SOME RE-ESTABLISHMENT PROBLEMS.

By OWEN JONES.

This article reproduces the substance of a talk given to the Rotorua branch of the Institute of Foresters; it deals only with the Rotorua-Taupo-Putaruru region and mainly with Pinus radiata; its purpose is to indicate some of the problems in the hope of provoking discussion that may be helpful towards their solution.

Utilisation is now taking place in P. radiata stands in the Rotorua region on a considerable scale, and indications are that this is likely to increase appreciably in the near future; in consequence re-establishment to a corresponding degree is also called for, so that the time is opportune for a critical examination of the methods employed. A visit to any felling or utilisation operation leads inevitably to the opinion that the product of the planted areas is by no means one hundred per cent. Particularly in unthinned stands the amount of waste due to dead or undersized material in the felling areas, and to loose knots or other defects in the milled product, is painfully obvious, and naturally evokes the query as to whether this cannot be avoided, or at least substantially reduced, in the next rotation. It is necessary for foresters to face these facts and to aim at producing material more suitable to market requirements. To achieve this effectively it is necessary to consider utilisation at the beginning of the rotation or even before the stands are established, instead of when they have grown and are approaching maturity.

The first major problem is regeneration; is it to be natural or artificial? Here there are two extremes, both employed in current practice: complete reliance upon natural regeneration, or complete reliance upon artificial regeneration by means of replanting after burning off the slash.

In order to arrive at a decision as to the methods of regeneration to be adopted for any forest area it is necessary to give careful consideration to a number of factors; amongst these are the silvicultural system adopted for working the forest, the habits and requirements of the species to be grown, seed production, liability to excessive weed growth or attacks by injurious insects, slash disposal, and supplies of labour available, all of which affect more or less directly the primary considerations of costs and results. Let us consider briefly each of these factors.

Silvicultural System.

The system generally adopted at present is that of clear-cutting, under which successive areas are clear felled and regenerated.

The chief advantages of this system are: (a) it is the simplest of all high forest systems, since it dispenses with marking operations requiring skill, occupying the time of the staff, and so costing money; (b) it represents the utmost concentration of work, every usable tree on the felling area being taken; this means a larger outturn per unit
of area, and therefore greater economy in felling and extraction, than in systems where only a portion of the trees are felled at a time; (c) it affords complete overhead light, an important consideration in the case of a strong light demander such as *P. radiata*; (d) there is no damage to the young crop through felling and extraction of timber, since all this is completed before the young crop originates; (e) as a rule the new crop is established more rapidly under the clear-cutting system than under systems in which regeneration is established by degrees; this saving of time may be of considerable advantage.

Its chief disadvantages are: (a) the complete clearance of the forest cover may produce adverse growth conditions; e.g. deterioration of the soil through exposure to wind and sun; a rank growth of grass and weeds, which may interfere with regeneration and add to the cost of establishing it; multiplication of injurious insects which tend to breed in clearings where stumps are present in abundance; (b) it affords no safeguard against the rapid run off of rain water, thus exposing the area to erosion, especially on hill sides; (c) it results in the accumulation on the ground of large quantities of slash after the fellings; where utilisation is not intensive, and stems, tops and branches of some size are left, this slash forms the breeding ground of bark beetles, which can be particularly destructive to coniferous forests; (d) it produces a type of forest less resistant to damage by wind than the more uneven aged systems.

These disadvantages are intensified where individual felling areas are of large extent, or if the ground remains exposed for some time before the young crop closes up.

The system has been extensively employed in European forests, and has at times given rise to severe controversy, particularly when the abuse of silvicultural principles which has accompanied it in some instances has led to adverse results. These adverse results however, were due in no small measure to the introduction of species into regions outside their natural habitat, and not necessarily to the system itself. The economic advantage of felling and extracting the largest quantity of timber from the smallest area in the shortest time, especially in places in which ordinary means of transport are deficient, and in which the construction of special export works is necessary, is so great that its adoption in this region appears inevitable. It is specially indicated for strong light demanders, such as *P. radiata*; it must, however, be borne in mind that it is unsuitable, at all events with large individual felling areas, for unstable hillsides where serious erosion is to be feared, or where clear-cutting is followed by a heavy growth of weeds which prevent reproduction except at prohibitive cost.

