THE LOGGED PODOCARP STANDS OF THE LONGWOOD RANGE, SOUTHLAND

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I. INTRODUCTION

A problem which has exercised the minds of many New Zealand foresters over the past several decades has been that of the restoration to productivity of the logged podocarp forests. The derelict condition of these forests, particularly of those of the southern hill country, is generally well known, but, rather surprisingly, a clear factual account of the present condition of the stands nowhere appears in print. A very considerable body of information has accumulated in forest records and a wealth of detailed descriptive material is pigeon-holed in the archives of the National Forest Survey; but, unless this information be periodically dragged forth into the light of day, the problem as a whole is unlikely to receive the attention it deserves.

It may very well be, of course, that no substantial action to resolve the problem will prove possible under present economic circumstances but, as population grows and pressure on the land increases, the problem will loom ever larger. There can be no doubt but that, at some date perhaps not far distant, the logged podocarp lands must be taken in hand with a determined attempt made to restore them to a condition such that they can once more play an important part in the over-all land-use economy of the country. They cannot be allowed to support, indefinitely, a worthless growth of scrub hardwoods.

Admittedly, one school of thought holds to the view that, in course of time, the podocarps will re-establish and that a continued measure of fire protection, coupled with unlimited patience, is the only measure required to be undertaken. But what, in fact, is the true position ? How much podocarp advance growth or regeneration is on the ground after thirty, forty or even seventy years ? What is the present condition of the logged podocarp stands ?

The answers to these questions are largely contained within existing records. For this present paper which deals specifically with the logged podocarp stands of the Longwood Range, the answers given below have been abstracted from the sample plot records of the Forest Survey, the field work having been carried out during the years 1946-47.

II. GENERAL DESCRIPTION

Briefly, the logged podocarp stands of the Longwood Range extend across some 30,000 acres on the foothills and lower slopes of the range which itself lies some 30 miles to the west of the city of

Invercargill. The terrain, throughout, is typically easy with undulating rounded hill-slopes rising to altitudes seldom exceeding 1,200 ft. Steep, or otherwise difficult ground constitutes but a small fraction of the whole. No portion of the area lies more than six miles from rail or more than four to five miles from metalled roads.

The soils, characteristically moderately leached, moderately compact, nut-structured silt or silt-clay loams with greyish shallow 'A' horizons are potentially highly productive forest soils though of strictly marginal agricultural value. Of the total logged area well over one-half is held under permanent forest reservation.

The rainfall is not excessive, varying from 60 to 80 inches per annum normally well distributed throughout the year. Snow seldom lies on the lower slopes and frosts, though frequent in winter, seldom exceed 12 to 15° F. on the hill slopes or 20° in frost basins.

In other words, the basis factors of site would appear wholly favourable to the practice of intensive sustained yield forestry ; and the virgin podocarp stands have, in the past, yielded 4-500 million bd. ft. of high quality softwood timber (minimum estimate). The remnant virgin stands (5,000 acres in 1946) will yield an additional 50-70 million bd. ft. The harvest of the virgin crop has, or will have been, spread out over almost a full century. Logging commenced in approximately 1870 and will near completion in 1970. But what follows the taking of this harvest ?

A short description of the remnant virgin stands has already been given (1) and will not here be repeated in detail. Briefly, these stands, and by inference the virgin stands over the entire area, were rimu (*Dacrydium cupressinum*) stands with codominant or, more generally, sub-dominant Hall's totara (*Podocarpus hallii*) and miro (*P. ferrugineus*). There were considerable local variations in the number of stems per acre, 6 to 9 on the lower stocked sites and 30 to 45 on well stocked sites, with numerous pockets of 'dead' ground, scrub-filled, in gullies and on damp shaded slopes. Beneath the podocarps there was typically a strong, though very variable, understory of rata (*Metrosideros umbellata* syn. *lucida*) and kamahi (*Weinmannia racemosa*). On well stocked sites the podocarps were typically of medium diameter (12 to 24″ d.b.h.) but elsewhere were commonly of greater diameter (20 to 40″ d.b.h.).

On certain local sites, particularly where soils were derived from late tertiary sediments or basic volcanics and where aspect was particularly favourable, matai (*P. spicatus*) and kahikatea (*P. dacrydoides*) entered the stands occasionally achieving dominance. On such sites all podocarps were of large diameter and great age and stood widely spaced apart over a very dense and floristically rich shrubbery. Rarely, on such sites, totara (*P. totara*) or totara X Halls' totara hybrids were present.

