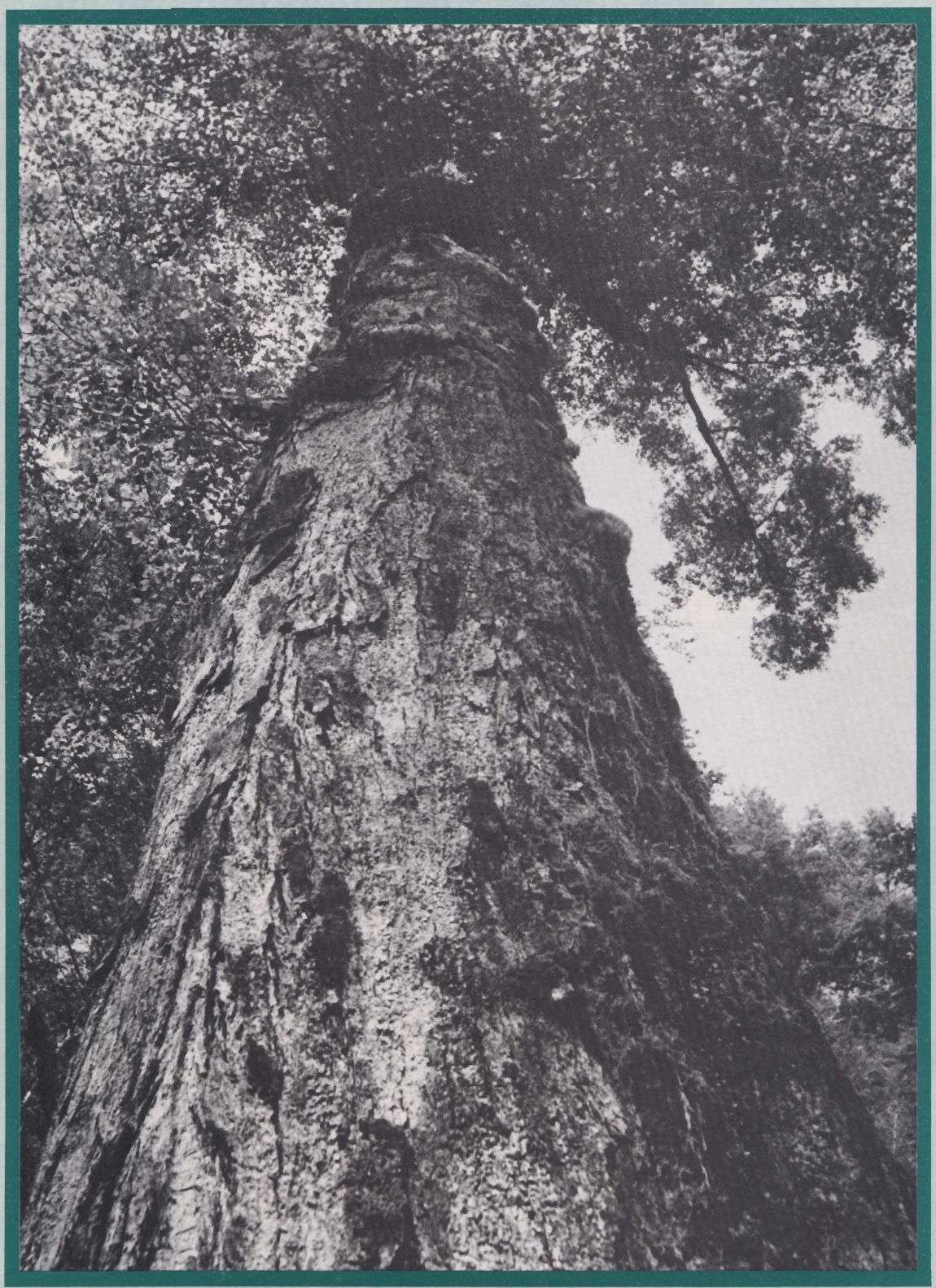

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COVER

Mature Red Beech, Westland.
Photo: Ian Platt.