**Habits and Requirements of the Species.**

*P. radiata* is a strong light demander; in its early youth it is susceptible to damage by frost, and particularly by late frosts occurr-
ing when the new season’s growth is in full swing. It has shown itself well suited to the soil and climatic conditions prevalent over the bulk of the areas in the region, except for the flats and gullies in which the effects of frost are felt most severely. In such situations it is apt to be killed outright when it is young, or to suffer loss of the leading shoots so that it develops a bushy habit which materially reduces its economic value, and in consequence its re-establishment in such positions cannot be recommended. It also shows a marked tendency to produce double or multiple leaders and a strong branch growth generally. This also militates against its utility, and points to the necessity for securing seed only from the best-formed mother trees and to keeping the young crops dense.

**Seed Production.**

In the choice of regeneration methods an important part is played by the amount of seed produced, some species being noticeably shy bearers, whilst other species produce considerable quantities with great regularity. So far as *P. radiata* in this region is concerned seed production appears abundant and regular from a comparatively early age, as has been evidenced by the prolific crop of seedlings that has sprung up on burnt areas, even when the trees on these areas were still quite young. *P. radiata* however, differs from many species, which form and shed their seed in the one season, in that its cones may remain unopened on the trees for quite a number of years; even after the trees have been felled and the stems and branches carrying the cones have dried out the cones themselves display a marked reluctance to open and shed their seed, unless they are stimulated by some such agency as fire. This may be partly due to the trees on some areas, which are being felled at such relatively young ages as 16-20 years, not having reached the stage at which natural regeneration would normally have to occur. Even in such cases there is a considerable amount of regrowth where other conditions are favourable; but it seems quite possible that full crops can only be secured within a reasonable space of time if the normal processes of seed shedding are assisted.

**Weed Growth.**

It is a characteristic of the clear cutting system that it is liable to a great growth of weeds on the felled areas, particularly when these are of large size or if the regeneration period is prolonged. The forest areas in this region are no exception to the rule, and the growth of weeds is both rapid and prolific as soon as the forest cover is removed. This makes it imperative that, in order to avoid undue expense and difficulty, a new crop should be established as soon as possible after felling operations have been completed. If for any reason this is not practicable, measures to reduce the weeds to a minimum and make it possible for the young trees to keep ahead of
them will have to be sought. Consideration might be given for
instance to running stock on the area for a time, though this would
preclude the possibility of natural regeneration and necessitate re-
course to planting.

**Injurious Insects.**

Nothing suffers so much from attacks of injurious insects as the
clear felling system. Many of these insects breed in stumps or in dry
ground; clear felling by providing stumps in large numbers and
by exposing the soil to the drying effects of wind and sun offers
exceptionally favourable breeding conditions.

Hitherto the exotic forests in this region have been fortunate
in their comparative freedom from insect pests; there is no guarantee
however, that this immunity will continue. Already one potential
source of serious damage, *Hylastes ater*, is well established in some
localities; precautionary measures, such as keeping the stands at all
times in as healthy a condition as possible and arranging felling
series so as to avoid extensive adjoining areas, are thus clearly indi-
cated to reduce the possibility of damaging outbreaks.

**Slash Disposal.**

Where stands have not been thinned, and where a six-inch top
diameter is adopted as a minimum, it is inevitable that very appreci-
able quantities of slash are left upon the ground after felling and
logging. This slash greatly impedes access to the areas, and would
make planting operations difficult and costly; so that if the areas are
to be planted the slash must first be disposed of, the only practicable
means being by burning. For natural regeneration of relatively
young stands a case can also be made out for burning the slash, as this
appears effective in securing the timely opening of the cones and so
providing an adequate supply of seed, provided that the fire is not
too fierce. Prompt slash disposal could also help in the control of
insects by reducing their potential breeding grounds.