Kahikatea was also well represented on local swamp sites and on local pockets of wet ground throughout. The wet ground kahikatea were characteristically of smaller diameter than those found in the matai sub-type.

On the upper slopes of the range, circa 800-1,200 ft., and toward the valley floors, the podocarp stands merged into silver beech (*Nothofagus menziesii*) stands with widespread development of mixed beech/podocarp forest; and tongues of beech extended down all major streams through the podocarp stands. These pure beech or mixed beech/podocarp stands are not considered further in this account which deals solely with 'pure' podocarp stands.

III. FIELD WORK

The Longwood forests were surveyed photogrammetrically and were sampled by a line-plot survey with plots established at half-mile intervals along east-west lines one mile apart. Each plot consisted of a *main plot* one acre in size (500 x 200 links) over which were tallied all stems, merchantable and cull, exceeding 12 inches diameter breast height. Within this plot an *intermediate plot* (1/20th acre, 100 x 50 links) was established and on this all stems from 4 to 12 inches diameter were booked. Within this intermediate plot a *quadrat* (1/80th acre, 50 x 25 links) was laid out and on the quadrat all advance growth or regeneration, saplings and seedlings, of commercially valuable species was counted, and all secondary species were listed and coded for frequency of occurrence. (For a more complete account of survey techniques see (2)).

A total of 86 plots fell within the logged podocarp stands of the Longwoods and the tables set out below have been compiled from the records of these plots.

All variations in type have been disregarded and averages have been struck over the whole extent of the logged stands. The objective has not been to determine causes but simply to demonstrate and portray the present average condition of the forest. Significant variations whether due to site or micro-site peculiarities, to the effects of varying times, methods and intensities of logging, to the effects of animal browsing, or to initial variations in stand composition, will be discussed, to a limited extent, in comments on the tables.

IV. THE FOREST AS IT IS

A. RESIDUAL PODOCARPS, SEED TREES, ADVANCE GROWTH AND REGENERATION

TABLE I

STEMS PER 100 ACRES

Species :	1 Seed Trees :	2 Total Merchantable :	3 Poles :	4 Saplings :	5 Seedlings :
Rimu	104	56	23	93	558
Miro	164	60	279	373	7,442
Totara	38	21	186	651	930
Kahikatea	28	16	—	—	—
Matai	18	4	—	—	—

EXPLANATION AND COMMENT.

Column 1, *Seed Trees*

Total stems, merchantable and cull, exceeding 12 inches diameter breast height, residual after logging; i.e., in effect, the average number of seed trees per 100 acres. It must be remembered that one half of these will, in all probability, be male trees. A few of the poles listed in column (3) may, in addition, be of sufficient size and age to throw viable seed.

Column 2, *Total Merchantable Stems.*

Total stems, per 100 acres, of merchantable form and quality (12 inches plus diameter). Typically, these merchantable stems are small, 12 to 14 inches diameter, or are excessively rough, flangy or heavily branched with some decay in evidence. Stems of good form and size are normally restricted to gullies or other sites where extraction has proved difficult. It will be obvious at a glance that salvage or re-logging projects are economically impracticable.

Column 3, *Poles*

Advance growth from 4 to 12 inches breast height diameter. Many of these poles have suffered logging damage and their satisfactory future development is problematical. Few are of optimum form and quality.

Column 4, *Saplings*

Advance growth and/or regeneration from 1 to 4 inches in diameter breast height. Many of these saplings are strongly malformed and show signs of having undergone long periods of suppression and stagnation. The worst of the malformed and obviously moribund specimens were not tallied but, even so, Table I probably overstates the average number of saplings per 100 acres likely to develop satisfactorily. Rare individuals or sapling groups, principally of rimu, appear healthy and vigorous.

Column 5, Seedlings

Established seedlings exceeding 6 inches in height and up to 1 inch diameter. There is commonly a 'flush' of seedlings less than 6 inches in height present throughout the logged stands but these are markedly impersistent and were not tallied. Many of the so-called seedlings that were tallied are of considerable age. One rimu 'seedling' held under observation for six years showed no perceptible height growth during that period. Many of these so-called seedlings must ante-date logging operations. Table I will clearly overstate the average number of seedlings likely to develop into satisfactory saplings.

There is very heavy mortality in miro at all stages of growth. Countless miro germinate, apparently annually, but very few survive to reach a total height of more than a few feet. Saplings and pole miro tallied in columns (3) and (4) appear, in the main, to be survivors from advance growth established prior to logging.