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Forest economics and policy

B. M. H. Sharp and B. B. Hull

ABSTRACT

The economics of deriving raw materials from forests is examined. Competitive markets are consistent with the notion of efficiency, although they may not produce results that are fair. Sustainability as an alternative criterion suffers from problems of commensurability and an inability to identify preferred options when a choice between alternative patterns of use is possible. Given a choice among a number of sustainable use rates, competitive markets satisfy both criteria. Institutional arrangements are significant variables in forestry policy because they provide a basis for competitive markets and they determine the distribution of benefits and costs associated with use.

INTRODUCTION

The rate at which many of New Zealand's forest resources are being used is a topic of public debate. Some claim contemporary use rates are not sustainable. Others express concern that products derived from quality indigenous trees are being wasted. Public debate has also focused on non-market benefits and costs. Forests provide habitat for wildlife and contribute to soil and water conservation. Harvesting trees can result in off-site impacts such as increased siltation of rivers, estuaries, and harbours. Some forests have social and cultural values.

Expression of these concerns by conservation and preservation organizations contributed to a decision to separate the conservation and production functions of the New Zealand Forest Service. The Treasury argued that the objectives of conservation and production were better served by separating the functions of management agencies. The new Forestry Corporation is expected to operate on a commercial basis, and the Department of Conservation is responsible for natural resource conservation.

Our aim is to consider the economic aspects of using a renewable resource to supply forest industries with raw materials. Clearly this supply is provided by a collection of private individuals and firms including the New Zealand Forestry Corporation. It involves a range of institutional arrangements and includes public and private systems of ownership. Actions by this collection of public agencies, private firms, and individuals will result in patterns of forest use that vary across regions and over time.

We do not dispute the biological bounds placed on the notion of renewability. However, to the extent that many future use patterns are possible, determining a given use rate becomes significant. Economic analysis can help solve the problem of determining use rates. Our aim is to introduce and discuss concepts relevant to an evaluation of options for sustainable forest use.

The approach in this paper is limited, intentionally so. We do not consider off-site and non-market costs and benefits, nor do we attempt empirical analysis. We intend only to provide a basic background and to outline the significant issues in evaluating New Zealand forest resource policy. Such an approach lays important groundwork for analysis of specific forest resources in New Zealand's rapidly evolving policy environment.

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DEMAND AND SUPPLY

A complete characterization of the actors in the forestry sector includes the Crown, private resource owners, the public agencies and private firms which use the raw material, and consumers of the final products (national and international). To simplify the discussion, we use a very simple relationship that might exist between a collection of individuals and firms growing trees and a number of sawmills requiring raw materials.

Demand for Raw Materials

People purchase housing, furniture, books, and newspapers; all products which use raw materials obtained from forests. Consumer willingness to pay for these finished products is summarized by market demand, a relationship between price and quantity demanded. It is not unreasonable to expect quantity demanded to increase as price falls. In addition, demand for a product can change with changes in income, changes in the price of related goods, and changes in consumer tastes. For example, the national demand for furniture made of kauri might increase as the average level of household income increases.

Demand by mills for the raw materials of forests is therefore a demand derived from consumer demand for final products. Consider the demand for logs, which is derived from the demand for plywood. To determine derived demand we need to know something about demand for the product plywood, supply of other inputs used by mills to produce plywood, and prices of substitutes to plywood. A particular plywood producer's derived demand for logs depends on the price the producer receives for plywood and on the cost of obtaining factors of production such as labour, energy, and machinery.

The mill manager's maximum willingness to pay for logs is given by the difference between the cost of non-log factors of production and the revenues obtained per unit of output. Market demand for logs is given by the sum of individual mill demands. The essential point is that consumer willingness to pay for finished products and the cost of non-log factors of production co-determine demand for logs.

Supply of Raw Materials

The cost of supplying logs reflects the cost of obtaining the right to harvest trees and the cost of harvesting the trees and transporting logs to the mill. Variations in forest owner willingness to sell are the result of differences in owner objectives for forest management. Owners are likely to delay selling their trees if they expect real stumpage prices to rise sufficiently in the future. Some owners attach positive non-market values to their forests, such as those associated with wildlife, and tend to be less interested in selling. Other owners are only concerned about immediate market value of the forest's logs.