Although slash disposal by burning, as the only practicable
method, facilitates access, opens cones for the release of seed, and
reduces insect breeding grounds the process unfortunately has other
far less favourable aspects. A fire fierce enough to dispose of the
bulk of the slash will also destroy a great deal, if not all of the humus
which has been built up during the life of the stand, and which is so
valuable for tree growth and in regulating the run off of rain water.
It is perhaps hardly necessary to refer also to the danger of the fire
getting out of control and spreading to the unfelled stands.

**Labour Supplies.**

Supplies of labour at present are exceedingly scarce and difficult
to obtain; no doubt this position will rectify itself once the war is
over, but even then the high rate of wages likely to prevail must
greatly influence any decision to replant on a large scale, involving as it would heavy employment of labour for seed collection and extraction, nursery work, transport and actual planting of the trees.

**Natural and Artificial Regeneration.**

Speaking in general there are only three situations under which a new crop cannot be attained through natural regeneration: where seed trees are too remote or too few; where, through soil deterioration, the seed will not germinate or the young trees become established; where a change of species is necessary. There is, however, nearly always more or less irregularity in natural regeneration, which is apt to be overdense in some places and too open in others, so that in order to obtain a full stocking all over it is necessary to provide for more or less artificial regeneration; but it is regarded as axiomatic that wherever practicable reproduction ought to be the result of the fellings themselves.

The advantages of natural regeneration are: (a) It involves less expenditure of both money and labour. In some cases the outlay may be nil; usually however some artificial help has to be given, by planting, seeding or by soil preparation; even so the cost is considerably smaller. (b) The far larger number of trees tends to produce cleaner, straighter stems. (c) The roots are undisturbed from the outset. (d) These last two features promote vigorous, healthy growth, and help to protect the stands against damage by frost, wind, weeds or insects.

The disadvantages of natural regeneration are that it requires more skilful forest management, that it often takes longer, and that the crop produced may be uneven.

The advantages of artificial regeneration are: (a) It is independent of the local occurrence of seed, since sufficient supplies for nurseries can be obtained, if necessary from a distance. (b) This enables operations to proceed in a systematic and regular manner, carrying out the desired quantity of regeneration year by year, and so providing a steady supply of produce. (c) Where seed is collected, and not purchased from outside sources, care can be taken to ensure that is is obtained from mother trees of desirable form; in either case double headed or otherwise unsuitable trees can be rejected and not planted. (d) The regular spacing facilitates any subsequent weeding or line opening that may be necessary.

The disadvantages of artificial regeneration are: (a) It is costly and involves the employment of a good deal of labour. (b) The trees receive a considerable check in the planting out process. (c) The roots may be badly placed, e.g. bent up or squeezed together. (d) These last two features may retard growth and render the trees more susceptible to damage by frost, wind or insect attack.

Careful consideration, both of general principles and of their particular application to local areas, leads to the opinion that natural regeneration should be the ultimate aim. There will be a certain
amount of natural regeneration in any case, and every effort should be made to make this as full and complete as possible, reducing the amount of artificial assistance to a minimum.

The marked tendency of *P. radiata* in these areas to the development of branches and double or multiple leaders, the rapid and prolific weed growth on the felled areas, and the presence of *Hylastes* all point clearly to the desirability of establishing a fully adequate crop of young trees from the outset, even though this does entail cleaning and thinning later on. To secure this by means of planting would involve a high cost per acre; this may not seem of paramount importance where comparatively all areas are being dealt with annually, but for large scale operations it involves very substantial sums, with a greatly augmented seasonal staff. Advantage should therefore be taken of immediate somewhat limited operations to build up a technique which can be satisfactorily applied to subsequent large scale work.

Undoubtedly there are difficulties to be overcome in securing satisfactory natural regeneration, especially in the case of youngish stands which are not yet at the normal regeneration stage. These difficulties vary somewhat from place to place, or according to whether the area is hilly or level; means whereby they may be met have yet to be defined, and at present only comments and suggestions are possible.

