prawns and shrimps, such crabs as we have, and the other of our usable invertebrates is essentially still ahead of us. They will come into such utilisation only when this nation grows beyond its present rural status. We verge now on the situation where we may no longer be able to neglect the full harvest of the sea and this includes the full utilisation of the marine invertebrates.

THE EXPLOITATION OF THE INDIGENOUS FORESTS

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HISTORY OF EXPLOITATION

A thousand or so years ago the indigenous forests covered most of the land surface of New Zealand, the main unforested areas being those where climates were too extreme to allow forest to develop, or where volcanic eruptions, floods, or earthquakes had created seral conditions (Holloway 1954).

The Moa Hunters are believed to have been responsible for removing, or hastening the removal of large areas of climatically unstable forest from the more arid eastern plains and hills of both islands and may also have burnt forest in many other localities, probably retarding the regeneration of forests over the volcanic plateau of the central districts of the North Island (Holloway 1954).

The Maori of the Fleet, arriving in New Zealand some six hundred years ago, brought with them a number of tropical food plants which they were able to grow in warmer districts, clearing areas of forest to provide planting sites (Taylor 1958). As the native population increased in size so did their impact on the forests, particularly in northern districts where the greater part of post-fleet population was domiciled (Buck 1950). Towards the end of the eighteenth century a number of European vegetables were introduced, of these the potato being of particular importance, providing the Maori, for the first time, with a staple food that could be grown in all districts with a certainty of good yields — and which could be bartered with trading ships, missionaries, and settlers for muskets, axes, and other goods. This resulted in a great increase in the rate of forest destruction in all inhabited districts (Cameron *in press*).

Thus, by the time organised European settlement commenced, the indigenous forests had been reduced to some 28 million acres, perhaps half their primeval area. Most of this depletion can be called forest destruction, rather than forest exploitation, as only a very small proportion of the timber was used to any purpose, most of it disappearing in smoke during wild-fires. Maori utilisation of the forest was more for birds than for timber. The few trees needed by a tribe to build canoes, dwellings, or fortifications, to make tools or for fuel, could have been obtained from the forest with little visible effect.

The European settlers set about the destruction of the forests of lowland and hill country much more purposefully. Within a hundred years the area of indigenous forest had been reduced to less than 15 million acres, most of this being non-merchantable forest on steep, mountainous terrain. For the settler it has often been said, "one blade of grass was worth two trees", and this cannot be denied. Only in east coast districts was there any shortage of timber for fencing or building houses. Elsewhere timber was, at first, only valuable where it was situated

sufficiently close to a safe harbour to make export possible. In time an internal sawmilling industry developed but the supply of timber for this was seldom from land being developed for farms. Thus most of the timber from forest cleared for farming was burnt; again, forest destruction rather than forest exploitation.

Much of the forest that has been logged for timber for commerce over the last hundred years still retains a residual forest cover, some areas having been logged two, even three, times as standards of utilisation have changed and new tree species become merchantable. Many areas have been developed to farmland, sometimes with very indifferent results, but a large part has suffered from the ravages of fire and now remains, devastated and wasted, neither growing useful timber nor supporting a farming industry.

THE INDIGENOUS FORESTS TODAY

In 1955 the New Zealand Forest Service completed a stocktaking of the indigenous forest resources (Masters *et al.* 1957). This showed that of the 14,500,000 acres of forest left, only some 2,060,000 acres were available and merchantable on current standards, the remainder being non-merchantable mainly because of low timber volumes per acre or because it was protection forest on steep, mountainous terrain. These acreages can be compared with the general land classification data given in Table 1.