Hall's totara seedlings and saplings are normally of excessively poor form. They are usually heavily branched with multiple leaders. No matai or kahikatea seedlings, saplings or poles occurred on any of the plots. Young kahikatea were occasionally mentioned in field reports as occurring in between plots and small impersistent seedlings less than 6 inches in height occur, locally, in abundance ; but no young matai are mentioned in the field reports as having been seen on or off the plots.

B. THE SCRUB HARDWOODS

There has been, as the above figures prove beyond doubt, a virtual complete failure of all podocarp regeneration. What has taken the place of the podocarp stands ?

The present composition of the stands is, perhaps, best shown by the following table (Table II) which lists, by species, by diameter classes, all stems other than podocarp, occurring on a representative 100 acres. The stands are not, of course, at all uniform in composition but vary rapidly almost from acre to acre in accordance with local site conditions and with variations in logging history. But this is the mass of woody vegetation which must be dealt with in any attempts which may be made to restore the logged stands to productivity.

Variations in the general pattern are best shown in Table III (vide infra) ; the picture given by Table II is a broad composite one to be interpreted broadly.

TABLE II

SCRUB HARDWOOD STEMS PER 100 ACRES

SPECIES :	Diameter Classes in Inches :					
	4-12 :	12-20 :	20-30 :	30-48 :	48 Plus:	Total :
Weinmannia racemosa	6,279	980	413	123	28	7,823
Metrosideros umbellata	1	66	67	46	15	195
Griselinia littoralis	233	94	48	16	5	396
Fuchsia excorticata	2,488	148	16	3	—	2,655
Nothopanax colensoi	1,744	23	—	—	—	1,767
Nothopanax edgerleyi	139	348	24	—	—	511
Nothopanax simplex	279	256	—	—	—	535
Pseudopanax crassifolium	69	23	—	—	—	92
Schefflera digitata	69	—	—	—	—	69
Elaeocarpus hookerianus	46	2	5	1	—	54
Carpodetus serratus	605	7	—	—	—	612
Pseudowintera colorata	442	—	—	—	—	442
Pittosporum eugenioides	222	24	—	—	—	246
Pittosporum tenuifolium	—	2	—	—	—	2
Pennantia corymbosa	140	4	—	—	—	144
Paratrophis microphylla	—	1	—	—	—	1
Suttonia australis	139	—	—	—	—	139
Aristotelia serrata	837	—	—	—	—	837
Myrtus obcordata	46	—	—	—	—	46
Coprosma species	69	—	—	—	—	69
Melicytus ramiflorus	—	1	—	—	—	1
Melicope simplex	23	—	—	—	—	23
TOTALS :	14,320	1,979	573	189	48	17,109

TREEFERNS : Dicksonia squarrosa, D. fibrosa, Hemitelia smithii 13,140

COMMENT

Small tree or large shrub species occasionally exceeding 4 inches in diameter breast height and known to be present in the stands though not recorded as occurring on any of the plots include *Nothopanax arboreum, Melicytus lanceolatus, Hebe salicifolia, Plagianthus betulinus,* and the small podocarp, *Phyllocladus alpinus.* The Coprosma species listed include *C. linariifolia, C. robusta, C. lucida, C. rotundifolia, C. areolata* and *C. foetidissima* together with several small-leaved species of uncertain identification. The tree-ferns listed include only those possessing a well-developed caudex or trunk. The numberous juveniles present, and individuals of the low-growing species *Alsophila colensoi,* were not tallied.

General comment will be withheld pending consideration of Table III but one or two items might be noted at this juncture.

The first concerns the over-all economic poverty of these scrub hardwood stands. All hardwood stems exceeding 12 inches in diameter breast height and of potentially merchantable form were tallied separately, the minimum requirement set being the production of a clean log 16 feet in length. By this low standard 14 stems, only, per 100 acres were classified as potentially merchantable: rata (9); kamahi (2); and pokaka, *Elaeocarpus hookerianus,* (3). A few of the under 12 inch kamahi are of sufficiently good form for possible use as round mining timber and some of the larger broadleaf, *Griselinia littoralis,* could be split for fencing posts; but the great bulk of the crop is economically valueless. Much of it is, in fact, valueless even for firewood; only two of the species present, rata and broadleaf, are good fuel woods, with one fair fuel wood, kamahi.

All species present are represented by fully mature specimens, i.e., no species is likely to enter diameter classes greater than the maximum now shown for that species; and, with the exception of rata, kamahi and pokaka, none commonly attain a height growth exceeding 50 feet. Most of these species are, in reality, large shrubs rather than small trees and, at maturity, combine to form a low tangled canopy from 20 to 40 feet above the forest floor. The term 'scrub hardwood stand', already employed, is strictly accurate.

