PROTECTION-FOREST PROBLEMS IN NELSON-MARLBOROUGH
A PRELIMINARY REVIEW

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Introduction

The districts of Nelson and Marlborough, which together constitute the Nelson Forest Conservancy, are more uniformly mountainous than any of the other former provincial districts of New Zealand. The population of the region is concentrated on a few pockets of coastal lowland and largely upon the flood plains of the major rivers. Inland, to the north and west, the floors of the deep valleys support a few hundred farmers and a half dozen isolated village settlements. The highlands are occupied only to the east but support an even sparser population engaged in fine-wool production on a basis of extensive pastoralism. There are only two townships with populations exceeding 500 people, situated more than 20 miles from the sea, these functioning as communication and/or mining centres as well as market towns. Considerably more than one half of the land is unoccupied, the area of land in all tenures not effectively occupied possibly exceeding two-thirds of the total. Nearly 40% of the land is under reservation as State forest, with substantial additional areas under reservation in other forms such as national parks and scenic reserves.

Significant development of new lands for agricultural or pastoral use is unlikely. With greater probability, some of the land now used for pastoral production must ultimately be retired from grazing. Much forest land now held freehold or leasehold by farmers is not likely ever to be broken in. Any increase in production must come from better use of lands already developed. Other resources are limited. The goldfields are already exhausted though there remain substantial reserves of coal with the possibility of uranium and other ores. The regional hydro-electric potential is high but remains virtually untapped. Apart from developments in these fields and from further development of coastally situated industries processing secondary or primary products, the economic prospects are restricted. Further economic growth of the region must increasingly depend upon developments in three directions—forests, fisheries, and tourism. Of these, forest development must stand first. The forests must not only supply the raw materials required by the primary, secondary, and mining industries, but must also be managed for protection of the valley lands and lowlands against flood, for protection of the hydro-electric resource, and for maintenance of scenic and recreational assets. In other words

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the forests must ultimately prove the foundation stone of the entire regional economic structure.

The Forests

In pre-European times, the region was densely forested with the exception of lands within the catchments of the Awatere and Clarence Rivers and of south-eastern tributaries of the Wairau River. Apart from these natural grasslands, the only open lands were coastal Maori clearings (extensive only around Tasman Bay), lands above the timber line (altitude 4,000 to 5,000 ft), and local bogs, swamps, and estuarine and riverbed lands. Following European settlement, forest clearance proceeded rapidly, inland from Tasman Bay and Golden Bay, around the Marlborough Sounds, in the Wairau Valley and along the Kaikoura coast, but slowly in the wet western valleys. Normally, despite the appearance of the country from the main highways, there was little clearance of forest from the high mountains. The forests that were destroyed were the forests of the lowlands, of the low hills, and of the lowermost mountain slopes along the line of the major valleys. The great bulk of high-mountain protection forest survived intact. The vanished forests were the potential timber-production forests of the region.

Today, therefore, we still have in Nelson Conservancy a considerable forest estate, the total area of native forest that remains amounting to approximately 3 million acres, or one-fifth of the total for New Zealand; but of this considerable estate, less than one-sixth is forest significantly potential for timber production. The remainder, 2½ million acres, together with an almost equal area of unoccupied subalpine scrub land, alpine grassland, and high-alpine waste land, is of negligible value as a source of raw materials but must be managed, without direct revenue return, for control of water yield, for prevention of floods and destructive land erosion, for the preservation of scenery and recreational facilities.

These mountain forests of Nelson, disregarding all forest below 1,000–1,500 ft altitude, are almost entirely beech forests. There is commonly a thin representation of podocarps to 2,000–2,500 ft; kamahi and rata are locally abundant, particularly in the far west and on the coastal mountains where they may, in a few instances, occur to the exclusion of beech; and a wide range of minor forest types is found throughout, especially in the far north-west and on the seaward slopes of the Seaward Kaikoura Range. But well over 90% of all the mountain forest is beech forest.

