AN ECOLOGICAL CLASSIFICATION OF THE FOREST TYPES OF THE WESTLAND PODOCARP REGION*

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Introduction

The task of classifying the forests of any region, of distinguishing, defining and listing all the various types of forest represented, is a task which can be approached in various ways. Criteria of stand differentiation will vary immensely in accordance with the interests and objectives of the forester doing the job. In this instance I make no apology for presentation to you of a patently theoretical classification, the product of a distant armchair rather than of patient field work, for my interests are, currently, theoretical rather than practical.

I claim no detailed knowledge of the forests of the Westland podocarp region, but I can claim a fairly thorough acquaintance with forests to the north, east and south, with the forests to the north of the Grey, to the east of the main divide, and with the forests to the south of the Haast. And, against the background of this knowledge, I have tried to view the podocarp stands between the Grey and the Haast in perspective, seeking out the broadest patterns of forest type distribution but avoiding involvement in matters of fine detail.

This detail must, very often, be of immense importance to the forester on the spot, to the man concerned with immediate problems of forest management; but it is my belief that correct interpretation of such points of detail is fundamentally dependent upon prior acquisition of a broad understanding of the forests as a whole. To appreciate the significance of a picture, to see its inherent structural patterns, we must first look at it from a distance, though later it might be necessary to examine the brush strokes with a magnifying glass. And so, I would suggest, it must also be with the forests.

In the present case I have obtained my distant view through examination of all aerial photograps of the Westland region, through study of all Forest Survey field records, and through inspection, on the ground, of a selection of the apparent most characteristic types of stand. I feel, therefore, that the picture I have obtained is correct inbroad outline and in perspective. In this belief, I submit my account, hoping that it will contain at least a few items or notions of general interest.

But I have, first, certain acknowledgements to make. As already stated, I have made no detailed study of the forests on the ground. Instead, I have methodically picked the brains of all Forest Survey

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officers who have been engaged in Westland, appropriating such of their observations and ideas as seemed good to me. Many of these officers have gone far out of their way to check sundry items for me; no small matter, as all appreciative of conditions of travel in Westland forests will be aware. In particular I owe much to Assistant Forester J. Rawson who, in satisfaction of my curiosity, has pushed willingly through many of the worst swamps and supplejack entanglements on the Coast. But though I make these acknowledgements, I retain full responsibility for all errors of commission or omission. I have perhaps rejected many sound observations or hypotheses, accepting many erroneous ones. The faults are, therefore, my own.

Basic Hypotheses

In approaching the study of the forests of any new region, in this case the forests of the Westland podocarp region, I usually find it best to begin by posing a few questions.

To what extent are the forests comparable with those of regions already well known? To what degree are comparable phenomena traceable? Are the forests of the new region entirely novel in type or do they merely present variations on a theme already well understood? Are the forests of the several regions explicable in terms of the same general hypotheses?

These are the questions that spring to the mind; and I would answer them here at the outset by saying that, in type, the forests of the Westland podocarp region are not entirely peculiar to Westland; by saying that they are explicable in terms of hypotheses elaborated through study of other forests; and by saying that they do behave in thoroughly predictable fashion.

I might even go further and say that, granted foreknowledge of the soils, climate and forest species of the region, the occurrence and behaviour of all major forest types in Westland could be forecast in advance and without any first-hand experience in the region at all. And, in part, this account is such a prediction; it is for those of you with ampler local knowledge than myself to judge its accuracy.

In a lengthy paper now in press, I have sketched out the main hypotheses, acceptance of which permits the publication of these apparently rash statements; but it is not possible to develop the full argument here. All that I can do is to outline the basic hypothesis, emphasizing the point that there are good grounds for belief in its validity, and emphasizing, moreover, that several research workers, other than myself, have independently reached, or are rapidly reaching, similar conclusions.

This basic hypothesis, bluntly put, is to the effect that all South Island forests, the Westland podocarp forests included, are in a fundamentally unstable condition consequent on comparatively recent (13th centry) variations in effective regional climates. In other words, many present stands are thought to be ill-adjusted to site

while others are of purely temporary character representing phases in the re-adjustment of the forests to site.