As already stated, the stands are not all homogeneous in composition but vary rapidly almost from acre to acre. Some sites are given over wholly to a low dense thicket growth of *Aristotelia serrata,* of *Nothopanax species,* or of *Coprosma foetidissima.* Other sites carry dense stands of heavy boled, heavily branched, low canopied, *Fuchsia excorticata.* And kamahi occurs in tangled sapling or pole thickets or in open stands of heavy boled, over-mature veterans commonly in association with veteran rata. This intense local variability is partially demonstrated in Table III.

TABLE III

FREQUENCIES OF OCCURRENCE AND RELATIVE ABUNDANCE OF SPECIES

(Based on 86 plots)

SPECIES :	(1) S	(2) W	(3) M	Total :
Weimannia racemosa	10	28	35	73
Metrosideros umbellata	8	2	—	10
Griselinia littoralis	19	21	1	41
Fuchsia excorticata	9	18	14	41
Nothopanax colensoi	16	27	2	45
Nothopanax edgerleyi	10	4	—	14
Nothopanax simplex	14	7	—	21
Nothopanax arboreum	1	—	—	1
Nothopanax anomalum	1	—	—	1
Pseudopanax crassifolium	13	3	—	16
Schefflera digitata	14	8	—	22
Carpodetus serratus	19	18	—	37
Pseudowintera colorata	22	27	4	53
Pittosporum eugenioides	3	2	—	5
Pittosporum tenuifolium	2	—	—	2
Pennantia corymbosa	6	1	—	7
Suttonia australis	17	7	—	24
Suttonia divaricata	3	1	—	4
Aristotelia serrata	14	27	4	45
Myrtus obcordata	2	—	—	2
Myrtus pedunculata	4	—	—	4
Coprosma foetidissima	16	38	15	69
Coprosma rotundifolia	15	21	1	37
C. robusta and lucida	7	2	—	9
Coprosma (other spp.)	22	4	—	26
Melicytus ramiflorus	1	—	—	1
Melicytus lanceolatus	—	1	—	1
Melicope simplex	3	—	—	3
Rhipogonum scandens	5	8	1	14
Rubus species	15	27	—	42
Muehlenbeckia australis	3	1	—	4

EXPLANATION AND COMMENT

Table III lists all woody species, including those which do not attain diameters exceeding 4 inches breast height and including also the major lianes and climbers present, recorded on the 86 quadrats examined. Each species, as it occurred on each quadrat, was classified according to whether it was represented by single specimens only (S), was widespread (W), or formed the main part of the scrub or small tree tier on the quadrat (M), a simple classification roughly corresponding to presence, sub-dominance or dominance.

The final column of the table gives the total number of quadrats, out of a gross total of 86, on which each species was recorded ; column (1), the number of quadrats on which each occurred as single specimens only ; column (2), the number on which each was widespread ; and column (3), the number of quadrats on which each formed the main part of the total woody vegetation. Thus, for example, *Coprosma foestidissima* was present on 69 quadrats out of a total of 86 examined ; it was widespread or sub-dominant on 38 quadrats ; and it was dominant on 15. *Melicytus lanceolatus,* on the other hand, was present in considerable amount on one quadrat but occurred on no others at all.

This table, therefore, permits a rough and ready visualisation of the stands. The widespread dominance of kamahi, the frequent dominance of fuchsia, and the importance of the parts played by *Aristotelia serrata, Coprosma foetidissima,* and the several species of *Nothopanax,* are clearly shown. *Rubus* species, recorded on approximately one quadrat out of every two examined, occur with sufficient frequency to be considered potential nuisance species should any stand rehabilitation work be undertaken ; the liane, *Rhipogonum scandens,* would locally prove a silvicultural hindrance ; but the vine, *Muehlenbeckia australis,* would be unlikely to be a source of trouble.

