REGENERATION OF PODOCARPS IN A CENTRAL NORTH ISLAND FOREST

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SYNOPSIS

The conditions under which podocarps regenerate are described with particular reference to Pureora Forest in the West Taupo region. Effective podocarp regeneration is scarce in the dense podocarp forests; it occurs more frequently, however, beneath a gradually opening hardwood canopy such as that provided by large dying individual trees within scattered podocarp/tawa forest, or by older stands of Leptospermum *and* Weinmannia *in fire-induced scrub. Examples are given of cyclic regeneration in older forest types and of the initiation of dense podocarp forest in recent times in fire-induced secondary forest. Tree ferns and vigorous growth of the larger-leaved mesophytic shrub-hardwoods prevent the recruitment of podocarps. Good seedling and sapling regeneration of podocarps has been found in limited areas of old cut-over forest but it will not develop into a future crop without silvicultural treatment to reduce competition from hardwoods.*

Limited regeneration of podocarps has been obtained within ten years of controlled selective logging of virgin forest, but much of this becomes suppressed if not released by tending. Silvicultural treatment to establish natural or artificial regeneration of podocarps cannot be justified on purely economic grounds. Even where an adequate stocking of rimu regeneration is obtained, merchantable trees will not be available for at least 150 years.

INTRODUCTION

This paper attempts to provide a basis for assessing the prospects for management of podocarp/tawa forest as a permanent resource of indigenous timbers. The main study area is Pureora Forest where the author was posted in 1957 to investigate the feasibility of managing the indigenous forest. Pureora Forest is situated on the central North Island plateau 20 miles north-west of Lake Taupo. The forest types occurring here have been described by McKelvey (1963). One of the most extensive types is scattered podocarp/tawa (Type M2) characterized by a stocking of about 23 large mature podocarps per hectare over dense tawa (*Beilschmiedia tawa*) and other hardwoods. Seedling and sapling regeneration of podocarps is generally more abundant than in dense podocarp forest (Types L1 and L2) but stems between 10 cm and 30 cm

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diameter are rare as in so many virgin forests throughout New Zealand.

Uncontrolled destructive logging, experimental selective logging, a forest edge modified by fire, and an enclave of fire-induced *Leptospermum* and *Weinmannia* scrub, provide areas in which the regeneration of podocarps can be compared with that in virgin stands of podocarp/tawa and of dense podocarp forest. Before considering some of the regeneration mechanisms which appear to operate in these different types, a brief account will be given of the general environment of the study area and some of the ecological characteristics of the five main podocarp tree species, namely, rimu (*Dacrydium cupressinum*), matai (*Podocarpus spicatus*), miro (*P. ferrugineus*), kahikatea (*P. dacrydioides*) and totara (*P. totara*).

THE ENVIRONMENT

The Pureora study area is 500 to 550 metres above sea level on flat to rolling country. The soils are volcanic sands and gravels derived from rhyolitic Taupo ash erupted about 130 A.D., and these overlie silty loams derived from older ash showers. The Taupo ash is 50 to 100 cm thick on flatter areas but is thinner, or lacking, on steep slopes.

The climate is cool and moist with a mean annual temperature of 10.5° C and an average rainfall of 1800 mm well distributed throughout the year Some 80 ground frosts a year, with a maximum severity of —12° C have been recorded at the Pureora Climate Station, but up to —17° C has been recorded in depressions. Features which may limit the establishment or growth of podocarp seedlings in the open or in thin-crowned scrub are the frequent occurrence of frosts and occasional cold desiccating winds during the growing season.

The main points concerning animal life as it affects regeneration are that opossums (*Trichosurus vulpecula*) are rare, red deer (*Cervus elaphus*) are increasing but have made little impact on the forest until the last ten to fifteen years, the native bird life is relatively abundant, and the black rat (*Rattus rattus*) is present throughout the forest.

SEED PRODUCTION AND GERMINATION

Cone Development

The female cones are initiated in autumn and at Pureora pollination occurs from late November to January. In miro, matai and rimu the interval between pollination and fertilization spans two growing seasons as fertilization occurs about September, some nine months after pollination. The ovules of totara and kahikatea appear at the commencement of new growth about mid-November and are fertilized about a month after pollination, so that this phase of the life-cycle is completed in one growing season.