The reluctance of the cones in the felled tops to release their seed might be countered by leaving a certain number of seed trees evenly distributed over the area, or by means of pre-seeding, i.e., of sowing seed between the rows shortly before the stand is felled to ensure the presence on the ground of at least a certain amount of seed. Felling and logging operations would have to follow this seeding closely enough to ensure that the resultant seedlings were not destroyed and the seed used should be collected only from trees of desirable type. The use of fire to induce the cones to open is not advised; the control of fire to a degree which will open the cones without at the same time destroying the seed, the humus and any advance seedlings is a matter of impossibility or of great good fortune, and the introduction of fire into a forest area should be contemplated only as a last resort when all other measures have failed.

In any area of natural regeneration there are almost invariably gaps which need filling and overdense patches which need to be thinned. It is desirable that both these operations should be carried out as early as possible; the filling, in order that the neighbouring trees should not obtain so great a start as to make the operation useless; the thinning, so as to reduce expense. In both cases, however, early treatment is by no means easy, as the unrotted slash and the rapid growth of fern render it difficult to penetrate the stands or to see just what needs doing when inside them.

The second major problem is that of species. In the existing exotic forests in this region *P. radiata* preponderates over all other
species, and it produces so great a volume per acre in so short a time that it seems likely to continue to hold pride of place. The timber it produces, though not of very high grade, is quite a good general utility line, suitable for a variety of purposes. Its two main disadvantages are grain distortions and knots; grain distortions are symptomatic of young trees, and there is reason to believe that the timber laid down in later years will be reasonably straight grained; knots are much less important in older trees because of the greater relative amount of wood. This makes it unfortunate that at present and probably in the near future, so much milling is taking place in relatively young and immature stands, as this involves the risk of P. radiata timber acquiring a bad name which will be difficult to live down in later years, even though milling is then confined to better timber from older and more mature stands.

It is not, however, sufficient to state baldly that P. radiata is likely to continue to be the main species. "P. radiata in this region is a markedly variable tree, with several distinct types or races; scattered throughout there are examples with straight, relatively cylindrical barrels and with comparatively few and small branches, even when growing out in the open. This is a most desirable type, and it is important that any seed collection, whether for nursery use or for purposes of pre-seeding, should be confined to this type.

In localities specially subject to frost damage, such as flats and gullies, of which a certain proportion inevitably occur in any extensive area, P. radiata is difficult to establish, and even if established does not yield satisfactory results, as it is very prone to damage by the unseasonable frosts prevalent throughout the region and subsequent attack by Diplodia. Under such conditions therefore it must be replaced by a harder species; several species have been tried for the purpose, of which P. ponderosa has proved the most satisfactory.

On areas not specially subject to frost there are a number of conifers which are capable of growing well provided that discretion is used in their location, e.g. Douglas fir, European larch, P. strobos, P. larchio. The question is whether better timber than that of P. radiata can be produced within a reasonable time.

It is possible to obtain information as to rates of growth and reactions to local conditions of soil and climate both of the species mentioned and also of other species which have been tried; only very limited amounts of timber from species other than P. radiata have so far been utilised however, so that information as to their qualities is meagre. Nor does there appear to be any known method of predicting accurately what sort of timber a species will produce when grown outside its natural habitat and under conditions which may vary appreciably from those for which data are available. Because for instance the species named produce high grade timber in virgin forests, it does not necessarily follow that they will produce similar high grade timber in plantations on a comparatively short rotation under different conditions of soil, climate and ecology.
Available information indicates that few, if any species will approach *P. radiata* in volume production per acre in even approximately the same time; for the species mentioned rotations would probably be twice as long as that for *P. radiata*. The resultant timber must therefore possess marked merchantable advantages to render its growing attractive financially, though it might be considered desirable from a national economic standpoint in order to produce the range of timbers necessary to fill varied needs.

The third major problem is that of tending. Whilst it may appear at first sight that the treatment to be given to stands during their life is hardly a re-establishment question, yet this is not actually so, as knowledge or expectation that stands will or will not receive treatment such as thinning and pruning may influence to a considerable extent the methods adopted in establishing them.