TABLE 1. *Land classification, New Zealand at* 1958, *adapted from Yska* (1961)

Category	*Area (millions of acres)*	*Per cent of total area*
Agricultural land	32.4	49.3
Indigenous forest	14.5	22.1
Unoccupied, unforested	7.1	10.7
Scrub, fern and second-growth forest	5.1	7.8
Parks and reserves, unforested	2.4	3.7
Barren and unproductive	1.8	2.7
Built upon	1.3	2.0
Exotic forest	0.9	1.4
Minor islands	0.2	0.3
Total area	65.7	100.0

The volume of timber remaining in the merchantable area of indigenous forest was assessed in 1953 at 21,763 million board feet. This has now been depleted to about 19,500 million board feet, felling having proceeded at a mean annual rate of 320 million board feet, representing some 30,000 acres per annum of forest cutover.

It has been the policy of the New Zealand Forest Service since its inception in 1919 to conserve the remaining indigenous timber resources. This has been effected in two ways. Firstly, by the establishment of large areas of exotic forest a new source of timber has been created, thus reducing the dependence of timber-using industry upon material from the native forests. Secondly, although it has not proved possible to make substantial reductions in the total annual cut of

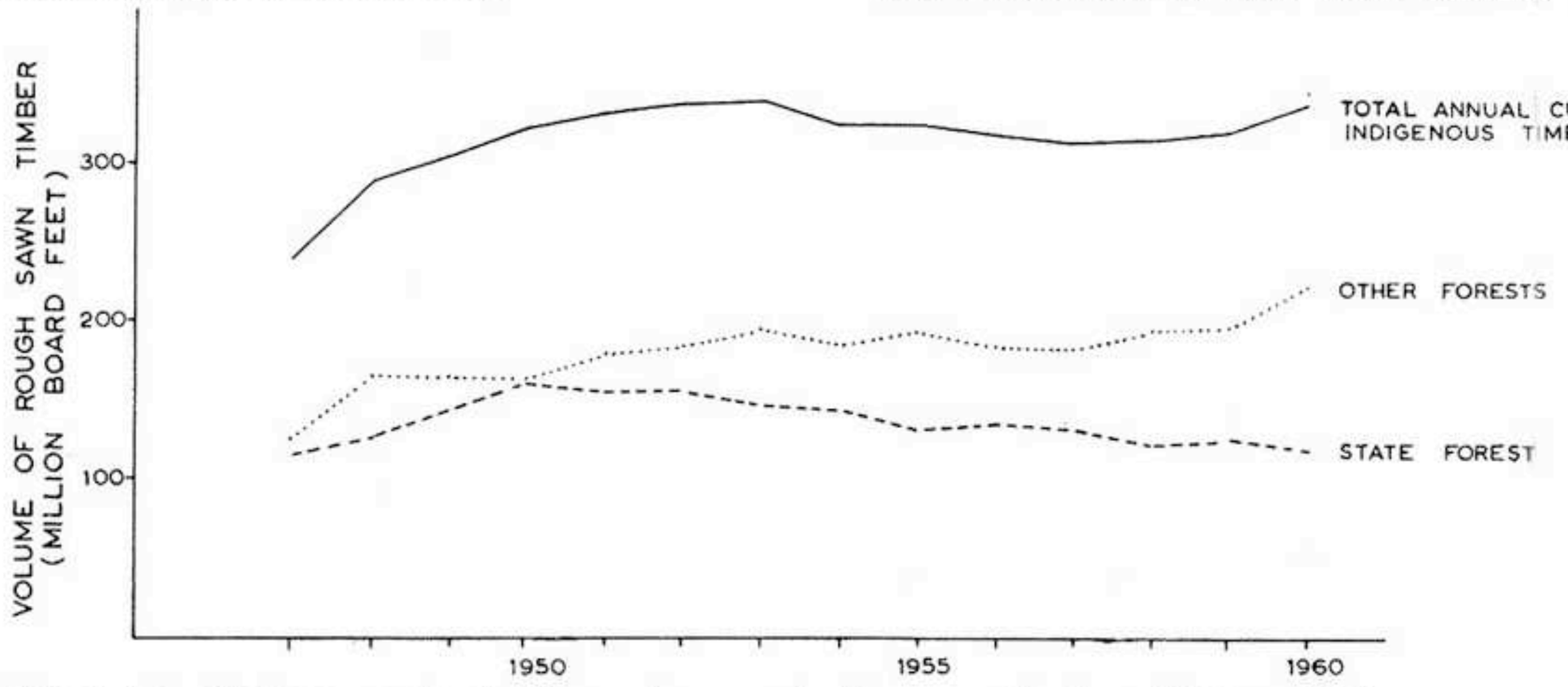

FIGURE 1. *Volume output of rough-sawn indigenous timber, 1947 to 1960.*

indigenous timber, there has, in recent years, been a steady decrease in the volume of timber being cut from State Forests (Figure 1). No overall reduction of any consequence is likely to occur until the forests on privately owned land become exhausted.

