PROBLEMS OF FORESTRY AS THEY AFFECT LAND-USE FOR AGRICULTURE IN WESTLAND

Part 2: The Protection Forests

J. T. HOLLOWAY

Senior Principal Scientific Officer, Forest and Range Experiment Station, N.Z. Forest Service, Rangiora

THE AREA of Westland Forest Conservancy is approximately 3,800,00 acres, of which about 2,300,000 acres, or 60%, is steep, unoccupied, mountain land held in Crown ownership as State Forest, unalienated Crown Land, or National Park. The value of this land, for timber production or for agricultural or pastoral use, is entirely negligible, yet upon the safe custody of it the future of Westland must largely depend. The most cursory evaluation of flood hazards, particularly in respect to the key agricultural and pastoral lands on the flood plains of the rivers, will show that this statement is no exaggeration. Under Westland conditions, protection works designed by man will not be worth twopence if there is failure to maintain an adequate cover of vegetation on the flanks of the mountains.

It is widely known that Westland is blessed by abundant rainfall, but it is not so widely appreciated that the annual falls of 100 in. or so that are experienced on the coast are exceeded three or **even** four times in the upstream alpine valleys. Falls have been recorded, during an exceptionally damp summer, of 32 in. in 27 hours, 96 in. in 10 days, and 272 in. in 11 wecks. This **is** not Scotch mist that kisses the land as it falls, but a destructive force that can tear a mountainside apart and, particularly when it hits the remnants of a heavy winter snowpack, convert the most innocent-looking mountain runnel into a frightening torrent that can toss and tumble boulders the size of a house.

There are, in fact, only two things that render the flood plains of Westland habitable. The first is the dense mass of multitiered vegetation that, by virtue of this same heavy rainfall, blankets the mountain-sides, and the second is the typical Westland gorge, cut deep and narrow into the floors of ancient-glacial valleys, through which all rock debris **must** pass and, in **passage,** largely be ground to sands and **sills** susceptible of further onward transport by the rivers, across the flood plains, to the sea. Coarse materials, of such size that they are readily dumped by the rivers where gradients change, do not currently reach the flood plains

in significant amounts except where there are no major upstream gorges.

Any, Westland river may, indeed, be regarded as an infernal engine of immense, potential, destructive power. The vegetation mass is the governor, the gorges constituting an: automatic choke. Both components arc showing signs of malfunction. There are gorges, impenetrable on foot ten years ago, through which a way can now be forced. They are filling, slowly as yet, with the debris of erosion. If they are permitted to fill, the way will be cleared for coarser and coarser detritus to reach the flood plains in greater and greater amounts. The automatic choke will. no longer operate, just as it no longer operates in many mountain-land tributaries of east coast South Island rivers.

But the real trouble, of course, is with the functioning of the governor, that mass of living and dead plant matter that cushions the land against the direct impact of torrential rainfall and binds both the soil and rock waste into place. This is made up, in broad terms and with the exact proportions varying greatly from valley to valley, of one-third forest and subalpine scrubland and one-third alpine grassland. The remainder is largely high alpine rock and snow desert with small oases of alpine moorland, and rock or scree vegetation.

The forests and subalnine scrublands occupy the steepest country, the angle of slope normally exceeding 35 to 40°, rising to 70" or more without a break in the forest or scrub-land cover. The timberline is normally at about 2,800 ft, the subalpine scrublands above timberline merging irregularly into the alpine grasslands at altitudes between 3,300 and 3,800 ft. Soils are skeletal and strongly leached. They may be derived from, and rest directly upon, bedrock — alpine schists merging eastwards into greywackes and argillites -or they may be derived from and overlie deep unconsolidated solifluction or other periglacial deposits. Such deposits, poised ready to be shed into stream channels consequent on any weakening of the plant cover, may be found on slopes far steeper than the normal angles of repose of such materials.

Six broad classes of subalpine scrubland have been described, soil factors (depth, drainage and age or degree of leaching) in conjunction with altitude and aspect, determining their distribution. The classification of the forests into distinct types is, however, not so easy. Kamahi and rata are the usual dominants throughout, either species locally achieving complete dominance. Rimu, miro and

other lowland podocarps occur widely dispersed or in local pockets at altitudes up to 1,500 ft but are rarely present in significant amounts at greater altitudes. Hall's totara, present throughout, occurs most abundantly toward the timberline where kaikawaka may also be an important species. Both kaikawaka and rata may persist well into the scrubland zone above the true timberline.