In the product from the stands at present being milled there is a great preponderance of knotty material of relatively small sizes, and only a very limited percentage of large or clear timber. Such material is well enough for low grade purposes such as case timber, and possibly also for flooring, lining and weatherboards, but is not suitable for higher grade purposes such as mouldings, joinery, furniture, veneer or plywood. Low grade material has not an unlimited market; it is always of comparatively low value, and if put upon the market in excessive quantities its price may drop so low as to render its production quite unattractive financially. From the economic standpoint it must be recognised that mere volume production in itself means little, and that value production is the important thing. Thus to obtain the best results from the forest areas it is necessary to manage them in such a way that the percentage of better class material shall become as large as possible. Which leads to a consideration of such measures as thinning and pruning.

In South Africa some six years ago measures were adopted which were designed to reduce production costs, to limit the percentage of small-sized and defective material, to maintain an approximately even-ringed growth, and to give the maximum output of large, clear, relatively valuable timber. Very briefly this was to be attempted by means of comparatively wide initial spacing, early and heavy thinnings, and pruning all final crop trees up to a height of 22 feet. Fuller details as to these South African proposals are given in the review of Dr. Craib's bulletin elsewhere in this issue.

Information as to the success or otherwise attained in practice by the South African methods is not at present available, nor can any pronouncement be made as to their suitability for application to the forests in this region, though it seems probable that the conditions differ and that modifications would be needed to obtain satisfactory results here. As in the case of natural regeneration, there are unresolved difficulties in regard to thinning and pruning, so that here again only suggestion and comment are offered.
One main difficulty in relation to the thinning of *P. radiata* in this region is that at present there appears to be no outlet for the resultant material or none that would justify the cost of its extraction. The operation thus entails an immediate outlay none of which is recoverable directly, whatever benefits it may prove to have had in the future. This raises two questions: can thinnings be contemplated if they consist merely in knocking down the surplus trees and leaving them to rot *in situ*, and should original spacing be widened so that no thinning is needed at all or becomes necessary only after the trees have attained usable size?

The knocking down of the surplus trees without any attempt to remove them would not be a very expensive operation, particularly if carried out as early as possible in the life of the stand; its results, at a reasonable rate of compound interest, should be favourable financially, provided the work was efficiently done, though so far as is known no figures of actual tests have been recorded. Leaving the stems to rot *in situ* might be held objectionable as likely to foster the introduction of insects or fungi; it seems doubtful, however, whether the stems would be more dangerous in this respect when rotting on the ground than they would whilst standing in a dead or dying condition. It would, however, be a contribution of undoubted value to silvicultural possibilities if some means could be found of utilising small thinned material, so that the expenses of thinning could be at least covered, and the operation should not have to await increased returns at some indefinite date in the future for its justification.

If a stand starts at more or less normal density and is not thinned, when it comes to be felled a considerable percentage of the original trees will have been suppressed and will be dead. These dead trees represent an appreciable waste of growth potential, as they are of no utilisation value themselves, whereas if the energy which has gone into their production could have been concentrated into the final crop trees the total production from the area would have increased considerably in both volume and value. Where regular thinnings are possible much of this waste is prevented, as the trees are removed before they die and are utilised. Where thinnings are not possible it has been suggested, in order to obviate at least a part of this waste and to confine the growth potential of the area so far as possible to final crop trees, that the number of stems should be reduced from the outset very materially, or even to that which the area can carry at maturity.

There are certain obvious objections to this proposal. Such wide spacing in the initial stages would considerably delay the closing of the canopy, the establishment of true forest conditions and the suppression of the fern and scrub. It is essential that the trees comprising the final crop should all, or the large majority of them at any rate, be good trees without double leaders or similar defects. *P. radiata* in this region is very prone to double leaders, and severe restriction of numbers from the outset would leave little or no choice,
so that final results might be distinctly unsatisfactory. Wide initial spacing would also encourage the strongly branching habit to which *P. radiata* is also prone, resulting in coarse knotty timber, again with unfortunate effects upon the final crop. These adverse results would be materially lessened if the stands comprised only, or even largely, the straight small-branched type to which reference has already been made.