Variations in owner willingness to sell cause supply costs to increase with the quantity of logs. The more logs mills wish to purchase, the more the mills must pay per log, since mills must buy logs from owners who attach successively higher value to their forests. A supply schedule expresses this relationship by describing the quantity of logs suppliers are willing to sell at various prices. The supply schedule slopes upward, reflecting the increasing cost of obtaining additional logs.

Equilibrium

Markets depend upon, and operate within, a set of institutional arrangements. Those holding rights to the forest's raw materials are willing to relinquish these rights at various prices. Buyers are willing to buy logs at prices reflecting their cost of production and consumer demand for final products. Market equilibrium price is the outcome of a bargaining process between these sellers and buyers. The price tends to move toward the point where the quantity of logs forest owners are willing to sell equals the quantity mills are willing to buy.

Prices in our economic system derive from markets and we typically rely on this mechanism to provide relative values that guide resource allocation and the distribution of goods and services. One of the attractions of competitive markets is that this interaction between willing buyer and willing seller can result in maximum net social benefits, given the existing distribution of income.

Efficiency is the most commonly used criterion in economic analyses of resource allocation. In competitive markets, equilibrium price and quantity exchanged is described as being efficient. The outcome is efficient because market price is the mill's willingness to pay for the "last log" and is also the cost of obtaining rights to use that log. Price equals marginal cost. At a higher output, the cost of an additional log exceeds its value to buyers. At a lower output, some potential gains are foregone, since some logs whose value exceeds cost are not exchanged.

A requirement for efficient operation of the market mechanism is that participants are able to control and transfer rights to property. The set of forest property rights prior to the reorganization of the Forest Service is quite different from that existing today. Under the new organizational structure, raw materials produced from state-owned forests gravitate to buyers willing to pay for the full costs of supply. Those previously enjoying a subsidy now have to pay competitive prices. Consumers not previously enjoying access to a competitive supply of raw materials now have an opportunity to benefit from competitive conditions. Establishing a system of property rights conducive to market efficiency also carries with it a change in the distribution of benefits and costs.

The bargaining process is complicated by concentrations of market power and legal agreements that compromise smooth operation of the market. Large buyers of raw materials might be able to negotiate supply contracts with small forest owners at lower than competitive prices. Long-term stumpage contracts might have clauses which artificially distort prices. Nevertheless, to the extent that markets are characterized by competition where a relatively large number of mills compete to purchase from a relatively large number of forest owners, the market produces results which maximize net benefit.

Welfare Economics

Almost without exception, the great works of economics have gone beyond the description and analysis of the workings of the economic system. Appraisal and evaluation of approaches to organizing our economic system and managing natural resources falls within the domain of welfare economics, the term for the normative branch of economics. The applied welfare economist is therefore interested in determining if introduction of a specific policy, project, or management regime makes people better off than the alternatives.

In economics, it is assumed that society's well-being is made up of the well-being of individuals in the society.

The individual is the originator of preference and therefore value. It is basically utilitarian in its ethical stance (Olafson, 1973). The propriety of this ethical stance has been examined by philosophers and economists (Rawls, 1971; Page, 1977).

The problem of deriving operational indicators of welfare has confronted economists for over one hundred years. The essence of the problem is how to measure individual welfare, how to add up these preferences, and how to compare the aggregates. In the case of raw materials obtained from forests, we can use prices as a measure of the value derived from use. Consumers and firms compare the benefits and costs of use, exchanges are made in the market, and we observe prices which reflect the trade-offs made. Prices and other monetary measures provide indicators of value in a market (Just *et al.*, 1982). The appropriateness of using these measures for public policy analysis depends upon the context and held values upon which market decisions are made (Brown, 1984).

TIME

Time is important because of uncertainty over the ultimate impacts of current decisions, particularly as they relate to the management of renewable resources. Time also matters because the present generation can influence the resource endowment future generations inherit. Just how contemporary actions affect future generations depends on technological change, the availability of substitutes, and future preferences.

