A BASIS FOR THE MANAGEMENT OF NEW ZEALAND KAURI (*AGATHIS AUSTRALIS* (D. DON) LINDL.) FOREST

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ABSTRACT

*The area of primeval kauri (*Agathis australis *(D.Don) Lindl.) forest has been substantially reduced. There now exists a significant second-crop resource.*

Kauri forests are important ecosystems which are valuable for timber production plus non-wood values and benefits.

The management potential of kauri has been indicated by research. This and other considerations resulted in a revised kauri management policy being introduced in 1973.

Sustained yield management is prescribed for timber production zones. This necessitates a knowledge of the ecological characteristics and an appreciation of growth dynamics, stand structures and extent of the resource. The productivity of second-crop stands suggests that there exists the opportunity for increasing the present cut.

To preserve its biological features areas of kauri forests have been set aside in scientific reserves. Re-afforestation is primarily aimed at rehabilitating disturbed forest and silvicultural tending is designed to promote the growth of regenerating areas. Harvesting in mature stands has been suspended and for environmental, engineering and management reasons helicopter logging is practised in second-crop stands.

The principal function of kauri management will continue to be to protect intrinsic forest values. However, it will also prescribe activities aimed at producing a small perpetual yield of timber.

INTRODUCTION

New Zealand kauri (*Agathis australis* (D.Don) Lindl.) is the southernmost species of the genus. The other 12 species of *Agathis* are concentrated in the tropics (Whitmore, 1979; Bowen and Whitmore, 1980).

Before the colonisation of New Zealand by Europeans, in the early 19th century, there was in the vicinity of 1.5 million hec-

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tares of forest containing kauri. Kauri was not dominant throughout although there were some extensive tracts where it was the predominant tree species in the forest canopy (Hutchins, 1919).

Most of the pristine kauri forest, particularly lowland areas, has been exploited or destroyed. No attempt was made following early logging to provide for the establishment of a future timber crop. Large expanses of both unmodified and cut-over forest were burnt and cleared for agricultural use or when searching for fossil kauri "gum".

By 1975 the old-crop kauri resource (*ca.* 400-1000 years old) had been reduced to only 6239 ha (Lloyd and Guild, 1976). This forest is mainly confined to scattered uplands along the western side of the North Auckland peninsula and to remote locations on the Coromandel peninsula and Great Barrier Island.

There now exist considerable areas of immature, or second-crop kauri forest. These stands have arisen fortuitously following the destruction of the primeval forest cover. The area of second-crop kauri forest, or scrubland containing regenerating kauri exceeds 60 000 ha (Halkett, 1980a).

MANAGEMENT PHILOSOPHY AND POLICY

An increasing awareness of environmental values has become evident in New Zealand in recent years. Publicly owned kauri forests are recognised as nationally important ecosystems. However, modern life styles have meant that these forests have been caught in a crossfire of increasing demands, commodity use of physical resources, and protection needs of a myriad of intangible amenities.

Because kauri forests have simultaneously become more valuable for high quality timber production and for providing a host of other values, differences of opinion over management policies and practices have been evident. Every endeavour is made to undertake management of State Forest kauri areas in a way which reflects and responds to predominant public philosophy and needs.

With the formation of the N.Z. Forest Service in 1921 some measure of control over kauri exploitation was introduced. Early research work did indicate that, of the indigenous softwoods in New Zealand, kauri was the most amenable to silvicultural tending (Barton, 1975). The relatively long history of stand manipulation by the N.Z. Forest Service, together with other considerations, led Government, in 1973, to approve a revised kauri management

policy. This policy has as its objective the perpetuation of kauri as a species both in unmodified stands and as managed forests. The N.Z. Forest Service formed a Kauri Management Unit to implement this policy through a series of prescriptions which aim to:

1. Reserve further representative areas of mature and immature kauri and allied forest association in scientific reserves.
2. Manage remaining kauri areas as healthy stands with production of timber incidental to achieving the prime aim of management.
3. Reduce the permissible annual cut to the lowest level consistent with economic, social and legal constraints.
4. Acquire, where possible, areas of kauri regeneration not already in Crown ownership.
5. Reinstate a programme of artificial establishment of kauri.
6. Intensify research into the silviculture and ecology of kauri.

While substantial tracts of kauri forest have been set aside primarily for the protection of soil and water or biological values, restricted areas are recognised as having a production potential and have been demarcated for timber management. The utilisation of kauri forests for timber is centred on second-crop stands. This shift in production emphasis, from selective logging in old-crop kauri to harvesting in younger stands, has taken place over the past three years as techniques for the continued management of second-crop forest have been evolved and tested (Halkett, 1980a).

THE PRINCIPLES OF AND BASIS FOR SUSTAINED YIELD TIMBER MANAGEMENT

Sustained yield management is prescribed for kauri forest areas zoned for timber production. Harvesting activities need to maintain forest productivity and create suitable conditions for the establishment of naturally regenerating or planted seedlings.