To overcome some of these objections to wide initial spacing it has been proposed that the trees should be pruned. In order to justify pruning economically a minimum radius of four inches of clear timber must be imposed upon the knotty core before the tree is felled. On its inner side this ring of clear timber is affected by grain distortion round the stubs of the pruned branches; on its outer side portions of it are lost in milling in the slab waste; on both sides it is affected by the growth necessary to convert a truncated cone into a cylinder. As a result, in order to secure an effective zone of clear timber four inches in thickness, it is necessary to have a diameter increase over bark at any part of the pruned stem of not less than twelve inches. To afford the stems an opportunity to increase in diameter to this extent, as well as to limit the knotty core to the smallest possible dimensions—obviously an important desideratum—it is necessary to carry out pruning as early as possible in the life of the tree. With wide spacing the growth of fern and scrub is apt to be so dense in the early years that pruning operations become both difficult and expensive. There would thus be a definite likelihood of the work being postponed until the undergrowth had been suppressed sufficiently to permit easier access and better visibility, by which time the trees might well have grown to such a size that the operation would no longer be economic. There is too, always the possibility, however good the original intentions may have been, that when the time came pruning would not be carried out at all.

It is realised that the questions touched upon are by no means the only ones that might be raised in relation to re-establishment, and that the treatment even of them is in places somewhat sketchy. There is, however, no claim or attempt to make a final pronouncement upon any of the points indicated. If the article succeeds in drawing attention to and stimulating thought upon matters which seem to merit urgent and serious consideration, it will have served its purpose.

**Summary**

Three major problems—regeneration, species, tending—relating to re-establishment of *P. radiata* in the Rotorua region are discussed. Is regeneration to be by natural or artificial means? Advantages and disadvantages of the clear cutting system, habits and requirements of the species, seed production, injurious insects, slash disposal, labour supplies; advantages and disadvantages of both natural and artificial regeneration; despite difficulties natural regeneration should
be the ultimate aim. _P. radiata_ at present the main species, and likely to continue so; in frost subject localities replaced by _P. ponderosa_; information meagre as to timber qualities of species other than _P. radiata_; such species require longer rotations, so timber must be markedly superior to render their growing attractive. The tending to be given to stands may influence re-establishment methods; present high proportion of low grade material might be reduced by thinning, wider spacing or pruning; possibilities and difficulties are briefly outlined.

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**REGENERATION OF CLEAR FELLED INSIGNIS PINE AT WHAKAREWAREWA STATE FOREST, ROTORUA.**

By J. F. Lysaght.

**Introduction.**

Insignis pine (_Pinus radiata_) has been established in New Zealand for many years. It grows extremely fast, bears cones freely and re-generates on to open land near standing trees where conditions are suitable. In many parts of New Zealand and in the Rotorua District in particular, many thousands of acres have been planted in this species. Harvesting of the crop is now commencing in earnest with the clear felling of hundreds of acres annually. Most of this land is unsuitable for other purposes and will continue to be used for forest purposes so that re-establishment now becomes a problem of importance.

Previously felling was almost entirely from farm shelterbelts or small isolated areas which in most cases were not re-forested but reverted to grazing. At other times burning of the slash and re-planting was practised, while in a few places exclusion of stock after felling resulted in abundant natural regeneration. In Whakarewarewa State Forest clear felling of _Pinus radiata_ has been carried out over the last four years at a rate of more than 80 acres a year, and it is here that this study of regeneration has been made.

**Description of Area.**

Most of the area clear felled has been in Compartment 22 which is divided into two parts; 22/1 is of 236 acres, sloping down from 2,400' in the extreme south to rolling country at about 1,400' occupying one-third of the area in the north; 22/2 is of 284 acres and slopes fairly steeply from 2,400' on the east to 1,200' on the west. The higher slopes of both sub-compartments, particularly 22/1, represent a somewhat poorer site quality and are more exposed to the wind. The soil consists of from 4" to 6" of dark loam over loose gravelly pumice with occasional outcrops of rhyolite rock.