All forest contains an abundance of small trees and large shrubs, the composition of this forest understorey varying greatly with the density of the upper canopy, altitude, aspect, and depth and freedom of drainage of the soil. Beneath this tier, there are, successively, small shrub, tall fern, low fern and herb, and moss tiers, equally variable in composition from place to place. And finally, as the last defence of the soil, there is-usually a thick carpet of litter and humus, the latter permeated through and through by an inextricable tangle of feeding roots.

Superimposed upon this intricate mosaic, there is an equally complex pattern of seral forest types representing all stages in the recolonization, by forest, of landslip scars, the processes of recolonization proceeding in diverse directions, at diverse rates, towards diverse ends. A wide variety of minor forest types occupy shady gullies and ravines, seepage hollows, and other such places. A partial simplification of these complex patterns is found only to the north of the Taramakau and to the south of the Paringa rivers where the mountain-land forests are beech forests.

The above description applies to all mountain-land forest between these two rivers. The key feature is the density of the plant cover and, both for the forests and the scrublands, its multistoreyed character. It is not known whether a significant volume of water is withheld by it, permanently or temporarily, from the streams, thereby contributing toward a reduction in peak storm flows, but it does effectively absorb the full energy of storm rains. The rain, driven by the wind, strikes the upper forest canopy with full force but its energy is dissipated long before it reaches the forest floor where 'it is absorbed by the litter and humus 'and released quietly to the streams. Direct observations have shown that, although streams rise rapidly, there is no overland flow or litter or soil wash in intact virgin forest, even towards the end of storm rains exceeding 24 in. in 24 hours. The water reaching the streams is humus stained but not silt laden. There is no sheet wash or gullying.

Erosion under natural conditions, in fact, proceeds catastrophically through localized landslips, the frequency of

which, in the past as in the present, is attested by the mosaic of seral forest types described above. Under Westland climatic conditions and in the absence of animals, however, the scars heal with astonishing rapidity, recolonization by plants commencing even before mass movement has ceased.

This picture is now changing. Red deer were introduced in 1898. Chamois have spread widely through the ranges over the past 25 to 30 years. Thar are still spreading northwards and southwards from their liberation point near Mt. Cook and, in the north, are now entrenched in the upper catchment of the Hokitika River and its tributaries. Opossums were liberated on many occasions between 1895 and 1930 and have thriven exceedingly, and hares have crossed the main divide from Canterbury to occupy the western alpine grasslands. Goats and, in the past, wild cattle liave established themselves locally.

The detailed study of the effects of these animals on the forests and scrublands is a matter fraught with complications. If it is a difficult matter to analyse, with any pretence to statistical accuracy, the effects upon pastures of varying levels of stocking by domestic animals whose numbers can be prescribed and controlled, it is an almost impossible task for dense, multi-storeyed forests and scrublands, of complex composition, occupying 30 to 70" slopes under a rainfall of 300 to 400 in. annually, the numbers of animals and combinations of species present varying greatly from place to place and from time to time and to an extent that can only be estimated. Nevertheless, certain broad trends are so obvious as to be indisputable.

First of all, there is a general trend toward depletion of forest understoreys, coupled with the steady elimination of the most highly palatable species, a trend only partially and locally compensated for by the spread of unpalatable or browse-resistant species. Secondly, and most conspicuously, there has been widespread mortality of the forest dominants, kamahi and rata, consequent, almost certainly, on their repeated heavy defoliation by opossums, though the final *coup de grâce* may be given by scale-insect attack. Thirdly, pronounced changes in the condition of the forest floor are in train consequent both on animal trampling (and the concentration of feeding roots in the surface humus layers must be remembered) and upon the opening up of forest interiors to sun and wind. The soil carpet of mosses, liverworts and small ferns is disappearing and there is a steady reduction, in all areas frequented by hoofed animals, in the depth of forest litter, And finally;

with respect to the forests, the processes of forest regeneration on landslide scars are brought to a halt. Most of the colonizing species are palatable, the open slip faces, particularly where they lie to, the sun, themselves being most attractive to animals.