In industry, exotic timbers have successfully replaced indigenous in many uses. However, there are a number of purposes for which suitable grades of timber are not yet available from the exotic forest, in particular weatherboarding, quality flooring, high grade plywoods, window and door framing and sills, and furniture timbers. The demand for indigenous timber is likely to continue as long as the resources last.

The exploitation of the indigenous forests has many aspects and is subject to many influences. Not the least of these is that of price control. The implications of this will not be discussed here other than to state, without qualification, that under price control the true value of the produce from the indigenous forest cannot be assessed. Thus the economics of indigenous forest production and management remain unresolved.

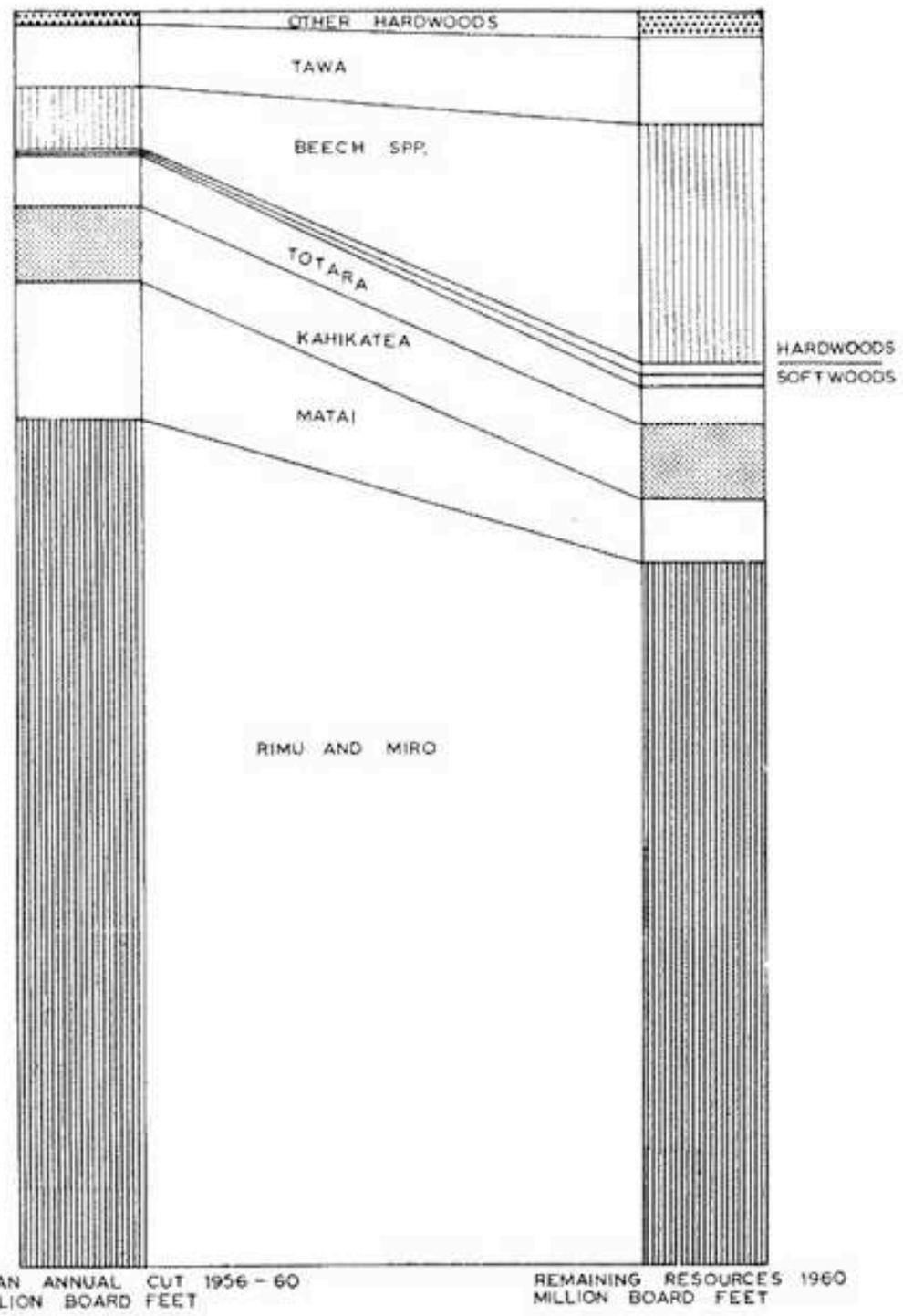

FIGURE 2. *Diagram illustrating imbalance between cut and remaining indigenous timber resources.*

A growing problem in the indigenous forest is that of unbalanced exploitation. The native timbers differ considerably in their qualities and end use. As a result trees yielding special-purpose timber, particularly matai, are being overcut in proportion to their resources, whereas several trees yielding good general purpose timbers but requiring special care in sawing and seasoning, for example, beech species, remain virtually untouched. This problem has been added to by the unwillingness of both the timber trade and the general public to change from familiar timbers to timbers of which they have had no experience and which, in some districts, may have fallen into disfavour because of ignorance of the correct methods of handling and seasoning. This imbalance between present cut and resources is illustrated in Figure 2 and Table 2. Probably the best way to correct it is to encourage the development of industries designed to use the timber of such