All species of beech are represented in the region though traces, only, of black beech survive. Black beech, in Nelson, was largely a species of northern valley forests, now destroyed. Hard beech is a frequent dominant on steep valley slopes to an altitude of 2,000–2,500 ft in the west and north but is absent from the forests of many inland valleys and in the south-east. Red beech is the normal dominant throughout the great mass of the forests to an altitude of 3,000–
3,500 ft, in some instances reaching 4,500 ft. Silver beech, which is normally subdominant in all red beech forest, is the usual dominant in high-altitude forest in the west but, toward the east, is displaced by mountain beech. Where pockets of forest extend out into the eastern grasslands, these are usually pure mountain beech but, in the west, mountain beech is commonly found only on particularly shallow and infertile soils or on wet acid peats.

On the coastal mountains and in the west, forest understoreys are normally dense both in the scrub and in the ground tiers. Inland and to the east the forest is more open except toward the timberline, where a heavy low cover of divaricating shrubs and stunted beech regeneration is usual. The timber line, itself, varies in altitude from 3,500 ft in the south-west to 5,000 ft in the north and north-east. Above the timber line, where not destroyed by deer, a belt of dense subalpine scrub, covering an altitudinal range from under 100 to over 300 ft, is normally present. Except in the south-east, the alpine grasslands extend across the mountain summits, true alpine barrens occurring only on the highest peaks above 6,000–6,500 ft. Except on the Kaikoura ranges, which rise to 9,500 ft, only a few peaks are above 7,000 ft, with the highest at 7,600 ft. There are no glaciers and few permanent snowfields.

These forests and mountains have been inhabited by introduced animals for longer than any other forests in New Zealand. The first liberations of animals now classed as noxious were made in 1773, when goats and pigs were set ashore in Queen Charlotte Sound by Captain Cook. Red deer, the first in New Zealand, were liberated near Nelson city in 1851. Possums were introduced in 1890. Animals of these four species are now very widely distributed throughout the region. Fallow deer, liberated in 1864, 1887, and 1901 have not spread far from the points of liberation and are comparatively few in numbers. They are outnumbered by chamois, which entered the Nelson highlands from the south about the year 1940. Rabbits are present throughout the mountain valleys and, in past years, have been the main cause of depletion of the south-eastern grasslands. Hares occur abundantly throughout the alpine grasslands.

Nevertheless, despite this long history of animal use, the forests do not display, for the most part, any obvious outward sign of depletion or damage. Save around the fringes of the south-eastern grasslands there is no strong visual evidence of catastrophic land erosion. In inland valleys, scarred mountain slopes bear witness not to damage done to the forests by introduced animals but to the great earthquake of 1929. Mountain slopes unwisely cleared of forest and now a wilderness of bracken fern and charred logs are unsightly but are nevertheless stable and safe from animal pressure so long as fire is kept out. Guts, gullies, and active screes on the Canterbury pattern are conspicuous only on the ranges to the south of the Wairau Valley and to the east of the Spenser and St. Arnaud Ranges. There are no great areas of standing dead rata-kamahi forest of the type now
distressingly common on the Ruahine Range or along the western flanks of the Southern Alps.

A more detailed inspection, however, soon reveals that there are grounds for serious concern. Though much far-western forest remains in near-virgin order, most of the forest has undergone, and is undergoing, profound modification. Forest understoreys have been reduced in density and altered in composition. Soil litter is thin and forest topsoils frequently display signs of compaction and sheet washing. Advance growth of forest dominants, particularly in inland and eastern high-altitude forests, within areas favoured by deer in winter, and wherever goats are numerous is present in insufficient amount for replacement of normal canopy losses. Heavy damage has been done to the subalpine scrub land, in some instances amounting to complete destruction, and depletion of the alpine grasslands is locally far advanced.

These changes have not, to date, been studied in as thorough a fashion as is desirable. This will take very many years of patient effort. We can, however, be certain that trends which are in evidence over extensive areas of forest lead in wholly undesirable directions, and that time is not with us. Action toward control of noxious-animal populations, more intensive and better directed than heretofore, will be essential long before the results of detailed research are available.

The lines along which action must be taken are obvious. Their determination requires only brief study of the land-settlement and geological maps of the region, coupled with a slight knowledge of regional climates, of the habitat preferences of the various species of animal present, and of the recuperative powers of the forests. Analysis of the situation in these respects is the prime purpose of this paper.