The ovules of all species grow rapidly after fertilization and have almost reached their full size by December or January.

Fleshy seed coats or receptacles ripen from April to June when the seed is dispersed largely by birds.

Periodicity of Seed Crops and Abundance of Seed

Periodicity has been studied by means of pairs of seed traps (described by Beveridge, 1965) placed beneath the crowns of 19 permanent seed trees. Results for seven years are illustrated in Fig. 1. Rimu and kahikatea show the most marked periodicity. Kahikatea bears the heaviest seed crops and up to 14 000 sound seeds per square metre have been collected in one seed fall; once ovules are produced in quantity in late spring a good seed crop usually results. Very few or no sound seeds are produced in the two- or three-year intervals between good seed crops, and periodicity in kahikatea fruiting appears to be controlled by physiological factors.

The seven rimu seed trees have borne moderately good seed crops including two in successive years. Observations over the past 15 years indicate that there are periods of two to four years when little sound seed is produced. In some years quantities of small unfertilized ovules have often been observed in autumn during seed collection but no good seed crop has resulted the following year, possibly owing to failure in fertilization.

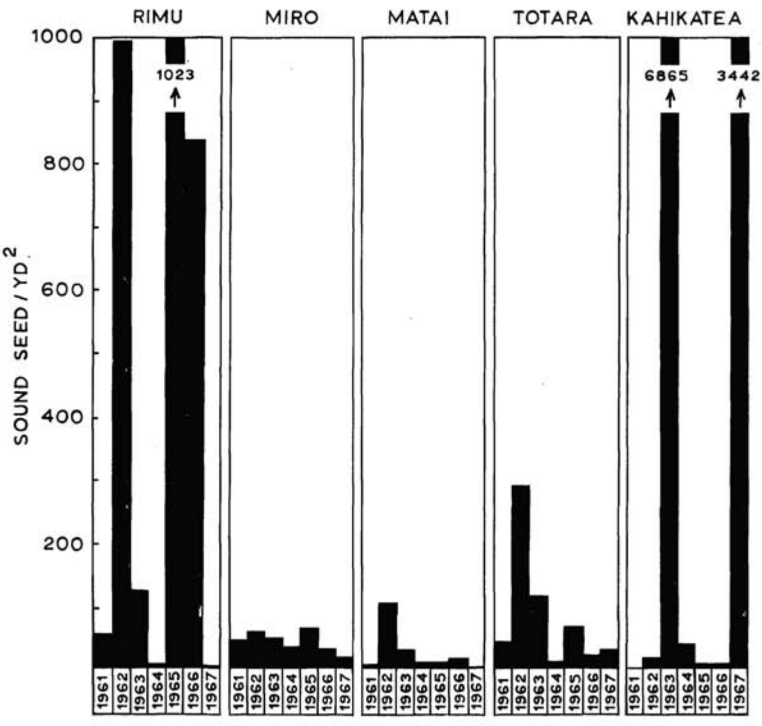

FIG. 1: *Periodicity of podocarp seed crops.*

Matai is the only species which has failed to produce a good seed crop at Pureora during the period of observation. Ovules are often produced in abundance and there is usually no lack of pollen. The main cause of failure appears to be insect attack on the developing ovules, and most of the seed drops before ripening. Insects raised from malformed ovules include gall midges (Cecidomyidae), parasitic Hymenoptera and the tortricid *Carposina gonosemana* (J. S. Dugdale, pers. comm.).

The miro and totara seed trees have produced light but regular crops. Totara occasionally produces normal-sized seeds on fleshy receptacles but they lack embryos.

Crops may be much heavier than indicated by the number of seeds collected in the seed traps which deflect some seeds. In 1967, for example, up to 950 seeds per square metre were collected from the ground beneath one of the miro trees.

The occurrence of years in which there are poor crops of all podocarp species (*e.g.*, 1961 and 1964) is more apparent than the occurrence of years in which all species fruit well.

Dispersal and Destruction of Seed

The seeds of all five species are well adapted for dispersal by birds but most seed is probably distributed by only three species of native birds — the New Zealand pigeon (*Hemiphaga novaeseelandiae*), the tui (*Prosthemadera novaeseelandiae*) and the bellbird (*Anthornis melanura*). Four introduced species are minor distributors of podocarp seed, mainly at the forest edge — the blackbird (*Turdus merula*), thrush (*Turdus philomelos*), starling (*Sturnus vulgaris*) and Indian mynah (*Acridotheres tristis*). Concentrations of tuis and pigeons have been observed in heavily fruiting stands. The large-seeded miro is almost entirely dependent on the pigeon for dispersal of seed to areas where seedlings can become established. Effective regeneration is not found beneath the parent trees in any of the podocarp species.