The extent to which these trends are in evidence varies greatly from valley to valley, and even from place to place' within one valley depending upon the duration of animal occupation, the levels of animal populations and fluctuations in levels, the species and combinations of animal species present, and upon the preferences of the animals themselves for slopes of various aspect, types of forest or combinations of types, and the nature of the terrain, etc. There has, however, generally been maximum depletion of forest understoreys in areas close to the timberline on slopes of sunny aspect, where these are readily accessible from the alpine grasslands. The pattern of rata-kamahi mortality is a complex one, but dead trees tend to appear first within old stands occupying steep rocky well-drained ground, particularly where there has already been depletion of the undergrowth by ground-feeding animals, such areas initially providing the most suitable habitat for opossums. Subsequent trends are confused but appear to depend, in part, upon the habitat preferences of opossums and, in part, upon interactions between opossums and ground-feeding animals.

Much of the subalpine scrubland remains in a near-virgin condition. It is virtually impenetrable and has been heavily-used by deer and chamois only along leading ridges and other main travel routes where it may be rapidly destroyed with conversion of tracks into eroding watercourses. Opossums penetrate it locally and to a limited extent, seeking out the choicest palatables. The only exception to these broad generalizations concerns one main class of scrubland (mountain-ribbonwood scrubland) that occupies the recent soils of high altitude slip-faces, talus slopes and alluvial fans. Regeneration of this extensive and important class of scrubland is wholly prevented in the presence of browsing animals, grassland and fern communities developing in its place. There may be some subsequent invasion by unpalatable shrubs but how far this will proceed is not yet known, nor is it known how satisfactory the grassland and fern cover will be on such steep and unstable ground.

The net outcome of these modifications of the forests and scrublands has been, wherever such modifications are

most advanced, a palpably unsatisfactory change in the behaviour of tributary streams. It is difficult to set a figure on this because, in such country, a proportion of all tributaries will be behaving erratically at any one time consequent on the vagaries of local landslides or cloud-bursts. But where all or most tributaries, at one and the same time, are scouring their channels or bringing down increasing loads of rock waste, then the existence of abnormal watershed conditions can reasonably be deduced, particularly if there is other evidence to support this conclusion1

This supporting evidence can be derived in many different ways. The ability of virgin multi-storeyed forest to absorb rainfall exceeding 24 in. in 24 hours, transmitting the water to the streams quietly without wash of litter or erosion of the soil, has already been described. On the same occasion that this was observed closely, parallel observations were made in a nearby, moderately depleted piece of forest. Here, after 2 to 3 hours of continuous rain, there was surface flow, displacement of litter, and wash and incipent finger-gulleying of the soil. The stream draining this area did not appear to rise any more quickly than the stream draining the virgin forest area but it rapidly picked up a heavy silt load. Stream-bank abrasion and scouring was pronounced and many temporary litter and debris dams formed, leading to the development of destructive surges in flow.

On the evidence, the Forest Service is compelled to campaign for all-out efforts toward animal control. There are those who suggest that nothing should be done pending verification of the present conclusions by controlled experiments, or until such time as sufficient data can be collected to satisfy the most fanatical statistician, or until a greater fundamental understanding of the animals themselves has been gained, or until it is certain that nature itself will not restore a satisfactory state of balance. And there are also, of course, those who seek the maintenance of animal populations at such undefined and undefinable levels as will satisfy their frequently conflicting requirements for sport, venison recovery,' or opossum skins. But when, from depleted high-altitude forest displaying, locally, not the slightest sign of satisfactory adjustment to the presence of introduced animals, one looks down the debris-laden channel of a misbehaving mountain torrent towards the farms and homesteads on the flood-plains below, such arguments must be discounted.

Control, to the full extent of present abilities, is needed now. Waiting, and it will be a long wait, for all research frills to be added will lead to a strong chance, amounting in many instances to a virtual certainty, that the damage done to the watersheds will be irreparable.