**Geological Factors**

A sharp quadripartite division of Nelson Conservancy into distinct geological provinces is instantly recognisable on any regional geological map. Recognition of these provinces, and appreciation of their diverse character with respect to erosion potential, is fundamental to a study of regional protection-forest problems. (See accompanying map.)

**Western Province.** The mountains of the western province are carved in old and hard rocks of high erosion resistance—gneissic and granitic rocks, marbles, quartzites, sandstones, argillites, conglomerates, limestones, tuffs, biotite schists, greywackes, gabbros, and hornfels of pre-Cambrian to early Mesozoic age. There are enclaves of Tertiary sedimentary rocks but, of these, only the more resistant limestones and sandstones outcrop widely in areas of high relief. Tertiary sediments of low resistance occur mainly in the valleys or on plateau surfaces. Pleistocene rocks, mainly deep gravels, occur extensively only in the Inangahua lowland. Despite the precipitousness
of these mountains, therefore, the processes of normal geological erosion are slow. Forest devastation could lead to loss of the shallow mountain soils but not to rapid disintegration and erosion of bedrock with consequent extreme aggradation of river channels. In addition, and for the same reason, the mountain slopes are not mantled with the huge accumulation of talus and solifluction material, relict from the ice ages, that is characteristic of the mountains of Canterbury and Westland. There is no great mass of disintegrated rock debris, perched high above the valleys, ready to be swept downhill immediately the forest cover is weakened.

Central Province. This is a lowland province of river flood plains backed by hills of gentle relief, carved from Pleistocene gravels. There remains a considerable extent of forest on the highest of these hills, but these can scarcely be considered protection forests. They are, despite their present poor quality, potential production forests. They have been seriously damaged by deer, with loss of productive capacity and notable and detrimental modification of the soil with respect to water infiltration and retention; but this has not led, and is unlikely to lead, to acute land erosion and consequent riverbed-aggradation troubles.

North-eastern Province. The mountains of the north-eastern province, though steep, are not as rugged or as high as those of the western or south-eastern provinces. For the greater part, they do not rise above the regional timber line, here at 4,500–5,000 ft. The rocks are chlorite schists of moderate erosion resistance or greywackes, these latter being somewhat older (Permian–Carboniferous) and harder than those to the south-east. A variety of volcanic and intrusive rocks, of considerable erosion resistance, outcrop along the western flanks of the mountain mass. There is little evidence of past glaciation, and the mountains carry no great burden of solifluction material or other rock waste. All told, the erosion risk, on geological grounds, must be considered greater than in the western province, though moderate in comparison with the south-eastern province.

South-eastern Province. The south-eastern province is a greywacke province. Other rocks, schists in the south-west, basalts and various sedimentaries in the Awatere and Clarence valleys, are of such restricted occurrence that they may, for present purposes, be entirely disregarded. The mountains are young and steep. Bedrock is intensely shattered and faulted. There are major accumulations of talus and solifluction material (though not to the extent normal in Canterbury), and geological erosion is severe. The potential for acceleration of erosion is uniformly high.
Climatic Factors

For the three mountain provinces, therefore, the degree of risk, on geological grounds, may be assessed as low, moderate, and high in the western, north-eastern, and south-eastern provinces respectively. Though no accurate data are available with respect to the climates of these mountains, general climatic outlines are sufficiently well known to permit assessment of the degree of risk on climatic grounds also. The order runs: high in the south-east, moderate in the west, and low in the north-east.

Western Province. Rainfall is high and well distributed through the year, total annual rainfall exceeding 200 in. on the far western mountains, decreasing toward the east. Winters are cool in the valleys to cold on up uplands, where heavy snow may lie for considerable periods. Frost action, however, is not intense in comparison with that experienced in the south-eastern province or in the Canterbury mountains, winter cloud cover and winter snow effectively reducing the number of transgressions across freezing point (i.e., temperature movements, upward or downward, through freezing point) experienced each year, and comparatively little bare ground being exposed to frost. Winds of gale force are experienced but are normally accompanied by rain, so that wind erosion is not a factor of consequence. The only climatic factor suggestive of high erosion risk is periodic high-intensity rain, but this is counterbalanced by the density and vigour of the vegetation under the humid to superhumid conditions prevailing. Increase in frost action and increase in water erosion, however, would necessarily follow any pronounced depletion of the vegetation.