The lightest seed is produced by rimu (100/g) but sound seed usually falls attached to well-developed fleshy receptacles unless detached by birds. Thus most sound rimu seed usually falls within 10 m of the parent crown and is rarely dispersed by wind for more than 40 m.

A high proportion of the seed produced by miro, matai and rimu is destroyed on or beneath the parent trees. The black rat is partial to seed of all three species but recruitment of seedlings is affected only if seed is eaten after dispersal away from the parent crowns. The destruction of seed on rimu crowns, apparently by finches, probably causes the greatest loss for this species.

Totara seed appears to be unpalatable to all seed-eaters (rats and birds) except the native parakeet (*Cyanoramphus* spp.). Seed destruction is not an important factor in the reduction of heavy kahikatea seed crops.

A fuller account of dispersal and destruction of podocarp seed is given by Beveridge (1964).

Longevity of Podocarp Seed in the Forest

Sowing of seeds from packets buried beneath the litter and duff in the forest for different lengths of time showed that all kahikatea seed germinated in the summer following seed fall. After burying for one year and then sowing, up to 50% of rimu and totara seed germinated in the spring 18 months after seed fall. Some miro and matai seed remained dormant but viable during four years' burial and when sown the seed germinated more quickly than freshly-fallen seed.

Seed Germination and Survival of Podocarp Seedlings

Germination at Pureora commences about mid-November and may continue throughout the summer. The bulk of the rimu, totara and kahikatea seed germinates in the summer following seed fall, but matai and miro seed, owing to natural dormancy, germinates sporadically over a period of years. Opening of the canopy, as in logging, will induce the germination of miro seed, but seedlings also become established beneath large tawa, aided by the comparatively large food reserves of the seed and the strong shade-tolerance of small seedlings.

Germination of all species occurs readily on a wide range of sites and small seedlings occur in many places unsuited to their further growth. Rimu, for example, may germinate *en masse* on bare pumice sand beside logging roads, and a few weeks later in litter and fibrous duff beneath seed trees or on shaded tracks and logs. Kahikatea seedlings are widespread throughout dense podocarp forest in the summer following a heavy seed fall. Most of these seedlings die in the first two summers. In quadrats established beneath parent trees in dense podocarp forest the few ringed seedlings of kahikatea and rimu that survived five years reached a height of only 5 cm.

The recruitment of small podocarp seedlings within the forest appears to be inhibited only by dense leaf litter from tree ferns and broadleaved species. Recruitment is induced by ground scarification such as occurs in post splitting operations within high forest. Increased light resulting from the removal of ground vegetation may then allow slow growth of seedlings of the more shade-tolerant species such as rimu and kahikatea but these are suppressed by regrowth within a few years.

NATURAL METHODS OF REGENERATION

Regeneration in Virgin Forest

The main method of regeneration appears to be by very slow development beneath a large dying hardwood tree, the most common species at Pureora being kamahi (*Weinmannia racemosa*). Established seedlings may occasionally be released by windfall, but more often invigoration or new growth of ferns, shrub hardwoods and climbers smother any podocarp seedlings already present. A windfall does not directly induce the recruitment of any podocarp species except, perhaps, miro.

Cyclic regeneration may be clearly seen in the following sequence observed in scattered podocarp forest (podocarp/kamahi/scrub hardwoods type):

(1) Windfall of a large overmature podocarp.

(2) Invasion or increase of tree ferns until a colony of rhizomatous *Dicksonia squarrosa* is formed. The dense litter inhibits terrestrial recruitment of all podocarps and hardwoods.

(3) Development of epiphytic growth of hardwoods, particularly kamahi, on tree fern stems.

(4) Suppression and death of most of the tree ferns by hardwoods, and development of kamahi to a large size when it becomes a suitable perching tree for birds, particularly pigeons.

(5) Recruitment of podocarp seedlings mainly from bird-dispersed seed.