Several of the species listed in Tables II and III play no really significant part in the stands as a whole. Many of them, e.g., *Paratrophis microphylla, Myrtus obcordata, Melicope simplex, Melicytus ramiflorus, Pennantia corymbosa, Plagianthus betulinus* and, though to a lesser degree, *Pittosporum eugeniodes, P. tenifolium and Melicytus lanceolatus,* are restricted to local sites which formerly carried podocarp stands containing a matai element. Other species, e.g., *Myrtus pedunculata, Suttonia divaricata, Nothopanax anomalum* and several of the small-leaved divaricating *Coprosmas* are, on the Longwood Range, primarily species of the silver beech or of the mixed beech/podocarp stands in which they may occur in abundance. And finally, yet other species occur widely distributed throughout all the various scrub hardwood communities represented but, following logging of the podocarps, they have not increased markedly in abundance. By and large, they occupy today only the sites they occupied in the virgin stands before these were logged. Typical of such species are *Suttonia australis, Pseudopanax crassifolium,* and several of the *Coprosma* species notably *C. robusta, C. lucida, C. linariifolia* and *C. areolata. Carpodetus serratus* has spread to a modest degree and achieves a luxuriance of growth uncommon in virgin forest; but it belongs rather to the foregoing group of 'standstill' species than to the species group next to be considered.

Disregarding, for the moment, the floristically rich scrub communities developed on former matai sites, it will be seen that the present forest crop is essentially a mosaic of communities, of varying ages and degrees of maturity, characterised by local dominance of one or other of the following species : kamahi, fuchsia, *Coprosma foetidissima, Aristotelia serrata,* and *Pseudowintera colorata. Griselinia littoralis,* several of the *Nothopanax* species, and *Coprosma rotundifolia* play parts of local importance ; but the communities dominated by one or other of the five species of the first group consitute the real key communities. One or other of these five species was dominant on 72 out of the 86 quadrats examined ; and on several of the remaining quadrats two or more of them were co-dominant. All other species listed in the tables occupy no more than minor ecological niches within the basic communities.

Inter-community boundaries are not, of course, always clear cut and the separate communities frequently merge into one another or occur intermingled in complex fashion ; but each basic community does occur 'pure' with formation of more or less extensive stands characterised by the universal dominance of a single species.

Several of these basic communities are clearly of an impermanent character. Communities of the strongly light demanding *Aristotelia serrata* cannot long persist and must be replaced in course of time by communities of shade tolerant species. *Aristotelia* thickets, which develop characteristicaly in the wake of fire or on sites heavily logged with complete canopy destruction, are typically invaded by fuchsia, by kamahi, or by *Pseudowintera,* with local invasion by one or other of the *Nothopanox* species. Fuchsia is generally the most aggressive invader on moist shaded sites with deep porous soils, kamahi being favoured on dryer sites where the soils tend to be compact. *Pseudowintera* enters the *Aristotelia* thickets in quantity on a wide range of sites but survives and achieves dominance principally in those instances where the stands are open to browsing animals, this species being the least palatable to animals of all shrub species present.

Coprosma foetidissima communities are likewise of a temporary nature and commonly nurse young crops of kamahi. This *Coprosma,* like *Aristotelia serrata,* is a 'firewood' species. It appears to favour sites where the fires have been of insufficient intensity to destroy all forest duff and, additionally, sites somewhat colder than those favoured by *Aristotelia* ; but *Coprosma feotidissima* thickets develop also on a wide range of unburned sites, the precise factors of site favouring it being as yet unknown.

In other instances, burned sites, or ground extensively bared by logging operations, has been colonised by fuchsia, by *Nothopanax colensoi*, or directly by kamahi ; or by admixtures of several or all of these species. There would seem to be no clearly definable set of 'rules and regulations'. Chance would seem to play a preponderating part. Which of the several potential invading species threw a good seed crop shortly after the ground was bared ? Which of the species was favoured by local climatic conditions in the few critical seasons immediately following the destruction of the old stand ? These chance factors would seem to be of frequent importance.

But whatever path the various successions take, they would appear to lead, directly or indirectly, towards the ultimate development of kamahi stands. The fuchsia communities may hold their own against kamahi for a very long time to come, if only by virtue of the longevity of this species and its predilection for moister sites than those generally favoured by kamahi. But most of the other species, now aggressive, must ultimately be driven back to those minor sites occupied by them in the old virgin forests. Even in the dense floristically rich stands developed on the old matai sites there are vigorous kamahi poles and saplings. Competition is intense, up to 25 separate shrub or small tree species have been recorded on one single 1/80th acre quadrat, but the kamahi saplings appear likely to survive all competition and suppress all competitors.

On those sites where removal of the podocarps left a stand of mature kamahi with the forest canopy virtually undisturbed, there is no indication but that a position of long enduring stalemate has been attained. The forest understories, in such stands, are thick with treeferns upon the trunks of which young kamahi become established epiphytically, sending roots downward to the soil and crowns irregularly upwards to fill chance gaps in the upper canopy. There *may* be some *slight* tendency toward the re-establishment of the podocarp species in these old kamahi stands, small rimu seedlings certainly occur on such sites with greater frequency than elsewhere though never in really significant numbers per acre ; but all podocarp regeneration is strongly suppressed. Stagnation is universal and many supposed seedling podocarps may be, by ring count, thirty or more years of age. The large kamahi in these mature stands are wholly of unmerchantable form. Kamahi, when of terrestrial seedling origin, occasionally develops a bole of potentially merchantable form ; but when of epiphytic origin, never.