The most immediate requirement is a greater understanding of animal behaviour, including a knowledge of population dynamics, not for determination of the necessity for control, but to facilitate control and render it more effective. For example, knowing that casual hunting may merely skim the cream of the population, or even, in some cases, by over-concentration on non-breeding components, actively encourage population growth, it is necessary to know when, where and how to hit breeding components hardest. And it is necessary to know much more about the mutual interactions of populations of the various species of animals so that, in controlling one species, the population growth of others is not accidentally triggered.

All the answers, or even all the problems, are far from being known. Nevertheless, the steady application of new techniques combining intensive sustained hunting with the use of modern poisons distributed in carefully selected localities from the air does show that the task is not impossible. The sustained application of these techniques over a period of several years, in the topographically and climatically most difficult Hokitika River catchment, has provoked a satisfactory vegetation response. It is not a strong response yet, but merely increased survival of seedlings of palatable species and a modest trend toward the thickening of the plant cover on slip-faces, but it *is* there. Trends toward depletion are currently halted, though there is a long way to go before satisfactory conditions can be fully restored.

GENERAL REFERENCES

Chavasse, C. G. R., 1959: Westland's wealth. N.Z. ***For. Serv.*** *Inf.* ***Ser.*** *No. 29.*

Chavasse, C. G. R., 1962: Forests, soils and land forms of Westland. ***N.Z. For Serv.*** *Inf.* ***Ser. No. 43.***

Director-General of Forests, ***1964:*** *Annual* ***Report,*** C.3. Govt. Printer, Wellington.

Gibbs, H. S.; Mercer, A. D.; Collie, T. E., 1950: Soils and agriculture in Westland. ***Soil*** *Bureau Bull.* ***No. 2 (New*** Series).

Holloway, J. T., ***et*** *al.,* ***1958:*** *Interim* ***Report*** *on the* ***Hokitika River*** *Catchment, Westland.* Unpub. N.Z. Forest Service report.

McKinnon, A. D., 1964: ***A Survey of*** *New Zealand's Indigenous* ***Timber Resources*** *and a* ***Forecast*** *of Future Sawn* ***Timber Production.*** Paper presented to Fourth N.Z. Geography Conf., 1964.

Masters, S. E.; Holloway, J. T.; McKelvey, P. J., 1957: *The National Forest Survey' of New Zealand, 1955*: ***Vol. I, The Indigenous Forest Resources* of *New Zealand. Govt.*** Printer, Wellington.
Wardle, P., 1960: The subalpine scrub of the Hokitika River Catchment, Westland. ***Trans. Roy. Soc. N.Z., 88 (1): 47-61.***

DISCUSSION

How do opossums kill rata trees? It is suggested that it could be by continuous disbudding.

MR HOLLOWAY: Heavy defoliation and destruction of buds over a period of years would probably be sufficient in itself. More frequently trees weakened in this way finally succumb to attack by other pathogens — e.g., scale-insects.

Has thought been given to the introduction of curnivorotts predators?

MR HOLLOWAY: The thought has been entertained many limes, though no one has been bold enough to pursue the matter very far. Quite apart from the obvious drawbacks, it is still a matter for dispute amongst animal ecologists as to how effective predator control really is.

Have youany datu on animal populations in 1957 as compared with the present time?

MR WRAIGHT: There are no exact data because there is no satisfactory, practicable census technique, but, in the case of the Hokitika River catchment, there has definitely been a major reduction in numbers of red deer as shown by a marked decreasc in abundance of pellets, a marked decrease in shooting tallies, and abandonment of tracking systems.

Of ***all the pests named which one would be the most dangerous from our prosperily point of view?***

MR HOLOWAY: Red deer without any question, because they are the most widespread and wide-ranging animals, but it must be remembered that combinations of two or more species are always likely to be more harmful than any single species alone. The opossum/red deer combination in rata-kamahi forests of the West Coast type is a particularly bad'one.

Is the opossum a greater menace to the stubility of hill country than deer?

MR HOLLOWAY: Usually not. For all beech forests deer arc by far the greater menace. Opossums are a major menace only in certain types of forest and then, normally, only where they occur together with introduced ungulales.

What area is needed for forestry in the case of hill soils to make it an economic venture?

MR MOLLOY: This must depend upon location in respect to access and markets and upon many other factors as well, but the minimum area in any one location would be of the order of 500 acres.