It is only in terms of this hypothesis that the forest types of the Westland podocarp region begin to assume recognizeable patterns of distribution and behaviour; and it is in terms of this hypothesis that I would classify the stands.

The Forest Types of the Mountains

I would begin in the generally accepted fashion, by drawing a sharp line of distinction between the forests of the mountains and the forests of the lowlands; that is, between the forests of skeletal upland soils principally derived from schists and greywacke and the forests of the coastal gravel plains and terraces, valley alluviums and coastal dunes. In this we have a wholly natural subdivision of types in full accord with all pedological, physiographic and climatic factors.

I do not intend dealing, at any length, with the forest types of the mountain group. It is probably sufficient to say that we have here, as would be expected, a very wide range of forest types with distributions governed by factors of altitude, exposure, soil depth, soil drainage, and so on; and, as would also be anticipated, we have, in addition, a wide assortment of temporary forest types developing and re-developing on sites periodically laid bare through the processes of normal geological erosion.

There are few, if any, types of forest on the Westland slopes of the Southern Alps which do not occur, also, in other regions. With but one major execption, the timber content of these stands is negligible. The stands are of material value only in the wide field of soil and water conservation. Inherent trends in their development, and induced trends consequent on the presence of populations of alien animals, demand thorough study but this has not been possible to date. For the moment I would but draw your attention to the exceptional type, noted above, where there is a significant timber content.

This, again, is not a forest type peculiar to Westland but is one well known from most regions. It is a type known to all of you, the rimu/rata/kamahi type in which the rimu, with few significant exceptions, are massive veterans. Few young rimu are ever present, saplings or poles, though impersistent seedlings may occur.

By all authors, these veteran rimu have been considered relict from some previous type of forest, usually by implication in the statement that the kamahi/rata stands form a "developing climax." But all such mountain slope rimu stands in the South Island are, today, in roughly the same stage of over-maturity or senescence, a most improbable state of affairs were we dealing with a normal forest succession occasioned by the influence of the several species, themselves, on the site or with cyclical phenomena; a state of affairs, however, readily explicable by assuming the universal operation of some factor common to all sites, i.e., by assuming comparatively recent variation in the climatic factor.

We are forced, I think, to assume that, at some not far distant date, climatic factors permitted the establishment and vigorous growth of rimu in the stands of the lower mountain slopes where, today, rimu does not regenerate or re-establish, but is steadily displaced by rata and kamahi. And this variation in climate must, equally, have had some effect upon the forests of the lowlands.

But before analysing these effects I must re-emphasize the point that I am intentionally slurring over all matters of detail. Even in respect to the comparatively uniform stands of the lower mountain slopes many variations in the general pattern can be traced. No variations yet studied, however, have demanded any significant amendment of the basic hypothesis. In perspective view the variations are strictly minor matters of detail. The principal developmental trend is clear; a trend, more or less rapid, toward the elimination of rimu as a significant stand component.

The Forest Types of the Lowlands

As a consequence of climatic variation, rimu is disappearing from the forests of the mountains, present stands being of relict character, overmature or senescent. But it is just as certain that the rimu stands of the lowlands, by and large, are not over-mature or senescent stands; they are typically young to early mature stands displaying a markedly group even-aged or an uneven-aged structure. The predicated climatic variation had quite contrary effects on the forests of the mountains and on the forests of the lowlands.

From studies of forests of other regions, it has been deduced that the old climate, that is to say the climate operative when rimu stands in full vigour occurred on the lower slopes of the mountains, was both warmer and wetter than present climates. The assumption is, therefore, that this wet climatic era was marked by a much stronger development of lowland bogs and swamps than occurs in Westland today, lowland forest being more or less restricted to local dry ground, to inter-terrace slopes, stream and river margins, well drained alluvial soils, and so on, though there may have been more extensive stands of bog or swamp forest species, silver pine, kaikawaka or kahikatea, than are found today. And, with decreasing effective rainfall, concurrently with the elimination of the rimu from the stands of the mountain slopes, an effect of increasing cold, rimu, and other species, spread out across the lowland bogs and swamps.