species as beech as a raw material, at the same time restricting the sale of standing timber of the less abundant species. The Forest Service, with a persistent and well planned programme of research and publicity, overcame prejudice against the use of exotic timbers for general purposes in New Zealand. An equally intensive campaign for more general acceptance of the timber of beech species, emphasising their merits as timbers in their own right rather than as substitutes for less readily available species (Reid 1959) should also meet with success.

THE INDIGENOUS FORESTS OF THE FUTURE

At present rates of exploitation the indigenous timber resource can be expected to disappear in about sixty years' time (Table 2). That this will happen is most unlikely, for forest at present non-merchantable because of low timber content or because of difficult terrain can be expected to yield timber as new methods of logging develop, as timber becomes more valuable and management more skilled. Also, efforts

TABLE 2. *Resources of indigenous timber, present mean annual cut and cutting life in each species at present rates of exploitation.*

Species	*Resources at 31.3.60 million bd. ft.*	*Percentage of total resources*	*Mean annual cut, 1956–60 million bd. ft.*	*Percentage of total cut*	*Exhaustion of resources at present rate of cutting (years)*
Rimu and miro	11,247	56	218.1	67.5	52
Matai	926	5	34.4	11	27
Kahikatea	1,288	6	18.3	6	70
Totara	692	3	11.8	4	59
Kauri	159	1	1.1	0.3	144
Minor softwoods	149	1	0.6	0.2	248
Total softwoods	14,461	72	284.3	89	51
Beeches	3,784	19	16.4	5	230
Tawa	1,430	7	16.2	5	88
Minor hardwoods	486	2	3.4	1	143
Total hardwoods	5,700	28	36.0	11	159

are being made to bring large areas of State-owned indigenous forest under permanent sustained yield management. Nevertheless, the rate at which the indigenous forests are being depleted of their timber content is a matter that should cause serious concern.