(6) Development of a podocarp sapling group as the kamahi crown thins and dies. Windfall of adjacent podocarps at this stage may enlarge the gap and hasten development of the podocarp group.

Terrestrial establishment of kamahi in high forest is uncommon, but may occur on the subsoil exposed by lifting of the large plate-like root system of a wind-fallen podocarp with its associated raw humus and topsoil. The kamahi may also become established on the uplifted root plates. In podocarp/tawa forest (Type M2) there is a very common association between groups of podocarp seedlings and saplings and kamahi stumps or moribund kamahi, often of massive size and irregular form, indicating an epiphytic origin.

The cycle above may take 200 to 300 years from the time of windfall of the mature podocarp until the next generation of pole podocarps is established.

Podocarp poles (stems 10 to 30 cm dbh) are in fact rare over large areas in all the high forest types examined near Pureora, and the small areas of dense poles that do occur are usually associated with swampy ground or places where a fire history is suspected.

A complete enumeration of all merchantable podocarp trees over 45 hectares, and a line sampling over 30 hectares of podocarp/tawa forest gave the following results. There were 30 merchantable podocarps per hectare, consisting of 20 rimu, 5 miro, 3 matai and 2 kahikatea. Most trees were in the diameter range 45 to 150 cm, and the 105 cm diameter class contained the greatest number of rimu stems. All the totara and some of the matai were hollow and were not enumerated. These defective trees occurred mainly scattered through shallow basins of shrub hardwoods or round their margins. Frequent old fallen totara were found in these basins. The sound timber trees tended to be concentrated in groups, particularly on the ridges.

In a sample of seedlings from 15 cm to 3 m in height, in plots of 4 m^2, rimu occurred in 15% of the plots, miro in 25% and totara, tanekaha (*Phyllocladus trichomanoides*), kahikatea and matai in from 1% to 3%. Rimu was associated with kamahi stumps and miro with large-crowned tawa. Podocarp seedlings were absent beneath tree fern groups, dense-crowned shrub hardwoods, areas of profuse tawa regeneration, and in moist depressions with a dense cover of ground ferns beneath shrub hardwoods.

In plots of 100 m^2 rimu and miro occurred as saplings in 17% of the plots, but there were only three stems of these species between 10 and 30 cm dbh. The podocarp saplings were mainly associated with kamahi stumps.

Ring counts on nine podocarp stumps in the middle diameter range (70 to 80 cm) in a block of 10 hectares indicated ages ranging from 450 to 600 years, whilst 800 rings were counted on a rimu of 100 cm dbh. Most of the larger matai and all the totara were hollow or otherwise unsound in the middle of the stump. Ring counts of matai in the Urewera region, however, indicate that this species can reach 1000 years. From the ring counts, all the trees had taken from 100 to 150 years to reach 15 cm dbh.

Regeneration after Fire

Except in frost hollows, seedling, sapling and pole-sized podocarps are everywhere abundant in the shrub ecotone between podocarp/tawa high forest and fire-induced heath-type vegetation of the open plain. This ecotone is usually a strip 40 to 100 m wide. In transects at right-angles to the forest edge, the different podocarp species are found entering the scrub in roughly the following sequence as the nurse species increase in height and provide a moister and less frosty habitat. In the ecotone studied, no podocarp tree species has become established in the heath of *Dracophyllum subulatum*, although *Phyllocladus alpinus* enters in this way on frosty flats adjacent to dense podocarp forest in some areas. Matai, totara and tanekaha appear as small and unthrifty seedlings in low manuka (*Leptospermum scoparium*). Healthy rimu seedlings appear in association with shrubby kamahi where this is found entering beneath taller *Leptospermum* thickets, and then develops beneath a thinning canopy of large kamahi. Miro is found only where broadleaved shrub hardwoods have replaced the *Leptospermum* and provided a more mesophytic micro-climate. Small kahikatea seedlings are found by streams or in seasonally flooded areas within the *Leptospermum*. A narrow belt of pole-sized podocarps of all species may occur emergent from shrub hardwoods or kamahi before the appearance of large tawa. Stem analyses have shown that poles of all species have taken from 50 to 100 years to reach 15 cm dbh.

On the fire-damaged margin of high forest, seedling and sapling podocarps are usually abundant, particularly where groups of mature podocarps are absent. Spot fires have probably occurred within such areas in the heavy litter of rimu or on isolated dead spars. The podocarp regeneration here is often associated with large kamahi stumps.