North-eastern Province. The climate here, by New Zealand mountainland standards, must be considered mild and equable. The maritime influence is strong except in the extreme south-west corner of the province, where the climate approaches a continental type. Frost action is strong only in this south-west corner. There is greater risk of drought with consequent weakening of the vegetation than in the western province; and strong winds are more frequently dry winds, so that the risk of wind erosion is higher. Periodic rains of very high intensity are experienced. All told, however, in by far the greater part of the north-eastern province the erosion risk due to climate must be considered low.

South-eastern Province. The climate in the mountains of the south-eastern province is strongly continental in type. Winters are very cold with intense frost and a high number of transgressions across freezing point. Regional bedrock is notoriously susceptible to fragmentation by frost. Summer droughts occur frequently and the strongest winds are usually hot, dry, and gusty. Wind erosion is marked. High-intensity
rains, though possibly less frequent than in other provinces, are experienced periodically, and may come after prolonged drought when the vegetation is at its weakest. Predisposition to severe erosion, on climatic grounds, is acute.

**Animal Factors**

Red deer thrive best wherever, within short distances, there exists a good balance between forest, scrub land, and grassland. Lands of very high or very low rainfall are not as suitable as lands with moderate rainfall coupled with high sunshine hours. Goats favour the semi-arid lands, or the driest mountain slopes within areas of moderate rainfall. Rabbits and hares both prefer open short grasslands* such as are found where rainfall is low or droughts are frequent. Chamois prefer high mountains that rise above the limits of vegetation; they feed most extensively amongst the scree and rocks above the limits of closed plant cover. Pigs do not thrive in very wet forest. Possums, though favouring forest with low to moderate rainfall, are not known to build up to very high populations in beech forest in comparison with rata-kamahi forest even though the latter may be in an area of extremely high rainfall. It is instructive to examine the conditions obtaining in the three mountain provinces of Nelson Conservancy in the light of these requirements.

**Western Province.** In the extreme west and in the south-west, conditions do not favour rise in deer populations to very high numbers. The forest mass is disproportionately large in comparison with the extent of alpine grassland, much of the latter being of low carrying capacity. But there is rapid improvement in deer habitat from west to east. Conditions are favourable to deer to the east of the Maruia-Matakitaki watershed and along the eastern fall of the mountains from the Matiri River northwards. On the western fall of these mountains, the extensive areas of limestone country draining to the Mokihinui and Karamea Rivers also provide suitable habitat conditions.

There is little country in the west suitable for goats, though local factors compensating for high rainfall may encourage the establishment of local colonies—e.g., such colonies may be expected on dry broken limestone escarpments. More extensive occupation of the country by goats is likely only along the comparatively dry mountain slopes draining to the Motueka River. Much of the province is not good chamois country, the mountains not rising sufficiently above the limits of closed plant cover to provide the extensive broken rocky slopes with partial cover that chamois prefer; but again there is a marked west-to-east improvement in habitat. High possum populations are to

*Short grassland is (a) grassland composed of predominantly turf-forming species, or (b) strongly depleted tussock grassland.
be expected wherever rata-kamahi-dominant forest occurs, particularly where relatively dry ground conditions obtain. There is little ground favourable to rabbits, and much of the alpine grassland in the west is too heavy and wet for hares. Much western forest is too wet for pigs.

North-eastern Province. High deer populations are to be expected only towards the south-west, the only area where there exists a suitable balance between forest and grassland; and in this area, only, are suitable chamois habitats found. Conditions for pigs, goats, and possums are good, though possums are necessarily hampered in population growth by the absence, over wide areas, of rata-kamahi forest. Rabbits and hares are virtually tied to the grasslands in the south-west corner of the province.