It is my contention that, in terms of these ideas, the entire complex range of present-day lowland forest types can be understood: let us follow through one or two of the mechanisms involved.

1. *Successions of acidic bog soils.* (Principally Okarito and Waiuta Soils.)

The lowlands, hypothetically and anciently, were marked by widespread development of bogs and swamps but with no sharp dividing line between bog and swamp. All bog soils were not equally acid. All bogs were not equally wet. Drainage was impeded in

varying degree from bog to bog in accordance with their even more ancient history. And all bogs did not lie equally close to seed sources of potential invading species.

We would expect, therefore, the processes of colonization of the bogs by forest species to proceed at varying rates and in varying manners, giving rise to a wide variety of young lowland stands. And we might, I think, reasonably anticipate the occurrence of certain bog soils, of sufficiently hostile character to the invasion of forest species, which would remain as bogs even under the new climates, possibly becoming even more strongly "boggy" with continued impedance of drainage.

The simplest manner in which forest stands developed on the old bogs was one which is still operative and is readily traceable today. This was the slow development, marginally around the bogs and extending out across them, of rimu stands, the succession proceeding through stages characterized by the dominance of manuka, followed by silver pine, followed by rimu itself. In its later stages this succession inevitably gives rise to patchwork, group even-aged stands, remnant pockets of open bog persisting; and the younger pole rimu groups contain relict stems of silver pine or even of manuka.

Alternatively, manuka, pine and rimu established on local pockets of dry ground, on raised hummocks, and so on, across the full extent of the bogs, with later development of rimu stands across the inter-hummock spaces. This process inevitably gives rise to rimu stands of strongly uneven-aged structure. Or both these processes could proceed concurrently to give rise to stands of indeterminate structure.

But, again, I am purposely over-simplifying matters, for many species other than manuka, silver pine and rimu were involved. Kaikawaka locally played a part of some significance, though this is not yet understood; and kahikatea on the less acid soils was a species of local importance. It will be appreciated, however, that in these various ways a very wide range of forest types, characterized by the universal dominance of rimu, can develop, and that, in close juxtaposition, stands characteristic of all stages in these processes will be found. Uneven-aged, even-aged and group even-aged rimu stands, of ages from youth to maturity, will be found in intimate admixture with residual pockets of open bog, and with all possible stages in the various successions well represented.

This quilt-work pattern of rimu dominant stands will be interrupted wherever less acidic soils occur, i.e., where the soils are formed from recent alluviums or wherever the forest successions have been from swamp (as distinct from bog) to forest; and it will also be interrupted wherever older stands, relict from the earlier climatic era, occur on sites which have always been well drained. These latter stands typically approach those of the lower mountain slopes in type, containing a preponderance of old veteran rimu dispersed through heavy kamahi, rata and quintinia (e.g. the stands of Arahura soils).

In other words, even at these low altitudes, the final stages of the forest successions would seem to lead to the development of scrub hardwood stands. At a comparatively late stage kamahi, rata and quintinia all enter the rimu stands developed upon old bog soils though on few, if any, sites have as yet assumed complete dominance; but the trend is there, nevertheless, and we can, with some justification, name the typical succession the manuka to silver pine to rimu to scrub hardwood succession. Many early stages in this last phase, rimu dominant to scrub hardwood dominant, can be found.

Finally, under this heading, there will occur on many sites stands of secondary origin which have developed following local catastrophic destruction by wind or other agencies, of stands representative of various phases in the primary succession. And these secondary successions, as I hope to indicate in a brief section under the heading "Silviculture" will proceed in many diverse fashions.

The net result of all these many processes will be, and has been, the development of a most intricate mosaic of forest types varying significantly in specific composition, in timber content, and in silvicultural potential, almost from acre to acre. In perspective view, the whole complex is readily comprehensible; but whether the "bits and pieces" can be sufficiently disentangled on the ground for practical silvicultural purposes I am inclined to doubt.

2. *Successions of Swamp Soils*

In typical forest successions on acid bog soils, kahikatea plays an insignificant part; but in the successions of swamp soils it is the principal species. I do not wish to deal with these swampland successions at any length. In fact I cannot, for I have a negligible knowledge of them.