Groups of podocarp seedlings may also be found in islands of broadleaved hardwoods within the matrix of *Leptospermum;* these seedlings must have originated from seed deposited by fruit-eating birds feeding or roosting there. Even individual emergent specimens of species such as lancewood (*Pseudopanax crassifolium*) and *Pittosporum colensoi* may have small podocarp seedlings beneath them. Seedlings in the pure *Leptospermum* have probably arisen from seed distributed by birds in flight leaving the forest edge; such distribution has been observed where concentrations of tuis are feeding on totara and kahikatea.

Extensive podocarp regeneration has been studied in a 65 hectare enclave of *Leptospermum*/kamahi almost entirely surrounded by podocarp/tawa forest. Line sampling has shown that seedlings and saplings of podocarp tree species are present throughout this area and are particularly abundant within 60 m of fruiting trees at the forest edge and on dry ridge tops. They are absent from boggy and frosty depressions where *Dracophyllum* replaces *Leptospermum.* Established seedlings are, however, scarce in the pure *Leptospermum,* particularly beneath the 12 m high canopy of kanuka (*L. ericoides*). Developing regeneration is nearly always associated with a thin or dying canopy of kamahi aged from 30 to 100 years, only three to five metres high on ridge tops, but up to 12 metres on flat ground and near the forest edge. Judging from ring counts on kamahi and kanuka, fires must have swept parts of this area until 50 to 150 years ago. No part of the area is more than 400 m from a podocarp seed source.

Regeneration was assessed in 25 m^2 plots on 5 km of lines, amounting to 3% of the total area. The results showed that 79% of quadrats were stocked with podocarps over 15 cm high, but stems over 10 cm dbh were present on only 5% of the quadrats; rimu was present on 81% of the stocked quadrats while miro, matai, totara, kahikatea and tanekaha each occupied 2 to 4%. It is assumed that dense podocarp forest has been initiated in this area.

Regeneration in Logged Forest

Quite extensive areas have been sampled for regeneration of podocarps, but good stocking of well-established regeneration has been confined to limited areas where seedlings and saplings of rimu and miro occur, mainly in older cutovers where logging did not remove the entire podocarp seed source. In one such area over 100 ha on the central Mamaku plateau, rimu seedlings are found even round the stumps of felled trees, and these seedlings probably arose from seed on the ground at the time of logging. Rimu has often regenerated on ground disturbed by logging operations, particularly in the beds of old tramways, or along their margins.

During the past 30 years, however, logging has usually involved the removal of all the seed-bearing podocarps except a few with defective stems. In densely stocked stands, uncontrolled logging operations have destroyed most of the small seedling regeneration present at the time of logging, and in canopy gaps generally a dense growth of ferns and hardwoods has prevented the development of survivors or the recruitment of new seedlings. Logging does, however, induce the germination of miro from seed already on the ground, and both advance growth and new seedlings may persist for many years and reach a height of one to three metres while dominated by a hardwood canopy. In residual patches the regeneration associated with kamahi stumps will continue to grow, sometimes aided by increased light from adjacent felling.

A regeneration survey along almost 10 km of lines in logged podocarp/tawa forest of the south Mamaku plateau, 20 to 30 years after logging, showed that 10% of 16 m^2 plot samples were stocked with podocarp seedlings, mainly under two metres high. Of the stocked quadrats, 82% were occupied by miro and 18% by rimu seedlings. Less than 1% of 16 m^2 samples were stocked with podocarps between 2.5 and 30 cm dbh.

A more intensive study has been made of forest near Pureora selectively logged on an experimental basis by removing approximately one-third of the merchantable trees. The incidence of podocarp regeneration seven years after logging may be described as follows:

(a) *Residual forest:* Germination of miro has been induced by breaks in the canopy, and advance growth seedlings beneath a tawa canopy, which were provided with side light, are growing well. Recruitment of rimu seedlings beneath tawa continues, but the seedlings growing on undisturbed soil are mainly ephemeral. Small kahikatea seedlings, also ephemeral, are widely dispersed although there are a few parent seed trees.

(b) *Heads of felled trees.* No regeneration of any podocarp species exists owing to the rank regrowth of ferns and dense-canopied shrub hardwoods.