The position with respect to rata should here be noted. It has already been stated that this species was frequently, in the virgin forests, co-dominant with kamahi in the tier immediately below the physiognomic podocarps. But it plays next to no part in the second growth stands. If reference is made to Table II it will be seen that the diameter class distribution of rata is strictly anomalous. Only a single stem, in the 4 inch to 12 inch breast height diameter group, is recorded per 100 acres. And most of the smaller rata recorded in Table III were of coppice origin, springing from stems smashed during logging. In view of the known slow rate of growth of rata it is clear that this species has shown no power of effective spread, or even of effective re-establishment for a very long period of time, possibly measurable in centuries. This argument might not hold were we dealing with the species *Metrosideros robusta* which, from epiphytic origins, can develop into a large trunked tree. But *Metrosideros umbellata*, when established epiphytically, normally remains a small shrub. The large rata present in the Longwood forests, today, commenced life as seedlings rooted in the soil or on the debris of the forest floor; and few seedlings or saplings of comparable origin are now to be found.

Present forest successions all head in the one direction, the development of economically valueless kamahi stands. *Fuchsia excorticata* might remain the dominant species over wide areas and broadleaf, particularly on the old matai sites, may be more strongly represented in the new forest than ever it was in the old; but no crop of any economic value is at all likely to develop even though the stands were to be protected against fire and against grazing and browsing animals for a century or more. A few podocarps may struggle through the scrub hardwood canopy but all indications are that form will be excessively poor, growth rates extremely slow, and the total number of stems per acre wholly negligible. But what are the alternatives? Before discussing these, however, the general vegetational picture might be completed with a short account of the present vegetation of the forest floor.

C. THE VEGETATION OF THE FOREST FLOOR, EPIPHYTES, ETC.

In Tables II and III, and in the commentary on these tables, a fairly complete general account of the woody vegetation has been given. Beneath these shrubs and shrubby trees there is a typically strongly developed ground floor vegetation locally marked by a luxuriant development of tuft ferns.

TABLE IV

FREQUENCIES OF OCCURRENCE AND RELATIVE ABUNDANCE.

(Tuft ferns, etc.)

SPECIES:	(1) S	(2) W	(3) M	Total:
Blechnum discolor	12	50	17	79
Blechnum capense	11	22	2	35
Polystichum vestitum	14	11	1	26
Asplenium bulbiferum	9	11	0	20

TABLE IV.—*continued.*

SPECIES :	(1) S	(2) W	(3) M	Total :
Leptopteris hymenophylloides	3	4	0	7
Dryopteris pennigera	1	0	0	1
Histiopteris incisa	12	1	0	13
Pteridium aquilinum	3	1	0	4
Carex and Uncinia spp.	4	2	0	6
Astelia species	7	0	0	7
Microlaena avenacea	3	0	0	3

EXPLANATION AND COMMENTS

Table IV sets out the same type of basic information as that shown in Table III. Thus, for example, *Blechnum discolor* was present on 79 of the 86 quadrats examined ; it was represented on 12 of the quadrats by single plants only ; it was widespread on 50 ; and it was the dominant species of the forest floor vegetation, an almost complete or a complete floor cover, on 17 quadrats.

To be added to the list are the juveniles, locally very numerous, of the major treeferns, *Hemitelia smithii, Dicksonia squarrosa* and *D. fibrosa,* together with the small treefern, *Alsophila colensoi.* Other common ferns, several being normally low epiphytes, include *Polystichum richardi, Blechnum pattersoni, B. lanceolatum, B. pennamarina, B. fluviatile, Polypodium billardieri, P. grammitidis, P. diversifolium, Cyclophorus serpens, Asplenium flaccidum, Leptopteris superba,* and many species belonging to the genera *Hymenophyllum* and *Trichomanes.*

Herbaceous species of the forest floor, occasionally abundant, include representatives of the following genera :—*Acaena, Nertera, Enargea, Ranuculus* (some exotic), *Erechtites, Cotula,* etc., and of the orchidaceous genera, *Thelymitra, Pterostylis* and *Corysanthes.*