Discounting

Growing trees to supply raw material necessarily involves long time periods. A kauri forest might take 80 years to reach harvestable age. Even a pine forest might take 25 years to reach harvestable age. Because of these long time horizons, benefits and costs must be discounted to a common (present) time (Barton and Horgan, 1980). We make four observations. First, discounting is a method of placing a relative weight on future benefits and costs; it is not a procedure for calculating future benefits and costs. Future benefits and costs must be established first. For example, if we expect the price of kauri products to increase over time, this should be included in the projected flow of benefits, not be factored into the discount rate itself.

Second, competitive market discipline requires producers to maximize the present value of profits (Samuelson, 1976). If a producer fails to do so, and rights to resources are transferable, resources gravitate to those firms that do maximize the present value of profits. Failure to follow this principle results in inefficiencies; the nation forgoes real wealth.

Third, the relation between the discount rate and resource depletion is ambiguous. It does not necessarily follow that high discount rates result in accelerated depletion of a natural resource. For example, the rate of change in relative prices and poor economic performance of the economy as a whole might reduce depletion rates.

Fourth, the discount rate applies to all future flows of benefits and costs; not just "money-valued" transactions. Thus, a comprehensive estimate of the cost of forestry must include an estimate of the value of opportunities foregone by using the land for forestry.

Intertemporal Efficiency

Present-day managers make decisions that influence future flows of benefits and costs (Page, 1977). The net present value criterion, as used in cost-benefit analysis, is an intertemporal version of the efficiency criterion. A project is judged to be 'worthwhile' if the present value of net benefits is positive.

Cost-benefit analysis describes and quantifies all advantages and disadvantages of a policy, alternative development projects, or set of management options. Attention is focused on estimating return, expressed in terms of net present value, to the nation. Barton and Horgan (1980) use this framework to evaluate radiata pine and kauri. All inputs – capital, labour, land, fertilizer, seedlings – should be included at their opportunity cost to the nation. Benefit estimates are derived from what consumers are willing to pay for the timber products. All values are time-dated and are expressed in equivalent units.

Valuation is particularly difficult for forest investments where horizons are commonly longer than 30 years. This difficulty should not be sidestepped too quickly by appealing to

the impact that a positive discount rate has on benefit flows far in the future. Newman *et al.* (1985) show that the rate of price change, even given discounting and the long production period, is important in determining rotation length.

Distribution

The efficiency of the present value criterion is one of its chief virtues. However, proposals based on the present value criterion might also turn out to be inconsistent over time. Inconsistency follows from the impact that contemporary decisions have on future opportunities. One generation using the criterion to select a forest use pattern has an impact on future patterns of use. The same criterion followed by the second generation provides another plan. Strotz (1955-6) has shown that the second generation would want the opportunity to revise the forest resource it inherited. This is what Strotz referred to as the intertemporal tussle.

Competitive markets allocate resources efficiently for any given distribution of wealth. But markets do not solve the problem of what is a fair distribution of wealth among people at a point in time or among generations. This observation is relevant to forestry because the natural resource has a relatively long production period and decisions are connected over time. Forestry planning today has implications that span future generations. We cannot rely on market forces *ipso facto* to provide the signals necessary for a fair distribution of benefits and costs. Income redistribution is properly the function of the central government, not the market for logs.

Uncertainty

Significant uncertainty characterizes the market for timber and related products. Uncertainty arises from climatic events, technological change, changes in legal agreements, changes in the world economy, and so on. Consider the uncertainty that surrounds estimates of kauri stand yields and kauri timber prices in 80 years. Uncertainty creates difficulty for economic analysis because there is no universal price for uncertainty and because attitudes to risk and uncertainty vary by circumstance and across decision makers.

Even with the uncertainty of plans with a one-hundred-year horizon, Naslund (1977) argues that guaranteeing continuous forest production is desirable. More recently, Mills and Hoover (1982) use portfolio analysis to examine the proposition that landowners investing in forestry development seem to be making an 'unwise' investment. They found that forest investments in combination with other investments, such as government bonds, are preferred options. Forestry investments were found to be fairly risky if held singly, but desirable as a means to diversify a portfolio of other assets.