The present generations of New Zealanders have inherited large areas of cut-over forest, perhaps a million acres in all, most of this now lying idle and only very slowly redeveloping a stocking of merchantable trees. Moreover, this area is being added to at a rate of some 30,000 acres annually. Very little of this is being converted to productive farm land and, because of the large area of scrub- and fern-covered land awaiting development (Table 1), it seems most unlikely that this position will change much in the foreseeable future. Also, a large part of the cutover forest, even where it is in a devastated condition, has an important protective function to fill and its development to agricultural land should be resisted. In some areas the complete conversion of cut-over indigenous forests to forests fully stocked with exotic species is being attempted but this concerns only small areas, probably not exceeding 500 acres a year at present. Even if the whole planting efforts of the Forest Service could be concentrated on the cut-over indigenous forests to the exclusion of other afforestation work, at present it would still leave 75 per cent or more of the area coming available each year unattended.

It is important, therefore, that the management of areas of cutover indigenous forest should be thoroughly investigated, particularly in districts such as Westland where it is unlikely that land of this category will be required for agriculture and where conversion to forests of exotic species seems difficult and expensive at present. During the past five years the New Zealand Forest Service has supported a programme of research into the management of the indigenous forests, with particular emphasis upon modifying felling and logging practices to leave the forest in a better condition for management after exploitation, and upon rehabilitating areas of cut-over forest.

Particular emphasis should be given in this discussion to the important part the beech forests could play in our future timber economy. It has already been pointed out that they are underexploited at present. Holloway (1961) has pointed out that the volume of the resources of beech assessed in 1955 was very conservatively estimated, as at that time (and today) only the best sawlogs were being taken. Therefore it is probable that, as far as future exploitation of beech is concerned, the forests might contain as much as three times the assessed volume of timber; the remainder coming from trees at present being bypassed in logging, from merchantable timber remaining in partly logged forests, and from forests whose function at present

is mainly protective but which could, under skilled management, yield important quantities of timber. Moreover, the beech forests can be regarded as being silviculturally suitable for permanent management for the sustained yield of timber, growing at least as vigorously and aggressively as their European counterpart. They provide a large source of perpetually renewable raw material and a use for this must be found.

The known resources shown in Table 2 do not include timber from the millions of acres of forest of mountainous country that forms the greater part of the indigenous forest estate. In some areas these contain quite large volumes of timber of merchantable tree species and, in other places, methods may be found of increasing the timber content of these forests. In countries more densely populated than New Zealand mountain forests are being successfully managed and in some places (for example Switzerland) are yielding large quantities of timber without their value as protection forests being affected. The maintenance of these as healthy, fully stocked forests, which never become overmature or decadent, has greatly increased their stability and reduced erosion hazard.

PRINCIPLES OF INDIGENOUS FOREST MANAGEMENT

The main objects of management in the indigenous forests are, first, to maintain a complete and stable cover of forest trees, and second, without reducing soil stability or increasing flood hazard, to provide a permanent yield of timber for commerce, while maintaining recreational and scenic values.

Wherever forests are permanently managed for the production of timber there are certain basic principles that must be followed. Knuchel (1953), discussing the concept of sustained yield, wrote, "A managed forest may be termed sustained which continuously, year after year, provides a supply of timber ripe for felling, in contrast to intermittent managing and plundering".

Perfect sustained yield can be regarded as being identical with perfect conservation. The forest is a living entity and, in common with all living things, the trees which form the forest both grow and die. In the natural forests growth and mortality do not always balance, but in forests under perfect management a state of active growth is maintained, volumes are kept at a more or less constant level, and the annual growth (measured as volume increment) is regularly harvested. Thus forests managed for sustained yield become a truly inexhaustible resource.