The early stages of a typical succession are simple enough, the establishment of a swamp vegetation with nigger-heads and other such species, the development of peripheral stands of flax, the incoming of coprosmas and other shrubby species, and the seeding in of kahikatea to give rise to the densely stocked, more or less even-aged kahikatea stands well known to most of you. But there are many variations on this simple theme.

Occasionally, where soils are of intermediate status between those of typical bog and typical swamp, this straightforward kahikatea succession will merge with the manuka-silver pine-rimu succession leading to the development of very complex stands of these several species. Or the swamps may be part filled with alluvial detritus and the stands to develop will be of a character intermediate between those of true swamp and alluvial ground. Or again, in a late stage toward the development of a typical stand of swampland kahikatea, the swamp might receive a sudden influx of acid bog water leading to stagnation of the kahikatea and to the later incoming of species more tolerant of acidic conditions.

I believe that all these things have happened, sometimes on a

significant scale, sometimes on a minor local scale, always adding to the complexity of the lowland forests. The broad patterns of change and development remain evident but the detail is inextricably confused.

The swamp-land kahikatea stands, on the evidence to hand, appear to be of greater inherent stability, under present climates, than do the rimu dominant stands developed on acid bog soils. There is not the same comparatively rapid incoming of the scrub hardwood species though, in a few cases, there is a suggestion that rimu might enter, or might have entered, mature swampland kahikatea stands and there might be some tendency toward the succession kahikatea to rimu to scrub hardwood; but it is difficult to verify these suspicions, today, for so many of the kahikatea or kahikatea/rimu stands have been cleared to pasture.

3. *Successions of Recent Alluvial Soils*

These, again, are difficult to study for the stands of alluvial soils, where not cleared to pasture, have typically been grazed by cattle for many years. These are the matai/totara containing stands with constant but variable representation of both rimu and kahikatea. These alluvial soils are intensely variable, rocky, stony or silty, well drained or poorly drained, subject to periodic inundation or comparatively flood free, and the stands vary accordingly.

They are also, of course, of widely varying age with origins in periodic destruction, partial or complete, of pre-existing stands by flood. The occurrence of stands of uniform composition and in uniform condition, of significant extent, could not be anticipated and does not occur.

Moreover, there are grounds for suspecting that the processes of stand development on fresh alluvial sites today, do not exactly match the processes of the past. The appearance of many old stands suggests that the podocarp species were once vigorous colonizers of bared alluviums but they do not behave as pioneer species under present day climatic conditions. Instead, new ground is now pioneered by a wide range of shrubby hardwood species though a few podocarps may enter the stands at a later date in stand development; and this same trend toward the development of floristically rich scrub hardwood stands in place of podocarp stands is evident in the older podocarp containing alluvial soil stands themselves. This is a trend wholly in line with events in all other forest types, in the South Island, containing a significant representation of matai.

But I do not want to emphasize this point. My main purpose in making mention of these stands of alluvial soils is demonstration of the fact that we cannot expect them to be other than intensely variable. And throughout the mosaic patterns of the stands developed upon bog soils and the stands developed upon swamp soils, we have local development, occasionally over areas as small as a single acre, of these complex alluvial soil stands.

4. *Other Successions and Stand Types.*

In perspective all forest types extraneous to the three broad groups, the type groups of the bog soils, of the swamp soils, and of the alluvial soils, appear relatively unimportant; but a few other type groups are of local significance. Coastwise, within reach of salt spray, there is a palpable deterioration in quality of all timber containing stands and a range of coastal scrub types are developed. And, coastwise again, there are locally extensive stands occupying consolidated sand dunes of varying age with soils variously podsolized.

These old dunes carry stands closely akin in type to the stands developed upon acid bog soils on the gravel terrace lands though commonly modified through proximity to the coast. Rimu stands occupy the dune ridges, open bogs appear in the interdune hollows and, marginal to the bogs, rimu/silver pine or silver pine/manuka stands are found. Kahikatea is well represented but principally only where the interdune hollows are drained by freely flowing streams. The whole gamut of types as found on the terrace lands is recapitulated on the dune-lands though it would not be safe to say that developmental patterns and trends run parallel. No thorough study of the type complex of the dune-lands has yet been made.