WHEN TO HARVEST

Processing industries require a reliable supply of raw materials. In a competitive market, industries bid for this supply in the market. Forest owners base their harvesting decisions on expected prices. From the forest owner's point of view, timing the timber harvest is a major decision because of the long production period involved, the large investments made in planting and management, and the large expected returns per unit area.

Sustained Yield

Traditionally, forest managers assert that sustained yield is the appropriate management objective. Sustained yield is recommended on the grounds that it protects the resource base for the longest possible time. For indigenous forests, Froude *et al.* (1985) define sustainability as:

> . . . harvesting in a manner consistent with the rate and type of natural replenishment, using methods compatible with the long-term survival of the forest. (p. 7)

The Indigenous Forest Policy adopted by the Government in 1975 recognizes the importance of developing logging techniques which ensure sustained timber yield. While many foresters remain confident that sustained yield is feasible, efforts to develop suitable techniques are often thwarted by climatic conditions, insufficient funds for research, and long-term logging contracts (Nature Conservation Council, 1981).

There are two difficulties with the notion of sustained yield. The first arises when production involves a number of interacting resources. A high level of yield from a given unit of land might be sustainable, but only by increasing the use of other resources such as fertilizer. Second, it is likely that many levels of sustained yield are feasible. The question becomes: which sustained yield should be selected? Some advocate a policy of maximum sustained yield by following a planting, thinning, and cutting cycle that maximizes output of stumpage, averaged over many repeated cycles (Samuelson, 1976). The notion of sustained yield is shown in Figure 1.

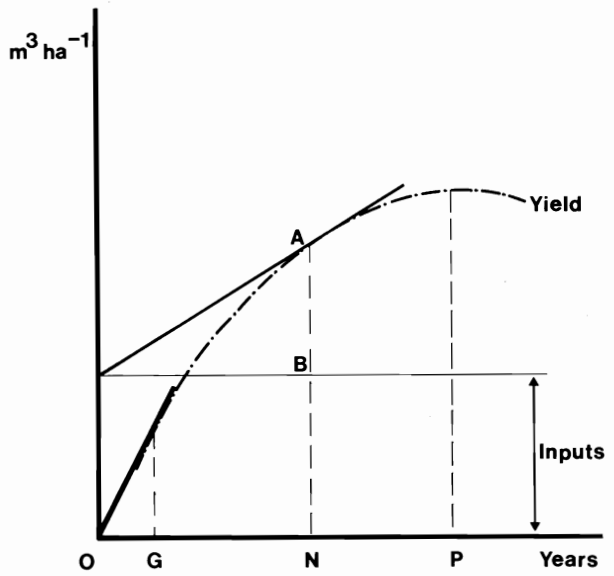

Figure 1: Sustained Yield

If we ignore the cost of establishing the forest, maximum (gross) sustained yield occurs at G. Notice that this does not occur at the point of maximum product (P). Waiting the additional (P-G) years means forgoing greater increments to product from growth of younger trees. Of course, there are opportunity costs associated with planting, managing, and harvesting trees. These costs are shown in Figure 1 as yield forgone (BN). They have the effect of increasing the rotation yield to N years. Maximum net sustained yield, gross yield less opportunity costs, is shown as AB (Samuelson, 1976).

Optimal Harvesting

The absence of benefit and cost valuations over time distinguishes the sustained yield criterion from the present value criterion. Economic analysis of optimum harvest date is concerned with costs and returns. Three categories of cost are relevant. First, there is the input of capital, labour, and materials during production. Second, there is an opportunity cost associated with the value of the investment. Third, the land locked into forestry production has an opportunity cost associated with its use. The charge against forest use should be based on the highest net return possible from the best alternative use.