The untended indigenous forests, in general, are regarded as having no increment,

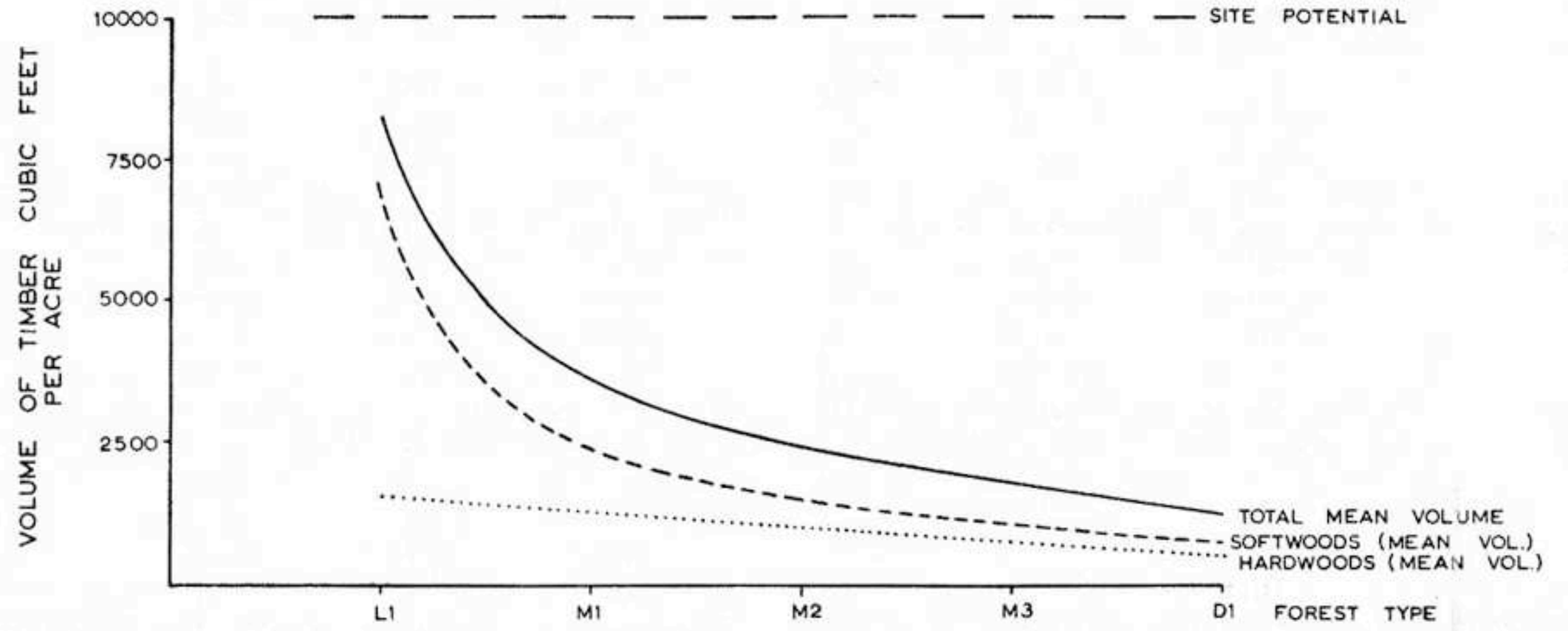

FIGURE 3. *Effect of age of association upon the timber content of the forest (West Taupo forests).*

growth of individual trees being offset by the death of others. So far as the total volume of cellulose, lignin, and other plant products per acre are concerned this is probably correct, but where only the volume of merchantable timber per acre is being considered, most untended forests show a periodic decrement in volume. An example of this is given in Figure 3, where the volume of merchantable timber in the forest decreases as the forest passes from dense seral podocarp forest (Type L1, McKelvey and Nicholls 1957) through older successional stages towards a hardwood (*syn.* broadleaved) dominated climax (or near climax) forest in which podocarps are only poorly represented and the hardwoods mainly belong to species that do not yield useful timber (Type D1, *ibid.*).

In planning sustained yield management in the indigenous forest two fundamental characteristics of the forest must be taken into account. First, with few exceptions, the seedlings of the native trees become established and grow well only under the protective cover of a nurse vegetation which provides the necessary balance of shelter and freedom from suppression, for example, kauri under tall kanuka, podocarps under tall manuka or scattered scrub hardwoods. Even the seedlings of beech species require partial shelter and seldom survive where the exposure is complete. (In many forests today populations of deer and/or opossums are so dense that regeneration is completely prevented, even where environmental conditions are otherwise eminently suitable.) Secondly, most of the natural forests are either overmature, being dominated by trees that are senescent or decadent, or contain an over-representation of trees of one or two age classes. Under either condition the forests are in a decadent state, because regeneration is disproportionate and inadequate.