In addition to an appreciation of the ecological status of the species, sustained yield management requires a detailed knowledge of the extent of the growing stock, stand structures, productivity, regeneration requirements and appropriate harvesting techniques. Much of this information can only be obtained by conducting detailed forest studies.

Recognition of the ecological characteristics of species and forest associations is an essential aid in determining appropriate silvicultural practices. For instance, successional vegetation pat-

terns indicate species tolerance levels. (Climax associations are usually composed of slower growing tolerant species and seral stages are dominated by intolerant species).

Ecological Features

The presence of kauri gives the forest of northern New Zealand a physiognomic distinctiveness. However, examination of an area of kauri will reveal that, like tropical forests, no one tree species predominates. Taraire (*Beilschmiedia tarairi*) dominated hardwood stands are often a conspicuous feature although kauri or podocarp (Podocarpaceae) stands are in ascendancy in many areas (Cockayne, 1909). Kauri stands are rarely larger than a few hectares and are usually confined to the poorer upper slopes and ridge sites, being forced to retreat to these more inimical localities because of their competitive disadvantage with initially faster growing, and more aggressive, hardwood species (Sando, 1936). Kauri also inhabits wet undulating plateaus where the degraded soil conditions, coupled with the great longevity requiring only low rates of replacement, appear to give kauri a competitive advantage over hardwood species on these less favourable sites (Beveridge, 1977).

Well established kauri seedlings are rare beneath stands of mature kauri (Cheeseman, 1914; Cockayne, 1958). It appears that under pristine forest conditions seedlings are unable to survive owing to the poorly lit conditions and the presence of a deep layer of resinous, acidic litter (Bieleski, 1959).

Factors which inhibit the establishment of kauri seedlings in mature stands are not present beneath hardwood forest, scrubland or second-crop kauri stands. The absence of a dense layer of acid litter and intensive root competition allow kauri seedlings to become established and the abundance of light stimulates growth. Tea-tree (*Leptospermum* spp.) scrubland and other seral hardwoods notably towai, (*Weinmannia silvicola*) and hard beech (*Nothofagus truncata*) are appropriately described as kauri "nurse crops" (Mirams, 1957).

The removal of forest by destructive logging or fire sets in train a succession of forest redevelopment. Seral hardwoods which quickly invade disturbed areas form the first stage of the secondary succession. As this scrubland develops, stocking declines and surviving stems increase in height. The additional amount of light reaching the ground allows other species to develop. The second tier of vegetation is often composed of hardwood genera, such as: *Pittosporum, Coprosma, Pseudopanax, Olearia, Cyathodes, and Brachyglottis* (McKelvey and Nicholls, 1959).

Gradually softwood species begin to appear and develop through the overtopping vegetation (McKinnon, 1937). The emerging juvenile softwood forest is characterised by pole kauri occurring in dense stands. Tanekaha (*Phyllocladus trichomanoides*) is a common associate occasionally occurring in the forest canopy but, more usually, along with podocarps as subdominant stems. Moderately dense hardwood species often form a lower tier Sometimes vestiges of the former nurse crop are evident, large and senescent, often with attendant *Astelia* and *Collospermum* epiphytes.

Growth Data

Growth information for mature kauri stands is limited. Data available suggest that 1 to 3 m^3/ha/yr is about the order of productivity. However, growth patterns may vary widely depending on stand condition. Decrement which exceeds growth obviously occurs in overmature stands, and in younger stands where "gum bleeding" has caused accelerated decay (Hutchins, 1919).

Well stocked untended second crop stands have a productivity of 5 to 9 m^3/ha/yr. Stands which have received a thinning treatment exhibit a productivity of 6 to 10 m^3 (refer to Table 1). This comparison suggests a favourable response by second-crop stands to tending.

TABLE 1: VOLUME[1] INCREMENT FOR UNTENDED AND TENDED (THINNED) SECOND-CROP KAURI

Stocking Category (stems/ha)	*Average Diam.[2] (cm)*	*Diam. Range[3] (cm)*	*Periodic Annual Increment[4] (m^3/ha)*
Untended stands:			
<200	26	15-52	2.85
200-400	27	17-49	4.83
400-600	23	16-35	7.65
>600	24	16-40	8.85
Tended stands:			
<200	24	17-35	4.16
200-400	25	15-42	6.45
400-600	28	15-50	9.90
>600	26	15-60	9.80

[1]Total stem volume.
[2]Average diameter of all stems >15 cm dbh.
[3]Mean diameter range of plots within each stocking category.
[4]Periodic annual increment data have been calculated over varying lengths of time for different plots.

The kauri forest production zone consists predominantly of second-crop stands. If portions of this resource are stood aside, at this stage, because of some uncertainty about stand parameters or future management strategy, together with a consideration of physical problems such as limited access, at least 2500 ha of second-crop forest are currently considered as potentially available for timber supply. The total volume of this resource is considered to exceed 500 000 m^3 with a gross annual increment of 12 500 m^3. Although it is likely to take 20 to 50 years before many stands attain merchantable piece size and density requirements, there appears to be the potential for an increase in the present harvest from second-crop forest.