Determining the optimum rotation under sustained rotation has received much attention from economists over the years. It is not a trivial exercise. In 1849, Faustmann produced a description of the rotation scheme that emerges in a competitive environment. By maximizing net present value over an infinity

of cycles, Faustmann shows that the optimal rotation period is shorter than that obtained under a policy of maximizing net sustained yield. Binkley (1987) shows that economic rotations can be greater than, equal to, or less than the rotation which maximizes sustained physical output of the forest.

The rule is summarized as: harvest when

change in		interest on the		annual rental
	=		+	
stumpage value		standing timber		value of the land

Figure 2 illustrates this harvesting rule. The annual change in stumpage value is given by DSV, interest on the value of standing timber is IS, and AV describes the annual rental value of the land. Trees are left to grow as long as DSV exceeds IS+AV. Optimal harvesting occurs at T*. Notice that the maximum value of harvested timber occurs at T'. This is not the economic optimum because it ignores the annual costs of maintaining the resource (IS+AV).

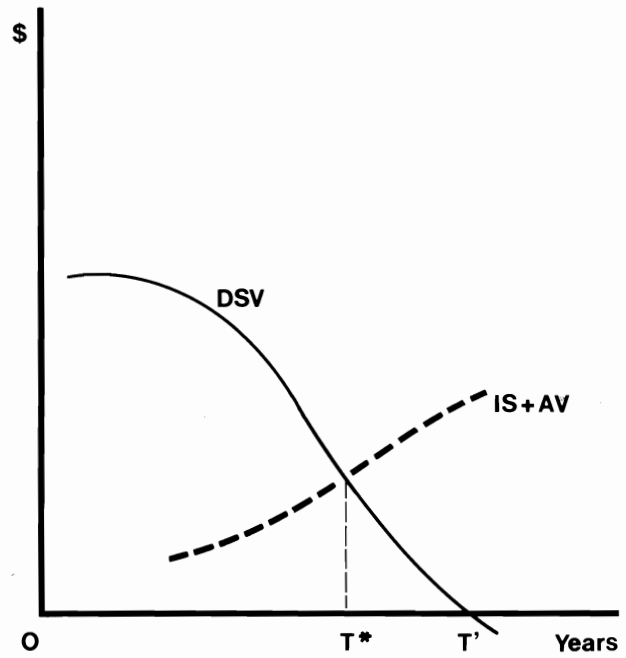

Figure 2: Optimal Rotation Length

The above method has the advantage that it easily deals with some of the complexities of an ongoing forest operation. The forester need not have accurate information about lifetime growth rates of trees, since the harvesting decision is made on a year-by-year basis based on actual growth. So long as log prices, interest rates, and annual rents are changing smoothly, the harvesting decision requires little information about the future. Once again, the decision to harvest is made each year and is based on actual price changes.

FOREST POLICY

Public policy researchers are certainly concerned with describing the effect that individuals, groups, and organizations have on decisions by elected and appointed policy-makers. Beyond mere description, however, researchers must explain and predict the consequences of changes in institutional arrangements, particularly changes initiated by Government. We have outlined some economic theory useful in understanding the consequences of changes in government forestry policy.

Institutions – laws, administrative procedures, and operating rules – provide the basis of market transactions. We have already noted the role of property rights, a subset of institutions, in the operation of competitive markets. Formal organizations such as government agencies, corporations and state-owned enterprises, are manifestations of specific institutions. Each organization has its own set of internal rules and operating procedures.

A basis for forest policy is found in the divergence between what society expects and the outcomes associated with the existing set of institutional arrangements. Public concern over performance of the Forest Service led to a change in organizational structure. The new structure will influence decisions made by those operating within the sector. The primary aim of institutional change was to set up the conditions conducive to efficiency, and we expect to see a change in the level and distribution of benefits and costs associated with forest resource utilization. The attendant distribution of benefits and costs may lead to political pressure in the future to further alter institutional structure in the forestry sector.

Institutional change is one of the most potent policy instruments available. Government policy for economic management and the restructuring of the Forest Service is a significant change in institutional structure. The effects of this change will be seen in the markets for wood products, intertemporal patterns of resource use, profitability of forest investment, and the contribution of forestry to national economic growth.