South-eastern Province. Conditions are near optimum for deer and chamois on the Spenser and St. Arnaud Ranges, the dearth of forest cover farther to the east leading to a decrease in deer numbers and the habitat remaining excellent for chamois. Optimum conditions for goats, rabbits, and hares exist throughout the low-rainfall lands in the south-east, where also there is much suitable pig terrain. Possums, though widespread throughout, are checked in numbers by the absence of preferred forest types, minor areas of these occurring on the eastern slopes of the Seaward Kaikoura Range.

Factors of Vegetation Recovery

It will be obvious that conditions are generally most favourable, for most species of animals, in the south-eastern province and, secondarily, over those portions of the western and north-eastern provinces draining towards the central lowland. The very wet mountains of the far west and south-west, and the completely forested mountains of maritime-climate lands in the north-eastern province, though containing habitat enclaves suitable for local population build-up of one or other animal species, are less likely to support rapid population growth of many species over wide areas.

It will also be obvious that the lands favoured by the greatest number of species are the lands where the vegetation must be weakest under animal attack—in general, the lands of greatest drought risk, most prolonged frost risk, and shortest growing season. The forests subjected to the heaviest pressure from animals are those that are naturally open, with a limited range of secondary species capable of sustaining browsing and thus of shielding, in some degree, advance growth of the forest dominants, this advance growth being subject to high normal establishment hazards. The facts are clear and do not require amplification. The forests are hit hardest where recuperative power is least.
Land-use and Economic Factors

Consideration of land-use and other economic factors can be equally brief. Intensity of settlement is well indicated on the map by the density of the road network. The overriding importance of the Nelson and Blenheim lowlands, largely the flood-plain lands of the Motueka, Waimea, and Wairau Rivers, is obvious. Minor agricultural settlements occupy flood-subject lands on the Takaka, Aorere, Pelorus, and Karamea Rivers, and valley lands within the Buller River catchment. Picton and other eastern seaboard townships are largely sited well above the major rivers, though communications are liable to be disrupted by flood. The Kaikoura lowland is subject to flooding by several minor streams and rivers. The hydro-electric potential is greatest in the Buller River catchment but stations are currently in operation only on the Cobb and Waihopai Rivers. Westport, at the mouth of the Buller, is in a vulnerable position should control of the catchment be lost.
The main point to be emphasised is the great economic importance of the Motueka, Waimea, and Wairau Rivers and the potential importance of the Buller. Other rivers, particularly those draining to the west, are comparatively unimportant. Serious damage to the watersheds of the Motueka, Waimea, Wairau, or Buller Rivers would be of immediate regional or national significance. Damage to other watersheds would be of local and sometimes petty economic significance only.

Summary by River Catchments

The discussion to this point can best be summarised by considering each major river catchment in turn, grouping catchments with common characteristics. Boundaries for these are also shown on the map (Buller, Wairau, Pelorus, Awatere and Clarence, Motueka and Waimea, Takaka and Aorere, western rivers excluding the Buller, and Seaward Kaikoura streams).

**Buller River.** Most of the catchment lies within the western geological province. Erosion risk is low on geological grounds, moderate on climatic grounds. There are minor areas of high animal potential but the risk of rapid upsurge in animal numbers is generally low. The recuperative power of the forests is high. But for that portion of the catchment within the south-eastern geological province, the erosion risk on both geological and climatic grounds is high, habitat potential for deer and chamois is high, and the forests are of reduced recuperative power. The economic importance of the catchment is high (valley farms, communications, river-port, scenic and recreational values) and is likely to grow (hydro-electric potential).

**Western Rivers (excluding Buller).** The catchments of these rivers lie wholly within the western geological province. Erosion risk is low on geological grounds, moderate on climatic grounds. There are local areas of high animal potential but greater areas of very low potential. The recuperative power of the vegetation is very high. These river catchments are of minor economic importance.

**Takaka and Aorere Rivers.** The catchments of these two rivers lie wholly within the western geological province. Erosion risk is slight on geological grounds, moderate on climatic grounds. Animal potentials are moderate to low. The recuperative power of the forests is good. The catchments of the Takaka and Aorere Rivers are of modest economic importance. Valley and flood-plain lands are rich but small. One Takaka River tributary (the Cobb) is harnessed for power generation.