The small climber, *Metrosideros hypericifolia,* occurs abundantly throughout as also do the vines, *Parsonsia heterophylla* and *P. capsularis,* the former achieving particular luxuriance on old matai sites. Other climbing plants include two or more species of the genus *Clematis.* The archaic *Tmesipteris tannensis* is a common epiphyte together with the orchids, *Earina autumnalis* and *E. mucronata.*

Introduced herbs, principally grasses and 'thistles', occur commonly on sites recently logged and on sites frequented by cattle. Thickets of gorse and broom (*Ulex europaeus* and *Cytisus scoparius*) are found along old tramways, the seed having been brought in mixed with riverbed brake sand; and elderberry, *Sambucus nigra*, is commonly present in the scrub communities develped on old matai sites. Few other exotic species of note are represented.

Individually, with the exception of the tuft fern, *Blechnum discolor*, all the above species are of comparatively minor significance; but in the mass they add appreciably to the heavy blanket of vegetation that covers the ground and, in the mass, they will add to future silvicultural difficulties. *Blechnum discolor*, the individual tufts of which can attain a height exceeding four or five feet, is a potentially serious silvicultural weed species. It can spread rapidly by underground stolons, smothering the seedlings and juveniles of incoming tree species. It is unpalatable to animals and, like *Pseudowintera colorata*, increases measurably in abundance on all sites frequented by them.

Carex, *Uncinia* and *Astelia* species, and the bush oat grass, *Microlaena avenacea*, potential silvicultural weeds in many other logged podocarp forests, are not aggressive in the Longwood stands. *Polystichum vestitum*, *Asplenium bulbiferum* and *Leptopteris hymenophylloides* are all browsed by animals and only locally retain a place in the vegetation. *Dryopteris pennigera* is restricted in distribution to the old matai sites. But the two brackens, the bush bracken, *Histiopteris incisa*, and the common bracken, *Pteridium aquilnum*, would spread rapidly were any considerable clearings to be made preparatory to either the establishment of a new crop of indigenous timber species or to the planting (or sowing) of exotic species. *Blechnum capense* does not achieve the luxuriance common for this species in high rainfall districts and would be unlikely to be a source of any difficulty.

V. THE FOREST AND THE FUTURE

From the foregoing account of the forest as it is, the nature and full complexity of the problems that lie ahead will be readily apparent to all foresters. These many problems, both economic and silvicultural, must be faced if a measure of productivity is, at any time, to be restored to these logged lands.

At the moment there are no indications that a satisfactory second crop of podocarps will ever be, or can be, obtained. After an average lapse of time of from 25 to 35 years since logging, regeneration in satisfactory amounts and quality is wholly wanting. In fact, it is possible to go beyond this and state that there has been negligible regeneration of commercially valuable species in stands logged for 70 years. Regeneration counts were made on 50 quadrats falling within stands logged more than 30 years ago, 30 to 70 years plus, for a total yield of 1 podocarp sapling and four seedling podocarps.

Whatever the cause of this failure, and elucidation of causes has not been the purpose of this paper, the simple fact of failure must be recognised. It might, however, be stressed that if there were any set of circumstances under which regeneration could be procured, then some indication of this should have been obtained during the course of field survey. By accident or design, on one site or another, a full range of logging and silvicultural techniques have been employed; but the answer is always the same. There would appear to be no significantly greater number of podocarp seedlings and saplings on areas still carrying appreciable numbers of seed trees than there are on sites remote from seed trees. There are no marked differences in evidence between sites unburned and sites where fire has followed logging though it is certain that few seedlings are ever found on sites repeatedly burned. Few, if any, seedling podocarps establish under the dense canopy of fuchsia thickets or within heavy groves of treeferns but otherwise they occur widely, though sparesely, distributed throughout most scrub hardwood communities and on most sites. On only one site type do healthy rimu seedlings and saplings appear with greater frequency than elsewhere, though even in this instance in insufficient numbers for full stand reproduction. These exceptional sites are characterised, not by any significant variation in the scrub hardwood communities, but by their warm sheltered aspect with 'warm' deep soils, dark brown, free, crumb-structured silt or sandy silt loams, markedly at variance with the characteristic regional soils.

This exception lends support to the view, to be expressed in another paper, that the podocarp species are, at the moment, out of phase with respect to regional climates; that the old podocarp forests became established during a period of warmer climate than the present; and that to this climatic variation must be attributed, at least in part, the failure of the stands to regenerate following logging. But this topic is not one for further immediate development. For the moment, the above exception is merely an exception to be noted.