(c) *Ground disturbed by logging operations but retaining humus and topsoil.* Dense wineberry (*Aristotelia serrata*) thickets have formed where the tree canopy has been removed. On flatter areas the ground has been thoroughly rooted by pigs, leaving only an occasional miro or matai seedling which must have arisen from seed on the ground at time of logging.

(d) *Heavily scarified ground along extraction tracks.* Small patches of abundant seedling regeneration, mainly rimu, have appeared on bare pumice sand, and recruitment continues. Where shelter, but not direct overhead shade, is present, seedlings have grown to a height of 30 cm in the six years since logging. Many of the seedlings on heaped soil at the side of tracks are becoming suppressed by ground ferns. These seedling patches are usually situated within 20 m of a parent seed tree.

GROWTH RATES OF REGENERATION

Growth Rates of Podocarp Seedlings

In virgin forest, in places where competition from ferns and broadleaved species is not severe, the shade-tolerant seedlings of rimu, kahikatea and miro may reach one or two metres in height over a period of 20 to 50 years; at this stage most stagnate and annual shoot growth of 2 to 5 cm is counteracted by the subsequent death of shoot tips. If further light is admitted by the death or deterioration of trees in the hardwood canopy, the podocarps will continue to grow. Seedlings 1.5 to 3 metres in height, released in this way, have mean annual height increments of 7 to 30 cm, kahikatea having the fastest growth rate and matai the slowest.

A long period of slow early growth is also characteristic of podocarps that have emerged through fire-induced scrub of *Leptospermum* and *Weinmannia* at the forest edge. Stem analyses of 12 podocarp poles (10 to 25 cm dbh and 11 to 14 m high) that are now growing as dominants or codominants, show that rimu reached a height of 3 m in 20 to 35 years, kahikatea in 30 years, totara in 12 to 30 years, and matai in 60 years.

The potential growth rate of the different species varies markedly. In Pureora nursery, small seedlings of totara growing under the most favourable conditions showed a height increase of up to 50 cm in one season, whilst the most vigorous rimu grew only 20 cm. In experimental plantations established in central North Island, the best growth shown by rimu has been beneath canopy gaps 10 m in diameter, made in reverted cutover forest of the Mamaku plateau by felling or by killing the hardwood canopy with chemicals. The mean annual height increment of the best 20% of the seedlings (2 to 5 per planted group) has been 18 cm for the period of seven years after planting. As the current height increment is now 25 cm, these seedlings should reach a height of three metres in 15 years from sowing of seed in the nursery. Planted seedlings are suppressed by ground and tree ferns and heavy-crowned species such as mahoe (*Melicytus ramiflorus*), but can grow well when overtopped by the lighter-crowned growth of species such as wineberry.

Growth of Podocarp Seedlings released from Competition

Stagnating or slow-growing seedlings have shown a moderate response to removal of competition, particularly when the canopy has been lightened gradually. Cutting of competing shrub hardwoods leads to a vigorous coppice growth which results in further suppression of the podocarps. In fire-induced stands, killing of the kamahi nurse may lead to an initial check in the growth of rimu, but growth rates improve after two or three years.

Different methods of releasing groups of podocarp seedlings from competing hardwoods have been tried in old reverted logged forest of the Mamaku plateau. In the subsequent period of ten years, naturally regenerated seedlings of five podocarp species showed an annual height increment of 8 to 10 cm in treated groups, compared with less than 3 cm in untreated groups. Planted seedlings in this trial showed growth rates of the same order as natural seedlings.

It has been fortuitously discovered that one of the cheapest methods of releasing established but suppressed seedlings of rimu and miro from a shrub hardwood canopy formed in reverted cutover forest is to aerially spray with water-based herbicides. These chemicals defoliate the hardwoods, but lack of penetration of spray and the relative resistance of podocarps to phenoxyacetic compounds enables long-suppressed seedlings to respond to the increased light.

Removal of broadleaved species and some ferns by cattle grazing also assists establishment of podocarp seedlings. Rimu and miro are particularly unpalatable to cattle, and in extensive grazing of logged forest on the Mamaku plateau these species and tawa were the only tree species to remain relatively undamaged. Strips of regenerating podocarps at the forest edge bordering on farmland are often the result of cattle grazing, though the effects of fire may also be involved in many cases.