Other type groups, or type variations, are found, for example, where granitic rocks or diorites outcrop and on local outcrops of tertiary sediments, but these are not of regional significance. They do not, in any case, present any problems in interpretation. Type variations and variations in distribution patterns on soils developed on these outcrops differ from the basic regional forest types and type distribution patterns to no greater extent than could well be anticipated.

One final point: it will be appreciated that, in the above discussion of the forest types of the region, I have studiously avoided any mention of the many forest types represented in the region today, but which owe their character to, or differ from, basic types as a result of interference by human or animal agencies. These would demand a treatise to themselves. But I would stress the point that, quite apart from the activities of European settlers and their animals over the past 100 years, there have been men on the coast for 1,000 years. In all other South Island regions there is some evidence in respect to the distribution and structure of of existing forests, of the long-continued use of fire by the Maoris or their forerunners. We would not expect these effects to be strongly marked on the Coast but there are reasonable grounds for suspecting that many of the open bogs of today, particularly the drier pakihi, owe their present condition to repeated burning over many centuries. And there are likely therefore, to be many such areas where present events do not fit into the general scheme of things sketched out in this regional review. The probability of an ancient fire history is one which must at all times be borne in mind.

Forest Survey Mapping

My thesis has been, as you will be aware by now, that the forests of the Westland podocarp region, though readily comprehensible, must be, and are, intensely variable in type with constant variation almost, it might be said, from acre to acre. Particularly with respect to the forests of the lowlands, we cannot anticipate the occurrence in any area of any compact stand of uniform type and appreciable extent. But, on the scales employed and in the time available, it has not been possible even to attempt the task of mapping all variations in type. Such a task would probably prove to be imposible, for, between types, there exist all possible intergradations.

Resort has therefore been made to the lumping of types, grouping together all types with comparable timber contents, a legitimate course since the prime purpose of the Survey has always been the determination of regional timber resources. But, even so, many of our type maps are fairly complex. They could have been made a little simpler by further grouping of types, still retaining sufficient accuracy for volumetric purposes, but an endeavour has been made not to lump types of one type complex with those of another in the hope that the maps will thereby retain some usefulness in the silvicultural field. This has been no easy task but it has been undertaken, I believe, with some measure of success; and I would again acknowledge, in this connection, the work of Assistant Forester Rawson, whose laborious and more or less thankless task it has been. I have disagreed with him in many points of detail and interpretation, but I do believe that the finished maps provide a reasonably accurate and useful portrayal of the forests as they really are.

Silvicultural Postscript

We hope that our Forest Survey type maps of the forests of the Westland podocarp region will be of some use in the silvicultural field. And I hope that, perhaps, one or two of the ideas contained in this report will equally be of use. I do not want to trespass far into this field, but I would like a few more minutes of your time to put forward a notion or two. I would confine my remarks strictly to the matter of intensive management of the forests for sustained yield of rimu, neglecting other species entirely.

If management of the rimu forests on a nationally significant scale, in the interests of sustained yield, is a practicable proposition anywhere in the South Island, this will be in the lowland forests of Westland. It will be management of what I have called the type complex of the acid bog soils, of stands having their origin in the bog to manuka to silver pine to rimu succession. The swamp soils and alluvial soils will sometime be required for agriculture, wherever extensively developed, while sustained yield management of the rimu stands of the lower mountain slopes where the present rimu crop appears obviously relict is, I suggest, a technical impossibility.

But the acid soils of the silver pine/rimu complex are unlikely

to be required for agricultural purposes. Present rimu crops are comparatively young crops, by podocarp standards, and have clearly developed under present climates. So far the prognosis is entirely satisfactory. Does it continue so on further investigations?

I would like to take the simplest case and suggest, in ecological terms, what can be expected following logging of the stands.