Marginally, where the podocarp stands merge into mixed beech/podocarp or into pure beech stands, there is a marked tendency for silver beech to invade the podocarp sites; and this process is accelerated by logging, silver beech competing vigorously with all the various scrub hardwood species. Silver beech seed, however, does not carry far and for all practical purposes the potential replacement of the podocarp stands by beech must be disregarded. It is a replacement that, technically speaking, could be hastened but which, economically would not be practicable nor even clearly desirable. Silver beech forests, already in being, are almost certainly of sufficient extent to be capable of meeting future demands for timber of this species.

The following options would appear to be the only ones open:—

(A) The maintenance of the *status quo*, leaving the logged lands, indefinitely, in an unproductive state, a breeding ground for red deer (*Cervus elaphus*), opossums (*Trichosurus vulpecula*) and feral cattle.

(B) Forest to farm, the replacement of the indigenous scrub hardwood stands by exotic pastures. Freehold and leasehold logged lands will, almost certainly, be cleared to pasture; but these are, by and large, the ploughable lands; conversion problems, with respect to unploughable lands held in other tenures, would be far more acute.

Quality pastures could be established on the old matai sites where the soils, in contrast to the typical regional hill soils already described, are moderately deep, free, crumb structured loams; but such sites are of insignificant total extent with few compact areas of sufficient size to provide a single economic farm unit. The leached, compact, shallow, nut structured soils developed over the greater part of the logged lands would be most difficult to break into or hold in pasture except by frequent cultivation.

(C) The replacement of the scrub hardwood stands by exotic softwoods. The difficulties to be faced are many and do not need stressing. Soils and climate are known to be favourable to a wide range of exotic conifers but many could not survive in direct competition with the scrub hardwoods; few are sufficiently shade tolerant to permit employment of simple underplanting techniques without extensive and costly scrub cutting operations. Other species, of proven worth, could not be employed while opossum populations remain at high levels; or are too susceptible to fungal diseases, e.g., *Armillaria mellea,* widespread on the logged lands.

No matter whether it is in the choice of species or in the choice of establishment techniques, the difficulties are legion as will be as well known to readers of this paper as to the writer. But if the logged lands are not to remain economically sterile, solutions must be sought. We are not, at any rate in the South Island, over-endowed with productive or potentially productive lowland but here are lands which could, at a price, be returned to production. Left to themselves, these potentially productive soils will, as it has been the purpose of this paper to demonstrate, produce nothing of value. The immediate plea is, therefore, for a wider experimental attack on the problems involved so that, when the opportunity offers, the work of restoration can be efficiently handled.

SUMMARY

The derelict condition of the logged podocarp lands of the Longwood Range, Southland, is demonstrated and an account is given of the scrub hardwood stands that have developed since logging.

There are no indications that any second crop of podocarps will be, or can be, obtained. If these lands are ever to be restored to productivity, exotic species must be introduced.

This work of restoration will, in view of the density of the scrub hardwood growth now on the ground, be both difficult and costly; it probably could not, or need not, be undertaken for many years to come. But an early and wide attack on the many problems involved, on an experimental scale, is recommended.

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FOREST COLONISATION AFTER RECENT VOLCANICITY AT WEST TAUPO

By P. J. McKELVEY

1. INTRODUCTION

Between Lake Taupo and the Main Trunk Railway is the extensive forest tract of West Taupo. The area selected for study here extends from near Titiraupenga Mountain in the north to the Wanganui River and Kakaramea and Tihia Mountains in the south (see accompanying map), approximately 300,000 acres. Forest colonisation following extensive volcanic eruption 1,700 years ago has produced a zoning of distinctive forest associations around eruptive centres.

Topographically and geologically the area is rather complex. In the north is the andesitic spine of Titiraupenga (3383 ft.) and the symmetrical cone of Pureora (3793 ft.), greywacke capped with andesite. Around the bases of these two mountains and in the saddle between them is a dissected, gently sloping ignimbrite sheet. The Hauhungaroa Range (3000 ft—3600 ft.), a tilted dissected greywacke fault block with scarp face to the east, forms a north-south axis to the West Taupo area. The southern end of the range, the andesitic block of Waituhi and Hauhungaroa (3541 ft.), is separated from the main salient by a low lying saddle on which is the extensive forest surrounded clearing, the Whenuakura Plain. North-west of the plain are the high ignimbrite escarpments of Motere (3248 ft.) and Tuhua (3425 ft.). Flanking both sides of the north part of the Hauhungaroa Range, like sea around a rocky prominence, are moderately to deeply dissected gently tilted ignimbrite sheets. Ignimbrite