INJURIOUS AGENCIES

Totara is the most light-demanding and drought-resistant species considered here, but it is also the species most subject to defoliation by insects (mainly tortricid and geometrid caterpillars) and injury by frost. Height growth in natural seedlings occurs in one or two short flushes, each lasting for a period of two or three weeks before hardening of the foliage and formation of a resting bud. Seedlings beneath *Leptospermum* are frequently damaged by both late and early frosts during the short growing season, which covers a period of four to five months from bud burst about mid-November to the first sharp frosts in late March or April. The significance for totara of a slight change in climate is indicated by the annual height increments of a young plantation established in four metre high *Leptospermum*. For four of the first five years the current annual height increment ranged from 8 to 12 cm but in the unusually wet and cloudy growing season of 1962-3 no damaging unseasonable frosts occurred and the increment was 22.5 cm.

The other podocarp species are comparatively free from insect damage as small seedlings, although shoot tips may be killed by tortricid caterpillars. Kahikatea and rimu seedlings over one metre high that are growing in well-lit situations are prone to attack by the stem borer *Navomorpha lineatum*, usually associated with cicada oviposition scars, resulting in the death of the top 25 to 100 cm. Frost damage has not been observed on species other than totara and tanekaha, possibly because seedlings usually become established only in sheltered positions. In February 1960, however, the growing tips of kahikatea in open-grown groups were scorched by a cold gale-force wind. These seedlings had been exposed by logging 15 years previously and had continued to grow at the rate of 10 to 25 cm a year. New growth on mature matai trees may become blue and withered in midsummer, and it is suspected that cold winds cause desiccation of soft young shoots.

PROSPECTS FOR MANAGEMENT OF PODOCARP/TAWA FORESTS IN CENTRAL NORTH ISLAND

Selective logging of virgin podocarp/tawa forest has been shown to be technically feasible, but podocarps of intermediate size are scarce and seedling regeneration will require releasing from competing ferns and shrub hardwoods. Neither podocarps nor tawa can penetrate a shrub tier in gaps made by logging; two releasing treatments would generally be required, each at a minimum cost of $25 to $40 per hectare. Even after releasing, natural and group planted seedlings of rimu show a mean annual height increment of only 8 to 15 cm.

As growth rates of rimu are slow at all stages, it would take at least 150 years to obtain a second crop of merchantable sawlogs after completing the regeneration period. This period, defined as the time taken to obtain an adequate stocking of trees that do not require further release from competition, will take 30 to 50 years for natural seedlings; this is the time taken for rimu to reach 5 m in height. The most vigorous rimu seedlings planted in forest gaps reach this height in 20 years from sowing of seed in the nursery.

Enrichment of partially logged forest with group-planted rimu or with exotic species may be justified where there are grounds for retention of the indigenous forest environment, and where the production of timber is not the main objective.

The findings of this paper apply particularly to Pureora Forest where the impact of browsing animals has been slight. Selective felling trials have also been carried out in podocarp/tawa forest in Whirinaki Forest, where browsing animals have made a much greater impact on the vegetation; ten years after selective logging, regeneration of podocarps is scarce and growth has been retarded by deer and opossum browsing. Other studies have been made on the Mamaku plateau and in Rotoehu Forest, and the general conclusion reached has been that there are very poor prospects for management of central North Island podocarp and podocarp/tawa forests for timber production.

In view of the poor management prospects, and the recent decline in the market for podocarp timbers, there is a strong case for early review of the fate of the remaining virgin merchantable indigenous forests of this region. If logged indigenous forest is generally to be scheduled for conversion to exotic forest crops in order to retain the land in production, there is all the more reason for a policy of placing virgin forests in the category of long-term timber reserves. This would give sufficient time for reasonable decisions to be made on permanent reservation of areas for scientific, recreational and amenity purposes. Before any further stands of virgin forest are logged, the ultimate land use of such areas should be decided.

REFERENCES

Beveridge, A. E., 1964: Dispersal and destruction of seed in central North Island podocrap forests. *Proc. N.Z. Ecol. Soc., 11:* 48-55.

Beveridge, A. E., 1965: Durable seed traps. *N.Z. For. Serv. For. Res. Inst. Res. Leaflet No. 9.*

McKelvey, P. J., 1963: The synecology of the west Taupo indigenous forest. *N.Z. For. Serv. Bull. 14.*