CONCLUSIONS

Society must make choices about use of its forest resources. In its narrowest sense, economics is concerned with determining optimal policy, with the efficiency criterion providing the yardstick for evaluating the expected performance of forest investment and changes to forest policy. The criterion does not guarantee sustainable supply, nor can it be expected to produce a "fair" distribution of costs and benefits now or across generations. Alternative criteria exist, such as sustained yield, which also help shed light on the problem of choice.

Neither efficiency nor sustainability are sufficient criteria for choosing a policy because the probability of adopting a policy depends upon the costs and benefits it confers to individuals and groups within our society. A better understanding of the role of property rights and institutional arrangements, including markets, in the allocation of natural resources and the distribution of the benefits and costs associated with use enhances society's chances of using renewable resource in a sustainable way.

ACKNOWLEDGEMENTS

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INSTITUTE NEWS

NZIF Council activities

The full Council met in July, November and February and an Executive consisting of the President, Vice-President, Secretary and Treasurer have met at about monthly intervals.

The main highlights of the meetings have been:

1. New Zealand's prestigious forestry award, the Kirk Horn Flask and Medal, will be presented for the first time at the Annual General Meeting in May next year.

2. A NZ Forest Service award will be instituted based on donations received for this purpose.

3. The implementation of the new membership categories has been undertaken. All affiliate members would automatically become Associate members; the election of the first Fellows has begun.

4. An 'Issues Committee' comprising Ms Crozier and Messrs Bunn, Cameron, and Vaughan has been involved in preparing a number of submissions for the Institute.

5. Council has put forward a nomination for the Richard St Barbe Baker Foundation's third Man of the Trees Award. Our President was invited to be part of the nominating committee.

6. The topic of professional registration has been under consideration.

7. The financial state of the Institute has been of concern and efforts have been made to remind those with late subscriptions, to sell more handbooks and to trim costs.

8. Council has also been involved with matters relating to consultants, membership, the journal and general administration.

Preparation for NZIF 1988 Conference/AGM is progressing well

Planning for the New Zealand Institute of Foresters 1988 Conference and AGM is well under way. The conference, to be held at the THC Chateau, Tongariro, from 11th-15th May, has the theme "National Lands – Mechanisms of Management".

The technical sessions of the conference address issues and conflicts involving land-use planning, user pays philosophy and the approach and attitudes being adopted by the newly-created corporations and departments to the management of public lands.

Full programme details and registration form will be sent to all members.
Plan now to attend.
For enquiries contact:
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FAX (073) 479 380
Ph (073) 475 899

Award to commemorate NZ Forest Service

The NZIF has been the recipient of approximately $6000 from the residual funds of the various social and other groups within the Forest Service. These funds will be utilized by the Institute to set up an annual award for outstanding contributions to practical forestry to commemorate the record of the NZ Forest Service in training competent forest managers.

A small committee will be working on the rules and reporting back to Council. It is envisaged that local sections will be responsible for nominations from their region. Suggestions on the name and conditions will be welcomed by Lindsay Vaughan, Harry Bunn and Tom Johnson.

Thomas Kirk award

NZ Institue of Foresters has received, through the Royal Society, a silver and horn flask presented to Thomas Kirk by Captain Campbell Walker earlier this century. No doubt the flask was carried and well used by Kirk on many of the botanical expeditions that have led to him being so closely associated with the flora of New Zealand.

Kirk's outstanding work on, and knowledge of the forest botany of New Zealand is recognized in plant names and publications. The Institute, through the availability of the flask and a small associated sum of money, now has an opportunity to both recognize Kirk's work and promote similar levels of endeavour in the wider forestry field.

Council of the Institute have agreed to use the flask and money as the basis for an award to be made in alternate years, the Thomas Kirk Award. It is to recognize outstanding contributions to Forestry (in the widest sense) and would consist of the Kirk Horn Flask (held for a month) and a medal to be retained by the winner.

The Institute have examined the costs of manufacturing dies and casting medals for this prestigious award and find that the cost is quite substantial. We