When these facts are taken into account, management of the natural forest can proceed only where clear felling is not practised (unless a seed source is retained and ways and means are found of establishing a suitable nurse vegetation over the felled area), and where felling is preceded by silvicultural work designed to increase the regeneration status of the area. In either case, at present, a major problem is that of controlling the growth of the more aggressive weed species.

Forest management, considered simply, may be either by way of even-aged or uneven-aged structures within the forest. The preference shown by most New Zealand timber species to regenerate under the shelter of other trees indicates a greater suitability for managment as uneven-aged forest and the development and maintenance, therefore, of a stem size distribution curve as indicated by curve A in Figure 4. (A more common state in the indigenous forest is that shown by curve B.) The individual problems of even-aged and uneven-aged management have been described elsewhere (Cameron 1960).

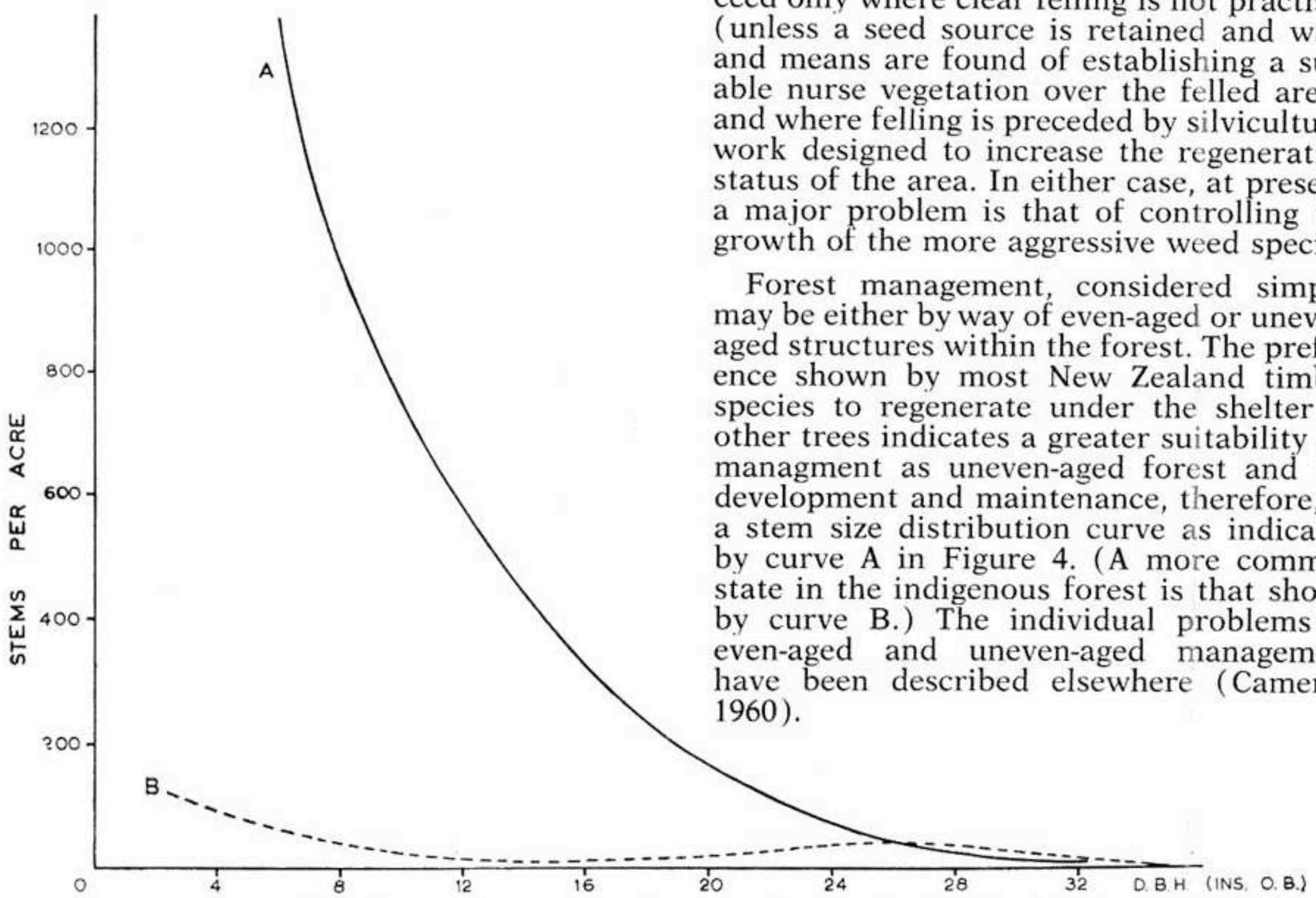

FIGURE 4. *Stem size distribution; A, managed uneven forest, Switzerland (after Knuchel); B, unmanaged type L forest, West Taupo.*