MANAGEMENT PRACTICE

Kauri forests are often capable of enduring a range of uses without compromising any particular use. Where conflicts between different uses are anticipated the merits of competing uses are weighed up and one is recognised as dominant. Dominant use is the basis for designating management zones. Other uses are permitted within zones provided they do not conflict with the chosen dominant use. Uses are divided into major categories of protection, production, and recreation (Kirkland, 1975).

Scientific Reserves

The kauri estate administered by the Forest Service is widely spread, fragmented and occurs from near sea level up to a little over 800 m above sea level. The associated tree species vary enormously, from pohutukawa (*Metrosideros excelsa*) and puriri (*Vitex lucens*) on the coast to yellow silver pine (*Dacrydium intermedium*) and southern rata (*M. umbellata*) and even silver beech (*Nothofagus menziesii*) at higher altitudes. Securing an adequate representation of the diverse kauri forest types and associated fauna necessitates a number of scientific reserves spaced throughout the range of kauri. In excess of 40% of the kauri resource contained within State Forest has been zoned to safeguard soil and water or biological values.

Artificial Establishment

The 1973 Kauri Policy provided the stimulus for the reinstatement of the artificial establishment programme aimed primarily at rehabilitating forest areas which have suffered because of

the indiscretions of man. This work was curtailed in 1964 because of propagation problems, variable success with planting, high costs and the uncertainty about future prospects for kauri forest management.

Currently 40 000 seedlings are planted out each year (Cooper *et al.*, 1981). Between 1974 and 1982, 683 ha were stocked with kauri seedlings.

Most establishment involves enrichment planting in scrubland or disturbed forest. A minor amount of open planting is undertaken and some restocking of selectively logged areas of mature and second-crop forest is also carried out. Survival has largely been in the region of 65 to 90% although as low as 10% in some areas. The major cause of high mortality has been periodic excessively dry conditions in areas where the hardwood "nurse crop" is short and sparse, affording little protection to planted seedlings. Seedling height increment has been in the order of 10 to 30 cm per year.

Based on current establishment practice, about 130 to 170 ha are likely to be enriched annually. Land available and suitable for treatment will sustain the present programme for some time to come.

Silvicultural Tending

The 1973 Kauri Policy also reactivated the declining interest in silvicultural tending activity. This work involves ring-barking hardwood stems which overtop juvenile softwood growth. This liberation procedure induces a gradual increase in light as girdled stems die, thus promoting softwood growth. Between 1973 and 1982, 3614 ha of regenerating kauri forest was treated in this way.

Harvesting

Timber production is confined to a very limited area of the kauri estate. The current annual allowable cut is 870 m^3. Selection management is used as the tool of sustained yield timber production. It involves the use of uneven-aged silvicultural procedures in such a way that periodic harvesting is undertaken, a continuous high forest cover is maintained, natural or artificial restocking of desired species takes place, and controlled growth and development of trees through a range of diameter classes occurs (Meyer *et al.*, 1961). A major aim of management is to protect the non-wood forest values.

Selective logging in mature stands which has been undertaken since 1970 was suspended in 1979 because of the detection of a significant kokako (*Calleas cinerea wilsoni*) population in areas zoned for log production. Selective logging in mature kauri stands involved the removal of 20 to 25% of stand volume. Techniques employed were considered to be the best possible compromise between the practicalities of felling and hand'ing large piece size material and maintaining the forest structure. Post-logging studies indicated that attempts made to protect residual trees and other forest values had been successful although logging-induced damage, particularly where it affects root systems, may have a subtle long-term influence on forest health and productivity (Halkett *et al.*, 1980).

Because much of the second-crop kauri is located on steep broken terrain, the impact of ground hauling on soil and water, aesthetic and other forest values would be environmentally unacceptable. This consideration, together with management and engineering constraints, precludes the use of conventional logging methods in many second-crop stands. The use of helicopters for log extraction was tested in 1980 and is now an operational technique in these kauri forest areas. There is no question that this logging method is expensive when viewed in narrow financial terms. Justification for its use needs to include recognition of the importance of non-wood forest values (Halkett, 1980b).

CURRENT AND FUTURE MANAGEMENT EMPHASIS

The principal function of kauri forest is, and will continue to be, to safeguard soil and water, biological and other intrinsic forest values. The forests will also continue to offer extensive opportunities for recreational pursuits, and have wide aesthetic appeal. Current and future forest management will accord these aspects high priority but will also prescribe artificial re-afforestation and silvicultural tending activity which will, in part, be motivated towards producing a small perpetual yield of timber. Harvesting and other management undertakings will need to be thoroughly researched, carefully planned and well executed so that all forest values and benefits are maintained or enhanced.

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