Where there has been a simple succession from open bog through manuka and silver pine to even-aged rimu stands with later incoming of understorey hardwood species, logging can take place at any one of a number of stages in stand development. It could take place at an early stage where the rimu are small and some silver pine, or remnants of this species, remain in the stands; or it could take place at a later stage where the rimu verge on maturity and the stands contain a strong representation of scrub hardwoods. Now it is my belief that early logging will tend to throw the succession back to an even earlier stage, i.e. we would not get immediate regeneration of rimu but re-development of bog or possibly re-entry on to the site of manuka and/or silver pine. Rimu will not re-appear until the appropriate stage in the normal succession is again reached.

On the other hand, with late logging and after the appearance of the scrub hardwoods in the stands, it is my belief that logging serves only in acceleration of the normal succession with immediate development of the final scrub hardwood crop, a crop containing only accidental young rimu.

But there should, in theory, be some intermediate stage in between too early and too late, at which the rimu stands could be logged without either throwing back or accelerating the normal succession. And with logging of the stands at this stage we should get regeneration of rimu provided sufficient seed sources are reserved.

These seem to me to be the things that have happened where more or less even-aged rimu stands have been logged. On some sites there has been reversion to bog or development of manuka/silver pine thickets; on some sites an appreciable amount of rimu regeneration has appeared; and on other sites the scrub hardwood species have run riot. Post-logging activities, fire, animal-grazing, etc., have, of course, distorted the picture, but I believe that it is essentially correct.

Now it would obviously be economically impracticable to seek out, for management, all the local rimu stands in precisely the right condition for the procurement of rimu regeneration in this simple manner. These stands occur scattered throughout the mass of the forests, surrounded by and merging with other stands of very diverse character. Can the management field be widened?

I believe that the failure of rimu to re-establish where stands are logged at a late stage in their development, i.e., in those cases where the scrub hardwoods take over the sites, is a simple matter of competition. With the sites held clear of the scrub hardwoods for a sufficiently long period for adequate seeding in of the new rimu

crop, and with adequate reservation of seed trees, rimu should re-establish and, on such site, might even display faster rates of growth than on sites where volunteer regeneration occurs. This has happened, for example, where comparable types of forest have been logged on the terrace lands to the west of Port Craig, Western Southland, the scrub hardwoods, in this locality, having been held in check by deer. But the establishment period, in my view, will be a very long one, a matter possibly of five or six decades; and the practicability of the proposition therefore boils down to a simple matter of economics.

Again the field could be widened by judicious reservation of the youngest rimu stands for further increment, reservation possibly accompanied by a careful thinning of the stands. But I would suggest that these young stands occur, by and large, on the very worst rimu sites, on the sites where the poorest growth is to be anticipated. The best rimu sites, in terms of the basic hypothesis, were occupied by rimu during the first few centuries of the present climatic era and now carry sub-mature to mature stands or, where logged, have been pre-empted by scrub hardwoods. Only the poorest soils remain unoccupied by rimu to this day; and only very poor ones carry extensive young crops. There can be no growth rate comparability from site to site. In fact, certain of the present pole crops appear to me to be wholly stagnant. The poverty of certain sites seems sufficient to bring all normal successions to a halt. Rimu crops may develop so far but no further. Some apparently young stands, on this count, are in reality old stagnant stands.

There are difficulties and conundrums no matter which way we turn. The forests are complex and no simple silvicultural prescription will ever be widely applicable. But, in respect to certain types of stand on certain types of soil, sustained yield management of rimu does appear a technical possibility. With skilled selection of stands for management, with adequate reservation of seed sources, and with due safeguards taken against rising water tables following logging, at least a partial measure of technical success seems assured.

The evidence, to me, adds up to one thing only, to the desirability of strip fellings through sub-mature and early mature rimu stands of Okarito soils. The strips must be narrow for adequate seed coverage and for full control of ground water levels; and the period between the logging of adjoining strips must be a long one for satisfactory crop re-establishment. Some portions of each strip may revert to manuka/silver pine and on other portions dense (but possibly controllable) scrub hardwood thickets may develop; but a new rimu crop should appear over a substantial portion of each strip, over, perhaps, 50 per cent. of the total strip area where the initial forest type complex was particularly favourable.

For other types of stand on other types of soil the prognosis seems less happy, but sub-mature and early mature rimu stands on Okarito soils are of sufficient extent to warrant vigorous action.