**Motueka and Waimea Rivers.** The catchments of western tributaries of the Motueka River lie within the western geological province. Erosion risk is slight on geological grounds, moderate on climatic
grounds. Animal potential is generally above that normal for the western province and the recuperative power of the forests is much reduced. The catchments of eastern tributaries of the Motueka and of all tributaries of the Waimea lie within the north-eastern geological province. The risk of erosion on geological grounds is moderate; on climatic grounds it is low; but on both geological and climatic grounds the degree of risk is greater than for the remainder of the north-eastern province, rising rapidly toward the south-west. Animal potential is moderate to high, the recuperative power of the forests being moderate to low, below normal for the province. Economic values are very high. The valley and flood-plain lands are as intensively cultivated as any in New Zealand.

**Pelorus River.** The catchment of the Pelorus River lies wholly within the north-eastern geological province. Erosion risk is moderate on geological grounds, low on climatic grounds. Animal potential is moderate to low and the recuperative power of the forests is strong. Economic values are modest. Valley lands are rich but of small extent. Communications are important (Nelson–Blenheim Main Highway and possible rail route).

**Wairau River.** The catchments of tributaries entering the Wairau from the north lie within the north-eastern geological province. Erosion risk is moderate; the risk on climatic grounds is slight. Animal potential is moderate (in the south-west) to low. The recuperative power of the forests is moderate to high. The catchments of tributaries entering the river from the south, on the other hand, lie within the south-eastern geological province. The erosion risk is high, particularly in the south-west, and the recuperative power of the forests is low. The economic importance of the Wairau River catchment does not need emphasising. The greater part of the population of Marlborough is concentrated on the valley and flood-plain lands of the lower Wairau Valley. Protection of these lands against flood is already difficult and costly. Economic development must increasingly be tied to development of irrigation farming.

**Awatere and Clarence Rivers.** The catchments of these two rivers lie wholly within the south-eastern geological province and the erosion risk is therefore very high on both geological and climatic grounds. The potential for growth of noxious-animal populations to destructive levels is very high for all animals except deer and possums. There is little true forest cover. The economic importance of the catchments is related to pastoral occupation and maintenance of stock-carrying capacities. There is little high-value land on the river flood plains but major floods disrupt road and rail communications.
Seaward Kaikoura Streams. The catchments of these streams lie wholly within the south-eastern geological province. Risk of erosion on geological grounds is very high but is below normal for the province on climatic grounds (maritime influence). Animal potentials are high for most species. Forest recuperative power is above normal for the province. Economic significance is moderate (Kaikoura agricultural lands, road and rail communications, and scenic values).

Conclusion

There is thus, as already stated, no real difficulty in determining a correct course of action. Until such time as sufficient men, backed by sufficient funds, are forthcoming to tackle the immense task of protection-forest management and noxious-animal control on all fronts at once, a rigorous system of priorities must be laid down—a system which will take cognisance of factors of economic importance, degree of erosion risk, potential for the growth of noxious-animal populations, and ability of the forests to withstand, and recover from, animal use. Indicated top priorities are the catchments of the Wairau, Waimea, and Motueka Rivers, and that portion of the Buller River catchment within the south-eastern geological province. The removal of one deer, chamois, goat, or other animal from the forests of these catchments will be more profitable than removal of a dozen animals from the catchments of far western rivers. The attack on goats should certainly be continued wherever these animals are found, particularly throughout the south-eastern province, and there is probable need for action against deer wherever they occur in high numbers in areas adjacent to priority catchments (e.g., upper catchments of the Karamea and Mokihinui Rivers), to provide against reinfestation of critical areas. But, otherwise, strict adherence to priorities is the only policy that will repay effort. Action other than noxious-animal control and fire prevention (provided that control of animals can be gained) will probably be necessary only in the south-eastern province and, to a limited extent, in the west and south-west of the north-eastern province. In these areas, reforestation of denuded lands on a major scale must ultimately prove essential.

NOTE: Although the Seaward Kaikouras district lies within the Canterbury Forest Conservancy it has been found convenient for the purposes of this study to consider it with the Nelson Conservancy.