Similarly, management may be intensive or extensive. At present most indigenous forests are incompletely stocked with timber trees and contain a large, if not predominant, admixture of non-merchantable trees or species (Fig. 5). Intensive management involves a large capital investment; it demands, therefore, large returns, and necessitates the creation of forests more or less fully stocked with trees of merchantable species showing high volume increments. In contrast, extensive management involves much less ambitious forms of silviculture and accepts smaller yields. Both systems have their place in indigenous forest management.

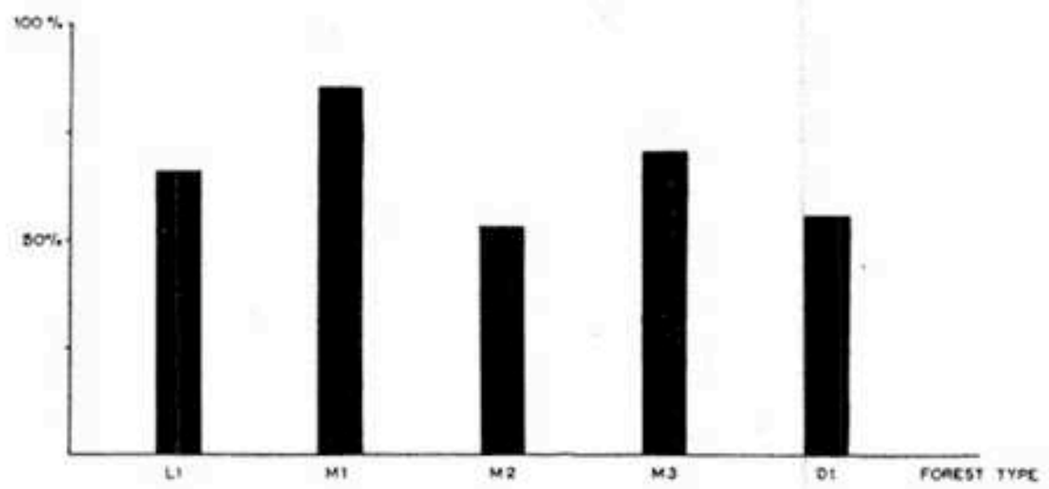

FIGURE 5. *Stocking of poles and trees, percentage of non-merchantable species.*

The future management of the native forests is in no way simple or straightforward. There are many uncertainties, many alternatives, and at present it can only be said that all possibilities are being considered and, in some forests at least, there is good hope of success. That there will be a permanent indigenous forest estate there is no doubt. Regarding the future of this the policy of the New Zealand Forest Service (as stated to the British Commonwealth Forestry Conference in 1957) is likely to remain unchanged, "To protect, conserve, and, where possible, perpetuate the remaining indigenous forests".

Upon the shoulders of the present generation has fallen the task of solving the many problems of forest management, and if this is achieved the indigenous forests will remain in perpetuity.

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